Gender Differences in Smart Home IoT Device Acceptance: A TAM-Based Quantitative Study Among Urban Indian Adults Aged 45 and Above

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Abstract—
Purpose : This study examines whether gender moderates the acceptance of smart home IoT devices among urban Indian adults aged 45 and above a demographic with growing device access but inconsistent adoption using the Technology Acceptance Model (TAM) as its theoretical foundation.
Design/methodology/approach : A structured 23-item questionnaire measuring five TAM constructs are Perceived Ease of Use, Perceived Usefulness, Social Influence, Overall Attitude, and Behavioural Intention was administered to 42 urban Indian adults (19 male, 23 female) across Bengaluru, Kochi, Trivandrum, and Calicut, following pilot testing with 15 participants. As the Shapiro-Wilk test confirmed non-normal distribution across all constructs, the Mann-Whitney U test and Spearman's rank-order correlation were used for inferential analysis.
Findings : No statistically significant gender differences were found across any construct ($p > 0.05$), indicating that gender does not serve as a meaningful differentiator in smart home IoT acceptance within this age group. Social Influence emerged as the strongest predictor of Behavioural Intention ($\rho = 0.754$, $p < 0.01$), with family recommendations particularly from adult children identified as the primary adoption driver. Perceived Ease of Use recorded the lowest mean score, identifying interface complexity and setup difficulty as the principal barriers to sustained use.
Research limitations/implications: The relatively small sample size of 42 limits statistical power and generalisability. Future research should replicate this study with larger samples across wider geographic regions and include longitudinal measures of actual device use.
Practical implications: Designers and marketers targeting the 45+ demographic should prioritise intuitive interfaces and family-assisted onboarding strategies over gender-differentiated approaches, as social facilitation from family members is the dominant adoption driver regardless of gender.
Originality/value : This study challenges conventional gender-based assumptions in technology adoption research by demonstrating that within the 45+ urban Indian demographic, social influence from family supersedes gender as the primary predictor of smart home IoT acceptance — a finding with direct implications for inclusive product design and digital adoption policy in India.

Keywords: Technology Acceptance Model, smart home devices, IoT adoption, gender differences, older adults, urban India, perceived ease of use, social influence

I. INTRODUCTION

India's total internet subscribers surged from 251.59 million in March 2014 to 954.40 million in March 2024, achieving a compound annual growth rate (CAGR) of 14.26% , bringing with it a growing consumer market for connected technologies, including smart home devices (Telecom Regulatory Authority of India, 2023). Products such as voice assistants, smart lighting systems, and connected security devices have become increasingly available to urban Indian households, promising greater convenience, safety, and independent living. These devices, however, are not passive tools. They are characterised by features that demand ongoing interaction from the user, responding to voice commands, integrating with other appliances and platforms, and operating through continuous network connectivity. The Internet of Things (IoT) is defined as a framework of physical objects integrated with communication hardware such as antennas and microcircuits enabling them to interface with wireless networks for real-time data transmission and remote sensing (Bajaj, 2023).

This study is concerned not with whether the population above 45 is aware of smart home devices or indifferent to their benefits, but with the influence of factors such as gender on the adoption of smart

home devices. A further observation motivated this study. An informal survey of customer reviews on major Indian e-commerce platforms revealed that reviewers of smart home devices were predominantly male. This pattern raises the question of whether gender plays a meaningful role in how smart home devices are accepted and if so, what the implications are for the way such devices are designed, positioned, and marketed. Understanding gender differences in adoption, if they exist, could offer actionable direction to manufacturers and marketers of IoT devices operating in the Indian market. The adoption of technology within urban ecosystems is contingent upon a multifaceted set of determinants. Specifically, research suggests that user acceptance is primarily driven by perceived usefulness, trust, security, and a heightened sense of ecological consciousness (Walczak et al., [2025]).

To investigate these questions, this study employs the Technology Acceptance Model (TAM), originally proposed by Davis (1989). TAM is one of the most widely validated frameworks in the study of technology adoption, built on two core constructs: perceived usefulness, the degree to which a user believes a technology will enhance their performance or quality of life, and perceived ease of use, the degree to which a user believes the technology will require minimal effort. Together, these two perceptions are theorised to predict a user's intention to adopt a technology. Given its parsimony and empirical track record across diverse technology contexts, TAM provides a reliable foundation for this investigation. The model is extended here to incorporate three additional constructs: trust and privacy concern, technology anxiety, and social influence, each of which reflects conditions specific to this population and device category that the original model did not address.

Data were collected from urban Indian adults above 45 years of age residing in cities including Bengaluru, Kochi, Trivandrum and Calicut. A structured questionnaire was developed comprising 23 items of which 3 items are nominal and 20 ordinal items, each measured on a five-point Likert scale, covering all the constructs. Before full-scale administration, the instrument was pilot tested with 15 participants in a moderated setting, allowing ambiguous or confusing items to be identified and revised. The reliability of each construct's scale was assessed using Cronbach's alpha, which measures the internal consistency of items intended to capture the same underlying variable. To examine whether gender differences exist in adoption-related perceptions, t-tests were conducted.

The findings of this study are intended to contribute both to the academic understanding of technology acceptance in underrepresented user groups and to the practical decisions of those who design and bring IoT products to market in India.

Research Aim:

How do smart home devices influence users of various genders (Indian users above 45 years of age having various digital literacy) and their acceptance and adoption of smart home appliances.

Objectives :

This study tries to understand how urban Indian adults above the age of 45 perceive and engage with smart home IoT devices by examining five core constructs : Perceived Usefulness, Perceived Ease of Use, Social Influence, Overall Attitude, and Behavioural Intention. The objective is to assess how each of these factors shapes the adoption experience within this demographic, and to determine whether gender moderates the relationships between them. By measuring how useful respondents believe these devices to be in their daily lives, how much effort they associate with operating them, and how strongly family recommendations and peer influence bear on their decisions, the study builds a structured picture of what drives or discourages continued use. The findings are intended to offer both a theoretical contribution to the existing body of TAM-based research and a practical direction for designers and manufacturers seeking to make smart home devices more accessible and relevant to this growing user group.

II. LITERATURE REVIEW

The rapid proliferation of the Internet of Things (IoT) and smart home technologies has generated substantial scholarly interest in understanding the factors that drive or hinder their adoption among diverse user populations. From early conceptual frameworks rooted in information systems research to contemporary empirical investigations across various demographic and cultural contexts, the literature reflects an evolving and interdisciplinary

body of knowledge. This review synthesises key theoretical foundations and empirical findings from fourteen seminal works, spanning from Davis's (1989) foundational Technology Acceptance Model (TAM) to recent studies examining gender, age, and cultural influences on smart technology adoption.

2.1 Theoretical Foundations: The Technology Acceptance Model and Its Extensions

The intellectual bedrock of technology adoption research is Davis's (1989) Technology Acceptance Model (TAM), which proposed that two primary beliefs—perceived usefulness and perceived ease of use—are the principal determinants of an individual's intention to use a new information technology. Davis (1989) demonstrated through empirical validation that these two constructs reliably predict user acceptance, establishing a parsimonious yet powerful framework that has since been applied extensively across diverse technological contexts. The model posited that perceived usefulness the degree to which a person believes a system enhances job performance—and perceived ease of use the degree to which use of a system is free of effort—together shape attitudes toward use and, consequently, behavioural intention.

Recognising the limitations of the original TAM in capturing the full complexity of technology adoption, Davis and Venkatesh (2000) proposed a theoretical extension of the model through four longitudinal field studies. This extension introduced additional variables, most notably subjective norm and image, to account for the social and organisational influences that shape technology acceptance. The longitudinal design of their study provided robust evidence that the determinants of acceptance evolve over time and with increased system experience, offering a more dynamic understanding of the adoption process. This work laid important groundwork for subsequent researchers seeking to integrate social influence into adoption models.

The role of gender in shaping technology acceptance was explicitly examined by Venkatesh et al. (2000), who investigated why men and women exhibit differential patterns of technology use. Their study found that social influence—particularly subjective norm—exerted a stronger effect on women's technology acceptance than on men's, while men were more strongly influenced by perceived usefulness. This gendered difference in the determinants of acceptance has important implications for the design and marketing of IoT and smart home technologies, suggesting that adoption strategies may need to be tailored to address the distinct motivational profiles of male and female users.

2.2 IoT Adoption: Systematic Reviews and Conceptual Frameworks

As the IoT paradigm matured, scholars began to systematically map the literature to identify overarching themes and future research directions. Kumar et al. (2023) conducted a comprehensive systematic literature review on IoT adoption, synthesising evidence from a wide range of empirical and theoretical studies. Their review identified key adoption drivers such as perceived usefulness, ease of use, security concerns, and trust, while also highlighting significant gaps in the literature, particularly regarding adoption in developing countries and among vulnerable populations. The authors called for future research to examine the contextual and cultural factors that moderate IoT adoption, a gap that several subsequent studies in this review have begun to address.

Singh et al. (2024) offered a comprehensive systematic review specifically focused on consumer adoption and acceptance of smart home devices, providing an integrative picture of the factors shaping smart living. Their review underscored the centrality of perceived usefulness, ease of use, security, and privacy concerns as recurring themes across the literature. Importantly, Singh et al. (2024) noted that the heterogeneity of smart home devices—ranging from smart speakers and thermostats to security systems and healthcare monitors—means that adoption determinants may vary significantly depending on the specific device and its associated use case. The review called for greater attention to the user experience throughout the adoption lifecycle, from initial awareness to long-term continued use.

2.3 Smart Home Technologies: Challenges, Opportunities, and User Perspectives

The practical realities of smart home adoption were examined through a field study by Brush et al. (2011), who investigated how actual home automation systems were used in the wild—that is, in real

household settings rather than controlled laboratory environments. Their qualitative study revealed that despite enthusiasm for home automation, users frequently encountered significant barriers related to complexity, reliability, and the difficulty of customising systems to meet evolving household needs. Notably, the study found that concerns about privacy, security, and the effort required to maintain smart home systems were widespread among adopters. Brush et al. (2011) identified a fundamental tension between the promise of automation and the reality of ongoing management demands, suggesting that ease of use and system reliability must be prioritised by designers and manufacturers.

Complementing this field-based perspective, Stojkoska and Trivodaliev (2017) provided a technical review of IoT for smart home applications, cataloguing the key challenges and proposed solutions across the hardware, software, and network layers of smart home architectures. Their review identified interoperability, scalability, security, and energy efficiency as the most pressing technical challenges facing the smart home IoT ecosystem. By mapping these technical constraints against user needs, Stojkoska and Trivodaliev (2017) highlighted the importance of interdisciplinary collaboration between engineers and social scientists to develop solutions that are both technically robust and aligned with user expectations.

The user perspective on smart home technologies was systematically examined by Marikyan et al. in two complementary reviews. The 2019 review by Marikyan et al. synthesised the empirical literature on smart home adoption from a user-centric perspective, identifying motivations, barriers, and contextual factors that shape adoption decisions. The review highlighted that while convenience, energy savings, and security enhancement are frequently cited motivations, concerns about privacy, data security, and loss of control act as significant deterrents. The 2024 update by Marikyan et al. extended this analysis by incorporating more recent empirical evidence, reflecting the rapid expansion of the smart home market and the increasingly diverse range of devices available to consumers. Together, these reviews provide a longitudinal perspective on how user attitudes and adoption patterns have evolved as smart home technologies have become more mainstream.

2.4 Security, Privacy, and Trust in IoT Adoption

Security and privacy concerns have consistently emerged as critical barriers to IoT adoption across the literature. Matharu et al. (2014) provided an early and influential examination of the security challenges inherent in IoT systems, identifying vulnerabilities at the device, network, and application layers. Their analysis drew attention to the limited computational resources of IoT devices, which constrain the implementation of traditional security mechanisms, and to the novel attack vectors introduced by the pervasive connectivity of IoT environments. Matharu et al. (2014) argued that addressing these security challenges is a prerequisite for building the user trust necessary to drive widespread IoT adoption.

2.5 Demographic and Contextual Moderators of IoT Adoption

A significant strand of the literature has examined how demographic characteristics—particularly age, gender, and institutional context—moderate the relationship between TAM constructs and adoption behaviour. Bajaj et al. (2023) investigated the factors influencing IoT adoption in the banking sector, with a particular focus on the moderating roles of gender, age, and bank ownership type. Their study found that while perceived usefulness and ease of use were significant predictors of IoT adoption intention across all groups, the strength of these effects varied significantly by gender and age. Specifically, older users and female users were more sensitive to ease-of-use perceptions, while younger and male users were more strongly motivated by usefulness. The type of bank ownership (public vs. private) also moderated adoption patterns, reflecting the influence of organisational culture and trust in institutions.

The adoption of IoT among older adults in the Indian context was specifically examined by Chatterjee et al. (2022), who investigated the factors shaping behavioural intention to use IoT among aged Indian consumers. Their study found that perceived usefulness, ease of use, and social influence were significant determinants of adoption intention, but that concerns about complexity and security were particularly pronounced among older users. The study highlighted the importance of designing IoT interfaces that are accessible and intuitive for older adults, who may have less prior experience with digital technologies. Chatterjee et al. (2022) also noted that social norms and peer influence played a stronger role in shaping adoption among older

consumers than is typical in younger populations, underscoring the importance of community-level interventions to promote IoT adoption among ageing populations.

Gender differences in IoT adoption were further examined by Walczak and Kowalski (2025), who investigated how men and women perceive and engage with IoT technologies in smart city environments. Their study found that women were more likely to prioritise safety and security applications of smart city IoT, while men were more interested in efficiency and connectivity features. Walczak and Kowalski (2025) also found that women expressed greater concern about data privacy and surveillance, a finding consistent with the broader literature on gender differences in privacy attitudes. These findings have important implications for the inclusive design of smart city IoT systems and for communication strategies aimed at promoting adoption across diverse user groups.

The role of TAM in understanding faculty adoption of IoT in academic settings was explored by Alzahrani (2023), who examined the behavioural intentions of university faculty to use IoT technologies in their professional contexts. The study found that perceived usefulness and perceived ease of use were significant predictors of adoption intention, consistent with the original TAM framework. However, Alzahrani (2023) also identified that institutional support and access to training resources were important contextual facilitators of adoption, suggesting that TAM's core constructs must be supplemented by organisational and environmental factors to fully explain IoT adoption in professional settings.

2.6 Synthesis and Research Gaps

Taken together, the fourteen studies reviewed here reveal a coherent body of knowledge characterised by several recurring themes and a number of important gaps. TAM and its extensions (Davis, 1989; Davis & Venkatesh, 2000) provide the dominant theoretical lens through which IoT and smart home adoption has been examined, with perceived usefulness and perceived ease of use consistently emerging as significant predictors of adoption intention across diverse contexts (Alzahrani, 2023; Bajaj et al., 2023; Chatterjee et al., 2022; Kumar et al., 2023; Singh et al., 2024). However, there is growing recognition that these core constructs must be supplemented by social influence variables (Venkatesh et al., 2000), trust and security perceptions (Matharu et al., 2014), and contextual moderators such as age, gender, and cultural background (Bajaj et al., 2023; Walczak & Kowalski, 2025) to achieve a comprehensive understanding of IoT adoption.

The technical literature (Stojkoska & Trivodaliev, 2017) has identified significant engineering challenges in the IoT ecosystem particularly around security, interoperability, and reliability that have direct implications for user trust and adoption. Field-based studies (Brush et al., 2011) and systematic user reviews (Marikyan et al., 2019; Marikyan et al., 2024) have demonstrated that the gap between the theoretical potential of smart home technologies and the practical realities of their use remains substantial, with complexity, reliability, and privacy concerns acting as persistent barriers.

Important gaps remain in the literature. First, the majority of empirical studies have been conducted in developed country contexts, limiting the generalisability of findings to emerging economies where IoT adoption trajectories may differ significantly. Second, while demographic moderators have been examined, longitudinal studies tracking how adoption determinants change over time as users gain experience with IoT systems are relatively rare. Third, the literature has predominantly focused on individual-level adoption, with comparatively less attention to household-level dynamics and the social processes through which smart home adoption decisions are negotiated within families. Addressing these gaps represents a productive agenda for future research.

Conclusion

This literature review has synthesised fourteen key works on the adoption of IoT and smart home technologies, tracing the development of theoretical frameworks from Davis's (1989) foundational TAM through to contemporary studies examining demographic, institutional, and cultural moderators of adoption. The evidence consistently points to the centrality of perceived usefulness, ease of use, and trust as adoption drivers, while security concerns, complexity, and privacy risks act as significant barriers. The literature also highlights the importance of tailoring adoption strategies to the specific needs

and characteristics of different user populations, including older adults, women, and users in non-Western contexts. As IoT technologies continue to penetrate daily life, a nuanced and user-centred approach to understanding and promoting adoption will be essential for researchers, designers, and policymakers alike.

III. THEORETICAL FRAMEWORK

This study is grounded in the Technology Acceptance Model (TAM) as its primary theoretical framework. Originally proposed by Davis (1989) and derived from the Theory of Reasoned Action (Fishbein and Ajzen, 1975), TAM provides a parsimonious and empirically validated model for predicting individual technology acceptance behaviour. The model posits that two core perceptual beliefs perceived ease of use (EOU) and perceived usefulness (U) determine a user's attitude toward a technology, which in turn predicts behavioural intention (BI) and ultimately actual use behaviour.

In the present study, TAM is adapted for the smart home IoT context with gender introduced as an external moderating variable, following the extension proposed by Venkatesh and Morris (2000). The adapted model proposes that gender moderates the relationships between perceived ease of use, perceived usefulness, and behavioural intention such that the relative weight of each TAM construct in predicting adoption intention differs significantly between male and female respondents.

The theoretical model for this study operates as follows. Perceived ease of use, shaped by respondents' prior technology experience and digital self-efficacy, directly influences both attitude toward use and perceived usefulness. Perceived usefulness, reflecting respondents' beliefs about the practical benefits of smart home devices in daily life, directly influences attitude and behavioural intention. Attitude toward use mediates these relationships and predicts behavioural intention. Critically, gender collected as a demographic variable in Section A of the survey acts as a moderating variable that is expected to significantly alter the strength and direction of these relationships. Age, education, device ownership, and years of experience are included as control variables.

Hypotheses

This framework allows the study to address all five hypotheses: that men and women differ significantly in their perceived usefulness scores (H1); that men and women differ significantly in their perceived ease of use scores (H2); that perceived ease of use positively predicts intention to use across both groups (H3); that perceived usefulness positively predicts intention to use across both groups (H4); and that gender significantly moderates the relationship between TAM constructs and behavioural intention (H5).

IV. CONSTRUCTS AND ITEMS USED

The theoretical framework of this study is grounded in the Technology Acceptance Model (TAM), originally proposed by Davis (1989). TAM posits that an individual's intention to adopt a new system is primarily determined by two cognitive beliefs: Perceived Usefulness and Perceived Ease of Use. To ensure the reliability and validity of the research, these abstract constructs are operationalized through a multi-item measurement scale adapted to the context of Smart Home IoT for users aged 45+.

Perceived Usefulness (PU)

Davis (1989) defines Perceived Usefulness as "the degree to which a person believes that using a particular system would enhance his or her job performance" (p. 320). In the context of domestic IoT, this construct is adapted to measure the degree to which a user believes that smart devices (e.g., voice assistants, smart lighting) improve their quality of life, home security, or daily efficiency.
Which is measured through items assessing task productivity, life enhancement, and functional value.

Perceived Ease of Use (PEOU)

Perceived Ease of Use refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). For the target demographic of urban Indians above 45, this construct is critical as it captures the "Confidence Gap." If a device requires significant cognitive load or external assistance (setup dependency), the PEOU is low, which negatively impacts the Intention to Use. Which is measured through items regarding the clarity of voice commands, ease of initial

configuration, and the absence of technical frustration.

Beyond the core TAM constructs, this paper investigates the role of Gender as a significant moderator in technology adoption. Scholarly literature suggests that gender differences often manifest in how PU and PEOU influence Behavioral Intention. Research indicates that men tend to be more influenced by Perceived Usefulness, whereas women's adoption decisions are more strongly driven by Perceived Ease of Use and subjective norms (Venkatesh and Morris, 2000). This study tests whether these gendered patterns hold true for the 45+ demographic in India, particularly in how "Trust" and "Technology Anxiety" vary between male and female users in shared urban environments.

The survey instrument consists of five core constructs, each measured using a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). All items are adapted from Davis (1989) and Venkatesh and Morris (2000), rephrased for the smart home IoT context and for the linguistic and cultural accessibility of urban Indian adults aged 45 and above.

Construct	No. of Items	Sample Item
Perceived ease of use	3	Learning to use this device did not take much effort.
Perceived Usefulness	3	Using this device improves my quality of life at home.
Attitude towards Use	5	I feel positively about incorporating smart home devices into my home.
Behavioural Intention	4	I would recommend smart home devices to my family or friends.
Social Perception	4	My children or family members think I should use this device.

V. SAMPLE DETAILS

Participants were recruited using a multi-stage non-probability sampling technique. Initial recruitment targeted household units (husbands and wives) to ensure a balanced gender distribution, aligning with the quota sampling approach used in prior user experience studies. To expand the reach, a snowball sampling method was employed, where initial respondents were encouraged to share the survey link within their personal networks with instructions to send the link to husband and wife separately.

To ensure the sample was representative of the target demographic (experienced IoT users in a specific age bracket), two screening questions were used as inclusion criteria, First one is Age Filter where only individuals aged 45 and above were permitted to proceed. Second is the Usage Filter where only active users of Internet of Things (IoT) devices were included. Respondents who did not meet both criteria were automatically excluded from the study. This rigorous screening process ensures that the data reflects the insights of a "purposive" group of experts rather than a general, unqualified population.

VI. DESCRIPTIVE STATISTICS

Descriptive statistics will be computed for all constructs and demographic variables to provide a profile of the sample and establish the baseline characteristics of the data before inferential analysis. The following descriptive measures will be reported: For continuous variables (Likert-scale construct scores), the mean, standard deviation, minimum, and maximum will be computed for the full sample and separately for male and female subgroups. This allows a preliminary visual inspection of gender differences in construct scores prior to hypothesis testing. For categorical variables (gender, age group, education level, city, device ownership, years of

experience), frequency counts and percentages will be reported.

The table below presents the anticipated descriptive statistics structure for the five core constructs, to be populated upon data collection:

Construct	Full Mean	Full SD	Male Mean	Male SD	Female Mean	Female SD	Min	Max
Perceived Ease of Use	3.57	0.69	3.64	0.79	3.50	0.61	2	5
Perceived Usefulness	3.71	0.54	3.68	0.42	3.75	0.67	2	5
Attitude Towards Use	4.00	0.41	3.95	0.30	4.05	0.52	3	5
Behavioural Intention	3.93	0.36	3.90	0.28	3.97	0.46	2	5
Social Perception	3.82	0.46	3.78	0.41	3.86	0.51	2	5

VII. STATISTICAL ANALYSIS

The analysis was conducted using an Independent Samples T-test, specifically applying Welch's T-test to account for potential unequal variances between the male and female groups. This procedure is internationally recognized for its robustness in comparing the means of two distinct groups. The methodology involved segmenting the respondents into male (n=19) and female (n=23) groups, followed by a systematic calculation of mean scores, variances, and standard deviations for each identified construct. By computing the standard error and the resulting T-statistic, the study determined the probability, or p-value, of the observed differences. This rigorous step-by-step approach ensures that the findings are not merely the result of sampling error but reflect a true representation of the data within a 95% confidence interval.

The empirical results across all five constructs; Perceived Ease of Use, Perceived Usefulness, Social Influence, Overall Attitude, and Behavioural Intention consistently lead to the failure to reject the null hypothesis. Regarding Perceived Ease of Use (PEOU), the p-value of 0.4244 indicates that the difference between male and female scores is statistically negligible, suggesting that both genders find the technology equally navigable. Similarly, the Perceived Usefulness (PU) analysis yielded a p-value of 0.5102, confirming that the instrumental value of smart home technology is viewed through a similar lens regardless of gender.

Further analysis into external and internal psychological drivers, namely Social Influence and Overall Attitude, produced p-values of 0.7397 and 0.8733, respectively. These figures demonstrate a high degree of uniformity in how social pressures and personal predispositions affect the two groups. Finally, the Behavioural Intention to continue using the technology showed the narrowest margin of difference with a p-value of 0.8590. Collectively, these findings suggest that for users over the age of 45, gender does not serve as a significant differentiator in the adoption or perception of smart home systems.

Theoretically, this study challenges the traditional assumption that demographic factors like gender remain a primary influence throughout the entire product usage life cycle. It supports a shifting paradigm in design research which suggests that as a technology matures and as a user cohort ages, functional requirements and perceived utility override gender-based variances. This contributes to the literature on the "usage life cycle" by demonstrating that in the identification and incorporation phases of technology adoption, the instrumental benefits of a product provide a stabilizing effect that minimizes demographic differences.

VIII. CRONBACH'S ALPHA

Perceived Ease of Use (PEOU) was assessed via three items that measured the cognitive and physical effort required to operate the device, specifically focusing on the ease of achieving desired outcomes and the learnability of the interface. Perceived Usefulness (PU) consisted of three items evaluating the pragmatic value and functional impact of the device on the user's domestic life and task efficiency. To account for social dynamics, Social Influence was measured using four items that tracked the impact of familial recommendations and the influence of trusted social circles on the user's adoption behavior. Overall Attitude was captured through five items reflecting the user's general favorability and positive affect toward integrating smart technologies into their home environment. Finally, Behavioural Intention was operationalized with five items designed to predict long-term usage patterns, including the likelihood of future purchases and proactive recommendations to others.

Cronbach's Alpha and Internal Consistency
To validate the reliability of the measurement scales, Cronbach's alpha coefficients were calculated for each of the five constructs. This step is critical in ensuring that the multiple items within each scale are internally consistent and represent a single underlying concept. In line with psychometric standards, a coefficient above 0.70 is considered an acceptable threshold for reliability in exploratory design research.

The results of the reliability analysis confirm that all five scales meet or exceed the required threshold for internal consistency. The Overall Attitude scale demonstrated high reliability (\alpha = 0.892), followed closely by Behavioural Intention (\alpha = 0.866), suggesting that the items in these scales are highly cohesive in measuring the users' psychological disposition and future intent. The constructs of Perceived Ease of Use (\alpha = 0.778) and Perceived Usefulness (\alpha = 0.761) also showed acceptable reliability, confirming their suitability for evaluating the pragmatic qualities of the devices. Although Social Influence (\alpha = 0.720) yielded the lowest coefficient, it remains above the acceptable limit, indicating a valid measurement of the diverse social factors influencing adoption.

Inferences

The high internal consistency across all constructs provides a robust foundation for identifying how positive user experiences are sustained over time. The strong reliability of the Instrumentality-related scales (PEOU and PU) is particularly significant, as it suggests that users' perceptions of functional efficiency and domestic utility are stable and well-defined during the usage phase. This consistency aligns with longitudinal studies indicating that while hedonic qualities may fluctuate, pragmatic appreciation remains a primary driver of sustained positive experience.

Furthermore, the high reliability of the Overall Attitude scale indicates that users form a coherent, integrated perspective on the value of smart home devices once they move past the initial orientation phase. These findings suggest that the chosen items effectively capture the transition from "first-time usage" to "familiarization," where functional dependency and emotional attachment begin to coalesce. These preliminary results facilitate a deeper investigation into how these constructs interact with demographic variables, such as age and gender, to influence the total product usage life cycle.

IX. NORMALITY OF DATA

To determine the appropriate statistical techniques for hypothesis testing, the distributional characteristics of the dataset were evaluated. Given the sample size of 42 participants, the Shapiro-Wilk test was employed as the primary diagnostic tool, as it is widely recognized for its superior power in detecting departures from normality in small to medium-sized samples. The null hypothesis (H_0) for this test posits that the data is normally distributed, while the alternative hypothesis (H_1) suggests a significant deviation from a normal distribution.

The results of the Shapiro-Wilk computation indicated significant p-values ($p < 0.05$) across all five constructs: Perceived Ease of Use ($W = 0.878$, $p = 0.0003$), Perceived Usefulness ($W = 0.870$, $p = 0.0002$), Social Influence ($W = 0.868$, $p = 0.0002$), Overall Attitude ($W = 0.866$, $p = 0.0002$), and Behavioural Intention ($W = 0.785$, $p = 0.0000$). Consequently, the null hypothesis was rejected for every variable, confirming that the data does not follow a normal distribution. This outcome is frequent in user experience research utilizing Likert-

scale instruments, where responses are often skewed toward favorable ratings, reflecting a ceiling effect common in technology adoption studies.

The identification of non-normal distribution has significant implications for the subsequent analytical methodology. While parametric tests like the Student's t-test are often considered robust against minor violations of normality, the consistent and significant skewness observed across all constructs necessitates a cautious approach. Therefore, in alignment with rigorous academic methodology, non-parametric alternatives such as the Mann-Whitney U test or Kruskal-Wallis test will be prioritized for inferential analysis to ensure the validity of the findings and to account for the ordinal nature of the survey data.

X. INFERENCES / FINDINGS

The quantitative analysis was conducted using a multi-stage statistical approach to validate the measurement model and explore the relationships between constructs. Initial data preparation involved mapping the 5-point Likert scale responses to numerical values and calculating composite scores for each construct (Perceived Ease of Use, Perceived Usefulness, Social Influence, Overall Attitude, and Behavioural Intention). Given the sample size ($n = 42$) and the ordinal nature of the data, the Shapiro-Wilk test was performed to check for normality. Since all constructs violated the assumption of normal distribution ($p < 0.05$), non-parametric statistical methods were prioritized.

Descriptive statistics, including means and standard deviations, were calculated to assess the central tendency of user perceptions. To examine the associations between adoption factors and future intention, Spearman's rank-order correlation was employed, as it is robust to non-normal distributions. Furthermore, the Mann-Whitney U test was utilized to investigate differences in user experience across demographic variables, specifically gender, to determine if adoption patterns varied between male and female participants. All computations were performed using Python with the SciPy and Pandas libraries.

The descriptive analysis reveals a generally positive reception of smart home technologies among the participants, who are primarily aged 45 and above. The highest mean scores were recorded for Overall Attitude ($M = 4.00$, $SD = 0.41$) and Behavioural Intention ($M = 3.93$, $SD = 0.35$), suggesting a high level of acceptance and a strong propensity for continued usage. Perceived Usefulness ($M = 3.71$, $SD = 0.54$) and Social Influence ($M = 3.82$, $SD = 0.46$) also showed high ratings, whereas Perceived Ease of Use ($M = 3.57$, $SD = 0.69$) was relatively lower, indicating that while users find the technology beneficial, they still perceive a degree of effort in mastering the systems.

The correlational analysis yields critical insights into the drivers of adoption for this demographic. Social Influence was found to have the strongest positive correlation with Behavioural Intention ($\rho = 0.754$, $p < 0.01$). This indicates that for users over 45, recommendations from family members—particularly children—and trusted peers are the most significant predictors of their intention to continue using or expanding their smart home ecosystem. Furthermore, Overall Attitude showed strong correlations with both Perceived Ease of Use ($\rho = 0.655$) and Perceived Usefulness ($\rho = 0.642$), suggesting that a positive psychological disposition toward the technology is equally dependent on its functional utility and its ease of interaction.

Inferential testing for gender differences via the Mann-Whitney U test revealed no statistically significant variations between male and female participants across any construct ($p > 0.05$). For instance, the difference in Behavioural Intention between males ($M = 3.94$) and females ($M = 3.92$) was negligible ($p = 0.628$). These results suggest that the "gender gap" in technology adoption is non-existent in this context; both groups value functional benefits and social validation similarly. Finally, the usage data highlights that Smart TVs (used by 90% of respondents) and Voice Assistants like Amazon Alexa serve as the primary gateways for older adults entering the smart home environment.

XI. MANAGERIAL IMPLICATIONS

The findings provide actionable insights for designers and marketers of smart home devices targeting the middle-aged and elderly demographic. Given that Social Influence is the primary driver of intention, marketing strategies should focus on "family-centric" adoption models. Designing features that allow children to easily set up or remotely

manage devices for their parents could lower the barrier to entry. Furthermore, since Perceived Ease of Use had the lowest mean score, manufacturers should prioritize simplifying the initial learning curve, perhaps through voice-guided tutorials or simplified physical interfaces, to ensure that the "first-time usage" phase leads to a sustained positive experience.

From a managerial perspective, these findings suggest that industry practitioners should avoid overly gendered marketing strategies when targeting the 45+ demographic. Instead, resources should be directed toward enhancing the "instrumentality" and "ease of use" of the products, as these are the universal drivers of positive user experience identified in the data. Designers should focus on creating seamless, intuitive interfaces that cater to the cognitive and physical needs of the age group as a whole, rather than developing gender-specific features.

XII. THEORETICAL IMPLICATIONS

Theoretically, this study contributes to the literature on the Technology Acceptance Model (TAM) and User Experience (UX) by highlighting the shifting weight of adoption drivers across different age cohorts. While many studies emphasize individual utility, this research demonstrates that for the 45+ demographic, Social Influence may eclipse individualistic factors like Perceived Usefulness in predicting long-term intent. This suggests that the "social" dimension of the Unified Theory of Acceptance and Use of Technology (UTAUT) is particularly critical when designing for populations that may rely on intergenerational support for technological fluency. The study also reinforces the idea that pragmatic qualities (instrumentality) remain the bedrock of a positive UX curve throughout the product usage life cycle.

CRediT Authorship Contribution Statement

Parvathi: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing - Original Draft, Visualization.

Sreeram: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing - Original Draft, Visualization.

Prashanth Cherian Kochuveetil: Supervision, Conceptualization, Methodology Guidance

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