The Development Research of Bicycle Systems Based on SWOT - AHP Model

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Abstract. At the end of 2016, public bicycle system were affected to different degrees in various places due to the sudden rise of bike-sharing. In order to explore the development of public bicycle under the impact of bike-sharing, this paper take Xi’an public bicycle system as the research object. Then, the SWOT-AHP model was used to analyse the strengths and weakness of the system; the external opportunities and threats qualitatively and quantitatively, in order to find out the strategic model that adapt to its development. The results show that the public bicycle system in Xi'an should adopt a growth strategy, take advantages of the internal strengths of the system and the external opportunities to reduce the impact of bike-sharing development.

1. Introduction
The city are facing problems such as traffic congestion and traffic pollution because of the acceleration of urbanization. Public bicycle service was appeared in order to solve urban traffic problems, improve the utilization of road resources, respond to low-carbon travel, and the problem of “last mile” travel [1]. Beijing became the first city where used the public bicycle service system in 2006 and there are already more than 300 cities established public bicycle system now. In 2014, the bike-sharing was born, but it was limited to use on the university campus originally, then, bike-sharing served the public community soon [2]. By 2018, bicycle brands seized the market of major cities with the strengths of riding easily and no fixed stops, such as mobike, ofo [3]. It is a hot research spot that the development of public bicycle under the mutual competition and promotion of bike-sharing. X F Wang said that the relationship of bike-sharing and public bicycle are not competitive, but promote each other [4]. Z P Xu taken the operation and management mode of the bike-sharing market and the public bicycle as the research object, combined the riding convenience of bike-sharing and the easy management of the public bicycle, obtained the optimal resource allocation of them[5]. H F Qi considered the characteristics of urban public bicycle and bike-sharing, established a dynamic evolutionary game model of government and travellers, calculated the equilibrium points of the model and evolutionary stability trend under different parameters [6]. Y N Chen discussed the internal financial structure of “Yong an Xing” public bicycle company from the perspective of financial management, discussed the development of the public bicycle model [7]. S H Ma used multi-objective planning methods to construct a game model from the three aspects of government utility maximization, corporate profit maximization and user satisfaction maximization [8].

2. Material and Methods

2.1 Model analysis
SWOT analysis, also called situational analysis, is a popular strategic analysis tool. It is a structured analysis of the strengths, weaknesses, opportunities and threats, within the industry to identify factors that are beneficial to their own development and weakness, to be suppressed and circumvented, which propose practical industrial development countermeasures. On the whole, SWOT can be divided into four strategic models: Strength-Opportunity (SO), Weakness-Opportunity (WO), Weakness-Threat (WT), Strength-Threat (ST). The framework of the SWOT analysis is shown in figure 1.

In order to analysis the development of public bicycle system in Xi'an , the research including evaluate the internal strengths and weakness of the system, external opportunities and threats, quantify the internal and external factors, and analyze the various environmental factors in the system.

2.1.1 Strength of public bicycle system development. Government provided financial subsidies and low fees(S1); The vehicles are parked orderly, in line with the needs of urban management(S2); The equipment and scale of public bicycle are complete gradually(S3); Equipped with special maintenance to dispatch vehicles(S4).

2.1.2 Weakness of public bicycle system development. User groups are limited because of swiping card (W1); Piled parking design was lack of flexibility (W2); Layout and scale of lease point limited the scope of users (W3).

2.1.3 Opportunities of public bicycle system development. Company should learn from the successful experience of bike-sharing and improve the rental system (O1); Plenty of travel needs and potential users (O2); Government support the development of low carbon environmental protection and intelligent transportation (O3); Development of information technology provide technical support (O4).

2.1.4 Threats of public bicycle system development. The contents including: The rapid rise of bike-sharing grab a large number of users (T1); Development of electric bike-sharing (T2); Urban land is tightly and the environment of riding is poor (T3); Influence of weather and climatic conditions (T4).

2.2 Model of SWOT-AHP

Combined with analysis of SWOT model, the public bicycle system development strategy was the target layer, and the strengths, weakness, opportunities and threats are used as the criterion layer to establish the public bicycle development strategy transfer hierarchy, then, constructed the SWOT-AHP model as shown in figure 2.
Development strategy of public bicycle system under the influence of shared bicycles in Xi’an

3. Results

Table 1 show the result of Xi’an public bicycle system development strategy structure construction factors and judgment matrix between various factors, through the matrix to find the priority of index layer of each factor which related to each target layer, then, tested consistency ratio of different judgment matrix.

| Strength | S1 | S2 | S3 | S4 | Weights (wi) | Consistency ratio |
|----------|----|----|----|----|--------------|------------------|
| S1       | 1  | 6  | 3  | 5  | 0.5882       |                  |
| S2       | 1/3| 1  | 1/2| 5/6| 0.0980       | λ max = 4.0005   |
| S3       | 1/5| 2  | 1  | 5/3| 0.1961       | CR = 0.0002      |
| S4       | 1/6| 1/2| 3/5| 1  | 0.1176       |                  |

Opportunities

| Opportunities | O1 | O2 | O3 | O4 |
|---------------|----|----|----|----|
| O1            | 1  | 3  | 7  | 6  | 0.6087 |
| O2            | 1/3| 1  | 7/3| 2  | 0.0229 |
| O3            | 1/7| 3/7| 1  | 6/7| 0.0870 |
| O4            | 1/6| 1/2| 7/6| 1  | 0.1014 |

Threats

| Threats      | T1 | T2 | T3 | T4 |
|--------------|----|----|----|----|
| T1           | 1  | 4  | 5  | 6  | 0.6042 |
| T2           | 1/4| 1  | 2  | 3  | 0.2008 |
| T3           | 1/5| 1/2| 1  | 2  | 0.1207 |
| T4           | 1/6| 1/3| 1/2| 1  | 0.0744 |

Weakness

| Weakness     | W1 | W2 | W3 |
|--------------|----|----|----|
| W1           | 1  | 2/3| 2  |
| W2           | 3/2| 1  | 3  | 0.3333 |
| W3           | 1/2| 1/3| 1  | 0.1667 |

For the assignment of factors to the weight of the target layer, a new judgment matrix was
constructed by selecting the index factor with the largest number of judgment matrix.

Table 2. Inter-group judgment matrix.

|   | S  | W  | O  | T  | w_i | Consistency ratio |
|---|----|----|----|----|-----|------------------|
| S | 1  | 2  | 1/3| 1/3| 0.1333 | |
| W | 1/2| 1  | 1/6| 1/6| 0.0667 | $\lambda_{max}=4.0042$ |
| O | 3  | 6  | 1  | 1  | 0.3999 | CR = 0.0016 |
| T | 3  | 6  | 1  | 1  | 0.4001 | |

Through the weights of various indicators in Table 2, the impact of specific indicators (strengths, weaknesses, opportunities and threats) on the development of public bicycle systems in Xi'an can be obtained. The weights and ranks of each specific indicator are shown in Table 3.

Table 3. Public bicycle development under grow of bike-sharing in Xi'an.

|   | S  | W  | O  | T  | w_i | rank |
|---|----|----|----|----|-----|------|
| S1| 0.5882| 0.0667| 0.3999| 0.4001| 0.0784| 5 |
| S2| 0.0980| 0.0222| 0.2435| 1 |
| S3| 0.1961| 0.0213| 0.0348| 8 |
| S4| 0.1176| 0.0111| 0.0406| 7 |
| W1| 0.3333| 0.2008| 0.2008| 0.2008| 0.2008| 2 |
| W2| 0.5000| 0.0803| 0.0803| 0.0803| 0.0803| 4 |
| W3| 0.1667| 0.0483| 0.0483| 0.0483| 0.0483| 6 |
| O1| 0.6087| 0.2435| 2 |
| O2| 0.0229| 0.2417| 3 |
| O3| 0.0870| 0.0348| 8 |
| O4| 0.1014| 0.0406| 7 |
| T1| 0.6042| 0.2417| 2 |
| T2| 0.2008| 0.0803| 4 |
| T3| 0.1207| 0.0483| 6 |
| T4| 0.0744| 0.0298| 10 |

The factors affected the development of public bicycle in SWOT model are different. According to the overall ranking results, there are five factors that have a higher impact on the development of public bicycle systems in Xi'an: Public bicycle company should learn from the successful experience of bike-sharing and improve the rental system; The rapid rise of bike-sharing grab a large number of users; Huge travel needs and potential users; Development of electric bike-sharing; Government provided financial subsidies and low fees.

The rise of bike-sharing is not only a challenge, but an opportunity for the development of public bicycle. In order to maximize the use of public bicycle resources and maintain market competitiveness, company should grasp its' development accurately. The public bicycle development strategy is the result of combination of strengths, weaknesses, opportunities and threats. Therefore, the four variables of them were used as the semi-axis, and the points ‘S’, ‘W’, ‘O’, ‘T’ on the coordinate axes, which represent overall strengths, weakness, opportunities and threat levels, the strategic quadrilateral is an important basis for the development of public bicycles and the results can be determined by the center of gravity of the quadrilateral. The areal coordinates are calculated as follows:

$$P(X, Y) = \left(\frac{\sum_{i=1}^{4} x_i}{4}, \frac{\sum_{i=1}^{4} y_i}{4}\right)$$

(1)

The result shown in Figure 3, it can be determined by the center of gravity of the quadrilateral, in which the center of gravity is located determines the type of strategy.
4. Conclusions

It can be seen from Figure 3 that gravity point ‘P’ is located in the first quadrant. Therefore, the development of the public bicycle system in Xi’an should adopt the Strength-Opportunity strategy, that is, to take advantage of the internal strength of the enterprise and take advantage of external opportunities. The expectation is to use internal strengths to capture and exploit the opportunities which offered by changes in the external environment. The specific practices are as follows:

- Given full use of public bicycle advantages.
  1. Company should continue the free charge strategy in previous an hour, and launch free in holiday;
  2. Company should work with management department to maintain park and use in order, supervise and report the behaviour of violations;
  3. Company should choice site selection and site size measurement reasonably;
  4. Company should strengthen the inspection and maintenance of public bicycles to ensure the vehicle's integrity and comfort.

- Public bicycle companies should seize the opportunity.
  1. Public bicycle companies can learn from their strengths and innovate rental systems, such as launching pile-free vehicles, supporting mobile phone code scanning and positioning vehicles, assembling smart locks, and monitor travel data dynamically;
  2. Public bicycle companies need to get the favour of users by improving service levels, satisfying users’ travel needs and explore potential customers;
  3. Due to the development of information technology, all ideas have the possibility to realize, which provides unlimited possibilities for the development of public bicycles. Public bicycle companies should seize the opportunity to seek ideas and technological innovations, such as the development of mobile client APP, the discovery and collection of data, the innovation of dispatch systems and vehicle design.

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References

[1] Tan, N. (2013) Research on the Supply Mode of Urban Public Bicycle Service. Guangxi University.
[2] Rao, C.L., Huang, S.F. (2018) Study on the Supply Mode of Urban Public Bicycle Service——Taking Wuhan Public Bicycle Project as an Example. Journal of China University of Mining & Technology (Social Science Edition), 20(05):24-33.

[3] Zhang, H.B., Wang, Y.R. (2018) Research on the Complementarity of Bike-sharing and Public Bicycles——Taking Nanjing as an Example. Chinese business theory, (11): 165-167.

[4] Yu, Q.L., Wang, Y.R. (2017) How do public bicycle and bike-sharing develop together? https://www.kzwr.com/article/380957.

[5] Xu, Z.P., Zhu, Y.T. (2018) Research on the Complementarity of Bike-sharing and Public Bicycles. Chinese business theory, (11): 28-30.

[6] Qi, H.F., Hu, D.W. (2018) Game Analysis of the Choice of Slow Traffic Mode in Urban Sharing under Bike-sharing. Traffic Engineering, 18(03):12-17.

[7] Chen, Y.N., Ge, J.J. (2018) Analysis on the Development of Piled Public Bicycle Mode under the Impact of Shared Bicycle Mode——Taking “Yong an Xing” Public Bicycle System as an Example, (02): 3-4.

[8] Ma, S.H., Yang, Y., Wang, Y.Q. (2018) Research on the development of public bicycles under the influence of shared bicycles. Transportation System Engineering and Information, 18(01):231-236+244.