Design of Intelligent Water Cup for Sugar Detection Based on Kano Model

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Abstract. Objective: In order to prevent health problems caused by excessive sugar intake, a smart water cup which can detect the sugar content of drinks is designed to remind users to take in sugar reasonably every day and meet their life needs of reasonable sugar control. Methods: Firstly, KJ method was used to arrange and sort the demand hierarchically, and then Kano model was used to sort out the demand of sugar control population, so as to clarify the multiple demands of users' age or health status for products. Secondly, the existing liquid sugar detection technology is analyzed, and the feasibility and application mode of infrared spectroscopy in water cup are discussed. Results: Based on the demand of sugar control and interaction mode, the water cup design scheme was obtained, and the rationality of the structure and function of the model was evaluated, and the design was optimized. Conclusion: according to customer demand for control of sugar, sugar measuring cup with existing technology, can users daily drink for drink sugar content were detected and timely warning, by means of visual reminder to prevent from eating too much sugar the damage to health of users, at the same time design case for daily liquid sugar testing research provides effective empirical reference.

Keywords: Kano Model · Smart Water Cup · Sugar Detection · Interaction Design

1 Introduction

In recent years, people's consumption of sugary drinks has shown a rapid growth trend. As of 2019, the cumulative output of China's beverage industry was 177.635 million tons, with a year-on-year growth of 7% [1]. In order to effectively control People's Daily sugar intake and reasonably prevent the risk of disease, the equipment to detect the sugar content in drinks has become a new demand in people's life. At present, SGLT-2I is a new oral hypoglycemic drug, which can effectively reduce glucose and improve symptoms [2]. In terms of instrument measuring sugar, the existing sugar measuring instrument is mostly industrial equipment, mostly used in food safety detection, composition analysis and other aspects, the huge instrument equipment and other factors can't meet the diverse needs of users to measure sugar, coupled with the current civil liquid sugar measuring equipment is very few. In view of the current market vacancy and users' demand for sugar

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control, how to reasonably control sugar has become the focus of people's attention, and a portable product that can effectively detect daily sugar intake is designed to effectively meet users' demand. Guided by The Kano model, a user questionnaire was designed to summarize the functional requirements of sugar cups, and the design factors affecting user satisfaction were analyzed and measured, providing practical significance for future research in the field of sugar cups.

2 Demand Analysis of Sugar Control

The daily intake of sugar for healthy adults in China is about 30 g [3]. The nutrition community believes that sugar should provide no more than 5% of a person's total energy. [4] According to the report on nutrition and Chronic Diseases of Chinese residents in 2020, the average age of sugar sufferers in China is relatively young [5], 80% of the people who buy drinks are young people, mostly students and office workers. Due to the rapid pace of life and long-term intensive work at the present stage, people in a state of tension and anxiety unconsciously take in a lot of sugar to relieve pressure, and thus drink sugary drinks more frequently and have a higher risk of disease. However, people do not know the harm caused by excessive sugar intake to the body. Because sugar intake can promote the continuous secretion of dopamine in the human brain, which is mainly responsible for the transmission of "happiness", people will feel happy after consuming a certain amount of sugar, which is also the reason why people cannot resist sugar [6]. In addition, drinking sugar-sweetened beverages does not give users the same feeling of satiety as taking in the same calories from solid food. As a result, users do not feel burdened and thus drink more frequently.

At the same time, the drawbacks continue to highlight. People to buy the product when buying drinks the amount of sugar concentration is not known, the survey found most users when buying drinks will not take the initiative to consciously observe the composition table, only 33% of the buyers will observe composition table, 32% of people who have intention to control the sugar levels taken but it's difficult to precise control, Some drinks in sugar is very high, easy to order from the beverage intake of more than one day on the total sugar intake, and regular intake of people eat three meals a day, one day intake of sugar intake will be far beyond the standard prescribed by the who, inadvertently burden and damage to the body health, so in terms of drinking sugar control to strictly control.

The energy provided by sugar accounts for 50%–60% of a person's daily energy [7]. Assuming that the weight of an adult female is 50 kg, the total energy needed for that day is 1800 kilocalorie. We set the sugar energy supply ratio as 55%, that is, 990 kilocalorie energy is provided by sugar. Because each gram of sugar provides 4 kilocalorie of energy, 252 g of sugar per day is optimal for healthy adults. The amount of sugar in the staple food is about 200 g, and the remaining 52 g is the total amount of sugar in vegetables, fruits and drinks. Based on this, it is best to control the amount of sugar in drinks for healthy adults under 52 g [8].

3 Function Analysis of Sugar Control Water Cup

3.1 Kano Model Analysis of Sugar - Controlled Water Cup

In this paper, users' needs for sugar detection cups are designed, and users' needs for sugar detection cups are studied to fully understand the needs of users, so as to provide more design elements. KJ affinity graph method will summarize the chaotic product information, and gradually form a clear logical framework, so as to find a new way to solve the current problem [9]. Measuring sugar cup is a product involving the combination of many design factors. The collected data are classified by KJ method, and the evaluation index elements are supplemented and screened. Finally, the hierarchy structure of measuring sugar cup was determined. It can be divided into three types: target layer: that is, the overall target of the hierarchical structure model, which is the hierarchical functional demand of sugar detection cup. First-level index: three design index elements, namely intelligent B1, comfort B2 and convenience B3, are extracted according to KJ method as evaluation elements of criterion layer. Second-level indicators: according to the design elements of first-level indicators, a total of 11 s-level evaluation indicators (C1–C11) were screened out through KJ analysis and induction. The hierarchical functional indicators of sugar detection cup design are shown in Table 1.

Kano model plays a guiding role in product improvement, which mainly analyses product quality characteristics and how to improve user satisfaction, so as to quickly locate the direction of product design [10]. According to the analysis method of Kano model, find the product design direction that can improve user satisfaction, and the deficiencies and defects of existing products, find the breakthrough of products that need to be improved, so as to improve the design of existing products [11].

Table 1. Hierarchical functional indicators of sugar detection water cup design.

The target layer	Level indicators	The secondary indicators
Sugar detection cup functional requirements	B1 intelligent	C1 Intelligent sugar measurement
		C2 drinking frequency monitoring
		C3 sugar line setting function
		C4 Sugar overload prompt function
		C5 Sugar intake record function
		C6 Health advice
		C7 indicator warning
	B2 comfort	C8 APP
		C9 Temperature control function
		C10 easy to clean
	B3 portability	C11 is small in size and light in weight

Table 2. Measuring sugar cup function summary table.

The target layer	Level indicators	The secondary indicators	Type of requirement (%)				
			Very like	Like	Neutral	dislike	Very dislike
Sugar detection cup functional requirements	B1 intelligent	C1 Intelligent sugar measurement	35	39	13	19	7
		C2 drinking frequency monitoring	5	16	43	26	10
		C3 sugar line setting function	20	28	30	15	7
		C4 Sugar overload prompt function	34	30	20	10	6
		C5 Sugar intake record function	21	25	21	28	5
		C6 Health advice	30	13	21	31	5
		C7 indicator warning	25	30	20	21	4
	B2 comfort	C8 APP	18	30	33	15	4
		C9 Temperature control function	13	25	31	20	11
		C10 easy to clean	43	25	8	21	3
	B3 portability	C11 is small in size and light in weight	28	30	13	23	6

In the research stage, adopts questionnaire investigation method, easy to understand user requirements, clear user requirements belong to what type, according to customer's attitude is composed of five levels, respectively, set "very like", "like", "neutral", "dislike", "very dislike" to design the survey questionnaire, and acquire the real effective questionnaire 61 copies. According to the evaluation table of Kano model, the functions of the sugar measuring cup are summarized as shown in Table 2.

According to the Kano category summary data of the functional requirements of sugar cups, the Better-Worse coefficient was calculated to represent the functional requirements of sugar cups. See Table 3.

According to the Better-Worse coefficient, the functional demand attribute classification of sugar cups is shown in Table 4.

In type expected demand, C1 Intelligent sugar measurement, C3 sugar line setting function, C4 Sugar overload prompt function, C7 indicator warning, C8 APP these

Table 3. Better-Worse coefficient for measuring functional requirements of sugar cups

Level indicators	The secondary indicators	Satisfaction factor	
		Better	Worse
B1 intelligent	C1 Intelligent sugar measurement	0.55	-0.80
	C2 drinking frequency monitoring	0.66	-0.23
	C3 sugar line setting function	0.62	-0.52
	C4 Sugar overload prompt function	0.53	-0.68
	C5 Sugar intake record function	0.48	-0.48
	C6 Health advice	0.36	-0.45
	C7 indicator warning	0.52	-0.57
B2 comfort	C8 APP	0.65	-0.5
	C9 Temperature control function	0.63	-0.43
	C10 easy to clean	0.34	-0.72
B3 portability	C11 is small in size and light in weight	0.46	-0.62

Table 4. Induction of functional demand attribute of measuring sugar water cup

Requirement attributes	Measuring sugar cup demand function
Excitatory need	C2 drinking frequency monitoring
	C10 easy to clean
	C11 is small in size and light in weight
Expectant need	C1 Intelligent sugar measurement
	C3 sugar line setting function
	C4 Sugar overload prompt function
	C7 indicator warning
	C8 APP
Basic demand	C9 Temperature control function
Undifferentiated demand	C5 Sugar intake record function
	C6 Health advice

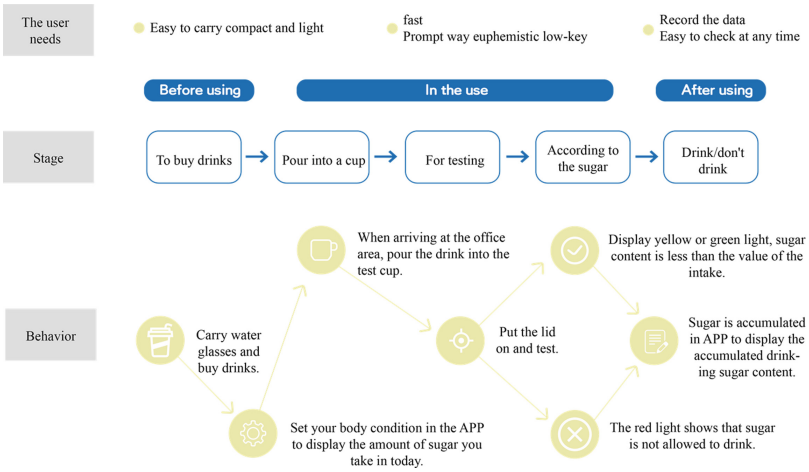

Fig. 1. User test sugar travel map analysis.

five functions become people to the key requirements of sugar water, is the key to improve customer satisfaction, once will greatly raise the purchasing power of customers, according to the research results show that Sugar detection and hints are the key aspects of interaction design. In terms of drinking frequency monitoring, easy cleaning, small size and light weight, the analysis shows that if the product has these functions, it will improve user satisfaction, but if it does not have these functions, it will not affect user satisfaction. Because on the market at present is not refer to the detection of sugar water, but as a drinking water cup, temperature control function is the basic demand of the products available in the market has basically met the necessary function, due to no difference demand less effect on user's satisfaction, don't need too much, so only need to focus on the realization of the expected demand.

After KJ analysis and induction, it is found that the demand of sugar cup is the most intelligent. Based on this, the intelligent design of products in the design process has become the key design to improve user satisfaction [12]. In the process of user use, the usage flow is shown in Fig. 1. Buy from user to go out for drinks, will drink sugar water into the test, measurement of sugar content in drink, can use different colors to distinguish between sugar content and to drink, once the red light flashing represents the drinks is beyond the scope of users on the same day the normal sugar intake, drinking is prohibited. Use different colors to remind and alert users. After using the APP, it can timely see the daily sugar intake and a change in body condition through statistical analysis of the data, so as to reasonably control sugar.

3.2 Kano Model Analysis of Sugar - Controlled Water Cup

As you drink, in order to be able to design a measuring cup of sugar detection, according to the survey found near infrared spectroscopy in the detection area has its own advantages, first of all, the test speed, about 1 min to complete the sample test, high efficiency, able to perform nondestructive testing, and has a good penetrability, can directly with diffuse

reflection measurement method to test the samples, And its analysis cost is low, no pollution, energy saving and environmental protection. At present, this detection method has been widely used in the food safety detection industry, which can effectively detect the sugar in drinks [13]. Existing new technologies can further simplify complex folded NIR optical systems to vertical optical paths consisting of only Fabry-Perot cavities and single point photodiodes, and reduce large NIR spectral systems to the size of a fingernail, greatly improving the portability and stability of NIR optical systems [14].

Through the analysis of Kano model and USER demand analysis of KJ method, the design direction of the detection cup is obtained, and the design points are summarized to guide the design practice.

(1) Adjustable sugar intake. When using, users can set the sugar intake range in advance according to their own actual situation, reasonable and effective sugar control.
(2) Reasonable hints. When using, the visual color feedback is given to the sugar content range of the drink according to the sugar measurement results. Different colors correspond to different sugar content range, and the reminding method is accurate and effective.
(3) Miniaturization. Due to the temporary environment of the user, the demand for portability is more prominent. Lightweight and small in size will not only be more convenient for users to carry, but also reduce users' intake when drinking.

4 Design Practice

4.1 Sugar Detection Cup Modelling Concept Design

Norman, an American cognitive psychologist, believed that a good product must have a good appearance, and the external packaging of the product is the first impression left on people [15] Is it nice or not? Whether to let consumers remember, whether to produce the desire to buy, are the design needs to consider the problem.

This type of detection cup, in the shape of the barrel body, so that not only saves the use of space, easy to carry and convenient for people to grasp; Material selection of relatively smooth material, light and practical; The overall shape of the curved surface and rounded corners, so that the overall feeling of the product is soft, to reduce users in the use of the process of knocking against the damage; At the top of the lid, the water ripple pattern and curved surface are more designed, making the product look flexible and interesting without being too rigid. The cup body is wide on the top and narrow on the bottom. The mouth of the cup is wide, which is convenient for pouring drinks and cleaning inside the cup body. In terms of volume, let people reduce the amount of drinks as far as possible, and the overall cup volume is small. This testing water cup double cup body, the inner metal thermal insulation material is qualitative, there's a thermometer on the shell display, after the user pour drinks, cover the lid, gently press the round button on the lid, began to test, then, with a circular hole at the bottom of the inner cup body is opened, a small number of liquid will flow in the hole, the hole is below the detection area, When liquid flows will be to test the liquid, painted on the scale line, after testing the sugary data will be showed in the form of color on cup body, according to different sugar content, the indicator light to show the feedback of different colors respectively,

Fig. 2. Check the overall effect and details of the cup.

Green and yellow represent drinks with less than 10 and 25 g of sugar that are acceptable to drink, orange means that the sugar content of drinks in the cup reaches 50g, which should be drunk with caution. Once the red light on the lid is on, it means that the sugar exceeds the specified amount, the lid will be locked and users are forbidden to drink, as shown in Fig. 2.

4.2 Interaction Design of Sugar Detection Cup

With the coming of the era of intelligence, the prevalence of experience economy at present, the user experience with the use of the products has higher requirements, a single product has been unable to meet the needs of users, a good product must include a good experience, good experience to be indispensable in the design of a, Based on this, the process of product and user interaction becomes more and more important. Interaction is actually a process of two-way information exchange between users and products, which is a key step to establish emotional connection between products and uses [16]. rOf the two-way communication, feedback is an important part of interaction design, the expression of feedback form is mainly embodied in the visual, smell, hearing and touch a variety of levels, such as good feedback can optimize product experience, let people like this product and would like to use this product, so it is very important to the result of the feedback. The specific use process of the product is also part of a good experience. As shown in Fig. 3, a simple and clear use process is more convenient for people to use. A good product experience can not only solve practical problems, but also make users feel comfortable and happy during the experience [17].

This cup interacts with users in setting sugar intake, detecting whether sugar exceeds the standard and whether it can be drunk. The form of expression is mainly reflected in vision, which is more suitable for users' psychology than other display methods such as hearing, and the form of expression is not too obvious. Different color display, there is a certain warning effect. As for the feedback of sugar information, on the basis of ensuring intuitive and easy to understand and users' privacy, the more difficult the operation is, the more likely it is to be favored by users. Therefore, visual feedback becomes the first choice in the design. As shown in Fig. 4, simple visual feedback satisfies people's psychological needs.

APP is an auxiliary tool with a simple and clear interface that mainly highlights product functions. It is divided into three main parts: sugar intake, body condition and

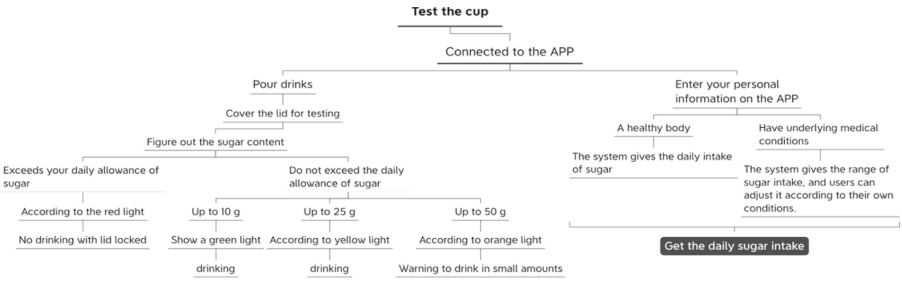

Fig. 3. Test cup use flow chart.

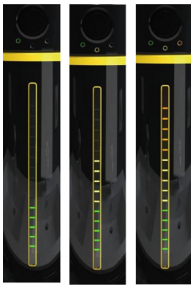

Fig. 4. Effect of indicator light on sugar content.

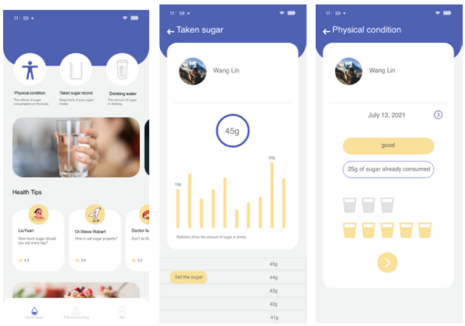

Fig. 5. Client APP interface design.

drinking water condition. There is more comprehensive introduction of sugar consumption in the APP. When users use the APP, it is convenient for them to consult relevant information, so that they can not only have a clearer cognition of their own body conditions, but also have more understanding of how to control sugar reasonably. As shown in Fig. 5, the combination of the product and interface is more convenient for people to use.

The new interactive use experience can deepen users' memory of the product, enhance people's experience and feelings, so as to effectively establish emotional connection. The interactive way endows the product with emotional temperature, makes the

product have a profound humanistic flavor, and reduces the use experience of raw and cold in the process of use.

5 Conclusion

In this paper, according to customer demand for sugar, reasonable and objective demand for have taken sugar groups, was taken to control the sugar levels, construct user requirement model, through the KJ method will be classified, user requirements and the product function to find out by the demand of the customer satisfaction, according to the results of the Kano model needs to have a taste of sugar intake of users, This paper puts forward the design and research direction of sugar cup, and summarizes the shortcomings of existing products from the aspects of appearance and function. From the perspective of human nature, the respect for the user in the process of interaction of psychological feeling, pay attention to the use of the user experience, emotional temperature to products, from the perspective of health, reasonable control user sugar intake, avoid the perturbation caused by too much sugar caused by various diseases, protect the user's health, this sugar detection glass design provides reference for the same type of product design.

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