Art Horizons
ISSN Print: 3079-5176
ISSN Online: 3079-5184
https://doi.org/10.63313/ah.9001

The design exploration of smart wearable glasses for the elderly based on AHP-QFD

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How to cite this paper: Huang,M.J., Yang,C.L. and Zhang,Y. (2025).The design exploration of smart wearable glasses for the elderly based on AHP-QFD. Art Horizons, 01, 1-.16
https://doi.org/10.63313/ah.9001
Published:2025-03-07

Abstract

Nowadays, the demand for smart wearable devices among the elderly is growing steadily. As an emerging wearable device, smart wearable glasses have great potential in assisting the daily lives of elderly individuals. However, existing products generally suffer from issues such as limited functionality, complex operation, and insufficient elderly-friendly design, making it difficult to meet the real needs of elderly users. To scientifically and reasonably improve the daily quality of life for the elderly, and to explore designs that align with the usage needs of this demographic, this study focuses on the design of smart wearable glasses. Through research, a hierarchical analysis model of functional requirements for smart wearable glasses for the elderly is established, and the AHP is used to determine the weight values of various requirements, identifying the key functional needs of the elderly. Next, the QFD method is applied to establish the relationship between user needs and quality characteristics, clarify design requirements, and ultimately obtain an optimized design solution. Finally, the design process of the smart wearable glasses is completed, from identifying pain points to implementing solutions. This study provides a scientific and systematic theoretical approach to the design of smart wearable glasses for the elderly, contributing to improving the elderly-friendliness of the product, enhancing the user experience, and offering theoretical support and practical reference for aging-friendly design.

Keywords

Aging-friendly design; smart wearable glasses; elderly demographic; Analytic Hierarchy Process (AHP); Quality Function Deployment (QFD).

1. Introduction

With the gradual increase in the aging population, the overall concept of "big health" is gaining increasing attention. The home-based elderly care model is becoming more popular, and the number of health-related products for the elderly is rising year by year. According to data from the National Bureau of Statistics' Seventh National Population Census, from 2007 to 2020, the number of people aged 60 and above has been steadily increasing, with 56% of the elderly population falling within the 60-69 age range(National Bureau of Statistics of China. ,2021).With the growing popularity of smart devices, Augmented Reality (AR) technology has undergone signifcant development and established itself as a crucial domain for these intelligent devices.The iterative maturity of wearable technology has made smart wearable glasses a promising solution to alleviate the pressure of social elderly care, due to their advantages in real-time performance, continuity, and environmental awareness. Currently, many scholars are conducting design and research in this area. For example, Chen Han and others have conducted sustainable design research on smart wearable products for younger elderly individuals, aiming to optimize the living experience of this group(Chen, H., Shen, L., & Liu, Y. , 2022).Wu Yue and others, through research using the Kano-AHP method, have provided a reference for similar smart wearable glasses, while also conducting design and research on smart wearable jewelry(Wu, Y., Yu, S.,& Zhang, M., et al. , 2024).Wang Wenbin and others have studied and examined the direction of integrated development between the elderly care industry and the smart wearable industry, promoting the comprehensive and coordinated development of the smart wearable industry(Wang, W. , 2022).Hameed et al.37 combine FMEA, QFD, TRIZ, LCA, and fuzzy TOPSIS methodologies to redesign a pressure relief valve (PRV) in an economic, sustainable, and innovative way(Hameed, A. Z., Kandasamy, J., Aravind Raj, S.& Baghdadi et al., 2022).Currently, existing research has made certain achievements in the design of smart wearables and design methods. However, there are still issues such as a low integration of products with users' daily experiences, insufficient exploration of the needs of the elderly, and a lack of systematic aging-friendly design methods. This study aims to provide theoretical reference for alleviating the social elderly care pressure caused by aging, through design research based on the elderly population.

2. Research status and analysis of aging-friendly smart wearable glasses

2.1. Research status of smart wearable glasses

Smart wearable glasses are designed to integrate intelligent technology into daily wear, aiming to monitor the human body and provide other forms of assistance through human-machine interaction and advanced technology. These products are equipped with data collection, processing, and feedback functions. Research shows that aging-friendly smart wearable glasses primarily fall into categories such as health monitoring, motion-sensing control interaction, comprehensive life assistance, and physiological function enhancement. The research trends for aging-friendly smart wearable glasses are moving towards human-centered design, improved health management features, integration with smart home systems, and the development of medical-grade devices.Compared to traditional information technology products, these features give smart wearable devices unique market competitiveness and social value(Ni, C., Tang, J., & Shao, B., et al. , 2023).The smart wearable glasses for the elderly, as studied in this paper, integrate daily health monitoring and alert systems based on the aforementioned basic forms. Unlike ordinary smart products for the elderly, these glasses optimize aspects such as font size, display clarity, and ease of operation, while also incorporating voice interaction technologies to reduce operational complexity and meet the design goals for aging-friendly solutions.

2.2. The current aging situation and the significance of research on aging-friendly smart wearable glasses

2.2.1. The current aging situation

In 2003, the world fully entered the aging process. By 2015, the global elderly population ratio reached 12.3%, and it is expected to rise to 16.5% in 15 years. The large and complex elderly population has generated multifaceted demands for aging-friendly products. The market for products suitable for the elderly has expanded dramatically, yet the elderly-related industries, particularly the aging-friendly smart wearable industry, are still in their relatively early stages. There is still considerable room for progress in the design and development of aging-friendly smart wearables. One of the main reasons for this is the lack of thorough exploration of the real needs of elderly users. At present, there is a broad usage of smart wearable glasses among users, with significant demand for such products. As traditional basic needs are gradually being met, attention should now shift to addressing the psychological and physiological needs of the elderly from a gerontological perspective. In terms of physiological health management, real-time monitoring of elderly individuals' vital signs and remote health monitoring should be implemented; in terms of social interaction, features such as voice chatting and video calling can help elderly people stay in contact and interact with family and friends, thus fulfilling their emotional needs.

2.2.2. The significance of research on smart wearable glasses

The research on smart wearable glasses is not only of great significance in terms of technological innovation and market expansion, but also has a profound impact across multiple fields such as society, economy, and healthcare. Smart wearable glasses are not just tools for health management; they can also significantly enhance users' quality of life. For elderly users, smart wearable devices can provide functions such as emergency calls and location tracking, enhancing their ability to live independently and increasing their sense of safety and well-being. In addition, the applications of smart wearable glasses in entertainment, social interaction, and other areas are continually expanding, further enriching the user's life experience and improving both their psychological and physiological aspects, in alignment with the goals of aging-friendly design.

Smart wearable products stand out particularly in meeting the specific needs of certain groups. For example, elderly individuals, chronic disease patients, and sports enthusiasts all have specific health management and safety needs in their daily lives. In terms of the needs of these specific groups, smart wearable devices can provide customized solutions to address these user requirements, thereby enhancing the quality of life and the sense of security on a psychological level for the target user groups.

3. AHP

3.1. Overview of the AHP method

The AHP is a systematic multi-criteria decision-making method proposed by American operations researcher Thomas Saaty in the 1970s. AHP decomposes complex decision problems into a hierarchical structure and, through comparative judgments and mathematical calculations, evaluates the relative importance of each decision factor to ultimately arrive at the best decision solution.In recent years, it has been applied by many scholars in the field of product shape evaluation design, improving the objectivity and scientific nature of design reviews and enhancing the accuracy of design decision-making(Ni, C., Tang, J., & Shao, B., et al. , 2020).The AHP method can systematize and hierarchize complex decision problems, allowing decision-makers to clearly see the structure of the problem and the relationships between various factors. In conclusion, the AHP method is an effective decision analysis tool that helps decision-makers solve complex, multi-objective, or unstructured decision problems.

To effectively apply the AHP, one of the most critical issues to be considered is the definition of the problem and then the determination of the criteria and sub criteria. Decision-making with AHP can be done by pairwise comparisons or by ranking the criteria when the number of sub-criteria related to the criteria is high (>9). A large number of criteria may prevent consistent pairwise comparisons. For this reason, it is recommended that they should be distinctive, have as little in common with each other as possible, and be few(Saaty, T. L. , 2008).

3.2. User research

AHP allows for the calculation of the weight of importance for each sub-criterion by conducting pairwise comparisons between the sub-criteria of the established criteria.In order to fully understand the complete process of using smart wearable glasses in practice and more accurately analyze the target users' needs, a combination of qualitative and quantitative methods was adopted in the initial research phase. The focus was on the elderly group's experience and feedback during the use of smart wearable glasses, capturing potential opportunities. A questionnaire was used for preliminary quantitative research on the elderly group's demand for wearable glasses. Based on the initial research data, several representative typical users were selected for in-depth follow-up interviews and daily life observations to obtain their real needs.

3.2.1. Survey data collection and analysis

The survey was conducted to analyze and understand the living conditions of elderly individuals, their level of understanding of smart wearable glasses, and their expected outcomes. A combination of online and offline methods was used to distribute the survey to the target group, with 75 questionnaires sent out and 70 valid responses collected. The research subjects were elderly individuals aged between 50 and 70, a group with specific lifestyle habits and certain learning abilities, capable of providing targeted feedback for the optimization of smart wearable glasses. The purpose of the survey was to comprehensively understand the needs and behaviors of the user group, providing a basis for product and service innovation.

The survey data was organized and analyzed, revealing the user characteristics and their needs as follows:

1)Basic Information: The survey shows that the living conditions of elderly individuals mainly fall into three categories: living alone, living with children, and living with a spouse. However, the analysis reveals that 64% of elderly individuals either live alone or with another elderly person. Therefore, when designing, it is important to consider the ease of operation and safety of wearable glasses, ensuring that they are convenient for elderly users to operate and use in their daily lives.

2)Behavior Patterns: By connecting the touchpoints of elderly individuals' purchasing and usage of smart wearable glasses with different user thoughts and behaviors, we can identify the final pain points and opportunities. The user behavior patterns are summarized into two categories: home activities and outdoor travel. During users' travel activities, it was found that their emotions reached a high point, with safe and convenient travel being an opportunity for future design. In the target users' home life, the need for thoughtful companionship in daily life is a major demand, and how to predict information in advance and make reasonable life plans are issues that need to be addressed during the usage process.

3)Demand Analysis: Elderly individuals over the age of 50 generally show a high level of acceptance toward smart wearable glasses, but when it comes to satisfaction with existing products, only a small group is satisfied. In subsequent research and analysis, it is necessary to explore multiple dimensions, including appearance design, user experience, health, and safety, in order to meet the actual needs of elderly users.

3.2.2. Typical user interviews and analysis

Given the significant differences in the comprehensive characteristics of the elderly population, user interviews were conducted to allow them to express their opinions and feelings more authentically and naturally. During the actual interviews, the interview outline was flexibly adjusted based on the users' specific statements and situations, in order to comprehensively and deeply explore their real needs and usage pain points. The questionnaire survey supplemented the interview by structuring content that was difficult to quantify, helping the research to gather a broader range of statistical data. After the survey was completed, the raw data from the interviews and questionnaires were thoroughly organized and categorized, ultimately creating a detailed and structured user needs hierarchy model.

3.3. Constructing the hierarchical analysis model

Constructing the hierarchical analysis model involves breaking down the problem into different constituent factors and organizing these factors into different levels based on their interrelationships and membership, forming a multi-level analytical structure. When constructing the service system for smart wearable glasses for the elderly, it is necessary to consider multiple levels and dimensions in detail.Based on the preliminary research on the design requirements of smart wearable glasses, the summary includes three dimensions: personality features, form features, and functional features, establishing 12 evaluation criteria.The goal layer of this structure is the aging-friendly smart wearable glasses user needs (A); the criterion layer is divided into personality features, form features, and functional features (B); the sub-criterion layer (C) contains a total of 12 specific needs,see Figure 1.

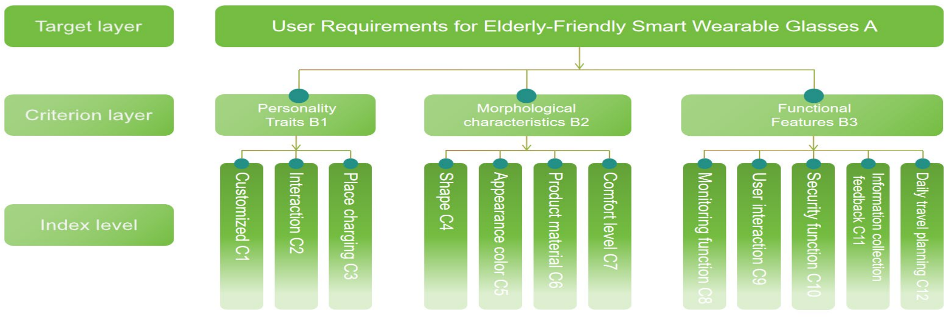


Figure 1. Demand hierarchy analysis structure of smart wearing glasses

3.4. User needs weight analysis

AHP constructs a pairwise comparison matrix based on the relative importance of the relevant needs and performs consistency testing to obtain the weight values corresponding to each level of needs(Dai, Y., Zhang, Z., & Chen, N., et al. , 2022).The criterion layer and indicator layer of the target user needs are compared with each other, proposing 9 levels of importance. Based on the relative importance of the indicator layer, a pairwise comparison method is used to compare the indicators within the same layer and assign values.AHP requires pairwise ratio comparisons between all pairs of criteria and for all pairs of alternatives with respect to each criterion. Various scales for the pairwise comparisons have been proposed; the most commonly used one is composed of the integers from 1 to 9 and their reciprocals(Sahin, S., 2024), see Figure 2.

Assigned value	Definition
1	Equally important
3	Weak importance
5	Strong importance
7	Demonstrated importance
9	Absolute importance
2, 4, 6, 8	Intermediate values

Fgure2. Scale 1 to 9(Sahin, S., 2024)

The AHP method is used to calculate the weights of user needs. Four relevant experts are invited to score the target need factors, and the weighted average of the raw data is calculated based on the scores to determine the user need weights. A pairwise comparison matrix is then constructed(Li, X., Liang, J., & Li, H. , 2021).After weighting and taking the geometric mean, the judgment matrix for each criterion layer is obtained.The weights ofB1~B3、C1~C3、C4~C7、C8~C12are calculated, and each judgment matrix passes the consistency test, resulting in the weight matrices for each level， see Table 1~4.

Table 1. User demand judgment matrix

	B1	B2	B3	w_i
B1	1	1/2	1/3	0.163 4
B2	2	1	1/2	0.296 9
B3	3	2	1	0.539 6

Table 2. Personality characteristic judgment matrix

	C1	C2	C3	w_i

C1	1	1/3	1/2	0.163 4
C2	3	1	2	0.539 6
C3	2	1/2	1	0.296 9

Table 3. Morphological feature judgment matrix

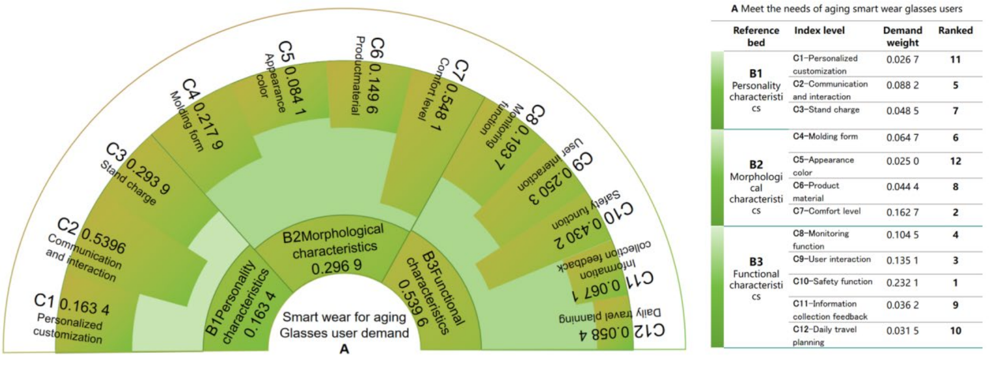
	C4	C5	C6	C7	w_i
C4	1	3	2	1/4	0.217 9
C5	1/3	1	1/2	1/5	0.084 1
C6	1/2	2	1	1/3	0.149 6
C7	4	5	3	1	0.548 1

Table 4. Functional feature judgment matrix

	C8	C9	C10	C11	C12	w_i
C8	1	1/2	1/3	4	5	0.193 7
C9	2	1	1/2	3	4	0.250 3
C10	3	2	1	5	6	0.430 2
C11	1/4	1/3	1/5	1	1	0.067 1

3.5. User research

Sort and summarize the weights of the 12 requirements, see Figure3.The final ranking results are as follows: Safety features, comfort level, user interaction, monitoring functions, communication and interaction, molding form,stand charge, product material, information collection and feedback, daily travel planning, personalized customization and appearance color.These ranked requirement weights are then imported into the QFD model to construct the Quality Function Deployment matrix, providing technical support and guidance for the subsequent design.



Reference bed	Index level	Demand weight	Ranked
B1 Personality characteristics	C1-Personalized customization	0.026 7	11
	C2-Communication and interaction	0.088 2	5
	C3-Stand charge	0.048 5	7
B2 Morphological characteristics	C4-Molding form	0.064 7	6
	C5-Appearance color	0.025 0	12
	C6-Product material	0.044 4	8
	C7-Comfort level	0.162 7	2
B3 Functional characteristics	C8-Monitoring function	0.104 5	4
	C9-User interaction	0.135 1	3
	C10-Safety function	0.232 1	1
	C11-Information collection feedback	0.036 2	9
	C12-Daily travel planning	0.031 5	10

Figure 3. Meet the needs of aging smart wear glasses users

4. QFD

4.1. Overview of the QFD method

Quality Function Deployment (QFD) is a user-driven product design and development method, pioneered by Yoji Akao in Japan in the early 1960s. QFD is a structured design tool oriented towards consumer needs, commonly used to translate customer requirements and demands into technical characteristics of new or improved products and services(Wang, J., Liu, S., & Wu, S., et al., 2023).Quality Function Deployment (QFD)21 is a tool in quality management and product development that formulates connections between customer requirements, ofen known as the Voice of the Customer, and the attributes and specifcations of a product or service. It is used to align design and manufacturing decisions with customer needs by creating a House of Quality (HOQ) that links customer requirements to the product or service features and specifcations. QFD assists designers in understanding customer expectations, improving product or service quality, reducing design and production errors, and ultimately enhancing customer satisfaction(Michael, L. D., Johnson, D., Renaghan & L. M., 1999).

The core tool of the QFD method is the House of Quality, which links customer needs and design characteristics through a matrix format. It quantifies the relationships between them and determines the priority of design requirements based on the weight of user needs(Wu, X., Hong, Z., Li, & Y. Zhou et al., 2020).Its left wall represents user needs, the ceiling represents design requirements, and the middle is the relationship matrix, which forms the basic structure，see Figure4(Li, L., & Ye, Z. , 2023).Based on the priority of design requirements, key design requirements can be identified, and design strategies can be developed to optimize user experience. Through QFD, customer needs can be better understood and met, enhancing the product's market competitiveness and customer satisfaction.

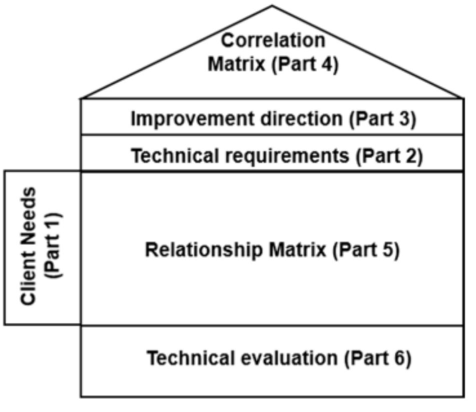


Figure 4. Basic structure of the House of Quality(Li, L., & Ye, Z. , 2023)

4.2. Establish the House of Quality

The Quality Function Deployment (QFD) technique serves as a bridge to convert identifed consumer demands into technical specifcations. It ensures that products are not only functionally robust but also resonate with the target customer, thus achieving a harmonious balance between technical feasibility and consumer desirability(Revelle, J. B., Moran, J. W., & Cox, C. A., 1998).Through the AHP analysis and calculations, the user requirement indicator weights for the elderly smart wearable glasses were obtained, and the consumer demands and their respective weights were integrated into the "left wall" of the HOQ (House of Quality). To ensure the objectivity and practicality of the design, the correlation between user needs and product technical elements was analyzed in depth. Three design professors and two graduate students specializing in design were invited for professional judgment, resulting in the selection of 15 key technical characteristics. After in-depth analysis, these 15 key technical characteristics were placed in the "ceiling" of the HOQ,see Figure 5.

Using the QFD (Quality Function Deployment) method, the importance of product features is ranked. After obtaining the user requirement weights and design specifications for the smart wearable glasses, the feature weights are calculated and normalized. These weights are then filled into the basement section of the House of Quality. Finally, a relationship matrix is established to construct the House of Quality model,see Figure 5.The black circle with a value of 5 represents a strong correlation; the white circle with a value of 3 represents a medium correlation; the triangle with a value of 1 represents a weak correlation; and the blank value of 0 represents no correlation.

Calculate the absolute and relative weights of the technical requirements based on the formula(Wang, N., Shi, C., & Wei, Y., et al. (2023)).

$$\mathrm{W_j} = \sum_{\mathrm{i}=1}^{\mathrm{q}} \mathrm{W_i}\,\mathrm{P_{ij}}$$

$$\mathrm{W_k} = \frac{\mathrm{W_j}}{\sum_{\mathrm{i}=1}^{\mathrm{q}} \mathrm{W_j}} \tag{1}$$

In the formula: $\boldsymbol{W_j}$ represents the absolute weight of the technical requirements,$\boldsymbol{P_{ij}}$ represents the correlation coefficient, and $\boldsymbol{W_k}$ represents the relative weight of the technical requirements.

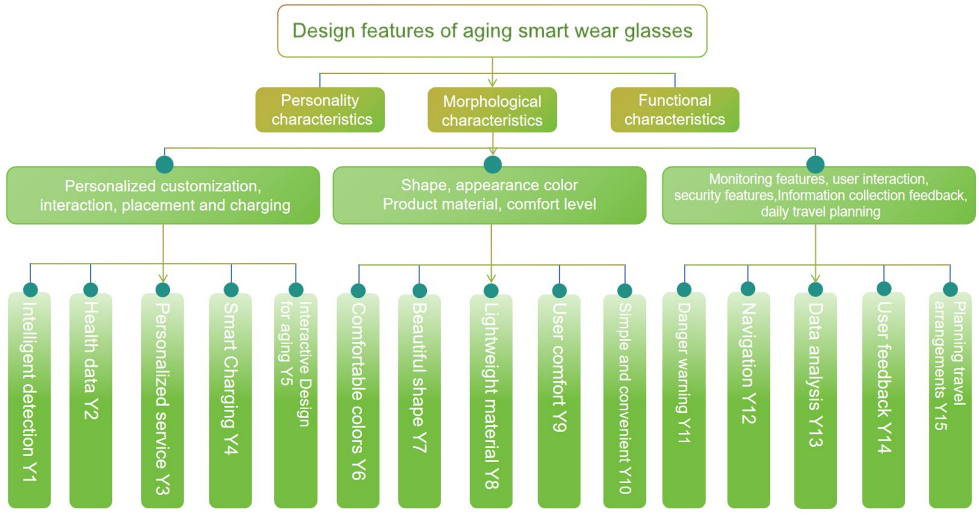


Figure 5. Design features and user requirements mapping

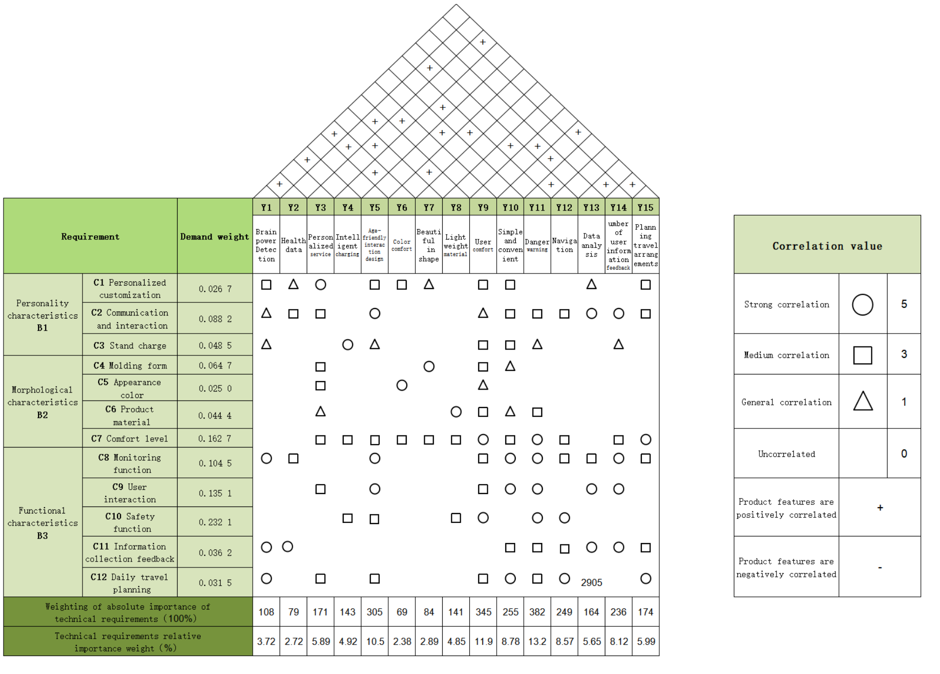


Figure 6. QFD relation matrix

The roof section is the product characteristics correlation matrix,see Figure 6.The "+" indicates a positive correlation between two product characteristics, while the "-" indicates a negative correlation. If the improvement of one product characteristic promotes the optimization of another, it is a positive correlation; conversely, it is a negative correlation. If there is no significant correlation between the two product characteristics, it is left blank.Through the analysis of the "basement" of the HOQ quality house, the importance ranking is summarized as follows based on the product characteristics scores and priorities:Danger warning > User comfort > Age-friendly interaction design > Simplicity and convenience > Navigation > User information feedback>Travel arrangement planning> Personalized service >Data analysis> Smart charging>Lightweight material >Intelligent detection> Aesthetic design>Health data >Color comfort.

4.3. Conversion of key design requirements

The collected and organized requirements were analyzed to extract key design elements, which were then ranked according to their importance. Using the relationship matrix, the correlation between design elements and user needs was quantified. Design elements with higher importance values should be prioritized as critical design factors. Based on the weighted ranking of each module, the design guidance concludes that the focus should be on (danger warning, user comfort, age-friendly interaction design, simplicity and convenience, and navigation) as starting points for divergent innovation in the design of age-friendly smart wearable glasses, ensuring that the real needs of users are thoroughly considered.

In the process of accurately translating users' actual needs into design practice, the design of an intelligent wearable glasses for the elderly is comprehensively guided by the 12 demand analysis weights derived from the AHP analysis and the 15 technical elements refined through QFD. This ensures that the design of the glasses aligns with the needs of elderly users, integrating the requirements transformation and guiding design practice comprehensively.

5. Design strategy for smart wearable glasses for the elderly

5.1. Smart wearable glasses for the elderly

Through the key design elements extracted from the preliminary research and final analysis, a design strategy is developed. Compared to traditional smart wearable glasses, aging-friendly smart wearable glasses place more emphasis on the real needs of the elderly. With smart glasses as the product's design focus, this study explores and designs aging-friendly smart glasses. The design incorporates features such as danger alerts, user comfort, aging-friendly interaction design, simplicity and convenience, and navigation, providing comprehensive care and protection for the target users. By continuously optimizing product functionality and design details, a higher-quality living experience is offered to the elderly.

5.1. Smart wearable glasses for the elderly

Aging-friendly smart wearable glasses focus on a minimalist design in terms of product appearance, ensuring they fit seamlessly into daily life scenarios. Whether in a home setting or during outings, the design facilitates easy wear for the target users, while maintaining a certain level of aesthetic appeal. The design features a lightweight and comfortable frame, made from flexible or smart materials, making it suitable for long-term wear.

Key product features, such as comfort, functionality, and aesthetic appeal, were identified and prioritized in this analysis. These insights were converted into technical specifications using the QFD method. For example, comfort might be translated into specifications for weight and material choices, functionality into user interface design, and aesthetic appeal into the shape and color of the product. A typical example of such a contradiction might be balancing the need for lightweight glasses with sufficient battery life and high-resolution displays. This methodology, which combines customer feedback with technical innovation, not only enhanced the user experience of the smart glasses but also drove innovation in their design(Lee, C. K. M., Tsang, Y. P., Chong, W. W. & Au et al., 2024).

Using the conceptual design of smart glasses products as an example, the feasibility and effectiveness of the proposed methodology are demonstrated。According to the results, have been generated to improve the sustainable design of smart glasses, which can be grouped into five categories:

1)Minimalist interface, convenient experience

Minimalism, ultimate ease of use, with the design focus centered on the needs of the elderly. Through a minimalist interface design and intuitive operation, it ensures they can quickly get started and use the device with ease. The introduction of a smart voice assistant allows the elderly to complete all operations using voice commands. The icons are kept to the bare minimum, avoiding a complicated interface that could lead to difficulty in use. Font colors contrast sharply with the background to ensure clarity under any lighting conditions. The device's appearance is simple, equipped with a smart charging case for easy charging and storage.

2)Smart navigation, smooth journey

When designing the navigation detection module for aging-friendly smart wearable glasses, it is essential to consider the special needs of the elderly, ensuring that it is simple to use and fully functional. The glasses provide precise walking navigation, guiding the wearer to their destination and preventing them from getting lost. The navigation display module integrates a transparent screen on the lens to show the navigation route, warning information, and more. Environmental perception is incorporated to detect the surrounding environment, identifying obstacles, potholes, or other potential hazards, and alerting the wearer. On the technical side, GPS is used for real-time location tracking and navigation. Infrared sensors detect surrounding obstacles to avoid collisions. Considering the elderly's cognitive abilities and hand-eye coordination, the design features a simple, intuitive interface and voice commands, making it easier for the target users to operate.

3)Dynamic information, real-time updates

The dynamic information module is designed to update health data in real time, facilitating the collection and transmission of user information. A dedicated area on the device's interface is allocated to display dynamic information such as heart rate, blood pressure, weather, etc. This information is presented in an intuitive and concise manner. Customization options allow elderly users to adjust the information update frequency, display methods, and more according to their needs. User interaction can be performed through voice commands, touch, or simple gestures to interact with the glasses, ensuring ease of use for the elderly. The hardware design of the information detection module, which includes various sensors, processing units, and communication interfaces, ensures accurate information collection and real-time feedback.

4)Customizable itinerary, easy travel

The travel arrangement module is one of the key functions of the system, with the main goal of helping elderly users achieve a safe, convenient, and personalized travel experience. Based on the wearer's needs and preferences, it provides the optimal travel plan. One-click itinerary planning: The device has a built-in intelligent itinerary planning system, where users only need to input their destination or select a preset travel scenario, and the system will automatically plan the optimal route. The GPS module collects real-time location data for positioning and travel planning. It also monitors the wearer's movement status to determine whether they are walking, stopped, or experiencing an abnormal situation. The travel arrangement module is the core part of providing intelligent travel services for the elderly, helping them plan the safest and most convenient travel routes based on real-time health status, traffic information, and environmental awareness.

5)Safety alerts, life protection

The module aims to continuously monitor the wearer's physiological state and surrounding environment, identify potential dangers, and issue timely warnings. Health monitoring and alerting: It tracks key physiological indicators such as heart rate, blood pressure, and blood oxygen saturation in real-time. Through multi-sensor data fusion, intelligent analysis, and prompt feedback, the danger alert module can minimize the risks elderly individuals face in daily life, especially in scenarios such as going out, exercising, or health anomalies. Environmental hazard detection: It monitors the surrounding environment, such as obstacles and dangerous areas, and provides early warnings to the wearer. Emergency response and assistance: In case of danger, the system immediately alerts the wearer through voice, vibration, or visual prompts, and activates the emergency assistance function.

6. Conclusion

In summary, this study not only addressed the challenges faced in sustainable product design, but also demonstrated the feasibility of an integrated innovation design process based on AHP and QFD.Through research, the final technical features and user needs have been distilled, providing a certain research approach and development space for the design. Due to the unique characteristics of the elderly population, it is necessary to consider both their physiological and psychological needs, offering a fresh perspective for designing wearable glasses for the elderly. In summary, aging-friendly smart wearable glasses, as a product combining technological innovation and elderly care services, have broad development prospects and significant social value. With continuous research and optimization, they are expected to create a better quality of life for the elderly, fulfilling both physiological and psychological needs.

Acknowledgements

This research was financially supported by the Zhejiang Provincial Department of Education Visiting Engineer "University-Enterprise Cooperation Project" (Project No. FG2024081) and the Teaching Construction and Reform Research Project of Wenzhou Polytechnic (Project No. WZYzd202402).

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