Design and Research of Tableware Cleaning Machine Based on Kano Model

Xi Zeng ⬤, Qi Wang ⬤*, Huabing Zhou, and Wanting Chen ⬤

Wuhan Institute of Technology, Wuhan City, Hubei Province, China

```
EMAIL:3899594@qq.com(Xi Zeng);
  727743949@qq.com(Qi Wang)*;
zhouhuabing@gmail.com(Huabing Zhou);
 1821110974@qq.com(Wanting Chen)
```

Abstract. Objective To improve the efficiency and cleaning power of current cleaning machine, enhance the sense of user experience, and commit to the continuous progress and development of society. Methods Based on the Kano model, the paper discusses the user needs of the tableware cleaning machine, sorts the importance priority of different types of users, and uses the Better-Worse coefficient calculation method for auxiliary calculation to get the importance of the cleaning machine needs. Results Combined with the results of demand analysis, the product function was planned, the design concept of the tableware cleaning all-in-one machine was practiced, and a product meeting the demand was designed. The conclusion provides reference for the design of cleaning machine, and provides different directions for its related design.

Keywords: Kano model; User demand; Dishwasher; Tableware and food cleaning; Ultrasonic wave

1   Introduction

With the development of China's economy and science and technology, the lazy economy has become popular, which has prompted great changes in the kitchen electricity industry. According to the data of China Business Information Network, in 2020, the number increased to 1.919 million, consumption expanded 10 times, the popularity trend of cleaning machines is significant. Dishwashers originated in Europe and the United States, at the beginning of design, only aimed at light oil cleaning, while Chinese cuisine commonly used frying, frying, frying and other cooking methods, tableware residue more oil, Western machines can not effectively cope with Chinese heavy oil. This study is based on the user experience, based on the young group, take the Kano model for analysis, mining the real needs of cleaning machine in different family environments, to explore in the 21st century with the continuous development of science and technology, how to apply ultrasonic technology and structure optimization to improve the efficiency of cleaning and user experience.

2   Overview of user requirements

In the face of the global epidemic attack, the emergence of different types of cleaning machines has also brought a new direction for the kitchen electricity industry to get rid of the impact of the epidemic. Among them, diet health is a link that people pay special attention to. In daily life, food pesticide residues and detergents will have an impact on people's health. Under the continuous update of technology, such as too long cleaning time, incomplete cleaning, rice residue blocking water, poor user experience and other problems are gradually exposed. At present, the basic function and technical conditions of the cleaning machine are more mature, but the cleaning strength and the user's sense of experience still need to be improved, especially for the cleaning of the general cleaning machine is difficult to do. According to the existing literature, there are many achievements in the technological development of spray dishwasher. Lin zhao ping et al [1]. improved the cleaning effect of the dishwasher by changing the speed of the spray machine Lin Zhao ping et al. improved the cleaning effect of dishwasher by changing the speed of the spray machine. Xu Ming et al [2] changed the original shelf, to achieve the height of the shelf adjustment, greatly reduce the labor intensity, while meeting the emission of special tableware. Li yu ping et al [3]. found in the experiment that ultrasonic improved cleanliness and coverage in dishwashers.

3   Overview of Kano model method

Kano model is a user demand analysis method proposed by Japanese professor Akira Noki in the 1980s. It is a tool for classifying and prioritizing user demands. Based on the analysis of the impact of user demands on user satisfaction, Kano model reflects the nonlinear relationship between product attributes and user satisfaction. According to the satisfaction of demand, Kano divides demand into five categories: necessary type, expectation type, charm type, undifferentiated type and reverse type, which are represented by English letters M, O, A, I and R respectively.

As shown in Figure 1, the Kano model is represented by a two-dimensional coordinate system. The horizontal axis represents the degree of full or inadequate function of the product, which can also be understood as the closer to the left, the lower the degree of functional perfection. The vertical axis represents user satisfaction, and the five curves in the figure represent the five quality relationships of Kano model respectively. Through the above quality determination, it is easier to clarify the relationship between different quality and satisfaction, and find out the important quality items that effectively improve user satisfaction.
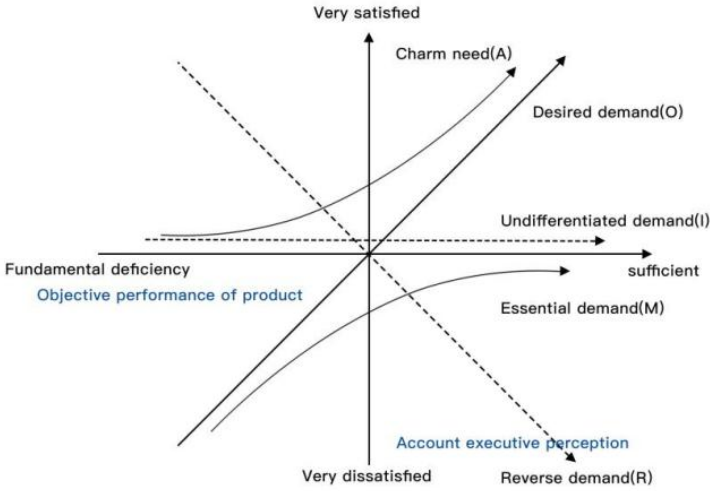
Fig. 1. KANO model diagram

4   Research on cleaning machine demand based on Kano model

4.1   Demand research

In this survey, various functional requirements collected were summarized and sorted according to relevance through card classification. Secondly, it is found that the majority of kitchen users are female, and the majority of family members are 2-5 people [4]. In order to analyze the functional needs of users on the cleaning machine, according to the integrated user information in the early user research, and design the Kano model two-way questionnaire, the question uses two positive and negative directions to ask, in order to have this kind of function to obtain the user satisfaction survey. Finally determine the typical functional requirements of the cleaning machine. The following is the typical functional requirements of the cleaning machine and their brief introduction, As shown in Table 1.

Table 1. Functional requirement list

Serial number	Typical function	Demand profile
One	Spray cleaning	The surface stains can be rinsed off when the stain is put into the dish
Two	disinfection	Remove residual cleaning agent from the surface of the dishes
Three	dry	Hot drying removes water stains from the surface of the dishes
Four	Shelf storage	Easy access to dishes and as many cutlery as possible
Five	Drain pipe	Avoid clogging the machine with food left in the dishes
Six	Sealing rubber ring	The sealing rubber ring is used in the opening and closing door to achieve the effect of water storage
Seven	Ultrasonic cleaning	Target stubborn stains for cleaning

4.2   Demand analysis

Kano model sets problems from positive and negative directions according to the user's demand degree, and analyzes the psychological state of users when certain specific needs are met or not met. The questionnaire results will be compared with the analysis table of Kano model to obtain various attributes of each demand point. In order to understand and analyze user needs more clearly, Berger. proposed the better-worse coefficient calculation method to assist identification, which is Better=（O+A）/（M+O+A+I),Worse=(O+M）/（M+O+A+I)×(-1)[5]. The Better-Worse coefficient is a more explicit indication of the impact on user satisfaction when a requirement is met or not met, As shown in Table 2.

Table 2. Functional requirement list

Better value	The absolute value of the Worse	Demand profile
>0.5	>0.5	Expectant demand (O)
<0.5	<0.5	Undifferentiated demand (I)
>0.5	<0.5	Charismatic need (A)
<0.5	>0.5	Prerequisite Requirement (M)

5   Functional planning and design of all-in-one cleaning machine based on Kano model

5.1   Introduction to design

When planning the functions of the cleaning all-in-one machine, according to the importance of long-term practice of KANO model theory, it can be divided into four levels successively: necessary demand M > expected demand O > charming demand A > indifferent demand I. The functional planning analysis of the product is made according to the four levels of requirements without considering the undifferentiated requirements.

According to the results of the preliminary investigation, the interaction of the three elements of human-product-environment is fully considered. The cleaning component adopts ultrasonic wave as the core component of cleaning, which is composed of the cleaning part together with the traditional rotary spray structure. Due to the small population of the family, the design will change the internal shelf structure to increase the types of tableware placed [6]; The traditional upstream and downstream pipelines are usually 2-3cm, so the design is to widen the pipelines and use the funnel section to assist the semicircular expansion pipeline to solve the problem.

5.2   Analysis of key design principles

Ultrasonic wave is a kind of mechanical wave with very short wavelength, which is a kind of sound wave with a frequency higher than 20hz. It vibrates very many times per second. The stains on the surface of the objects cleaned by ultrasonic technology can be peeled off by impact force or cracks appear, continuous impact, and finally the dirt can be quickly peeled off on the surface of the objects cleaned. The design will adopt the ultrasonic principle to integrate into the existing products, and the ultrasonic module is placed on the inner back wall of the cleaning machine [7]. Five 100w shakers use water as a medium to clean greasy dishes.

The internal shelf of the cleaning machine is mainly used to place tableware so that it can be cleaned by the spray of water column. It is mainly divided into specific tableware positions by the splicing combination of steel pipes. The design will revolve around how to place the most number and categories of tableware in the smallest space, the whole internal space of the shelf is divided into four parts for the design, mainly for the family with a small number of family. Due to limited space, the design will use a movable folding shelf, with four sets of upright brackets below the bowl area, allowing the mouth to be placed downward to clean the inside of the cup [8].

The section design will adopt the principle of funnel. The bottom surface of the dishwasher adopts the same principle as the cone part of the funnel, and the depression of the whole plane is about 5°. The design can make the meal residue flow out of the pipeline along the impact force of water.

The semicircle is integrated into the design, using one side is a plane on the other side is a semi-circular shape, and the funnel section connection makes the meal slag can flow along the impact of the water to the pool, and in order to facilitate the cleaning and replacement of the whole stainless steel two sections of metal pipe, in the folding part of the storage and the middle of the double-layer telescopic hose, The double-layer design can not only prolong the pipeline but also avoid dirt and dirt when the pipeline is stretched. The detachable design provides space for subsequent cleaning and parts maintenance.

5.3   Core functional architecture

The internal ultrasonic module of the cleaning machine is combined with its rotating spray turning head as the main cleaning part of the body. The ultrasonic module group consists of five 100w shakers, and the spray turning head is designed to be one tall and two short to avoid collision within it.

The internal shelf is made of ordinary form to place the basic tableware, and the cup can be placed for cleaning after the stand is rotated. Two pulley sets are arranged at the back of the shelf, and a bracket is arranged on the front side, which can be pulled out of the shelf and placed on the plane formed by opening the door for convenient access to tableware, As shown in Figure 2.

The pipe structure is composed of semicircular telescopic pipe, the main body is made of stainless steel pipe, avoid rust, in the middle and folding part of the telescopic

hose design, can increase the length and can avoid the water outlet matching the semicircular outlet, the maximum avoid clogging.

Fig. 2. Product usage scenario diagram

6   Conclusion

This paper mainly uses the Kano model to analyze the needs of the products, and summarizes the problems existing in the products and the direction of improvement. At the same time, the final positioning of the products is obtained according to the design and investigation of the user's use process and psychological needs.

Through the preliminary research and model analysis, the direction, function and size of the design are finally obtained. The design absorbs the advantages of the existing cleaning machine to a certain extent, and is optimized after integration to provide new ideas for the design. So that its form is more in line with the needs, and can adapt to the use of a variety of places, at the same time, the author from the relevant technical principles, ergonomics and other aspects of optimization. In the continuous test to draw conclusions, the final output of the design results and verification and feasibility analysis.

Acknowledgment

References

1. Lin Zhaoping, Zhang Linfeng, Liu Yao, Pan Haifeng. Spray device and its rotating speed of the net effect of the dishwasher research [J]. Journal of electronics science and technology, 2020 (S1): 54-56, DOI: 10.19784 / j.carol carroll nki issn1672-0172.2020.99.014.

2. XU Ming. Design of a Dishwasher Rack Adjusting Mechanism [J]. Daily Appliances,2015(12):45-48.

3. Li Yuping, Zhou Liqun. Ultrasonic dishwasher technology [J]. Journal of electronics science and technology, 2004 (Z1): 155-156. The DOI: 10.19784 / j.carol carroll nki issn1672-0172.2004. Z1.058.

4. Fang Wen, Zhou Haixin, Zhang Kaichuan, Jiang Huling. Based on user requirements of the development of Chinese dishwasher opportunity analysis [J]. Journal of electronics science and technology, 2021 (5): 80-83. The DOI: 10.19784 / j.carol carroll nki issn1672-0172.2021.05.013.

5. Huang Guanglong, Zhang Xin. Customer Demand Analysis Based on KANO Model and TRIZ Theory: A Case Study of Product Design [J]. Industrial Design, 2018 (12): 152-154.

6. Tang Shenjie, Shengsheng, CAI Xungru. Research and Application on Fixing Method of Refrigerator Glass Shelf [J]. China Daily Electrical Appliances,2021(07):74-76.

7. Li Mingfeng, WANG Haojie, Wang Songbo, Huang Shuqing, Xu Shurong. Study of dishwasher two-way rotating spray cleaning system [J]. Journal of electronics science and technology, 2021 (S1): 169-172. The DOI: 10.19784 / j.carol carroll nki issn1672-0172.2021.99.040.

8. Liu Yuan-hao, WANG Qian, Han Yu-zhu, DUAN Shi-jie, LIU Yi-lei. Ultrasonic cleaning machine design [J]. Mechanical and electrical information, 2021 (22): 40 and 42, DOI: 10.19514 / j.carol carroll nki cn32-1628 / tm. 2021.22.016.