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# Factors that Influence Home IoT Adoption in Ipoh, Perak

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**Abstract**: The Internet of Things (IoT) was developed continuously and extended to other fields' use. Home IoT is a domestic appliance with internet connectivity (enabled with sensors, controllers, and communication systems) to allow users to control the object and adapt to their needs. It has become a trend to use worldwide and grow continuously. Previous research indicated a need for a comprehensive IoT ecosystem, no standardization in Home IoT technology, and fewer concerns about the level of security and privacy in the country were barriers to current IoT adoption in Malaysia. The factor influencing Home IoT adoption should be studied to explore the potential of adopting Home IoT in Ipoh, Perak citizens. Therefore, this study purposely investigates the relationship between perceived usefulness, perceived ease of use and perceived risks to the adoption level of Home IoT in Ipoh, Perak citizens. A quantitative research survey was used for data collection. Descriptive statistical analysis and correlation analysis were used to analyze the collected data results using SPSS software (Statistical Package for the Social Sciences). The results of the correlation analysis show that perceived usefulness and perceived ease of use had a significant positive relationship with the adoption level of Home IoT; Meanwhile, perceived risk had a significant negative relationship with the adoption level of Home IoT. Therefore, understanding the factors that impacted the adoption of Home IoT can help related parties to improve the adoption of Home IoT in Ipoh, Perak citizens. Further study can express more dimensional factors and expand the scope of research.

**Keywords**: Home IoT, adoption level, perceived usefulness, perceived ease of use, perceived risk

## 1. Introduction

Internet of things (IoT) refers to an object that is able to connect to the network (wired, wireless, and Internet Protocol (IP)) in turn to perform the exchange of data to achieve smart recognition, positioning, tracking, monitoring, and administration. The Internet of Things (IoT) was coined by

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Kelvin Ashton during his work at Procter & Gamble (P&G) in the year 1999, and he describes IoT as based on RFID technology (Kevin, 2010).

Home IoT is well known as the ability to control domestic appliances electrically via an internet-connected system. Home IoT is a domestic appliance with internet connectivity (enabled with sensors, controllers, and communication systems) to allow the users to control the object and adapt to the user's needs. Home IoT is controlled through a central hub and remotely controlled by an app that installs in a device, in turn the Home IoT can perform controlling, monitoring and regulation of functions in a private household. The Home IoT covered a wide range from large domestic appliances such as refrigerators to small domestic appliances such as a smart toothbrushes. Nowadays, a few companies are the leader in the Home IoT industry, such as Amazon, Google, Samsung, and Xiaomi (Weissman, 2014). There are offering a lot of Home IoT-related products.

Home IoT has become a trend of use worldwide. Based on Statista (2016), the market size of Home IoT is expected to be raised in these few years and achieve USD207.80 billion in the year 2026. The United States, China and the United Kingdom is the country which spends the most on Home IoT. This represented the people made sense of adapting Home IoT into their life. The Home IoT increased the conformity, security, convenience, and efficiency of energy consumption. These attracted consumers to adapt the Home IoT into their daily life and are expected to bring the benefit to fulfil their demands.

In 2021, there are more than 10 billion active Internet of Things devices (IoT) reported and used by human beings (Jovanovic, 2022). In Malaysia, IoT development is the context Malaysia wants to be concerned about. However, Wan Mokhtar (2018) states that the adoption of Home IoT in Malaysia was relatively low compared to neighbouring countries. This was proven with the statistical evidence from Statista (2022); the revenue generated from Home IoT in the year 2021 in Malaysia is only USD202.40 million. It was relatively low compared to India (USD 4159.00 million), Vietnam (USD 209.00 million) and Indonesia (USD305.10 million). This shows the Malaysian least intention to adopt Home IoT products into their life (Wan Mokhtar & Ismail, 2018).

Furthermore, the Ministry of Science, Technology and Innovation (MOSTI) proposed National IoT Strategic Roadmap, which pointed out the barriers to current IoT adoption in Malaysia. It included a lack of a comprehensive IoT ecosystem, no standardization in technologies of the present-day Home IoT components, and concerns about the country's level of security and privacy (Siew, 2019).

According to Shuhaiber and Mashal (2019), perceived usefulness and perceived ease of use were given a high impact on the adoption of Home IoT. These factors influence a person's perceived value toward the intention of adopting Home IoT. Furthermore, the benefits of Home IoT positively impacted the adoption of Home IoT (Shank *et al*., 2021). Home IoT's benefits, including overall benefits, social knowledge, and ease of control, attracted the adoption of Home IoT. These had shown the adoption of Home IoT was influenced significantly by perceived usefulness and perceived ease of use in public's adoption.

Home Internet of Things (Home IoT) is a relatively new technology to the public. The public's willingness to try new things without known pros and cons of new things, especially new technology always at a low level. The perceived risk of Home IoT will be one of the topics concerned when deciding on adopting Home IoT. Privacy risk and security risk would be the main barrier that causes resistance to the adoption of Home IoT into daily life (Wilson *et al*., 2017). Home IoT was perceived as the component potentially exposing the user to threat and risk (Shuhaiber & Mashal, 2019). This was supported by the evidence which stated that cyber risks are an existing thread to modern business and online applications such as smart factories and smart homes, which impact the decision of people to adopt themselves into Home IoT (Miller & Griffy- Brown, 2018).

Therefore, to archive the research objectives, the key factors that influence the Home IoT adoption among Ipoh, Perak citizens are determined. Consequently, the adoption of Home IoT among Ipoh, Perak citizens is predicted.

This research is beneficial to Home IoT product manufacturers. With this research, the Home IoT manufacturer will know the primary factor of public expectations of the Home IoT. Besides, the Home IoT manufacturer also understands the barriers to the public adopting Home IoT into their life. Therefore, the manufacturer has an opportunity to enhance their product specification or modify the price to adapt to the expectation of the public on Home IoT. As a result, the sales volume of Home IoT will experience a booming increase, and the adoption of Home IoT also will be raised.

Additionally, this research also provides information on Home IoT to the public. This research gathers much general knowledge regarding Home IoT, such as the definition of Home IoT, usage of Home IoT, the benefit of adoption of Home IoT, and other information. This will increase the knowledge level of the public on Home IoT. Therefore, they will know well about the advantage of Home IoT, and the acceptance level of Home IoT will rise.

Furthermore, this research also gives an advantage to Perak State Government. This research also gathers data relate to the usage frequency of Home IoT of Ipoh, Perak citizens. This gave a portion of data to the state government and fostered a policy or strategy regarding adopting Home IoT into Ipoh, Perak citizen's daily life. In turn, the "Smart City" and "Smart Home" projects can be moved beyond and accelerate the progress of these projects.

This research concentrated on the factor influencing the adoption of the Home Internet of Things (Home IoT) in Ipoh, Perak. The study's respondents are citizens, including teenagers, workers, and elders living in Ipoh, Perak. The researcher used a quantitative approach which is a survey, to conduct the data collection the research. The questionnaires will be distributed online because it is more cost-effective and quickly reaches more people to capture the data to improve the accuracy of the research.

## 2. Literature Review

The purpose of the researcher doing the literature review is to clarify and explore the current understanding of research to the research topic and the field studied. Besides, the evaluation of the past literature is also will be done in this part. The researcher is focusing on past reviews and studies in conducting the literature review of this research. This part will also analyze the theoretical and conceptual framework and suit the research. At last, the researcher will carry out the research's hypothesis to examine the relationship between the independent and dependent variables of this research.

### 2.1 Internet of Things (IoT)

The first concept of the Internet of Things came from the electromagnetic telegraph, which allowed the flow of electronic signals between two machines, and Baron Schilling invented it in Russia in the year 1893. The Internet of Things (IoT) was coined by Kelvin Ashton during his work at Procter & Gamble (P&G) in 1999. At that time, he described IoT- based Radio-Frequency Identification Technology (RFID) (Kevin, 2010). The first invention of IoT came from a group of students who studied at Carnegie Melon University in the early 1980s. They had created a micro-switch in Coca-Cola vending machines, which function as a sensor to keep track of the stock and whether the Coke can is cold or hot in the vending machines and report sales data and reorder alert to Coco-Cola suppliers

Many different conceptions of IoT have been introduced, and its definition keeps changing and modifying. In conclusion, the Internet of Things (IoT) is an internetworking physical object (referred to as "connected devices" or "smart devices"), either devices, vehicles, buildings, or other items that are embedded with electronics, software, sensors, actuators, and network connectivity which enable these

objects to collect and exchange data (IGI Global, 2022).

*(a) Home internet of things (Home IoT)*

Home Internet of Things is often referred as Smart Home or Home automation system. It is defined as domestic devices and applicants that enable with sensors, controllers, and communication systems capable with internet connectivity, in turn to collect data about users and to respond and adapt to the needs of the household and performed communication with one other, remotely monitored, accessed, or controlled from any location by using a network-connected device (Balta-Ozkan *et al*., 2013)**.**

Based on the definition above shows the technologies and the benefits that aim to provide the Home IoT. The Home IoT was using of smart devices (wired or wireless) or sensors that connected to a communication network to keep track for monitoring and track of the user activity and process to a set of data (Orwat *et al*., 2008). Therefore, the system can integrate the current behaviour and improve the users' quality of life.

2.2 Definition of the Dependent Variable

*(a) Adoption of home IoT*

Based on IGI Global (2022), a peer review content publication website, there are a lot of versions of the definition of "adoption". A few " adoption " concepts are suitable for this research. Adoption is defined as a decision to full use of an innovation as the best course of action available (Sparling *et al*., 2010). Besides, adoption is also known as a process of understanding and acceptance of a concept, and strongly believe the acquisition and use with implied will generate a positive result. (Lau & Hooper, 2009). Furthermore, adoption defined as an action or fact of adopting or being adopted and it's also seen as the act or process of beginning to use something new or different (Ali & Soar, 2016). In conclusion of this concept, adoption of Home IoT is an act, decision or process of understanding the existing and innovated Home IoT technology, and intent to acquire and use the Home IoT technology with forecasting a positive outcome will be generated after the implementation of the Home IoT technology.

2.3 Definition of Independent Variables

*(a) Perceived benefit*

Perceived benefit is defined as the overall evaluation of the value and cost of using Home IoT technology (Kim *et al*., 2007; Sirdeshmukh *et al*., 2002). Besides, perceived benefits are also defined as beliefs about the positive outcomes associated with a behaviour in response to a real or perceived threat (Raghunath *et al*., 2021). For this research, perceived benefit is meant by the benefit of adoption of Home IoT technology that the respondents had known before they use Home IoT products.

*(b) Perceived ease of use*

Ease of use indicated to low level of difficultly and does not require great effort in use (David *et al*, 1986). Perceived ease of use in this research referred to the degree to which a user believe that the use of technology would help in free the user from physical and mental effort (Shuhaiber & Mashal, 2019). For this research, perceived ease of use defined as the degree of user believe they would be free from effort in use of the Home IoT.

*(c) Perceived risk*

Perceived risk defined as the consumer's level of uncertainty regarding the outcome of a purchase decision (Kasemsap, 2016). Perceived risk also represents a consumer’s subjective perception of uncertainty about the consequences and outcomes of adopting an innovation (Yuner, 2020). Perceived risk also refers to the respondent's expectation of the potential outcomes of an action owing to his or her degree of uncertainty about adopting Home IoT technology. Perceived risk usually include security, privacy, financial and technical risks (Shuhaiber, 2016).

2.4 Underpinning Theory (Unified Theory of Acceptance Use of Technology)

Davis introduced Technology Acceptance Model (TAM) in 1989, and the theory was extended by Venkatesh, Thong, and Xu in 2003 (Venkatesh *et al*., 2016). TAM is the most influential theory in explaining adoption behaviour in information technology. TAM predicts that perceived usefulness (PU) and Perceived Ease of Use (PEU) are positively impacted onto a user's attitude (AT) toward the use of a system. Behaviour Intention (BI) to use is a linkage of user's attitudes toward the system and perceived usefulness. Continuously, Behavior intention contributed to determining the Actual Use (AU) of the system.

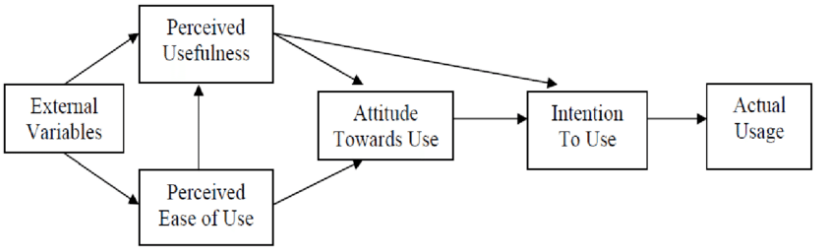


**Figure 1: Technology Acceptance Model (Davis, 1989)**

According to Shuhaiber and Mashal (2019), the perceived risk had been added to the conceptual framework of the study of the user's acceptance of Smart Home. There is a need to examine the perceived risk, which includes security, privacy, financial and technical risks, since the IoT is perceived as a technology that perceived as high risk and the threat that expose the user in disclosure and violating of user's information privacy, high loss of data confidentiality and authentication (Shuhaiber & Mashal, 2019).

2.5 Hypothesis development

(i) Perceived usefulness has a significant positive relationship to the adoption of Home IoT in Ipoh, Perak citizens.
(ii) Perceived ease of use had a significant positive relationship to the adoption of Home IoT in Ipoh, Perak citizens.
(iii) Perceived risk had a significant negative relationship to the adoption of Home IoT in Ipoh, Perak citizens.

2.6 Conceptual framework

Figure 2 reflects the independent variable, which consists of perceived usefulness (H1), perceived ease of use (H2), and perceived risk (H3). Besides that, the researcher has also identified dependent variable will be Home IoT adoption in Ipoh, Perak citizens. The table reflects the relationship between this research study's independent and dependent variables and is clearly defined for future reference.

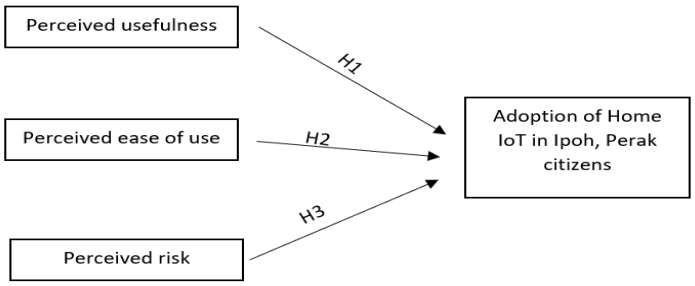


**Figure 2: Conceptual Framework of the research**

## 3. Research Methodology

Research methodology should undergo while conducting a study. It is one of the essential criteria of a study. The research methodology consists of the workflow and the process of a study conducted. Therefore, a clear view of the study will enhance the reliability of information and the validity of the collected data. As a result, the research question was answered accurately and provided useful information to the researcher. This chapter includes research design, process, sampling, instrumentations, reliability, pilot study, data collection, and data analysis. The study aims to provide insight into the adoption of Home IoT into Ipoh, Perak citizens.

## 3.1 Research design

Research design is the framework of research techniques and methods that choose by the researcher in conducting the study. Research design provides clear process details to gather the information needed to solve problems from research (Nor Shila, 2016). This study will proceed with the quantitative approach by using a survey to identify the factors influencing the adoption of Home IoT and the adoption level of Home IoT in Ipoh, Perak citizens. All the data collected will undergo the data analysis process by using the SPSS software application to examine the means, standard deviation, reliability, and validity of the data.

### *(a) Survey method*

This study will use the survey method in the data collection phase. The main reason for the questionnaire to be the mainstream of primary data collection is its low cost and effectiveness. In this study, the researcher is using a questionnaire to understand the insights and opinions of Ipoh's citizens and the factors influencing them to adopt Home IoT in Ipoh, Perak citizens.

## 3.2 Research Process

Research processes are critical to a study. The research always starts with defining a problem related to insights into adopting Home IoT in Ipoh, Perak citizens. The interest area associated with the research topic was identified in this stage. Next, the data and materials close to the topic must be searched and gathered to gain more knowledge and opinions about the study. The researcher deeply searched the data and information to identify the factor influencing the adoption of Home IoT. After this, the researcher picks the research design that best suits the study. The next process is to collect data to conduct the researcher's desired data. Lastly, the researcher will analyze the data, process it into useful information, and discuss the result. The study is completed by concluding all the information of the study.

## 3.3. Respondent

### *(a) Population*

In the Statistic view, a population is a collection of individuals from which data are needed to gather knowledge (Banerjee & Chaudhury, 2010). This study's population consists of teenagers, workers and elders who experienced the Home IoT in Ipoh, Perak. Based on ICT Use and Access by Individuals and Households Survey Report (ICTHS) 2021, it is reported that the ICT penetration of Malaysian is recorded at a very high level of 83.5% on computer usage, 96.8% on internet usage and 98.7% on mobile phone usage. Perak is the state that 2nd lowest wealthy level state in Malaysia. Ipoh, Perak had a great research value in evaluating the adoption level of Home IoT to identify the city's development potential.

### *(b) Sampling technique*

Sampling is the process of selecting a subset from the entire population and signifying a portion of the population (Eta *et al*., 2020). The researcher used a non-probability sampling technique and narrowed it to convenience selection as the primary sampling method of the study. Convenience sampling is favoured among researchers because it is a low-cost and simple alternative compared to other sampling techniques (Greenwood, 1954). Furthermore, the respondents are easier to reach since the convenience sampling's respondent characteristic is often readily and easily available.

### *(c) Sampling size*

The total population of Ipoh, Perak citizens, is around 842,000 people (Population Stat, 2022). Referring to the sample size determination table of Krejcie and Morgan (1970), if the population reached 75,000 people, the corresponding required respondent for the sampling is 382 people.

3.4 Data collection

*(a) Primary data*

The primary data is the first-hand material that is collecting from the survey. It gathers for a specific goal (Hox & Boeije, 2004). The data will be collected from respondents through a survey. The data collection process undergoes in Ipoh, Perak. The questionnaire was designed as a Google form and distributed through social media like Facebook. This is the best and most efficient way to reach the people and maintain a low cost. The data can be collected easier and quicker through technology tools.

3.5 Instrument

A research instrument is a measuring tool to obtain the data and information used (Chua, 2011). It consists of five parts: Section A, Section B, Section C, Section D, and Section E. The previous study was adopted into the research questionnaire.

The researcher adopted the questionnaire based on these authors: Nawi *et al*. (2021) Part A, Tsourela and Nerantzaki (2020) Part B, Shuhaiber and Mashal (2019) Part C, Part D, Part E. Those questionnaires are adopted and modified based on the suitability of the study.

3.6 Measurement of Variables

*(a) Likert scale measurement*

The purpose of the questionnaire is to obtain data related to factor that influence the adoption of Home IoT and the adoption level of Home IoT in Ipoh, Perak citizens. The questionnaire will be distributed through online platforms such as Facebook and WhatsApp. The questionnaire uses a Likert scale measurement to engage the respondent's involvement to answer the question and obtain the expected outcome. Five options were offered to select respondents, ranging from 5 (strongly agree) to 1 (strongly disagree).

3.7 Pilot Study

A pilot study should be conducted to measure a research instrument's validity and reliability. The researcher can identify the research instrument's weakness and improve it immediately (Ahb Wahid & Lee, 2006). The appropriate sample size to undergo the pilot test ranges from 20-30.

3.8 Reliability and Validity

The sample considers a good sample when the research reliability and validity are desirable. The good reliability and validity level indicate the result was not corrupted. The instrument's validity and durability analysis is critical to keeping the quality of the questionnaire from being susceptible to mistakes (Rosseni *et al*., 2009).

To ensure the reliable calculation over time and different objects in the instrument, it is essential to undergo the reliability test and examine how accurate of the sample is (Sekaran, 2016). Cronbach Alpha coefficient is the tool of most widely used internal consistency measure. It is the most appropriate measure to test for reliability when the questionnaire is using of Likert scale (Wyatt, 2000).

3.9 Normality Test

Normality test purposely to calculate the possibility of the data being naturally distributed with random variables and ensure it is distributed normally. Normally distributed data should have a symmetrical bell-shaped curve with the information of mean, median, and mode with the same value. Two types of methodology can be used in normality tests. Kolmogorov-Smirnov test (K-S) and Shapiro-

Wilk test (S-W) are designed to test normality with a numerical method to match the data to normal distribution.

3.10 Analysis of Data

*(a) Descriptive analysis*

Descriptive analysis is used to describe the demography data collected from the survey and summaries it (Kenton, 2018). It provides simple summaries of the sample and measures. The descriptive analysis in this study was the analysis of the respondents' demography, which included gender, age, education level, income level, and Home IoT usage per day. Besides, it is also suitable for obtaining the frequency and percentage, mean, and standard deviation of the questionnaire to determine the adoption level of Home IoT in Ipoh, Perak citizens.

*(b) Correlation analysis*

The strength of the relationship between two quantitative variables can be tested by correlation analysis. In this study, the researcher utilizes correlation analysis to examine the relationship between independent variables (perceived usefulness, perceived ease of use, perceived risks) and dependent variables (adoption of Home IoT of Ipoh, Perak citizens).

## 4. Analysis and Findings

4.1 Respond rate

The questionnaire was distributed randomly online. A total of 221 responses were successfully collected. This is 163 responses, less than the target sample size of 384, but it is still acceptable for this research.

4.2 Reliability analysis

*(a) Reliability test for the pilot test*

**Table 1: Pilot test reliability test result**

| Variables | Cronbach's Alpha | No. of item |
|---|---|---|
| Adoption of Home IoT, ADP | 0.858 | 5 |
| Perceived Usefulness. PU | 0.895 | 5 |
| Perceived Ease of Use, PEOU | 0.906 | 4 |
| Perceived Risk. PR | 0.880 | 4 |

The pilot test was conducted by the Ipoh, Perak citizens who had experiences with Home IoT. The Cronbach's Alpha value of DV, adoption of Home IoT ($\alpha$=0.858) and IV, perceived usefulness ($\alpha$=0.895), perceived ease of use ($\alpha$=0.906), perceived risk ($\alpha$ =0.880) indicated all instruments were highly reliable and consider satisfactory. Cronbach Alpha value of all instruments was above 0.6, which is above the acceptable range of the reliability (Bryman & Bell, 2007).

*(b) Reliability test for the actual study*

**Table 2: Actual test reliability test result**

| Variables | Cronbach's Alpha | No. of item |
|---|---|---|
| Adoption of Home IoT, ADP | 0.782 | 5 |
| Perceived Usefulness. PU | 0.829 | 5 |

| | | |
|---|---|---|
| Perceived Ease of Use, PEOU | 0.841 | 4 |
| Perceived Risk. PR | 0.873 | 4 |

The dependent variable, the adoption of Home IoT, had the lowest Cronbach's Alpha value of the study, which is 0.782. However, this variable still considers high-level reliability data. Followed by Cronbach's Alpha value of independent variables, perceived usefulness was 0.829, perceived ease of use was 0.841, and perceived risk was 0.873. According to the general rule of thumb, Cronbach's Alpha value above 0.6 is acceptable, 0.7 – 0.8 is highly reliable, and 0.8-0.9 is a very high reliable (Hair *et al*., 2010). Thus, all variable's data are highly reliable.

4.3 Descriptive analysis - Demographic

*(a) Gender*

**Table 3: Gender of the respondent**

| Gender | Frequency | Percentage (%) |
|---|---|---|
| Male | 116 | 54.7 |
| Female | 96 | 45.3 |
| Total | 212 | 100.0 |

Table 3 shows the demographic respondents by their gender. There are 116 male (54.7%), and 96 female (45.3%) was involved in the studies. The questionnaire was distributed evenly among the citizens in Ipoh, Perak.

*(b) Age*

**Table 4: Age of respondent**

| Age | Frequency | Percentage (%) |
|---|---|---|
| 15-24 years old | 59 | 27.8 |
| 25-34 years old | 97 | 45.8 |
| 35-44 years old | 44 | 20.8 |
| 45 and above | 12 | 5.7 |
| Total | 212 | 100.0 |

Table 4 shows the demographic respondents by their age. Most respondents are 25-34 years old, 97 respondents or 45.8% of the total. On the other hand, the respondent 45 years old and above is the minority, with only 12 respondents or 5.7%. Additionally, 59 respondents are 15-24 years old (27.8%), and 44 respondents are 35-44 (20.8%). In conclusion, the majority of the Ipoh, Perak citizens who were involved in the research based on their age group were distributed between the ages of 25 and 34.

*(c) Education level*

**Table 5: Education level of respondent**

| Education level | Frequency | Percentage (%) |
|---|---|---|
| SPM | 16 | 7.5 |
| STPM | 16 | 7.5 |
| Diploma | 49 | 23.1 |
| Bachelor's degree | 106 | 50.0 |
| Master's degree | 24 | 11.3 |
| PhD | 1 | 0.5 |
| Total | 212 | 100.0 |

Table 5 shows the demographic of the respondent by their education level. From the result, half of the respondents (50.0%), or 106 respondents, had a bachelor's degree. Followed by Diploma, which

was 49 respondents (23.1%), a master's degree, which was 24 respondents (11.3%) SPM, and STPM, which was 16 respondents (7.5%). Only 1 respondent, or 0.5% of the total respondent, has a PhD. Most of the respondents in the research had a bachelor's degree.

*(d) Income*

**Table 6: Income level of respondent**

| Income level | Frequency | Percentage (%) |
|---|---|---|
| RM1500-RM1999 | 32 | 15.1 |
| RM2000-RM2499 | 61 | 28.8 |
| RM2500-RM2999 | 79 | 37.3 |
| RM3000-RM3499 | 26 | 12.3 |
| RM3500 and above | 14 | 6.6 |
| Total | 212 | 100.0 |

Table 6 shows the demographic of the respondent by their income level. The majority of the respondent received a monthly income between RM2500-RM2999, of which 79 respondents (37.3%). Next, there were 61 respondents, or 28.8% of the total respondent, who received income in the range of RM2000-RM2499. Come next to the respondents who received monthly income in the range of RM1500-RM1999, which was 32 respondents (15.1%), and respondents who received monthly income in the range of RM3000-RM3499, which was 23 respondents (12.3%). The minority of the respondents received monthly income above RM3500, occupying only 14 respondents (6.6%). Most of the respondent's income level was distributed in the range of RM2500-RM2999.

*(e) Time spent on Home IoT everyday*

**Table 7: Time spent on Home IoT every day of respondent**

| Time spent everyday | Frequency | Percentage (%) |
|---|---|---|
| Less than 1 hour | 48 | 22.6 |
| 1-3 hours | 83 | 39.9 |
| 4-6 hours | 74 | 34.9 |
| 7-9 hours | 7 | 3.3 |
| 10 hours and above | 0 | 0.0 |
| Total | 212 | 100.0 |

Table 7 shows the demographic of the respondent by their time spent on Home IoT every day. Most of the respondents spent 1-3 hours in use of Home IoT every day, and there were 83 respondents (39.9%) in this category. Followed by the respondent who used Home IoT 4-6 hours per day, 74 respondents (34.9%), and the respondent who used Home IoT for less than 1 hour per day, 48 respondents (22.6%). There are only 7 respondents or 3.3% of the total respondent, were heavy users of Home IoT, they spent 7-9 hours every day in the use of Home IoT. No respondent used Home IoT for 10 hours and above.

4.4 Adoption of Home IoT

**Table 8: Home IoT adoption of respondent**

| Intention and Adoption | Mean | Standard Deviation | Level |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Given the chance, I intend to use Home IoT products and applications. | 4.66 | 0.814 | High |
| I am willing to use Home IoT products and applications in the near future. | 4.43 | 0.659 | High |
| I will frequently use Home IoT products and applications. | 4.58 | 0.673 | High |
| I will recommend Home IoT products and applications to others. | 4.60 | 0.684 | High |
| I will continue using Home IoT products and applications in the future. | 4.56 | 0.742 | High |
| Average mean | 4.57 | 0.714 | High |

Table 8 shows the questions relate to the respondents' intention and adoption of Home IoT. The highest mean was recorded at 4.66, indicating respondents intend to use Home IoT products and applications. In contrast, the lowest mean was recorded at 4.43, indicating respondents are willing to use Home IoT products and applications soon. Overall, the intention and adoption of respondents toward Home IoT were at a high level, with an average mean score of 4.57 and a standard deviation score of 0.714.

4.5 Perceived usefulness of Home IoT

**Table 9: Perceived usefulness of respondent toward Home IoT**

| Perceived Usefulness | Mean | Standard Deviation | Level |
|---|---|---|---|
| Using Home IoT would enable me to accomplish home tasks more quickly. | 4.74 | 0.643 | High |
| Home IoT would make be useful for me to control home expenses and bills. | 4.33 | 0.713 | High |
| Using Home IoT would enhance the quality of life. | 4.53 | 0.750 | High |
| Using Home IoT would enable me to accomplish home tasks easier. | 4.62 | 0.615 | High |
| Overall, I would find using Home IoT to be advantageous. | 4.63 | 0.629 | High |
| Average mean | 4.57 | 0.668 | High |

Table 9 shows the questions related to respondents' perceived usefulness toward Home IoT. The respondent agreed that the use of Home IoT helped them accomplish home tasks more quickly, with the highest mean score of 4.74 out of 5.00. The lowest mean score, 4.33, indicated that respondents believe Home IoT would help control home expenses and bills. In short, the respondent had a high level of perceived usefulness toward Home IoT, with an average mean of 4.57 and a standard deviation of 0.668.

4.6 Perceived Ease of Use of Home IoT

**Table 10: Perceived ease of use of respondents toward Home IoT**

| Perceived Ease of Use | Mean | Standard Deviation | Level |
|---|---|---|---|
| I feel using Home IoT would be easy. | 4.75 | 0.661 | High |
| I feel learning to use Home IoT would be easy for me. | 4.48 | 0.725 | High |
| I feel my interaction with the Home IoT would be clear and understandable. | 4.53 | 0.684 | High |
| I feel I would find it easy to get Home IoT objects to do what I want it to do | 4.63 | 0.666 | High |
| Average mean | 4.60 | 0.684 | High |

Table 10 shows the questions related to respondents' perceived ease of use toward Home IoT. The highest means score of 4.75 indicated that respondents felt used of Home IoT would be easy. Additionally, the respondents believed learning in the use of IoT would be easy, with the lowest mean score of 4.48. Altogether, respondents' perceived ease of use toward Home IoT had a high central tendency with an average mean score of 4.60 and a standard deviation score of 0.684.

4.7 Perceived Risk of Home IoT

**Table 11: Perceived risk of respondent toward Home IoT**

| Perceived Risk | Mean | Standard Deviation | Level |
|---|---|---|---|
| I have privacy concerns associated with Home IoT. | 1.79 | 0.992 | Low |
| I am anxious about my personal data by using Home IoT. | 1.91 | 0.917 | Low |
| I have security concerns associated with Home IoT. | 1.89 | 1.065 | Low |
| I am anxious about the data security of the Home IoT. | 1.81 | 0.942 | Low |
| Average mean | 1.85 | 0.979 | Low |

Table 11 shows the questions related to the respondent's perceived risk toward Home IoT. The highest mean score of 1.91 shows that respondents do not agree that Home IoT would make users suffer from personal data leakage issues. Besides, the lowest mean score of 1.79 indicated that respondents did not agree that privacy concerns associated with Home IoT would happen. To summarize, the average mean of 1.85 and standard deviation of 0.979 indicated the perceived risk of respondents toward Home IoT at a low level.

4.8 Normality test

**Table 12: Test of normality**

| | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df. | Sig. | Statistic | df | Sig. |
| ADP | .281 | 212 | .000 | .685 | 212 | .000 |

Table 12 shows the result of the normality analysis of adoption (ADP). In this research, the Kolmogorov-Smirnov test was used due to the sample size is 212, which is over 50. The significant value or P-value for adoption (P=0.00) was below 0.05, thus data is non-normal data. To conclude the result, the dependent variable, the adoption of Home IoT (ADP), was non-normally distributed data. Therefore, the non-parameter test, Spearman's rho, would be used in correlation analysis for this research's independent and dependent variables.

4.9 Correlation analysis

**Table 13: Spearman's rho correlation analysis result**

| | | Adoption | Perceived Usefulness | Perceived Ease of Use | Perceived Risk |
|---|---|---|---|---|---|
| Adoption | Correlation Coefficient | 1.000 | 0.527** | 0.473** | -0.222** |
| | Sig.(2-tailed) | - | 0.000 | 0.000 | 0.000 |
| Perceived Usefulness | Correlation Coefficient | 0.527** | 1.000 | 0.557** | -0.200** |
| | Sig.(2-tailed) | 0.000 | - | 0.000 | 0.000 |
| Perceived Ease of Use | Correlation Coefficient | 0.473** | 0.557** | 1.000 | -0.211** |
| | Sig.(2-tailed) | 0.000 | 0.000 | - | 0.000 |
| Perceived Risk | Correlation Coefficient | -0.222** | -0.200** | -0.211* | 1.000 |
| | Sig.(2-tailed) | 0.000 | 0.000 | 0.000 | - |

** Correlation is significant at the 0.05 level (2-tailed)

Table 13 shows the correlation analysis result of the result by undergoing Spearman's rho test. The result shows that all independent variables had a significant relationship with dependent variables. Perceived usefulness has a moderate positive relationship with the adoption of Home IoT (r = 0.527, P = 0.000); perceived ease of use has a moderate positive relationship with the adoption of Home IoT (r = 0.473, P = 0.000), and perceived risk has a slightly negative relationship with adoption of Home IoT (r = -0.222. P = 0.000).

**Table 14: Summary of Hypothesis Result**

| Hypothesis | Statement | Result |
|---|---|---|
| H1 | Perceived usefulness has a significant positive relationship to the adoption of Home IoT in Ipoh, Perak citizens. | Accepted |
| H2 | Perceived ease of use had a significant positive relationship to the adoption of Home IoT in Ipoh, Perak citizens. | Accepted |
| H3 | Perceived risk had a significant negative relationship to the adoption of Home IoT in Ipoh, Perak citizens. | Accepted |

## 5. Discussion, recommendation, and conclusion

This chapter aims to discuss the findings presented in the previous chapter concerning the research questions and hypotheses developed for this study. The researcher discusses the study findings on the platform of the research questions and objectives in this chapter. The researcher also identifies some limitations of the study, recommends some directions for future research based on the research constraints, and concludes the research based on such research findings.

### 5.1 Findings based on objectives

*(a) To examine the relationship between perceived usefulness and adoption of Home IoT in Ipoh, Perak citizens.*

H1: Perceived usefulness has a significant positive relationship to the adoption of Home IoT in Ipoh, Perak citizens.

The Spearman correlation result shows the relationship between perceived usefulness (PU) and adoption (ADP) of Home IoT in Ipoh, Perak citizens are 0.527, indicating a moderate relationship between these variables. Besides, the existence of a relationship proved with a significant value (P-value) of 0.000, which is below 0.05. Hence, H1 is accepted. This result is consistent with the previous study (Shuhaiber & Mashal, 2019). According to Shuhaiber and Mashal (2019), perceived usefulness is crucial in positively influencing the adoption of Home IoT. A user who highly perceived the usefulness of Home IoT would appear the feeling such as trustworthy, reliable, and competent.

Consequently, these feeling bring up the value of Home IoT in their mindset, and the intention of use arise. As a result, the actual use of the Home IoT increased too. Furthermore, this result was supported by Hsu and Lin (2018). Home IoT is a technology that is more work-oriented and task-oriented. Therefore, the user's expectation in its usefulness in terms of performance and efficiency would add perceived value to Home IoT that motivates people the adoption of Home IoT (Hsu & Lin, 2018). There is sufficient and strong evidence to support the significant moderate positive relationship between perceived usefulness and adoption of Home IoT in Ipoh, Perak citizens. Hence, Hypothesis 1 (H1) is accepted.

*(b) To examine the relationship between perceived ease of use and adoption of Home IoT in Ipoh, Perak citizens.*

H2: Perceived ease of use has a significant positive relationship to the adoption of Home IoT in Ipoh, Perak citizens.

A significant but weak positive relationship exists between perceived ease of use (PEOU) and adoption (ADP) of Home IoT in Ipoh, Perak citizens. Spearman's rho correlation results show a correlation coefficient value of 0.473 and a significant value of 0.000. It proved that the relationship existed and has a positively weak relationship between the variables. This result was consistent with the previous research, which mentions that perceived ease of use has a significantly weak positive relationship adoption of Home IoT (Tsourela & Nerantzaki, 2020). In the context of new technology such as Home IoT, the user will be more likely to adopt their behaviour into it when they are perceived the new technology is easy to use (Tsourela & Nerantzaki, 2020). Further interpretation, the Home IoT provider would provide more detailed information, operation training, and testing-use to increase their adoption of Home IoT.

Consequently, potential users had a more positive attitude and a higher tendency to adopt Home IoT if they perceived the new technology as easy to use (Liu & Chou, 2020). Based on these explanations, sufficient evidence supports the significance of the weak positive relationship between perceived ease of use and adoption of Home IoT in Ipoh, Perak citizens. Hence, H2 is proven and accepted.

*(c) To examine the relationship between perceived risk and adoption of Home IoT in Ipoh, Perak citizens.*

H3: Perceived risk has a significant negative relationship to the adoption of Home IoT in Ipoh, Perak citizens.

Spearman's rho test results show a significant and weak negative relationship between perceived risk (PR) and adoption (ADP) of Home IoT. The correlation coefficient value of -0.222 and significant value of 0.000 proved that this hypothesis is valid and accepted. The negative value of the correlation coefficient value indicated the negative relationship existing between these variables: Meanwhile, the significant value below 0.05 proved the validity of the relationship. This result was consistent with the past study. According to Shuhaiber and Mashal (2019), perceived risks such as perceived risk and privacy risks were obstacles that negatively influenced the intention of the user toward Home IoT. The leaking and losing of personal data can lower the trust levels in Home IoT. As a result, it negatively impacts the user's adoption of Home IoT (Shuhaiber & Mashal, 2019). However, the research outcome provided different views and opinions regarding the perceived risk and adoption of Home IoT. According to Shank *et al*. (2021), most respondents are not over-concern about the perceived risk but are willing to adopt Home IoT. This is because they believe the Home IoT manufacturer would prioritize securing customer privacy and security (Shank *et al*., 2021). In conclusion, hypothesis 3 is accepted since most evidence supports the research's result.

5.2 Limitation of Study

Even though the research was completed and came out with satisfactory results, a few limitations existed. Firstly, the time given to complete the research is minimal. Even though the researcher spread the questionnaire online, collecting and blasting the data on social media took time. This was troubling the researcher in filling the required sampling size as in the plan. Only 212 out of 384 responses were successfully collected during the data collection phase.

Besides, the researcher met challenges while distributing the questionnaire to the respondents. Some respondents might not answer the questionnaire with their full loyal and honesty. This might

happen because they want to finish it fast and should have paid more attention to the information in the questionnaire. Consequently, the results may be different from the past research.

Lastly, communication between the researcher and respondent was a problem throughout the survey distribution process. Some respondents, such as elders or uneducated people, needed help with reading and speaking in English. Therefore, it takes time for respondents to understand the meaning of each instruction and the question in the survey.

### 5.3 Recommendation for Future Research

The research was drawn with some recommendations based on the overall implications of the research. In future research, the scope of the study might be expanded to a larger population, such as the whole of Perak state, to get more data. In turn, the data of the research would in more complete.

Besides, the data collection process would be done more efficiently with a longer time. Therefore, the researchers had more time to collect data and prepare well.

Next, future researchers might use various approaches in conducting the research data, such as focus groups or interviews, to study the relationship between the factor and adoption of Home IoT.

Lastly, the researcher can develop more elaborate scales to measure the dimensions of perceived usefulness, perceived ease of use, and perceived risk to enrich for current coverage of Home IoT adoption.

### 5.4 Conclusion

The research was conducted for a year. To summarize, all research objectives and research questions had been successfully answered, together with empirical evidence of the relationship between the factors and adoption of Home IoT among Ipoh, Perak citizens. This research also provided research limitations of this research and recommendations for future research.

Based on the results, perceived usefulness, perceived ease of use, and perceived risk significantly impacting to the adoption of Home IoT. Spearman's rho correlation analysis shows that perceived usefulness and perceived ease of use have a significant positive relationship with the adoption of Home IoT in Ipoh, Perak citizens: Whereas perceived risk has a significant negative relationship with the adoption of Home IoT in Ipoh, Perak citizens.

Besides, the demographic result also provided another important view to evaluate the adoption of Home IoT in Ipoh, Perak citizens. Based on the result, most respondents were light users of Home IoT among Ipoh, Perak citizens. Most of the users used Home IoT for 1-3 hours and 4-6 hours a day. Therefore, penetration of Home IoT into Ipoh, Perak citizens were moderate and can be improved in the near future.

Home IoT is a key technology to improve life quality and simplify daily work. The researcher hoped that this study would help related parties understand the relationship between perceived usefulness, perceived ease of use, perceived risk, and adoption of Home IoT. Therefore, strategies can be developed to increase the adoption of Home IoT in Ipoh, Perak. In turn, more recognition of Home IoT could be in the mind of Ipoh, Perak citizens, and adoption of Home IoT relatively increase.

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