Consumer Perception, Innovativeness, and Readiness in Smart Home Technology Adoption: Evidence from Malaysia

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ABSTRACT

The rapid development of smart home technologies (SHTs) has generated significant global interest due to their potential to enhance efficiency, convenience, and security in residential living. However, the adoption of these technologies in developing countries remains relatively limited, often constrained by technological, financial, and socio-psychological barriers. This study seeks to examine the critical factors influencing the adoption of SHTs among residents of Melaka Tengah, Malaysia. Drawing upon the Technology Acceptance Model (TAM), the research focuses on four key constructs perceived cost, perceived ease of use, perceived usefulness, and consumer perceived innovativeness and their influence on users' intention to adopt smart home systems.

A quantitative research design was employed, with survey data collected from 384 respondents. Statistical analyses, including Pearson correlation and multiple regression using SPSS, were conducted to test the relationships between the identified constructs and adoption intention. The results indicate that perceived ease of use and consumer perceived innovativeness significantly and positively predict adoption intention, while perceived cost exerts a significant negative influence. Interestingly, although perceived usefulness demonstrated a positive correlation with adoption intention, it was not found to be a statistically significant predictor in the regression analysis.

The findings provide both theoretical and practical contributions. From a theoretical perspective, the study extends the application of TAM to the Malaysian smart home context, highlighting the relative importance of usability and innovativeness over perceived usefulness in predicting adoption. From a practical standpoint, the results underscore the need for strategies that reduce financial barriers, simplify technological interfaces, and appeal to consumers' innovativeness to encourage adoption. These insights are particularly relevant for technology developers, marketers, and policymakers seeking to expand the accessibility and inclusiveness of smart home ecosystems in emerging markets. Ultimately, the study emphasizes the importance of affordability, user-centered design, and innovative engagement as critical enablers for fostering broader acceptance and sustainable integration of smart home technologies within Malaysia's residential sector.0

Keywords: "Virtual Reality (VR)" "Educational Technology" "Tertiary Education" "Technology Adoption" "Barriers to Innovation"

INTRODUCTION

Smart home technologies (SHTs) have emerged as a transformative component of modern residential living, offering households the potential to enhance energy efficiency, safety, and convenience through the integration of intelligent and interconnected systems. These technologies encompass a wide range of automated and remotely controlled devices, including lighting, heating, ventilation, air conditioning (HVAC), security monitoring, and household appliances (Nikou, 2019; Park et al., 2016). A notable example is the smart

thermostat, which is capable of learning residents' behavioural patterns and autonomously adjusting temperature settings to optimize both comfort and energy consumption (Shin & Park, 2017). Such innovations exemplify the broader promise of SHTs to redefine the relationship between technology, sustainability, and quality of life.

Globally, the adoption of SHTs has gained considerable momentum, particularly in developed nations where consumers are increasingly motivated by lifestyle convenience, environmental sustainability, and improved household security. Nevertheless, the diffusion of SHTs in developing economies has been less pronounced and often fragmented. Prior research attributes this slow uptake to multiple factors, including perceived cost, perceived usefulness, perceived ease of use, and consumer innovativeness (Nikou, 2019). Beyond these constructs, social and psychological barriers such as concerns about privacy and data security, limited trust in technology providers, and resistance to altering established domestic routines further hinder widespread acceptance (Balta-Ozkan et al., 2013; Marikyan et al., 2019).

In the Malaysian context, Melaka Tengah offers a timely and relevant setting for investigating the adoption of SHTs. As a rapidly urbanizing district with a population of approximately 617,000 residents (Department of Statistics Malaysia, 2023), it reflects the evolving dynamics of urban living in a developing nation. With increasing modernization and digital integration, the potential for SHT adoption in Malaysia is evident. However, despite this socio-economic potential, the actual uptake of SHTs remains limited (Salimon, Gorondutse, & Abdullah, 2018). This disparity between the availability of advanced technologies and their adoption in households suggests the presence of underlying barriers that extend beyond technological accessibility alone.

Problem Statement

Although smart home technologies (SHTs) are designed to enhance quality of life through automation, intelligent monitoring, and seamless control of household systems, their adoption in Malaysia particularly in Melaka Tengah remains limited. Several critical barriers continue to hinder widespread acceptance.

First, privacy and data security concerns pose a substantial challenge. Smart home systems collect and process extensive personal data, raising fears of surveillance, cyberattacks, and unauthorized access. These concerns are compounded by low public awareness of data protection mechanisms and a general lack of trust in service providers (Wahab et al., 2018; Kam et al., 2023).

Second, financial constraints remain a pressing issue. The high initial cost of installation, coupled with ongoing expenses for upgrades and maintenance, discourages adoption, particularly among middle- and lower-income households. In developing contexts, such as Malaysia, discretionary spending on emerging technologies is limited, making affordability a key obstacle (Hong, Nam, & Kim, 2020; Basarir-Ozel, Turker, & Nasir, 2022).

Third, digital literacy and technical capability also influence adoption readiness. Elderly users and those with limited technological skills often lack the confidence to manage complex systems (Basarir-Ozel et al., 2022). Even for more digitally adept consumers, interoperability challenges stemming from fragmented devices, varied communication protocols, and proprietary platforms create complications in system integration. This fragmentation, combined with fears of being locked into inflexible or non-upgradable systems, further reduces adoption intentions (Phan & Kim, 2020; Li et al., 2021).

Finally, operational issues such as unresponsive devices, unintuitive user interfaces, and inconsistent performance erode user satisfaction and trust. These shortcomings highlight that barriers to adoption extend beyond the availability of technology, encompassing systemic, financial, and psychological factors (Kam et al., 2023).

Taken together, these challenges underscore the urgent need to better understand the determinants of smart home technology adoption in Malaysia. A systematic investigation into the barriers and enablers influencing consumer readiness will provide valuable insights for stakeholders. Such an inquiry is essential to inform strategies that address adoption challenges, foster consumer trust, and promote the development of accessible, inclusive, and sustainable smart home ecosystems tailored to Malaysia's socio-economic context.

LITERATURE REVIEW

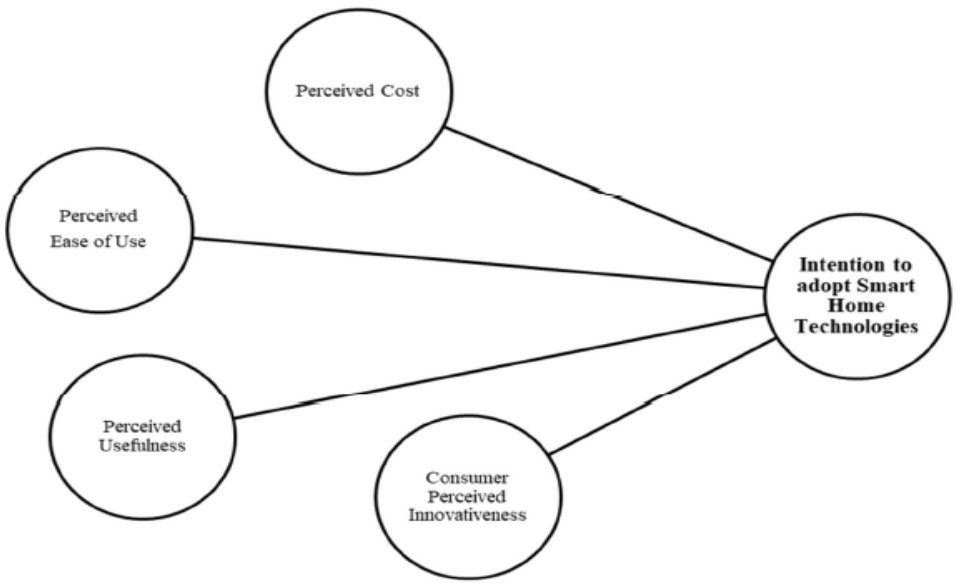
Smart Home Technology

Smart home technology (SHT) refers to the integration of interconnected devices that enable remote monitoring, automation, and control of household functions through internet connectivity. These systems allow homeowners to manage lighting, temperature, security, and entertainment systems via smartphones or networked devices from virtually any location (Hayes, 2024). At the foundation of SHTs lies a network of IoT-enabled devices, typically linked through a central hub or smart platform, which facilitates seamless communication and automation (Gunnell, 2023).

Smart homes generally rely on wireless connectivity, most commonly through household Wi-Fi networks, to support communication between devices, mobile applications, and smart bridges (Das, 2022). Adoption often occurs incrementally, with users beginning with a single device such as a smart speaker or lighting system and gradually expanding their ecosystem as trust and familiarity increase (Gunnell, 2023). Central to this ecosystem are home automation systems, which serve as unified control centers for diverse smart appliances, improving both efficiency and convenience.

The architecture of a smart home consists of multiple interdependent components. At the user-facing layer are smart devices and appliances, such as adaptive lighting, intelligent HVAC systems, and smart refrigerators, which offer personalized control and enhanced energy efficiency. Supporting these are automation systems that coordinate device interactions and allow centralized management through mobile applications or hubs. Sensors such as motion detectors, temperature monitors, and smoke alarms supply real-time environmental data to support safety and automation. Complementing these are security systems that include remotely accessible smart locks, surveillance cameras, and automated alarms, providing comprehensive protection and peace of mind for residents (Gunnell, 2023).

To understand the adoption of these technologies, the Technology Acceptance Model (TAM) is frequently applied. TAM posits that two primary constructs perceived usefulness and perceived ease of use shape an individual's behavioral intention to adopt technology, which in turn drives actual use (Pavlou, 2003; Novita & Prasetio, 2024).



Among additional determinants, perceived cost has been identified as a critical barrier to adoption. This factor reflects users' evaluation of the financial burden associated with purchasing, installing, and maintaining smart home systems. Numerous studies confirm that high perceived costs negatively influence adoption intention. For instance, research in Indonesia demonstrated that perceived cost significantly reduced consumer readiness for smart homes, highlighting its central role in shaping acceptance alongside value and usability (Novita & Prasetio,

2024). Similarly, studies in Jakarta applying the UTAUT2 framework reported that financial concerns and limited technological knowledge hindered uptake (Oktavia et al., 2023). Nikou (2018) further employed Structural Equation Modelling (SEM) and Fuzzy-set Qualitative Comparative Analysis (FsQCA) to show that cost perceptions exert a strong negative effect on behavioral intention, while Pal et al. (2018) found similar results in elderly healthcare contexts. Collectively, these findings underscore the need to address financial barriers to facilitate wider diffusion of smart home technologies.

Another influential factor is consumer perceived innovativeness, which refers to the extent to which individuals see themselves as open to and ready for new technologies. Consumers with higher self-perceived innovation are more likely to adopt smart home systems. Nikou (2018) found innovativeness, alongside constructs such as social influence and user attitudes, to be a key predictor of behavioral intention toward SHT adoption. Likewise, Novita and Prasetio (2024) emphasized the importance of psychological attributes such as optimism and innovativeness in shaping consumer preparedness. Together, these studies suggest that consumers who perceive themselves as innovative exhibit a greater willingness to embrace emerging technologies.

The construct of intention to use reflects an individual's readiness and willingness to adopt and integrate a technology into daily life. In the context of smart homes, intention to use encompasses decisions to adopt devices for convenience, energy efficiency, security, and comfort. Prior studies highlight perceived usefulness, ease of use, cost, and innovativeness as central determinants of adoption intentions. Perceived usefulness, defined as the belief that technology enhances performance, remains a consistent predictor of adoption (Sharma & Kuknor, 2021). Similarly, perceived ease of use significantly influences adoption by lowering the perceived complexity of use (Daruwala & Oberst, 2022). Perceived cost has been shown to reduce readiness by increasing financial hesitation (Oktavia et al., 2023), while consumer innovativeness contributes positively by fostering openness to experimentation with new systems (Novita & Prasetio, 2024).

In summary, the intention to adopt smart home technologies emerges from a combination of perceived benefits, usability, affordability, and consumer innovativeness. Understanding how these factors interact is essential for developers, marketers, and policymakers in designing strategies that align with user expectations. Such insights are vital for improving adoption rates, enhancing user satisfaction, and ensuring that smart home technologies are both accessible and sustainable in diverse socio-economic contexts.

METHOD

This study investigates the factors influencing residents' intention to adopt smart home technologies in Melaka Tengah, Malaysia, through the application of a quantitative research design. Primary data were collected using a structured survey questionnaire distributed to a sample of 384 respondents. The instrument was developed to capture perceptions regarding four key constructs perceived cost, perceived ease of use, perceived usefulness, and consumer perceived innovativeness as well as respondents' overall intention to adopt smart home technologies.

Responses were measured using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). This scaling approach facilitated the quantification of attitudes and perceptions, enabling subsequent statistical analysis. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS), which allowed for rigorous examination of the hypothesized relationships between independent and dependent variables.

Several statistical procedures were employed. Descriptive analysis was conducted to summarize the data and provide insights into central tendencies and variability across the constructs. Reliability and validity tests were performed to confirm the internal consistency and accuracy of the measurement items. Pearson correlation analysis was used to assess the strength and direction of associations between variables, while multiple regression analysis was applied to evaluate the relative significance of each predictor and to identify the factors most strongly associated with adoption intention.

By employing this systematic methodology, the study aims to generate robust empirical evidence on the determinants of smart home technology adoption in Melaka Tengah. The findings are expected to provide both

theoretical contributions to technology adoption literature and practical recommendations for developers, marketers, and policymakers seeking to encourage broader adoption of smart home technologies in the Malaysian residential sector.

RESULTS AND DISCUSSION

In general, the data presented in table 3 indicates noteworthy and favorable correlations between Intention to use and various factors: efficiency ($r = 0.535$, $p < 0.001$), perceive ease of use ($r = 0.637$, $p < 0.001$.), perceive of usefulness ($r = 0.762$, $p < 0.001$.), and service trust ($r = 0.799$, $p < 0.001$).

	PC	PEoU	PU	PI	INT
Perceived Cost	1				
Perceived Ease of Use	-0.604**	1			
Perceive Usefulness	0.564**	0.6700**	1		
Perceive Innovativeness	0.583**	0.552**	0.581	1	
Intention to use	0.568**	0.616**	0.536**	0.762**	1

**. Correlation is significant at the 0.01 level (2-tailed).

EF= efficiency, PEU= Perceive ease of use, PU = Perceive of usefulness, ST- Service Trust, IU= Intention of using the SST in QSRFrom the table, the correlation result of the first variable illustrates Perceived Cost toward the dependent variable, the test is significant as stated with the significant $r = -0.568$ while $p < 0.001$. Thus, these two variables have a moderate negative relationship. Next, for the second independent variable which is Perceived Ease of Use, the correlation relation results toward consumer intention to use smart home technology stated that they have a significant relationship. This is because the value of test correlation coefficient, $r = 0.616$ $p < 0.001$. Hence, these two variables illustrate a moderate positive relationship. Apart from that, followed by the independent variable that is Perceived Usefulness towards dependent variable, which is consumer intention to use, the results indicate that the test is significant where, $r = 0.536$ whereas $p < 0.001$. Therefore, both variables have a moderate positive relationship. Additionally, the independent variable which is Consumer Perceived Innovativeness toward the dependent variable is consumer intention to use. According to table 4.8, the factor of consumer perceived innovativeness was significantly correlated to consumer intention to use in positive correlation, where $r = 0.523$ and $p < 0.001$. Thus, both variables indicate a moderate positive relationship.

Consumer Perceived Innovativeness (CPI) is identified as the second most significant predictor, with a beta value of $\beta = 0.153$, and p value is 0.003 where $p < 0.05$. Perceived Usefulness (PU) ranks next with a beta value of $\beta = 0.097$, p-value is 0.080 where $p > 0.05$, accounting for a variation of 10.3%. Lastly, Perceived Cost (Cost) has the least impact on the dependent variable, with a beta value of $\beta = -0.225$, $p < 0.05$, contributing to a variation of 24.2%

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	T	Sig.
(Constant)	1.999	0.350		5.174	<0.001
Perceived Cost	-2.42	0.055	-0.255	4.366	<0.001
Perceived Ease of Use	0.342	0.058	0.330	5.948	<0.001

Perceive Usefulness	0.103	0.059	0.097	1.758	0.080
Perceive of Innovativeness	0.170	0.056	0.153	3.036	0.003

The findings of this study yield several important managerial implications for advancing the adoption of smart home technologies. A central insight is the significant negative association between perceived cost and consumers' intention to adopt such technologies (Endah Novita & Prasetio, 2024; Nikou, 2018). This outcome highlights the necessity of addressing financial barriers as a priority. Strategies such as offering flexible financing options, emphasizing long-term cost savings particularly in energy efficiency and providing transparent and competitive pricing structures may enhance the perceived affordability of smart home solutions (Oktavia et al., 2023).

Perceived ease of use emerged as a strong positive determinant of adoption intention, reinforcing the importance of user-friendly design and supportive infrastructure. Firms should prioritize the development of intuitive, user-centric interfaces, supplemented by step-by-step user guides and responsive customer service. Such efforts are likely to improve user experience, strengthen consumer confidence, and lower the entry barriers for first-time adopters (Daruwala & Oberst, 2022).

Interestingly, while perceived usefulness demonstrated a positive correlation with adoption intention, it was not found to be statistically significant in this study (Sharma & Kuknor, 2021). This finding suggests that emphasizing functional benefits alone may be insufficient to encourage adoption. Instead, perceived usefulness should be integrated with cost-effectiveness and ease of use to create a more compelling value proposition for consumers.

Furthermore, consumer perceived innovativeness was identified as a significant predictor of adoption intention (Nikou, 2018). This indicates that consumers who consider themselves technologically innovative are more inclined to embrace smart home systems. Consequently, marketing strategies should target early adopters by highlighting advanced features, fostering communities of practice, and leveraging peer influence through testimonials and shared user experiences. Such approaches can enhance trust and expand market reach (Endah Novita & Prasetio, 2024).

In summary, the study underscores four critical strategies for technology providers: reducing financial barriers, enhancing usability, contextualizing usefulness in relation to cost and simplicity, and engaging innovative consumer segments. Collectively, these measures can support broader acceptance and sustainable integration of smart home technologies within residential markets.

CONCLUSION

This study examined the determinants of consumer intention to adopt smart home technologies by drawing upon constructions from established technology acceptance frameworks. The findings indicate that perceived cost, perceived ease of use, perceived usefulness, and consumer perceived innovativeness play important roles in shaping adoption behavior (Nikou, 2018; Endah Novita & Prasetio, 2024). Specifically, a moderate negative correlation was identified between perceived cost and adoption intention, underscoring the extent to which financial concerns act as a deterrent (Oktavia et al., 2023; Nikou, 2018). Conversely, perceived ease of use demonstrated a strong positive influence, reinforcing its critical importance in fostering adoption (Daruwala & Oberst, 2022).

The research employed a rigorous quantitative methodology incorporating descriptive statistics, reliability testing, Pearson correlation, multiple regression, and hypothesis testing. While perceived usefulness was positively associated with intention to adopt, the relationship did not reach statistical significance, suggesting that functional benefits alone may be insufficient to motivate adoption (Sharma & Kuknor, 2021). In contrast, consumer perceived innovativeness emerged as a significant predictor, indicating that individuals who identify

as open and receptive to new technologies are more likely to adopt smart home systems (Nikou, 2018; Endah Novita & Prasetio, 2024).

Taken together, the results suggest that reducing perceived financial barriers and enhancing ease of use are essential for increasing adoption rates. At the same time, highlighting the innovative attributes of smart home technologies may further stimulate consumer interest and readiness. These insights provide valuable implications for industry stakeholders, particularly technology developers, marketers, and policymakers, who seek to expand market penetration and align product development with consumer expectations (Pal et al., 2018).

Despite its contributions, this study is subject to several limitations. First, the research was conducted within a single district Melaka Tengah which may limit the generalizability of the findings to other regions of Malaysia with different socio-economic profiles. Second, the reliance on self-reported survey data introduces the potential for social desirability bias, which could affect the accuracy of responses. Third, the study adopted a cross-sectional design, capturing consumer perceptions at a single point in time. Such an approach may not fully reflect the dynamic nature of technology adoption, where attitudes and behaviors evolve alongside technological advancements and market conditions.

Future research could address these limitations by expanding the study to multiple regions or adopting a comparative approach across urban and rural contexts to capture diverse perspectives. Longitudinal studies would also be valuable in tracing how consumer readiness and adoption behavior change over time. Furthermore, integrating qualitative methods, such as interviews or focus groups, could provide deeper insights into the socio-cultural and psychological dimensions of adoption. Finally, future investigations could incorporate additional constructs, such as trust in service providers, perceived risk, or sustainability concerns, to develop a more comprehensive understanding of smart home adoption in emerging markets.

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