KANO Model-Based Design Analysis of Healing Function Requirements for Intelligent Sleep Aid Products

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Abstract. Sleep disorders have become a prevalent health problem on a global scale. The integration and innovation of technology and design to improve sleep quality and physical and mental health has become a social issue that demands urgent attention. The study focuses on user needs, analyzing five types of needs: basic, expectation, excitement, non-differentiated and reverse. The aim is to explore the diversified needs for healing functions of intelligent sleep aid products, their hierarchical structure and optimization thinking. The study combines literature and market trends to propose a demand analysis and practical support for the design of healing functions suitable for sleep aid products.

Keywords: User research, Sleep disorders, Healing products, Intelligent design

1 Introduction

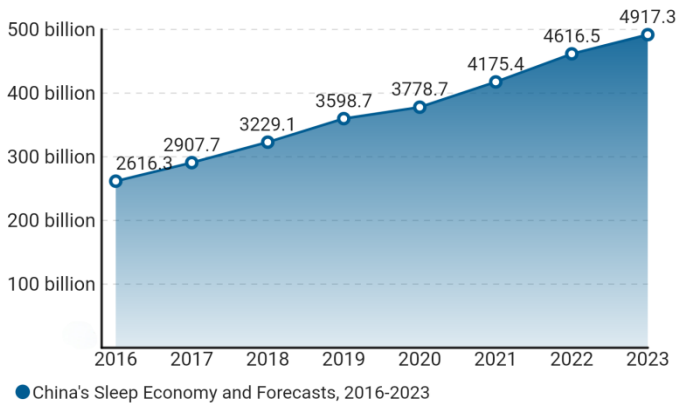

Fig. 1. 2016-2023 Forecast of China's Sleep Economy

Statistics from the China Sleep Research Society (2024) indicate that approximately 300 million Chinese citizens experience sleep problems to various extents, with the 22-

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40 age group being particularly severely affected. The market size of the 'sleep economy' industry has grown from261.6 billion yuan in 2016 to 495.58 billion yuan by 2023.With the expansion of public demand and technological innovation, China's 'sleep economy' market is expected to reach 658.68 billion yuan by 2027 (As shown in Fig.1).

In order to enhance the healing effect of intelligent sleep aid products, developers unfolded service design through multi-dimensional experiences of physiology, psychology and environment in order to satisfy emotional demands[1].The data model clarifies users' expectations and satisfaction with the functions of sleep aid products, providing a scientific basis for decision-making.

2 Relevant Studies

2.1 Intelligent Sleep Aid Products Market Development

With the development of artificial intelligence technology, sensor technology can accurately capture sleep-related data, such as heart rate, respiratory rate and the number of times of turning over, laying the foundation for the realization of product functions[2].The identification of sleep patterns and potential problems through data analysis and intelligent algorithms enhances the degree of product intelligence and functional diversity, and also brings a higher quality sleep experience, expanding business opportunities and market space[3].The categorization of intelligent sleep aid products is delineated below (As shown in Table 1 for details):

Table 1. Classification of intelligent sleep aid products on the market

categorization	Types of sleep aid products	Product Name and Description
Home Sleeping Products	Smart Mattress	1. Mousse iSleepAi air-assisted sleep mattres 2.MLILY Dream Lily M3 Pro Trio Model
	Smart Pillow	1. AI Smart Pillow 2. Fibre Sense Smart Pillow
Sleep environment products	Sleeping light	1.Intelligent sleep light 2. Sleeping projection lamp
Sleeping aid products	Sleeping Aromatherapy	1.Lavender Sleep Aid Aroma 2. Aroma Diffuser
	Sleeping Aid	1.Melatonin 2. Tranquilizer
AI Technology-based sleep aids	Sleep monitoring equipment	1.Huawei Bracelet 8 2. Sleep Tracking Camera

2.2 The KANO Model and Its Applications

The KANO model is a scientific tool for analyzing user needs and prioritizing product features, and was first introduced by Noriaki Kano, a professor at the Tokyo Institute of Technology, in 1984[4].The model delineates the non-linear correlation between product characteristics and user satisfaction.[5].This is illustrated in Figure 2:

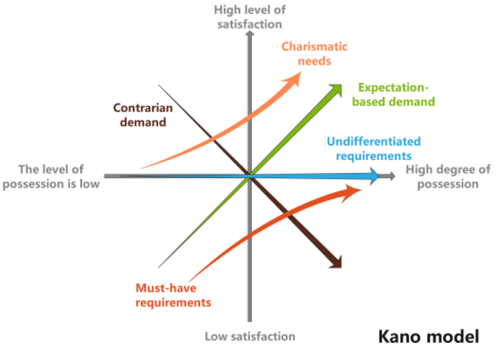

Fig. 2. KANO model diagram

The KANO model is a scientific approach to user needs analysis that utilizes a two-dimensional assessment framework, encompassing a structured questionnaire. The model employs a systematic questionnaire design to construct positive and negative bi-directional measurement questions for product functions and service modules. This approach enables a scientific assessment of the differences in users' perceptions of each attribute[6].The application of a five-level scoring system furnishes a data-driven decision-making foundation for the prioritization of product features and the optimization of services, As shown in table 2. This quantitative assessment framework facilitates the identification of the most effective strategies for the enhancement of products and services.

Table 2. Comparison of the classification of KANO model evaluation results

Product/service requirements		The reverse problem				
		Like it	Should	Don't care	Take it	Don't like it
Forward problems	Like it	Q	A	A	A	O
	Should	R	I	I	I	M
	Don't care	R	I	I	I	M
	Take it	R	I	I	I	M
	Don't like it	R	R	R	R	Q

Note: 'A' stands for Attractive Needs, 'O' stands for Expected Needs, 'M' stands for Basic Needs, 'I ' for undifferentiated needs, 'R' for reversed needs, and 'Q' for questionable attributes.

The KANO model's applicability extends beyond a single domain, playing a pivotal role across multiple fields, including but not limited to governmental systems, child

supervision, traditional culture education, intelligent product development, and cultural heritage preservation. Its integration into these diverse domains serves to foster the development and progression of associated sectors, thus demonstrating its multifaceted significance within the academic and practical domains[7].

2.3 KANO Model Research Methodology Process

The study constructed a systematic research path and analytical framework of needs, identification, validation, classification to strategy transformation (e.g., Figure 3):

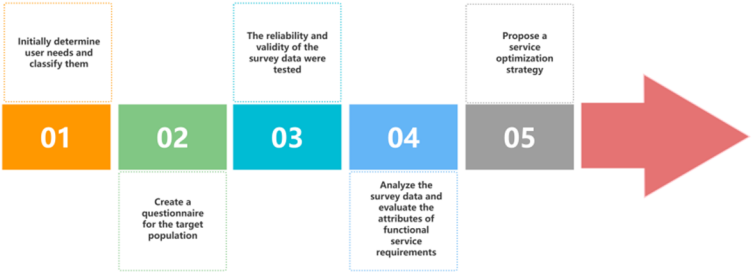

Fig. 3. Flowchart of the KANO model study

3 Intelligent Sleep Aid Product Healing Function Demand Research

3.1 Influences on Sleep

Sleep is an essential adaptive process that facilitates physical recovery and contributes to optimal physical and mental health. The quality of sleep exerts a significant influence on both physical and mental health, particularly in individuals afflicted with sleep disorders, which are frequently accompanied by emotional disturbances. The most prevalent symptom of sleep disorders is insomnia, which is frequently triggered by psychological and environmental factors[8].The prevailing factors contributing to this phenomenon are multifaceted, encompassing physiological, psychological and environmental elements, as well as external factors.

Physiological factors are understood to refer to the effects of bodily functions and hormonal changes on sleep. It is theorized that by-products of metabolism drive the brain into a state of sleep for the purpose of processing these substances.Psychological factors encompass a broad spectrum of emotional states, ranging from stress and anxiety to positive emotions such as excitement and pleasure. These factors have the capacity to influence sleep quality by modulating hormone production. Furthermore, external environmental factors, such as sound, light, materials, odour and temperature, have been demonstrated to have a significant impact on sleep quality[9].

3.2 Sleeping Aid Products Market Status and Trends

Psychological factors encompass a broad spectrum of emotional states, ranging from stress and anxiety to positive emotions such as excitement and pleasure. These factors have the capacity to influence sleep quality by modulating hormone production. Furthermore, external environmental factors, such as sound, light, materials, odour and temperature, have been demonstrated to have a significant impact on sleep quality. In addition to the upgrading of consumption, the market demand is exhibiting a transition from economic and practical considerations to quality and intelligence. A correlation analysis of 15 sleep-aiding function requirements and insomnia triggers was conducted, resulting in the construction of a function setting system with empirical auxiliary utility (as shown in Table 3). This provides a scientific basis for product development.

Table 3. Summary of healing function settings for sleep aid products

dimension (math.)	functional requirement	Serial number
physiological factor	Monitor sleep data (e.g. heart rate, breathing, sleep duration)	A1
	Provides real-time feedback and in-depth analysis of sleep conditions	A2
	Enables long-term data analysis to generate personalized sleep trend reports	A3
	Electrotherapy Sleep Service	A4
	Personalized sleep aids based on physiological data	A5
psychological factor	Equipped with relaxing massage function	A6
	Realizes emotion perception and provides relaxation suggestions	A7
	Integrated counseling or emotional regulation functions	A8
	AI-driven sleep optimization recommendations	A9
	Supports AR/VR immersive sleep aid experience	A10
	Provide an interactive experience to help you sleep	A11
	Combined with a meditation program or relaxation training	A12
External environmental factors	Intelligent adjustment of ambient light and temperature	A13
	Integration of natural therapies (e.g. aromatherapy, sonic therapy)	A14
	Play sleep-aiding white noise or music	A15

4 Research and Analysis of Demand for Healing Function of Sleep aid Products Based on KANO Model

4.1 Target User Selection and Questionnaire Development

A total of 218 questionnaires were distributed in the study, of which 40 were invalid, resulting in an overall validity rate of 81.65%. The data collection period was from November 2024 to January 2025. The questionnaire employs a two-dimensional measurement method, establishing a five-level evaluation scale for the presence/absence of functions. It further identifies the priority of users' expectations through the comparison analysis of explicit and implicit demand, thus providing a scientific basis for product optimization.

The questionnaire was divided into two parts: Part I (1-5 questions) Basic information about the user, Part II (6-20 questions) User's view of specific functional requirements:(6-8 questions) environmental factors; (9-13,20 questions) physiological factors; (14-19 questions) psychological factors (as shown in Table 4).

Table 4. KANO questionnaire

Questionnaire survey
Question3.Do you have insomnia Question5.your main sleep issues? (Multiple choices are possible) Question6.Intelligent adjustment of ambient light and temperature to optimize the sleep environment - (if this feature is available/not available) Like it/Should/ Don't care/Take it/ Don't like it.

4.2 Better - Worse Coefficient Analysis

In order to prioritize the functional attribute requirements, the Better-Worse coefficient calculation method proposed by Berger et al. is adopted, The Better and Worse coefficients are calculated as shown in Equations (1) and (2):

$$Better = \frac{(A+O)}{(A+O+M+I)} \tag{1}$$

$$Worse = \frac{(M+O)}{(A+O+M+I)} \tag{2}$$

The Better and Worse coefficients of the functional items of the healing function of intelligent sleep aid products are shown in Table 5, based on formulae (1) and (2).

Table 5. Summary of KANO model analysis results

Function	Better Coefficient	Worse Coefficient
6. Environmental Adjustment	48.68%	-19.74%
8. Natural Therapy	45.7%	-22.52%
9. Data Monitoring	44.08%	-15.79%
10. Sleep Analysis	36.54%	-21.79%
12. Personalized Plans	33.55%	-19.35%
14. Emotion Recognition	32.89%	-38.82%
13. Massage Function	31.21%	-21.02%
18. AI-Driven Sleep	25.81%	-35.48%
16. Meditation Courses	25.16%	-19.35%
11. Long-Term Data Reports	25%	-18.75%
15. Integrated Counseling	24.52%	-23.87%
17. Interactive Sleep Aid	22.78%	-21.52%
20.Electrotherapy Sleep Service	21.71%	-37.5%
19. AR/VR Sleep Support	20%	-14.19%
7. Sleep Music Playback	18.42%	-32.89%

4.3 User Requirements Prioritization Analysis

In order to present the distribution of each function, a four-quadrant plot of the Better-Worse coefficient is shown in Figure 4. The Better coefficient is used as the vertical axis, the absolute value of the Worse coefficient is used as the horizontal axis, and the mean value (0.304, 0.241) is used as the origin of the coordinates.

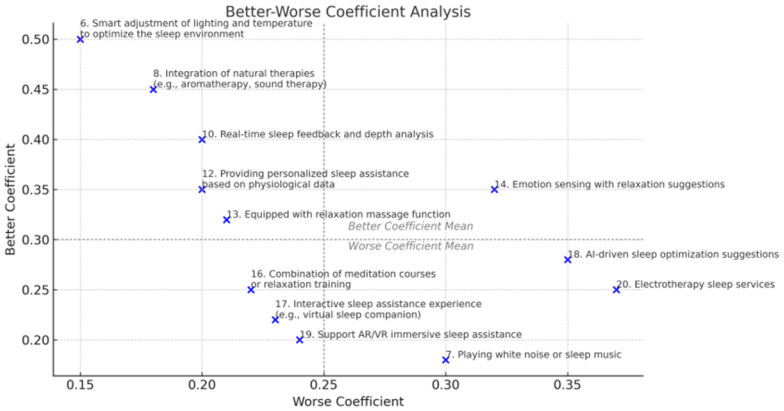

Fig. 4. Scatter plot of Better-Worse sensitivity rectangle

The product features are prioritized in the order of Essential, Desired, Charming and Undifferentiated Needs. Through the KANO model of better value and worse value to establish a coordinate system, calculate the mean value and set the origin, intuitively display the distribution of user needs, help function optimization. The results show that

the mandatory requirements (A9, A4, A15) are key to ensuring basic experience and must be met; Expectation demand (A7) has a direct impact on user satisfaction and should be focused on optimization; Glamour demand (A13, A5, A2, A6, A14, A1) has the potential to increase the attractiveness of the product and is worthy of attention; Undifferentiated demand (A12, A11, A10, A3, A8) has a weaker impact and can be used as a direction for subsequent optimization.

5 Optimization of the Healing Function of Intelligent Sleep Aid Products

The design of smart sleep aids is a multidisciplinary field that encompasses psychology, physiology, industrial design and information technology[10].The aforementioned proposal provides a theoretical basis and a practical path to enhance the healing function of intelligent sleep aid products. However, it is imperative to judiciously consider the healing function of intelligent sleep aid products in terms of their developmental priority. Firstly, it is essential to ensure the satisfaction and optimization of fundamental needs, and to guarantee the function of regulating the environment of intelligent products. Once essential functions have been perfected, it is then possible to consider satisfying expectation-type and glamour-type needs in turn, which can significantly improve the overall satisfaction of users with the products.

Based on the results of these analyses, this study proposes the following functional optimization scheme:

Improve essential requirements, focusing on ensuring the stability and reliability of basic functions, improving monitoring accuracy by optimizing AI algorithms, ensuring smooth audio playback, and combining user profiling and interactive guidance to improve personalized services and ease of use. It meets expectancy-based needs, focuses on multi modal data fusion, improves the ability of emotional perception and dynamic relaxation programme generation, and builds a closed-loop 'monitoring-feedback-adaptation' service. Deeply digging into the Glamour type demand, using intelligent sensing and natural therapy technology to achieve autonomous adjustment of the sleep environment, while integrating emotional computing and embodied interaction to strengthen the emotional experience of the product and the user's sense of identity.

6 Conclusion

In this paper, we employ the KANO model and the Better-Worse coefficient to categorize the functional requirements of intelligent sleep aid products. This enables us to identify the healing functional requirements of users for intelligent sleep aid products and propose the optimization of targeted functional services. The theoretical underpinnings and practical guidelines it delineates are instrumental in the design of intelligent products intended to facilitate sleep. Furthermore, it advocates for the integration of product innovation and user needs within this domain. It is recommended that future research explore the application of the KANO model in other smart healing products.

Furthermore, it is suggested that the widespread use of smart products be promoted in order to enhance quality of life and health management. However, the study is not without its limitations. These include the following: limitations in the sample, the depth of technology implementation, insufficient market validation, changes in demand dynamics, and insufficient interdisciplinary integration. It is suggested that future research should focus on improving the design and optimization of the healing function of smart sleep aid products. This can be achieved through more extensive user research, technical implementation solutions, market validation and interdisciplinary collaboration.

References

1. Yi Wenxuan. Research on Product Interaction Design for Art Healing of GAD Patients under the Perspective of Cognitive Psychology[C]//Beijing Chinese and Foreign Visual Arts Institute, ISVAH Organising Committee. Proceedings of the First International Symposium on Visual Arts and Humanities. China University of Geosciences (Wuhan):,2024:5.
2. Li Junhua,Wei Jianfu. Design Research of Sleep Aid Products based on A-KANO Model[J].*Art and Design,* 2023,2(12):109-111.
3. Zhang Leyan. Research on Interactive Product Design from the Perspective of Art Healing[J]. Footwear Craft and Design,2024,4(21):74-76.
4. ZHANG Xinyue, Fang Wang. Function Optimization of Government Intelligent Q&A System Based on KANO Model [J]. *Information Science*, 1-26.
5. Yilu He,Huiwen Wang. Design of Children's Intelligent Monitor Based onKANO and Kansei Engineering[J]. Packaging Engineering,2024,45(22):106-113+126.
6. Caligiore D .Healing with Artificial Intelligence[M].CRC Press:2025-02-21.
7. HONG Gang,LI Fengxue. Research on Functional Requirements and ServiceOptimization of Cultural Heritage Digitalization ServicePlatform Based on Kano Model[J]. Library Journal,2024,43(09):95-105.
8. Xu, Q., Jiao, R.J., Yang, X., Helander, M., Khalid, H.M., Opperud, A., 2009. An analytical Kanomodel for customer need analysis. Design Studies 30, 87–110.https://doi.org/10.1016/j.destud.2008.07.001.
9. Liu Zhiyuan.Intelligence based on immersiveexperience Sleep aid product design research [D]. East China Normal University,2022.DOI:10.27149/d.cnki.ghdsu.2022.002102.
10. Ylenia C ,Giulio M ,Riccardo R , et al.Evaluating digital health attributes for users' satisfaction: an application of the Kano model[J].The TQM Journal,2025,37(3):831-852.