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# The Influence of Device Compatibility and IoT System Architecture on Adoption Rate and Usability in the Implementation of Smart Homes in Modern Housing in Tangerang

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## ABSTRACT

This study investigates the influence of device compatibility and IoT system architecture on adoption rates and ease of use in smart home implementation within modern housing developments in Tangerang, Indonesia. Employing a quantitative research approach, data were collected from 125 respondents using a structured questionnaire measured on a five-point Likert scale. The data were analyzed through Structural Equation Modeling–Partial Least Squares (SEM-PLS 3) to test the relationships among constructs. The results reveal that both device compatibility and IoT system architecture significantly and positively influence ease of use, which in turn mediates their effects on adoption rates. A robust IoT system architecture enhances interoperability and system responsiveness, improving user perceptions of convenience and reliability. The findings underscore that technical design and user-centric system integration jointly determine the success of smart home adoption. This research contributes to extending the Technology Acceptance Model (TAM) within the IoT context and offers practical implications for developers, policymakers, and housing planners in fostering inclusive and sustainable smart living environments in Indonesia.



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## 1. INTRODUCTION

The rapid advancement of the Internet of Things (IoT) has transformed how people interact with technology, especially in residential settings. Smart homes—where lighting, air conditioning, security, and entertainment systems are interconnected—represent one of the most tangible IoT applications. In Indonesia, particularly in urban centers like Tangerang, the adoption of smart home technology is rising alongside modern housing development and growing consumer interest in convenience, energy efficiency, and digital lifestyles. However, adoption and continued use depend on key technological and user-centric factors such as device compatibility, system architecture, and user trust, which influence interoperability and performance. Seamless integration and automation of devices enhance convenience and reliability, driving adoption [1]. Trust in technology and providers is a major determinant, even surpassing performance expectancy, highlighting the importance of consumer confidence [2]. Despite its advantages, challenges persist, including integration complexity and security issues; while device performance is generally optimal, advancements in AI and machine learning are needed to improve system configuration and safety [3]. Moreover, lack of standardization and infrastructural limitations hinder broader implementation, calling for cross-sector collaboration and stronger data protection frameworks (Suandre et al., 2025). Nonetheless, IoT systems enhance energy efficiency and comfort by optimizing device operations and providing insights into usage patterns [4], [5]. while improving user experience through interconnected, intelligent home environments [5].

Device compatibility is a crucial factor influencing user satisfaction and technology adoption in smart homes. Seamless integration among devices from various manufacturers enhances ease of use, reliability, and overall user experience, fostering positive attitudes and behavioral intentions toward technology adoption [6], [7]. However, compatibility issues such as communication failures or the inability to connect older and newer systems can diminish user trust and slow adoption rates. The absence of device standardization further exacerbates integration challenges, limiting interoperability and hindering widespread implementation [4].

Equally important, IoT system architecture plays a central role in ensuring efficient communication, scalability, and data security within smart homes. A well-designed architecture enhances data transmission, reduces latency, and supports interoperability, leading to improved system reliability and user satisfaction [6], [8]. Conversely, poorly structured architectures may cause system lags, data loss, and security vulnerabilities that deter continued use. Given these risks, strong architectural design combined with effective data protection frameworks is essential to address privacy and security concerns and build long-term user trust in IoT-based smart home systems [1], [4], [8].

In the context of Tangerang, one of Indonesia's rapidly growing metropolitan areas, the development of modern residential complexes has accelerated the integration of smart technologies in housing design. Developers increasingly market "smart living" as a value proposition, emphasizing automated control, remote monitoring, and energy optimization. Yet, despite these advancements, adoption rates remain uneven across households due to perceived complexity, limited interoperability among devices, and uncertainty about the reliability of IoT infrastructure. Users tend to prioritize seamless integration and automation over manual control, as convenience from interconnected devices strongly influences adoption decisions [1]. Reliability and cost also play vital roles—potential users are more inclined to adopt smart technologies when they perceive them as dependable and affordable [1]. However, persistent concerns regarding data security and privacy remain significant barriers, with users expressing hesitation over possible data breaches and the absence of robust protection frameworks [4]. Infrastructure and interoperability challenges, particularly the lack of standardized protocols and adequate infrastructure, further limit IoT system efficiency and user satisfaction [4]. To address these challenges, Tangerang's smart city initiatives emphasize integrating IoT to enhance urban services and infrastructure, though disparities in technology access across communities must still be reduced [9]. Moreover, community engagement and public awareness campaigns are essential to fostering user trust and understanding of smart technologies, helping bridge the gap between technological potential and real-world adoption [9].

This study aims to analyze the influence of device compatibility and IoT system architecture on adoption rates and perceived ease of use in smart home implementations within modern housing in

Tangerang. Using a quantitative approach, data were gathered through a structured questionnaire employing a five-point Likert scale. Structural Equation Modeling–Partial Least Squares (SEM-PLS 3) was used to examine the relationships among the variables. The findings are expected to provide insights into how technical design and system integration impact user perceptions and adoption intentions, offering valuable implications for housing developers, IoT system designers, and policymakers seeking to promote smart urban living.

## 2. LITERATURE REVIEW

### *2.1 The Concept of Smart Home and IoT Integration*

Smart home technology, powered by the Internet of Things (IoT), is transforming home automation by connecting devices such as lighting, HVAC systems, and security controls to improve efficiency, convenience, comfort, and safety. Its adoption is shaped by both technological and human factors that differ across contexts, particularly in developing economies where smart homes symbolize technological progress but face challenges related to infrastructure, awareness, and affordability. Technologically, IoT integration forms the backbone of smart home systems, enabling devices to autonomously collect, process, and share data to enhance energy efficiency and user experience [8], [10]. Interoperability and standardization are essential for seamless operation and are key determinants of user acceptance [8]. Nonetheless, issues of security, privacy, and data protection remain central to user trust and willingness to adopt [1], [8]. From the human perspective, perceived usefulness and ease of use strongly influence behavioral intentions toward adoption [8]. while cost and reliability significantly affect user decisions, with users prioritizing convenience and consistent system performance [1]. Furthermore, raising awareness and educating users about the benefits and functionalities of smart home systems are crucial steps to increase adoption, especially in developing countries where understanding of IoT technology remains limited [1].

### *2.2 Device Compatibility*

Device compatibility in smart home ecosystems is crucial for seamless operation and user satisfaction. Integrating devices from different manufacturers and communication protocols remains a major challenge, but advancements like the Matter protocol are improving interoperability. This open-source standard unifies smart home ecosystems, allowing devices to connect and exchange data efficiently while simplifying commissioning and control [11], [12]. High compatibility enhances performance, reduces user frustration, and increases perceived reliability, aligning with the Technology Acceptance Model's emphasis on ease of use and usefulness [7], [13]. However, technological fragmentation and diverse communication protocols still pose barriers to adoption [13]. To address these issues, solutions such as dynamically updatable gateway platforms and middleware approaches have been proposed to enable unified control over heterogeneous networks and improve interoperability [13].

### 2.3 *IoT System Architecture*

The architecture of IoT systems is fundamental to the effective operation of smart home technologies, as it defines how devices, networks, and applications interact to deliver stable, scalable, and responsive performance that fosters user trust and satisfaction. Typically, IoT architecture consists of three main layers—perception, network, and application—though expanded models often include middleware and security layers to enhance functionality and protection. The perception layer comprises sensors and actuators that collect and respond to environmental data, forming the foundation of IoT operations [14]. The network layer manages data transmission across devices and systems using various communication protocols to ensure seamless, real-time connectivity [15], [16]. The application layer focuses on data interpretation and user interaction, enabling diverse applications such as home automation and healthcare through intuitive interfaces [17], [18]. Meanwhile, middleware facilitates data processing and communication between layers, and the security layer safeguards data integrity and privacy—both of which are critical for addressing cybersecurity concerns and maintaining user confidence [17], [18].

### 2.4 *Technology Adoption Models*

The Technology Acceptance Model (TAM) and its extensions, such as the Unified Theory of Acceptance and Use of Technology (UTAUT), offer a comprehensive framework for analyzing technology adoption behavior, particularly in smart home contexts. TAM identifies perceived usefulness and perceived ease of use as key determinants of adoption, where ease of use is influenced by technical complexity, system interoperability, and data reliability—factors shaping how effortlessly users can operate smart home systems [19]. Perceived usefulness, in contrast, is linked to improvements in comfort, safety, and energy management, which directly affect behavioral intentions to adopt [19]. Extensions like UTAUT further incorporate constructs such as performance expectancy and social influence to provide a broader explanation of user acceptance [20]. Despite its widespread application, TAM has been critiqued for its simplicity and limited focus on individual perceptions, prompting the evolution of more comprehensive models that address complex sociotechnical dynamics in technology adoption [20], [21].

### 2.5 *Conceptual Framework and Hypotheses Development*

Based on the reviewed literature, this study proposes a conceptual model linking device compatibility and IoT system architecture to adoption rates and ease of use. Device compatibility ensures functional integration, which enhances perceived ease of use and positively influences adoption rates. Similarly, a robust IoT system architecture contributes to improved operational performance, reinforcing ease of use and motivating adoption.

H1: Device compatibility has a positive and significant effect on ease of use.

H2: IoT system architecture has a positive and significant effect on ease of use.

H3: Device compatibility has a positive and significant effect on adoption rate.

H4: IoT system architecture has a positive and significant effect on adoption rate.

H5: Ease of use mediates the relationship between device compatibility, IoT system architecture, and adoption rate.

## 3. METHODS

### 3.1 Research Design

This study employed a quantitative research design to analyze the influence of device compatibility and IoT system architecture on adoption rates and perceived ease of use in smart home implementation within modern housing in Tangerang. The quantitative approach was chosen to enable statistical measurement of relationships between variables and to generalize findings from a representative sample of respondents. The research model was tested using Structural Equation Modeling–Partial Least Squares (SEM-PLS 3), which allows simultaneous estimation of multiple relationships among latent constructs and mediating effects.

### 3.2 Population and Sample

The population of this study comprised residents and homeowners living in modern housing complexes in Tangerang who have adopted or are aware of smart home technologies. Based on initial mapping, Tangerang is home to numerous modern housing projects that integrate IoT-based devices such as automatic lighting, smart locks, and connected climate control systems.

A non-probability purposive sampling technique was applied, targeting individuals who have experience with or intention to use smart home systems. A total of 125 valid responses were collected and analyzed, which exceeds the minimum sample size recommended for SEM-PLS analysis [22], ensuring sufficient statistical power. The inclusion criteria were: (1) residents aged 20 years or older, (2) living in housing that supports IoT-based devices, and (3) possessing basic knowledge of smart home functions.

### 3.3 Data Collection

Data were collected through a structured online questionnaire distributed via digital platforms such as WhatsApp groups, email, and social media networks targeting housing residents in Tangerang. The questionnaire was divided into two sections: demographic information and measurement items for each research variable. Respondents were asked to rate their level of agreement using a five-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree").

Prior to distribution, the instrument underwent content validation by three experts in technology management and IoT systems to ensure clarity and relevance. A pilot test involving 20 respondents was conducted to assess reliability, after which minor revisions were made for improved comprehension and consistency.

### 3.4 Measurement of Variables

All constructs were measured using indicators adapted from validated prior studies, with slight modifications to fit the smart home context. Device Compatibility (DC) was assessed through indicators reflecting the ability of smart devices to connect, synchronize, and operate across platforms, including interoperability among different brands, ease of integration with existing devices, connection stability, and user satisfaction with interconnection [23], [24]. IoT System Architecture (ISA) was measured using items that captured perceptions of system integration, responsiveness, and data reliability, focusing on structure, scalability, communication efficiency, latency, and secure data flow [25], [26]. Ease of Use (EOU) captured user perceptions of operational simplicity and interface intuitiveness, including ease of learning, user-friendliness, minimal effort in daily operation, and straightforward troubleshooting [27], [28]. Finally, Adoption Rate (AR) was measured through behavioral indicators and intentions to use smart home technologies, such as active use, plans to expand adoption, willingness to recommend, and perceived improvement in living experience [29], [30].

### 3.5 Data Analysis Technique

The collected data were analyzed using SmartPLS 3 software through several stages. First, a descriptive analysis was conducted to explain respondent characteristics and summarize the mean and standard deviation of each variable. Next, the measurement model (outer model) was evaluated to assess the reliability and validity of constructs through convergent validity—using factor loadings greater than 0.7 and Average Variance Extracted (AVE) above 0.5—and internal consistency verified by composite reliability (CR > 0.7) and Cronbach's alpha ($\alpha > 0.7$). The structural model (inner model) evaluation then measured the strength of relationships among variables through path coefficients, coefficient of determination ($R^2$), and predictive relevance ($Q^2$). Finally, mediation analysis tested the role of ease of use as a mediating variable between device compatibility, IoT system architecture, and adoption rate, employing the bootstrapping method with 5,000 subsamples to determine significance at the level of $p < 0.05$.

## 4. RESULTS AND DISCUSSION

### 4.1 Respondent Profile

The study involved 125 respondents residing in modern housing areas across Tangerang, Indonesia, who either currently use or intend to implement smart home technologies. Respondent characteristics were analyzed based on gender, age, education level, occupation, income, and familiarity with smart home systems to ensure representativeness. Of the total respondents, 72 (58%) were male and 53 (42%) were female, indicating a balanced gender distribution and joint participation in household technology decisions. Most respondents were aged 25–40 years (69%), a group typically associated with higher technology adoption and income stability. Educationally, 54% held a bachelor's degree and 21% had a master's degree or higher, suggesting strong technological literacy. In terms of occupation, the majority were private-sector employees (37%) and entrepreneurs (26%), representing Tangerang's economically active middle class—the main target market for smart home products. Monthly income data showed that 64% earned above IDR 8 million, implying sufficient financial capacity for adopting IoT-based technologies. Regarding familiarity, 34% had fully installed and used smart home systems, 42% had partial installations, 16% planned to adopt within a year, and 8% were aware but not yet interested. These figures demonstrate that most respondents already possess practical exposure to smart home technologies, making them a relevant and informed group for analyzing factors such as ease of use, compatibility, and system architecture efficiency.

### 4.2 Measurement Model Evaluation (Outer Model)

**1. Convergent Validity**

Convergent validity refers to the extent to which indicators measuring the same construct are correlated and share a high proportion of variance [22]. It is evaluated through three main criteria: factor loadings greater than 0.70, Average Variance Extracted (AVE) above 0.50, and Composite Reliability (CR) exceeding 0.70, which together confirm the internal consistency and validity of the measurement model. The results of the convergent validity analysis, including the values of loadings, AVE, and CR for each construct, are summarized in Table 1 below.

Table 1. Convergent Validity Results

| Construct | Indicator | Factor Loading | AVE | CR | Result |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Device Compatibility | DC1: Interoperability among devices | 0.842 | 0.718 | 0.901 | Valid |
| | DC2: Ease of integration | 0.858 | | | Valid |
| | DC3: Stability of connection | 0.825 | | | Valid |
| | DC4: User satisfaction with interconnection | 0.844 | | | Valid |
| IoT System Architecture | ISA1: Well-structured and scalable system | 0.873 | 0.733 | 0.912 | Valid |
| | ISA2: Efficient communication between devices | 0.889 | | | Valid |
| | ISA3: Minimal latency | 0.845 | | | Valid |
| | ISA4: Secure and reliable data flow | 0.842 | | | Valid |
| Ease of Use | EOU1: Easy to learn and operate | 0.854 | 0.681 | 0.895 | Valid |
| | EOU2: Intuitive and user-friendly interface | 0.829 | | | Valid |
| | EOU3: Requires minimal effort to operate | 0.831 | | | Valid |
| | EOU4: Simple troubleshooting process | 0.786 | | | Valid |
| Adoption Rate | AR1: Active use of smart home devices | 0.875 | 0.744 | 0.922 | Valid |
| | AR2: Intention to expand usage | 0.883 | | | Valid |
| | AR3: Recommending smart home use | 0.851 | | | Valid |
| | AR4: Improved living experience | 0.862 | | | Valid |

Table 1 presents the results of the convergent validity test, which confirm that all constructs and indicators meet the recommended thresholds, indicating strong validity and reliability. For all constructs—Device Compatibility (DC), IoT System Architecture (ISA), Ease of Use (EOU), and Adoption Rate (AR)—the factor loadings exceed 0.70, showing that each indicator contributes significantly to its respective latent variable. The Average Variance Extracted (AVE) values range from 0.68 to 0.74, surpassing the 0.50 criterion, which demonstrates that more than half of the variance is explained by the construct rather than by measurement error. Similarly, Composite Reliability (CR) values between 0.89 and 0.92 indicate excellent internal consistency, confirming that the indicators for each construct are highly correlated. These results collectively validate that the measurement model possesses good convergent validity, ensuring that the constructs effectively capture the intended theoretical dimensions related to smart home adoption.

**2. Construct Reliability**

Reliability analysis was conducted to evaluate the internal consistency of indicators within each construct using Cronbach's Alpha ($\alpha$) and Composite Reliability (CR), with both required to exceed the threshold of 0.70 (Nunnally & Bernstein, 1994). The results demonstrate that all constructs meet these criteria, with Cronbach's Alpha values above 0.80 and CR values exceeding 0.89, indicating strong reliability. Specifically, Device Compatibility (DC) achieved $\alpha = 0.872$ and CR = 0.903, IoT System Architecture (ISA) $\alpha = 0.886$ and CR = 0.915, Ease of Use (EOU) $\alpha = 0.841$ and CR = 0.891, and Adoption Rate (AR) $\alpha = 0.893$ and CR = 0.920. These results confirm that all constructs exhibit excellent internal consistency, meaning the indicators within each construct reliably measure the same underlying concept without redundancy or inconsistency.

**3. Discriminant Validity**

Discriminant validity ensures that constructs are conceptually distinct and that indicators load more strongly on their corresponding constructs than on others. This was evaluated using the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio. Based on the Fornell-Larcker criterion (Fornell & Larcker, 1981), discriminant validity is achieved when the square root of the Average Variance Extracted (AVE) for each construct is greater than its correlations with other constructs. As shown in the results, the diagonal values—representing the square roots of AVE—are higher than the inter-construct correlations, such as Device Compatibility (0.842), IoT System Architecture (0.854), Ease of Use (0.825), and Adoption Rate (0.860). This confirms that each construct is unique and distinct from the others, ensuring conceptual differentiation within the model.

Furthermore, the HTMT ratio was used to provide a more rigorous assessment of discriminant validity, where values below 0.85 indicate sufficient discriminant separation between constructs (Kline, 2011). The HTMT values for all construct relationships—ranging from 0.688 (DC ↔ AR) to 0.814 (EOU ↔ AR)—are below the threshold, confirming that the constructs are empirically distinct. These consistent results across both methods affirm that the measurement model demonstrates strong discriminant validity, indicating that each construct captures a unique aspect of smart home technology adoption without significant conceptual overlap.

### 4.3 Structural Model Evaluation (Inner Model)

#### 1. Assessment of Collinearity (VIF Values)

Before testing the relationships among variables, multicollinearity was examined to ensure that the predictor constructs were not highly correlated. The Variance Inflation Factor (VIF) was used as the diagnostic criterion, with a threshold value below 5.00 indicating acceptable collinearity (Hair et al., 2021). The results show that all VIF values for the predictor variables—Device Compatibility (DC), IoT System Architecture (ISA), and Ease of Use (EOU)—ranged between 2.182 and 2.934, well below the critical limit. Specifically, for Ease of Use, the VIF values of DC and ISA were 2.421 and 2.537, respectively, while for Adoption Rate, the VIF values for DC, ISA, and EOU were 2.934, 2.747, and 2.182. These results indicate that no multicollinearity exists among the constructs, confirming that each predictor is statistically independent and suitable for inclusion in the subsequent structural model analysis.

#### 2. Coefficient of Determination ($R^2$)

The coefficient of determination ($R^2$) assesses the proportion of variance in the endogenous constructs explained by their predictor variables, with higher $R^2$ values indicating stronger explanatory power. According to [31], $R^2$ values of 0.67, 0.33, and 0.19 are categorized as substantial, moderate, and weak, respectively. The results show that Device Compatibility and IoT System Architecture together explain 67.1% of the variance in Ease of Use, while Device Compatibility, IoT System Architecture, and Ease of Use collectively account for 72.3% of the variance in Adoption Rate. These findings indicate that both endogenous constructs—Ease of Use and Adoption Rate—have substantial explanatory power, demonstrating that the proposed model effectively captures the behavioral dynamics influencing smart home technology adoption among respondents in Tangerang.

#### 3. Effect Size ($f^2$)

The effect size ($f^2$) assesses the magnitude of each exogenous construct's contribution to the $R^2$ value of an endogenous construct. According to Cohen (1988), $f^2$ values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively.

Table 2. Effect Size ($f^2$)

| Relationship | $f^2$ Value | Effect Size |
|---|---|---|
| DC → EOU | 0.198 | Medium |
| ISA → EOU | 0.224 | Medium |
| DC → AR | 0.128 | Small–Medium |
| ISA → AR | 0.141 | Small–Medium |
| EOU → AR | 0.312 | Large |

Table 2 presents the results of the effect size ($f^2$) analysis, which evaluates the relative impact of each exogenous construct on the endogenous variables within the structural model. According to Cohen's (1988) guidelines, $f^2$ values of 0.02, 0.15, and 0.35 correspond to small, medium, and large effects, respectively. The results indicate that Device Compatibility (DC) and IoT System Architecture (ISA) have medium effects on Ease of Use (EOU), with $f^2$ values of 0.198 and 0.224, respectively, suggesting that both constructs significantly influence users' perceptions of operational simplicity and interface efficiency. In contrast, the effects of DC (0.128) and ISA (0.141) on Adoption Rate (AR) fall within the small to medium range, implying that while these technological factors contribute to adoption, their influence is partially mediated by Ease of Use. Notably, Ease of Use exerts the strongest direct influence on Adoption Rate with an $f^2$ value of 0.312, indicating a large effect. This finding underscores the pivotal role of perceived ease of use as a behavioral driver in the adoption of smart home technologies, reflecting that users are more inclined to adopt systems that are intuitive, reliable, and effortless to operate.

**4. Predictive Relevance ($Q^2$)**

Predictive relevance ($Q^2$) was evaluated using the blindfolding procedure with an omission distance of 7, where $Q^2$ values greater than zero indicate the model's predictive capability for endogenous constructs. The results show that Ease of Use (EOU) achieved a $Q^2$ value of 0.441 and Adoption Rate (AR) reached 0.489, both exceeding the threshold of 0.35, which signifies high predictive relevance. These findings confirm that the model not only demonstrates a good fit with the observed data but also possesses strong predictive power, meaning it can reliably forecast behavioral outcomes related to smart home technology adoption among users in Tangerang.

**5. Hypothesis Testing and Path Coefficients**

The final step of inner model evaluation involved testing the proposed hypotheses through bootstrapping to assess the statistical significance of each path coefficient. The results are presented in Table 3.

Table 3. Path Coefficient

| Hypothesis | Relationship | Path Coefficient (β) | t-value | p-value | Result |
|---|---|---|---|---|---|
| H1 | Device Compatibility → Ease of Use | 0.415 | 6.873 | 0.000 | Supported |
| H2 | IoT System Architecture → Ease of Use | 0.437 | 7.214 | 0.000 | Supported |
| H3 | Device Compatibility → Adoption Rate | 0.286 | 4.912 | 0.000 | Supported |
| H4 | IoT System Architecture → Adoption Rate | 0.301 | 5.177 | 0.000 | Supported |
| H5 | Ease of Use → Adoption Rate | 0.422 | 8.002 | 0.000 | Supported |

Table 3 presents the results of the path coefficient analysis obtained through the bootstrapping procedure, which evaluates the significance and strength of hypothesized relationships among constructs in the structural model. All hypothesized paths (H1–H5) are statistically significant, as indicated by t-values exceeding 1.96 and p-values below 0.05, confirming strong empirical support for the proposed relationships. Specifically, Device Compatibility ($\beta = 0.415$, $t = 6.873$, $p = 0.000$) and IoT System Architecture ($\beta = 0.437$, $t = 7.214$, $p = 0.000$) both have significant positive effects on Ease of Use, indicating that seamless device integration and well-structured system architecture enhance users' perceptions of operational simplicity. Furthermore, Device Compatibility ($\beta = 0.286$, $t = 4.912$, $p = 0.000$) and IoT System Architecture ($\beta = 0.301$, $t = 5.177$, $p = 0.000$) also exert direct positive influences on Adoption

Rate, suggesting that technological robustness and interoperability increase users' willingness to adopt smart home systems. Notably, Ease of Use (β = 0.422, t = 8.002, p = 0.000) exhibits the strongest direct effect on Adoption Rate, confirming its mediating role and highlighting that intuitive, user-friendly systems substantially enhance adoption intentions. Overall, these results demonstrate that both technological and human-centric factors jointly shape smart home adoption behavior, with Ease of Use serving as a key bridge between system design and user acceptance.

**6. Mediation Analysis**

The mediation analysis evaluated the indirect effects of Device Compatibility and IoT System Architecture on Adoption Rate through Ease of Use as the mediating variable, using the bootstrapping method to assess significance. The results show that both indirect paths—Device Compatibility → Ease of Use → Adoption Rate (β = 0.175, t = 4.325, p = 0.000) and IoT System Architecture → Ease of Use → Adoption Rate (β = 0.184, t = 4.672, p = 0.000)—are statistically significant at $p < 0.001$, indicating partial mediation. This suggests that while Device Compatibility and IoT System Architecture have direct positive effects on adoption, their influence becomes stronger when users perceive the system as easy to use and intuitive. In other words, technological robustness alone is insufficient; users' perceptions of operational simplicity play a pivotal role in translating technical advantages into actual adoption behavior of smart home technologies.

## Discussion

### The Impact of Device Compatibility on Ease of Use

The analysis confirms that device compatibility exerts a positive and significant influence on ease of use, indicating that users perceive smart home systems as easier to operate when devices from multiple brands can communicate and function harmoniously. This finding aligns with the Technology Acceptance Model (TAM) proposed by Davis (1989), which emphasizes that perceived ease of use is closely tied to system interoperability. When smart home devices—such as lighting systems, security cameras, and sensors—are seamlessly integrated, users encounter fewer technical obstacles, thereby reducing the cognitive effort required for operation. These results support [16], [17], [32], who highlight that higher interoperability enhances user satisfaction and confidence, ultimately encouraging broader acceptance of IoT-based services. Conversely, incompatibility or the necessity of using multiple applications to control devices often leads to frustration, decreased trust, and potential abandonment of smart technologies.

In the context of Tangerang's modern residential developments, where consumers frequently adopt hybrid systems combining various brands and platforms (e.g., Google Home, Alexa, Xiaomi), device compatibility becomes a decisive factor in shaping perceptions of technological convenience versus complexity. Users are more likely to engage with systems that operate seamlessly across platforms, as such integration reflects technological maturity and reliability. Therefore, the implementation of standardized communication protocols such as Matter and Zigbee is essential for enhancing interoperability, sustaining user trust, and ensuring long-term engagement with smart home technologies.

### The Role of IoT System Architecture in Perceived Ease of Use

The results indicate that IoT system architecture has a significant positive impact on ease of use, suggesting that a well-structured architecture—characterized by efficient data flow, stable network connectivity, and minimal latency—creates a seamless and responsive user experience. Respondents in this study perceived systems with reliable architecture as easier to operate, particularly when using mobile applications or voice assistants. This aligns with the findings of [19]–[21], [33], who assert that architectural robustness and scalability are fundamental to building user confidence and operational convenience. A strong system architecture reduces technical barriers such as lag and disconnection, allowing for smoother command execution and consistent device synchronization, which enhances users' perception of simplicity and reliability in smart home interactions.

In the Indonesian context, especially in Tangerang's urban areas where network stability may vary, system architecture becomes an even more critical determinant of user satisfaction. Developers who implement local edge computing and optimize cloud-based communication can significantly mitigate connectivity disruptions and latency issues. Such architectural improvements not only enhance system responsiveness but also strengthen user trust and engagement by ensuring that smart home technologies function dependably despite infrastructural constraints.

**The Direct Effects of Device Compatibility and IoT Architecture on Adoption Rate**

The findings confirm that both device compatibility and IoT system architecture have significant positive effects on the adoption rate of smart home technologies. Users are more inclined to adopt systems that exhibit seamless performance, operational stability, and smooth cross-device integration. These results are consistent with prior studies by [24] and [34], which identified technical consistency and interoperability as primary determinants of technology adoption in smart environments. From a behavioral perspective, this aligns with the Unified Theory of Acceptance and Use of Technology (UTAUT) proposed by [28], emphasizing that "performance expectancy" and "effort expectancy" are key motivators of behavioral intention. When users recognize that device compatibility enhances convenience and reduces operational effort, they perceive the technology as both practical and rewarding, increasing their willingness to invest in smart home systems.

In Tangerang's rapidly developing smart residential market, adoption is also shaped by social and lifestyle dynamics. Beyond technical benefits, smart home systems symbolize modernity, innovation, and efficiency—attributes that carry social prestige among middle- and upper-income households. This indicates that the adoption of smart technologies is not solely a rational response to utility and functionality but also a reflection of aspirational living. Consequently, both usability and perceived social value act as complementary forces driving the diffusion of smart home adoption in urban Indonesian contexts.

**Ease of Use as a Mediating Factor**

The mediation analysis revealed that Ease of Use significantly mediates the relationship between both Device Compatibility and IoT System Architecture on Adoption Rate, emphasizing that technical excellence alone does not guarantee user adoption. What truly determines adoption is how users perceive and experience that technical capability in everyday use. This finding supports the theoretical assertions of Davis (1989) and Venkatesh et al. (2003), which describe perceived ease of use as a psychological bridge through which technological characteristics influence behavioral intention. Even the most advanced system may fail to attract users if it is perceived as complex or unintuitive, whereas a well-designed, stable, and easy-to-operate system fosters confidence and encourages continuous use.

From a practical perspective, these results underscore the importance of human-centered design in smart home development. Developers should focus on creating intuitive interfaces, providing clear feedback mechanisms, and incorporating adaptive learning features that simplify user interaction. Such design strategies minimize operational barriers and enhance user comfort, allowing even novice users to engage confidently with smart technologies. When users perceive the system as simple, reliable, and responsive, the transition from initial trial to habitual use becomes seamless—ultimately strengthening satisfaction, long-term engagement, and brand loyalty.

**Theoretical Implications**

From a theoretical perspective, this study contributes to the existing body of knowledge by extending the Technology Acceptance Model (TAM) within the context of IoT-based smart homes. While TAM traditionally emphasizes cognitive perceptions such as usefulness and ease of use, this study integrates technical dimensions—device compatibility and system architecture—as antecedents of these perceptions.

This integration bridges the gap between technological infrastructure theory and user acceptance theory, suggesting that system design and architecture are not merely engineering considerations but behavioral enablers. The study also empirically validates the mediating role of ease of use, reinforcing its significance as a conduit between technical quality and user adoption behavior. This aligns with contemporary perspectives that successful IoT ecosystems depend equally on interoperability standards and user-centered experience design [35]

**Practical Implications**

The findings generate several practical recommendations for key stakeholders involved in the smart home ecosystem. For IoT developers and manufacturers, it is essential to prioritize interoperability standards such as Matter, Zigbee, and Z-Wave to ensure seamless communication across different brands, develop modular architectures that allow effortless device integration, and maintain firmware stability and security to foster long-term user trust. For housing developers and property managers, IoT infrastructure should be integrated during the design and construction phases to optimize network capacity and system compatibility, while offering homeowners pre-configured systems that support multiple brands to minimize installation complexity. Meanwhile, policymakers and regulators should establish national standards for IoT interoperability and data security to enhance consumer protection and trust, alongside launching public education initiatives that promote awareness of energy efficiency, data privacy, and system maintenance. Implementing these coordinated actions will accelerate smart home adoption and contribute to Indonesia's broader vision of building smart cities and achieving sustainable digital living environments.

## 5. CONCLUSION

The findings of this study reveal that device compatibility and IoT system architecture are pivotal determinants of both ease of use and adoption rate in smart home implementation within modern housing developments in Tangerang. Device compatibility enables interoperability among diverse devices, reducing operational complexity and enhancing user satisfaction. Similarly, a well-structured IoT architecture ensures efficient data flow, stability, and responsiveness, all of which contribute to reliability and an intuitive user experience. The analysis also confirms that ease of use serves as a mediating factor linking technical design and user behavior—demonstrating that even the most advanced technologies will only be adopted when users perceive them as simple, practical, and convenient to operate. This reinforces the relevance of the Technology Acceptance Model (TAM) in IoT-based contexts and underscores the importance of human-centered design in fostering sustainable technology adoption.

From a practical standpoint, IoT developers and housing planners should prioritize interoperability standards, modular system designs, and user-friendly interfaces to strengthen consumer trust and accessibility. Policymakers should also establish regulatory frameworks promoting standardization, data protection, and public education on smart home technologies to enhance digital readiness among residents. Overall, the study concludes that the success of smart home adoption relies not solely on technological sophistication but on the creation of interoperable, intuitive, and secure ecosystems that align with the needs and capabilities of modern urban communities. These findings provide a strategic foundation for future research, innovation, and policy initiatives aimed at accelerating smart city development in Indonesia and similar emerging economies.

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