Design Requirements for Accessible Dining Apparel for the Visually Impaired

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Abstract

This study addresses the lack of targeted research on accessible dining clothing for the visually impaired. In response to this gap, we conducted a mixed-methods study involving in-depth interviews, questionnaire surveys, and real-world experiments with visually impaired participants to examine their specific clothing needs during meals. The findings reveal key challenges in color recognition, stain detection, garment cleaning, functional design, and personalization. Based on the results, we identify core design requirements for accessible bibs, including stain-resistant materials, ergonomic structures, and aesthetic considerations tailored to user preferences. This paper contributes empirical insights and practical guidelines to support inclusive design in sustainable fashion, offering a theoretical foundation for the future development of accessible clothing for the visually impaired.

Keywords: Visually Impaired; Accessible Design; Sustainable Fashion; Design Requirements

1. Review

Sustainable fashion and development have gained growing public attention. In this context, barrier-free design has emerged as a key trend in the development of China's fashion industry, as well as globally. Wang Yingying [1] pointed out that solving the development problems of the fashion industry is the fundamental purpose of the research on sustainable fashion design methodology; Gu Yanqin [2] proposed that sustainable design is intended to guide and satisfy consumer demands and to maintain the continuous satisfaction of the demands. Based on demographic data from China's sixth national population census (National Bureau of Statistics, 2011) and the second national sample survey of persons with disabilities (China Disabled Persons' Federation, 2010), the proportion of persons with disabilities in the total population and the distribution of different disability categories were systematically analyzed. The results show that by the end of 2010, the total number of disabled individuals in China was approximately 85.02 million, accounting for 6.34% of the national population. The World Health Organization reported that the number of the visually impaired in China has reached more than 17 million [3]. According to the report, the number of visually impaired in China accounts for occupied 38 percent of the total number in the world, and is still growing at a rate of 20 percent per year [4]. Secondly, in terms of legislation, the Law of the People's Republic of China on the Construction of Barrier-Free Environments has been implemented to provide legal protection for the construction of barrier-free environments in the context of aging populations [5]. Accessibility, as a concrete implementation of sustainable fashion in adaptive clothing, has become urgent and crucial for addressing the access needs of visually impaired individuals in the fashion industry, while promoting the integration of sustainable fashion concepts and adaptive clothing design. This integration addresses the practical needs of the visually impaired and reinforces the core principle of inclusivity in sustainable fashion, thereby driving industry-wide innovation.

Research related to accessible clothing mainly focused on the physically challenged group, while the needs of the visually impaired have not yet been adequately studied. Scholars such as Ding Hongyue [6] proposed the principle of pervasive design by analyzing the characteristics of the visually impaired population; Yuwen Taman [7] et al. initially explored the effects of clothing on the physiology and psychology of the people with disabilities; Luo Yimin [8] et al. systematically elaborated on the development of the national standard of Touch Graphic Design Guidelines and Legends as well as the content of the standard; and Zhang Yannan [9] et al. carried out the apparel

design in terms of apparel logos, colors, styles, and craftsmanship. He Jiatan further expanded the scope of accessible clothing design by introducing a framework that integrates functionality, aesthetics, and psychological comfort across instinctive, behavioural, and reflective levels [10]. All the above studies focused on the functionality, physiological, and psychological impact of clothing and logo designs. However, there remains a significant gap in research on the needs of adaptive accessories for people with disabilities and their functionality in specific scenarios, such as dining, which constitutes a substantial portion of daily life (e.g., 7.2 hours on average). International studies have explored the general clothing needs of visually impaired individuals [11] and reviewed smart wearables for mobility and sensing support [12]. Although there have been studies on the life portraits of visually impaired individuals [13], research on clothing accessories in specific daily scenarios has received little attention. However, little attention has been paid to clothing accessories in specific daily scenarios. This study focuses on dining—an activity involving frequent contact with garments and hygiene challenges—and proposes user-centered design guidelines for accessible bibs based on empirical needs analysis and observational insights.

The purpose of this paper is to investigate the adaptive clothing accessory needs of individuals with visual impairments, with a specific focus on dining-related requirements. First of all, three forms of research were carried out: in-depth interviews, questionnaire surveys, experimental interviews, questionnaires and experiments in the dining scenes, and it was found that the visually impaired had certain obstacles in the areas of color recognition and matching, detecting, and cleaning of dirty clothing in the dining scenes, and it still needs to make more efforts to develop the functional and practical designs of clothing, clothing marking and structure, and personalization and aesthetic expression, and so on. Then, based on the results of the research, we summarized the requirements of the visually impaired for accessible bibs in the dining scenarios.

2. Methods

The research on accessible bibs for the visually impaired was conducted in three methods, namely, in-depth interviews, questionnaire surveys, and dining scene experiments. Based on the concept of sustainable fashion, the visually impaired and the able-bodied groups are both the subjects of the research.

2.1 In-depth Interviews

Focus groups and in-depth interviews were used to conduct the interviews. The research was conducted from April to September 2024 to understand the potential demands and acceptance for the clothing of the visually impaired. To ensure the universality of research samples among the visually impaired, 20 representative participants with diverse backgrounds were selected for the study. Participants in the study came from diverse backgrounds, including but not limited to individuals affiliated with organizations supporting people with visual impairments, such as blind massage centers, schools for the visually impaired, blind associations, blind art troupes, arts and public welfare organizations, and those experiencing unemployment or homelessness.

2.2 Questionnaire Surveys

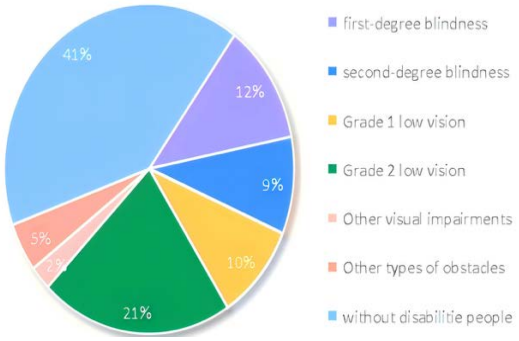


Fig.1 Distribution of barriers in the research sample.

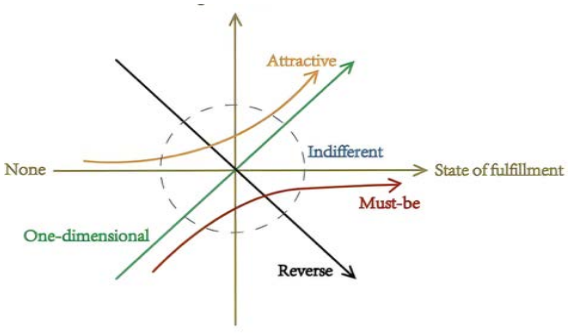


Fig.2 Schematic diagram of the Kano model

A random sampling method was used to distribute and collect the questionnaires through online research. To further analyze and verify the demands of the visually impaired for accessible bibs on a wider scale based on interviews, an online questionnaire survey was conducted from August to September 2024 among the visually impaired people with different levels of visual impairment across the country. More than 50 questionnaires were collected, and the questionnaire surveys summarized the basic disability status of the respondents, and the distribution of disability status is shown in Fig.1.

For the questionnaire design, firstly, to further identify the specific user needs of the bibs and to achieve the optimal design solution. The Kano model, which emerged in the 1980s, is notable for its simplicity and has become a valuable analytical tool for researchers and practitioners by helping them in their efforts to understand and anticipate customer expectations [14]. The study used the KANO model to refine and prioritize the demand attributes (Fig.2), and then, based on the barriers of the visually impaired, the study optimized the questionnaire setup in the questionnaire setting section (Table 1).

Table 1. Points to note in the pre-release session of the questionnaire

Direction of obstacles	Obstruction points	Solution
Questionnaire platform selection	Unable to fill in the verification code	Selected Tencent questionnaire platform
Type of title	Difficulty in reading, misreading by screen-reading software due to specific filling patterns and interspersing of different question types	The questions have been reorganized into multiple-choice and fill-in-the-blank questions that are easy to use.
Title content	Complex language leads to difficulties in understanding and time-consuming problems in filling out the form.	Streamline text and add an option to change item alerts.
Psychological feeling	Some visually impaired groups feel offended and misinterpret meal pockets as a metaphor for being unkempt and incapable of self-care.	Addition of a section to the questionnaire stating the reasons for the choice of bibs and an evaluation of the feelings of the person completing the questionnaire.

In summary, this questionnaire is finally divided into three main parts: 1) KANO questionnaire: set up positive and negative questions for product features and services to accurately capture the psychological feelings of the respondents; 2) basic information: coverage, gender, handicap, occupation, and residence status; 3) open feedback: collect suggestions for improvement of the questionnaire to improve the quality of the follow-up questionnaire. The specific questionnaire is attached.

2.3 Dining Scene Experiments

Questionnaires were distributed and collected through online research. To guide the functional design of the accessible meal bibs, from August to September 2024, five visually impaired individuals and one other without-disability were invited to participate in the experiment. The experiment required subjects to wear full-frontal aprons for two days. Throughout this period, photographs were taken of their breakfast, lunch, and dinner meals, as well as of the aprons' condition post-meal. This study recorded 18 meals across 6 participant groups to observe stain distribution and the protective effects of bibs in reducing food residue and liquid splashes, thereby providing empirical data for the subsequent development of accessible bib designs.

3. Results

3.1 In-depth Interview Results and Analysis

The surveys on the clothing needs of the visually impaired concluded that there were more than 40 obstacles, and since the attributes of the needs showed strong interconnections and potential interactions with each other, to

improve the efficiency of solving these needs, these attributes of the needs were categorized into five main aspects. By focusing on each of these dimensions, comprehensive satisfaction of the needs in this area will be achieved (Table 2, Fig.3):

Table 2. Analysis of the five demand attributes

	Main factors	Times of demand points mentioned	Percentage (%)
1	Practical and functional design of clothing	22	31.01
2	Color recognition and aesthetic matching issues	15	21.13
3	Shopping and Choice Barriers	14	19.72
4	Personal self-care and the problem of carrying auxiliary tools	6	8.45
5	Social consciousness and personalized needs of clothing	5	7.04

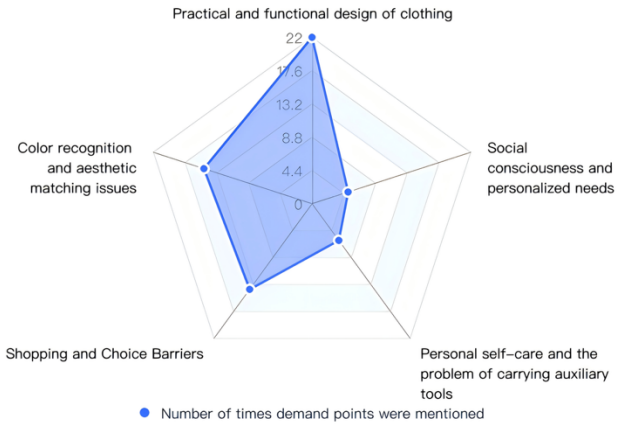


Fig.3 Radar chart of the five needs

Considering the quantity of identified demand points and feasibility constraints arising from functional limitations of garments and accessories, this study will prioritize the primary demands of the first two groups. Specifically, the obstacle points within Groups 1 and 2 will be re-extracted and reclassified to generate Table 3.

Table 3. Ordering of specific obstacle points, drawn by the author

	Barrier point description	Number of occurrences	Percentage (%)
1	Difficulty in color recognition and matching	15	21.13
2	Problems in detecting and cleaning soiled clothing	10	14.08
3	Inadequate functional and practical design of clothing	9	12.68
4	Clothing identification and construction problems	9	12.68
5	Barriers to personalization and aesthetic expression	6	8.45

3.2 Results of the Questionnaire and Analyses

3.2.1 Questionnaire Reliability and Validity

Firstly, the questionnaire was conducted online in August 2024, and 50 copies were collected. According to the pre-test results, one and a half minutes is a reasonable time to complete the questionnaire. Therefore, the questionnaires with too short a duration, i.e., less than one and a half minutes, or a lack of consistency of options were deleted from the online survey, and finally, 42 valid responses were obtained, with a validity rate of 84. Then, SPSS was used to analyze the reliability of the questionnaires, and Cronbach's alpha coefficients under each dimension in the KANO research questionnaires were all exceeded 0.6, so the questionnaires' reliability could be trusted. In SPSS validity analysis, the KMO test value of positive and negative questions is 0.755, and both p-

values are less than 0.01, the cumulative variance explained after rotation is 68.205>50, which means that the amount of information of the research items can be extracted effectively and can be analyzed subsequently [15].

3.2.2 Demand Prioritization Analysis

Based on the method and calculation principle of the Kano model, the Kano statistics of 20 service elements are shown in Table 4.

Table 4. Summary of KANO model analysis results, drawn by the author

No.	Functions Services	A' (%)	O (%)	M (%)	I (%)	R (%)	Q (%)	Classification results	Better (%)	Worse (%)
A	Braille signs and tactile signs	19.05	14.29	16.67	42.86	2.38	4.76	Undifferentiated properties	35.90	-33.33
B	Clean and Stain Resistant Fabrics	16.67	28.57	30.95	16.67	2.38	4.76	Required Attributes	48.72	-64.10
C	Velcro or magnetic closure	7.14	14.29	45.24	28.24	4.76	0.00	Required Attributes	22.50	-62.50
D	Multi-functional pockets	2.38	9.52	47.62	33.33	7.14	0.00	Required Attributes	12.82	-61.54
E	Complexity or simplicity of design, degree of use of trim and seams	11.90	23.81	35.71	21.43	2.38	4.76	Required Attributes	38.46	-64.10
F	Shopping platform for the visually impaired	4.76	47.62	21.43	14.29	9.52	2.38	Desired Attributes	59.46	-78.38
G	Shopping guide service	2.38	35.71	30.95	16.67	7.14	7.14	Desired Attributes	44.44	-77.78
H	Personalized service	9.52	16.67	38.10	26.19	9.52	0.00	Required Attributes	28.95	-60.53
I	Clothing matching seminars or workshops	2.38	28.57	47.62	14.29	7.14	0.00	Required Attributes	33.33	-82.05
J	Accessibility to assistive devices	9.52	35.71	28.57	19.05	7.14	0.00	Desired Attributes	48.72	-69.23

Remarks: A: Attractive Attribute, O: Desired Attribute, M: Mandatory Attribute, I: Undifferentiated Attribute, R: Reverse Attribute, Q: Questionable At tribute.

Taking the horizontal coordinate as the absolute value of Worse and the vertical coordinate as the Better value, a Better-Worse coefficient diagram is made, as shown in Fig.5, the first quadrant is the desired attribute, the second quadrant is the glamour attribute, the third quadrant is the non-differentiated attribute, and the fourth quadrant is the must-have attribute.

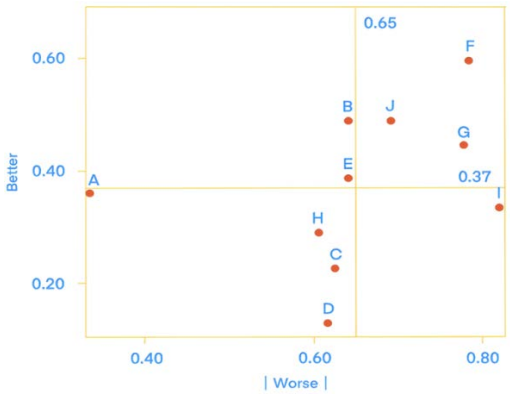


Fig.4 Better-Worse coefficient plots, drawn by the author

According to the previous section, the study should focus on the three core attributes in the KANO model: essential attributes, desired attributes, and glamour attributes. From the table, it could be understood that clean and stain-resistant fabrics, Velcro or magnetic fasteners, multifunctional pockets, complex or simple designs, the degree of use of decorations and seams, personalized customization services, and fashion matching seminars or workshops are essential attributes that should be addressed as a primary design requirement. Shopping platforms for the visually impaired, shopping guide services, and the convenience of using assistive devices are desired attributes, considered desired attributes and positively correlated with user satisfaction. As for Braille and tactile signage, since they are judged to be non-differentiating attributes, they may be incorporated as needed depending on the application context.

In comparison with the Better-Worse Coefficient Chart, the classification of some attributes has been adjusted, with clean and stain-resistant fabrics, complicated or simple designs, and the degree of decoration and seam usage becoming glamour attributes, which can greatly enhance user satisfaction, while Velcro or magnetic fasteners, multifunctional pockets, and personalized customization services have been changed to non-differentiated attributes, which have a weaker impact on end-user satisfaction.

In summary, based on the premise of enhancing user satisfaction, the study should conduct an in-depth research and innovation on the design aspects of shopping platforms for the visually impaired, shopping guide services, the convenience of using assistive devices, clothing matching seminars or workshops, clean and stain-resistant fabrics, complicated or simple design, and the degree of decoration and seam usage, while adopting a flexible strategy for the treatment of non-differentiated attributes to ensure the effective allocation and utilization of resources. The use of resources should be ensured by adopting a flexible strategy in the treatment of non-differentiated properties.

3.3 Dining Scenario Experiments Results and Analysis

The results of the experiments are presented in Fig.6, where the bibs are mainly concentrated on the front chest and abdomen, effectively protecting these areas from food residues and liquids. Fig.6. provides an overall visualization of stain distribution, showing that food residues were primarily located at the neckline, central chest, and upper thigh regions of the bibs.

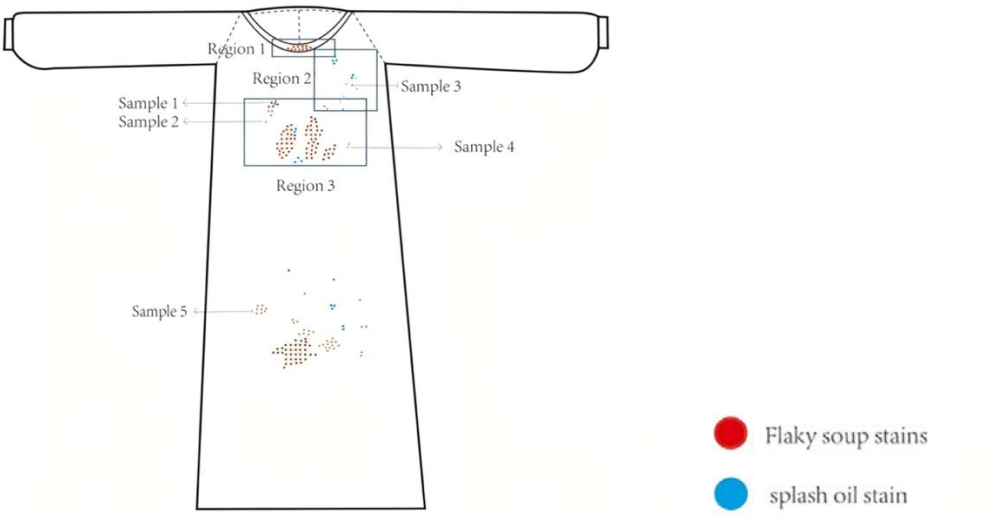


Fig.5 Visualization of the experimental results of the bibs

It was found that the appearance of stains during meals is usually related to 1) the splashiness of the food, 2) the technique of using cutlery, 3) the protective effects of the bib, and 4) individual eating habits. The analysis by region combined with the type of stains leads to design suggestions: region 1 needs anti-leakage and soft fabrics that fit the neck structure to prevent soup from entering; Region 2 needs to use waterproof and grease-proof fabrics so that splattered grease naturally slips and falls into the micro-arc structure; region 3 needs to be combined with ergonomics and structural adjustments, such as micro-arc modeling, to pocket the stains securely.

4. Discussion

Based on survey and experimental data, this study identified key clothing needs of visually impaired individuals in dining contexts, including stain-resistant fabrics, ergonomic protective structures, and easy-to-wear garment configurations. Unlike previous research focusing on general dressing needs or assistive technologies [11][12], this study emphasizes garment-based functional optimization in the high-frequency context of dining. Targeted material and structural recommendations help reduce technological reliance and address gaps in contextual clothing design. The findings expand the adaptability of inclusive apparel and support the development of practical, accessible clothing. To enhance practicality, future apron designs should better accommodate users' physical characteristics and habits. Bib styles should also be made more portable and easier to wear, improving independence and comfort during meals. These directions can further advance the real-world application of inclusive design for visually impaired users.

5. Conclusion

Through the in-depth interviews, questionnaires, and dining scene experiments, this paper researches the accessible clothing needs of the visually impaired, mainly focusing on the accessory needs in the dining scene, and draws the following conclusions.

1) The research study summarizes five major demand aspects of the visually impaired: practicality and functional design, color recognition and aesthetic matching, shopping and choice barriers, personal self-care, carrying of aids, social awareness, and personalized needs. Among them, the problems of practical and functional design, color recognition, and aesthetic matching were particularly prominent. Further analysis showed that difficulties in color recognition and matching, problems in detecting and cleaning dirty clothes, and insufficient functional and practical design of clothes were the main barriers faced by the visually impaired.

2) The questionnaire summary is divided into two directions for setting up and prioritizing the needs. In terms of setting up needs, there are four main points: a universal platform, easy-to-operate topics, clear and concise topic content, and positive psychological feelings; in terms of prioritizing needs, shopping platforms for the visually impaired, shopping guide services, ease of use of assistive tools, clothing matching seminars or workshops, clean and stain-resistant fabrics, complicated or simple designs, and the degree of use of decorations and seams. In terms of need prioritization, the seven needs of visually impaired shopping platforms, shopping guide services, ease of use of aids, clothing matching seminars or workshops, clean and stain-resistant fabrics, complicated or simple designs, and the degree of use of decorations and seams need to be focused on.

3) In the scenario experiments, firstly, stains were concentrated on the neckline, chest, and front of the thighs in a dining environment. Then, in terms of design details, the designer needs to analyze and adjust the fabric and structure scientifically and rationally.

This paper provides scientific suggestions for the design of accessible clothing for the visually impaired and provides a certain theoretical basis and experience for subsequent research on accessible clothing for the visually impaired.

6. Acknowledgement

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