Chapter 1
A Study on the Adoption of Smart Home Technologies Among the Homeowners in Malaysia

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ABSTRACT

It is an undeniable fact that by implementing smart home technology (SHT), the quality of life for the occupants within can be improved for different aspects such as safety, leisure, comfort, and healthcare. However, it is discovered that Malaysians are highly reluctant in adopting SHT in their house. The research approach undertaken was quantitative method by sending questionnaire through emails. This research found the main key features of SHT are that they have high helpfulness level in improving the occupants' quality of life; the chapter lays out the main factors affecting the home buyers to adopt SHT and the main challenges exist staying in a smart home. Moreover, attractiveness and clear interface are both main factors affecting the smart homeowners to adopt SHT from the smart home users' perspective. However, poor operationality is rated as the most challenging limitation faced by the smart home users themselves. Also, poor operationality has the most significant influence on the smart home user's overall satisfaction level toward the smart home system.

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INTRODUCTION

In this current era, urbanized areas are rapidly being influenced by advanced technology to promote a more comfortable living environment to level up the quality of life of society. And in response to the above statement, smart home technology (SHT) is an emerging technology that catches the eyes of human civilization nowadays.

SHT incorporates common devices that control features of the home (Amri & Setiawan, 2018). A smart home can monitor the environment within a house and operates independently based on the data collected such as the user's behaviour pattern, the humidity of the surrounding, and the light intensity of the external environment.

SHT concept is only getting attention from the public over the last decade (Baharudin, 2019). The features that exist in a smart home provide equal benefits for people of all ages (Tee Wei, 2019). This technology is much more convenient and beneficial compared with a "traditional home" which needs to operate manually by the users themselves.

In short, the primary objective of SHT is to provide house automation, reduce environmental emissions and provide comfort to the occupants within (Gram-Hanssen & Darby, 2018).

BACKGROUND

Concept of Smart Home

Smart homes are homes that are equipped with sensors working towards monitoring different aspects such as the occupants' behaviour and the surrounding environment of the occupants. According to Kirsten and Sarah (2017), they pointed out that from an occupant's perspective towards a smart home, 'smarting' may be the integration of electrical devices such as lighting, security, and photovoltaic generation to function automatically in a house. According to Essiet, Sun, and Wang (2019), we are expecting the concept of a smart home to be evolving in line with the development of technology.

Key Features of a Smart Home

A smart home must-have features that aim to minimize human interaction and also minimizing the usage of energy to reduce pollutants and waste (Hargreaves, Wilson, and Hauxwell-Baldwin, 2018).

The first key feature is the smart home security feature. A smart home security feature is important as it can notify homeowners of any threats and problems as early as possible (Mohammad & Chad, 2019). With the technology integrated with the smart security feature, it can keep track of the homeowner's behaviour and habit, therefore has the capability of notifying the occupant whenever anything suspicious is being detected by the sensor (Amgad, Hammod, Suliman, 2020).

The next key feature of a smart home is the entertainment feature. The entertainment feature of a smart home provides interactive entertainment such as gaming, Smart TV, and various voice-command-based multimedia features (Bestoun, Miroslav, 2019). Smart entertainment feature does not serve as a mandatory functionality of a smart home, however, it provides excitement and increases the quality of life for the occupants within. (Alam, Khusaro, Naeem, 2017).

Furthermore, healthcare is also another key feature of a smart home. Healthcare is considered a significant part of daily life. Therefore, as technology develops, IoT can be integrated with healthcare appliances in a smart home as well (Lauren & Sherif, 2019). Smart healthcare appliances such as wearable sensors, smart kitchens, and environmental sensors can promote and monitor the health of the occupants within.

Furthermore, energy efficiency is another key feature of a smart home which is extremely beneficial for long-term cost savings for the smart home users themselves (Vishwakarma & Upadhyaya, 2019). By integrating IoT with the electrical appliances in a smart home, motion sensors can be used to detect and turns off electrical appliances automatically whenever someone leaves a room to save energy (Vishwakarma & Upadhyaya, 2019).

The last reviewed smart home's key feature in this research study is IoT based on smart appliances which refer to the integration of IoT with appliances in a smart home varies in types such as cleaning machines, refrigerators, television, robots, and many others (Haidawati, Feuead, Kushsairy, Sheroz, 2018). IoT-based smart appliances can maximize the convenience and comfort of the occupants in a smart home.

Factors Affecting the Adoption of Smart Home Technology Among Homeowners

According to Ng, Baharudin, Hussein, and Hilmi (2019), it is important to identify the factors affecting homeowners in deciding whether to adopt SHT in their homes in Malaysia.

The first main factor will be the attractiveness of SHT revolves around being a powerful tool to harness the power of IoT technology to perform various technological features which attracts the interest of home buyers to adopt SHT (Ng, Ahmad, Lubna, Hilmi, 2019). Some of the attractiveness includes the conveniency provided to the occupants, the cool-looking display feature, and the long-term cost-saving feature.

The next factor affecting the smart homeowner to adopt SHT will be the clear interface of a smart home. According to Fabi, Spigliantiti, and Corganati (2017), a clear, understandable, and simple interface is expected to be included in a smart home which is one of the main intentions of homeowners to adopt SHT in their house. A clear interface can enhance the living experience which is one of the main goals of the SHT (Jacob, 2018).

Furthermore, information accuracy is also one of the factors affecting the home buyers to adopt SHT. Information accuracy is always one of the main factors in determining how well a sensor system of a smart home is (Marco, 2018). Sensors and beacons are the basic elements of a smart home that plays an essential role in detecting and transmitting information throughout the smart home system. For the sensors to possess maximum benefit to the users themselves, they need to be precise and accurate (Mohammad, Yousef, Ahmad, Ismael, 2019). Therefore, information accuracy is one of the factors affecting the homeowners to adopt SHT.

Besides, the self-satisfaction factor is also one of the main factors affecting the home buyers to adopt SHT. According to Debajyoti, Tuul, and Suree (2017), one of the main factors affecting smart homeowners to adopt SHT is the SHT being able to satisfy their desire in improving their quality of life. This is also agreed by Hidayati, Mokhtar & Ismail (2018), stating that most of the occupants are expected the SHT to be able to enhance the quality of their life to their self-satisfaction.

The next factor affecting the intention of home buyers to adopt SHT is perceived security. According to Ng, Baharudin, Hussein, and Hilmi (2019), perceived security is also one of the main factors for the intention of smart homeowners to adopt SHT in their house. As the maturation of security technology

keeps advanced for the past few decades, the security system is becoming a huge concern to occupants of smart homes (Mohammad & Chad, 2019).

Lastly, the last factor reviewed in this research study is perceived privacy. Privacy in a smart home focuses on preventing the leakage of personal information of users, such as locations, preferences, identity, photos, videos, and movement (Supriya, Vikas, 2019). Therefore, a good privacy system for a smart home can protect the user's private information. According to Ng, Baharudin, Hussein, and Hilmi (2019), perceived security impacts positively the intention of homeowners to adopt SHT in their houses.

Limitations and Constraints Living in a Smart Home

smart home provides home automation which benefits the occupants a lot in daily life. According to Bernheim, Bongshin, Ratul, Sharad, Stefan, and Colin (2016), the majority of smart homeowners are quite positive about their experience staying in a smart home. However, there are still constraints and challenges met by the occupants while staying in a smart home.

The first challenge reviewed in this research study is the high ownership cost. Smart home costs a great deal at the initial installation stage (James, 20). The monetary cost for the installation of smart homes is relatively higher than normal homes. According to a research study conducted by Bernheim, Bongshin, Ratul, and Sharad (2016), the high initial installation cost is one of the main challenges in the opinion of smart homeowners.

The next challenge is inflexibility. One of the main challenges of living in a smart home is the inflexibility of the smart home systems (Suha & Khalil, 2019). According to Menachem (2019), smart home users are expecting the integration of different brands of appliances in a smart home. Therefore, if there are difficulties in the integration of different brands, it possesses a challenge to the smart home users themselves. Besides, the requirement for structural changes with the SHT installation is also considered one of the inflexibilities of a smart home.

Furthermore, poor operationality is also one of the challenges met staying in a smart home. Regular interaction and maintenance of smart appliances are daily interactions of the smart home users with the SHT itself. According to Asmah, Basarudin, Yusoff, and Dahlan (2019), smart home users are facing various challenges and issues in the daily operation of the smart automation system such as the sudden unresponsiveness of some of the smart appliances themselves. The unpredictable behaviour of smart appliances is a great challenge which is facing by smart home users themselves.

The last challenge of staying in a smart home reviewed in this research study is privacy and security issues. As most smart homes integrate IoT technology as a platform for various smart appliances to be connected, despite the advantages of IoT technology, there are still security limitations and challenges that need to be faced by smart home users. Since the scope of IoT technology is wide, there are a lot of security issues that need to be taken note of in aspects such as data storage, wireless sensor networks, performance, and privacy protection (Joseph, Andreas, Paul, 2016). Therefore, security and privacy issues are also the main challenges that smart home users are facing nowadays.

PROBLEM STATEMENT

SHT is expected to be widely implemented by occupants since it is aimed to maximize the quality of life of occupants. However, according to a study conducted by Leeraphong, Papasratorn & Chongsuphajaisid-

dhi (2016), the adoption rate of SHT is generally low in developing Asia countries including Malaysia, this survey was done in the year 2020-2022. Most Malaysians are reluctant to implement SHT in their house due to different factors concerning them (Asmah, Basarudin, Zuryati, Nuarral, 2018). According to a study conducted by Mokhtar and Ismail (2018), there are still several questions remaining unsolved regarding the adoption of SHT among homeowners in Malaysia. These questions contribute to the low implementation rate of SHT in Malaysia.

According to Fabi (2017), most Malaysians do not know how well-versed the facilities of a smart home should have to be recognized as a smart home. Currently, in Malaysia, there is still no specific statute stipulating the basic elements of a smart home (Asmah & Baharudin, 2018). Therefore, most home buyers do not know what is the helpfulness level of the key features of a smart home in improving their quality of life.

Next, many homeowners are wondering if it is worth implementing SHT in their homes in this current era (Asmah, Basarudin, Yusoff, Mahathir, & Nuarrual, 2018). The main factors affecting smart homeowners in adopting SHT in Malaysia are not known publicly. Therefore, the majority of house owners are not confident in implementing SHT due to their uncertainty about the satisfactory level of implementation of SHT.

Next, the challenges and limitations that exist when staying in a smart home are not known publicly as well (Tom & Richard, 2017). Therefore, this decreases the confidence level of homeowners in Malaysia to adopt SHT in their houses. It is an undeniable fact that any homeowners that do not experience SHT before will have perceptions and concerns about confidence issues in the implementation of SHT in their homes. An individual will only have confidence in the implementation of SHT after he/she understands all information on the SHT concept. Malaysia still has a lot of room of understanding the perception of occupants before the SHT is widely implemented among homeowners.

AIM, OBJECTIVES, AND HYPOTHESES OF THE STUDY

The primary aim of this research is to study the adoption of SHT among homeowners in Malaysia. According to Mokhtar and Ismail (2018), research and academic studies that explain the adoption of SHT among homeowners are lacking in Malaysia. Therefore, this study intends to fill this gap in the contexts of "helpfulness of SHT", "factors influencing the SHT adoption" and "perception of occupants towards the SHT problems", by carrying out the following objectives below:

This study strives to attain the following objectives:

1. To recognise the helpfulness level of key features in a smart home in improving the quality of life from the user's perspective.
2. To evaluate the factors influencing homeowners to adopt smart home Technology
3. To identify the perception of occupants towards the problems faced after the implementation of smart home Technology in their home

Further from the literature, age was pointed out by many researchers, including Amgad, Hammod, Suliman, (2020), Asmah & Baharudin, (2018). Mokhtar and Ismail (2018), and Fabi (2017), mentioned that age is strongly affecting the users in the operation, installation, and usage of SHT. Therefore, it

brings the define of the following hypothesis. The hypotheses that are related to the objectives of this research is as the following:

H1. The higher the age of smart home users, the higher the investment of time is needed to manage and operate the smart home system.
H2. The higher the age of smart home users, the more burdensome and troublesome the user will feel towards the installation process.
H3. The higher the age of smart home users, the lesser they have the knowledge on the usage of the smart home system.

RESEARCH METHODOLOGY

Data Collection Method

The methodological approach used in this research is a quantitative approach. An online survey questionnaire is used to collect the primary data from the target respondents which is the smart homeowners in Malaysia.The sample size of this study is 384 number by using the sample size formula intruduced by Krejcie and Morga (1970). Meanwhile, the target respondents of the study are the smart home end users. Simple random sampling and snowball sampling will be used to collect the data from a predetermined sample size within a fixed deadline of one month for the data collection period.Only close-ended questions were prepared in the questionnaires. Section A is the demographic section, and Sections B, C, and D are sections for questions related to the 1st objective, 2nd objective, and 3rd objective respectively in this research. A 1-10 interval scale format is used for the respondents to indicate their opinion on the questions asked in sections B,C and D. All the questionnaire questions were tested with a pilot study among the students in the campus to develop the following questions. The questions were properly developed to ensure that it could have a acceptable reliability and normality to ensure a significant dataset for all.

Design of Questionnaire

Section B questionnaire focuses on the perception of smart home users towards the helpfulness of key features in a smart home in improving the quality of life. Therefore, in this section, respondents are required to answer several questions that are related to the helpfulness of a smart home's key features in helping them to improve their quality of life. The respondents are required to answer several questions based on 1-10 scale (Not helpful to Very Helpful) to reflect their perception towards the helpfulness of each key feature. There are 15 questions asked in section B and the questions are grouped into 5 categories. The categories namely, Security Features, Entertainment Features, Healthiness Features, Energy Efficient Features, and IoT Based Household Smart Appliances, One example of the survey question for Security Features is written as "A2 - Describe your opinion on helpfulness level of a smart digital door lock". Next, one example of the survey question for Entertainment Features is written as "B1-Describe your opinion on the helpfulness level of a Smart TV". All the other questions, 15 of them in total, can be seen in Table 2 from Key Findings in Relation to Objective 1 subtopic.

Next, section C of the questionnaire focuses on questions that aimed to obtain data on the perception of smart home users towards the factors influencing them to adopt smart home Technology in their house.

Same as In Section B, the respondents are required to answer several questions based on a 1-10 scale (Not agree to Strongly Agree) to indicate which are the factors influencing them the most to stay in a smart home. There are 20 questions asked in section C and the questions are grouped into 6 categories. The categories namely, Attractiveness, Clear Interface, Information Accuracy, Self-Satisfaction, Perceived Security, and Perceived Privacy. One example of the survey question for Attractiveness is written as "F2 - I choose to adopt smart home system due to the high quality of attractive display system". Next, one example of the survey question for Information Accuracy is written as "H1- I choose to adopt smart home system because the environmental sensors give real-time information on the weather condition to me". All the other questions, 20 of them in total, can be seen in Table 4 from Key Findings in Relation to Objective 2 subtopic.

Lastly, section D of the questionnaire focuses on questions that aimed to obtain data on the perception of smart home users towards the challenge and limitations met when staying in a smart home. Same as in Section C, the respondents are required to answer several questions based on a 1-10 scale (Not agree to Strongly Agree) to indicate which are the challenges and limitations that bother them the most when staying in a smart home. There are 14 questions asked in section D and the questions are grouped into 4 categories. The categories namely, High Ownership Cost, Inflexibility, Poor Operationality, and Difficulty in Achieving Privacy and Security. One example of the survey question for High Ownership Cost is written as "M1 – The initial cost of adopting smart home Technology is high". Next, one example of the survey question for Inflexibility is written as "N1 - It is not easy for me to integrate different brands of smart appliances." All the other questions, 14 of them in total, can be seen in Table 5 from Key Findings in Relation to Objective 3 subtopic.

Data Analysis Method

Both descriptive analysis and inferential analysis will be used to analyse the data collected for this research. For descriptive analysis, a comparison of mean and ranking of Relative Importance Index (RII) methods will be used. For inferential analysis, the reliability test, correlation test, and multiple regression test will be used to analyse the relationship between independent variables and dependent variables of this study using statistical software named as Statistical Package for Social Science (SPSS).

FINDINGS

Demographic Profile

A total of 3840 sets of questionnaires were sent out to smart homeowners in Malaysia, a number of 10 times the sample size of the respondents. However, within the defined one-month time frame for the data collection period given to this study,a result 182 participants responded to the questionnaires within the defined time frame.

Key Findings in Relation to Objective 1

Table 2 shows the results on the opinion of the respondents towards the helpfulness level of key features of a smart home in improving their quality of life.

Table 1. Demographic analysis

No.	Demographic	Frequency	Percentage
1	**Gender**		
	Male	93	51%
	Female	89	49%
2	**Age Group**		
	20-30	57	31%
	30-40	53	295
	40-50	55	30%
	50-60	17	10%
3	**Status**		
	Single	50	28%
	Married with child	118	65%
	Married without child	14	7%
4	**No. Years staying in a smart home**		
	Below 1 Year	37	20%
	1-3 Years	98	54%
	4-6 Years	47	26%
5	**Type of smart home system**		
	Hardwired	6	3%
	Wireless	105	58%
	Partial	71	39%

For Security Feature (A), smart digital door lock (A2) and surveillance system (A3) are ranked 1st followed by smart fire detection system (A1) which is ranked 2nd. For Entertainment Feature (B), Smart TV (B1) is ranked 1st followed by smart speaker (B2) and smart display (B3) which are both ranked 2nd. For Healthiness Feature (C), wearable sensor (C1) is ranked 1st followed by environment sensors (C3) which is ranked 2nd and smart kitchen (C2) which is ranked 3rd. For energy-efficient feature (D), the smart AC system (D3) is ranked 1st followed by smart lighting (D1) and smart plugs (D2) which both ranked 2nd. Lastly for IoT-based household smart appliances, the smart coffee maker (E3) is ranked 1st followed by smart robots (E2) which is ranked 2nd and smart refrigerator (E1) which is ranked 3rd.

From the 1-10 scale (Not Helpful to Very Helpful) being rated by the respondents, the energy efficient feature (D) has the highest overall mean value of 9.10 and is ranked 1st among other main key features. This means that in the opinion of the smart home users, the energy efficient feature is the most helpful key feature in improving their quality of life. This is agreed by Vishwakarma and Upadhyaya, Kumari, and Mishra (2019) stating that energy efficiency is one of the most important features which attracts most of smart home users. Especially in Malaysia where the electricity tariff is relatively higher than in other countries such as Singapore, energy-efficient features will be emphasized more by the smart home users.

Next, security feature (A) is ranked 2nd with an overall mean value of 8.67. This means that smart home users think that the security feature is the second most helpful feature in improving their quality of life. This is also supported by Bernheim, Bongshin, Ratul, and Sharad (2016) stating that home buyers

Table 2. Descriptive Analysis on the Helpfulness of Key Features of a smart home in improving the Occupants' Quality of life

	Variables	1-10 Scale (Not Helpful to Very Helpful)					
		N	Mean	RII	Rank	Overall Mean	Overall Ranking
Key Feature: Security Feature						8.67	2
A1	Smart Fire Detection System	182	8.31	0.32	2		
A2	Smart Digital Door Lock	182	8.80	0.34	1		
A3	Surveillance and Automation System	182	8.90	0.34	1		
Key Feature: Entertainment Feature						8.27	3
B1	Smart TV	182	8.51	0.34	1		
B2	Smart Speaker	182	8.13	0.33	2		
B3	Smart Display	182	8.17	0.33	2		
Key Feature: Healthiness Feature						6.82	5
C1	Wearable Sensors	182	7.19	0.35	1		
C2	Smart Kitchen	182	6.43	0.31	3		
C3	Environmental Sensors	182	6.86	0.33	2		
Key Feature: Energy Efficient Feature						9.10	1
D1	Smart Lighting	182	9.08	0.33	2		
D2	Smart Plugs/ Smart Sockets	182	9.03	0.33	2		
D3	Smart AC system	182	9.18	0.34	1		
Key Feature: IoT Based Household Smart Appliances						7.29	4
E1	Smart Refrigerator	182	6.64	0.30	3		
E2	Smart Robots	182	7.45	0.34	2		
E3	Smart Coffee Makers	182	7.79	0.36	1		

are emphasizing the security feature of a smart home nowadays. Although Malaysia is a relatively safe country, however by having security features installed in a smart home, the homeowners will feel more secure and relaxed staying in a smart home.

Entertainment feature (B) is ranked 3rd with an overall mean value of 8.27. Entertainment feature comes after energy efficiency and security features as entertainment are just feature that facilitate a better comfortable environment for the smart home users. This is agreed by Bestoun & Miroslav (2019) stating that the entertainment feature is exciting and is expected to be included in a smart home to be more interactive with the homeowners. However, the entertainment feature is not a necessity for all smart home users.

Next, IoT-based household smart appliances (E) is ranked 4th with an overall mean value of 7.29. Smart household appliances is ranked as the second bottom feature due to it being able to be adopted individually. According to Haidawati, Fuead, Kushsairy, and Sheroz (2018), smart appliances such as smart robots or smart cleaning machines are appliances that are commonly being adopted in normal homes. Therefore, smart household appliances are not considered as a peculiar feature of a smart home which is important in improving the quality of life in the opinion of smart home users.

Lastly, the healthiness feature is ranked last (5th) by the respondents with an overall mean value of 6.82. It means that from the perception of smart home users, the healthiness feature is the least helpful key feature in improving their quality of life. This is agreed by Jia, Liu, Jiang, Wu, and Wang (2020) stating that although the smart home system can enhance the healthiness of the users themselves. However, most of the smart home users don't see this as an important feature in a smart home. In the perspective of health, it is important to seek medical advice from the medical doctor instead of relying on the technological tools that are approved by the Ministry of Health. As such, healthiness tools is rather contribute little in assisting the house owners.

Comparison of Overall Mean Value between Male and Female Respondents

The overall mean value of the key feature in a smart home obtained will be analysed and compare between male and female respondents to provide a clearer view of the difference of perception between male and female respondents towards the helpfulness level of smart home key features.

Table 3 shows that the difference in the mean value obtained for Security Feature (A), Energy Efficient Feature (B), and IoT-based Household Smart Appliances (E) are not of a huge difference. This means that both male and female respondents have the same level of opinion regarding the helpfulness level of key features A, B, and E.

For the Entertainment feature (B) and Healthiness feature (C), male respondents have a relatively higher mean value compared to female respondents. This means that the opinion male respondents, they think that both of the mentioned features has a higher level of helpfulness in improving their quality of life compared to the opinion of female respondents. This is agreed with Singh, Pyschoula, Kropf, Hanke, and Holzinger (2018), stating that male smart home users tend to have more interest in adopting high-end technology devices in a smart home. Where this finding is in generally correct, as everyone know men are having higher interest in technology things such as cars, machineries, tools and gadget.

Key Findings in Relation to Objective 2

Table 4 shows the results on the opinion of the respondents regarding their level of agreement towards the factors affecting them to adopt SHT. For attractiveness factor (F), conveniency provided by smart appliances (F1), energy efficiency provide (F4) and long-term cost saving (F5) is ranked 1st followed by good-looking display feature (F2) and high-end technology smart appliances (F3) which are both

Table 3. Comparison of the overall mean value for helpfulness level of key feature of a smart home between male and female respondents

	Key Features of a smart home	Mean Value		Difference of mean
		Male	Female	
A	**Security Features**	8.59	8.74	(0.15)
B	**Entertainment Features**	9.64	6.83	2.81
C	**Healthiness Features**	7.53	6.08	1.45
D	**Energy Efficient Feature**	9.07	9.12	(0.05)
E	**IoT based Household Smart Appliances**	7.35	7.23	0.12

Table 4. Descriptive analysis of the factors affecting smart home users in adopting smart home technology

	Variables	1-10 Scale (Not Agree to Strongly Agree)					
		N	Mean	RII	Rank	Overall Mean	Overall Ranking
Main Factor: Attractiveness						8.94	1
F1	Conveniency provided by smart appliances	182	9.13	0.20	1		
F2	Good-looking display features	182	8.79	0.19	2		
F3	High-end technology smart appliances	182	8.82	0.19	2		
F4	Energy Efficiency provided by smart appliances	182	8.98	0.20	1		
F5	Long term cost saving	182	8.97	0.20	1		
Main Factor: Clear Interface						8.54	2
G1	Clear interface system for easy understanding	182	8.70	0.25	1		
G2	Multiple system of a house can be displayed at once	182	8.47	0.25	1		
G3	User friendly and saves time	182	8.64	0.25	1		
G4	Flexibility of controlling appliances	182	8.36	0.25	1		
Main Factor: Information Accuracy						6.67	5
H1	Sensors within a smart home giving a real time information	182	6.14	0.46	2		
H2	Allow user to detect danger or threat immediately	182	7.20	0.54	1		
Main Factor: Self-Satisfaction						7.87	4
J1	smart home provides a comfort living environment	182	9.08	0.29	1		
J2	Smart appliances saves human effort and time	182	8.88	0.28	2		
J3	Provides convenience to the elderly	182	7.12	0.23	3		
J4	Enhances healthiness of users	182	6.41	0.20	4		
Main Factor: Perceived Security						8.03	3
K1	smart home sensors can always monitor the surroundings	182	8.14	0.34	2		
K2	smart home Technology network is not easy to be hacked	182	7.52	0.31	3		
K3	Smart Door Lock system maximises the security of occupants	182	8.42	0.35	1		
Main Factor: Perceived Privacy						5.36	6
L1	User's personal data are protected by the security system of SHT network	182	5.30	0.33	2		
L2	The whereabouts of the users are kept confidential	182	6.03	0.37	1		
L3	All software and appliances controller are password protected	182	4.76	0.30	3		

ranked 2nd. For the Clear Interface factor (G), all 4 items; clear interface system for easy understanding (G1), multiple system of a house can be displayed at once (G2), user friendly and saves time (G3), and flexibility of controlling appliances (G4) are all ranked 1st. For the Information Accuracy factor (H), allowing the user to detect danger or threat immediately (H2) is ranked 1st followed by sensors giving real time information (H1) which is ranked 2nd. For Self-Satisfaction factor (J), smart home provides a comfortable living environment (J1) is ranked 1st, followed by Smart appliances saving human effort and time (J2) which is ranked 2nd, provides conveniency to the elderly (J3) which is ranked 3rd and lastly enhances the healthiness of users (J4) which is ranked 4th. For the Perceived Security factor (K),

the smart door lock system maximizes the security of occupants (K3) is ranked 1st, followed by smart home sensors can always monitor the surroundings (K1) which is ranked 2nd, and SHT network is not easy to be hacked which is ranked 3rd. For Perceived Privacy factor (L), the whereabouts of the users are kept confidential (L2) is ranked 1st, followed by user's personal data are protected by the security system of SHT network (L1) which is ranked 2nd and lastly all software and appliances controller are password protected (L3) which is ranked 3rd.

From the 1-10 scale (Not Agree to Strongly Agree) being rated by the respondents, the attractiveness factor (F) is ranked 1st with an overall mean value of 8.94. This means that in the opinion of the smart home users, factor F has the highest level affecting their decision in adopting SHT. This finding is agreed by Ng, Baharudin, Hussein, and Hilmi (2019) stating that the attractiveness of a smart home is its unique feature which is not commonly found in a normal home. Therefore, the finding of attractiveness being the most affecting factor is logical. Product attractiveness in interaction with decision-making style influences purchase intentions. Buyers are using an emotional decision-making style condition, they have higher purchase intentions for the high attractive product than the low attractive product (Francisco, Marcel, Rolando, 2022).

Next, clear interface (G) is ranked 2nd with an overall mean value of 8.54. This means that in the opinion of smart homeowners, a clear interface is the second most affecting factor for the homeowner to adopt SHT. This finding is expected and is agreed by Fabi, Spigliantiti, and Corgnati (2017) stating that smart home users are adopting the smart home system due to its user-friendly interface system.

Next, perceived security (K) is ranked 3rd with an overall mean value of 8.04. This means that security feature is still considered as a high affecting factor for home buyers to adopt SHT.

This finding is agreed by Ng, Baharudin, Hussein, and Hilmi (2019) stating that perceived privacy is one of the main factors for the intention of homeowners to adopt SHT in their house as a good security system installed can make the occupants within to feel more secure.

Next, self-satisfaction (J) is ranked 4th with an overall value of 7.87. This means the respondents have a moderate agreement level on self-satisfaction being their intention to adopt SHT. This finding is logical as stated by Fabi, Spigliantiti, and Corgnati (2017) stating that the mandatory feature of a smart home is to interact with the occupants within instead of just aiming to create a comfortable environment.

Next, information accuracy (H) is ranked 5th with an overall mean value of 6.67. This means that the respondents have a lower level of agreement on information accuracy being their intention to adopt SHT compared to the other factors. This finding is logical as most of homeowners have a higher consideration level for the functionality of a smart home instead of the accuracy of the information conveyed itself.

Lastly, perceived privacy (L) is ranked the last (6th) with an overall mean value of 5.36. This means that from the perspective of smart home users, factor L has the lowest affecting level on their intention to adopt SHT. This finding is agreed by Zheng, Apthorpe, Chetty, and Feamster (2018) stating that most smart home users are not confident with the privacy system of a smart home system. Most of the devices in your smart home will use your router for internet access. If a hacker can break into your router, they can potentially view the data from everything connected to it (Ng, Baharudin, Hussein, and Hilmi, 2019).

Key Findings in Relation to Objective 3

Table 5 shows the results on the opinion of the respondents regarding their level of agreement towards the challenges and limitations of staying in a smart home. For the high ownership cost challenge (M), the low perceived value of smart appliances (M3) is ranked 1st, followed by the huge investment of time

Table 5. Descriptive analysis on the challenges and limitations living in a smart home

	Variables	1-10 Scale (Not Agree to Strongly Agree)					
		N	Mean	RII	Rank	Overall Mean	Overall Ranking
Main Challenge: High Ownership Cost						5.69	3
M1	High initial cost	182	4.88	0.29	3		
M2	Huge investment of time is needed	182	5.72	0.34	2		
M3	Low perceived value of smart appliances	182	6.47	0.37	1		
Main Challenge: Inflexibility						5.37	4
N1	Difficulty in integrating different brand of smart appliances	182	5.61	0.26	3		
N2	Structural changes needed	182	3.49	0.16	4		
N3	Complicated installation of appliances	182	6.38	0.30	1		
N4	Lack of knowledge towards the usage of SHT	182	6.02	0.28	2		
Main Challenge: Poor Operationality						6.27	1
O1	Unexpected responsiveness of the system	182	5.89	0.31	3		
O2	Complex user interfaces	182	6.02	0.32	2		
O3	Expert consultants are needed	182	6.90	0.37	1		
Main Challenge: Privacy and Security Issue						5.76	2
P1	Presence based access appliances are easily being accessed by anyone	182	5.42	0.24	3		
P2	Privacy data stored in the IoT system is easily being leaked	182	6.05	0.26	2		
P3	Temporary access issue (such as giving temporary access is dangerous)	182	5.40	0.23	4		
P4	Remote access issue (controlling main gate with software is dangerous)	182	6.14	0.27	1		

is needed (M2) which is ranked 2nd, and the high initial cost (M1) which is ranked 3rd. For inflexibility challenge (N), complicated installation of appliances (N3) is ranked 1st, followed by lack of knowledge towards the usage of SHT (N4) which is ranked 2nd, difficulty in integrating different brands of smart appliances which is ranked 3rd and structural changes are needed (N2) which is ranked 4th. For poor operationality challenge (O), Expert consultants are needed (O3) is ranked 1st, followed by complex user interfaces (O2) which is ranked 2nd and unexpected responsiveness of the system (O1) which is ranked 3rd. For privacy and security issue challenge (P), remote access issue (P4) is ranked 1st, followed by privacy data stored in the IoT system is easily being leaked (P2) which is ranked 2nd, presence-based access appliances are easily being accessed by anyone (P1) which is ranked 3rd and temporary access issue (P3) which is ranked 4th.

From the 1-10 scale (Not Agree to Strongly Agree) being rated by the respondents, poor operationality (O) is ranked 1st with the highest overall mean value of 6.90. This means that from the perception of the smart home users, the level of agreement on poor operationality (O) exists as a challenge living in a smart home is the highest compared to other main challenges. This is also agreed by Ibrahim and Khalil (2019) stating that smart homeowners have high expectations on their daily interaction with the smart home system. Therefore, with poor operationality being a daily interaction challenge, it is logical for it to be rated as the biggest challenge of staying in a smart home.

Next, the main challenge which is ranked 2nd is privacy and security issue (P) with an overall mean value of 5.76. This finding is agreed by Bernheim, Bongshin, Ratul, and Sharad (2016) stating that with the current IoT-based smart home system, it is difficult to achieve full privacy and security for the occupants within. Therefore, it is logical as well for privacy and security issue (P) to be ranked as the 2nd highest level of agreement by the respondents towards it being a challenge in a smart home.

Next, the main challenge which is ranked 3rd is high ownership cost (M) with an overall mean value of 5.69. This means that in the opinion of the respondents, they have a lower agreement level on high ownership cost being the main challenge of a smart home. This finding is logical and agreed by James (2020) stating that although the initial installation cost for smart home is high.However, the smart home system provides long-term benefits to the smart home users themselves.

The last main challenge which is ranked 4th is inflexibility (N) which has the lowest overall mean value of 5.37. This means that the respondents have the lowest level of agreement towards inflexibility being the main challenge in staying in a smart home.

With technology nowadays, it is easy to integrate different brands of smart appliances in a smart home (Khalil, Ibrahim, 2019). Meanwhile, with IoT smart home systems being commonly adopted nowadays, structural changes are not needed anymore for the installation of a smart home system. Therefore, it is logical for inflexibility to have the lowest level of agreement of it being a challenge to stay in a smart home.

Comparison of Overall Mean Value Between Hardwired and Wireless Smart Home System

The overall mean value of the main challenges in a smart home obtained will be analysed and compared between hardwired and wireless smart home systems to provide a clearer view of the difference of perception between hardwired and wireless smart home users.

Table 6 shows the difference in overall mean value for poor operationality (0) is small with a slight difference of only 0.30. This means that both hardwired and wireless smart home users have the same level of agreement towards poor operationality (O) being a challenge staying in a smart home.

For high ownership cost (M) and Inflexibility (N), a hardwired system has a higher overall mean value compared with a wireless system. This means that hardwired smart home users have a higher level of agreement towards the main challenge M and N being a challenge staying in a smart home. This finding is logical and agreed by Teddy and Rahmithul (2017) stating that due to the need of installing wires throughout the hardwired smart home system, the cost needed for the installation will be high, and structural changes might be needed for the installation of wire which is inflexible.

Table 6. Comparison of overall mean value for agreement level of challenges staying in a smart home between Hardwired and Wireless System

	Challenges staying in a smart home	Mean Value		Difference of mean
		Hardwired	Wireless	
M	High ownership cost	7.50	5.73	1.77
N	Inflexibility	6.79	5.51	1.28
O	Poor Operationality	6.27	6.57	(0.30)
P	Privacy and Security Issue	5.13	6.09	(0.96)

For privacy and security issue (P), a wireless system has a higher overall mean value compared with a hardwired system. This means that wireless smart home users have a higher level of agreement towards privacy and security issue (P) being a challenge staying in a smart home. This finding is logical as stated by Khalil and Suhu (2019), due to the usage of a wireless smart home system, all data are transmitted using SHT network which might cause the leakage of smart home user's personal data.

Hypotheses Testing With Inferential Analysis

Reliability Test

Table 7 shows the result of reliability test for independent variables and dependent variables that will be analysed using correlation and multiple regression test under the later sections. The result shows all Cronbach's Alpha value of independent and dependent variables are above 0.70. Hence, all of the variables are in good reliability.

Normality Test

The normality test was conducted using skewness and kurtosis measurement. It is thus concluded that the data to be used for correlation and regression test are symmetric because the skewnss and kurtosis values are both lesser than +-2.00 for all the dimensional constructs and items of the study (George and Mallery (2010).

Table 7. Reliability test of the variables

Type	Variable	Cronbach's alpha	Reliability
Independent	M1. High initial cost	0.841	Very good
Independent	M2. Huge investment of time	0.795	Good
Independent	M3. Low perceived value of smart appliances	0.805	Very good
Independent	N1. Hard to integrate different brands of appliances	0.809	Very good
Independent	N2. Structural changes needed	0.829	Very good
Independent	N3. Complicated installation of appliances	0.800	Very good
Independent	N4. Lack of knowledge towards the usage of SHT	0.803	Very good
Independent	O1. Unexpected responsiveness of the system	0.843	Very good
Independent	O2. Complex user interface	0.834	Very good
Independent	O3. Expert consultants are needed	0.833	Very good
Independent	P1. Presence based access	0.795	Good
Independent	P2. Privacy data easily being leaked	0.811	Very good
Independent	P3. Temporary access issue	0.794	Good
Independent	P4. Remote access issue	0.799	Good
Dependent	Overall satisfaction level of the usage of smart home	0.833	Very good

Table 8. Normality test with skewness and kurtosis

Variables	Skewness		Kurtosis	
	Statistic	Sd. Error	Statistic	Std. Error
M2	-.241	.180	-1.318	.358
N2	-.449	.180	-.878	.358
N4	-.206	.180	-.920	.358
High Ownership Cost - M	-.031	.180	-.764	.358
Inflexibility – N	-.320	.180	-.562	.358
Poor Operationality – O	.186	.180	.286	.358
Privacy Security - P	-.299	.180	-.384	.358

Correlation Test

A correlation test is being carried out to justify the hypotheses of this research study. The relationship between the age group of smart home users and their level of agreement on items M2, N3, and N4 will be analysed using correlation test.

According to Deng, Deng and Cheong (2021), the higher the Pearson's correlation coefficient, it means that the higher an independent variable correlates with a dependent variable. Table 9 shows the result of the correlation test being carried out to identify the relationship between the age group of respondents and items M2, N3, and N4. According to the results shown, item N3 has the highest Pearson correlation value which is 0.885, followed by item N4 which is 0.869, and lastly which is item M2 which is 0.693.

Item N3 (The installation process is burdensome and trouble) has the steepest corelation line which further justifies the finding obtained in Table 9 which has the highest Pearson correlation value to the age group of respondents. On the contrary, item M2 (Huge investment of time is needed to manage and operate smart home system) has the least steep correlation line which also further justify the finding obtained in Table 9 which shows the lowest Pearson correlation value to the age group of respondents.

The result valuemeans that for every increment of the scale by 1 for the age group of respondents, it will affect 88.5% of item N3, followed by 86.9% for item N4, and lastly 69.3% of item M2. All of the Pearson Correlation is in positive value which means the age of respondents is affecting all 3 items positively. This finding is also agreed by Pal, Funilkul, Vanijja and Papasratorn (2018). According to their research study focusing on analysing the elderly user's adoption towards smart home system, the

Table 9. Correlation test between the age group of respondents & items M2, N3 and N4

		Value
M2: Huge investment of time	Pearson Correlation Significant Value	0.693 <0.001
N3: Complicated installation of appliances	Pearson Correlation Significant Value	0.885 <0.001
N4: Lack of knowledge towards the usage of SHT	Pearson Correlation Significant Value	0.869 <0.001

Table 10. The accepted hypothesis of this research study

	Hypothesis	Status
H1	The higher the age of smart home users, the higher the investment of time is needed to manage and operate the smart home system	Accepted
H2	The higher the age of smart home users, the more burdensome and troublesome the user will feel towards the installation process	Accepted
H3	The higher the age of smart home users, the lesser they have the knowledge on the usage of smart home system	Accepted

outcome conclude that elder users tend to have different difficulties in managing smart home system. Hence, it can be concluded that all 3 hypotheses of this research study are accepted according to Table 10.

Multiple Regression Test

Multiple regression tests will be used to study and analyse on the relationship between the level of agreement on the main challenges of staying in a smart home and the overall satisfaction level of staying in a smart home. Hence, the result is expected to determine which challenge affects the overall satisfaction level of staying in a smart home the most from the smart home users' perspective.

Table 11 shows the results of multiple regression test on the overall satisfaction level of staying in a smart home with the 4 main challenges of staying in a smart home which is high ownership cost (M), inflexibility (N), poor operationality (O) and privacy and security issue (P).

According to the results shown, only poor operationality (O) is accepted and is considered due to its p-value of <0.001. According to Maheswari, Priyanka, Thangavel, Vignesh, and Poongodi (2020), when the p-value is above 0.05, it means that the variable is no longer significant and shall be rejected. Therefore, apart from poor operationality (O), the other 3 independent variables M, N and P are rejected.

For the only independent variable being accepted which is poor operationality (O), the regression coefficient (unstandardized coefficient Beta) of it is positive at 0.410 which means that poor operationality (O) is affecting the overall satisfaction level of staying in a smart home by 41%. This finding is logical and is supported by the research study conducted by Harshal, RPalundarkar, Surve, and Biswas (2018). In their study, they pointed out that any problems arising from the daily usage of smart appliances will directly affect the satisfaction level of smart home users. Hence, where poor operationality (O) is a challenge arising from the daily interaction of the smart home users with the smart home system itself, it is

Table 11. Multiple regression test on the overall satisfaction level of staying in a smart home

	Independent Variable	Unstandardized coefficient Beta	P-Value
	Constant	0.737	0.380
M	High ownership cost	0.095	0.553
N	Inflexibility	0.225	0.133
O	Poor Operationality	0.410	<0.001
P	Privacy & Security Issue	(0.167)	0.064

Dependent Variable: Overall Satisfaction Level

logical for it to be the most affecting challenge towards the overall satisfaction staying in a smart home from the opinion of the smart home users.

CONCLUSION

This study is set out to determine the adoption of SHT from the smart home users' perspective. One of the most significant findings is from the perception of smart home users, the energy-efficient feature has the highest level of helpfulness among other key features in improving their quality of life in a smart home. This means that smart home users in Malaysia are emphasizing the energy efficiency of their smart home.

And from the opinion of male smart home users, rated a higher helpfulness level towards entertainment features and healthiness features compared with female smart home users. This means that male users are usually more attracted to high-end technology appliances such as smart TV or smart wearable sensors.

Next, from the perception of smart home users, the attractiveness of a smart home is the highest level affecting them to adopt SHT. This means that the attractiveness of the smart home features actually attracts the smart home users to adopt SHT which is not commonly found in normal homes.

Next, for the challenges faced staying in a smart home, poor operationality is rated as the biggest challenge faced. This means that if any problem arises from the daily interaction of the smart home users with the smart home system itself, it will create a huge challenge for the smart home users themselves.

The next significant finding is the higher the age group of the smart home users, the higher their level of agreement towards the lack of knowledge on the usage of SHT, the investment of time needed to manage the SHT, and the burdensomeness of the installation of the SHT system. This means that the smart home system can still be improved further to be user-friendly to all age groups of users.

In hypotheses testing to understand the relationship between the users' age towards the investment of time is needed to manage and operate the smart home system, the burdensome and troublesome towards the installation process, the knowledge on the usage of smart home system, are all positively correlated with age of the users.

The last significant finding is poor operationality being the biggest affecting factor to the overall satisfaction level of smart home users staying in a smart home. As mentioned before, poor operationality arises when the smart home users are facing unpleasant experiences during their daily interaction with the smart home system itself. Hence, this finding is meaningful as it proves the importance of the operationality towards the satisfaction level of smart home users staying in a smart home.

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KEY TERMS AND DEFINITIONS

Efficiency: Efficiency is the ability to avoid wasting materials, energy, effort, money, and time in doing something or in producing a desired result.

Energy: Power derived from the utilization of physical or chemical resources, especially to provide light and heat or to work machines.

Occupants: A person who resides or is present in a building.

Operationality: The functional skill, capability, and capacity of a person or organization to perform certain duties, tasks, and obligations

Satisfaction: Satisfaction is getting a thing that brings gratification, pleasure, or contentment.

Smart-Home: A home equipped with lighting, heating, and electronic devices that can be controlled remotely by smartphone or computer.

Technology: The application of scientific knowledge for practical purposes, especially in industry.