Academic Journal of Science and Technology
ISSN: 2771-3032 | Vol. 5, No. 3, 2023

Research on Improvement of The Design of DP Lamp Based on KANO-QFD

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Abstract: The number of contemporary college students is not only huge, but also showing a rapid growth trend. Then the research on the desk lamp used in the daily life of College Students' dormitory can effectively provide the basis for the good university life of students. With the development of the economy, the improvement of the quality of life, and the arrangement of the work and rest time of the contemporary college students affect the experience of the college students' user groups on the dormitory lamp. Based on the principles of KANO and QFD, combined with the characteristics of university students' dormitory lamp, In the process of completing the project,we use KANO principle firstly and then combine QFD principle.In the KANO stage, we need to calculate the comprehensive score of the importance of College Students' needs. In the QFD stage, the importance of design requirements is calculated, and the key design requirements are output at last, so as to carry out the lamp design planning, effectively transfer the diverse needs of college students, maximize the user satisfaction of college students, and provide effective method guidance for lamp designers.

Keywords: KANO Model, Quality Function Deployment (QFD), Lamp Design.

1. Introduction

Table lamp is a necessity for people's life. In the dormitory of college students, it is usually placed on the desk or bed table for lighting[1].It can be seen from the design of the table lamp that the light exposure range of the table lamp is relatively small, which also makes the use of the table lamp in collective life not inconvenient to others, and provides great convenience for college students' campus accommodation and provides students with learning and entertainment. Especially on university campuses, due to the schedule of work and rest, almost everyone has a desk lamp[2].With the widespread use of desk lamps, college students' demand for well-designed desk lamps has become more and more intense. On the contrary, many desk lamp designs are either single in function or inconvenient in use, which do not meet the real needs of college students. They do not pay attention to some of the service functions that people want, that is, they do not grasp the needs of users, The desk lamp used in the dormitory for college students does not fully reflect the needs of college students, and more improvement and investigation are needed in the design. From the perspective of the current situation of the development of "Jiuliang" college students' dormitory lamp,Many details do not well reflect the needs of college students. We apply KANO-QFD to the research on the design of table lamps for "long-term" college students' dormitories. We can start from user needs, investigate data, analyze, sort and classify them, and finally find out what needs to be improved, so as to improve the ability of table lamp design to control the overall situation, and use the method of combining KANO-QFD, We can find the design improvement requirements that can quickly improve customer satisfaction, so as to improve customer satisfaction and bring convenience to college students' life.

2. Theoretical Background

2.1. The KANO model

The KANO model was proposed by the Japanese quality management master Noriaki KANO in 1984. It can better show us the relationship between product quality and user satisfaction[3-4]. According to the correlation, the KANO model can obtain five elements: charm, basic, no difference, reverse, and expectation[5].

(1) Requirement type of KANO model:

Must-be quality is generally not attractive, but in the subjective impression of customers, it is the product itself [6]; One -Dimensional Quality represents that the better the satisfaction of customers, the higher the satisfaction of demand. Attractive Quality refers to the demand that is very attractive to users[7]. The existence of Independent Quality has no great impact on users. In the KANO model, Reverse Quality represents the demand that customers least want to see [8]. Its implementation will not improve satisfaction but reduce user satisfaction[9].

(2) Model analysis method:

The KANO model analysis method is a special questionnaire and analysis method. Its application is convenient to divide the quality elements of products into five basic needs, that is, to use the Likert scale for testing [10]. The questions in the KANO questionnaire are composed of positive and negative questions, which is convenient to measure the customer's attitude towards a certain problem [11]. O represents the expectation type, M represents the basic type, A represents the charm type, and R represents the reverse type, I represents no difference, and Q represents untrusted results[12].

2.2. Quality Function Deployment

Quality Function Deployment is called QFD for short. Its core feature is to listen attentively and understand customers' requirements [13]. It is a new product development research

method based on customers' premise. Quality function deployment (QFD) reflects a quality management tool based on the development prospect of the product and the customer's demand as the only basis for product research and development and improvement[14]. In product design and improvement, the application of QFD plays an important role. It is the first step for product research and development and improvement[15].

3. Research Methods

In the "Jiuliang" dormitory table lamp design research, we conducted a brief questionnaire survey on user needs, and then processed and classified the collected demand information, mainly using the affinity map method to divide the demand into levels. Determine the research theme when conducting demand research. In the design of the questionnaire, the questions should be as simple and accurate as possible, which is conducive to the patient filling of the respondents and ensures the reliability of the data. For the answers to open-ended questions, the KJ method can be used to sort out the demand information of the preliminary survey. The KJ method is the affinity graph method. This method is most commonly used in the classification analysis of user demand survey, which can help people sort out the relevant information classification from the complex information, and then get the final demand type.

4. "Jiuliang" Table Lamp Design Improvement Research

In the survey of the characteristics of university students' table lamp user group, the target group is mainly residential college students. Through the survey, the characteristics of the user group are analyzed and summarized. A total of 110 college students from freshmen to seniors were surveyed. According to their preferences, targeted data were collected, including age, gender, grade, time of lamp use, frequency of lamp use and other data. The letters L and numbers indicate the names of college students, and L1-L110 refers to the first to the 110th college students. After a preliminary understanding of the use of table lamps by college students, a demand survey was conducted. After the survey, a total of 28 preliminary information about the use needs of college students was obtained, as shown in Table 1:

Table 1. Preliminary collected user requirements

Number	Demand content	Demand serial number	Demand content
1	Durable	15	kinds of lights
2	Slow power consumption	16	Wear-resistant, easy to clean
3	Fast charging	17	Power display
4	Easy to use	18	Small fan function
5	Penholder function	19	Play music
6	Timing	20	Can be used as a mirror
7	Can be used as a mobile phone support	21	Voice control function
8	Easy to carry	22	Style variable
9	Rotable lighting	23	UV function
10	Adjustable lighting area	24	Automatic brightness adjustment
11	Eye protection	25	Flexible use of function keys
12	Post-it note function to remind to-do items	26	Can be used as a charging bank
13	Mosquito repellent	27	Humidifier function
14	Brightness adjustment	28	Additional lamp cover

The preliminary collected needs of college students are not specific enough, and need to be sorted out by using the affinity map method. According to the actual needs, the needs are divided into several levels to help understand the various levels of user needs. C represents the sorted user needs. After sorting out, a total of 24 users' needs for long-term table lamps are shown in Table 2:

4.1. Calculation of the comprehensive score of the importance of college students' needs

(1) Self-rating calculation of college students' importance

The value of the college student's need importance self-rating is the number 1-5, with the mean of the self-rating of the demand as the final self-rating value for the requirement. A questionnaire survey was conducted on the self-rating of the importance of needs, and the results are shown in Table 3:

(2) Calculate the KANO classification of college student needs

The KANO classification of college students' needs is shown in Table 4.

Table 2. Collated user requirements

Number	Tier1user requirements	serial number	Secondary user requirements
C1	Appearance requirements	**C11**	The style is variable
		C12	Simple
		C13	Abrasion resistant and easy to clean
C2	Brightness requirements	**C21**	Adjustable brightness
		C22	lights Includes
		C23	UV function
		C24	adjusted automatically
C3	Convenience needs	**C31**	Easy to carry
		C32	Rotatable illumination
		C33	Adjustable lighting area
		C34	an additional lampshade
		C35	Voice-activated
C4	Quality requirements	**C41**	durable
		C42	Slow power consumption
		C43	Fast charging
		C44	Eye protection
C5	Additional functional requirements	**C51**	Has a pen holder function
		C52	Can be timed
		C53	Can be used as a phone holder
		C54	a post-it note function
		C55	Battery level display
		C56	Repellent mosquitoes
		C57	Play music
		C58	a mirror

Table 3. List of user demand self-rating values

Ordinal	Hi	Ordinal	Hi	Ordinal	Hi
C11	3.51	**C32**	3.20	**C51**	3.66
C12	3.81	**C33**	3.56	**C52**	3.85
C13	3.95	**C34**	3.55	**C53**	3.68
C21	3.82	**C35**	2.75	**C54**	3.65
C22	3.29	**C41**	4.05	**C55**	4.05
C23	3.59	**C42**	3.99	**C56**	3.68
C24	3.58	**C43**	4.03	**C57**	3.57
C31	3.63	**C44**	4.08	**C58**	3.61

Table 4. List of user requirements KANO classification

Ordinal	A	O	M	I	R	KANO
C11	26	9	3	22	0	A
C12	7	7	26	20	0	M
C13	6	6	25	23	0	M
C21	7	13	23	17	0	M
C22	4	9	5	41	1	I
C23	26	8	5	21	0	A
C24	4	6	2	43	5	I
C31	3	28	9	20	0	O
C32	4	10	2	37	7	I
C33	32	6	1	21	0	A
C34	5	28	3	23	1	O
C35	5	5	3	39	8	I
C41	12	14	2	23	0	I
C42	13	25	5	17	0	O
C43	10	28	3	19	0	O
C44	12	11	22	15	0	M
C51	27	9	2	22	0	A
C52	24	11	2	23	6	A
C53	3	25	4	27	1	I
C54	22	12	4	21	1	A
C55	5	27	2	26	0	O
C56	4	7	3	45	1	I
C57	28	6	2	23	1	A
C58	3	3	2	45	7	I

(3) Calculate college student user satisfaction and adjustment factor

The present value of user satisfaction indicates the satisfaction of college students with the current demand for desk lamps in college dormitories, and the target satisfaction values are 1, 2, 3, 4, 5, 1 is the least important, and 5 is the most important. The user satisfaction index includes two aspects, one is the user satisfaction improvement index (SII), on the other hand, the user dissatisfaction reduction index (DDI), Ti is the absolute value of SII and DDI. However, the needs of college students with different KANO classifications may have the same value, and the k value is 0, 0.5, 1, 1.5 according to the KANO classification of the requirements, corresponding to irrelevant needs, basic needs, expected needs, and attractive needs, and the SII, DDI, Ti, and k values of college student user needs are shown in Table 5.

Table 5. Demand Satisfaction Index Value and K Value Table

Ordinal	SII	DDI	Ti	k
C11	0.58	0.20	0.58	1.5
C12	0.23	0.55	0.55	0.5
C13	0.20	0.52	0.52	0.5
C21	0.33	0.60	0.60	0.5
C22	0.22	0.24	0.24	0
C23	0.57	0.22	0.57	1.5
C24	0.18	0.15	0.18	0
C31	0.52	0.62	0.62	1
C32	0.26	0.23	0.26	1
C33	0.63	0.12	0.63	1.5
C34	0.56	0.53	0.56	1
C35	0.19	0.15	0.19	0
C41	0.51	0.31	0.51	0
C42	0.63	0.50	0.63	1
C43	0.63	0.52	0.63	1
C44	0.38	0.55	0.55	0.5
C51	0.60	0.18	0.60	1.5
C52	0.58	0.22	0.59	1.5
C53	0.47	0.49	0.49	0
C54	0.58	0.27	0.58	1.5
C55	0.53	0.48	0.53	1
C56	0.19	0.17	0.19	0
C57	0.58	0.14	0.58	1.5
C58	0.11	0.09	0.11	0

(4) Calculation of the improvement rate of college students' demand satisfaction goals

The goal improvement rate of college student demand satisfaction reflects the urgency of college students to fully realize a certain need, and the target improvement rate will directly participate in the comprehensive score of demand importance. The present value, target value, and satisfaction goal improvement rate of college student users after the questionnaire survey are shown in Table 6. By comparing the target improvement rate values between requirements, it is possible to see how eager users are to improve each demand. Among them,C11, C23, C33, C51, C52, C54, C57 are charismatic needs; C12, C13, C21, C44 are basic requirements; C22, C24, C32, C35, C41, C53, C56, C58 are irrelevant requirements; C31, C34, C42, C43, C55 are desirable requirements.

Table 6. User demand satisfaction value and target improvement rate value

NO.	S0	S1	Vi	NO.	S0	S1	Vi
C11	2.05	3.52	1.72	**C41**	2.41	4.39	1.82
C12	2.36	4.26	1.81	**C42**	1.55	3.22	2.08
C13	2.65	4.25	1.60	**C43**	3.25	4.12	1.27
C21	3.12	3.66	1.17	**C44**	3.69	3.94	1.07
C22	3.33	3.86	1.16	**C51**	3.54	4.65	1.31
C23	3.25	4.25	1.31	**C52**	3.23	3.96	1.23
C24	2.39	3.65	1.53	**C53**	2.16	3.68	1.70
C31	3.63	4.98	1.37	**C54**	2.59	3.78	1.46
C32	3.22	4.65	1.44	**C55**	2.45	3.99	1.63
C33	1.34	3.56	2.66	**C56**	3.58	4.56	1.27
C34	2.65	4.55	1.72	**C57**	3.54	4.96	1.40
C35	3.54	4.32	1.22	**C58**	3.26	4.52	1.39

(5) Calculate the comprehensive score of the importance of college students' needs

The comprehensive score of the importance of college student user needs after calculation is shown in Table 7, with a total of 24 user requirements, each corresponding to its own importance comprehensive score, in the QFD stage, the user requirements and comprehensive importance values in the table will be entered into the quality house to calculate the key design requirements.

Table 7. User Demand Satisfaction Score

Ordinal	Overall rating	Ordinal	Overall rating
C11	11.97	**C24**	5.47
C12	8.56	**C31**	8.07
C13	7.81	**C32**	5.82
C21	5.67	**C33**	19.68
C22	3.81	**C34**	9.51
C23	9.24	**C35**	3.36
C41	7.38	**C53**	6.27
C42	13.51	**C54**	10.58
C43	8.33	**C55**	10.09
C44	5.42	**C56**	4.69
C51	9.73	**C57**	9.93
C52	9.46	**C58**	5.01

4.2. Calculation of the importance of quality house construction and design requirements

According to the needs of college students, summarize the corres ponding design improvement requirements of long-term table lamps, so as to analyze the importance of each design requirement in the later QFD stage. After sorting, the product design improvement requirements are shown in Table 8:

Table 8. Table lamp design requirements

Ordinal	Level 1 design improvement requirements	Ordinal	Secondary design improvement requirements
D1	Exterior design	**D11**	Detachable design
		D12	Simple structure
		D13	Designed with protective layer
D2	Brightness design	**D21**	Gear design
		D22	UV light design
		D23	Light-sensitive design
D3	Convenient design	**D31**	Foldable storage design
		D32	Connected with a 360-degree rotation design
		D33	Lamp source segmentation control design
D4	Quality assurance	**D41**	The materials are well made
		D42	Large power storage capacity
		D43	a fast charging function
D5	Additional feature design	**D51**	Pen holder design
		D52	an electronic watch display
		D53	Phone holder design
		D54	Post-it note design
		D55	Battery power display
		D56	Small sound design

(1) Determine the design requirements and design requirements objectives

Combined with the QFD principle and user requirements, the design requirements corresponding to the design requirements are determined as shown in Table 9:

Table 9. Table lamp design requirements target

Ordinal	Level 1 improvement requires objectives	Ordinal	Level 2 improvement requirement objectives
DT1	On the basis of the original function, it gives users a comfortable, fresh feeling	**DT11**	It has two lighting methods to increase the freshness and convenience of use
		DT12	The table lamp has a simple structure
		DT13	The lamp housing has a cushioning protective layer
DT2	When users are in use, they can more comprehensively meet the various lighting needs of users	**DT21**	There are a variety of brightness gear designs
		DT22	It can be sterilized and banknote detection
		DT23	The brightness can be adjusted according to the external situation
DT3	Enhance user efficiency	**DT31**	The lamp can be folded
		DT32	Rotatable illumination
		DT33	There are three types of illuminated area
DT4	Ensure the quality of the product and durability	**DT41**	The material is hard
		DT42	Large power storage capacity
		DT43	Research and development of fast charging function
DT5	According to the actual needs of users, add additional functions to improve customer satisfaction	**DT51**	Add pen holder design to the lamp structure
		DT52	Time display
		DT53	Phone holder actual
		DT54	There is a post-it note area
		DT55	Battery level display
		DT56	Play music

(2) Determine the relationship between design requirements and college student needs

In the analysis of the design requirements, it is found that the design requirement D11 has a strong correlation with the user requirement C11, C13, C31, and the user requirement C32 has a medium correlation, and the user requirement C33, C51, C53, C54 has a weak correlation, the strong correlation relationship is represented by a circle, the value is 9, the medium correlation relationship is represented by a triangle, the value is 5, the weak correlation is represented by a five-pointed star, the value is 1, and the space indicates that it is not correlated. This is shown in Figure 1 of the two-dimensional matrix.

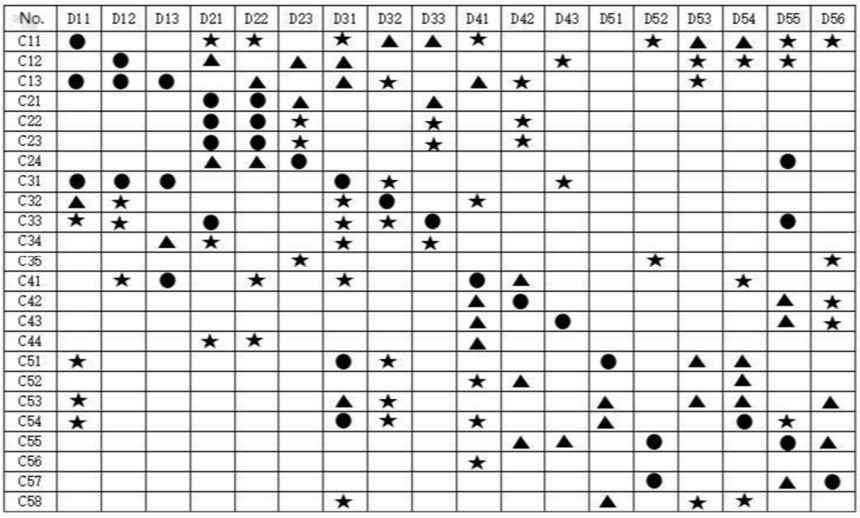

Figure 1. The relationship between the requirements of the lamp and the design requirements

(3) Calculate the importance of the design requirements

The quality house of the improvement design of the long-term table lamp is a collection of data such as the user needs, comprehensive score of needs, and design requirements of college students through questionnaire survey, and the importance and ranking of design improvement requirements calculated are shown in Table 10:

Table 10. The importance of table lamp design requirements

DT	**11**	**12**	**13**	**21**	**22**	**23**	**31**	**32**	**33**
Wj	326	252	256	442	260	146	418	183	278
sort	4	13	12	2	9	18	3	16	8
DT	**41**	**42**	**43**	**51**	**52**	**53**	**54**	**55**	**56**
Wj	284	289	228	259	259	161	303	507	224
sort	7	6	14	11	10	17	5	1	15

According to the importance value and ranking of design improvement requirements, product designers can clarify the priority level of each improvement design requirement, distinguish the priority and priority, and improve user satisfaction.

5. Conclusion

From the KANO-QFD output results, the power display design accounted for the highest proportion, from the quality house key design requirements output results, brightness gear design accounted for a relatively high proportion, according to the actual situation, the adjustment of the brightness of the lamp is very important for people's use, the more suitable gears can meet the various needs of users, from the QFD output results can also be seen, for the convenience of the lamp, the user still has some strong requirements, so the designer needs to start from reality, Design a lamp storage bag for the desk lamp, which can be stored when not in use. According to the actual situation and user satisfaction analysis, in the design of the long-term table lamp, the most important thing to improve is to increase the power display function of the lamp, followed by having a suitable number of gears to facilitate people's living needs, and then there is the design of the lamp storage, as well as the design of the post-it note function.

Based on the KANO model and QFD principle, combined with the characteristics of desk lamps used in college dormitories, the design of long-term desk lamps is studied, and the main content of this research is to combine the KANO model with QFD quality function development two research methods, so that the results are more reliable. The research content of this paper is not representative enough, so the paper needs further research and improvement.

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