



Empirical Study of Smart Home Technology Acceptance among Baby Boomers Using an Extended UTAUT2 Model

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Abstract

This quantitative research aimed to examine the factors influencing smart home technology acceptance among the baby boomer generation in Shanxi Province, China, by applying an extended Unified Theory of Acceptance and Use of Technology (UTAUT2) model. The sample consisted of 393 potential users selected through convenience sampling. Data were collected via an online questionnaire. Statistical analyses, including factor analysis and path analysis, were conducted using standardized statistical software to validate the research model and test the hypotheses. The research results revealed that performance expectancy, effort expectancy, and social influence significantly and positively influenced behavioral intention, with performance expectancy being the dominant predictor. In contrast, the effects of facilitating conditions and habits on adoption intention were not statistically significant. These findings provide actionable insights for stakeholders to develop effective marketing strategies and technological support tailored to baby boomer consumers.

Keywords: Smart home Baby boomer Technology acceptance Behavioral intention UTAUT2

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Introduction

The global population is aging due to advances in healthcare and declining fertility rates. This trend has spurred the rise of the “silver economy”, with older adults becoming a large and increasingly affluent consumer group (Zhou et al., 2024). Their spending is evolving from basic needs toward enjoyment and self-improvement, alongside a growing interest in technology that enhances their quality of life (Kim, 2024).

The proliferation of AI technologies, such as IoT and voice recognition, is rapidly transforming homes into intelligent environments, offering proactive services through devices like smart speakers and health monitors.

The early smart home market was primarily technology-driven, with product designs often prioritizing feature accumulation over user needs. As competition has intensified and market education has advanced, the industry is shifting from a “technology-oriented” to a “user-oriented” approach. The core challenge now is how to design products and tailor marketing precisely for diverse age groups and cultural backgrounds.

As the baby boom generation (born 1946–1964) enters retirement, its strategic value is becoming increasingly evident (Carpini, 2014). Compared to earlier generations, boomers possess greater financial resource (BCG, 2023), a more open mindset, and a strong demand for aging in place, health management, and daily convenience (Shi et al., 2025). Smart home features such as security monitoring, health assistance, and easy control align closely with these needs, positioning this cohort as a key driver of future market growth (Insights, 2025).

Despite extensive research on smart home adoption, few studies have focused on the baby boomer generation in China's inland provinces using the UTAUT2 framework. In recent years, Shanxi Province has been facing the dual pressures of economic restructuring and rapid population aging. This distinctive “getting old before getting rich” characteristic makes the study of smart home technology acceptance among the elderly in Shanxi uniquely relevant, as it provides a valuable context for examining the boundary conditions of the UTAUT2 model. The specific applicability and boundary conditions of this model for the baby boomer cohort in the Shanxi context, however, remain unclear and warrant further investigation.

To address these gaps, this study applies the UTAUT2 model to investigate the adoption intentions of the baby boom generation in central Shanxi Province a region undergoing resource-based economic transformation. Using survey data from 393 potential users and structural equation modeling analysis, this study seeks to answer two interconnected research questions:

RQ1: How do the core constructs of the UTAUT2 model (performance expectancy, effort expectancy, social influence, facilitating conditions, and habit) influence baby boomers' intentions to adopt smart home technologies in a context where they lack prior usage experience?

RQ2: How do generational characteristics moderate the UTAUT2 relationships?

By addressing these questions, this study aims not only to empirically validate the UTAUT2 framework within China's aging population but also to extend its theoretical boundaries by revealing how generational and contextual specificities shape technology acceptance among older adults.

Research Objectives

1. To examine the factors influencing behavioral intention to adopt smart home technology among baby boomers based on the UTAUT2 model.
2. To identify the most dominant predictor among the UTAUT2 constructs affecting adoption intention in the context of Shanxi Province.

Literature Review

The UTAUT Model

A number of theoretical models have been proposed to facilitate the understanding of factors impacting the acceptance of information technologies (Chau, 1996; Davis, 1989) (Taylor & Todd, 1995; Venkatesh et al., 2003). Among these studies, the Technology Acceptance Model (TAM) is one of the most influential and robust in explaining IT/IS adoption behavior. The key purpose of TAM was to provide a basis for discovering the impact of external variables on internal beliefs, attitudes, and intentions.

Venkatesh et al., (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT) model to consolidate previous TAM related studies. In the UTAUT model, performance expectancy and effort expectancy were used to incorporate the constructs of perceived usefulness and ease of use in the original TAM study. Although the UTAUT model posits that the Effort Expectancy construct can be significant in determining user acceptance of information technology, concerns for ease of use may become non-significant over extended and sustained usage. Therefore, perceived ease of use can be expected to be more salient only in the early stages of using a new technology and it can have a positive effect on perceived usefulness of the technology (Marchewka & Kostiwa, 2007).

Moreover, the UTAUT model attempts to explain how individual differences influence technology use. More specifically, the relationship between perceived usefulness, ease of use, and intention to use can be moderated by age, gender, and experience. For example, the strength between perceived usefulness and intention to use varies with age and gender such that it is more significant for male and younger workers. The effect of perceived ease of use on intention is also moderated by gender and age such that it is more significant for female and older workers, and those effects decrease with experiences. The UTAUT model accounted for 70 percent of the variance in usage intention, better than any of TAM studies alone (Dwivedi et al., 2019; Oye et al., 2014). Although UTAUT provides great promise to enhance our understanding for technology acceptance, the initial UTUAT study focused on large organizations. In addition, the scales used in UTAUT model are new as they are in combination of a number of prior scales, and therefore, the suitability of these scales needs to be further tested.

Existing research indicates that the application of the UTAUT model has limitations, mainly reflected in three aspects: Firstly, the moderating variables in the original model (such as voluntariness) may lack variability in actual situations, resulting in limited applicability; Secondly, the direct impact of convenience conditions on behavioral intentions deserves re-examination, even if there is the variable of effort expectation. Finally, the model ignores the influence of individual user characteristics (such as attitude, self-efficacy and personal innovation) on technology adoption behavior, which are precisely the key elements in explaining the differences in user behavior (Dwivedi et al., 2019).

The Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) posits that performance expectancy, effort expectancy, social influence, facilitating conditions, and habit are core determinants of behavioral intention (Venkatesh et al., 2012). However, the predictive power of these constructs may vary significantly across different user groups and technological contexts. This study applies this framework to Baby Boomers a cohort

characterized as “digital immigrants” who generally possess lower technology self-efficacy and higher technological anxiety compared to younger generations (Smith et al., 2020). Given these unique characteristics, the formation of their adoption intentions for smart home technologies is likely to follow a distinct pattern.

In the Chinese cultural context, filial piety and intergenerational support play a significant role in technology adoption among older adults (Nan, 2022). Adult children often act as technology gatekeepers, recommending and assisting with smart home devices for their aging parents. This cultural dynamic may moderate the effects of social influence and facilitating conditions. Moreover, previous research suggests that for elderly “digital immigrants”, facilitating conditions may function more as “enablers” rather than “direct motivators” (Nugraha et al., 2025), as they lack the baseline experience to evaluate technical support needs.

For Baby Boomers, the decision to adopt smart home technology is expected to be predominantly driven by rational cognitive evaluations. First, performance expectancy (PE) refer to the degree to which they believe the technology will enhance their daily lives, is anticipated to be paramount (Ghalandari, 2012). This generation faces practical challenges related to aging-in-place, such as health monitoring, safety concerns, and daily convenience. Smart home devices that effectively address these tangible needs are likely to be perceived as highly useful, thereby fostering adoption intention (Li & Fan, 2023);. Second, given their potential discomfort with complex digital interfaces, the perceived ease of use, or effort expectancy (EE), becomes a critical facilitator. A steep learning curve could pose an insurmountable barrier, making simplified interaction design essential for adoption (Pal et al., 2018). Third, the influence of the social circle, or social influence (SI), is expected to operate differently for this group. While peer influence might be weaker, the phenomenon of “digital feedback”, where adult children act as technology gatekeepers and recommend products to their aging parents could be a powerful driver (Nan, 2022). Facilitating conditions (FC), which refer to the availability of technical infrastructure and support, require users to have a baseline awareness of what support is needed and available. For Baby Boomers with no prior smart home experience, these considerations may not yet enter their conscious decision-making process, thus exerting a non-significant direct effect on intention. According to the original UTAUT2 framework, habit (HT) is defined as the extent to which people tend to perform behaviors automatically because of learning, and it is posited to directly determine technology use behavior while moderating the relationship between behavioral intention and use (Venkatesh et al., 2012). Empirical evidence has confirmed habit as a significant predictor of behavioral intention in smart home adoption contexts (Strzelecki et al., 2023). Surveyed 795 individuals and found that habit had the strongest effect on intention to use smart home devices, outperforming performance expectancy and personal innovativeness. Meta-analytic evidence further supports the robust predictive power of habit across various technology acceptance contexts (Dwivedi et al., 2019). Although some studies have noted that habit may be less applicable to first-time users at the early stage of adoption (Tamilmani et al., 2018), the inclusion of habit in this study serves to empirically test the boundary conditions of the UTAUT2 model for the baby boomer cohort. Therefore, we propose the following hypotheses:

H1: Performance expectancy has a significant positive impact on Baby Boomers' intention to use smart home devices.

H2: Effort expectancy has a significant positive impact on Baby Boomers' intention to use smart home devices.

H3: Social influence has a significant positive impact on Baby Boomers' intention to use smart home devices.

H4: Facilitating conditions has a significant positive impact on Baby Boomers' intention to use smart home devices.

H5: Habit has a significant positive impact on Baby Boomers' intention to use smart home devices.

Conceptual Framework

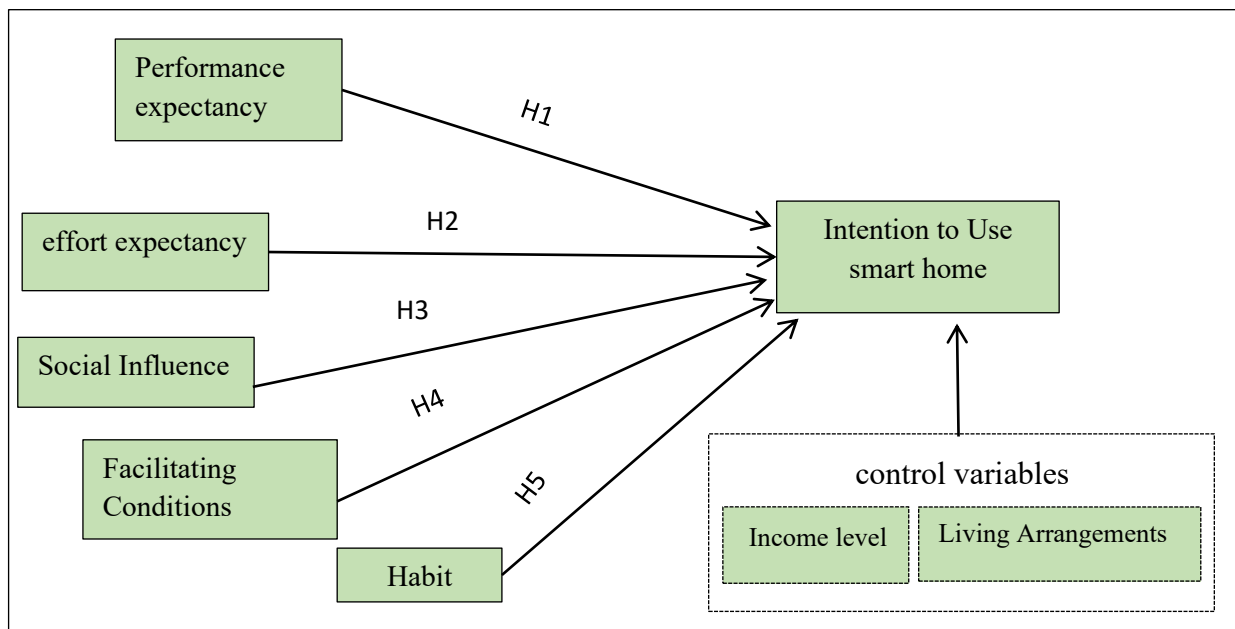


Figure 1: Conceptual Framework

Research Methodology

Sampling

The sample size was determined using Cochran's formula for cross-sectional surveys (Oribhabor & Anyanwu, 2019). Assuming a maximum variability ($P=0.5$) and a 5% margin of error at the 95% confidence level ($z=1.96$), the required sample size was calculated as:

$$n = \frac{P(1 - P)Z^2}{E^2} = \frac{0.50(1-0.50)1.96^2}{0.05^2} = 384.16$$

To account for potential invalid responses, we targeted approximately 400 participants.

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A total of 406 questionnaires were returned. After screening for missing data, straight lining, and response time (less than 120 seconds), 13 invalid responses were removed, yielding a final valid sample of 393 (effective response rate 96.8%). Table 1 presents the demographic characteristics of the sample.

Sampling techniques

Using convenience sampling, the questionnaire link was distributed through community WeChat groups and local senior centers.

Data Collection

Data were collected via an online survey (Wenjuanxing platform) from December 5–20, 2025, targeting baby boomers (born 1946–1964) in central Shanxi Province, China (Taiyuan, Jinzhong, Lvliang, Yangquan, and surrounding counties).

Construct and measurement

The questionnaire consisted of 25 items measuring six constructs (performance expectancy, effort expectancy, social influence, facilitating conditions, habit, and behavioral intention). All items were adapted from the validated UTAUT2 scale developed by Venkatesh et al. (2012) and modified to fit the smart home context. Each item was measured on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). A pilot test with 30 baby boomers was conducted to check clarity and wording; minor modifications were made based on their feedback.

Content Validity: The questionnaire was reviewed by the 3 experts, to assess content validity. Their feedback was used to refine the instrument, ensuring that all items were relevant to the research objectives and appropriately aligned with the study's constructs.

Reliability Testing: Cronbach α coefficients were employed for the reliability assessment, yielding a coefficient of 0.839. The reliability coefficients as the Cronbach index takes values between = 0.755-0.945, indicating high data reliability.

Data analysis

Through data analysis, this study explored the influencing factors affecting the baby boom generation's willingness to use smart homes in central Shanxi Province, China. The researchers conducted quantitative analysis using the Social Science Statistics Package for the Application of Research (SPSSAU), employing descriptive statistics, confirmatory factor analysis, and path analysis statistical methods to examine the association between user motivation and their willingness to use.

Results

Part 1 Descriptive statistical analysis

Table 1 The Personal Information

Variable Name	Variable Description	Sample size/PCS	percentage/%
Income	<3000 yuan	69	17.56
	3001-6000 yuan	111	28.24
	6001-10000yuan	113	28.75
	10001-20000yuan	72	18.32
	>20000yuan	28	7.12
City	TaiYuan	96	24.43
	JinZhong	96	24.43
	Lv Liang	101	25.70
	YangQuan	100	25.45
sex	Male	167	42.49
	Female	226	57.51
Housing conditions	Individuals living alone	37	9.41
	The couple	134	34.10
	Living with children	134	34.10
	Three generations living together	88	22.39

Part 2 Reliability and validity analysis

Table 2 Result of Scale reliability and validity coefficient tests.

Cronbach alpha coefficient		0.839
KMO		0.891
Approximate Chi-square		5182.997
Bartlett's Test of Sphericity	<i>df</i>	190
	<i>P</i> Value	0.000

Questionnaire validity was assessed through the Kaiser-Meyer-Olkin (KMO) test, yielding a KMO value of 0.891, above the threshold of 0.7, affirming effective information extraction from the research data. Additionally, Bartlett's test of sphericity ($p < 0.05$) was

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significant, confirming the questionnaire's reliability and validity for factor analysis, as depicted **Table 2**.

Part 3 confirmatory factor analysis

Table 3 Result of confirmatory factor analysis

Construct	Item	Coef.	Std.Estimate	AVE	CR
PE	PE1	1.000	0.894	0.787	0.937
	PE2	0.992	0.898		
	PE3	0.954	0.880		
	PE4	0.919	0.875		
EE	EE1	1.000	0.857	0.756	0.925
	EE2	0.997	0.859		
	EE3	1.026	0.888		
	EE-R	0.952	0.874		
SI	SI1	1.000	0.797	0.630	0.895
	SI2	0.952	0.786		
	SI3	0.964	0.790		
	SI4	1.059	0.816		
FC	SI-R	0.904	0.778	0.508	0.755
	FC3	1.000	0.742		
	FC2	1.030	0.735		
	FC1	0.886	0.658		
HT	HT1	1.000	0.860	0.702	0.904
	HT2	0.926	0.846		
	HT3	0.892	0.814		
	HT-R	0.925	0.830		
BI	BI1	1.000	0.867	0.774	0.945
	BI2	0.958	0.866		
	BI3	1.004	0.895		
	BI4	1.011	0.902		
	BI5	0.995	0.868		

All standardized loading coefficients (Std. Estimate) exceeded 0.6, indicating a strong measurement relationship. The reliability coefficients for the research data surpassed 0.6, confirming excellent statistical reliability for further analysis. The average variance extracted (AVE) for each construct ranged from 0.508 to 0.787, meeting the recommended threshold of 0.50 (Fornell & Larcker, 1981). Composite reliability (CR) ranged from 0.755 to 0.945, exceeding the recommended threshold of 0.70 (Hair et al.). As shown in Table 3, These results indicate adequate convergent validity. The square root of the AVE for each construct (ranging from 0.713 to 0.887) exceeded its highest correlation with any other construct, confirming discriminant validity.

Part 4 Model fitness test

Table 4 Results of the model fit test

Indicator	Criterion	Value	Conclusion
X^2/df	<3	0.921	Conformity
RMSEA	<0.10	0.000	Conformity
CFI	>0.9	1.003	Conformity
SRMR	<0.1	0.023	Conformity

The indexes and results of the model fit test are shown in Table 4. In the analysis results, The measurement model demonstrated an excellent fit to the data ($\chi^2/df = 0.921$, RMSEA = 0.000, CFI = 1.003, SRMR = 0.023), with all fit indices meeting or exceeding the recommended thresholds (in Table 4).

Part 5 Path Analysis of Factors Affecting the intention to Use

Table 5 UTAUT2 related variables statistic.

Hypothesis	Path	Path coefficient	S.E	C.R	P	Result
H1	PE→BI	0.517	0.059	8.746	0.000***	accepted
H2	EE→BI	0.237	0.056	4.223	0.000***	accepted
H3	SI→BI	0.147	0.053	2.742	0.006**	accepted
H4	FC→BI	-0.042	0.081	-0.513	0.608	rejected
H5	HT→BI	0.085	0.055	1.546	0.122	rejected

Notes: *** $p < .001$; ** $p < .01$; PE = Performance Expectancy, EE = Effort Expectancy, SI = Social Influence, FC = Facilitating Conditions, HT = Habit, BI = Behavioral Intention.

Structural model analysis revealed that performance expectancy ($\beta = 0.503$, $p < 0.001$), effort expectancy ($\beta = 0.237$, $p < 0.001$), and social influence ($\beta = 0.147$, $p = 0.006$) significantly and positively influenced baby boomers' behavioral intention to adopt smart home technology, accepted H1, H2, and H3. In contrast, facilitating conditions ($\beta = -0.042$, $p = 0.608$) and habit ($\beta = 0.085$, $p = 0.122$) showed no significant effects, thus H4 and H5 were rejected. All measurement model factor loadings were significant ($p < 0.001$), confirming construct reliability.

The results emphasize that performance expectation, effort expectation and social influence are the key factors of user behavior intention, while convenience and habit play a relatively limited role in the context of this study. (in The indexes and results of the model fit test are shown in Table 4. In the analysis results, The measurement model demonstrated an excellent fit to the data ($\chi^2/df = 0.921$, RMSEA = 0.000, CFI = 1.003, SRMR = 0.023), with all fit indices meeting or exceeding the recommended thresholds (in Table 4).

Part 5 Path Analysis of Factors Affecting the intention to Use

Table 5).

Discussion

This study found that performance expectancy (PE) has a significant positive impact on behavioral intention, which is highly consistent with the UTAUT theoretical framework and its numerous empirical research results (Venkatesh et al., 2003). The UTAUT model proposed by Venkatesh et al. (2003) defines performance expectation as the strongest predictor of behavioral intention, and this relationship has been repeatedly verified in subsequent cross-cultural studies (M. Hamakhan, 2020). Empirical studies on diverse technical scenarios such as cloud services (Ahmed et al., 2022), mobile applications (Novitasari et al., 2025) and educational technology (Alshrari, 2018) have all confirmed that when users perceive that the

technology can enhance their task performance, their intention to adopt it significantly increases.

The significant positive impact of effort expectation (EE) on behavioral intention is also supported by the literature. The UTAUT model indicates that the influence of effort expectations on behavioral intentions is particularly prominent in the early stages when users lack experience (Venkatesh et al., 2003). Empirical studies on Internet banking (Ahmed et al., 2022), mobile applications (Novitasari et al., 2025) and online learning (Alshrari, 2018) all confirm that the ease of use of the system significantly enhances users' willingness to adopt. The elderly user sample in this study may be in the early stage of smart home adoption, so the ease of operation of the system has become an important consideration in their decision-making.

The significant positive impact of social influence (SI) on behavioral intention is also in line with theoretical expectations. The UTAUT model lists social influence (i.e., subjective norms) as the core construct influencing behavioral intention, especially in situations with frequent social interaction (Venkatesh et al., 2003). Cross-cultural studies have shown that social influence plays a significant role in Internet banking (M. Hamakhan, 2020), cloud services (Ahmed et al., 2022) and technology adoption in higher education (Novitasari et al., 2025). This study found that the opinions of relatives, friends and social circles have an impact on the willingness of elderly users to adopt smart homes. This is consistent with the assertion of Venkatesh et al. (2003) that “social influence plays a stronger role in the early stage of adoption”, and is also consistent with the finding in cloud service research that social influence is listed as a “strongly significant determinant” (Ahmed et al., 2022).

The impact of promoting conditions is not significant, which is consistent with findings from some existing research which (Nugraha et al., 2025). may be due to the fact that inexperienced users have not yet formed a clear understanding of “technical support”, and this factor has not been incorporated into their early decision-making framework. Theoretically speaking, user experience is a key moderating variable in the technology acceptance model (Mensah & Khan, 2024). For inexperienced users, the formation of their behavioral intentions mainly relies on an abstract understanding of the inherent attributes of the technology (such as performance expectations and effort expectations), and a cognitive framework that directly links external support conditions with personal intentions has not yet been established. It is difficult for them to accurately assess the actual value and necessity of convenient conditions such as “technical support” at the early stage of decision-making. Secondly, the path of action of convenience conditions may be more indirect. Recent studies have suggested that FC may play the role of an “enabler” rather than a “direct motivator” (Nugraha et al., 2025). It indirectly influences behavioral intentions by significantly enhancing users' performance expectations and effort expectations. In the samples of this study, due to the users' lack of experience, this enabling effect of FC may not have been activated or clearly mapped to their behavioral intentions, resulting in the path coefficient of the direct effect not being significant.

The habit also did not reach a significant level, this result can be explained from the perspective of the adoption feature of smart home as a disruptive innovation. Firstly, from the theoretical perspective of habit formation, the “habit” construct in the UTAUT2 model is applicable to user groups that have had sufficient time to form automated behaviors. However, for users of new technologies in the early adoption stage, habits have not yet been formed, so it should not be expected that hedonic motives will drive automated behavioral responses (Tamilmani et al., 2018). As a disruptive innovation, smart home has not yet been integrated into users' daily life patterns. Users lack the accumulation of repeated use and long-term experience, making it difficult for them to form a “habitual” adoption tendency (Lee, 2012). Secondly, from the research progress of smart home adoption, this field is undergoing a

transformation from a “technology-driven” strategy to a “user-centered” approach (Park & Han, 2025). The latest research has found that the public's focus on smart home technology is shifting from simple functionality and convenience to more complex considerations such as privacy, security and ethics (Li et al., 2025). This means that for disruptive innovations like smart homes, the formation of the willingness to adopt requires a rational comprehensive assessment rather than a simple automatic response driven by habitual.

This study found that living structure has no significant impact on the adoption of smart home. This result shows that the family factor itself is a long-term neglected variable in the field of smart home research. The latest research clearly indicates that studies on the intention to use smart homes have long overlooked the role of family factors, and the influence of family factors (such as perceived family support) on the intention to adopt is indirectly achieved through mediating variables like optimism rather than direct main effects (Wu et al., 2025). This finding suggests that the influence of family structure on the willingness to adopt may need to be transmitted through other psychological mechanisms (such as risk perception and usefulness awareness), rather than through direct predictive relationships.

It is worth noting that the non-significance of facilitating conditions may be partially explained by the specific cultural and economic context of Shanxi Province. Compared to coastal cities like Shanghai, where elderly individuals are more likely to live alone and rely on formal technical support, baby boomers in Shanxi often live in multi-generational households (as shown in Table 1, 56.5% live with children or three generations together). In such settings, technical support is readily available from family members, reducing the perceived importance of formal facilitating conditions. This finding highlights the need to consider regional and cultural variations when applying the UTAUT2 model to technology acceptance among older adults in China.

Conclusion and Recommendations

Conclusion

An analysis of 393 baby boomers based on the UTAUT2 framework shows that their willingness to adopt smart homes is mainly driven by performance expectations, effort expectations and social impacts, while promoting conditions and habits have no significant direct influence. This reflects a unique pattern presented by this group in the initial acceptance stage, where rational cognitive assessment dominates, and situational and automatic factors have not yet intervened.

As “digital immigrants”, the baby boomers have relatively low technological self-efficacy, and the steep learning curve constitutes the main obstacle. Therefore, simplifying interaction design and reducing cognitive load should be the core considerations in product development. It is worth noting that the social influence within this group may mainly originate from within the family (such as suggestions for adult children), and future research needs to distinguish the sources of influence for verification.

Theoretical Contributions and Practical Implications

Theoretically, this study verified the boundary conditions of UTAUT2 in the baby boom population and revealed its adoption pattern dominated by “cognitive factors”. At the practical level, products targeted at this group should highlight functional value and simplify interaction to the greatest extent. Marketing strategies can leverage the influence of intergenerational families, using adult children as a bridge for information transmission and attaching great importance to the key touch point of the first use experience.

Limitations and Future Directions

The sample of this study is limited to the Shanxi region, and the universality of the conclusion remains to be verified. Cross-sectional design cannot reveal the dynamic evolution of influencing factors over time. In the future, tracking studies can be adopted. In addition, the specific sources of social impact were not distinguished, and further detailed analysis can be conducted later. Despite its limitations, this study provides an important empirical basis for understanding technology acceptance behavior in an aging society.

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