Journal of Infrastructure, Policy and Development 2024, 8(8), 6230.
https://doi.org/10.24294/jipd.v8i8.6230

Article

Consumer-consumption-need theoretical model for smart clothing: Construction and empirical study for Chinese silver-haired population

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CITATION

Li Z, Song X, Guo M, Fang L. (2024). Consumer-consumption-need theoretical model for smart clothing: Construction and empirical study for Chinese silver-haired population. Journal of Infrastructure, Policy and Development. 8(8): 6230. https://doi.org/10.24294/jipd.v8i8.6230

ARTICLE INFO

Received: 6 May 2024
Accepted: 27 May 2024
Available online: 12 August 2024

Abstract: In the era of artificial intelligence, smart clothing, as a product of the interaction between fashion clothing and intelligent technology, has increasingly attracted the attention and affection of enterprises and consumers. However, to date, there is a lack of focus on the demand of silver-haired population's consumers for smart clothing. To adapt to the rapidly aging modern society, this paper explores the influencing factors of silver-haired population's demand for smart clothing and proposes a corresponding consumer-consumption-need theoretical model (CCNTM) to further promote the development of the smart clothing industry. Based on literature and theoretical research, using the technology acceptance model (TAM) and functional-expressive-aesthetic consumer needs model (FEAM) as the foundation, and introducing interactivity and risk perception as new external variables, a consumer-consumption-need theoretical model containing nine variables including perceived usefulness, perceived ease of use, functionality, expressiveness, aesthetics, interactivity, risk perception, purchase attitude, and purchase intention was constructed. A questionnaire survey was conducted among the Chinese silver-haired population aged 55–65 using the Questionnaire Star platform, with a total of 560 questionnaires issued. The results show that the functionality, expressiveness, interactivity, and perceived ease of use of smart clothing significantly positively affect perceived usefulness ($P < 0.01$); perceived usefulness, perceived ease of use, aesthetics, and interactivity significantly positively affect the purchase attitude of the silver-haired population ($P < 0.01$); perceived usefulness, aesthetics, interactivity, and purchase attitude significantly positively affect the purchase intention of the silver-haired population ($P < 0.01$); functionality and expressiveness significantly positively affect perceived ease of use ($P < 0.01$); risk perception significantly negatively affects purchase attitude ($P < 0.01$). Through the construction and empirical study of the smart clothing consumer-consumption-need theoretical model, this paper hopes to stimulate the purchasing behavior of silver-haired population's consumers towards smart clothing and enable them to enjoy the benefits brought by scientific and technological advancements, which to live out their golden years in comfort, also, promote the rapid development of the smart clothing industry.

Keywords: silver-haired population; smart clothing; functional-expressive-aesthetic consumer needs model; technology acceptance model; risk perception; consumer-consumption-need theoretical model

1. Introduction

With the continuous updates and iterations of information technology and artificial intelligence, the ongoing development of the economy and society, and the continuous improvement of people's living standards, the trend towards a smarter and more intelligent society has become a major direction for future development (Chen and Ye, 2023; Wang and Wang, 2021). The public's aspirations and expectations for a better life and the continuous pursuit of a happier and more fulfilling future are growing. Smart clothing, a new entity born out of the information technology revolution, is both a fashion garment based on textiles (Chen and Ye, 2023) and a high-tech product characterized by intelligent technology (Alattar and Mohsen, 2023). It also falls within the category of special-needs clothing design (Orzada and Kallal, 2021), representing a product of wisdom created through the interaction of fashion garments and intelligent technology. Based on the specific needs of the research subjects, current smart clothing research is mostly centered around fields such as healthcare (Alattar and Mohsen, 2023; Mahmood and Lee, 2020; Thompson, 2016), health monitoring (Bunn et al., 2018; Runkle et al., 2019), infotainment (Ates et al., 2021; Channa et al., 2021; Weizman et al., 2020), leisure sports (Dizon-Paradis et al., 2022; Lee et al., 2021), and risk and public safety (Shakeriaski et al., 2022; Shen and Sun, 2023; Yang et al., 2018).The advent of smart clothing plays a significant role in promoting innovation, enhancing health and well-being, and improving the quality of people's lives (Imbesi and Scataglini, 2021). The market for smart clothing has grown from approximately $212 million in 2014 to over $1.8 billion in 2021, and it is projected that by 2025 or 2030, the market size may reach tens of billions of dollars (Orzada and Kallal, 2016; 2021; Wang and Wang, 2021). At the same time, the continuous development of smart clothing has not only expanded the functional attributes of clothing products but also, to a certain extent, provided greater possibilities for the silver-haired population to access intelligent aging products and experience the achievements of high-tech innovation (Imbesi and Scataglini, 2021). Compared to traditional clothing, the functions it possesses make smart clothing also suitable for the silver-haired population with certain intelligent and interactive behavior needs. Despite the promising prospects and functions of smart clothing, and its rapid rise as a hot topic in the clothing industry and research fields (Li et al., 2022), it is still in the early stages of commercialization, and there is still considerable uncertainty about consumer acceptance. Much of the research focuses more on the innovation, development, and application of smart clothing technology (Chen et al., 2016; Chen and Ye, 2023), and there is a scarcity of research on consumer acceptability and purchase attitude and behavior towards smart clothing (Orzada and Kallal, 2021; Wang and Wang, 2021), with even fewer studies targeting the silver-haired population (Chen and Ye, 2023; Imbesi and Scataglini, 2021).

Population aging has been spreading globally, with the world gradually growing "older" (CDRF, 2020). Population aging is projected to be one of the most significant social transformations and trends of the 21st century, exerting profound influences across virtually all sectors, leading to the increasing recognition of seniors as contributors to societal development (UN, 2022). Japan, South Korea, and the European Union, which have been the first to experience the impact of population aging, regard the silver-haired economy as a new economic growth point for aging societies (Ji and Dai, 2024). Concurrently, China has rapidly entered the phase of an aging society, where the silver-haired economy is also set to become a new engine for economic growth. This can be achieved by expanding the supply of products and services for the “silver-haired population”, creating more job opportunities, stimulating new consumer markets, and driving economic growth (Ji and Dai, 2024; Yi and Xu, 2023). Moreover, with Chinese large and rapidly growing market for smart clothing and wearable technology (Ye et al., 2022), the silver-haired population represents an incremental market rather than a saturated one. It is not a red ocean market but a blue ocean market. There is a necessity for targeted research on the consumption behavior of the silver-haired population regarding smart clothing in China, and studying Chinese consumer behavior will also provide significant opportunities for cross-cultural comparisons with research in other countries.

Most past studies, with a greater emphasis on medical backgrounds, have focused on functional and service design, with past research focusing on protective and health monitoring aspects (Shen and Sun, 2023), and to some extent, neglecting the consumption expectations and psychological needs of the silver-haired population for a smart lifestyle in their daily lives (Chen and Ye, 2023; Imbesi and Scataglini, 2021). This paper, with the elderly as the target consumers for smart clothing design, is not only an extension of humanistic care for the silver-haired population under the current development of scientific and technological innovation but also a new attempt and exploration of future intelligent aging products. In the research on smart clothing, some scholars have adopted the Technology Acceptance Model (TAM), the Functional, Expressive, and Aesthetic consumer needs model (FEAM), or a combination of both (Chen and Ye, 2023) for their studies. Imbesi and Scataglini (2021) proposed a user-centered design philosophy for smart clothing design for special needs, especially for the elderly, which requires an organic integration of consumer and user needs, interaction, experience, technology, and market technical requirements related to the innovation design process (Chen and Ye, 2023; Fernández-Caramés and Fraga-Lamas, 2018). Since the TAM model and the FEA consumer needs model are too general to explain the specific factors of the phenomena investigated, it is necessary to combine the two models to enhance the theoretical basis or to add additional variables to enhance their overall explanatory power (Bianchi et al., 2023; Chen and Ye, 2023; Tsai et al., 2020). Therefore, this study, based on the combination of the TAM and the FEAM, reconstructs a consumer-consumption-need theoretical model that integrates clothing design, technological innovation, and consumer psychology and behavior by introducing two new variables: interactivity and risk perception. Building on existing literature, this study proposes relevant research hypotheses and investigates the factors influencing the silver-haired consumers’ purchase of smart clothing through a questionnaire survey, and then analyzes and draws the model using SPSS and Amos software. It is hoped that through the construction and empirical testing of the smart clothing consumer-consumption-need theoretical model, it can stimulate the purchasing behavior of silver-haired population’s consumers towards smart clothing and promote the rapid development of the smart clothing industry.

2. Literature review

2.1. Smart clothing

Caird (1994) posits that smart clothing represents a new concept in apparel, combining the attributes of textile fabrics with computer functionalities. It is a functional garment that integrates material properties with electronic technology. With the further advancement of computer technology, smart clothing has emerged alongside wearable technology. Since 1999, smart clothing has evolved to a form that perfectly integrates clothing with computers. Consequently, Chae (2009) considers smart clothing as a new concept in apparel, a fusion of clothing with innovative IT functionalities that add value, including computer functions achieved through high technology (digital and applied IT technologies), while maintaining the inherent sensitivity of clothing. In this regard, smart clothing is described as an "intelligent system" capable of perceiving and communicating environmental and user conditions and stimuli (Cho et al., 2009). The Textile Institute (2001) defines smart clothing as a new apparel function that can provide interactive responses by sensing signals, processing information, and initiating responses. Turhan (2013) views smart clothing as wearable technology, an innovative technological development. Thus, smart clothing is also an innovative wearable device capable of receiving data from the user or his/her surrounding environment (Ju and Lee, 2020). Smart clothing embodies both fashion innovation and technological innovation, representing an innovative product concept with functions that preserve personal physical condition information, check the external environment, and utilize information technology, supporting various digital devices to provide essential functions for our future lives (Noh et al., 2016). Ju and Lee (2020) directly assert that smart clothing is the application of wearable devices in the fashion domain, integrating sensors and information technology into garments to offer dual functionalities of perception and feedback, enhancing value through electronic components. Smart clothing can not only detect changes in the external or internal environment but also respond to these changes through a feedback mechanism (Chen and Ye, 2023; Ju and Hu, 2017; Oliveira et al., 2022).

In summary, the distinction between smart clothing and conventional attire lies in the former's focus on actual human needs beyond the primitive requirement of clothing for warmth, such as psychological, economic, and social needs (Li et al., 2022). This paper posits that smart clothing is an intelligent new concept in apparel, belonging to both fashion garments based on textiles and high-tech products characterized by intelligent technology. It also falls within the scope of special-needs clothing design, representing a product of wisdom created through the cyclical interaction of consumer demands, fashion garments, and intelligent technology.

2.2. Technology acceptance model (TAM)

Davis (1989), building upon the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975), developed the Technology Acceptance Model (TAM), a more generalized adaptation. The TAM model is one of the most validated models for explaining the acceptance and intention to use information technology. Its objective is to predict and understand the use of information technology and to integrate technological and socio-organizational concepts to identify the key factors that lead to the acceptance or rejection of a technology by users (Davis et al., 1989). The model is based on perceived usefulness (PU) and perceived ease of use (PEOU) as key internal determinants to explain user behavior towards technology adoption, which can also be influenced by other external factors (Davis, 1989). These are the most frequently validated factors affecting users' attitudes towards technology and innovative products, as well as their intention to purchase (Davis et al., 1989). Researchers have confirmed TAM as a well-known and concise framework extensively applied to understand user adoption of technology across various contexts, including websites (Lee et al., 2006; Saleem et al., 2022; Venkatesh and Davis, 2000), smartwatches/mobile phones (Chuah et al., 2016; Park and Chen, 2007), and smart clothing (Chae, 2009; Chen and Ye, 2023). Despite its significant explanatory power, the framework may be too general to account for the specific factors of the phenomena investigated. Most studies based on the TAM either introduce additional variables to enhance its overall explanatory power or combine TAM with other theories to consolidate the theoretical basis of the research model (Chen and Ye, 2023; Tsai et al., 2020; Zin et al., 2023).

2.2.1. Perceived usefulness (PU)

Davis (1989) considers that perceived usefulness is the degree to which a person believes that using a particular system will enhance his or her job performance. Perceived usefulness is also how consumers measure the extent to which a product or function helps improve work efficiency when considering the application of a product, technology, system, or clothing. Perceived usefulness has consistently been recognized as a powerful predictor of the intention to use and adopt technology (Venkatesh et al., 2003; Ye et al., 2022). Hwang et al. (2016) found, in their study of solar-powered smart clothing, that perceived usefulness impacts American consumers' attitudes and intentions to purchase. Research on smart clothing in China has revealed that perceived usefulness has a significant positive effect on purchase attitudes and intentions (Chen and Ye, 2023; Wang and Wang, 2021). Based on the aforementioned research analysis, this study proposes the following research hypotheses:

H1a: Perceived usefulness positively affects purchase attitude.

H1b: Perceived usefulness positively affects purchase intention.

2.2.2. Perceived ease of use (PEOU)

Davis (1989) suggests that perceived ease of use is the degree to which a person believes that using a particular system will be free of effort. Perceived ease of use is also how consumers gauge the ease or difficulty of using a product, technology, system, or clothing. Park and Chen (2007) found that perceived ease of use positively influences perceived usefulness (Chuah et al., 2016; Wu and Sheng, 2022). Geng and Lu (2023) discovered, in their study of elderly people's use of artificial intelligence, that perceived ease of use has a positive impact on the purchase attitude of the elderly consumer group. Research on smart clothing in China has shown that perceived ease of use significantly positively affects perceived usefulness and purchase attitude (Chen and Ye, 2023; Wang and Wang, 2021). Based on the aforementioned research analysis, this study proposes the following research hypotheses:

H2a: Perceived ease of use positively affects perceived usefulness.

H2b: Perceived ease of use positively affects purchase attitude.

2.3. FEA consumer needs model (FEAM)

The complexity of smart clothing must be addressed by meeting user needs through clothing attributes. Therefore, Lamb and Kallal (1992) proposed the FEAM

(Functional-Expressive-Aesthetic Consumer Needs Model). This user-centric model encompasses three criteria: Functionality (FUN), Expressiveness (EXP), and Aesthetics (AES), and is widely used to identify and assess the clothing needs of target consumers, as well as to design any type of clothing (Chen and Ye, 2023). Consumers not only prioritize the functionality of smart clothing but also have higher expectations for its appearance (Li et al., 2022), requiring not only the improvement of consumers' health conditions but also the enhancement of their fashion sense (Chen and Ye, 2023).

2.3.1. Functionality (FUN)

Functionality (FUN) refers to the practicality, usability, and comfort of clothing, covering aspects such as fit, ease of movement, protection, and comfort (Lamb and Kallal, 1992). This performance revolves around the practicality and experiential nature of consumers' actual daily wear, serving as the most fundamental factor influencing consumers' acceptance of new technology (Dunne et al., 2005; Nam and Lee, 2020; Suh et al., 2010). In their study of smart clothing, Chen and Ye (2023) found that functionality has a positive and significant impact on perceived ease of use. Hwang et al. (2016) found that functionality positively influences consumers' perceptions of usefulness and ease of use. Based on the aforementioned research analysis, this study proposes the following research hypotheses:

H3a: Functionality positively affects perceived usefulness.

H3b: Functionality positively affects perceived ease of use.

2.3.2. Expressiveness (EXP)

Expressiveness (EXP) pertains to the consumer's personal values, self-esteem, and personal roles from the perspective of identity, integrating social status and cultural circles with psychological aspects, where the product design and use should align with the user's self-image (Ju and Lee, 2021; Ko et al., 2009; Stokes and Black, 2012). In their study on clothing design for people with special needs, Stokes and Black (2012) found that expressiveness positively affects perceived usefulness and should conform positively to users' expectations (Bakhshian and Lee, 2022). Research on smart clothing in China has shown that expressiveness has a significant positive impact on perceived usefulness and perceived ease of use (Chen and Ye, 2023; Wang and Wang, 2021). Based on the aforementioned research analysis, this study proposes the following research hypotheses:

H4a: Expressiveness positively affects perceived usefulness.

H4b: Expressiveness positively affects perceived ease of use.

2.3.3. Aesthetics (AES)

Aesthetics (AES) is an important criterion for consumers when evaluating clothing, as it is a vital means of visual communication (Chattarman and Rudd, 2006; Eckman et al., 1990) and should be consistent for psychological acceptance by consumers (Nam and Lee, 2020). Aesthetics refers to the consumer's perception and experience level related to the product's style or fashion, including novelty and beauty (Bu et al., 2021; Lamb and Kallal, 1992). Aesthetics, as an important factor in attracting consumers to make product purchase decisions, participates in the consumer's buying behavior (Chen and Ye, 2023). In their study, Hwang et al. (2016) found that aesthetics significantly influences the purchase attitudes and intentions of smart clothing consumers. Jeong et al. (2021) found, in their study of smart wearable devices as fashion products, that excellent appearance and structural design will increase user purchase intentions. Based on the aforementioned research analysis, this study proposes the following research hypotheses:

H5a: Aesthetics positively affect purchase attitude.

H5b: Aesthetics positively affect purchase intention.

2.4. Interactivity (INT)

Interactivity (INT) primarily refers to the process, centered around the consumer, where psychological, kinetic, behavioral, and expressive information is integrated and interacted with during the convergence of technology and smart clothing. This process enables smart clothing to better align with the inner needs of consumers in specific environments, leading to a more intelligent, effective, and pleasurable user experience (Hwang et al., 2016; McCann, 2009). Interactivity allows typically independent environments, organizations, units, or individuals to engage with each other. More precisely, it enables designers, marketers, brand personnel, consumers, and other industry professionals to genuinely interact and understand each other in a virtual reality setting. This interaction can lead to new perspectives, viewpoints, and angles through the collision of emotional experiences and inner thoughts, much like the emotional and cognitive aspects advocated by Jeon (2017) in human-computer-environment interaction. Also, interactivity emphasizes the social and cultural media functions that can be carried during human-computer-environment interactive activities based on information technology. The professional technology of clothing, the level of design, and consumer perception need to interact to exert brand effects (Sun and Zhang, 2012). Wang et al. (2020) believed, in their study of parent-child smart clothing, that interactivity positively affects the purchase attitudes and intentions of parent-child smart clothing. Based on the above research analysis, this study proposes the following research hypotheses:

H6a: Perceived interactivity positively affects perceived usefulness.

H6b: Perceived interactivity positively affects purchase attitude.

H6c: Perceived interactivity positively affects purchase intention.

2.5. Risk perception (RP)

Risk perception (RP) refers to the uncertainty consumers face when they cannot foresee the consequences of their purchasing decisions, which can affect the acceptance and use of technology by consumers (Schiffman and Kanuk, 2000). Conversely, risk perception has a negative impact on consumers' exploration, evaluation, and decision-making (Ju and Lee, 2020). Smart clothing is an innovative technological product with inherent risks, and risk perception can negatively influence the acceptance and use of technology (Ko et al., 2009). Rogers (2003) pointed out that the newer an innovation, the higher the uncertainty associated with this novelty, and the more likely consumers are to hesitate in adopting the product. Therefore, the uncertainty associated with innovation can be conceptualized through risk perception, which plays a significant role in forming purchase attitude and purchase intention towards new products (Park et al., 2005; Sjöberg, 2000). Individual decision-making depends on the perception of risk and the corresponding benefits (Duell and Steinberg, 2019; Yang et al., 2024), and risk perception is an important predictor affecting purchase attitude and purchase intention (Tamilmani et al., 2021). Research on smart clothing has found that risk perception has a significant negative impact on purchase attitude and purchase intention (Wang and Wang, 2021). Hwang et al. (2016) also found, in their study of solar-powered smart clothing, that risk perception significantly negatively affects the purchase attitude and purchase intention of American consumers. Based on the above research analysis, this study proposes the following research hypotheses:

H7a: Risk perception negatively affects purchase attitude.

H7b: Risk perception negatively affects purchase intention.

2.6. Purchase attitude and purchase intention (PA & PI)

Purchase attitude (PA) refers to the psychological inclination, feelings, or evaluative reactions of individual consumers towards a product or service during the purchase process, which is reflected in their perceptions, evaluations, and behavioral intentions (Chen and Ye, 2023). Based on Fishbein and Ajzen’s (1975) Theory of Reasoned Action (TRA), purchase attitude significantly influences consumers’ behavioral intentions, and purchase intention (PI) is a personal behavioral intention to buy a product or service, therefore, purchase attitude affects purchase intention (Davis, 1989; Davis et al., 1989). Several studies have found that consumer purchase attitude significantly affect purchase intention (Ko et al., 2008; Rahaman et al., 2022; Zhang and Chang, 2023). Based on the above research analysis, this study proposes the following research hypothesis:

H8: Purchase attitude positively and significantly affects purchase intention.

2.7. Consumer-consumption-need theoretical model (CCNTM)

The collection, compilation, and interpretation of user demands or usage considerations are key to initiating the design process of clothing (Pan and Stolterman, 2015). Clothing serves as a functional object that both protects and displays, aids or hinders movement, and also embodies social and personal significance (Chae and Evenson, 2014; Pan and Stolterman, 2015). Consequently, the demand for and the development of clothing designed for special needs have driven the formation and development of the FEA Model (Orzada and Kallal, 2016, 2021). Clothing design has thus evolved to form a continuous triadic standard cycle encompassing functionality, expressiveness, and aesthetics. These three criteria, as indivisible components of a whole, must go beyond mere functionality to possess sensory, aesthetic, and emotional appeal (Pink, 2006; Orzada and Kallal, 2016, 2021). Meanwhile, the need for the application of innovative technology has spurred the development of the TAM (Chen and Ye, 2023). However, to further stimulate market prosperity and growth, it is necessary to integrate these two models and create an interactive effect. During the interactive process between consumers and innovative technology, it is the perception of risk by the consumer that can genuinely trigger consumer purchase intention and behavior. Based on the aforementioned analysis, by integrating the interactive effects of the FEAM with the TAM, and adding the consumer’s risk perception, a holistic new model is formed that combines the two foundational models, their interactive effects, and the role of risk perception. This is the Consumer-Consumption-Need Theoretical Model proposed in this paper, as illustrated in **Figure 1**.

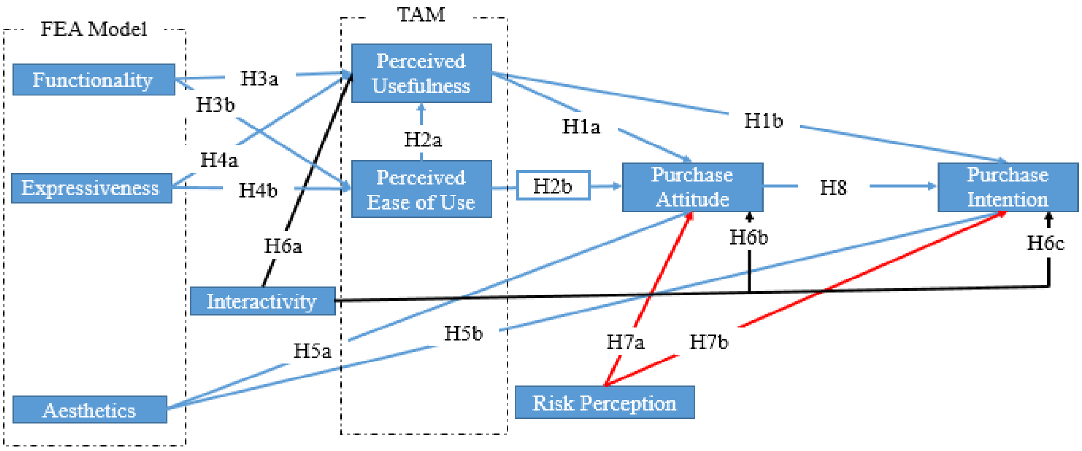

Figure 1. Consumer-Consumption-Need theoretical model.

Notes: FUN = Functionality; EXP = Expressiveness; AES = Aesthetics; PU = Perceived Usefulness; PEOU = Perceived Ease of Use; INT = Interactivity; RP = Risk Perception; PA = Purchase Attitude; PI = Purchase Intention.

3. Methodology

3.1. Questionnaire design

The questionnaire for this study was centered around the needs of the elderly population, specifically targeting the silver-haired population. The survey was divided into three main sections: 1) A brief introduction to smart clothing and targeted distribution to a specific age group; 2) a measurement model that, to ensure the reliability and validity of the research questionnaire, refers to established scales that have been empirically tested in relevant domestic and international literature. The questionnaire was designed with dimensions and items based on nine variables, with each variable consisting of 3 to 5 questions, resulting in a total of 38 measurement items; 3) an investigation and understanding of the basic situation of the research subjects aged 55–65 years old, who are part of the silver-haired population. All variables in this questionnaire are measured using a 7-point Likert scale, where 1 indicates "strongly disagree" and 7 indicates "strongly agree." The scales and items used in this questionnaire are presented in **Table 1**.

Table 1. Scale questions and references.

Variables	No.	Items	References
Functionality (FUN)	FUN1	The fit of smart clothing is critical.	(Chen and Ye, 2023; Wang and Wang, 2021)
	FUN2	The protection of smart clothing is critical	
	FUN3	The functions and features of smart clothing are stable	
Expressiveness (EXP)	EXP1	Smart clothing fits well with my lifestyle	(Ye et al., 2022)
	EXP2	Smart clothing meets my needs with other clothing I own	
	EXP3	Smart clothing coordinates well with other clothing I own	
	EXP4	Smart clothing will make me a leader in adopting new technologies.	

Table 1. (*Continued*).

Variables	No.	Items	References
Aesthetics (AES)	AES1	I attach great importance to the color matching of smart clothing	(Chen and Ye, 2023)
	AES2	I attach great importance to the proportion of silhouettes in smart clothing	
	AES3	I attach great importance to the fabric texture of smart clothing	
	AES4	I attach great importance to the innovation points of smart clothing	
	AES5	I attach great importance to the brand aesthetics of smart clothing	
Interactivity (INT)	INT1	Smart clothing with interactivity makes me find it interesting	(Wang et al., 2020)
	INT2	The interactivity in smart clothing will make me have the idea of wanting to purchase	
	INT3	The interactive characteristics of smart clothing are more obvious	
	INT4	I believe that the interactive nature of smart clothing will bring behavioral assistance that will improve and enhance my daily life	
	INT5	Interactivity should become the main core of development, design, and marketing of smart clothing	
Perceived Usefulness (PU)	PU1	Wearing smart clothing will improve my work efficiency.	(Chen and Ye, 2023)
	PU2	Wearing smart clothing will be a more comfortable experience	
	PU3	Wearing smart clothing can effectively improve my life	
	PU4	Smart clothing will meet my needs.	
Perceived Ease of Use (PEOU)	PEOU1	The uses of smart clothing are clear and easy to understand	(Ye et al., 2022)
	PEOU2	Smart clothing can be easily used	
	PEOU3	Smart clothing can be easily donned and doffed	
Risk Perception (RP)	RP1	When smart clothing is in early stages of launch, I am still willing to buy and try to keep up with the trend	(Hwang et al., 2016)
	RP 2	When smart clothing is widely launched and used, I have confidence in the product's performance	
	RP 3	When I come into contact with such smart clothing, I attach great importance to safety	
	RP 4	I feel at ease with the long-term use of smart clothing	
Purchase Attitude (PA)	PA1	It is wise to buy smart clothing	(Ye et al., 2022)
	PA 2	I like the idea of using smart clothing	
	PA 3	Wearing smart clothing is an exciting experience	
	PA 4	Wearing smart clothing can be fun	
	PA 5	Overall, I have a positive attitude toward smart clothing	
Purchase Intention (PI)	PI1	I think it's worth buying smart clothing	(Ye et al., 2022)
	PI2	Once I have a high-quality experience with smart clothing, I will recommend others to purchase it	
	PI3	When there is a relevant demand, I will purchase	
	PI4	When someone recommends to me, I will purchase	
	PI5	When the price difference between the two is not significant, I am willing to try smart clothing and I will purchase it	

3.2. Sample data collection

The questionnaire phase primarily involved distributing surveys through an online platform, with a total of 560 questionnaires issued. The collected questionnaires were screened according to the following established criteria: 1) Any questionnaires completed in less than 90 s were excluded; 2) questionnaires missing basic information were also excluded. Ultimately, 543 valid questionnaires were obtained, resulting in an effective recovery rate of 96.96%. The statistical analysis of the sample was conducted using SPSS version 24. Among the surveyed silver-haired population aged 55–65, approximately 47.3% were male respondents, 37.4% resided in urban areas, and 32.1% had a monthly disposable income between 2001 and 4000 yuan. For detailed information, see **Table 2** below.

Table 2. Descriptive statistics of the research sample.

Item	Options	Sample size	Percentage (%)
Gender	Male	214	47.3
	Female	238	52.7
Residence	Urban	169	37.4
	Rural	283	62.6
Monthly Disposable Income	Below 2000 yuan	174	38.5
	2001–4000 yuan	141	32.1
	Above 4001 yuan	133	29.4

3.3. Data analysis and hypothesis testing

This study collected effective data through questionnaires and employed SPSS and Amos software for the reliability and validity testing of variables such as functionality, expressiveness, aesthetics, interactivity, perceived usefulness, perceived ease of use, risk perception, purchase attitude, and purchase intention, as well as for model fit testing.

3.3.1. Common method bias test

Considering the potential impact of homologous bias on research results, this study used the Harman's single-factor test for the common method bias test (Podsakoff et al., 2003). The results revealed that the KMO value was 0.94 ($p < 0.001$), showing that the scales were suitable for factor analysis. There were nine factors with eigenvalues greater than 1, and the first factor explained a variance of 38.53%, which was less than the critical criterion of 40% (Zhou et al., 2022). Therefore, the impact of common method bias was not considered to be great in this paper.

3.3.2. Reliability and validity analysis

Reliability, or dependability, is primarily used to examine the internal consistency and stability of a questionnaire. This study selected the Cronbach Alpha coefficient and split-half reliability to assess the reliability of the scale. Generally, a Cronbach Alpha and split-half reliability above 0.9 are considered excellent; between 0.8 and 0.9 are considered good; between 0.7 and 0.8 are considered acceptable; and below 0.7 suggest that the scale needs revision. As shown in **Table 3**, the Cronbach Alpha reliability coefficient is 0.924, and the split-half reliability is 0.767. The research data's reliability values are above 0.7, indicating that the data meets the reliability standards and is suitable for further analysis.

Table 3. Reliability testing.

Item No.	Cronbach Alpha	Split-Half Reliability
38	0.924	0.767

Before applying factor model analysis, it is necessary to conduct a factor model suitability analysis on the scale data. The results of the questionnaire data analysis are shown in **Table 4**. The KMO test is used to investigate the degree of intercorrelation among variables. The KMO value for the scale data is 0.937, which is greater than 0.6, and it passes the Bartlett's test of sphericity at a significance level of 0.05 ($P < 0.05$). This indicates that there is significant intercorrelation among the test items of the research variables, suggesting that the questionnaire data is very suitable for factor analysis.

Table 4. KMO and Bartlett's test of sphericity.

KMO and Bartlett's Test	KMO Measure of Sampling Adequacy	Approximate Chi-Square	Degrees of Freedom	Significance
KMO	0.937	15,904.797	703	0.000

Validity, or effectiveness, is mainly used to examine the extent to which measurement results or methods can accurately reflect the constructs intended to be measured by the questionnaire, including convergent validity and discriminant validity. As shown in **Table 5**, factors with loadings greater than 0.60 and an Average Variance Extracted (AVE) greater than 0.50 possess good convergent validity. As shown in **Table 6**, the square root of all variable AVE values is greater than the correlation coefficients between each latent variable, indicating good discriminant validity among the latent variables.

Table 5. Reliability and validity tests.

Variable	No.	Factor Load	Dimension Cronbach's *α*	CR	AVE
FUN	FUN1	0.744	0.877	0.878	0.706
	FUN2	0.784			
	FUN3	0.748			
EXP	EXP1	0.752	0.849	0.85	0.586
	EXP2	0.708			
	EXP3	0.764			
	EXP4	0.746			
AES	AES1	0.681	0.866	0.867	0.567
	AES2	0.702			
	AES3	0.762			
	AES4	0.715			
	AES5	0.705			
INT	INT1	0.722	0.893	0.894	0.627
	INT2	0.793			
	INT3	0.712			
	INT4	0.752			
	INT5	0.728			

Table 5. (*Continued*).

Variable	No.	Factor Load	Dimension Cronbach's α	CR	AVE
PU	PU1	0.717	0.893	0.893	0.735
	PU2	0.674			
	PU3	0.740			
	PU4	0.776			
PEOU	PEOU1	0.800	0.906	0.907	0.709
	PEOU2	0.807			
	PEOU3	0.787			
RP	RP1	0.941	0.965	0.966	0.875
	RP2	0.926			
	RP3	0.934			
	RP4	0.938			
PA	PA1	0.725	0.909	0.91	0.668
	PA2	0.754			
	PA3	0.781			
	PA4	0.796			
	PA5	0.792			
PI	PI1	0.735	0.904	0.905	0.657
	PI2	0.652			
	PI3	0.796			
	PI4	0.731			
	PI5	0.753			

Table 6. Discriminant validity.

Variable	FUN	EXP	AES	INT	PEOU	PU	RP	PA	PI
FUN	0.840								
EXP	0.578	0.766							
AES	0.637	0.571	0.753						
INT	0.604	0.578	0.576	0.792					
PU	0.441	0.425	0.558	0.499	0.857				
PEOU	0.560	0.540	0.650	0.626	0.633	0.842			
RP	−0.252	−0.309	−0.215	−0.211	−0.256	−0.186	0.935		
PA	0.454	0.539	0.547	0.560	0.554	0.593	−0.271	0.817	
PI	0.642	0.542	0.612	0.604	0.535	0.685	−0.216	0.573	0.810

Notes: Diagonal data (bold) is the square root of AVE.

3.3.3. Model fitness test

According to the model adaptation test results in **Table 7**, it can be seen that the chi square degree of freedom ratio of the model is 2.603, which is less than 3. GFI, AGFI, NFI, and RFI reached 0.861, 0.838, 0.898, and 0.888 respectively, all above 0.8, indicating a good fitting effect. In addition, the test results of IFI= 0.935, TLI = 0.928, and CFI = 0.934 all reached an excellent level of 0.9 or above (Zhou et al., 2022). Moreover, the standardized factor loadings for each item's corresponding factors are greater than or close to 0.7. The combined reliability of each latent variable is greater than 0.8, and the average variance extraction (AVE) is greater than 0.5. Therefore, based on the analysis results of this study, it can be concluded that the FEAI model has a good fit, as shown in **Figure 2**.

Table 7. Structural model fitting metrics.

Indicator	CMIN/DF	RMSEA	GFI	AGFI	NFI	RFI	IFI	TLI	CFI
Ideal adaptation standard	(1, 3)	<0.08	>0.9	>0.9	>0.9	>0.9	>0.9	>0.9	>0.9
Acceptable adaptation criteria	(1, 5)	<0.08	(7, 9]	(7, 9]	(7, 9]	(7, 9]	(7, 9]	(7, 9]	(7, 9]
Overall model	2.603	0.054	0.861	0.838	0.898	0.888	0.935	0.928	0.934

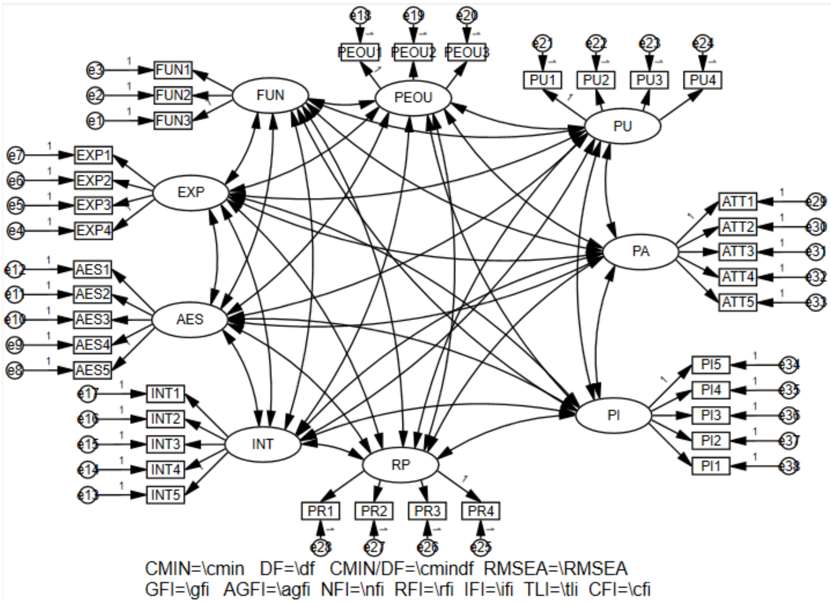

Figure 2. CCNTM path output map.

3.4. Result analysis

From the above analysis, it can be seen that the fitting effect of the FEAI model is excellent. Amos24 was used to test the path coefficients of the model (**Figure 2**). It can be seen from **Table 8**.

Table 8. Results of the research hypothesis.

Path relationship	Non-standardized estimated value	Standardized estimated value	S.E.	C.R.	*P*
H1a: PA ← PU	0.207	0.214	0.058	3.568	***
H1b: PI ← PU	0.403	0.370	0.056	7.240	***
H2a: PU ← PEOU	0.296	0.367	0.035	8.343	***
H2b: PA ← PEOU	0.169	0.216	0.040	4.261	***
H3a: PU ← FUN	0.147	0.175	0.044	3.349	***
H3b: PEOU ← FUN	0.316	0.304	0.059	5.355	***
H4a: PU ← EXP	0.164	0.141	0.061	2.712	**
H4b: PEOU ← EXP	0.411	0.285	0.084	4.912	***

Table 8. (*Continued*).

Path relationship	Non-standardized estimated value	Standardized estimated value	S.E.	C.R.	*P*
H5a: PA ← AES	0.171	0.156	0.056	3.042	**
H5b: PI ← AES	0.264	0.215	0.06	4.402	***
H6a: PU ← INT	0.284	0.269	0.055	5.18	***
H6b: PA ← INT	0.228	0.223	0.057	4.013	***
H6c: PI ← INT	0.203	0.178	0.06	3.415	***
H7a: PA ← RP	–0.052	–0.103	0.019	−2.764	**
H7b: PI ← RP	−0.015	−0.026	0.020	−0.764	0.445
H8: PI ← PA	0.155	0.138	0.053	2.896	**

Notes: ***$p < 0.001$, **$p < 0.05$.

3.4.1. Perceived usefulness

The *P*-values for the effects of perceived usefulness on purchase attitude and purchase intention are less than 0.05, reaching the 0.05 level of significance, and the coefficients are positive. This indicates that perceived usefulness has a significant positive impact on both purchase attitude and purchase intention, thus hypotheses H1a and H1b are supported. This suggests that smart clothing designed for the silver-haired population, featuring functionality and interactivity that align with the needs of this group, leads to a positive attitude towards smart clothing and fosters the behavior of purchasing smart clothing.

3.4.2. Perceived ease of use

The *P*-values for the effects of perceived ease of use on perceived usefulness and purchase attitude are less than 0.05, reaching the 0.05 level of significance, and the coefficients are positive. This shows that perceived ease of use has a significant positive impact on both perceived usefulness and purchase attitude, thus hypotheses H2a and H2b are supported. Since the smart clothing is targeted at the silver-haired population, its functional setup and interaction habits are more suited to this group, making the product more user-friendly and enhancing consumers' perception of the usefulness of purchasing this type of product, leading to a positive purchase attitude towards smart clothing for the silver-haired population.

3.4.3. Functionality

The *P*-values for the effects of functionality on perceived usefulness and perceived ease of use are less than 0.05, reaching the 0.05 level of significance, and the coefficients are positive. This indicates that functionality has a significant positive impact on both perceived usefulness and perceived ease of use, thus hypotheses H3a and H3b are supported. The functionality of smart clothing for the silver-haired population is more aligned with the needs of this group, and the better the functional design caters to consumer demands, the more it enhances consumers' perception of the product's usefulness and ease of use.

3.4.4. Expressiveness

The *P*-values for the effects of expressiveness on perceived usefulness and perceived ease of use are less than 0.05, reaching the 0.05 level of significance, and the coefficients are positive. This shows that expressiveness has a significant positive impact on both perceived usefulness and perceived ease of use, thus hypotheses H4a and H4b are supported. The silver-haired population places great importance on the content expressed by the product when wearing smart clothing, which should match the consumer's status, age, and other factors. At the same time, smart clothing should learn from consumers' behavioral data to provide more convenient life assistance, allowing silver-haired consumers to use smart new technology products without spending too much time and effort on learning and adaptation, while also meeting their needs, which encourages more people to choose such products.

3.4.5. Aesthetics

The *P*-values for the effects of aesthetics on purchase attitude and purchase intention are less than 0.05, reaching the 0.05 level of significance, and the coefficients are positive. This indicates that aesthetics have a significant positive impact on both purchase attitude and purchase intention, thus hypotheses H5a and H5b are supported. The design of smart clothing for the silver-haired population should follow certain aesthetic characteristics, meet the aesthetic needs of this population, and integrate with current fashion trends, thereby changing consumers' perceptions of smart clothing.

3.4.6. Interactivity

The *P*-values for the effects of interactivity on perceived usefulness, purchase attitude, and purchase intention are less than 0.05, reaching the 0.05 level of significance, and the coefficients are positive. This shows that interactivity has a significant positive impact on perceived usefulness, purchase attitude, and purchase intention, thus research hypotheses H6a, H6b, and H6c are supported. The interactive system, based on the daily behavioral needs and physiological characteristics of the silver-haired population, should play an auxiliary role after learning the user's daily behavioral habits. Effective assistance can improve the smart aging life for the silver-haired population and positively influence their willingness and behavior to use and purchase new smart technologies.

3.4.7. Risk perception

The *P*-value for the effect of risk perception on purchase attitude is less than 0.05, reaching the 0.05 level of significance, and the coefficient is negative. This indicates that risk perception has a significant negative impact on purchase attitude, thus hypothesis H7a is supported. Since the emergence of smart clothing for the silver-haired population belongs to the realm of new smart technology, the lower the risk perception, the more positive the consumer's intention to use such products. However, the *P*-value for risk perception on purchase intention is greater than 0.05 and does not reach the 0.05 level of significance, indicating that risk perception does not have a significant impact on purchase intention, and thus hypothesis H7b is not supported. The analysis suggests two possible scenarios: First, some members of the silver-haired population, due to abundant material living conditions and empty-nest lifestyles, are willing to try new experiences and have a novel attitude towards smart clothing for the elderly, driven by the need for aging products and remote monitoring by their children. Second, the current market has not yet seen clear sales of smart clothing, and most silver-haired consumers and their children, as purchasers, have an unclear willingness to purchase unfamiliar products, which remains to be explored.

3.4.8. Purchase attitude

The *P*-value for the effect of purchase attitude on purchase intention is less than 0.05, reaching the 0.05 level of significance, and the coefficient is positive. This indicates that purchase attitude has a significant positive impact on purchase intention, thus hypothesis H8 is supported. When consumers have a positive attitude towards smart clothing for the silver-haired population, their intention to purchase such products is also stronger.

In summary, except for hypothesis H7b, which is not supported, indicating that risk perception does not significantly affect purchase intention, all other research hypotheses are empirically validated. The consumer-consumption-need theoretical model constructed in this paper is also empirically validated, as detailed in **Figure 3**.

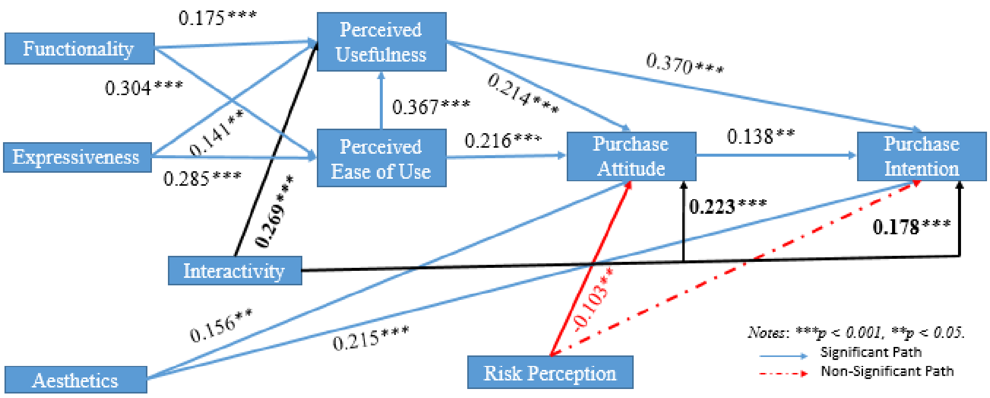

Figure 3. Consumer-consumption-need theoretical model.

4. Research conclusions and discussion

4.1. Research conclusions

This study, based on the integration of the TAM and the FEAM, reconstructs a consumer need theory model that combines clothing design, technological innovation, and consumer psychology and behavior by introducing two new variables: interactivity and risk perception. Building on existing literature, relevant hypotheses were proposed, and a questionnaire survey method was used to investigate the factors influencing the purchase of smart clothing by the silver-haired population. The results indicated that the newly constructed consumer-consumption-need theoretical model is valid. Specifically, functionality, expressiveness, interactivity, and perceived ease of use all have significantly positive impacts on perceived usefulness; perceived usefulness, perceived ease of use, aesthetics, and interactivity all significantly positively affect purchase attitude; perceived usefulness, aesthetics, interactivity, and purchase attitude all significantly positively influence purchase intention; functionality and expressiveness significantly positively affect perceived ease of use; risk perception has a significantly negative impact on purchase attitude, but risk perception does not have a statistically significant impact on purchase intention.

4.2. Theoretical implications

Firstly, this study specifically targets the elderly silver-haired population as the sole research subject to address the scarcity and insufficiency of previous research subjects (Chen and Ye, 2023; Imbesi and Scataglini, 2021), thereby making the conclusions more precise and the basis more robust. Facing this new era of rapid technological change and development, the global aging issue continues to intensify, exerting widespread social impact. Moreover, an increasing number of elderly individuals are becoming more affluent, open-minded, and receptive to new and emerging technological innovations. Despite being of advanced age, their mentality and behavior are increasingly youthful, and their consumption types are becoming more diverse and their purchasing power stronger. Smart clothing that caters to the unique needs of the elderly silver-haired population will represent a vast blue ocean market. Therefore, this paper specifically examines the elderly silver-haired population as a potential consumer group to more comprehensively grasp their psychological needs and decision-making behaviors towards smart clothing, thereby stimulating their purchasing behavior and promoting the rapid development of the smart clothing industry.

Secondly, as smart clothing is an interdisciplinary research field, the TAM and FEA Model are too general to explain the specific factors of the phenomena investigated. There is a need to combine the two models to enhance the theoretical basis or to introduce additional variables to enhance their overall explanatory power (Bianchi et al., 2023; Chen and Ye, 2023). Thus, this study, on the basis of integrating the TAM model and FEA Model, introduces the interactive variable of interactivity and the psychological decision-making variable of perceived risk. The aim is to fully and organically integrate the design process of smart clothing, technological innovation, and consumer psychology and behavior decision-making to construct a new model of consumer demand for smart clothing and to empirically validate it. This allows for the seamless continuation of previous research, promoting its continuity, sustainability, pioneering, and innovation, and ultimately better guiding the smart clothing industry in design, production, marketing, and service processes to thoroughly understand and meet the comprehensive needs of consumers, ensuring that smart clothing is more aligned with consumer and market demands, forming a core competitive edge.

Lastly, in line with the development trends of the economy and society, the needs and changes of new technologies, new customer groups, and new markets, the definition, connotation, and extension of smart clothing should be expanded and refined. Smart clothing should also evolve with the times, adding new content and connotations to meet the needs of the era and promote sustainable industry development.

4.3. Practical implications

With the rapid iteration and development of artificial intelligence, smart clothing, as a high-tech innovative product and fashion trend, has promising prospects and functions (Li et al., 2022), and the market size for smart clothing is continuously expanding (Orzada and Kallal, 2016; 2021; Wang and Wang, 2021). However, the world is currently undergoing a significant transformation and profound changes. International political situations are chaotic and unpredictable, and the global economic situation is fraught with uncertainty and gathering risk factors, with a further intensifying downturn trend. These uncertainties and trends not only have a significant impact on macroeconomic operations but also change micro-level corporate behavior and individual psychology and behavior (Yang et al., 2024). Therefore, this study will provide valuable insights and important management insights to stakeholders in the smart clothing industry (such as enterprise designers, marketers, retail partners, and as policy makers), the robustness of the industry chain and supply chain, as well as consumer awareness and education, in order to promote better and faster development of the smart clothing market. At the same time, it will also provide a clear roadmap for research and place it in a broader academic and industry context.

Firstly, within the research framework of the consumer-consumption-need theoretical model, various factors have a significant impact on the purchase attitude and purchase intention towards smart clothing. Although the technology of smart clothing is also continuously developing and improving, consumer demands are becoming more diversified. Enterprises cannot focus solely on technological innovation while neglecting the diverse needs of consumers, or they may only produce products that are visually appealing but not practically useful or well-received. Instead, they need to consider all aspects of clothing design, technological innovation, and consumer psychology and behavior. It is necessary to enhance the original demand for clothing while continuously meeting consumers' psychological, economic, and social needs (Li et al., 2022), to form the core competitiveness of the enterprise in the increasingly competitive market and remain invincible. If smart clothing can provide more functions to meet consumer needs, then the willingness of consumers to purchase smart clothing will be more favorable (Ge et al., 2023). Therefore, designers of smart clothing need to listen to consumer opinions in all aspects, integrate the latest fashion elements and technological attributes into the design of smart clothing, making it innovative, fashionable, and aesthetically pleasing, and consumers can also participate in the design of smart clothing.

Secondly, although the negative impact of risk perception on purchase intention is not statistically significant in the research presented in this paper, it does not mean that consumers do not care about risk. In practice, the concerns of consumers about risk should not be ignored. With the rapid development of artificial intelligence, potential risks in various aspects, such as ethical and moral issues, are emerging (Zhao, 2024). Therefore, the risks of innovative technology in smart clothing will also increase, and enterprises need to fully consider the needs and concerns of all parties during the research and development process. Marketing should also take a comprehensive approach, avoiding short-term and one-sided propaganda, and maintain long-term brand awareness.

Additionally, the current smart clothing market is closely focused on the needs and markets of young people and female population. However, based on the deepening of the global aging society, an increasing number of affluent elderly individuals with open-minded attitudes are emerging. Although their age is growing, their mental state and purchasing power are becoming stronger. The market for smart clothing aimed at the elderly will continue to grow, presenting a blue ocean market. Industry enterprises need to strengthen the development and research investment in the elderly market and produce smart clothing products that are more suitable for the elderly (Chen and Ye, 2023). Concurrently, society as a whole must make concerted efforts to set up publicity, education, and training for the silver-haired population, so as to prevent the emergence of information, digital, and technological gaps as a result of the rapid development of smart technology, while excluding the elderly group from the dividends of science and technology, which would be more than worth the loss.

Lastly, as the world will face the problem of aging population, the silver-haired economy will become a new economic growth point for an aging society (Ji and Dai, 2024; UN, 2022; Yi and Xu, 2023). Therefore, policy makers in various countries and regions need to view the silver-haired economy as a blue ocean market and develop new policies and standards at the institutional level, such as safety standards, ethical and moral constraints. Allowing the silver-haired population to consume smart clothing is both reassuring, worry free, and comfortable, ensuring that this market has sufficient market competition, legal regulation, and ethical constraints. This not only ensures the continuous good for humanity of smart technology, but also ensures the continuous innovation and sustainable development of the smart clothing market.

4.4. Limitations and future research

This study has several limitations. Firstly, the research was conducted in China, and the TAM and the FEAM have yielded contradictory conclusions across various countries (Chen and Ye, 2023), indicating cross-cultural differences that necessitate cross-cultural research and comparison. For instance, research on smart clothing for biomedical applications among the Korean population found that perceived ease of use in the TAM model has a significant positive impact on purchase intention (An et al., 2023; Noh et al., 2016), whereas it had no effect on the Chinese population (Noh et al., 2016). Therefore, due to significant cultural, economic, and ethnic differences, the results may not entirely align with the purchasing behaviors of other countries. Future research should verify the applicability of this model in countries with different cultural backgrounds.

Secondly, in the FEAM, functionality only affects purchase intention, and aesthetics only affect purchase attitude (Bakhshian and Lee, 2022). Davis (1989) suggests that perceived usefulness and perceived ease of use may require certain variables to indirectly influence behavioral intention, with purchase intention being a personal behavioral intention to buy a product or service. For example, when designing smart clothing, it is necessary to fully utilize ergonomics to achieve an organic integration between people and clothes, smart technology, and the environment to ensure its comfort and ease of use, which in turn affects the acceptance and satisfaction of consumers with smart clothing. Bailey et al. (2022) argued that there should be variables within the model that play an indirect role, such as mediation or moderation effects. Personalized smart clothing design based on individual aesthetics and form preferences can also greatly impact consumer acceptance and usage tendencies (Sonderegger and Sauer, 2010). Thus, the research model of this paper could incorporate many variables for further study to explore the internal mechanisms of the black box. For example, social support as a moderating variable (Mahmood and Lee, 2020), self-efficacy, price, social influence (such as peer pressure, social norms, and familial influence), and innovativeness (Chen and Ye, 2023), to explore the ultimate impact of various factors on smart clothing purchasing behavior.

Of course, to construct a more rigorous theoretical framework that clearly delineates how these models interact and influence each other, it is not only necessary to strengthen the conceptual foundation and explanatory power of the research, but also to fundamentally explore its inherent black box mechanism of action.

Third, due to the inconsistent conclusions in many research results on smart clothing and the lack of coordination and theoretical basis in previous research models (Bianchi et al., 2023; Chen and Ye, 2023), it is possible that interdisciplinary research on smart clothing design requires a more suitable theory to construct a new black box model. It is also necessary to reconceive some single variables and propose new research variables, such as reconceiving the three criteria in the FEA model into a specific variable, namely consumer demand; and reconceiving perceived usefulness and perceived ease of use in the TAM model into a specific variable, such as technology acceptance. Based on social psychology theories, these new constructs could be introduced into the black box model for empirical research.

Fourthly, the selection of risks and types of risk perception. Risk perception, as a multidimensional structure, includes social risk, psychological risk, performance risk, financial risk, privacy risk, time loss risk, and physical risk (Ko et al., 2009). Considering the time, energy, material resources, and financial resources required for each study, it is difficult to cover all aspects of any single study. All are based on the research focus and needs, selecting a certain type of risk for specific research, such as performance risk (Hwang et al., 2016; Ju and Lee, 2021; Wang and Wang, 2021). Considering the focus and innovation of this article, since it cannot cover all aspects, based on the perspective of the entire process of smart clothing consumption, starting from smart clothing and consumers themselves, we consider the issue of risk perception and scale selection. The focus is not on specific types of risks, but on who and from which perspective perceives the overall risk. This ignores the specific and diverse types of risks, but overall includes all types of risks. It is not an exaggeration to say that this can also be considered one of the innovation points of this article. Therefore, future research needs to select scales that are suitable for their specific research topics based on their respective research priorities and innovation points, and cannot be generalized in order to make the corresponding research more targeted and effective.

Fifth, future research needs to focus on analyzing the competitive situation of smart clothing. By understanding the similarities and differences between consumer perceptions of traditional clothing or other wearable technologies and smart clothing, more valuable analysis can be provided for the sustainable development of smart clothing, and the practical significance of research results can be enhanced. By leveraging the existing research results of traditional clothing, it is beneficial to promote more precise market positioning of smart clothing, clarify the advantages, disadvantages, opportunities, and challenges of smart clothing, and collaborate to promote the continuous development of this incremental market of smart clothing.

Additionally, in the descriptive statistics of the research sample, this article only provided information on gender, place of residence, and monthly disposable income. Future research can collect more information, such as educational background, occupation, health status, technology literacy, lifestyle, and economic development in the region (urban/rural), which are crucial for related research (consumer psychology, cognition, behavior, etc.). In order to identify and analyze different segmented markets through different needs and preferences, develop more precise marketing and design strategies, and ensure that smart clothing products meet the specific requirements of different segmented markets.

Lastly, this study employed a one-time sampling method for data collection, and the participant group consisted solely of the silver-haired elderly population, which inevitably presents common method bias effects and limits the generalizability of the findings. However, the study utilized a large sample size and statistical testing methods, with no severe common method bias issues detected. In future research, longitudinal tracking, work diaries, experiments, and other research designs should be adopted, employing multi-time-point, one-to-one paired sampling to avoid similar issues. Furthermore, to enhance the external validity of the research, future studies should expand the sample source by including other demographic groups to further improve the external validity of the research. In addition, this article is only a quantitative study, and future research can consider supplementing quantitative data with qualitative research methods such as interviews, focus groups, or case studies. Qualitative insights can provide a deeper understanding of the motivations, perspectives, and experiences of elderly consumers towards smart clothing, supplementing the quantitative analysis conducted in the study. Therefore, the organic combination of qualitative and quantitative research, which not only studies the temporal stability of the cross-section, but also investigates the dynamic changes over time, will make the research more comprehensive, robust, ecologically valid, and applicable.

Author contributions: Conceptualization, ZL; methodology, LF; software, MG; validation, MG; formal analysis, XS; investigation, XS; resources, XS; data curation, MG; writing—original draft preparation, ZL, MG and LF; writing—review and editing, LF; visualization, XS; supervision, LF; project administration, XS; funding acquisition, ZL. All authors have read and agreed to the published version of the manuscript.

Funding: The 2023 General Project of the Beijing Higher Education Association "Research on the Construction of a 'Dual Collaboration' Education Mechanism for Industrial Colleges of High level Characteristic Universities" (MS2023210); Beijing Institute of Fashion Technology 2024 Postgraduate General Teaching Reform Project (J2024-YB20).

Conflict of interest: The authors declare no conflict of interest.

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