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The Challenges of Developing Smart House

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Abstract

The development of smart houses has grown in significance as the search for environmentally friendly and energy-efficient built environment solutions continues. However, higher construction costs, low smart house development, lack of awareness, and insufficient research present notable challenges to the widespread adoption of these technologically advanced residential spaces. In "smart" homes, advanced technology is used to optimize operations, increase energy efficiency, and improve tenant comfort and safety. This research aims to explore developers' perceptions of smart house development, identify challenges in developing smart houses, and identify strategies to address these issues. The study is focusing on residential smart houses, particularly smart homes. Qualitative methods, including interviews with 3 respondents, were employed to collect information and examine the opinions and experiences of developers in the area. The method used for data analysis is content analysis. The findings reveal that developers perceive operational efficiency in smart houses, utilizing features like motion sensors and air conditioner temperature management to perceptibly reduce electricity consumption. The readiness for smart housing is influenced by customer feedback, budget considerations, and market demand. Challenges encompass higher construction costs, project complexity, and a lack of awareness. Smart house development is a relatively new concept, the low demand contributes to higher costs compared to conventional houses. To address challenges, strategies involve conducting cost analysis, comparing material functionality and costs, and hiring experienced stakeholders for successful execution. Emphasis is placed on proper planning, including resource allocation and device integration. By addressing the issues and challenges faced by developers in the sector, this study ultimately aims to facilitate the sustainable growth of smart houses in Malaysia.

1. Introduction

The growing interest in smart houses reflects a desire for more sustainable and energy-efficient built environments. These dwellings, equipped with advanced technology, excel in optimizing operations, enhancing occupant comfort and safety, and maximizing energy efficiency (Abdullah, 2020). Integrating sustainable building practices with real-time monitoring, remote control, and intelligent features – often powered by Internet of Things (IoT) devices like smart plugs – allows smart houses to seamlessly integrate into efficient energy management systems (Heo *et al*., 2017; Casado-Vara, 2018). This data-driven approach enables significant reductions in energy consumption and waste, aligning with both individual building energy management and broader sustainability goals (Huang, 2018). However, translating this potential into reality presents several challenges, particularly in developing nations. High costs associated with sustainable materials and smart technologies, gaps in technical skills required for their implementation, resistance to adopting changes from traditional practices, and limited financial incentives for embracing smart building solutions are all significant hurdles (Ghansah, 2021; Ejidike, 2022). Moving forward, overcoming these challenges requires a multi-pronged approach. Concerted efforts in research and development, targeted skills development programs, and the introduction of financial incentives for smart building adoption are crucial to unlocking the potential of smart houses for sustainable development, both in developed and developing countries.

1.1 Research Background

Building smart houses presents a distinct challenge for developing nations seeking to achieve sustainable construction. In Ghana, for instance, widespread adoption faces several hurdles (Ghansah, 2021). The use of smart, sustainable materials and equipment comes at a high cost, creating a significant barrier to entry. Additionally, technical difficulties during construction and a lack of expertise regarding smart technologies pose further obstacles. This lack of skilled personnel creates a demand for specialized jobs in smart house concepts and equipment, which are often unfilled, hindering development. Moreover, cultural and behavioral factors come into play, as resistance to adopting new technologies like smart houses from traditional construction practices can be strong.

1.2 Problem Statement

Although growing Asian nations like Malaysia, China, and Indonesia have been made aware of the advantages of smart homes, their development is still less widespread than it is in European nations (Yang & Lee, 2018). According to Habizah (2023), Malaysia also had one of the lowest rates of development for smart homes among Asian nations. A study has been done to explore the perception of developers toward smart houses. For example, a study by Hussain *et al*. (2020) said that cost is a critical challenge in smart house implementation. High initial investment and maintenance costs are major deterrents for developers. Smart houses can be costly because they involve the installation of various advanced technologies such as sensors, devices, and systems, which can be expensive to purchase, install, and maintain. According to Salimon and Gorondutse (2018), Malaysians are discouraged from wanting a home automation system due to a lack of exposure to the technology, its high cost, and its complexity. It is essential to fully address these issues and offer practical solutions that encourage acceptance, accessibility, and affordability of IoT-based smart home technologies in order to further the development and adoption of smart homes in Malaysia (Touqeer, 2021).

1.3 Research Questions

In order to address the research problems that arise regarding the development of smart homes, there are several questions that need to be answered. This research aims to understand:

1. What is the perception of developers towards smart house development?
2. What are the challenges to developing a smart house?
3. What are the strategies and suggestions for smart house development?

1.4 Research Objectives

This research is conducted with a focus on specific objectives to guide its implementation. The following are the objectives that this research aims to achieve:

1. To study the perception of developers towards smart house development.
2. To identify the challenges to developing a smart house

3. To determine the strategies for smart house development

1.5 Scope of Study

This study primarily focuses on residential smart houses, emphasizing developers' perceptions, challenges, and solutions regarding smart house adoption. It involves various research activities like data gathering and analysis to understand the deployment context in Selangor. Selangor was chosen due to its rapid urbanization and increasing demand for sustainable housing. Investigating smart house technology in this context aims to provide insights into its impact on urban development and sustainability, with the goal of aiding the progress of smart home technologies in the region.

1.6 Significance of Study

This study holds significant importance for various stakeholders, including the community, developers, government, and academic institutions. For the community, it provides information on how smart houses can increase energy efficiency and occupant comfort, leading to the development of healthier and more environmentally friendly communities. By learning how to overcome obstacles and make knowledgeable choices about the integration of smart houses, developers can gain from the research's findings and produce creative and energy-efficient structures. The government can use the study's insights to create supportive rules and regulations to encourage the implementation of smart house technology and advance Malaysia's sustainability objectives. Finally, academic institutions can make use of the results to advance knowledge, encourage additional study, and foster interdisciplinary cooperation in disciplines including architecture, engineering, environmental science, and urban planning.

2. Literature Review

It reviews relevant data that is relevant to and can be used to support the research topic. All the literature, journals, and data pertaining to smart houses will be compiled and reviewed in this section. In addition to covering the advantages and disadvantages of smart houses, a review of information pertaining to developers is included. Additionally included in this segment of the literature analysis are earlier smart building initiatives in Malaysia and the construction sector.

2.1 Definition of Smart House

Smart houses go beyond basic automation, using technology and intelligence to optimize energy consumption and enhance comfort (Abdullah, 2020). Aligned with green building goals, smart homes leverage networked devices for increased energy efficiency, contributing to sustainability (Abdennadher *et al*., 2015). The evolution from energy-efficient buildings to today's smart homes integrates wireless communication for effective energy management (Abdennadher *et al*., 2015). User-defined algorithms guide controllers, prioritizing energy efficiency (Sciutto, 2014).

2.2 Components of Smart House

A smart home's automation symphony depends on the harmonious interaction of interconnected parts. The system's eyes, or sensors, collect information on movement, temperature, and other things (Dutton *et al*., 2013). The intelligence of the system is provided by this data, which is interpreted by controllers (such as hubs or assistants) and used to initiate actions from controls (such as robotic appliances and smart plugs) (Wong & Au, 2022). The core system, which is a component of this ecosystem, networks, makes sure that everything communicates with everything else (Ishak *et al*., 2018). Ultimately, the user interface of your smart haven is provided by software and apps, which let you customize it (Ramli *et al*., 2019). Security systems, smart appliances, and other features can be added to this core orchestra to enhance it and create a responsive and intelligent home environment (Abdullah *et al*., 2020).

2.3 Benefits of Smart House

The adoption of smart house technologies brings significant benefits, creating a more sustainable, comfortable, and secure environment (Jennifer Amann, 2019). Residents enjoy convenience and comfort with automatic systems adjusting lighting, temperature, and security to personal preferences (Cui *et al*., 2022). Remote accessibility enhances ease and peace of mind (Yildiz, 2014), and safety improves through smart sensors and alerts, preventing crime (Lu *et al*., 2016). Smart homes also contribute to environmental sustainability by minimizing energy use and carbon footprints (Rashidi *et al*., 2019) and reducing water waste through intelligent water management systems (Chung *et al*., 2017).

- Energy Efficiency
- Indoor Air Quality
- Safety and Security
- Environmental Sustainability

2.4 The perception of Developer towards smart house development

Developers in Malaysia exhibit a nuanced view of smart house development, balancing potential and apprehension influenced by factors like awareness, technological readiness, market demand, and cost concerns (Yousif, 2020). While some see smart homes as a sustainability driver and an attraction for environmentally conscious tenants, concerns about upfront costs, integration challenges, and uncertain market demand create a cautious outlook (Yusof *et al*., 2022; Azmi *et al*., 2018). Technological complexity, especially for those lacking expertise, is a noted challenge (Jaafar *et al*., 2017). Unfamiliarity with the technology and a scarcity of success stories contribute to market ambiguity (Wong *et al*., 2019; Lim *et al*., 2023). Despite challenges, early adopters believe in the potential and competitive advantage of smart homes, paving the way for future adoption (Yusof *et al*., 2022).

2.4.1 Operational Efficiency

Operational efficiency is crucial for successful smart house development, involving optimized resource use and streamlined activities. Developers, influencing how operational efficiency is perceived and implemented, play a vital role (Johnson & Smith, 2019). Aspects like energy management, automation, occupant comfort, and building performance are key. Developers can enhance efficiency using modern technologies and design concepts, leading to better sustainability, cost savings, and user experience (Brown & Davis, 2020).

2.4.2 Market Demand

Developers recognize the demand for smart structures in commercial and residential settings, catering to tech-savvy tenants with cutting-edge amenities. Smart houses meet high standards and implement smart meter infrastructures to reduce peak demand, manage risk, cut emissions, and lower energy costs (Yan, 2018). This not only enhances occupant comfort and home efficiency but also creates a sizable market for home automation products. Khedekar (2017) notes the rapid expansion of the building and home automation market, with increased technology integration expected to drive demand, reduce costs, and enhance accessibility.

2.4.3 Enhanced Occupant Comfort

Smart homes go beyond efficiency and sustainability, becoming havens of personalized comfort and convenience. Developers prioritize features empowering residents. Shuja (2021) notes residents reclaiming time through smart systems, leading more comfortable, productive lives. Lee and Hong (2020) showcase personalized climates with smart HVAC systems. Sine (2022) highlights seamless control through mobile apps, simplifying interactions and saving time.

2.4.4 Developer's Readiness for Smart Housing

Developer readiness is a hurdle for smart home adoption in Malaysia. Concerns about cost and technological complexity, as highlighted by Shafiei *et al*. (2010) and Yusof (2007), contribute to this hesitancy. Smart housing implementation increases project management complexity, requiring collaboration with specialists. Qualitative research, like interviews, is crucial for understanding specific concerns (Drejer & Vinding, 2010). Solutions may involve government incentives, standardized smart home packages, innovative financing, collaboration with tech companies, industry standards, and skill development for developers. Open-source technology collaborations and streamlined plug-and-play solutions could reduce complexity and ease project management.

2.5 Challenges in Smart House Development

The widespread adoption of smart homes in Malaysia faces challenges outlined in. Additional context specific to Malaysia includes high construction costs, a significant barrier noted by Wong and Au (2022). Integrating smart technologies adds complexity, potentially causing delays and increased project costs, limiting accessibility. Meeting user needs is an ongoing challenge, requiring careful planning and customization for diverse preferences (Abdullah *et al*., 2020). Balancing user experience and technical advancements is crucial. Moreover, a lack of awareness among potential users hinders adoption, emphasizing the need for public education to bridge the awareness gap (Wong *et al*., 2019).

- Higher Construction Cost

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- Project's Complexity
- Lack of Awareness
- Meeting Specific User Requirements

2.6 Strategies for Smart House Development

According to research by Ghadikola & Sharma (2023), the goal is to chart a course toward a smarter future for all, making smart homes a transformative living experience for many, not just a privilege for a select few. Adopting user-centric design and strategic development can help overcome challenges associated with smart house development.

- Conducting Cost Analysis
- Hiring Experienced Stakeholder
- Implement an Awareness Campaign
- Government Incentives

3. Research Methodology

Research methodology lays the groundwork for the research methodology, emphasizing its importance in ensuring a systematic and efficient study process (Guthrie, 2010). Following a well-defined plan with prioritized stages is crucial for gathering reliable data and achieving trustworthy outcomes (Yap, 2011). Given the focus on perceptions, challenges, and strategies in smart house development, the research adopts a qualitative approach.

3.1 Research Design

The research design serves as a crucial framework for planning the study, integrating methodologies outlined by McMillan and Schumacher (1984) and Sileyew (2019). It plays a pivotal role in ensuring efficient study conduct in meeting research objectives, as emphasized by Durrheim (2006). Drawing from Yin's perspective (2009), the design guides the determination of data sources and gathering methods. Notably, interviews conducted via Microsoft Teams align with contemporary research practices. This study aims to delve into developers' perceptions of smart house development, identify associated challenges, and determine effective strategies. The research design is vital in achieving these objectives, providing a structured approach to navigating the complexities of smart house development research.

3.2 Research Methodology Process

In general, a flow chart is commonly used to illustrate the stages conducted to ensure the successful achievement of research objectives. Figure 1 depicts the flow chart ofthe research methodology.

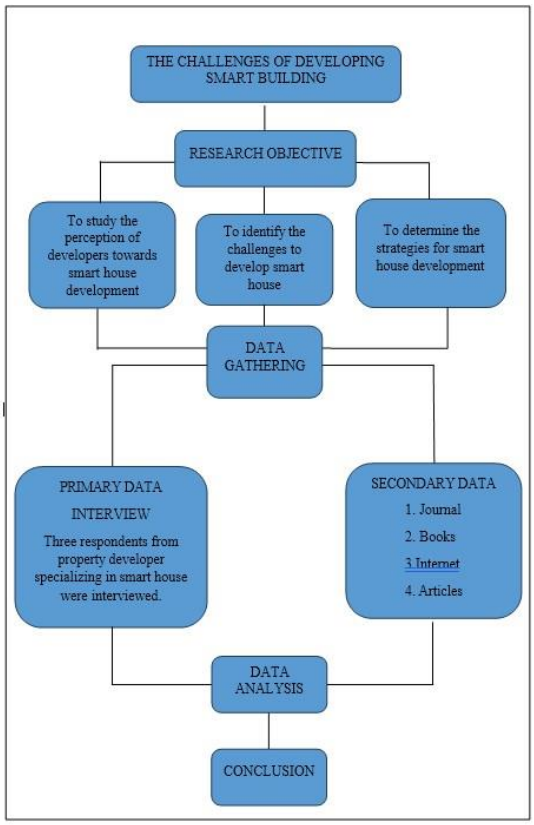

Fig. 1 *Research Methodology Flowchart*

3.3 Data Collection

This research adopts a qualitative method for exploring smart home development, incorporating an extensive literature review and in-depth interviews with industry experts. Analysing publications, journals, and news sources provide a comprehensive understanding of challenges, strategies, and perceptions around smart homes, surpassing the limitations of traditional surveys. Automated analytical methods by Kim and Kang (2018) enhance efficiency in extracting complex insights from existing data. The interviews with key figures reveal their perceived challenges, recommended strategies, and evolving views on smart home development.

3.3.1 Interview

Interviews are crucial for gathering in-depth information and understanding developers' perspectives in this study. Employing structured interviews guided by Babbie's (2008) framework ensures the quality of questions. The interviews focus on developers' experiences and explore perceptions of smart houses, specific development challenges, and potential strategies. This approach facilitates rich and contextual data collection, essential for comprehending the complex landscape of smart house development and the perspectives shaping its future (Edwards & Holland, 2020). The interview involves three key respondents, identified as Respondents A, B, and C, all representing a prominent property development company based in Selangor. During the interviews, data collection involves voice and video recordings, alongside written notes for accuracy. The duration is determined based on question complexity, usually within a 1-hour timeframe. Despite smooth interview sessions, scheduling the meeting proves time-consuming due to respondents' busy involvement in company matters.

3.4 Data Analysis

The data analysis in this research adopts a qualitative approach, incorporating content analysis as a fundamental method. Content analysis facilitates a thorough examination of challenges, strategies, and perceptions related to smart home development, enriching the qualitative findings. Additionally, an automated analytical method, as advocated by Kim and Kang (2018), is utilized for market research, extracting intricate insights from existing data efficiently. Moreover, interviews with industry experts contribute practical perspectives, enhancing the research's comprehensiveness and relevance. This research aims to offer valuable insights for optimizing coordination within the construction sector through the integration of content analysis and expert interviews.

4. Results and Discussion

4.1 Introduction

This section outlines the data analysis chapter for a study on smart house development challenges in Selangor. Primary data sources include interviews covering perceptions, challenges, and recommendations. It presents the data obtained from interviews with three developers in Selangor between October and December 2023, focusing on objectives related to smart house development.

4.2 Respondent's Background

The background of the respondents includes information related to the positions held and work experience of the respondents. This ensures that the data obtained by the researcher comes from respondents who are responsible or have the potential to answer the questions posed with more effective and accurate responses. The interview form's first section contains a question to collect information about the study participants' demographics. Table 1 lists the respondents who took part in this study.

Table 1 *Background of Respondents Involved in the Study*

Respondent	Position	Company	Years of Experience	Scope of Work
R1	Assistant Manager	A	12 Years	Project Implementation
R2	Project Manager	B	7 Years	Interior and Exhibition Design
R3	Executive Architect	C	2 Years	Designing and managing

Table 1 shows the background of the respondents involved in the study through the interview method. Based on Table 1, R1 is a project manager with 12 years of experience in project implementation. R1 manages teams, tackles challenge, coordinates projects for successful project execution, and enhances quality and efficiency. Meanwhile, R2 is a project manager in a property developer company with 7 years of experience. He manages projects from start to finish. This involved project planning, stakeholder coordination, client collaboration, and team management within budget and of the highest caliber. As for R3, he is an executive architect in a property developer company with 2 years of experience. R3 specializes in designing and managing architectural components. He is responsible for contributing to the company's design and development goals and ensuring excellence in project execution. The study involved three respondents with distinct roles and expertise in project implementation, management, and architectural design. Their diverse backgrounds contribute valuable insights to the research exploration of smart house development.

4.3 The perception of Developers towards Smart House Development.

While concerns linger (Wong *et al*., 2019), developers expressed optimism about smart home adoption, citing undeniable benefits like convenience, energy efficiency, and enhanced safety (Yousif, 2020). Interviews with three developers (R1, R2, R3) revealed their perspectives (Johnson & Smith, 2019) on Operational efficiency: All respondents emphasized energy savings through smart devices (Table 2), contributing to sustainability and cost reduction. Market demand: They acknowledge a growing market driven by tech-savvy younger generations and remote work trends. Occupant comfort: Automated features like lighting and thermostats were key to individual preferences and user satisfaction. This multifaceted approach paints a nuanced picture of developer attitudes toward the various factors shaping smart home development, informing future decisions and progress in this transformative field.

4.3.1 Operational Efficiency

They unanimously recognized the potential of smart home technologies to reduce energy consumption and optimize resource utilization. Respondent 1 emphasized the value of motion sensors for lighting and smart temperature management through air conditioners. Respondent 2 echoed this sentiment, highlighting the ability of smart systems to adjust light brightness and temperature automatically, leading to lower electricity bills. Respondent 3 further expanded on the point, providing examples of smart thermostats, automated lighting, and smart appliances contributing to enhanced operational efficiency. These perspectives align with Brown and Davis (2020), who suggest that embracing modern technologies and design concepts can improve operational efficiency in smart homes, resulting in greater sustainability, cost savings, and a more positive user experience.

This highlights the significant role that smart technologies can play in optimizing smart homes' performance and resource management.

> *"Smart home technologies, such as automatic lighting, thermostat management, and smart appliances, can improve energy efficiency. Residents can save money, and the environment is preserved through decreased energy use." (R3)*

Table 2 *Operational Efficiency*

Questions	Respondent 1	Respondent 2	Respondent 3
How can smart house technologies contribute to energy efficiency and cost savings in a residential setting?	• Motion sensor for lighting • Air conditioner and temperature management.	• Controlling the light and brightness. • Temperature	• automatic lighting thermostat management • Smart appliances. .
Are there any concerns among potential residents about the reliability of smart house systems in ensuring operational efficiency?	• Yes. • Needs to be updated from time to time to suit customer preferences.	• Yes. • System hacking.	• Yes. • Security flaws and system failure.
How do perceptions of operational efficiency vary across different demographic groups?	• Age • Impact of operational efficiency	• System Navigation and technology.	• Age • Digital knowledge • Lifestyle preferences

4.3.2 Market Demand

The developers' insights shed light on the evolving market demand for smart homes. Respondent 1 highlights the influence of demographics, suggesting that younger generations and individuals with higher education levels exhibit greater interest in smart home technology. This implies a tech-savvy and sustainability-conscious consumer base driving the demand. Beyond demographics, Respondent points to features like ambient aesthetics, automation convenience, and technological security as essential factors influencing market demand. Respondent 3 further emphasizes the importance of enhanced security systems, ease of use, and energy efficiency. These perspectives align with Khedekar.D (2017)'s observation of the rapidly expanding building and home automation market. Khedekar.D suggests that further technology integration could stimulate demand, potentially lower costs, and democratize access to smart homes. Table 3 shows the answers from all the respondents.

> *Youth generation and level of education are the main factors influencing the demand for smart house development." (R1)*

Table 3 *Market Demand*

Questions	Respondent 1	Respondent 2	Respondent 3
What factors influence the demand for smart houses in the current real estate market?	• Young generation. • Level of education.	• Ambient scenes. • Automation. • Technological safety.	• Integration of advanced technology. • Security system. • General convenience.
How do consumer preferences and lifestyle trends contribute to the growing or declining demand for smart houses?	• Connectivity and Control. • Remote work and energy-efficient solution.	• Preference for interior design concept and decoration. • Customizable lighting. • More safety.	• Energy savings • Security and convenience. • Lifestyle style trends. • Sustainability and technology.

4.3.3 Enhanced Occupant Comfort

The respondent emphasizes the impact of automated lighting and climate control, highlighting how these features create a more comfortable and personalized living environment. This aligns with Zenatix (2023), who points out that smart home features like customizable climate controls and convenient mobile access directly contribute to attracting and retaining residents. Agha *et al*. (2017) further strengthen this point by emphasizing how personalized features like individual climate control, smart amenities, and mobile app access for building features increase tenant happiness and improve the overall living experience.

> *"Smart technology, such as automatic lighting and climate management, often have a favorable effect on residents' overall quality of life by boosting comfort." (R1)*

Table 4 *Enhanced Occupant Comfort*

Questions	Respondent 1	Respondent 2	Respondent 3
How do residents perceive the impact of smart technologies on their overall living experience and comfort within a smart home?	• Automatic lighting • Climate management boosts comfort. • Favorable impact on their quality of life	• It depends on the amount and quality of smart devices. • Helps to provide comfort	• Perception is relatively low. • Perceived as a luxury symbol associated with wealth
How does occupant engagement with smart home systems influence their perception of comfort and convenience?	• Resident's engagement with the smart home system helps shape their perception.	• It depends on how knowledgeable they are about smart products.	• Active engagement with smart home systems enhances comfort and convenience for residents.

4.3.4 Readiness of Smart House Development

Customer feedback is important for the developers to succeed in their next project. Respondent 1 explains how their new development project has benefited from customer feedback. They also point out that market demand, cost-effectiveness, and the technology's ability to increase property value affect developers' readiness to use smart technologies. Budget, design concepts, and housing size also influence the developer's readiness for smart technology integration.

> *Positive responses from consumers influence our new development project. Moreover, market demand, cost-effectiveness, and technology in enhancing property value influence developers' readiness to integrate smart technologies." (R1)*

Table 5 *Readiness for Smart House Development*

Questions	Respondent 1	Respondent 2	Respondent 3
What factors contribute to developers' readiness to integrate smart technologies into their housing projects?	• Iinfluenced by positive responses from consumers. • Market demand • Cost-effectiveness • Technology enhancing property value	• Budget • Design concepts • housing size	• Incentives offered by the government. • Fast track approval • Exemption for low-cost housing.
What is the vision you had in mind for the smart house development?	• create sustainable and user-friendly homes. • Offer comfort and efficiency.	• Helps in interior design development. •	• Raise living standards. • Build sustainability with enhanced security.

4.4 The Challenges of Smart House Development

According to Ricardo Vargas (2022) several obstacles prevent the broad acceptance and implementation of smart houses in Malaysia. These challenges cover a variety of things that make it difficult to use and integrate smart house technologies correctly. Challenges in smart homes include cost accessibility (Ghadikola & Sharma, 2023), fragile security systems (Mayur *et al*., 2021), and addressing the user adoption gap (Khajavi *et al*., 2021). To unlock their full potential, smart homes must be technological marvels and accessible living spaces for everyone. According to Wong & Au (2022), integrating smart house technologies in construction projects can lead to delays and require complex planning. Respondents also emphasized project planning and collaboration with technology specialists to avoid delays, echoing Maylor's (2008) emphasis on efficient teamwork in coordinating different project components. Moreover, raising customer awareness about the benefits of smart homes is crucial, as highlighted by Chen (2019), who notes that potential cost savings and energy efficiency gains may go unnoticed, affecting practical acceptance.

4.4.1 Higher Construction Cost

Respondent 1 highlighted the complexity and cost implications of tailoring solutions to high-traffic areas, a sentiment echoed by Respondent 2. They emphasized the need for meticulous planning and standardized components for effective cost control during construction. Respondent 3 underscored the challenge of balancing costs while incorporating cutting-edge features, emphasizing the ongoing struggle to make smart technology affordable and valuable. This varied perspective on cost control in smart home development highlights complex dynamics, necessitating innovative solutions for financial feasibility.

> *"A notable challenge in the smart house development is managing costs effectively. Striking the right balance between affordability and advanced features is crucial. As these technologies can be expensive, finding ways to make them accessible while maintaining value poses a continual challenge." (R1*

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Table 6 *Higher construction cost*

Questions	Respondent 1	Respondent 2	Respondent 3
What did you learn from past projects to control smart house construction costs?	• The places people use the most.	• Study the size of each area and room. • Choose the device that suits the consumer's budget.	• Use standardised components. • Conduct thorough planning for efficient cost control.
What are the challenges you experience while developing a smart house?	• Controlling cost. • It is hard to make innovative features affordable while ensuring their advanced capabilities.	• Data security and privacy. • Safeguarding sensitive information from unauthorized access.	• Cost management • Expensive technology.

4.4.2 Project Complexity

Respondent 1 notes the challenge of technology becoming outdated during the two-year construction phase, especially if the property remains unsold. Project complexity is also linked to design concepts, electrical plans, and property size. Another respondent mentions the intricacies of smart house maintenance during renovations, potentially leading to system errors. Table 7 outlines responses on project complexity, with all three respondents stressing the importance of strong relationships with suppliers for smooth procurement. Respondent 1 highlights strategic scheduling for integration phases, collaborating closely with technical experts. This aligns with the perspectives of respondents 2 and 3, emphasizing pre-contract planning to prevent delays in complex smart technology implementation.

> *"The main elements that contribute to the complexity is a design concept, electrical plan, and property size." (R2)*

Table 7 *Project Complexity*

Question	Respondent 1	Respondent 2	Respondent 3
What main elements contribute to the complexity of smart housing projects from a development and construction perspective?	• Technology keeps updating from time to time.	• Design concept. • Electrical plan. • Property size.	• System error.
How do developers prevent delays due to complex smart technology integration?	• Must have good relationships with suppliers. • Implement careful project planning. • Collaborate with technology specialists.	• Prepare the schedule before signing the contract.	• Need to proper planning. • Stakeholders need to discuss and manage well.

4.4.3 Lack of Awareness

Table 8 shows that the level of awareness amongst potential home buyers is different. It varies from person to person, and there are diverse levels of awareness about their knowledge of smart houses. There's a growing understanding and awareness in terms of security and efficiency. In addition, respondent 2 said that potential homebuyers know the benefits of smart houses, such as safety and security matters. Meanwhile, respondent 3 acknowledges that awareness of smart house technologies differs among potential homebuyers based on the target market.

> *"Awareness among potential homebuyers varies, with a growing understanding of benefits like security and energy efficiency. Besides, most potential homebuyers are aware that smart house systems are user friendly and very convenient to do their work." (R1)*

Table 8 ***L****ack of Awareness*

Question	Respondent 1	Respondent 2	Respondent 3
To what extent are potential homebuyers aware of the benefits of smart home technologies?	• It varies from person to person. • Diverse level of awareness. • In terms of security and efficiency, there's a growing understanding.	• Safety matters. • Potential homebuyers are usually aware of safety measures.	• It varies based on the target market. • Elderly individuals • Awareness is likely limited. • Millennials have greater knowledge.
Are there regional or demographic variations in the level of awareness regarding smart homes, and if so, what factors contribute to these differences?	• Yes. • It varies regionally and demographically. • Factors are education, income, and lifestyle.	• Yes. • Usually new generation and young consumers. • Can navigate technologies more easily.	• Different level of education. • Income.

4.5 Suggestion for Smart House Development

By navigating the complex installation of cutting-edge innovation and economic pragmatism, drawing upon research by Ghadikola & Sharma (2023), it is to chart a course toward a smarter future for all. The three respondents share similar views on lowering construction costs, emphasizing the importance of a comprehensive cost-benefit analysis and collaboration with suppliers and technology providers (Ghansah, 2020). Additionally, overcoming project complexity is highlighted by hiring experienced project managers and professionals in smart house development, as Thomas (2008) suggested. The respondents agree on the crucial role of skills and expertise for stakeholders, supported by Zulch (2015), who notes that experienced project managers bring essential information to manage the complexities of developing smart houses.

4.5.1 Conducting Cost Analysis

As stated in Table 9, respondent 1 suggests comparing suppliers in terms of material, function, and cost. This measure ensures that a thorough evaluation is made to make an informed decision. Furthermore, respondent 2 suggests prioritizing main lights instead of accent lights and focusing more on the spaces where consumer usually spend their time the most because this will lead to cost reduction. Respondent 3 proposes to conduct a survey and questionnaire for future consumers to identify and determine their needs. By doing this, it is also a part of a proactive approach to understanding market preferences.

"Comparison between few suppliers in terms of material, functionality, and cost." (R1)

Table 9 *Conducting Cost Analysis*

Questions	Respondent 1	Respondent 2	Respondent 3
What methods are most effective in conducting a comprehensive cost analysis for smart housing projects?	• Comparison between suppliers in term of material, function and cost.	• Main lights instead of accent light • Focus on the spaces where consumer usually spends their time the most.	• Can do surveys and questionnaires for future consumers. • Identify what their needs.
What roles do government incentives or subsidies play in encouraging developers to invest in cost-effective smart housing solutions?	• It will benefit and have a positive impact on us.	• Loans fund • Low-cost house programs. • Import and export tariffs.	• Local government can promote smart housing. • Implement smart technology in their affordable housing project.

4.5.2 Hiring Experienced Stakeholder

Respondent 1 emphasized a strong electrical background, crucial for safe and efficient installation and operation (Table 10). Respondent 2 expanded on technical expertise, highlighting the need for modern interior design skills, software proficiency, technical drawing, and strong visualization for effective communication. Respondent 3 went beyond technical skills, emphasizing industry knowledge, understanding of project politics, and stakeholder influence skills for successful adoption. This diverse range of skills underscores the complex nature of smart home development and the need for a well-rounded team approach to navigate this evolving field's technical, aesthetic, and political landscape.

"The expertise that is needed is they must know the industry that is related to our project. They have to understand politics and power structure so that they can easily influence people to try and influence and convince people to implement this smart house technology in the construction industry. It can be identified through brainstorming and judged through their opinion and way of thinking." (R3)

Table 10 *Hiring Experienced Stakeholder*

Questions	Respondent 1	Respondent 2	Respondent 3
What specific skills and expertise are crucial for stakeholders involved in smart housing projects, and how can these be identified during the hiring process?	• Smart system more in electrical part. • Must have vast knowledge of electrical.	• Software construction drawing. • Visualization skills by creating animation render videos.	• Must understand politics and power structure. • Brainstorming and judging through their opinion and way of thinking.

How does collaboration and knowledge-sharing among experienced stakeholders contribute to the success of smart housing projects?	• Cooperation and knowledge sharing. • Reduce risks. • Maximise technology.	• Sharing experiences. • Helps create a better vision to achieve the company's goals.	• Clear communication. • Same expectation of the management.

5. Conclusion

The objectives of this research are to study the perception towards smart house development, to identify the challenges to developing smart houses, and to suggest strategies for smart house development. The respondents to this project are developers from Selangor. The research measures used in this study are qualitative methods, with data collected through interview sessions. The interview sessions were conducted, and more than 10 respondents from various companies were reached and approached. However, only three of the companies were able to provide and were willing to contribute to the interview session. The researcher used *Microsoft Word software to analyze* data given by respondents. Based on the data required, the respondents answered all of the questions concerning the perception, challenges, and strategies of the development of smart houses.

5.1 Summary of Objectives Achievement

The objectives of this research are to study the perception towards smart house development, to identify the challenges to developing smart houses, and to suggest strategies for smart house development. The respondents to this project are developers from Selangor. The research measures used in this study are qualitative methods, with data collected through interview sessions. The interview sessions were conducted, and more than 10 respondents from various companies were reached and approached. However, only three of the companies were able to provide and were willing to contribute to the interview session. The researcher used *Microsoft Word software to analyze* data given by respondents. Based on the data required, the respondents answered all of the questions concerning the perception, challenges, and strategies of the development of smart houses.

5.1.1 Research Objective 1: To study the Perception towards Smart House Development

Developers envision smart homes as energy-efficient and adaptable, catering to diverse user preferences and priorities. While acknowledging security and maintenance hurdles, they express optimism fueled by market trends and a commitment to sustainable design. According to Omar (2018), developers focus on energy-saving features like motion sensors and temperature control, emphasizing system reliability and user-friendly materials. Their positive outlook suggests a promising future for accessible and personalized smart living, potentially spurred by government incentives and technological advancements. This aligns with the findings of Khedekar (2017), who emphasizes developers' optimism in aligning projects with market trends and sustainability goals. The qualitative data collected from interviews further underscores these perceptions, with developers highlighting their willingness to adapt and integrate efficient technologies. One developer remarked, "Our vision is to create homes that not only utilize cutting-edge technology but also resonate with the lifestyle choices of our clients." This sentiment echoes the broader literature on smart house development, where the emphasis on user-centric design and energy efficiency is consistently recognized. These identified perceptions resonate with the existing discourse in the field, emphasizing a collective vision for a promising future in accessible and appealing smart homes.

5.1.2 Research Objective 2: To Identify the Challenges to Develop Smart House

Smart homes, while promising, face hurdles that require strategic solutions for sustainable development. Innovative design strategies and government support are actively countering construction costs, a significant impediment. According to Maylor (2008), strategic planning and design optimization can effectively mitigate the impact of rising construction costs. For instance, adopting prefabrication methods or leveraging sustainable building materials can contribute to cost efficiency without compromising the quality of smart homes. Project complexity demands strong supplier partnerships and meticulous planning (Maylor, 2008). Limited public awareness, especially among older and rural populations, calls for targeted campaigns emphasizing safety, affordability, and appeal to younger audiences (Omar, 2018). These insights, gained through developer

interviews, fulfill the research objective, revealing challenges and paving the way for bridging the gap between smart home potential and reality.

5.1.3 Research Objective 3: To determine the strategies for smart house development

This study offers a roadmap for developers, highlighting the importance of comprehensive cost-benefit analysis considering materials, functionality, and government incentives (Ghansah, 2020). Smart choices like supplier comparisons, design optimization, and consumer surveys can pave the way for financial sustainability. Skill development through training and education ensures a future-proof workforce capable of handling complex projects. By hiring someone with the knowledge, it can reduce risks, promote creativity, and maximize technology implementation. Overcoming project complexity can be significantly aided by hiring project managers and other professionals with experience implementing smart house projects (Thomas, 2008).

5.4 Closing

The study concludes with a comprehensive analysis of the research objectives, highlighting key findings and insights into the challenges and prospects of developing smart houses. In addressing Objective 1, developers exhibit a keen understanding of operational efficiency, emphasizing energy-saving features and demographic considerations. Their positive outlook and readiness to align projects with market demand signal a promising future for smart housing development. Objective 2, focusing on challenges, reveals strategic responses to higher construction costs, project complexity, and a lack of awareness among potential homebuyers. The multifaceted nature of these challenges underscores the complexities faced by developers in integrating smart technologies. Fulfilling Objective 3, the study provides actionable recommendations for smart house development, emphasizing cost analysis, and collaboration.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

Study conception and design: *Josielyn Jiding, Sharifah Meryam Shareh Musa;* ***data collection:*** *Josielyn Jiding;* ***analysis and interpretation of results:*** *Josielyn Jiding, Sharifah Meryam Shareh Musa;* ***draft manuscript preparation:*** *Josielyn Jiding, Sharifah Meryam Shareh Musa, Narimah Kasim and Rozlin Zainal. All authors reviewed the results and approved the final version of the manuscript.*

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