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Implementation of Smart Home Features in Sarawak, Malaysia

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***Abstract*—** The smart home is a technological advancement that improves people's quality of life by allowing them to do more with less effort and offering them several advantages in the areas of comfort, convenience, savings on expenses, safety, and others. However, the percentage of adoption of smart home features is still fairly low in Sarawak, Malaysia. The purpose of this study is to determine the benefits of adopting smart home features and to investigate the types of smart home features that owners of landed properties in Sarawak find most appealing to include in their homes. In this study, quantitative method was adopted, and 151 responses was collected. As a result, this study highlighted that the greatest benefit of smart home features is improved quality of life. Finally, the study found that smart security systems and safety control equipment are the most preferred types of smart home features by residents of landed properties in Sarawak.

***Keywords*—** Smart Home, Residential, Technology

I. INTRODUCTION

Shelter, which means a home, is a place giving protection to living things, such as human beings' temporary protection from bad weather and danger. Maslow (1943) mentioned that shelter is a part of the fundamental human physiological needs for survival. One third of the time is at work; the remaining time will be leisure time either at home or outside. Most people will choose to go back home after a long day of work. This means that humans spend at least one-third of their time at home. Since the year 2020, Malaysia has experienced three Movement Control Orders (MCO) to maintain social distance due to the COVID-19 pandemic. Therefore, to get ready for this type of emergency, it is essential to ensure and improve the comfortability and safety of staying at home.

Home is clearly the most important area since it is built on the notion of integrating smart technology into the dwelling environment, where most people are more likely to spend the bulk of their time, which has an impact on the quality of a person's life. Smart Home features allow homeowners to be equipped with a variety of gadgets, domestic appliances, integrated sensors, and other devices that can be controlled, accessed, and monitored remotely, providing essential services to satisfy the demands of their users (Balta-Ozkan, et al., 2014). One of the most severe concerns about smart home technology adoption is security. As the number of crimes like robbery, murder, and fires rises, a home surveillance system can be utilised to keep up with the rising crime rate (Ab-Rahman and Razaly, 2012). The worldwide senior population, particularly the number of persons aged 60 and over, has risen dramatically in recent decades and is predicted to reach nearly 2 billion in 2050, accounting for 22% of the entire global population (World Health Organization, 2016). Despite the favourable benefits of Smart Home Features and the rising business potential, data suggests that consumer acceptance is poor, particularly in developing Asian nations such as Malaysia, Singapore, China, South Korea, Thailand, and Indonesia (Leeraphong, et al., 2015).

In Malaysia, according to statistics which show very clearly that before the first COVID-19 case was discovered in Malaysia, people were spending less time at home. When Malaysia's government started to enforce the first Movement Control Order, MCO 1.0, on March 18th, 2020, the residential percentage increased sharply until the highest was 36.57%.

When it comes to MCO 2.0 on January 13th, 2021, the percentage raised but the uncertainty remained since each state switched between MCO, CMCO, RMCO, EMCO, and semi-EMCO based on the COVID-19 condition in each state. The residential percentage started to recover during MCO 3.0. It was a total lockdown that started on June 1st, 2021 (Our World in Data, 2022). This statistic shows more proof of the importance to ensure and improve the comfortability and safety of staying at home since the people were staying at home most of the time to maintain social distance.

II. PROBLEM STATEMENT

Utilizing smart home features will transform the "conventional" home into a "smart" home that offers several benefits to the users, including cost, time and energy savings. Despite the benefits of smart home features and the growing business potential, data suggests that adoption rates are still low, particularly in Asia's developing nations like Malaysia, Singapore, South Korea, and Indonesia (Yang, et al., 2018). According to Statista (2022), 14% is predicted to be the global penetration rate in 2022. Additionally, 36.1% of people who use smart home features are high earners, and 33.3% of people using smart home features worldwide are between the ages of 25 to 34 in 2021 (Statista, 2022). Consequently, young individuals or members of high-income groups make up one-third of the consumers of smart home features.

As mentioned by the past researchers, Chang & Nam (2021), the rate of adoption of smart home features is still modest, and not all age groups and income brackets have high rates of adoption. The researcher suggests to indicate the user perception on the preference and identify the factor of adopting such as gender, income level, residential type, experience in smart home and others. It is essential to investigate the needs of residents for smart home features in order to find ways to make the adoption and further development of the features easier and more understandable from the users' perspective. This will help identify potential areas for improvement for Malaysian smart home feature in the future.

III. AIM & OBJECTIVE

The research aim is to increase the implementation of smart home features in Malaysia. Therefore, in order to achieve the aim, the following objectives are important. There are two research objectives obtained in this research as follow:

1. To outline the benefits of the implementation of smart home features in Malaysia.
2. To explore the preferences of smart home features in Malaysia

IV. LITERATURE REVIEW

"Smart" has evolved to refer to innovative technologies that involve some degree of artificial intelligence. Smart technologies are distinguished by their ability to receive data from the surrounding environment and adapt accordingly. Long-term goal of smart technology is to increase the well-being of individuals through new concepts like the smart home.

A typical home that has devices and appliances installed and pre-programmed to make it operate intelligently is referred to as a smart home (Rasyidah, et al., 2020). The smart home system can be set to accommodate the user's daily routine, allowing the house to place orders at any time, regardless of whether someone is present. Balta-Ozkan, et al. (2013) stated that the network, which connects and coordinates all technical components and information about them, is what differentiates a smart house from a high-tech residence. Smart home feature is a part of the IoT and offer new sorts of services that match the preferences and demands of many consumers in their homes (Salimon, et al., 2018). In recent years, automation has grown in popularity due to the emergence of information technology, which has made it lower cost and simpler (Yang, et al., 2018).

According to Yeon, et al. (2018), the smart home features offer semi-smart home devices to meet the specific needs of family members, such as home security alarm systems to deter theft and property damage, and smart home products that can monitor lighting, temperature, multimedia, protection, and access control. Smart home, with the capacity to control all equipment and appliances in the house remotely or manually via a control unit, can provide ease and convenience to consumers for controlling and managing their energy use, as well as facilitate various family activities (Salimon, et al., 2018).

The benefit of smart home is that it may be centrally managed by a smartphone, allowing individuals to manage smart home services such as lighting, curtains, and information in real time (Koskela and Vaananen-Vainio-mattila, 2004). Yang, et al. (2018) stressed that a smart home device that can be centrally commanded must always be built and that a network connection such as Bluetooth, Z-Wave, and Wi-Fi is required.

Benefits to Adopt Smart Home Features

This section covers the strategies to adopt smart home features which includes the methods or ways to encourage users' intention to use. The strategies have outlined were efficient management of energy, better healthcare services, potential cost savings and benefits, and improved quality of life based on the studied literature.

Efficient Management of Energy

Ringel, et al. (2019) and Wilson, et al. (2015) discussed that the smart home enables efficient control of daily

energy use, to provide low-carbon energy transition and mitigate environmental impacts, such as reducing emissions of Carbon Dioxide which can cause global warming and ozone depletion. According to Ringel, et al. (2019), Sovacool and Del Rio (2020), and Zaidan and Zaidan (2020), the features of smart homes can give visualisation and monitoring functionalities for household energy management, which enables householders to change their behaviour and achieve energy efficiency without sacrificing convenience and comfort. Sovacool and Del Rio (2020), and Zaidan and Zaidan (2020) have also stated that the smart devices enable energy use transparency through visualisation and monitoring functionalities. Smart home features have enhanced users to use the energy resources in a smarter way.

In addition, Parag and Butbul (2018) stated that the smart home features can provide continuous, seamless interaction between the home and the smart grid, providing the grid with continuing demand flexibility resources for altering the demand curve.

The smart home features adoption in household energy management adds to the collaborative development of future energy services from a human-centred approach. Homeowners can improve their energy efficiency and reduce their impact on the environment by making little adjustments to their regular routines (Cockbill, et al., 2020).

Better Healthcare Services

Choi, et al. (2019) and Kadylak and Cotton (2020) found out that with the increasing number of older people in the world, smart home features provide benefit in home-based healthcare. Peek, et al. (2016), Arthanat, et al. (2020), and Basatneh, et al. (2018) indicated that the home-based healthcare services with smart characteristic are enhancing the quality of life and autonomy of the elderly and disabled. Smart home features protect users' independence at home by sensing, anticipating, and responding to their everyday actions in a socially acceptable and timely manner (Basatneh, et al., 2018). The term "smart home" is used in the healthcare or medical field to refer to “a home or dwelling with a set of networked sensors and devices that extend the functionality of the home by adding intelligence, automation, control, contextual awareness, adaptability, and functionality both remotely and locally, with the goal of improving the health and well-being of its occupants and assisting in the delivery of healthcare services” (Bennett, et al., 2017). Most of the time spent by seniors is in their living environment. Consequently, combining smart home with healthcare functions and services can provide the senior citizens with the benefits such as they can live in a familiar environment, maintain independence, enhance their life quality, and enhance the ability of healthcare professionals to provide personalised care (Arthanat, et al., 2020). These benefits would maximise the physical, social, and mental wellbeing of senior citizens (Choi, et al., 2019).

According to Peek, et al. (2016), and Arthanat, et al. (2020), even though older individuals tend to acquire new technologies at a slower rate than their younger counterparts, the numerous advantages of embracing smart technology have led them to adopt this innovation more readily, according to several studies. According to Peek, et al. (2016) and Choi, et al. (2019), the most significant advantage of smart home features provides continuous, non-invasive, and seamless healthcare services to the elderly when they continue to live independently and actively in their own homes. Wong and Leung (2016), Alaa, et al. (2017), and Lutolli and Vrhovec (2019) discussed that the home-based healthcare services with smart characteristic is cost-effective, and it is feasible for seniors and the disabled.

Potential Cost Savings and Benefits

The possible benefits brought about by the first two incentives are the cost reductions on daily necessities. According to Sovacool and Del Rio (2020), Zaidan and Zaidan (2020), Cockbill, et al. (2020), and Alaa, et al. (2017), the efficient energy management of smart home features enable householders to control household energy expenditures and move to cheaper service providers to decrease energy costs. Alaa, et al. (2017) and Arthanat, et al. (2019) stated that smart home-based healthcare services can minimise institutional care expenses and healthcare delivery costs. Combining healthcare services with smart homes can result in the cost-effective of societal healthcare costs, according to studies of Choi, et al. (2019), Kadylak and Cotton (2020) and Wong and Leung (2016). This is especially true in the perspective of a substantial socioeconomic load caused by rising medical bills of elderly. Adopting smart homes is a very profitable investment by converting the gained energy savings to profitable total investments (Ringel, et al., 2019). According to Shank, et al. (2020), the benefit of cost savings can only be provided by certain smart home features. However, with a rise in

savings and a reduction in the payback period of investment, the methods for adoption would expand (Paetz, et al., 2012).

Improved Quality of Life

According to Wilson, et al. (2015), Strengers and Nicholls (2017), and Sovacool and Del Rio (2020), smart home improves the controllability of most of household appliances and equipments. It enables to handle the living demands and enhances the convenience of daily life. Smart homes with the improvements and incorporation of Artificial Intelligent (AI) technology can achieve fully autonomous, which considerably decreases the labour of users in controlling household equipment and daily duties (Lutolli and Vrhovec, 2019). According to Sovacool and Del Rio (2020) and Parag and Butbul (2018), the benefits of controllability, convenience, and comfort of smart home features are the main cause of adoption for the majority of people. Moreover, the smart home can bring daily enjoyment (Strengers and Nicholls, 2017).

Preferences for Smart Home Features

This section describes the smart home features available in Malaysia. According to Balta-Ozkan, et al. (2013), the smart home features can be grouped based on the requirements of users. According to the research of Rasyidah, et al. (2020) in Johor, Hidayati, et al. (2018) in Hulu Langat Selangor, Yeon, et al., (2018) in Kuala Lumpur, and Bhati, et al. (2017) in Singapore, the smart home features can be categorised as Smart Energy and Lighting system, Smart Security and Safety Control, Smart Household Appliances, Smart Entertainment, and Smart Health.

Smart Enenrgy and Lighting

The Smart Energy and Lighting system enables more efficient energy usage. According to Hidayati, et al. (2018), the smart metre has the most useful features, while smart lighting and smart air conditioners are marginally useful to homeowners because some of the features are only needed daily, and the smart thermostat is not useful to homeowners because such features are costly to acquire. Rasyidah, et al. (2020) noted that people prefer to favour wireless lighting solutions because the smart home model would enable them to save energy, time, and money. Bhati, et al. (2017) noted that the essential components of a smart house are intelligent motion sensors, smart metres, air conditioners, temperature, and humidity sensors.

Security System and Safety Control

As shown by Internet Protocol (IP) cameras or Closed-circuit television (CCTV) protection, smart doorbells, and smart alarm alarms, according to Hidayati, et al. (2018), smart security and safety control is the top priority of the measures chosen by residents. Yeon, et al. (2018) discovered that most people acknowledged that security and alarm systems, CCTV, and sensors are key components of a smart house. Likewise, Bhati, et al. (2017) stated that smart cameras and smart locks are components of smart home security. Consequently, the smart security camera, the smart alarm and sensors, and the smart locks can be combined to strengthen the security system by incorporating a device hub to monitor and manage all the security system's capabilities. When the smart security camera and smart lock detect an intruder in the home, for instance, a notification is sent to the alarm system to start the siren.

Smart Household Appliances

Smart household appliances can reduce the number of people performing household duties because they can clean efficiently without human intervention. According to Hidayati, et al. (2018), the smart vacuum cleaner is not useful to homes due to its expensive features. Rasyidah, et al. (2020) discovered, however, that smart household appliances are the most popular smart home features than others such as smart energy and lighting. For instance, the authors identified cooking appliances as one of the most significant characteristics since it facilitates and simplifies their job in the kitchen. Therefore, smart home equipment can provide users with convenience, but their high price is a barrier. This enables adults to manage their household responsibilities while on the go or from the comfort of their couch.

Smart Entertainment

Smart entertainment enables more engaging interactions with electronic devices, such as watching videos, listening to music, and playing video games. The smart routers and smart televisions are the most useful smart home technologies for householders to purchase and use, but smart set-top boxes are only somewhat useful (Hidayati, et al., 2018). As smart entertainment did not contribute to cost efficiency, it would not be regarded a requirement for the residence.

Smart Health

According to Hidayati, et al. (2018), the authors tested among three smart health features which are fitness

tracker, smart toothbrush, and personal scale, the result stated the householders' preference for manual toothbrushes over smart toothbrushes has diminished the usefulness of smart toothbrushes. However, smart toothbrushes may make brushing easier, leading in better plaque removal.

V. METHODOLOGY

The purpose of the research methodology is to meet the research aim and objectives. The collection of primary and secondary data will occur. This investigation makes use of the quantitative research approach, which places a strong focus on objective calculation and the statistical. As a consequence of this, the quantitative data obtained from respondents will be analysed by means of the computer programme known as Statistical Package for the Social Sciences (SPSS). This research employed a non-probability sampling. This sampling strategy employed convenience sampling and purposive sampling. The Google form was adopted to collect the data. 200 questionnaires have been distributed to the respondents in Sarawak and 151 responses gathered.

VI. RESULT AND DISCUSSIONS

In this research, the range of age classified into 3 groups which are Generation Z (21 to 25), Millennials (26 to 41) and Generation X (42 to 57). Group 21 to 25 represents the people who directly worked after graduating from secondary school or the fresh graduates from university. Next, group 25 to 41 represent the stable income required to cover household or family expenses. Besides, the group 42 to 57 represents the person who has practically retired or reached the limit of their income level. The majority of respondents (48%) for this study are mid-aged, ranging from 26 to 41 years old, implying that they have reached a stable income level, which may influence their responses to the related questions. In order to provide a better understanding of the impact of income level on the implications of smart home features, the level of income has been categorised into B40, M40, and T20, as published in the Department of Statistics Malaysia, to determine whether the different income levels will influence the response data. B40 has an income of RM 4,850 and below; M40 has an income range of RM 4,851 to RM 10,959; and T20 has the highest income level at RM 10,960 and above. 45% of the respondents which is 68 out of 151 respondents was situated in the range of RM4,851.00 to RM10,959.00 (M40), while 28% of the respondents which is 43 out of 151 respondents have an income level below RM4,850.00 (B40). The income level with a range of RM10,960.00 and above (T20), occupied the remaining 27% of the respondents which is 40 out of 151 respondents.

Table 1: *Mean Ranking of Benefits of Smart Home Features*

Code	Benefits	Mean	Std. Deviation	N
BE1	Improve Quality of Life	4.28	.505	151
BE2	Efficient Management of Energy	4.19	.521	151
BE3	Better Home-based Healthcare Services Especially for Senior Citizens and Disabled	3.99	.505	151
BE4	Potential Cost Saving and Benefits	3.91	.494	151

In this study, the benefits of implementing smart home features were ranked using mean values. The range of mean values was between 2.91 and 4.28.

BE1 = 'Improve Quality of Life' was observed as the top benefit that was ranked by the respondents, with an overall mean value of 4.28. Sovacool and Del Rio (2020) suggest that smart homes have the ability to enhance control over household appliances and equipment, leading to better management of daily living requirements and increased convenience in daily life. Smart homes equipped with Artificial Intelligence (AI) technology can achieve full automation, thereby significantly reducing the burden on users in controlling household equipment and carrying out daily tasks. By referring to the results of the responses, it can be concluded that the improvement of life is very dependent on the types and features of smart home devices.

The second ranking of the benefits is BE2 = 'Efficient Management of Energy', with a mean value of 4.19. According to Renish, et al. (2011), smart home features can provide efficient energy management because they utilise sensors, schedules, and other technologies to monitor and control the home's energy consumption. Smart homes can optimise energy consumption and reduce waste by automating the control of lighting,

heating, and cooling systems. For instance, smart thermostats can learn the preferences and routines of residents and adjust the temperature accordingly to conserve energy. Moreover, smart homes can integrate with renewable energy sources such as solar panels, allowing householders to generate and store their own energy, thereby reducing reliance on the grid and lowering utility costs. Therefore, smart home features offer an intelligent and efficient method for managing energy consumption within the home.

Managing energy savings, it also reflects on the cost savings, but the BE4 = 'Potential Cost Savings and Benefits' ranked with the lowest mean value, which is 3.91. Smart home features can save money by optimising energy consumption and reducing utility bills. For example, a smart thermostat can adjust the temperature based on occupancy and resident habits, while intelligent lighting systems can turn off lights in unoccupied rooms. Additionally, smart homes can offer insurance discounts due to their enhanced security features, such as video monitoring and smart locks. Therefore, smart home features are an attractive option for homeowners because they optimise energy usage, prevent costly repairs, and offer insurance discounts. Although the variables have the lowest mean value, the thesis is also proven by other researchers, as smart home appliances may reduce 15% – 25% of energy consumption, thus reducing the cost at the same time (Zaidan and Zaidan, 2020).

Table 2: *Mean Ranking of Preferences of Smart Home Features*

Code	Preferences	Mean	Std. Deviation	N
P1	Security System and Safety Control	4.35	.568	151
P2	Smart Household Appliances	4.20	.533	151
P3	Smart Entertainment	4.02	.496	151
P4	Smart Energy and Lighting	4.00	.455	151
P5	Smart Health	3.96	.445	151

'Security System and Safety Control, is with the top mean value of 4.35 with the most preferred smart home features. According to Haney, et al. (2020), smart security systems provide a variety of features that can improve the safety and security of one's property. Remote monitoring is one such feature that enables users to monitor their property using a smartphone or other device from anywhere. This feature also allows them to receive real-time notifications if any suspicious activity or unexpected motion is detected near to the property. Smart security systems also deter potential thieves and intruders. The visibility of security cameras and smart locks deters would-be intruders from attempting a break-in. In the event of a security violation or other emergency, such as a gas leak or a fire, smart security systems provide immediate emergency response. This prompt response can mitigate the emergency's effects and save lives. Smart security systems are preferred by homeowners due to the numerous advantages they provide for enhancing the safety and security of their properties.

As the second highest mean value of 4.20, which is P2 = 'Smart Household Appliances', this perfectly indicates the respondent of the research, who is in the age range of 26 to 41. This is because the respondents within the age range are mostly busy with work instead of doing daily housework. The preferences of the respondent proved that instead of manually controlling the appliances, they prefer to have them function in advance before they reach home (Hidayati, et al., 2018). Surprisingly, P5 = 'Smart Health' is ranked last, with a mean value of 3.96. In the study of Tian, et al. (2019), smart health systems have the potential to reduce the environmental impact of healthcare, such as through reduced paper usage, remote monitoring, increased resource efficiency, telehealth services, and others. However, the smart health system may have some critical reasons to be the last choice of smart home features. For instance, smart health systems rely largely on electronic devices, such as sensors, monitors, and servers, which, when they reach the end of their useful lives, can lead to electronic waste. This waste can have a negative effect on the environment if it is not disposed of appropriately. In addition, the energy consumption of smart health systems is quite high, particularly for data storage and transmission, resulting in greenhouse gas emissions and other negative environmental effects. The production and distribution of electronic devices and other components used in smart health systems can have a significant impact on the environment, such as the production of rare earth metals that can lead to habitat devastation and water pollution. As there are currently no globally acknowledged environmental standards for

smart health systems, it is difficult for healthcare providers and manufacturers to assess and make changes to the environmental impact of these systems. Although smart health systems have the potential to reduce the environmental impact of healthcare, additional efforts are required to ensure that the smart health devices are designed and operated in an environmentally responsible manner.

VII. CONCLUSIONS

In summary, the results were generated based on the data collected from 151 respondents in Sarawak, Malaysia. The overall response rate for this research is 75.50%. The top three benefits of the implementation of smart home features were: (1) improved quality of life; (2) efficient management of energy; and (3) better home-based healthcare services, especially for senior citizens and the disabled. Besides that, the top three types of smart home features that residents in Sarawak most prefer were: (1) security systems and safety controls; (2) smart household appliances; and (3) smart entertainment.

Objective 1: To outline the benefits of the implementation of smart home features in Malaysia

The top benefit is 'Improve Quality of Life' with a mean value of 4.28, and 'Potential Cost Savings and Benefits' with a mean value of 3.91. Both mean values showed a smaller difference, which proved that all the benefits studied and questioned in the questionnaire achieved the agreed level. As mentioned before, smart home features can improve the quality of life by increasing convenience, safety, and energy efficiency. In short, smart home features can enhance daily living, save time and money, and provide greater peace of mind. experience. The adoption of smart home features means that people no longer care about the price, but rather about their quality of life and how to improve it. Although the smart home features look friendly for seniors or the disabled, there are some obstacles that affect their decision to implement smart home devices. For instance, if using the AI to voice control the lighting system fails due to a power cut-off or a system error, the senior or disabled person may find it difficult to settle immediately without asking for help from others. The benefit of 'Better Home-based Healthcare Services Especially for Senior Citizens and Disabled' may consider as a critical point to promote smart home features, but there still consist of others threats or opportunities to implement it.

Objective 2: To explore the preferences of smart home features in Malaysia.

The preferences for smart home features provided by the respondents were ranked accordingly with the mean rank. The top three most significant preferences are 'Security System and Safety Control', 'Smart Household Appliances', and 'Smart Entertainment', with a range of mean values from 4.02 to 4.35. However, the least perceived preference is 'Smart Health', with a mean value of 3.96, but it is actually considered preferable as the value is greater than the neutral value, 3.00. As the safety issue was the first consideration of the barriers, there may be various solutions to prevent it by keeping upgrading the system to the latest, which can protect against viruses. As an aside, 'Smart Household Appliances' was the most recommended system to adopt smart features because it acts as the daily usage for every household, which may ease the house owner's burden or reduce the burden of housekeeping. However, 'Smart Health' with a low mean rank can be explained because it is still immature to implement for the residents and is more appropriate to adopt in the hospital or healthcare community to enhance the quality and accuracy of the diagnosis. The author admitted that all the preferences of the smart home features were very favourable in terms of which fields were required and desirable.

VIII. RESEARCH IMPLICATION

The fact that the development of intelligent homes is still a new trend in Malaysia cannot be denied, where customers are uncertain and have a tacit understanding of them as a result of consumer obstacles (Hidayati, et al., 2018). Therefore, it is essential to consider an identity the benefits of smart home feature that can affect the smart home features implementation. In addition, the results of the study assist the market for smart home features in determining the strategies to increase the smart home features implementation in Malaysia. Lastly, this study helps the Malaysian smart home market by gaining an understanding of consumer preferences for various smart home functionalities. This is because boosting the implementation of smart home features depends heavily on consumer preferences.

The findings will be useful for future marketing and development of smart home features in communities, as the product can be modified according to consumer preferences and take into account the factors that influence implementation and the barriers to implement. Therefore, understanding these factors can help to

promote and encourage the adoption of smart home features in Malaysia.

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