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Article

The digital transformation of housing: A demography-sensitive scenario-based model of smart home acceptance for aging in place

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ABSTRACT

This study explores older adults' acceptance of IoT-based smart home systems using an extended Technology Acceptance Model (TAM) that incorporates trust alongside perceived ease of use (PEOU), perceived usefulness (PU), attitude toward use (ATU), and behavioral intention (BI). Data were collected from 166 older adults via visually enriched, scenario-based surveys tailored to enhance engagement and contextual comprehension. Structural Equation Modeling (SEM) and Multi-group SEM (MG-SEM) techniques were applied to examine both the general model structure and demographic moderating effects. Results reveal that trust is the most influential predictor of both PU and ATU, underscoring its central role in gerontechnological smart home acceptance decisions among older adults. PU significantly predicts ATU, which in turn strongly influences BI. While PEOU has no direct effect on ATU, it exerts a meaningful indirect effect on BI through PU and ATU. These patterns support the relevance of indirect usability pathways in technology acceptance. MG-SEM analyses highlight significant differences across demographic groups. Rural users show heightened sensitivity to ease of PEOU, whereas urban users display stronger trust-based pathways toward PU and BI. Younger elderly individuals are more influenced by ATU in forming BI, while older users associate PU and trust indicators with emotional and cognitive reassurance. Education and living environment also moderate several paths, confirming the need to consider contextual diversity in technology acceptance. This study contributes by extending TAM with trust, using scenario-based survey design, and integrating MG-SEM analyses to capture demographic and contextual variations. Findings emphasize the importance of personalized digital aging strategies and trust-based mechanisms for shaping older adults' technology acceptance.

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INTRODUCTION

Aging in place has increasingly become a core policy objective, aiming to enable older adults to maintain independent living within their current home environments (Straughan et al., 2025; Lee et al., 2024). When combined with digital health technologies and smart home solutions, this approach has substantial potential to enhance quality of life (Kutsal & Polatoglu, 2024). However, realizing this potential depends not only on technological accessibility but also on older adults' willingness to adopt such systems (Abdalrahim, 2025; Portegijs et al., 2023; Markoc & Bayram, 2025).

The Technology Acceptance Model (TAM) is one of the most widely used theoretical frameworks for explaining user behavior in the field of information systems. Its core constructs, perceived ease of use (PEOU) and perceived usefulness (PU), influence attitude toward use (ATU) and behavioral intention (BI). Yet, among older adults, this process is not shaped solely by cognitive evaluations. Emotional and relational factors, such as trust, also play a significant role in technology perceptions (Chen and Chan, 2014; Zhou et al., 2024). Therefore, the present study extends the classical TAM structure by incorporating trust as an additional determinant.

Moreover, older adults do not constitute a homogeneous group. Demographic factors such as age, gender, education, living arrangement, and settlement type can lead to meaningful differences in technology acceptance (Galkin et al., 2025). As prior research has often overlooked these demographic effects (Zhang, 2023), this study applies MG-SEM to compare structural relationships within the model across demographic subgroups.

A further contribution of this study lies in its integration of a scenario-based assessment approach. By utilizing visually supported life scenarios, participants were able to imagine and evaluate technologies they had not directly experienced, allowing the measurement of vicarious experience-based cognitive responses (Kang et al., 2020). This method offers a realistic and innovative means of assessing technology acceptance among older adults, particularly when direct experience is limited.

Taken together, the study makes three contributions: (i) extending TAM with the integration of trust, (ii) applying a scenario-based visual assessment method tailored to older adults, and (iii) testing demographic sensitivities through MG-SEM. An overview of the research design is presented in Figure 1.

In line with the analytical framework outlined above, the theoretical foundation of the study is addressed in the following section.

THEORETICAL BACKGROUND

Aging in place, gerontechnology, and IoT-based residential systems

In Turkey, approximately 80% of older adults reside in their own homes (TUIK, 2024), underscoring the growing relevance of the Aging in Place (AIP) approach. Spatial attachment, housing satisfaction, and social connections play critical roles in shaping the quality of life and psychosocial well-being of older adults (Markoc & Cinar, 2017). However, AIP should not be evaluated solely from a physical perspective. Instead, it must be understood as a multidimensional concept encompassing access to services, safety, social engagement, and technological support (Lee et al., 2024).

Gerontechnology refers to technological innovations specifically designed to support the lives of older adults. Within this scope, IoT-based systems contribute to independence and safety through functions such as remote health monitoring, fall detection, digital communication, and home automation (Rejeb et al., 2023). Yet, their effective use depends strongly on digital literacy levels and on older adults' attitudes toward technology (Zhang, 2023).

Demographic indicators in Turkey reveal significant challenges: only 12% of older adults hold a university degree, 21% are at high risk of social isolation, and partner loss is especially prevalent among women (TUIK, 2024). Healthcare utilization is also comparatively higher in this group. These findings emphasize the importance of technologies that reduce both personal and public healthcare burdens (Ahmed et al., 2025). Within the home environment, key concerns include safety, energy expenses, and support for activities of daily living. Accordingly, home automation systems, energy-efficient technologies, and mobile health services have been highlighted as vital tools for improving social sustainability (Barber, 2020; Allioui & Mourdi, 2023). A synthesis of elderly needs and corresponding IoT-based technological solutions identified in the literature is presented in Table 1.

In Turkey, only 26% of individuals aged 65 and older own a smartphone, and internet and computer usage rates remain even lower (TUIK, 2024). Notable differences also exist between rural and urban populations, while living alone significantly shapes attitudes toward technology (Markoc & Sari Haksever, 2019; 2025; Li et al., 2025).

Technology Acceptance Model (TAM) and technology adoption among older adults

The Technology Acceptance Model (TAM) (Davis, 1989) explains technology use through four primary constructs: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude Toward Use (ATU), and Behavioral Intention (BI). In recent years, TAM has been widely applied to examine older adults' technology adoption intentions. More recent

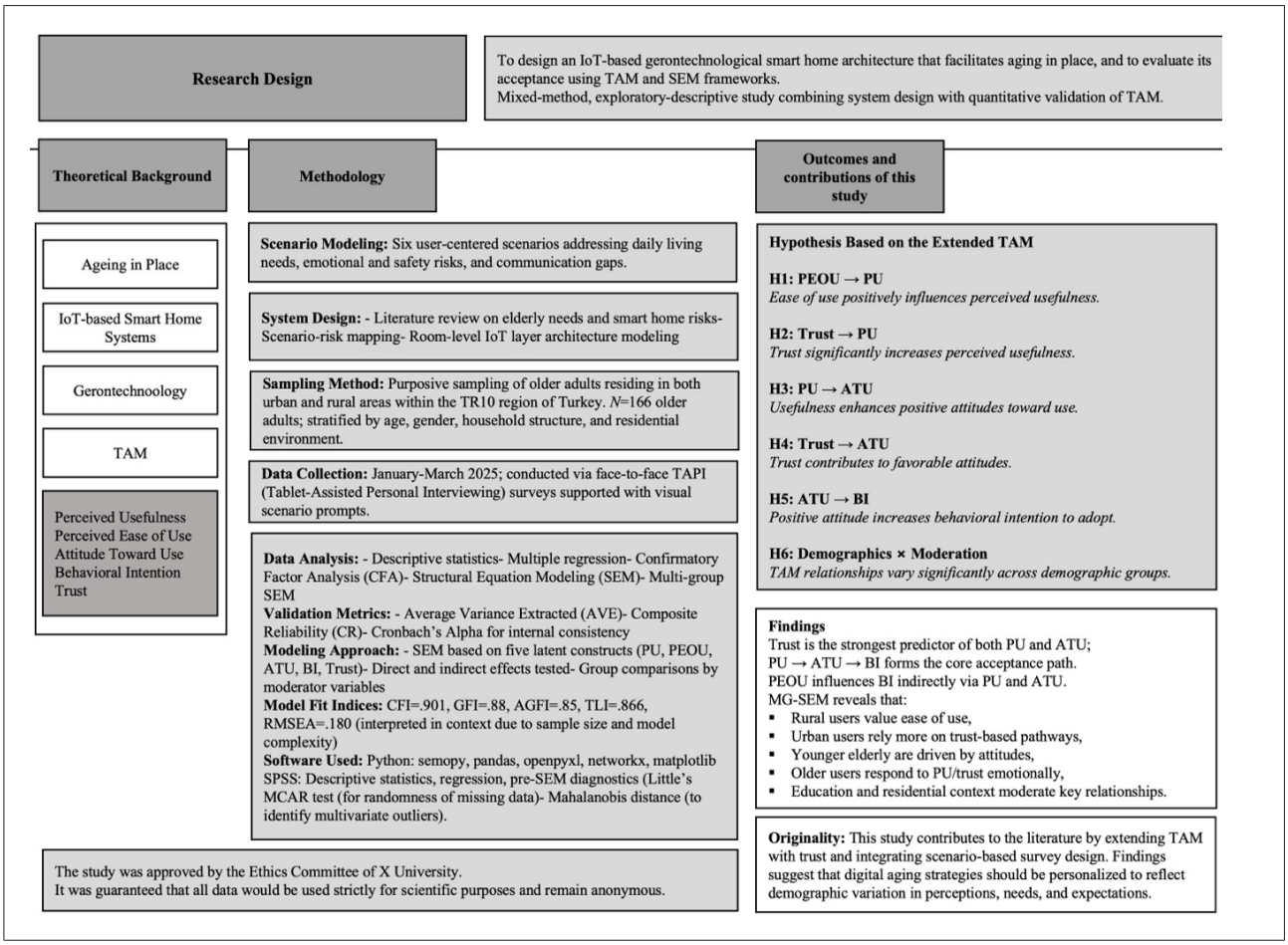


Figure 1. Research design.

Source: Designed based on the methodological framework of the study.

extensions of TAM have incorporated **trust** as a critical determinant and highlighted the moderating role of demographic factors in shaping PU and ATU (Zhou et al., 2024). Accordingly, this study adopts TAM not only as a cognitive framework but also as a socially grounded approach. Building upon structural relationships and demographic sensitivities identified in prior research, the next section details the methodology employed.

METHODOLOGY

Research Objectives and Hypothesis Development

This study aims to test the acceptance of a scenario-based, IoT-enabled smart home system developed in alignment with the principle of aging in place for older adults. The proposed framework extends the classical Technology Acceptance Model (TAM) (Davis, 1989) by integrating **trust**, which has been identified as a critical determinant in older adults' technology adoption (Zhou et al., 2024). Furthermore, the model investigates the moderating effects of demographic variables such as age, gender, and living environment on the relationships among key constructs (Galkin et al., 2025).

Previous research often treated older adults as a homogeneous group, overlooking variations in technology acceptance related to demographic characteristics. Addressing this gap, the present study proposes a model that is sensitive to demographic differences. Based on the scenario-driven system design and the extended TAM framework, the hypotheses summarized in Table 2 were developed. Hypotheses were tested through SEM and MG-SEM to evaluate the structural relationships and demographic moderating effects.

Taken together, the hypotheses presented in Table 2 establish the extended TAM framework that guides the empirical analysis. Building on this theoretical foundation, the following section introduces the study participants and describes the data collection process.

Participants

The study sample consisted of 166 older adults (*N*=166). The sample size was determined in line with the widely accept-

Table 1. Needs of elderly individuals and related technologies.

Area of Need	Proposed IoT-Based Solutions	Reference
Support for activities of daily living	Smart home assistants, automated lighting and heating systems, reminder mechanisms	Ehrenberg, 2024
Medication adherence and health monitoring	Wearable health trackers, medication dosage reminders, remote health monitoring systems	Liao et al., 2019
Indoor and outdoor security	Door/window sensors, motion detectors, smart lock systems	Sonamoni et al., 2024
Prevention of social isolation	Virtual social networks, video call-enabled digital displays, social robot applications	Welch et al., 2023
Energy efficiency and reduction of housing expenses	Smart energy meters, optimization systems for water/heat/appliance usage	Khan et al., 2024
Accessibility and ease of use in technology	Simplified user interfaces, voice-controlled systems, large-icon mobile applications	Khamaj & Ali, 2024
Emergency assistance	Emergency alert bracelets, fall detection sensors, panic button systems	Fernández-Bermejo Ruiz et al., 2022
Access to digital healthcare services	Telehealth platforms, remote doctor consultation modules	Haleem et al., 2021

Source: Developed from thematic analysis and related literature.

Table 2. Research hypotheses guided by the extended TAM model.

Hypothesis	Statement	Rationale
H1	Perceived ease of use (PEOU) positively affects perceived usefulness (PU).	According to TAM, systems that are easier to use are more likely to be perceived as useful, particularly by older adults with limited technological familiarity. Prior studies emphasize that ease of interface design enhances functional trust and utility perception (Davis, 1989; Zhang, 2023). PEOU → PU
H2	Trust has a positive effect on perceived usefulness (PU).	Trust functions as both a cognitive and emotional facilitator in risk-prone contexts such as aging populations. When users believe that the system is reliable and secure, they tend to view it as more beneficial for health, safety, and communication needs (Zhou et al., 2024; Li et al., 2025). Trust → PU
H3	Perceived usefulness (PU) positively influences attitude toward use (ATU).	When individuals perceive a technology as valuable or life-enhancing, this fosters a favorable attitude toward use. For older adults, tangible benefits such as fall detection or medication reminders significantly strengthen acceptance (Venkatesh & Bala, 2008). PU → ATU
H4	Trust positively influences attitude toward use (ATU).	A strong sense of system trust reduces psychological resistance and fosters a positive emotional orientation toward technology. In gerontechnology contexts, trust plays a critical role in reducing anxiety and increasing openness (Chen & Chan, 2014; Zhou et al., 2024). Trust → ATU
H5	Attitude toward use (ATU) positively affects behavioral intention (BI) to adopt smart home technology.	A user's general attitude toward a system is one of the most consistent predictors of their behavioral intention. This is aligned with TAM's core pathway and has been validated across technology acceptance studies, particularly among older adults (Holden & Karsh, 2010). ATU → BI
H6	The strength of TAM relationships significantly differs across demographic groups (age, gender, living environment), indicating moderating effects.	Sociodemographic variables shape both cognitive and emotional processing of technological systems. For example, age, education, and household structure may moderate the relative importance of trust and usability in adoption intentions (Portegijs et al., 2023; Rejeb et al., 2023). Demographics X Moderation

Source: Derived from existing TAM-based models and adapted for aging-in-place contexts.

ed guideline in SEM, which recommends a minimum of 10 observations per estimated parameter to ensure robust estimation and reliable testing of path coefficients (Kline, 2023). This approach provided sufficient statistical power, thereby eliminating the need for a separate *a priori* power analysis. The socio-demographic distribution of the participants is summarized in Table 3, which presents gender, age, educational attainment, living area, and household type characteristics.

Informed by these demographic profiles, the following section describes the instruments and measures employed to evaluate the extended TAM constructs.

Instruments and Measures

To collect data for this study, a three-part instrument was employed, consisting of visual scenario-based prompts, a TAM-based scale, and a demographic information form. First, based on a review of the literature, the needs and risk domains relevant to older adults were identified, leading to the development of eight user scenarios. These scenarios were matched with specific spaces within the smart home, associated risk factors, and corresponding IoT solution sets (Table 4).

The IoT-based solution architecture, designed in the context of residential spaces and system layers, is presented in Table 5. This approach enabled older adults to evaluate the system derived from scenario-driven cognitive responses, without requiring direct interaction or prior experience with the technology.

Technology acceptance was measured using the Technology Acceptance Model (TAM) developed by Davis (1989). The scale consisted of four core dimensions: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude Toward Use (ATU), and Behavioral Intention (BI). Additionally, a Trust dimension was incorporated into the model to reflect the study's focus (Chen & Chan, 2014; Zhou et al., 2024).

All items were rated using a 5-point Likert scale, and the statements were presented in a simplified language appropriate for the cognitive profiles of older adults. Demographic information, including age, gender, educational background, residential setting, and household structure, was also collected. To ensure the robustness and reliability of the dataset before conducting SEM, a series of preliminary diagnostic tests were applied. First, missing completely at random (MCAR) patterns were tested using Little's MCAR test to ensure the randomness of any missing data. Mahalanobis distance analysis was then conducted to identify multivariate outliers that could skew SEM estimations. Upon validating data quality, SEM analyses were carried out using the semopy library in Python, which enabled estimation of both direct and indirect effects. In addition to model computation, networkx and matplotlib libraries were employed to visualize the structural relationships among latent constructs and observed indicators. This integrated approach ensured both statistical rigor and visual clarity in interpreting the complex path relationships within the extended TAM framework.

Table 3. Participants' socio-demographic characteristics.

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	82	49.40
	Female	84	50.60
Age	60-65	52	31.33
	66-70	42	25.30
	71-75	17	10.24
	76-80	16	9.64
	81-85	21	12.65
	85+	18	10.84
Educational Level	Primary School	35	21.08
	Secondary School	14	8.43
	High School	47	28.31
	Bachelor's Degree	52	31.33
	Master's Degree	9	5.42
	Doctorate	9	5.42
Living Area	Urban	114	68.67
	Rural	52	31.33
Household Type	Living Alone	45	27.11
	With Spouse-Partner	63	37.95
	With Spouse and Children	5	3.01
	With Caregiver-Assistant	18	10.84
	With Mother and-or Father	2	1.20
	With Children Only	9	5.42
	Extended Family	24	14.46
Total		166	100

Source: Primary survey data (2025), analyzed using SPSS v26.

FINDINGS

Initially, the 16 items within the TAM framework were presented along with their mean and standard deviation (SD) values. Across the full sample, Items 10 and 11 emerged as the most highly endorsed, whereas Items 5 and 8 received the lowest levels of agreement (Table 6).

Beyond the descriptive results, the following section explores whether these technology acceptance constructs vary according to participants' demographic characteristics.

Table 4. Scenarios and related technologies in the context of elderly individuals' needs.

Needs	Scenario Description	Risks	Related IoT-Based Solutions
Assistance with Daily Living Activities	Every morning when Ms. Ayse goes to the bathroom, the lights automatically turn on, and the home assistant provides reminders.	Disorientation, tripping, forgetfulness	Automated lighting, voice assistant, ambient temperature control, reminder systems
Medication Adherence and Health Monitoring	Mr. Can's smart bracelet collects health data, provides a visual alert at medication time, and notifies family members if a dose is missed.	Missed medication, health deterioration, delayed intervention	Wearable health trackers, smart pillbox alert systems, real-time data transmission
Indoor and Outdoor Safety	When Ms. Zeynep forgets to close the front door, the system automatically locks it. A window sensor activates in response to wind.	Unauthorized access, injury from open windows/doors	Smart locking systems, door/window sensors, automatic closure mechanisms
Mitigation of Social Isolation	The system reminds Mr. Ahmet of his scheduled video call with his grandchild and enables one-touch connection.	Loneliness, social withdrawal, cognitive decline	Integrated video communication displays, social companion robots, automated reminder tools
Energy Efficiency and Cost Reduction	Lights automatically switch off in unused rooms, and the heating system adjusts based on home occupancy.	High energy costs, inefficient resource use	Smart energy meters, environmental sensors, automated control systems
Accessibility and Ease of Use of Technology	Ms. Hakan controls devices via voice commands such as "Turn on the lights" or "Turn off the TV."	Difficulty interacting with digital devices, visual limitations	Voice-controlled interfaces, simplified user interfaces, large icons
Emergency Assistance	Mr. Murat falls in the bathroom; the sensor on his wrist detects the motion and initiates an automatic emergency call.	Fall-related injury, lack of immediate help	Fall detection sensors, emergency alert wristbands, panic buttons
Access to Digital Health Services	Ms. Yasemin conducts a remote consultation with a nurse via a smart display, with her health data preloaded.	Missed diagnosis, lack of real-time medical attention	Telehealth-enabled displays, data transmission modules, digital appointment scheduling

Source: Developed according to gerontechnology needs mapping and IoT system integration within the study.

Mean differences by demographic variables

This section investigates whether the Technology Acceptance Model (TAM) constructs differ significantly according to participants' demographic characteristics. As presented in Table 7, findings from the multiple regression analysis indicate that age is positively associated with several core constructs. Specifically, older participants reported higher levels of Perceived Ease of Use (PEOU) and more favorable Attitude Toward Use (ATU). Trust also slightly increased with age, although the magnitude was smaller compared to other variables.

Moreover, living environment showed a significant effect: participants residing in urban areas exhibited substantially higher levels of Perceived Usefulness (PU), PEOU, ATU, Behavioral Intention (BI), and Trust. Similarly, household structure emerged as an influential factor; those living alone consistently reported greater scores across PU, PEOU, ATU, BI, and Trust, suggesting that solo dwellers perceive higher relevance, usability, and reliability of the smart home system.

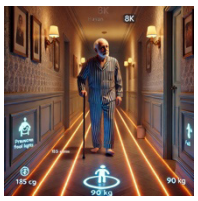
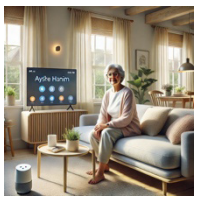
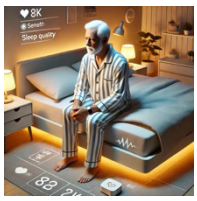
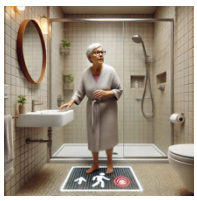
On the other hand, gender and educational level did not demonstrate statistically significant effects on any of the TAM variables. While individuals with higher education levels showed a trend toward greater ease of use, this relationship was not strong enough to reach statistical significance. These results highlight the nuanced ways demographic variables interact with technology perception, emphasizing the importance of personalized system design and targeted implementation strategies in gerontechnology contexts.

In summary, while demographic variables such as age, living environment, and household structure exert significant influences on technology acceptance, the next section employs SEM to explore the underlying causal relationships among TAM constructs.

Structural Equation Modeling (SEM) results

The five-factor technology acceptance structure (PU, PEOU, Trust, ATU, and BI) developed through Structural Equation Modeling (SEM) was tested using Confirmatory Factor Analysis (CFA). All factor loadings exceeded the threshold of .60 and were statistically significant, indicating strong convergent validity across the model constructs (Table 8).

Table 5. IoT-based system layers and components according to residential spaces.

	Entrance	Corridor	Kitchen	Living Room	Bedroom	Bathroom
Perception	Motion sensor, magnetic door sensor, facial recognition camera, RFID reader	Pressure sensor, light sensor, night motion detector	Gas detector, temperature sensor, smoke sensor, water leakage sensor	Ambient temperature-humidity sensor, motion sensor, vibration detector	In-bed pressure sensor, night motion detector, ambient light sensor, wearable health devices	Anti-slip floor sensor, water temperature sensor, fall detector, humidity sensor
Transmission	Wi-Fi, Zigbee, LoRa, RFID connectivity	BLE (Bluetooth Low Energy), Zigbee, Wi-Fi	Wi-Fi, Zigbee, NB-IoT	Wi-Fi, Z-Wave, MQTT over IP	BLE, Zigbee, Wi-Fi	Zigbee, Wi-Fi
Control/ Processing	Smart lock systems, access control scenarios	Timer-controlled lighting trigger, motion-based scenarios	Automatic stove shut-off system, voice alert module	Smart TV control unit, energy monitoring module, curtain motors	Automatic night light, emergency call systems, sleep analysis	Temperature balance control system, ventilation automation, panic button control module
Application	Mobile app notifications, video call integration	Automatic light control, remote monitoring interface	Cooking timer, energy consumption report	Voice assistant (Google, Alexa), mobile control panel	Sleep quality report, emergency notifications to relatives	Emergency call notification, water usage analytics report
						

Source: Developed within the scope of the study. Scenario illustrations were created using AI-based tools for visualization purposes only.

The overall fit of the measurement model is considered acceptable according to the following indices: CFI=0.901, GFI=0.88, AGFI=0.85, and TLI=0.866. However, the RMSEA value (0.180) is notably high. Nevertheless, the other fit indices confirm that the model demonstrates an acceptable fit within the theoretical framework. Although the RMSEA exceeds the commonly recommended upper threshold of 0.08, initially suggesting limitations in absolute model fit, this outcome can be attributed to the model's structural complexity, the inclusion of numerous paths and latent variables, and the relatively modest sample size. As Kenny et al. (2015) emphasize, RMSEA values are often inflated in small-sample, complex models; in such cases, relative fit indices such as CFI, TLI, and SRMR provide more reliable assessments. Within this context, the acceptable levels of the other indices indicate that the model is both theoretically and empirically supported. Thus, when interpreted contextually, the elevated RMSEA does not undermine the validity of the model. In addition, alternative and more parsimonious model specifications, such as versions without the Trust construct or without demographic moderation, were also explored; however, these simplified models yielded lower explanatory power and weaker fit indices, and were therefore not retained.

Examining the direct effects obtained through SEM (Table 9), Trust emerges as the strongest predictor of PU. This result robustly confirms *H2*, reinforcing the theoretical argument that trust operates as both a cognitive and emotional precursor to perceived usefulness in gerontechnological systems (Zhou et al., 2024; Li et al., 2025). While PEOU demonstrates a weak but statistically significant effect on PU, PU strongly predicts ATU, and Trust also exerts a significant influence on ATU. This finding supports *H3*, indicating that when older adults recognize clear functional benefits, such as increased independence or health monitoring, they are more likely to develop a positive attitude toward technology use. By contrast, the PEOU → ATU relationship was not statistically supported, suggesting that ease of use may influence attitude primarily indirectly through perceived usefulness. This provides empirical support for *H1*, affirming that ease of use contributes to perceived usefulness, albeit to a limited extent. The finding aligns with prior research emphasizing that intuitive system design enhances functional trust and utility perception, especially for users with limited digital proficiency.

Table 6. Descriptive statistics at the item level for technology acceptance constructs.

TAM Construct	Survey Item	Mean	SD
Perceived Usefulness (PU)	1. This system would make my home safer.	1.61	1.03
	2. This system would help monitor my health status.	1.42	0.80
	3. It would make it easier to carry out daily tasks.	1.70	1.05
	4. This system would help me live more independently at home.	1.80	1.06
Perceived Ease of Use (PEOU)	5. Learning to use this system would be easy for me.	2.62	1.21
	6. I would easily understand how to operate the devices.	2.36	1.03
	7. This system would fit well into my daily routine.	2.00	0.89
	8. Using devices through voice commands would be easy.	2.60	1.67
Attitude Toward Use (ATU)	9. Using this system would make me feel good.	1.74	1.08
	10. I would feel safer because of this system.	1.48	0.80
	11. This technology would make my life easier.	1.48	0.80
Behavioral Intention (BI)	12. I would like to use such a system in my home.	1.64	1.03
	13. I would be willing to try this system.	1.58	0.87
	14. I would use this system in my home for a long time.	1.74	1.16
Trust	15. I trust that this system would function properly.	1.52	0.93
	16. I believe it would call for help in an emergency.	2.20	0.84

Source: Based on item-level descriptive analysis of survey data collected in the current research using SPSS v26.

As expected, ATU strongly predicts BI. This confirms *H5*, underscoring that favorable attitudes, rooted in both emotional comfort and perceived benefit, are key drivers of adoption intention in smart home contexts. The standardized path coefficient exceeding 1, while uncommon, can occur due to high conceptual overlap between the ATU and BI constructs (Wolf et al., 2013; Venkatesh et al., 2003). In terms of indirect effects, PEOU influences both ATU and BI indirectly via PU. Similarly, Trust exerts a strong indirect effect on BI, mediated through both PU and ATU. This result validates *H4*, highlighting the psychological role of trust in fostering emotional safety and reducing technology-related anxiety among older individuals (Chen & Chan, 2014). Collectively, these findings underscore the pivotal role of Trust as a key determinant in technology acceptance.

The SEM diagram illustrates the standardized path coefficients (β), where each arrow indicates the direction and strength of influence between constructs. Latent variables (unobserved factors such as PU, PEOU, ATU, Trust, and BI) are represented as dark grey nodes, and each is linked to its corresponding observed indicators (survey items) via their factor loadings. This visualization displays standardized coefficients only, allowing for easier comparison of effect sizes across paths (Figure 2).

As shown in Figure 2, the structural model was tested using SEM, and the following section presents the findings of the multi-group analysis based on demographic moderators.

Multi-group SEM findings based on demographic moderators

These MG-SEM results provide robust empirical confirmation for *H6*, revealing that key TAM pathways are significantly moderated by demographic characteristics such as age, gender, education level, and residential environment. These findings underscore that older adults do not constitute a homogenous group in their technology acceptance behaviors. Instead, adoption patterns are context-sensitive and shaped by distinct cognitive, emotional, and sociocultural factors (Portegijs et al., 2023; Rejeb et al., 2023).

The MG-SEM results indicate that demographic variables, gender, age, education level, residential location, and household structure, exert significant moderating effects on several model pathways. Notably, differences based on gender and age were particularly evident for the relationships between Trust, PU, and ATU (Table 10).

Among female participants, the Trust → PU and PU → ATU pathways were stronger, whereas among males, Trust → ATU and BI → Willingness for long-term use emerged more prominently. In younger elderly participants, the ATU → BI relationship was more pronounced; for older participants, PU's emotional effect and the link between PEOU and Trust were stronger. For participants with lower educational attainment, all pathways (PEOU → PU, Trust → PU/ATU, PU → ATU) were more influential. In contexts characterized by low digital literacy, ease of use and trust played a critical role. In rural areas, the PEOU → PU and Trust → ATU rela-

Table 7. Direct effects of demographic variables on core TAM constructs.

Demographic Variable	Coefficient	p-value	Interpretation
PU - Perceived Usefulness			
Age	0.060	0.104	Slight trend (not statistically significant).
Living Environment	0.938	<0.001	Very strong effect: urban users perceive higher usefulness.
Household Structure	0.197	<0.001	Stronger usefulness perception among solo households.
PEOU- Perceived Ease of Use			
Age	0.244	<0.001	Older users perceive the system as easier to use.
Education Level	0.104	0.118	Not statistically significant; however, higher education appears to be associated with a tendency toward greater ease of use.
Living Environment	0.481	0.036	Urban residents report higher ease of use.
Household Structure	0.148	0.014	Individuals living alone or with care needs value ease of use more.
ATU- Attitude Toward Use			
Age	0.092	0.003	Older individuals show more favorable attitudes.
Living Environment	0.765	<0.001	Urban users report significantly more positive attitudes.
Household Structure	0.172	<0.001	Those living alone express more favorable attitudes.
BI - Behavioral Intention			
Age	0.114	0.003	Older users express higher intent to adopt.
Living Environment	0.811	<0.001	Urban residency strongly increases intent to adopt.
Household Structure	0.197	<0.001	Individuals living alone report greater adoption intent.
TR - Trust in the System			
Age	0.100	<0.001	Trust increases slightly with age.
Living Environment	0.598	<0.001	Rural residents report lower trust levels.
Household Structure	0.103	<0.001	Co-residence with family members is associated with lower levels of perceived trust in the system.

Source: Calculated from primary data collected in the study using regression analysis in SPSS v26.

tionships were dominant, whereas in urban areas, the PU → ATU path was stronger. These findings indicate that ease of use and trust are more salient in rural contexts, while perceived usefulness is a more decisive factor in urban settings. No significant structural differences were found across household structures, suggesting that individual perceptions may outweigh household composition in technology adoption among older adults.

DISCUSSION

This study explored older adults' acceptance of IoT-based home technologies through an extended Technology Acceptance Model (TAM), emphasizing the pivotal role of trust in shaping both perceived usefulness (PU) and attitude toward use (ATU). Consistent with *H2*, trust was found to significantly enhance PU, aligning with prior research that identifies trust as both a cognitive and emotional enabler in risk-laden contexts such as aging populations (Zhou et al., 2024; Li et al., 2025). Similarly, in line with *H4*, trust exerted a direct and meaningful influence on ATU. As Chen and Chan (2014) emphasized, trust functions as a critical affective mechanism that mitigates psychological resistance and nurtures emotional openness to technology among older users.

While perceived ease of use (PEOU) did not demonstrate a direct effect on attitude, its indirect influence through PU confirms *H1* and supports the mediated pathway described in *H3*. This finding reinforces the argument advanced by Davis (1989) and later echoed by Zhang (2023), that ease of use is valuable primarily insofar as it enhances the perceived utility of a system. In gerontechnological contexts, where older adults often rely on intuitive design and low cognitive burden, a system's usability indirectly facilitates positive attitudes, but only when perceived as functionally beneficial.

Attitude toward use (ATU) emerged as the strongest predictor of behavioral intention (BI), offering robust support for *H5*. This aligns with TAM's foundational structure and is widely supported in smart technology acceptance re-

Table 8. Factor loadings and significant interpretations.

Factor	Survey Statement	Loading (λ)	SE	p-value	Interpretation
PU	This system would make my home safer.	1.000	-	-	Independent living and assistance with daily tasks are primary determinants of perceived usefulness.
	This system would help monitor my health status.	0.610	0.041	<0.001	
	It would make it easier to carry out daily tasks.	0.945	0.038	<0.001	
	This system would help me live more independently at home.	0.943	0.039	<0.001	
PEOU	Learning to use this system would be easy for me.	1.000	-	-	Users' cognitive competence in technology shapes their perception of ease of use.
	I would easily understand how to operate the devices.	1.027	0.029	<0.001	
	This system would fit well into my daily routine.	0.695	0.051	<0.001	
	Using devices through voice commands would be easy.	0.652	0.054	<0.001	
ATU	Using this system would make me feel good.	1.000	-	-	Attitudes are shaped by psychological safety and expectations of quality of life.
	I would feel safer because of this system.	1.083	0.043	<0.001	
	This technology would make my life easier.	1.077	0.038	<0.001	
BI	I would like to use such a system in my home.	1.000	-	-	Users consider the system to be long-term and sustainable.
	I would be willing to try this system.	0.959	0.030	<0.001	
	I would use this system in my home for a long time.	1.087	0.054	<0.001	
TR	I trust that this system would function properly.	1.000	-	-	Trust regarding emergency responses may vary between individuals.
	I believe it would call for help in an emergency.	1.014	0.101	<0.001	

Source: Derived from confirmatory factor analysis conducted on TAM-based survey data.

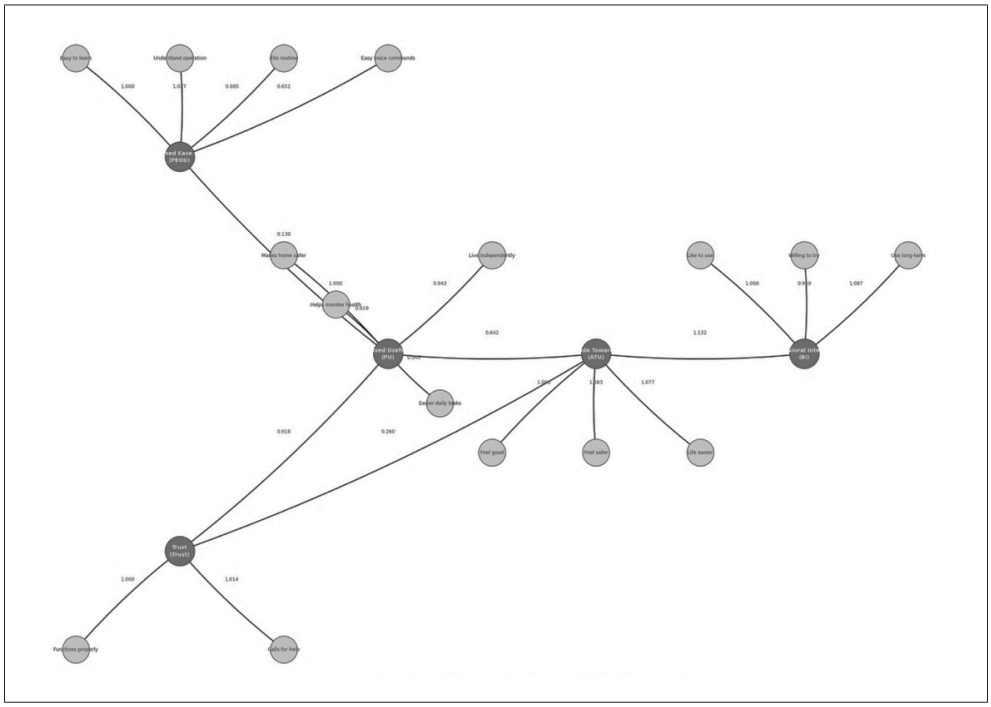


Figure 2. SEM diagram.

Source: SEM diagram constructed using Python, guided by the Technology Acceptance Model (TAM) extended with the Trust factor. The visualization was generated using networkx and matplotlib libraries within the scope of this study. Standardized path coefficients are annotated on the directional edges to represent the strength of relationships among latent constructs and observed indicators.

Table 9. Direct and indirect effects obtained within the scope of SEM.

Source	Target	Coefficient	p-value	Interpretation	Groups with Significant Differences
PEOU	PU	0.130	0.039	Significant	Family-dwelling, Rural, Younger participants
Trust	PU	0.918	<0.001	Very strong and significant	Female, Older, Higher education level, Urban
PU	ATU	0.642	<0.001	Very strong and significant	Female, Younger, Urban, All household types
PEOU	ATU	-0.002	0.943	Not significant	Weak and only significant in Older and Family-dwelling groups
Trust	ATU	0.260	<0.001	Strong and significant	Male, Older, Family-dwelling participants
ATU	BI	1.132	<0.001	Very strong and significant	Consistently significant across all demographic groups
PEOU	BI (indirect effect through PU→ATU)	≈ 0.094	-	Indirect effect	-
Trust	BI (indirect effect through PU→ATU)	≈ 0.668	-	Strong indirect effect	-

Source: Based on SEM results derived from the study data.

search involving older adults (Holden & Karsh, 2010). The emotional and psychosocial evaluation of smart home technologies, such as fall detection or medication reminders, appears to underlie the transition from favorable attitudes to concrete adoption intentions.

MG-SEM analysis revealed demographic moderation effects consistent with H6. Specifically, the strength of the PEOU → PU path was more pronounced among rural participants, potentially reflecting greater reliance on interface simplicity in less digitally saturated environments. Conversely, PU had a stronger effect on ATU in urban contexts, where technological exposure may heighten sensitivity to functional benefits. Gender-based patterns were also evident: women were more influenced by trust-mediated PU, whereas men exhibited stronger direct trust-to-attitude pathways. These findings support the notion of differentiated emotional versus functional evaluation strategies (Chen & Chan, 2014). Among lower-education participants, both trust and PEOU played amplified roles, underscoring the need for cognitive support and accessible design (Portegijs et al., 2023; Rejeb et al., 2023).

Although the scenario-based design relied on simulated rather than real-life interaction, this limitation was mitigated by adopting the vicarious experience framework (Kang et al., 2020), which emphasizes participants' ability to make informed judgments through guided visual scenarios. Nevertheless, the cross-sectional nature and geographically constrained sample may limit generalizability, suggesting the importance of future longitudinal and cross-cultural research.

Theoretically, the study makes a key contribution by integrating trust into TAM as a central construct influencing not only PU but also ATU and BI indirectly, thereby reinforcing the robustness of H2 and H4. Furthermore, the MG-SEM findings challenge the homogeneity assumption often made about older adults' technology acceptance, directly addressing critiques raised by Zhang (2023) and Chen and Chan (2014). Finally, the scenario-based approach proved effective in eliciting context-sensitive responses, offering a methodologically sound pathway for future gerontechnology research.

In addition to the current findings, the study offers several practical implications: Given older adults' reliance on trust and perceived usefulness in technology adoption, developers should prioritize simplicity, data security, and transparency in interface design. The stronger influence of ease of use among rural and lower-education groups highlights the importance of intuitive, low-cognitive-load solutions. Furthermore, the observed gender- and education-based differences suggest that awareness campaigns and training programs need to be tailored to specific demographic profiles. In this context, municipalities and healthcare providers could integrate IoT-based smart home technologies into age-friendly policies and infrastructure initiatives to support independent living among older adults.

CONCLUSION

This study provides an extended Technology Acceptance Model (TAM) analysis of IoT-based gerontechnological home systems, incorporating demographic moderators to capture the diversity of older adults' technology acceptance. Findings highlight that perceived ease of use indirectly influences attitudes through perceived usefulness, while behavioral intention is predominantly shaped by attitudes. By integrating demographic sensitivity and scenario-based evaluation, the study advances a more context-aware un-

Table 10. Multi-group SEM analysis.

Moderator	Path (Independent → Dependent)	Direction of Difference	p-value	Interpretation
Gender	Trust → PU	Stronger in females	N/A	Trust increases perceived usefulness more significantly among women.
	PU → ATU	Stronger in females	N/A	Perceived usefulness plays a more dominant role in shaping attitudes among women.
	Trust → ATU	Stronger in males	N/A	Trust has a greater influence on attitude among men.
	BI → BI.3	Stronger in males	N/A	Behavioral intention affects BI.3 more strongly in men.
Age	ATU → BI	Stronger in younger elderly	0.002	Attitude is a stronger predictor of behavioral intention in younger elderly individuals.
	PU → PU.4	Stronger in older individuals	<0.001	The emotional/cognitive impact of PU is more significant among older people.
	PEOU → PEOU.1	Stronger in older individuals	<0.001	Perceived ease of use more strongly influences age-related trust among the elderly.
	BI → BI.3	Stronger in older individuals	0.001	Behavioral intention impacts safety/comfort structures more in elderly individuals.
Education Level	PEOU → PU	Stronger in lower-educated group	<0.001	Ease of use affects PU more in individuals with lower education levels.
	Trust → PU	Stronger in lower-educated group	<0.001	The impact of trust on PU is more prominent in the lower-educated group.
	PU → ATU	Stronger in lower-educated group	0.031	Perceived usefulness has a stronger effect on attitude in less-educated individuals.
	Trust → ATU	Stronger in lower-educated group	0.001	The relationship between trust and attitude is more significant in this group.
Living Environment	PEOU → PU	Stronger in rural areas	<0.000001	Ease of use positively and strongly affects PU in rural settings.
	Trust → PU	Stronger in urban areas	<0.001	In urban settings, trust perception is more effective on PU.
	Trust ← Trust.2	Stronger in rural areas	<0.001	Trust increases more with age in rural areas.
	Trust → ATU	Stronger in rural areas	<0.01	Trust significantly influences attitude in rural contexts.
	PU → ATU	Stronger in urban areas	0.031	In urban areas, PU is a more decisive factor on attitude.
Household Structure	All paths	No significant difference	>0.05	No significant structural differences were found based on household type.

Source: Derived from MG-SEM analysis conducted on study data using Python.

derstanding of how aging populations engage with smart home technologies. In particular, living environment, education level, and digital literacy were found to significantly shape acceptance pathways. These insights call for inclusive, human-centered design strategies that emphasize simplicity, emotional reassurance, and usability for aging populations.

Limitations and Future Research

Despite its contributions, this study has several limitations. First, the cross-sectional design constrains the ability to track behavioral changes over time; longitudinal approaches are needed to capture the dynamics of acceptance. Second, reliance on self-reported data raises risks of social desirability and discrepancies between perceived and actual behaviors; future work should incorporate behavioral and usage-based measures. Third, the research was conducted within the cultural context of Turkey, which may restrict generalizability. Additionally, the fact that this study was carried out in Turkey suggests that the findings may have been influenced by the cultural context. Strong family ties,

the tendency for older adults to live with family members, and widespread social responsibility norms regarding elder care may have amplified the prominent role of trust in the technology acceptance process. These cultural characteristics may have foregrounded perceptions of reliability and care support in technological systems. Future studies are therefore encouraged to investigate the generalizability of these findings across different cultural environments. Moreover, the exceptionally high standardized path coefficient between Attitude Toward Use (ATU) and Behavioral Intention (BI) (β=1.132) may indicate a partial discriminant validity limitation arising from the conceptual proximity of these constructs. Although strong theoretical justification and the CFA results support adequate convergent validity, future studies should further examine potential construct overlap using more stringent discriminant validity tests or alternative model specifications. Fourth, while the scenario-based approach supported contextual imagination, it did not allow direct interaction with technology; experimental or prototype-based designs are recommended for higher ecological validity. Fifth, the study relied on an extended TAM framework; incorporating alternative models such as UTAUT2 and constructs like facilitating conditions would offer a more comprehensive understanding. Finally, the absence of negative psychological constructs such as technophobia and privacy concerns limit the explanatory scope; their inclusion in future models could yield a more nuanced view of older adults' smart home acceptance.

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