



# An Exploration to Determine Essential Requirements for Smart Home Application

Fazilah Ismail, Sabrina Ahmad, Ummi Rabaah Hashim

**Abstract:** *The revolution of Internet of Things (IoT) will be able to revive the way people use the technology for a greater benefit. As we are embarking towards the golden age of technology, smart home application is gaining popularity as it adds convenience, comfort and peace of mind. There are variety of smart home applications worldwide which has diverse functionality with different perspectives and embedded assumptions. These scenario leads to uncertainty among the developers and leads to unnecessary effort to elicit requirements every time new application wants to be developed. Therefore, this paper presents an exploration to determine essential requirements for smart home application based on end user needs. An empirical investigation based on survey technique was conducted to determine essential requirements for smart home application. A case study of residents in Satellite City of Muadzam Shah, Pahang was conducted. The analysis was done by using T-Test and One Way Analysis of Variance (ANOVA). The results show that the respondents agreed the essential requirements for smart home application are Time Needs, Simplicity Needs, Security and Safety Needs and Mobility Needs.*

**Keywords:** *requirements engineering, essential requirements, smart home application*

## I. INTRODUCTION

A smart home is a home that is fully furnished with connected devices, appliances and sensors that can communicate with each other, and can be controlled remotely [1]. A smart home is defined as devices that are connected to each other and interact without any human intervention. The purpose of smart home development is to improve intelligence, have a comfortable lifestyle, safe and private and efficient energy saving at home. In relation to providing smart home facilities, more devices are provided in the market in a wide range of consumer technology such as accessories, audio, electronic gaming, fitness, health and biotech, internet services, robotics, sensors, smart homes, wearables, wireless devices and services.

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The latest trends have also become popular such as drones, virtual reality and augmented reality. A smart home is known as “intelligent” because it has a computerized system that enables controlling daily life centrally. Smart homes can be viewed such as the refrigerator becomes intelligent with the ability to inventory its contents by suggesting various menus and updating shopping lists, recommending and checking healthy alternatives, and automatically and routinely order groceries for busy households. The smart home systems might even ensure daily activities and hobbies such as automatically clean the cat litter box at certain times and a house plant system that enables watering automatically [2].

Growth in Internet of Things brings increased security risks and makes security essential, which requires a robust configuration in order to collect meaningful, reliable, and accurate data. Information of the system should not be visible to anyone except for a defined group of people [3]. In order to ensure our homes are safe and secure, security systems currently are able to connect to the house from anywhere through a smart-phone. The security systems can be furnished with smart touch screens, surveillance cameras, and motion sensors with auto detection, controlling and monitoring for 24 hours, environmental sensors for theft protection, emergency help, remote locking, and other devices. Moreover, the smart home attracts a wider range of consumers because of its potential safety and security matter that become high level and powerful.

A smart home concept is relatively new in Malaysia as many people lack of the knowledge about the concept and importance of smart homes in their daily life. Limited information regarding smart homes makes them uncomfortable and reluctant to improve their living style. The consumers also believe that a smart home system is costly and in need of high maintenance because of the devices operation and configuration. However, in reality, the smart home devices appear very easy to setup and are user friendly by just plug and play.

The purpose of this paper is to present a finding in an investigation to determine essential requirements for smart home application to forestall recurrent effort to develop similar system by developers. A survey technique is used to elicit the essential requirements from current and potential consumers in a housing area of Muadzam Shah, Pahang.

Following Introduction, Section II describes the methodology and followed by Section III which elaborates the findings. Section IV further elaborates on analysis and discussion. Finally, Section V concludes the paper.



## II. METHODOLOGY

This section explains the methodology to investigate the essential requirements for smart home application based on survey technique.

### A. Population and Samples

Sample respondents were identified from those living around Satellite Town in Muadzam Shah, Pahang. The housing area were new and most of the residents were professionals that make them have high potential to use smart home technology.

### B. Survey Questionnaires

The questionnaire comprised of three parts [4], which can be found in Appendix 1. The first part of the questionnaire contained demographic questions, such as gender, age, sex, occupation, and monthly income. The respondents were from various backgrounds to maintain the heterogeneity of the survey. The items in the questionnaire was adapted from a similar market survey related to the potential of a smart home application [5].

The second part of the questionnaire was designed to capture the consumers' familiarity and preferences on smart home application. It contains a combination of choice and structural questions related to the knowledge of respondents towards the smart home concept and the local demand of smart homes. The majority of these questions required the respondents to answer yes or no, and multiple choice questions. The multiple-choice questions consisted of three or more exhaustive, and mutually exclusive categories. The multiple choice questions asked for either single or multiple answers.

The third part was rating scale questions which were divided into five categories of requirements which are time, simplicity, security and safety and mobility. All the items used the 5-point Likert type scale whereby:

- 1 = strongly disagree;
- 2 = disagree;
- 3 = neutral;
- 4 = agree; and
- 5 = strongly agree.

### C. Data Collection

The questionnaire developed went through a pilot test to produce a better and reliable questionnaire. The pilot test was done with a few people in the neighboring area. The purpose is to ensure the validity and understanding of the questions among the sample in the same way. This is the very best practice in data collection method that enables to test and to verify the questionnaire to produce proper data collection [6].

Fifty sets of questionnaires were distributed to the respondents by hand and more were sent through Google form survey. After about two weeks, fifty-two feedback were returned for analysis.

## III. FINDINGS

This section presents demographic information and consumers' perspectives which derived from the first and second part of the survey questionnaire.

### A. Demographic Information

#### Gender

There were 52 respondents who participated in the survey. Among them, 32 of them which is 61.5% were female respondents.

#### Age group

The result shows that among 52 respondents, 18 are between 26-35 years old, 28 are between 36-45 years old and 6 are between 46-55 years old.

#### Marital status

Most of the respondents are married couple with children (86.5%), 3.8% are married couple without children and the rest are single.

#### Educational level

Among 52 respondents, about 48% has a bachelor degree, 36% has a master degree or higher and the rest has at least a certificate.

#### Personal income

Regarding personal income, about 25% of the respondents earn either RM2001-3000, RM3001-RM4000, RM4001-RM5000 and RM5001 above respectively.

#### Occupation

The population in the Satellite Town in Muadzam Shah, Pahang are mostly government servant and only 19% are working with private sectors.

### B. Consumers' Perspectives

The second part of the questionnaire survey depicts the consumers' perspectives towards smart home application. About 83% of the respondents acknowledge that they are familiar with smart home devices. As anticipated, not many of them are using smart home application since only 37% of the respondents installed smart home devices in their home. However, being asked if they are willing to adopt smart home application, 77% of the respondents said yes.

Considering which factors to consider when installing smart home application, usefulness appeared to be the most popular (30%) and closely followed by security (27%) and user friendly (24%) factors. According to the survey, price (19%) is the least factor to be considered when consumers decided to install smart home application. Besides, among smart lights, smart locks, smart garage door, CCTV and smart thermostat technologies, CCTV (27%) appeared to be the most popular and followed by smart locks (24%). According to the survey, smart thermostat (5%) appeared to be the least favourable technology. This may be due to tropical climate and no extreme temperature in Malaysia.

Referring to the survey results, the most influential motivation for consumers to adopt smart home application is safety (42%), followed by remote control (26%) and convenience (21%). Smart home application for saving is the least popular motivation as only 11% respondents vote for that.

Overall, consumers' perspective provided by this survey investigation gives an insight for the developers to focus on important factors and components preferred by potential consumers while developing smart home applications.

#### IV. ANALYSIS AND DISCUSSION

The third part of the questionnaire survey represents potential high level smart home application requirements. Several questions were designed to depicts the consumers' needs and they were grouped in generic requirements which are Time Needs, Simplicity Needs, Security and Safety Needs and Mobility Needs.

##### A. Descriptive Analysis

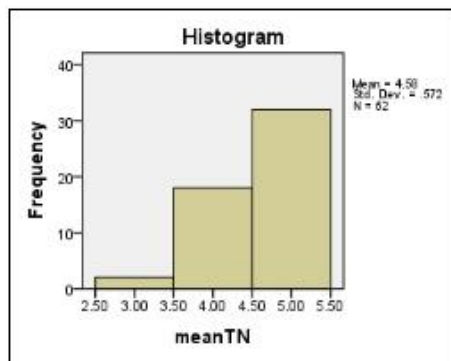
###### ▪ Time Needs

Table I shows the frequency table for Time Needs. Questions under this category query if the respondents agree that a smart home application providing assisted living save time and human efforts are desired.

**Table- I: Frequency for Time Needs**

	Frequency	Percent	Valid Percent	Cumulative Percent
Neutral	2	3.8	3.8	3.8
Agree	18	34.6	34.6	38.5
Strongly Agree	32	61.5	61.5	100.0
Total	52	100.0	100.0	

Figure 1 shows the histogram of mean time needs with the average of 4.58 mean value which indicates that almost all the respondents agree that the time needs is a requirement for smart home application. Based on the survey results, we assume that the majority of participants agree that saving time and effort is an important requirement in a smart home application.



**Fig 1. Histogram for Time Needs**

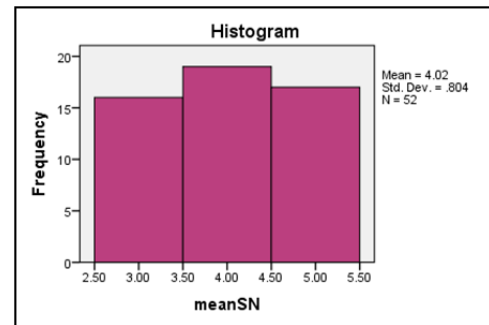
###### ▪ Simplicity Needs

Table II shows the frequency of Simplicity Needs. Questions under this category query if the respondents are expecting simplicity while using smart home applications.

**Table- II: Frequency for Simplicity Needs**

	Frequency	Percent	Valid Percent	Cumulative Percent
Neutral	16	30.8	30.8	30.8
Agree	19	36.5	36.5	67.3
Strongly Agree	17	32.7	32.7	100
Total	52	100	100	

Figure 2 shows that the mean value of Simplicity Needs is in the range of 4.02 which indicates 70% of respondents agree and strongly agree that Simplicity Needs is an essential requirement.



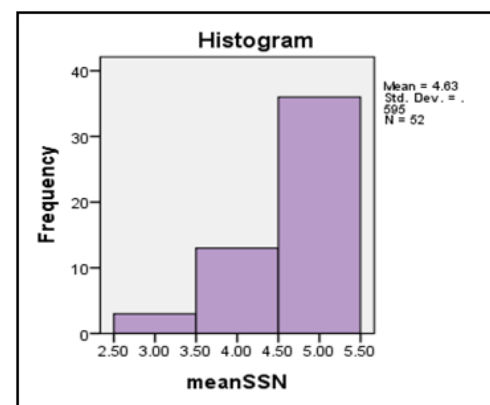
**Fig 2. Histogram for Simplicity Needs**

###### ▪ Security and Safety Needs

Table III shows the frequency of Security and Safety Needs. Questions under this category query if the respondents agree that security and safety components are expected in smart home application. The mean of the security and safety needs is 4.63 as shown by the histogram in Figure 3.

**Table- III: Frequency for Security and Safety Needs**

	Frequency	Percent	Valid Percent	Cumulative Percent
Neutral	3	5.8	5.8	5.8
Agree	13	25	25	30.8
Strongly Agree	36	69.2	69.2	100
Total	52	100	100	



**Fig 3. Histogram for Security and Safety Needs**

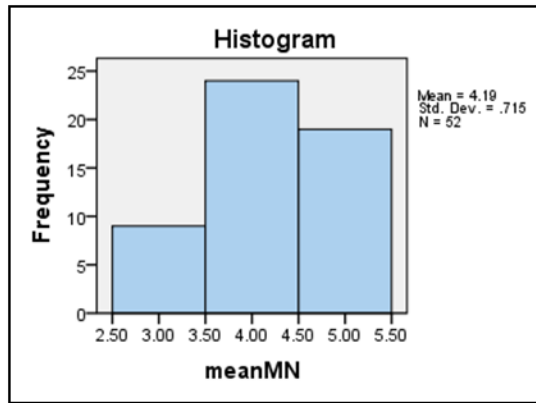
###### ▪ Mobility Needs

Table IV shows the frequency of Mobility Needs. Questions under this category query if the respondents agree that less mobility is expected when having smart home application at home. Mobility needs represent the ease of having remote control and gadgets to reduce the need of physical movement. The mean value for mobility needs is 4.19, as shown in Figure 4.

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**Table- IV: Frequency Mobility Needs**

	Frequency	Percent	Valid Percent	Cumulative Percent
Neutral	9	17.3	17.3	17.3
Agree	24	46.2	46.2	63.5
Strongly Agree	19	36.5	36.5	100
Total	52	100	100	



**Fig 4. Histogram for Mobility Needs**

### Inferential Analysis

An independent sample t-test was used to examine the differences between genders in terms of preferences to have

smart home application. The following hypothesis was tested:

H01: There is no significant difference between gender male and female in intention to adopt smart home application

Table VI shows the results of the difference in mean of the variables with the male gender having a higher mean value ( $M = 1.40$ ;  $SD = 0.503$ ) than female gender ( $M = 1.13$ ;  $SD = 0.336$ ). Furthermore, Table VII indicates that there is a statistically significant difference in scores for gender where ( $t = 2.368$  and  $p = 0.02$ ). These results show that females are more interested in adopting smart home application. Specifically, the result suggested that female consumers prefer to buy and install smart home application.

**Table- VI: Gender Statistic**

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Do you likely to adopt smart home device at your home?	male	20	1.4	0.503	0.112
	female	32	1.13	0.336	0.059

**Table- VII: The t-Test**

	Levene's Test for Equality of Variances	t-test for Equality of Means								
		F	Sig.	t	df	Sig.(2- tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Do you likely to adopt smart home device at your home?	Equal variances assumed	19.438	.000	2.368	50	.022	.275	.116	.042	.508
	Equal variances not assumed			2.163	29.677	.039	.275	.127	.015	.535

The second hypothesis is tested using ANOVA. One-way analysis of variance was used to examine whether marital status influenced the intention to adopt smart home application.

H02: There is no significant difference between marital status with intention to adopt smart home application.

Table VIII indicates the difference in mean of the variables with Married with children having a higher mean value ( $M = 1.23$ ;  $SD = 0.425$ ). Meanwhile, for single is ( $M = 1.00$ ;  $SD = 0.000$ ) and for Married without children is ( $M = 2.00$ ;  $SD = 0.000$ ). Furthermore, Table IX indicates that there is a statistical significant difference between the marital statuses regarding the intention to adopt smart home

application. The result shows that married people with children were most interested in smart home application.



Table- VIII: Descriptive Statistic

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
single	5	1.00	.000	.000	1.00	1.00	1	1
Married without children	2	2.00	.000	.000	2.00	2.00	2	2
Married and had children	45	1.22	.420	.063	1.10	1.35	1	2
Total	52	1.23	.425	.059	1.11	1.35	1	2

Table- IX: Analysis of Variance

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.453	2	.726	4.577	.015
Within Groups	7.778	49	.159		
Total	9.231	51			

## V. CONCLUSION

There are several techniques that can be used to elicit requirements for a system to be developed. This study adopted survey technique through questionnaire to capture essential requirements for smart home application. The questionnaire was designed based on preliminary study done through literature and current smart home applications in the market. The study conducted among residents in Muadzam Shah Pahang concludes that the respondents agreed that essential requirements for smart home application are Time Needs, Simplicity Needs, Security and Safety Needs and Mobility Needs. Further analysis indicates that there are significant differences between gender and between marital statuses which influence the decision to adopt smart home application.

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## REFERENCES

1. G. Battista, L. Evangelisti, C. Guattari, C. Basilicata and R. de Lieto Vollaro (2014). Buildings Energy Efficiency: Interventions Analysis under a Smart Cities Approach. *Sustainability*, 6(8), 4694–4705.
2. V.S. Gunge, & P.S. Yalagi, (2016). Smart Home Automation: A Literature Review. *International Journal of Computer Applications*, 975, 8887.
3. M. Alaa, A. A. Zaidan, B. B. Zaidan, M. Talal, & M.L.M. Kiah (2017). A review of smart home applications based on Internet of Things. *Journal of Network and Computer Applications*, 97, 48-65.
4. I. Brace, (2018). Questionnaire design: How to plan, structure and write survey material for effective market research. Kogan Page Publishers.
5. M., Pragnell, R. Moore, & L. Spence (2000). The market potential for Smart Homes. York: York Publishing Services.
6. R. Kumar (2019). Research methodology: A step-by-step guide for beginners. Sage Publications Limited.

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