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A Comparative Research on Awareness, Use, and Demand of Older Adults in China for Intelligent Products: Smarts TV as an Example

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Abstract

As China's population ages, smart devices are viewed as a critical tool for improving the lives of older adults. Actual usability requirements play a crucial role in deciding whether intelligent products can be utilized well and, eventually, accomplish effective ageing. This study used a questionnaire survey of older Chinese persons to investigate their attitudes, utilisation and needs for contemporary intelligent products and services. Older adult's knowledge and experience influence their operation and judgment of using intelligent products and smart TVs. According to the results of the questionnaire, in addition to practicality and visual appeal, functional guidelines for products are one of the usability needs of older adults.

Keywords: Older Adults in China, Intelligent Products, Smart TVs

Introduction

At the end of 2019, China's elderly population aged 65 and above stood at 254 million, accounting for 18.1% of the total population (Statistics China, 2020). China has the highest older adults globally, and the World Population Prospects 2019 estimates that the elderly population in China may exceed 400 million by 2030 (United Nations, 2020). By 2050, the population over 65 years old will reach 156 million. Asia's elderly population accounts for more than half of the total population, and there is a clear trend of aging in China in the future (Beard et al., 2016).

As a result, the aging of society has led to an increasing focus on the market of senior products (Huang & Yang, 2016). Even though various intelligent products have been produced in the market and permeated every aspect of our lives (Dou et al., 2019). But older adults often have obstacles, are slow, and are prone to make mistakes in using intelligent products, which puts higher demands on the usability of the products (Wang & Wu, 2022). In addition, smart TV is

one of the intelligent products that combine content, operation (OS), and Internet, and smart TV terminal can provide various services for our life (Andreadis et al., 2021; Zhang et al., 2017). Older adults are the primary users of Smart TVs, and more attention should be devoted to their demands (Ouyang & Zhou, 2018; Cuiping Wu & Hu, 2018).

The digital gap among older adults in China has been significantly affected by the prevalence of Smart TVs (Chen & Li, 2019). While older adults utilise computers, tablets, and other electronic devices in their leisure time, television remains a key medium. A questionnaire survey in Shanghai by Zhou (2021) indicated that older adults have a higher number of intelligent products and devices, such as smart appliances and smartphone watches, compared to devices aimed at self-help medical checkups or mental health. This finding aligns with Patrono et al., (2017) which indicates that employed individuals over 65 watches approximately three hours of television daily, while their unemployed counterparts average five (see Figure 1.1). Therefore, televisions, washing machines, telephones, and computers represent the most prevalent household appliances utilised by older adults. The consistent daily television consumption among older Chinese individuals can be attributed to television's role as their primary information source. Older adults demonstrate a strong reliance on and trust in traditional media (Wu et al., 2021).

Hours per day watched

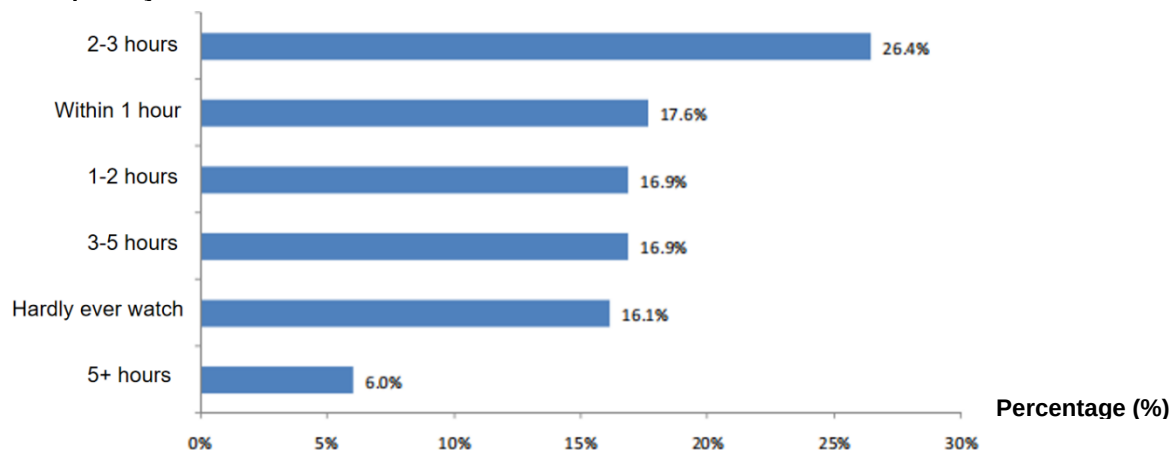


Figure 1.1: 2022 Chinese seniors' average daily TV viewing hours
(China Household Electrical Appliances Association(CHEAA), 2022)

Following the existing literature and market reports, the rapid growth of the intelligent product market has left many older adults unfamiliar with product features, leading to product abandonment. Therefore, this study employed a cross-sectional preliminary questionnaire survey. The survey was divided into two parts: Part A focuses on the knowledge and attitudes of current older adults toward intelligent products, while Part B studied smart TV use and functionality.

The main objectives of the study are as follows:

- 1.To investigate the current use of intelligent products and smart TVs by older adults in China at this stage.

2.To compare older adults' perceived, reported, and actual needs concerning intelligent products and smart TVs.

Older adults' current cognition and use of intelligent products and services may affect their needs. Based on questionnaire survey data, this paper studies the correlation between the cognition, use, and demand of intelligent products and smart TV services. This helps to understand the development status and demand for intelligent products for older adults in China. The study's findings are significant for enhancing the top-level design of the intelligent product system and increasing the model's promotion efficiency. Because of China's vast old population, cognition, use, acceptance, and demand for intelligent products and services may differ significantly between urban older adults and rural older adults' products. As a result, this article primarily surveys older urban people and uses smart TVs as an example to assess smart devices and make tailored recommendations.

Method

Questionnaires obtained all data. The researcher used the questionnaire in a pilot study with the subjects. The questionnaire was revised based on the study's findings and submitted to the University Ethics Committee for ethical approval. The questionnaire was created to understand better the usage patterns of intelligent products and the subjects' backgrounds, as intelligent products for older adults in China are fast evolving. The researchers selected participants using precise sampling criteria. The researchers then used the questionnaire to collect data, which they examined statistically and qualitatively using open-ended questions. The questionnaire used in this study was divided into two parts, and the main content of both questionnaires was similar, including respondents' knowledge and perceptions of intelligent products and smart TVs, as well as older people's health, living conditions, and personal traits. This paper focuses on analyses older people's awareness, use, and usability demands for smart TVs.

Table 1.1

Summary of Research Activities and Output For Phase II: Survey

Items	Research Activities	Research Output
Ethics Approval	Seeking ethical approval from Universiti Putra Malaysia Ethics Committee for Research involving Human Subjects (JKEUPM)	Ethical approval forms
Secondary revision of questionnaires	- Revision of the questionnaire on the "Status of the use of intelligent products and smart TVs by older adults in China." - Solicit comments and feedback on the questionnaire from experts and older adults' users.	Questionnaire design
Participants Recruitment	-Plan sampling methods to determine participant selection criteria. -Use snowballing for questionnaire collection.	List of older adults' contacts for data collection.
Data Collection	- Data were collected utilising paper questionnaires distributed by -Questionnaire Star online and in offline communities.	Empirical data from the survey.
Data Analysis and Discussion	-Interpret data. -Backtrack the research question and align it with research objectives and literature review.	Findings of research; Research conclusion.

This research focuses on urban older adults in Guangdong Province aged 60 to 75. This demographic was selected due to their higher likelihood, compared to their rural counterparts, of being familiar with and comfortable utilising new technologies, such as intelligent products and smartphones. Besides, businesses have identified urban older adults as a potential "grey market" consumer base. Considering the dispersed nature of the urban older adult population, a snowball sampling method was utilised to distribute and collect questionnaires. Frequency analysis, cluster analysis, ANOVA, and chi-square analysis were conducted to analyze the current usage patterns of intelligent products by older adults, to assess their needs, and to identify influential factors and dimensions.

The reliability of the questionnaire was assessed for both the pilot test and the actual measurements. The internal consistency and reliability were acceptable in both instances, with Cronbach's alpha exceeding 0.70 for each. The Cronbach's alpha for the actual data collection was marginally higher than that of the pilot test. This improvement in consistency and reliability reflects the revisions of the questionnaire following the pilot test.

The survey was conducted between July and October 2023 with focus on older adults in Guangdong Province, while also incorporating data from older adults in other provinces, using both online and offline survey distribution methods. The research team reached out to senior care organizations and communities in Guangdong Province, receiving a positive response and assistance from three; in-person surveys were also administered by team members in several parks.

For the in-person surveys, researchers orally presented the questions and response options to participants in Cantonese and recorded their answers. A total of 398 samples were collected, deriving 355 valid responses after the removal of 43 unsuitable samples. The vast majority of participants demonstrated strong cooperation throughout the study. Nevertheless, the length of the questionnaire presented challenges, as some participants had no prior experience with such questions. A small number of otherwise high-quality samples, despite one or two missing data points, were still considered statistically sound.

Results and Discussion

The questionnaires, initially developed in English, were translated into Mandarin. To ensure linguistic clarity and content validity before distribution, the wording and language of the questionnaires were subject to a rigorous double-check. This verification process was conducted by a panel of tutors at Universiti Putra Malaysia, all of whom have native-like fluency and expertise in English. The Mandarin translation was then reviewed by a researcher specialising in the language. The research aimed to conduct a preliminary analysis into the adoption and usage patterns of intelligent products, specifically smart TVs, among older adults in China. The findings from the research are systematically presented in three sections:

- i. Demographic Profile
- ii. Part A: Perceptions of the current state of use and desirable attributes of existing intelligent products; and
- iii. Part B: An evaluation of smart TVs' current status and contemporary utility level elements.

Demographic Profile

An analysis of the demographic frequencies indicates a balanced gender distribution among the participants. In terms of marital status, the majority of respondents, constituting a significant 80.56% (n=286), indicated they were married. Analysis of the current living arrangements indicated that 62.26% (n=221) of the participants resided with a partner or children. Regarding educational attainment, the largest proportion of respondents (47.04%, n=167) reported having completed elementary school. The distribution of monthly income highlighted that the highest percentage of respondents (40.28%, n=143) fell in the 1000-2999 CNY income bracket (see Table 3.1).

Table 3.1

Results of Demographic Frequency Analysis

Title	Options	Frequency	Percentage (%) ²	Cumulative percentage (%) ²
Gender	Male	177	49.86	49.86
	Female	178	50.14	100.00
Married	Single	24	6.76	6.76
	Married	286	80.56	87.32
	Divorced or separated	19	5.35	92.68
	Widowed	26	7.32	100.00
	Living alone	72	20.28	20.28
	Living with an older adult partner only	93	26.20	46.48
	Who are you living with?	128	36.06	82.54
Education background	Living in a nursing home/welfare home	46	12.96	95.49
	Living with friends	15	4.23	99.72
	Others	1	0.28	100.00
	No formal education	27	7.61	7.61
	Primary school	25	47.04	54.65
	Secondary school	75	21.13	75.77
	Lower Secondary Education	28	7.89	83.66
	Upper Secondary Education	167	7.04	90.70
	Tertiary Education (College or University)	32	9.01	99.72
	Others	1	0.28	100.00
	CNY 10000 and above	14	3.94	3.94
Monthly income	CNY 5000 - CNY 9999	39	10.99	14.93
	CNY 3000- CNY 4999	93	26.20	41.13
	CNY 1000- CNY 2999	143	40.28	81.41
	Under CNY 1000	49	13.80	95.21
	No income	17	4.79	100.00
Total		355	100.0	100.0

Despite typically having only an elementary school education, most middle-aged and older adults demonstrated relative ease in navigating the smartphone questionnaire, with many even offering practical suggestions. Offline interviews indicated that the widespread use of touch-screen phones for many years has necessitated adaptation among older adults. This familiarity has enabled them to utilise basic phone functions without difficulty. The offline questionnaires were also completed relatively smoothly, though older participants tended to include numerous subjective suggestions regarding product design.

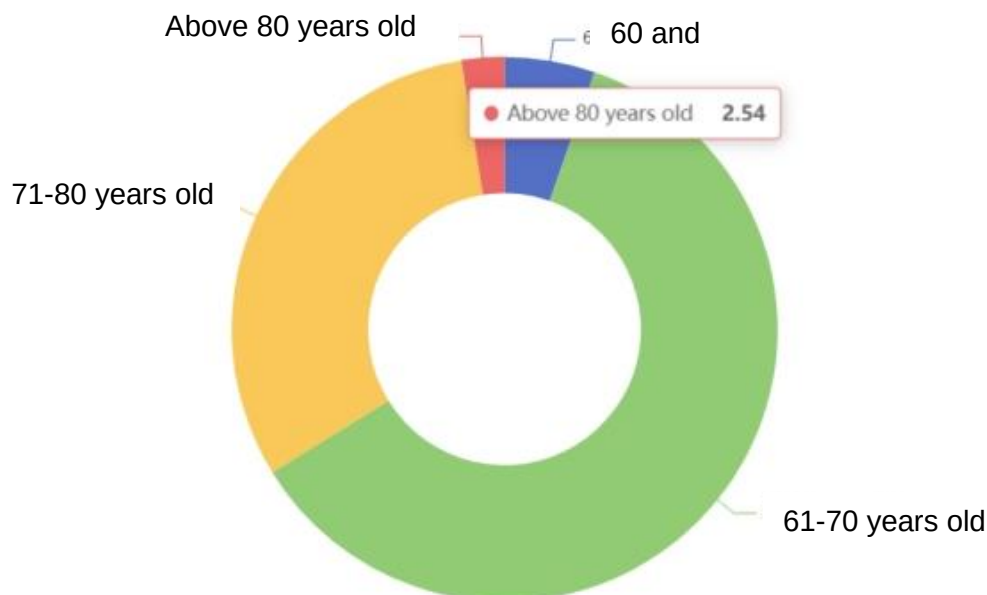


Figure 3.1: Age distribution of the older population

An analysis of respondent demographics indicates that 5.35% (n=19) were aged 60 and below, 60.85% (n=216) were between 61 and 70 years old, 31.27% were between 71 and 80 years old, and 2.54% (n=9) were 80 years old or above (see Figure 3.1). Regarding geographical distribution, Guangdong province had the highest representation at 56.9% followed by Henan province at 8.2% (see Figure 3.2).

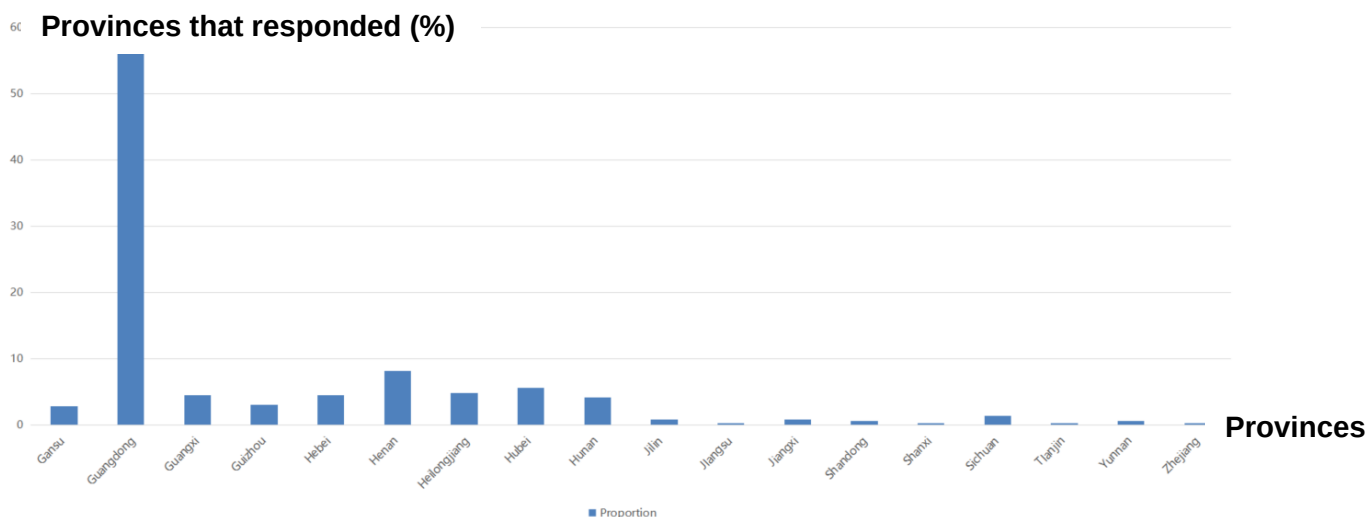


Figure 3.2: Province distribution

An income survey of the older adult group (see Table 3.2) indicates that children's support constitutes the most significant income source for 67.32% of respondents. This is followed by spousal support at 66.20% and retirement pensions, or insurance benefits at 60.28%. These three categories represent the primary income sources for the older adult participants. When analysing the physical health of the respondents, 34.93% (n=124) reported good health, 31.55% (n=112) described their health as neither good nor bad, and 16.06% (n=27) reported perfect health. Overall, the interviewed older adults group exhibited good health.

Table 3.2

The source of your income

Options	Penetration rate (n=355)
Retirement, pension, or insurance benefits	60.28%
Help from your children	67.32%
Government assistance or benefits	45.92%
From a spouse	66.20%
Income from work or business	29.30%
Others	0.85%
Aggregate	269.86%

Part A: Chinese Older Adults' Perceptions of Existing Intelligent Products

The findings in Part A shed light on the degree to which older adults in China, particularly those residing in Guangdong Province, utilise existing intelligent products and their perceptions of these products. In addition, the research categorises the importance of perceived elements of intelligent products based on the user experience of older adults.

The findings in part A can be categorised as follows:

- i. perceptions of intelligent products and the extent of their use by older Chinese people
- ii. the importance of perceived elements of intelligent products by older adults.

The Current State of Intelligent Product Usage

A survey measuring the level of understanding of intelligent products (see Table 3.2) indicates that 28.73% of respondents (n=102) are aware of these products. While 23.10% (n=82) have some knowledge, a smaller percentage, 21.41% (n=72), are familiar with intelligent products. Only 14.93% (n=53) report being very familiar with them. In summary, while most respondents have at least some awareness of intelligent products, the percentage demonstrating familiarity remains low. These data showed that older adults need more confidence in using intelligent products. They said they are only familiar with essential functions and need help understanding which products can be classified as intelligent.

Table 3.3

The level of knowledge (or familiarity) with intelligent products

Options	Frequency	Percentage	Cumulative percentage
Very familiar	53	14.93%	14.93%
Familiar	76	21.41%	36.34%
Neutral	102	28.73%	65.07%
Slightly familiar	82	23.10%	88.17%
Very unfamiliar	40	11.27%	99.44%
Others	2	0.56%	100.00%
Total	355	100.0%	

In addition, educational attainment is significantly related to knowledge of intelligent products ($\chi^2=58.264$, $p=0.001<0.01$) (see Table 3.4). Those with higher education demonstrate greater awareness (56.25%) compared to the average (28.73%). Similarly, 44.00% of respondents with a high school education exhibit some knowledge, exceeding the average of 23.10%. Specifically, 29.63% of respondents without formal education have some knowledge, surpassing the average for this category (23.10%); whereas, a lack of formal

education correlates with a lack of awareness, with 25.93% of this group reporting no knowledge, significantly higher than the average of 11.27%. These findings suggest a positive correlation between educational attainment and awareness of intelligent products among older adults.

Table 3.4

Results of chi-square analysis of education and knowledge of intelligent products.

Title	Items	Education background (%)							Total	χ^2	p
		No formal education	Primary school	Secondary school	Lower Secondary Education	Upper Secondary Education	Tertiary Education (College or University)	Others			
The level of knowledge (or familiarity) with intelligent products	Very familiar	5(18.52)	26(15.57)	13(17.33)	4(14.29)	2(8.00)	2(6.25)	1(100.00)	53(14.93)	58.264	0.001**
	Familiar	3(11.11)	42(25.15)	15(20.00)	6(21.43)	2(8.00)	8(25.00)	0(0.00)	76(21.41)		
	Neutral	3(11.11)	52(31.14)	16(21.33)	5(17.86)	8(32.00)	18(56.25)	0(0.00)	102(28.73)		
	Slightly familiar	8(29.63)	30(17.96)	21(28.00)	8(28.57)	11(44.00)	4(12.50)	0(0.00)	82(23.10)		
	Very unfamiliar	7(25.93)	17(10.18)	10(13.33)	4(14.29)	2(8.00)	0(0.00)	0(0.00)	40(11.27)		
	Others	1(3.70)	0(0.00)	0(0.00)	1(3.57)	0(0.00)	0(0.00)	0(0.00)	2(0.56)		
Total		27	167	75	28	25	32	1	355		
* p<0.05 ** p<0.01											

Analysis of current income (see Table 3.5) indicates a significant correlation with knowledge of intelligent products ($\chi^2=48.707$, $p=0.003<0.01$). Specifically, those with incomes of \$10,000 or more demonstrate a significantly higher familiarity (28.57%) compared to the average (21.41%). Similarly, the income bracket of \$1000-2999 exhibits significantly higher familiarity (27.97%) than the average. In addition, 42.86% of respondents with incomes of \$10,000 or more report a firm understanding of intelligent products, significantly surpassing the average of 28.73%. A similar trend is observed in the 3,000-4,999 income bracket, where 29.03% have some knowledge of such products, significantly exceeding the 23.10% average; whereas, a significant proportion (29.41%) of individuals with no income report a lack of knowledge regarding intelligent products, significantly higher than the 11.27% average. This pattern continues with those earning less than \$1000, where 24.49% express a lack of knowledge, again significantly higher than the average. These findings collectively suggest a positive relationship between income level and knowledge of intelligent products.

Table 3.5

Results of chi-square analysis of income and knowledge of intelligent products

Title	Items	Monthly income (%)						Total	χ ²	p
		10000 and above	5000-9999	3000-4999	1000-2999	Under 1000	No income			
Knowledge of (or familiarity with) intelligent products	Very familiar	0(0.00)	7(17.95)	11(11.83)	23(16.08)	9(18.37)	3(17.65)	53(14.93)	48.707	0.003**
	Familiar	4(28.57)	8(20.51)	15(16.13)	40(27.97)	7(14.29)	2(11.76)	76(21.41)		
	Neutral	6(42.86)	12(30.77)	30(32.26)	39(27.27)	12(24.49)	3(17.65)	102(28.73)		
	Slightly familiar	1(7.14)	8(20.51)	27(29.03)	34(23.78)	8(16.33)	4(23.53)	82(23.10)		
	Very unfamiliar	2(14.29)	4(10.26)	10(10.75)	7(4.90)	12(24.49)	5(29.41)	40(11.27)		
	Others	1(7.14)	0(0.00)	0(0.00)	0(0.00)	1(2.04)	0(0.00)	2(0.56)		
Total		14	39	93	143	49	17	355		
* p<0.05 ** p<0.01										

Comparing income and education level, we found that there is a positive correlation between high income and high education of older adults and awareness. This group of people has enough income to support the use of intelligent products and has a wide variety of home-smart products. They learn the functions of products quickly and have a strong understanding ability. On the other hand, a relatively large proportion of older adults with lower incomes need help understanding intelligent products. Therefore, the main difference in awareness among older adults appears in the influence of income. Older adults with lower incomes rarely buy higher-priced intelligent products, and they need more relevant knowledge of intelligent products because they use them less frequently.

Factors Affecting the Use of Intelligent Products

Analysis of factors influencing the purchase of intelligent products (see Table 3.6) indicates that 47.32% of respondents prioritise price and brand, while 43.10% focus on practicality and functionality. Therefore, price, brand, and practical functionality are identified as primary concerns for the older adult demographic considering these products.

In the previous literature review, we learned that most intelligent products for older adults are purchased by family members or offline. The only way to learn about intelligent products is through brand information recommendations from merchants' or family members' usage experiences. Although older adults are mainly concerned about practicality and functionality, when faced with unfamiliar products, they can only make choices based on the introduction of merchants or others and evaluating products in terms of applicability. They cannot adjust them according to their actual usage scenarios. In the face of a full product market, older adults, like young people, cannot buy suitable products through online information comparison.

Table 3.6

What are the Main Concerns when Buying Intelligent Products

Options	Penetration rate (n=355)
Price	47.32%
Brand	47.32%
Appearance	32.68%
Practicality, functionality	43.10%
Suitable for yourself/older adult at home	33.80%
Recommendations from the Internet or friends	21.41%
Others	1.41%
Total	227.04%

In the survey on "Reasons that hinder the use of intelligent products by older adults," (see Table 3.7), operational complexity represents the greatest obstacle. This finding highlights the challenges posed by current product interfaces, potentially creating a significant burden for this demographic. Besides, a significant proportion (70.99%) cite a lack of practicality as a deterrent. As previously established, older adults tend to exhibit a low usage cycle with intelligent products, potentially associated with unsustainable operation and customer loss. In addition, price represents a significant concern for 68.45% of older adults group.

There is an inevitable connection between complicated operations and impractical products. Although compared with ordinary products, intelligent products have increased human-machine intelligent interaction to guide users. However, many product designs didn't consider problems before and after use. For example, the sewage treatment of smart mops adds an extra burden of sink cleaning, and smart TV systems add button selection interactions. These additional usage processes will make consumers think the product isn't more practical, even if the main functions are realized, but the subsequent operations are too complicated. Using them is even more difficult for older adults with deteriorating physical functions.

Table 3.7

What Main Reasons Prevent Older Adults from Learning or Using Intelligent Products?

Options	Penetration rate (n=355)
The existing products are not practical	70.99%
The price is too high	68.45%
The operation is too complicated	85.35%
Poor design sense and poor experience	37.75%
Worried about privacy	23.66%
No difficulty in utilising	1.41%
Others	0.85%
Total	288.45%

A survey exploring the infrequent use of intelligent products (see Table 3.8) indicates that a significant proportion of respondents (58.76%) find these products impractical. Concerns about quality are prevalent (51.41%), alongside issues of excessive space requirements

(46.61%). The perceived complexity of operation deters a further 42.37% of respondents. Both impracticality and space constraints echo previously identified barriers. The high prevalence of "poor quality" reports is significant and likely due to various factors, including flawed modelling or systems, inadequate system feedback, and a failure to fulfil the intended purpose. These issues all point towards challenges in the interactive aspects of product use.

Table 3.8

What are the Reasons for Sometimes or Often being Reluctant to Use Intelligent Products?

Options	Penetration rate (n=355)
The size is too big and there is no extra space to use it	46.61%
Poor quality	51.41%
Unreasonable design	36.44%
Not practical	58.76%
Operation is too complicated to use	42.37%
Others	0.28%
Total	235.88%

A comparison of the data in Tables 3.6, 3.7, and 3.8 reveals that practicality has the most significant percentage of influence on the use of intelligent products by older adults, which is consistent with previous findings in the literature, and the issue that causes the influence of practicality factors is the product's usability. Second, there is a strong relationship between price and usability, with older people believing that higher-priced products should be more straightforward and practical and maximize utility to improve quality of life.

As a result, when there are usability concerns, products are placed on hold, resulting in products that take up space but have no place to be stored, as indicated in Table 3.8, such as smart home appliances. In contrast, the issue of intelligent product usability for older adults is related to operational interaction. Previous studies have shown that products for older adults should limit interactions. However, intelligent products reduce the main functional interactions and add additional follow-up feedback interaction problems.

Perceptions of the Attributes of Intelligent Products

When considering the features prioritised by older adults in intelligent products, a higher score denotes greater importance attributed to that factor by the respondent group. The analysis highlights the paramount importance placed on practical functionality, which represents the top-ranking factor. Interface clarity, particularly legible text size, secures the second position with a score of 4.200. Function guidance follows closely behind, scoring 4.054 and ranking third. This highlights the emphasis placed by older adults on the practical aspects of intelligent products. Table 3.9 further strengthens this observation, demonstrating that practical functions, clear function guidance, and a user-friendly interface take precedence in the considerations of older adults. Specifically, this contrasts with previous literature advocating for personalised artificial intelligence for older demographics. The current findings suggest that this demographic expresses limited demand for personalisation and artificial intelligence in intelligent products.

Table 3.9

The Essential Features of Intelligent Products

	Mean value	Standard deviation	Sort
Practical functions	4.203	.9166	1
The interface text size is clear	4.200	.9400	2
Functionality guidance	4.054	.9713	3
Easy-to-use operation	3.997	1.0374	4
The housing material is wear-resistant	3.938	1.0121	5
Interface display text and background colour contrast	3.932	.9631	6
The interface colour is bright and harmonious	3.910	.9816	7
Visualisation interface	3.870	1.0029	8
The material utilised is easy to clean/ Easy to clean	3.834	1.0240	9
Interactive voice prompts	3.792	1.0314	10
Artificial Intelligence	3.746	1.0350	11
Personally customised features can be added	3.713	1.0178	12
Stylish and graceful appearance	3.648	1.1212	13

When we compared the relevance of intelligent product features as viewed by older adults, we discovered that, in addition to practical features, interface text size, and clear visual elements, older adults place a higher value on functional guidance. Currently, most instructions on using intelligent products after purchase are obtained by scanning a cell phone code to watch videos or by reading the product's handbook.

Nevertheless, these two methods of learning are unfavorable to older adults. First and foremost, the interaction of cell phone scanning and viewing and repeatedly stopping to learn the operation is complicated for the elderly; using manuals with small letters and more content makes it impossible to read crucial information. On the other hand, if the intelligent products include an interface or voice assistance, older adults may struggle to understand it while watching or listening to it. They are perplexed by the simultaneous execution of commands and interactions, lack trust in operating the functions, and are concerned about product damage due to improper operation. That is why older adults seek assistance and guidance from family and friends.

Prior research has already established that, despite the widespread adoption of the internet and intelligent products, there remains a need to enhance older adults' understanding of home-based intelligent products. Factors such as education level and income have been demonstrated to influence older adults' perceptions of intelligent products. Specifically, individuals with lower education and income levels tend to view these products as both high-end and financially inaccessible, leading them to disengage from learning about or purchasing them. In addition, there is a need for greater clarity in defining what constitutes an intelligent product specifically for older demographics. Even when presented with various examples, older adults often struggle to categorise household items as "intelligent" or not, often relying on their children's evaluation of a product's intelligence because they were the ones who purchased it. Besides, the offline questionnaire survey indicated that many older adults have never utilised several features offered by their intelligent products and are hesitant to experiment with them due to a fear of being unable to revert to the device's default settings

Part B: Chinese Older Adults' Views on Smart TVs

The researchers chose smart TVs as a typical case, as they are the most frequently used intelligent products by older adults. The system is mainly Android, and the interface layout is similar. Part B's findings offer insights into the usage patterns and perceptions of existing smart TVs among older adults in China, with a primary focus on Guangdong Province. Meanwhile, the usability factors of smart TVs were ranked according to the user experience of older adults.

The findings of Part B can be summarised as follows:

- i. Degree of Smart TV Usage
- ii. Factors affecting the usability of Smart TVs

Comparison of Smart TV Use among Older Adults

The price represents the most critical factor influencing smart TV purchasing decisions among older adults, with 80% deeming it critical (see Table 3.10). High definition follows closely (76.34%), succeeded by an aesthetically pleasing appearance (63.66%) and multi-functionality (52.11%). As previously highlighted in the market analysis, the price range of smart TVs is extensive. High-end brands command prices between 8,000 CNY and 150,000 CNY for the same size, while mid-range options are between 1,000 CNY and 6,000 CNY. These price variations are driven by brand positioning, technological specifications, and display clarity. Design considerations, such as an aesthetically pleasing interface, appear to hold less sway.

TV prices have historically been costly, and their service life is approximately 5-10 years. As a result, older adults will be mainly concerned with price and clarity difficulties. They feel that costly televisions provide superior performance and a longer service life. The interface design and video color presentation both reflect the appearance. In addition to their own visual experience, the brand's promotional launch will play an important part.

Table 3.10

Factors to look for when buying a Smart TV

Items	Penetration rate (n=355)
Brand	39.15%
Price	80.00%
Good appearance	63.66%
High Definition	76.34%
Versatile	52.11%
Good looking interface	23.38%
Other	0.56%
Total	335.21%

In addition, in the survey of "whether to use other functions of the TV except for live TV," 79.86% of the respondents indicated they did not (see Table 3.11). In addition, the use of any additional functions, even by those who did engage with them, remained notably low. This data suggests that current smart TV system design, rather than prioritising user experience or brand system design, focuses primarily on the basic television features of live broadcasting and screen clarity.

In the eyes of older adults, smart TVs solely serve the purpose of live broadcasting, and additional Internet auxiliary features are rarely employed. The interactive jump is relatively slow because smart TV live broadcasting consumes significant memory. Furthermore, the smart TV interface is vast, and even if more operating functions are provided, the amount of information is overwhelming for older adults. Improper visual guidance will make them anxious and confused.

Table 3.11

Have you ever used any other system features of your smart TV besides live TV?

Items	Penetration rate (n=355)
No	79.86%
Projection playback of cell phone videos	14.08%
Game	17.32%
Movie/Drama/Variety Search	11.69%
Online Shopping)	12.54%
Online Education	2.82%
USB storage for pictures, music, videos, etc.	20.14%
Others	0.56%
Aggregation	159.01%

Factors Affecting the Usability of Smart TVs

An analysis of TV brand usage indicates that many older households own multiple smart TVs. Skyworth enjoys the highest usage rate at 70.42%, followed by Xiaomi at 66.48%. Hisense, Sony, Samsung, and TCL follow at 54.93%, 52.96%, 42.82%, and 42.54% respectively. These brands clearly dominate television consumption in this demographic.

The following table presents older adults users' ratings and rankings of specific utility features on current smart TVs (see Table 3.12). Specifically, no mean value exceeded a score of 4, suggesting that the usability of current smart TVs for this demographic is only moderate. Older adults are delighted with their smart TVs, "the remote control buttons are obvious and concise," with a score of 3.904, ranking first in the practicality/usability ranking, and was followed by "the material of the remote control feels very comfortable" and "the operation of the remote control is simple and clear." These findings highlight older adults users' preference for straightforward and comfortable physical interfaces. However, aspects related to the broader functionality of smart TVs, such as "the multifunctionality of Smart TVs is very practical," "Smart TV is smart," and "I am very familiar with the functions of Smart TVs," all received lower rankings. This suggests that older adults are not yet fully engaging with or finding value in the expanded functionality of smart TVs.

Table 3.12

Describe and rank the utility/usability elements of Smart TVs

	Mean	Standard deviation	Sort
The remote-control buttons are self-explanatory and easy to understand	3.904	.9954	1
The material of the remote control feels comfortable.	3.744	1.1017	2
The remote control is straightforward to operate.	3.732	1.1591	3
The voice search of the remote control is very convenient.	3.693	1.1950	4
Smart TV's navigation can quickly guide you to the program you want.	3.690	1.2350	5
The interface of Smart TV is very stylish and user-friendly.	3.637	1.0894	6
The interface of Smart TV is easy to navigate.	3.625	1.1898	7
The remote control looks very stylish and user-friendly.	3.611	1.1624	8
The Smart TV interface presents the features or program recommendations you want.	3.608	1.1480	9
The touch screen is more convenient than the remote control.	3.563	1.2525	10
The interaction of the smart TV is very smooth.	3.439	1.2253	11
You find the multi-functionality of the Smart TV very useful.	3.307	1.2068	12
You think the TV is brilliant.	3.290	1.1922	13
You are very familiar with the features of the Smart TV.	3.039	.9792	14

A comparison of questionnaire data concerning smart products and smart TVs indicates continuing issues for older adults in understanding the functionalities of smart products. These challenges are evident primarily in the areas of product visual design and human-computer interaction. Older adults expressed confusion regarding several functioning aspects of these products, particularly the usability of smart TVs.

The television, a technology long familiar to older adults, has recently evolved into the "smart TV" with the integration of new system functions. This has led to a decrease in older adults' success in using the device. Notwithstanding years of market availability, many system settings and newer features remain underutilized. Older adults' purchasing decisions center on brand recognition and price, with less emphasis on user experience. Therefore, the survey data indicate they did not utilize functions beyond live television broadcasting.

Moreover, in contrast to the familiar practice of memorizing channel numbers, contemporary smart TV interfaces offer rich content and expanded viewing choices. However, initial acceptance of this type of interface among older adults is low, hindering their ability to readily access desired programs. As a result, many available features remain unused.

Categorisation of Users According to Intelligent Product and Smart TV Preferences

Utilising a K-means clustering analysis method, as detailed in Table 3.13, three user groups are identified. These groups represent 18.03%, 40.28%, and 41.69% of the total sample, respectively. The relatively even distribution across these groups suggests the clustering model is effective. Cluster-1 represents individuals who generally disapprove of smart TV devices, consistently offering low approval ratings for both the televisions and their remote controls. Cluster-2 can be classified as a moderately approving group, with evaluation scores

for both intelligent products and remote controls generally between 3 and 4. In contrast, Cluster-3 demonstrates high levels of approval, typically assigning ratings above 4 to both devices and their remote controls.

Table 3.13

Summary of Basic Information on Clustering Categories

Clustering category	Frequency (N)	Percentage (%)
Cluster-1 Non-Approved Population	64	18.03%
Cluster-2 Medium Approval Population	143	40.28%
Cluster-3 Highly Approved Population	148	41.69%
Total	355	100%

A significant difference is identified in marital status among the subgroups ($\chi^2=25.074$, $p=0.000<0.01$) (see Table 3.14). Specifically, the high subgroups demonstrated a significantly higher marriage rate at 89.19%, compared to the average of 80.56%. Educational background also exhibited a significant difference ($\chi^2=35.445$, $p=0.000<0.01$). Specifically, 60.81% of the high subgroups reported having attained an elementary school education, significantly surpassing the average level of 47.04%; whereas, the low group displayed a significantly higher percentage of individuals with secondary school education (26.56%) than the average (21.13%).

Table 3.14

Results of Chi-Square Analysis

Title	Items	Cluster_Kmeans_753101(%)			Total	χ^2	p
		Low	Medium	High			
Gender	Male	31(48.44)	72(50.35)	74(50.00)	177(49.86)	0.067	0.967
	Female	33(51.56)	71(49.65)	74(50.00)	178(50.14)		
Total		64	143	148	355		
Marital status	Single	8(12.50)	10(6.99)	6(4.05)	24(6.76)	25.074	0.000**
	Married	39(60.94)	115(80.42)	132(89.19)	286(80.56)		
	Divorced or separated	9(14.06)	7(4.90)	3(2.03)	19(5.35)		
	Widowed	8(12.50)	11(7.69)	7(4.73)	26(7.32)		
Total		64	143	148	355		
Who do you live with now?	Living alone	14(21.88)	23(16.08)	35(23.65)	72(20.28)	14.927	0.135
	Living only with a partner	13(20.31)	41(28.67)	39(26.35)	93(26.20)		
	Living with children	18(28.13)	60(41.96)	50(33.78)	128(36.06)		
	Nursing home/welfare home	14(21.88)	14(9.79)	18(12.16)	46(12.96)		
	Living with friends	5(7.81)	5(3.50)	5(3.38)	15(4.23)		
	Other	0(0.00)	0(0.00)	1(0.68)	1(0.28)		
Total		64	143	148	355		
Education	No formal education	9(14.06)	11(7.69)	7(4.73)	27(7.61)	35.445	0.000**
	Elementary school	19(29.69)	58(40.56)	90(60.81)	167(47.04)		
	Secondary school	17(26.56)	28(19.58)	30(20.27)	75(21.13)		

Table 3.13

Summary of Basic Information on Clustering Categories

Clustering category			Frequency (N)		Percentage (%)			
	Junior high school education	10(15.63)	14(9.79)	4(2.70)	28(7.89)			
	High School Education	5(7.81)	12(8.39)	8(5.41)	25(7.04)			
	Higher education	4(6.25)	19(13.29)	9(6.08)	32(9.01)			
	Other	0(0.00)	1(0.70)	0(0.00)	1(0.28)			
Total		64	143	148	355			
Current income	10,000RMB or more	3(4.69)	6(4.20)	5(3.38)	14(3.94)	18.048	0.054	
	5000-9999RMB	7(10.94)	20(13.99)	12(8.11)	39(10.99)			
	3000-4999RMB	21(32.81)	37(25.87)	35(23.65)	93(26.20)			
	1000-2999RMB	16(25.00)	53(37.06)	74(50.00)	143(40.28)			
	Less than 1000RMB	13(20.31)	17(11.89)	19(12.84)	49(13.80)			
	No income	4(6.25)	10(6.99)	3(2.03)	17(4.79)			
Total		64	143	148	355			
* p<0.05 ** p<0.01								

The clustered chi-square analysis suggests that older adults with elementary school education exhibit a higher degree of acceptance towards smart TVs. This can be attributed to their limited need for the advanced features offered by these devices, as their current products adequately fulfil their basic requirements. In contrast, the lower subgroups with secondary school education and above believe that smart TVs should offer maximised value and prioritise user experience. These findings align with the earlier observations regarding the correlation between education level and the perception of intelligent products.

Open-ended Question Results and Synthesis Discussion

Older adults were asked, in an open-ended format (unlimited words), to offer suggestions regarding the intelligent products they currently use with their smart TVs. Considering the subjective nature of this prompt, responses varied in length and format, including paragraphs, single sentences, and keywords. These responses were then coded by the researcher over three rounds, with synonymous expressions consolidated to arrive at the final results for this open-ended question.

The results of the open-ended questions highlight older adult consumers' different functional requirements regarding intelligent products usage (see Figure 3.3). The prominent text size reflects frequently utilised terms such as "voice control," "voice reminder," "quick to search for functions," "simple to use," and "intelligent," indicating their significance. Several older adults also expressed a desire for simplified user experiences with current intelligent products. Following the identification and removal of redundant terms and sentences, a qualitative thematic analysis was conducted, resulting in three key themes: (i) operational interaction, (ii) targeted design, and (iii) **Practicality of Artificial Intelligence (AI)**. These themes are represented in the Word cloud image below.



Figure 3.3: Demand for intelligent products and Smart TVs among older adults

Operational Interactions

Older adults frequently cite difficulties in operating intelligent products and smart TVs as a significant barrier to adoption. While the concept of "interaction" itself is not well-understood by this demographic, common complaints such as "interaction," the most common keywords are "many steps," "no voice recognition," "no guidance," "too many useless functions," all point towards issues with the usability of these products. These operational challenges, already widely acknowledged in existing research, persist even in products specifically marketed towards older demographics.

In addition, the higher price point of many intelligent products, particularly smart TVs, often leads to inflated expectations regarding user experience. Consumers, enticed by a plethora of additional features and systems, may find themselves overwhelmed and unable to utilise the product to its full potential. While web-based interfaces offer cost-effective functionality and iterative updates, this advantage is often offset by an increased likelihood of operational errors. Indeed, ease of use remains a primary concern for both older adults and their families. Adult children, tasked with assisting their parents in completing the research's questionnaires, highlighted the prevalence of operational difficulties encountered by younger users, suggesting a need for more intuitive design across the board. Therefore, developers of intelligent products should prioritise user experience scenarios in their design process, focusing on usability as a key factor. While concealing certain functions might simplify the user interface for older adults, this approach contradicts the multifunctionality often touted as a selling point for these products.

Targeted Design

Despite the widespread use of intelligent products by older adults, the home intelligent products market does not specifically target this demographic. This oversight is likely due to the perception that seniors' needs are better served by medical, educational, and healthcare products, which represent more lucrative markets. However, the demand for smart home devices among older adults remains significant. Previous research suggests that older adults benefit from features such as large fonts, personalised settings, and tactile buttons. However, the persistence of these concerns in the study's questionnaire responses indicates that current intelligent product designs still fall short of adequately addressing these needs.

The questionnaire responses indicate that older adults, much such as their younger counterparts, are eager to engage with and learn about intelligent products. They, too, seek to integrate these technologies into their lives to enhance convenience and quality of life. This raises a crucial question: how effectively do existing targeted designs address the specific usability requirements of older adults' users?

Practicality of Artificial Intelligence (AI)

"Intelligence" represented the final theme from the questionnaire results. Previous research extensively explored "smart" products. With artificial intelligence developing, intelligent products are increasingly common. However, are all intelligent products "smart"? The questionnaire suggests not. Qualitative feedback indicates that while many intelligent products feature dialect recognition for intelligent voice interactions, older adults often need to repeat themselves for the product to understand them. Besides, many products are labelled "smart," but many older adults believe they are no different from ordinary household appliances. They consider it ridiculous that simply adding app control constitutes "smart" technology. They also feel smart TVs are similar to older models, except for picture clarity.

Vast data memory processing allows these "smart" devices to give optimal solutions or feedback based on user behaviour and voice. However, this "smart" feedback, especially with interfaces reliant on networked cloud displays, may be difficult to comprehend. Intelligent product control usually involves hands, eyes, and voice, which is difficult for older adults with declining physical abilities. Therefore, the questionnaire ranked "smart" as the least usable aspect of smart TVs.

Conclusion and Implications

This research employs a questionnaire to investigate the use of smart devices and smart TVs by older adults in China. Education and consumer abilities are the most important variables influencing their technological acceptance. At the same time, this research contributes to identifying the functions and services that older adults appreciate most in smart devices (smart TVs), with practicality, function guidance, voice, and reminder functions such as prominent button prompts being the most important considerations. The problematic operating procedure, unintuitive interface, and absence of aging-friendly functions of existing smart devices and smart TVs are the primary issues influencing their long-term use by the aged.

The questionnaire data gives product designers a clear path for improvement and encourages businesses to enhance smart TVs and other smart devices in a focused manner to serve older adults better. Furthermore, the survey results can help the government and relevant institutions formulate policies for digital services for older adults, such as popularizing intelligent products, providing digital education for older adults, and developing digital service platforms. On the other side, the study promotes cross-disciplinary collaboration in intelligent product design, gerontology, public health, sociology, and other disciplines, particularly for research on bridging the digital divide among older adults and enhancing their digital literacy. Overall, the contribution of this research can not only promote the design innovation of intelligent products and smart TVs but also help improve the quality of life of older adults and promote social care and support for older adults.

The preceding analysis and conclusions produce the following recommendations for government bodies and relevant businesses. First, advanced technologies, such as blockchain, should be employed to enhance the usability and security of platforms and applications associated with intelligent products. Second, the design of products, platforms, and applications should prioritize ease of use for older adults, specifically addressing the challenges this demographic encounters. Such considered design can increase both the frequency of use and perceived utility of intelligent products by this population. To boost the popularity of intelligent products and services, government agencies could facilitate partnerships among intelligence professionals, researchers, and business leaders, both domestically and internationally.

A key limitation of this study is the scope of the survey and the reliance on prospective research experiments. The current questionnaire offers only a preliminary exploration of intelligent product usage among older adults. A more complete understanding of practical usability challenges requires further comparative, experimental research with chosen case studies. Moreover, a larger product sample is necessary to generate more robust and convincing findings.

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