Research on QFD-based Bicycle-sharing Function Optimization from the Perspective of Public Management

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Abstract—**The popularity of shared bicycles greatly facilitates people's travel, and at the same time, the concept of environmental protection is deeply rooted in people's hearts. If the bicycle sharing industry wants to maintain a long-term development in the market, manufacturers should design products that meet the needs of consumers, and quality function deployment (QFD) is an effective tool for product function design. Based on the premise of satisfying the needs of consumers, the QFD method is used to establish a quality house of customer demand and product characteristics, thereby determining the design scheme of shared bicycle function optimization. The research results show that consumers pay more attention to the bicycle sharing functions such as convenience, safety and comfort. In order to better meet the needs of consumers, the paper finally proposes countermeasures to optimize those functions.**

Keywords—Bicycle sharing; Consumer demand; QFD

I. INTRODUCTION

Sharing bicycles is a model innovation of the urban slow-moving system, and is actually an implementation of "Internet + Transportation" [1]. The shared bicycle is flexible and convenient to use. It can provide solutions for citizens to travel short distances and public transportation system connections, and also plays an active role in guiding citizens to develop green travel and low-carbon and environmentally friendly travel habits. At present, the number of shared bicycles in each city has increased steadily. At the same time, the participation of consumers is very high. However, the shared bicycle industry wants to be based on the market for a long time and needs to cater to the numerous needs of the shared bicycle users.

Quality Function Deployment (QFD) is a planning process for market-oriented product design and development. The basic idea is that all activities in the product development process are driven by customer needs, preferences and expectations[2]. This paper aims to optimize the function of sharing bicycles. It is proposed to use QFD method to analyze the consumer's demand for shared bicycle functions, and propose countermeasures for optimizing the shared bicycle function for the needs of shared bicycle users, fully satisfying the needs of customers. Product design and development are reflected.

II. THE ACQUISITION OF CONSUMER DEMAND

Access to consumer demand is one of the most critical steps in the application of Quality Function Deployment (QFD)[3]. This article uses a questionnaire survey method. The survey targets users who share bicycles, including students at school and those who have already joined the work. A total of 100 questionnaires were designed according to the consumer's functional requirements for shared bicycles, including some basic information of the respondents: gender, occupation, age, etc., as well as the shape, quality, operation, and deposit of shared bicycles. Satisfaction and importance of projects such as fees, usage safety, etc. In this paper, a total of two shared bicycles, the ofo and the Mobike, were investigated. The basic information obtained from the questionnaire is as follows:

A. Basic information of the survey object

A total of 100 questionnaires were distributed, of which 94 were valid questionnaires and the questionnaire recovery rate was 94%. The effective questionnaires were collated and analyzed to obtain some basic information about the respondents (as shown in Table 1). In terms of gender, there are 45 female users sharing bicycles and 49 male users. In terms of occupation, there are 62 students and 32 people working in the workplace; all age groups of 12 to 40 years old are covered; The objects are all users of shared bicycles. These people are familiar with the various functions of shared bicycles, and the survey population is wide-ranging, so the survey objects have certain representativeness.

TABLE I   BASIC INFORMATION OF THE RESPONDENTS

Project	Total 94 people	Frequency	Effective percentage	Cumulative percentage
Gender	Female	45	47.9	47.9
	Male	49	52.1	100.0
Career	student	62	65.9	65.9
	Work man	32	34.1	100
Age	12~20	23	24.5	24.5
	21~25	47	50.0	74.5
	26~30	18	19.1	93.6
	30~40	6	6.4	100

B. Analysis of the needs of the respondents

Through the survey, we obtained some consumer demand for shared bicycle functions, and the basic information obtained was used to explore the relationship between the requirements through the affinity graph method, that is, the KJ method classifies these requirements. As shown in Table 2 below:

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TABLE II   SURVEY OBJECT DEMAND EXPANSION

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One layer of demand	Second floor demand	Three-tier demand
Cycling quality	Exterior	Moderate size
		Good quality
	Convenience	Easy to operate
		Timely repair
	Work efficiency	Quick search
		Fast riding speed
	Safe and reliable	Comfortable
		Safe use
	price	Low deposit
		Reasonable charge

C. Questions raised by the respondents

Through questionnaires and interviews, it is learned that although the current sharing of bicycles greatly facilitates people's travel, relevant users have raised many questions about the current status of shared bicycles.

(1)Some users lack the awareness of social morality. They only have their own convenience. It is necessary to scrape the bicycle QR code and brand and add the lock.

(2)Shared bicycles can be used by scanning codes. It is often seen that children under the age of 12 ride a shared bicycle on the road to chase chaos, there are many security risks.

(3)The rapid development of the shared bicycle market is not conducive to supervision, and the deposit refund of consumers has potential safety hazards.

(4)Sharing bicycles to over-concentrate hotspots, coupled with too few bicycle parking spots, led to the frequent occurrence of shared bicycles.

III. THE APPLICATION OF QFD IN THE DESIGN OF SHARED BICYCLE FUNCTION

A. Evaluation of importance

The market questionnaire is a way to obtain information directly from customers. The purpose of this paper is to share bicycle users. The purpose of the survey is to understand what practical functions consumers value most about sharing bicycles. The survey items include the appearance, convenience, reliability, work efficiency, price, etc. of the shared bicycle. The questionnaire score is designed to be 1-5 points (very unimportant-important), allowing the respondents to have the functional requirements of the shared bicycle. The importance was scored. Finally, 94 valid questionnaires were collected for statistical analysis, and the average value was obtained. Finally, the importance of the respondents' needs for sharing the functions of shared bicycles was obtained. The results of the survey are shown in Table 3: The shared bicycle users scored the highest scores for quick search and safety functions, which are 4.2 points. Secondly, the bicycles are required to have good quality and high comfort, with scores of

4.1 and 3.8 respectively. Consumers are not particularly concerned about the level of the car deposit and the speed of the ride.

B. Quality planning

Quality planning includes several steps in market competitive evaluation, quality planning, and weight calculation.

1) Market competitiveness assessment

It is an evaluation of the product and competitor products in response to customer needs in response to consumer demand, and conducts market competitive evaluation for each quality demand item to judge the market's competitiveness. The market competitiveness assessment mainly includes the following two contents:

(1)This product evaluation, that is, the consumer's satisfaction with the current function of the Mobike bicycle.

(2)Competitor product evaluation, that is, consumer satisfaction with the function of the small yellow car.

Competitive assessment data is obtained through market surveys, which reflect the strengths and weaknesses of current shared bicycles and where improvements are needed. The satisfaction of the customer's demand for a certain function of the shared bicycle is indicated by 1-5, where 1 indicates very dissatisfied and 5 indicates very satisfactory.

The results are shown in Table 3: Consumers have the strongest satisfaction with the size, quality and operation of the Mobike bicycles, and the scores are all 3.8 points; consumers also think that the Mobike bicycles are more convenient to find and safe to use; However, the status of the Mobike bicycle deposit was very unsatisfactory, and the score reached a minimum of 2.0 points. As for the functional satisfaction of the small yellow car, consumers think that the small yellow car is moderate in size and convenient to operate, the score is 3.7 points; but the consumer is not satisfied with its convenient and timely maintenance function, and the lowest Points are 2.9 points.

2) Plan quality

Set program quality and product feature points (marketing priorities) based on the importance of consumer demand.

(1) For quality requirements with high importance but low level of status and high level of competitors, at least the planned quality target value should be set to the same level as competitors. Such projects cannot be used as product characteristics.

(2) For quality requirements with high importance and high level of achievement but low level of competitors, the status quo can be maintained and used directly as a product feature point for marketing.

(3) For quality requirements with high importance but low levels of current products and competitors, the quality of the plan is set higher than the competitors, and the project can become a product feature point.

Therefore, the quality and convenience of the motorcycle can be regarded as the characteristic point of its products; and the deposit of the small yellow car is cheap and the size is suitable as the marketing focus of the product.

After setting the product characteristic point, you can calculate the level improvement rate, use the product level as the denominator, and plan the quality as the numerator, which indicates the degree to which the current status of the product needs to be improved in the quality planning. Use ◎ for 1.5, ○ for 1.2, and blank for 1 to quantify the product characteristic points. When it is 1.5, it means that the improvement of the product has a significant impact on sales; when it is 1.2, it means that the product improvement has a medium impact on sales; when it is 1, it has no effect.

$$\text{Level increase rate } R_i = \frac{\text{Plan quality}}{\text{Product level}}$$

Substituting the data into the formula (1) gives the level of improvement of the functions of the shared bicycles (as shown in Table 3).

3) Weight

It includes absolute importance of quality and relative weight of quality. The absolute importance (W_{ai})is calculated by the customer demand importance(K_i), the level improvement rate (R_i)and the product characteristic dot product(S_i)

$$w_{ai} = K_i \times R_i \times S_i$$

The absolute weight is converted into a percentage and is the relative weight(W_i)

$$W_i = (w_{ai} / \sum W_{ai}) \times 100\%$$

Through the questionnaire survey and the related data for analysis and calculation, the shared bicycle function planning quality house is obtained (as shown in Table 3).

TABLE III   THE QUALITY HOUSE FOR BICYCLE SHARING FUNCTION QUALITY PLANNING

Demand deployment				Quality planning						
Customer demand			Importance	Competitiveness assessment		Planning objectives			weight	
The 2 demand	The 3 demand			Mobike	Ofo	Planning quality	Level Increase Rate	Characteristics	Absolute	Relative
The 1 demand		Moderate size	3.5	3.8	3.7	3.8	1.0		3.5	6.9
	Exterior	Quality	4.1	3.8	3.3	4.4	1.16	○	5.7	11.27
	Work efficiency	Easy to operate	3.9	3.8	3.7	4.1	1.08		4.2	8.3
		Timely repair	3.8	3.3	2.9	4.0	1.21	◎	6.9	13.64
	Work efficiency	Quick search	4.2	3.7	2.9	4.4	1.19	◎	7.5	14.83
		riding speed	3.3	3.3	3.3	3.3	1.0		3.3	6.52
	Safe and reliable price	Comfortable	3.8	3.4	3.4	3.9	1.15		4.4	8.7
		Safe use	4.2	3.6	3.4	4.2	1.17		4.9	9.69
		Low deposit	3.3	2.0	3.0	3.3	1.65		5.45	10.77
		Reasonable charge	3.7	2.9	3.0	3.7	1.28		4.74	9.37
									50.59	100

Based on the consumer's judgment on the importance of shared bicycle function requirements, we can derive from Table 3:

(1)Consumers pay special attention to the safety performance of shared bicycles. Manufacturers should put the quality of bicycles first, and effectively protect consumers' personal safety. Secondly, the user wants to share the bicycle for easy searching, and the quality of the bicycle should be reliable.

(2)The quality, maintenance and timeliness of the Mobike bicycle is better than that of the small yellow car. It can be used as a product characteristic point of the Mobike bicycle.

(3) The Mobike deposit is obviously higher than the small yellow car deposit. In order to better meet the needs of consumers, it is hoped that the manufacturer can slightly reduce the Mora bicycle deposit.

C. Importance conversion

The quality of the demand for consumers is converted into the importance of technical demand by using the correspondence of quality houses[4]. The methods of importance transformation generally have independent collocation method and proportional distribution method.

This paper uses the independent point method. It is a method of directly multiplying the importance of the quality demand of the consumer by the values of ◎, ○, △ in the correlation matrix, and then adding them vertically. ◎, ○, the value of the △ symbol is 3:2:1.

The algorithm of the independent collocation method is as follows: K_i is the importance of the first quality requirement, R_{ij} is the value corresponding to the relationship symbol between the first customer demand and the first technical demand (3, 2, 1), C_j is important for the first technical demand. Degree.

$$C_j = \sum_{i=1}^{n} K_i \times R_{ij}, \, j = 1,2,3 \dots m$$

The results of the transformation of the importance of the shared bicycle quality requirement by the independent collocation method are shown in Table 4 below.

TABLE IV   QUALITY HOUSE MATRIX FOR BICYCLE SHARING FUNCTION PLANNING

Quality demand / Quality characteristics			Shape size	Economic	reliability	Feature	Timeliness	safety	Durability	Weights
Cycling quality	Exterior	Moderate size	◎			△		○		6.9
		Quality			○			○	◎	11.27
	Convenience	Easy to operate	○			◎		△		8.3
		Timely repair		△	◎			○	△	△	13.64
	Work efficiency	Quick search				○	◎			14.83
		riding speed			○	◎	○	△		6.52
	Safe and reliable	Comfortable	○			◎				8.7
		Safe use			○	△		◎	△	9.69
	price	Low deposit		◎		△				10.77
		Reasonable charge		◎	△					9.37
Importance			54.7	74.1	105.3	127.6	84.8	93.9	57.2	
Competitive Evaluation	Mobike		3.35	3.26	3.69	3.60	3.64	3.77	3.63	
	Ofo		3.44	3.60	3.40	3.49	3.28	3.37	2.93	
Design quality			3.7	3.8	4.0	4.2	3.8	4.2	3.7	

Through the Table 4 Quality House (HOQ) matrix, we can analyze that among the many features of shared bicycles, "functionality" has the highest weight of 127.6; secondly, the "reliability" and "safety" of shared bicycles, respectively. For 105.3 and 93.9; customers have the least attention to the shape and durability of shared bicycles, only 54.7 and 57.2. Therefore, the production enterprises should focus on the functions, reliability and safety of the bicycle in the design process of the shared bicycle scheme, and should also be treated reasonably in terms of the shape and quality of the bicycle.

IV. THE SHARED BICYCLE FUNCTION OPTIMIZATION DESIGN

A. Improve the safety of bicycle sharing use

Manufacturers should put the safety of shared bicycles in the first place. The technical performance of shared bicycles should conform to the current national standards and industry standards, ensure the reliable quality of vehicles, and at the same time protect consumers' personal safety, financial security and personal information security. Consumer traffic is more comfortable and convenient.

B. Enrich the function of bicycle sharing

Optimize the functions of the shared bicycle, for example, the height of the seat cushion can be automatically adjusted, and the speed can be reasonably adjusted according to the consumer's demand during the riding process, so that the consumer can operate more conveniently and feel comfortable during use. And increase the market share of shared bicycles, so that customers can find them when they need them.

C. Guarantee the reliability of bicycle sharing use

The company is responsible for the dispatching, cleaning, maintenance, recycling, etc., timely recycling of used vehicles, timely repair of damaged vehicles, to avoid bringing greater security problems. Bicycles can be made of lightweight materials with good materials. They are flexible and safe to use. The seats are designed to be adjustable for use by users of different ages and heights to ensure the comfort of cycling.

V. CONCLUSION

In this paper, the research on the optimization of shared bicycle function, the quality house model is constructed by QFD method, the demand of consumers is transformed into quantifiable factor indicators, and it is reflected in the shared bicycle optimization program. The research results show that the safety of the shared bicycle should be put in the first place. Secondly, consumers pay more attention to functional problems such as easy operation and comfortable riding. Therefore, producers should increase the sharing of bicycle functional construction and enable consumers to use it. It is more convenient and comfortable. At the same time, it increases the use of the bicycle market, and should set up bicycle parking spots in many places, which not only facilitates customers to find, but also regulates the parking of bicycles. On this basis, the needs of consumers are maximized.

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