An Assessment on the Smart Home Technology Adoption: Users' Perspective

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Master's Thesis in Information Systems

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Abstract

Subject: Information Systems
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Title: An Assessment on the Smart Home Technology Adoption: Users' Perspective
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Abstract: In the present energy levered world, the concept of energy conservation is in the high priority. People are looking for new ways to save energy and alternative energy sources. In this regard, smart home technology can be one of the best solutions. Thus, the aim of this study is to assess the adoption of smart home technology from users' perspective. Unified theory of acceptance and use of technology- 2 framework with privacy risk has been applied to assess the users' adoption behavior. A total of 175 responses are analyzed using partial least square- structural equation modelling method to test the proposed research model of this thesis. Eight important factors have been used to assess the users' behavioral intention to adopt. Among the eight formulated hypotheses, four are supported. It is found from this study that, performance expectancy, privacy risk, hedonic motivation and habit significantly influence the users' behavioral intention to adopt smart home technology. A significant number of respondents are concerned about the safety of their personal data in this technology. Moreover, a multi group analysis showed a significant influence of performance expectancy and habit on the male users, and hedonic motivation on the female users in the adoption of smart home technology. The only dependent variable of this study i.e. behavioral intention is explained by almost 59% variance. It is also evident from this study that users always prefer maximum values while considering to adopt a technology e.g. smart home technology.
Keywords: UTAUT, UTAUT-2, IoT, smart home technology, users' perception, PLS, privacy etc.
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Moinul Islam
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List of Acronyms

CFA	Confirmatory Factor Analysis
EE	Effort Expectancy
EPC	Electronic Product Code
FC	Facilitating Conditions
HM	Hedonic Motivation
ICT	Information and Communications Technology
IoT	Internet of Things
IS	Information Systems
LBS	Location Based Services
MGA	Multi Group Analysis
NFC	Near Field Communication
PE	Performance Expectancy
PEU	Perceived Ease of Use
PLS	Partial Least Squares
PU	Perceived Usefulness
PV	Price Value
RFID	Radio Frequency Identification
RSN	Robust Secure Network
SD	Self-Disclosure
SEM	Structural Equation Modeling
SHT	Smart Home Technology
SI	Social Influence
SWG	Smart Water Grid
TAM	Technology Acceptance Model
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology
VAM	Value-based Adoption Model
WSN	Wireless Sensor Network

1. Introduction

1.1 Background of the Study

Digitalization and development in the field of information technology has brought about a revolutionary change in our daily life. The impacts of this trend are now seen in different spares of life all over the world. People are becoming interested to adopt these latest digital trends for instance, the Internet of Things (hereinafter refers to as IoT) for making lives smoother, hassle free, convenient and simple (Dutton, 2014). From a general point of view, internet of things is network where physical devices like home appliances, vehicles are connected to an intelligent system consisting sensors, internet connection, software, actuators etc. that helps the system to interact with the devices and exchange data to control the devices (Dutton, 2014). Makori (2017) termed "IoT as a process of connecting devices and objects at homes and environment using intelligent technological systems for real time interaction and sharing of data, information and communication" (p. 657). "IoT is opening tremendous opportunities for a large number of novel applications that promise to improve the quality of our lives" (Xia et al. 2012, p. 1101). The purpose of the internet of things is to create an environment enabled with internet and people will have access to the environment from anywhere, anytime.

One very important aspect of internet of things is its application in home appliances which is known as smart home technology concept. With the advancement of technology, consumption level of energy is increasing day by day though the resources are very limited (Zhao et al. 2015). To reduce the excessive pressure on the energy level, the concept of smart home technology is introduced in recent years. We do not need to control the electronic devices rather they will be controlled by a central system. The smart home technology integrates several home appliances such as lighting system, home temperature controlling tools, security through a programmed system, to just name a few, to bring convenience and economic benefits for the users of these system. The main goal of the technology is to increase comfort in the daily life as well as to achieve efficiency in the energy consumption level and reducing costs in the households.

The market for smart home devices is increasingly growing because of several benefits provided by this technology such as remote access to control the home appliances (Yang et al. 2017), energy conservation through efficient management of the home appliances

(Bhati et al. 2017). Service providers are also coming up with newly designed smart devices in smart home concept. According to a study conducted by Marketsandmarkets (2017) forecasted that the smart home market will be expanded by 13.61% in between the year 2017-2023. Yang et al. (2017); Wong and Leung (2016) stated the factors such as governmental support, support service for efficient backup of the smart devices, user interface of the devices that influence the adoption of smart home technology but the aspect of users' perceptions towards the adoption of Smart Home Technology (SHT) is still untouched. Therefore, this thesis aims to address this gap and to assess the perception towards SHT adoption by the prospective households and individual users and to identify the factors influence their adoption behavior.

1.2 Research Problem

"In the last few years substantial progress has been made in smart home technologies and promises to support and assist us in our daily lives are higher than ever" (Smirek et al. 2016, p. 107). Moreover, most of the people across the world are familiar with this technology at least to some extend and they are very interested to adopt this technology in their everyday lives (Zhai el al. 2014). Another critical issue is energy saving which can be ensured through the implementation of smart home technology, but this aspect is not the core issue in this thesis. Thus, this new trend is influencing the behavior of the prospective users to adopt the technology and achieve a higher standard through smarter living.

1.3 Research Gap

Bhati et al. (2017) stated that the smart home concept as in the initial phage from energy conservation perspective. Studies on several aspects of this concept like- factors affecting the SHT adoption (Yang et al. 2017; Wong and Leung, 2016), technology and methods used in the smart home network (Robles and Kim, 2010), barriers of SHT adoption (Davidson et al. 2013; Khalid and Ahamed, 2015) etc. have been focused already. After reviewing related articles, the author found a few studies that considered the users adoption of smart home technology but using UTAUT 2 framework in assessing users' SHT adoption is missing in the literature. Therefore, this thesis aims to fill the gap in the existing smart home literature.

1.4 Objectives of the Study

The main objective of the thesis is to assess the users' perceptions towards the adoption of the SHT. The author of this thesis set other objectives such as identifying factors affecting the adoption and user experience of the smart home technology. The core objectives are as follows:

- To identify the antecedent factors that influence the adoption and users experience of smart home technology.
- To assess the perceptions towards the adoption of the smart home technology from users' perspective.

1.5 Research Questions

Based on the objectives of this thesis, three research questions have been developed to fulfill the objectives of this thesis. These will help to provide a well structure to this thesis.

The author set the following research questions for the study:

Research Question 1: How do the users evaluate their knowledge of smart home technology before adoption?

Smart home appliances are providing numerous benefits to the life of its users which are of great value (Yang et al. 2017). These values are improving the life and ensure the most efficient use of the limited resources. Thus, the aim is to present users' perception on the smart home technology adoption i.e. how do the users perceive SHT before their adoption of the technology.

Research Question 2: What factors affect the users' behavior towards adopting the smart home services?

According to Zhou et al. (2007), users' attitude towards using a technology must be affected by a number of factors on which an act to be performed depends. Before adopting and using the smart home technology at home, users consider a number of factors that affect their using intention for example, price of the technology. Therefore, this thesis tries to identify antecedent factors from the relevant literature that potentially influence prospective users' behavior to use the technology services.

Research Question 3: To what extent households and individual users are aware of Smart Home Technology?

As the concept of smart home is very new and achieved much attention in last few years, therefore it is necessary to know the perception of the users and their understanding of the concept. Thus, this thesis tries to present an overview on the current knowledge of the respondents on smart home technology issue.

1.6 Outline of the Thesis

The author divided this paper into seven chapters each of which deals with distinct aspects of the thesis. ***Chapter One*** focuses the background of the thesis, objectives set for the thesis and the research questions to fulfill the thesis objectives. ***Chapter Two*** discusses the related literatures in the field of smart home technology, those closely related to this field and the research gap existed. ***Chapter Three*** includes discussion on the relevant theories to support the conceptual model of this thesis. ***Chapter Four*** deals with the conceptual framework under which a research model is developed and hypotheses are formulated to reach the research goals. In ***Chapter Five***, the author develops an appropriate methodology for this thesis. This chapter reveals the ins and outs of the methods used to ensure how the thesis has been conducted. ***Chapter Six*** presents an analysis of the survey responses and discussion regarding the interpretation of the hypotheses. Finally, ***Chapter Seven*** is provided with the discussions on findings of the thesis, implications, future research opportunities and a concluding remark for the thesis.

2. Literature Review

This chapter aims to perform an extensive literature review according to the gap identified in Chapter one.

2.1 Internet of Things

Ashton (2009), used the term internet of things (IoT) for the first time when he was presenting his RFID concept for P and G's supply chain in 1999. Xia et al. (2012, p. 1101) termed Internet of things (IoT) as "The networked interconnection of everyday objects" which works by interacting with human and the devices in the IoT system. Nolin and Olson (2014) discussed the IoT convenience from three aspects where exchange technology interacts with several devices, exchange information about the users' and produces smart services. Personalization allows IoT to adapt users' choices quickly and acts accordingly.

Moreover, the disempowered smartphone owner means that the IoT can be controlled with any devices rather than a smartphone. According to Dutton (2014), services for instance manufacturing, transportation, health care etc. from IoT can change our life with convenience but it could also make IoT less effective while ignoring the privacy and other related issues due to the improper management of IoT. Makori (2017) stated that besides other fields like- supply chain and healthcare IoT also contributing in the academic field as it enhances the access to data, information, communication from any places using wireless connectivity and networking.

2.2 Security Issues in IoT Technology

According to Jing et al. (2014), security issues of IoT can be considered from the perspective of three layers for instance i) perception layer contains Radio Frequency Identification (RFID), Wireless Sensor Network (WSN), Robust Secure Network (RSN) etc. ii) security, transportation layer contains network security and iii) applications layer indicates the application of IoT. According to Maple (2017), confidentiality and privacy are two major security issues in smart technology and these arise from the service provider's systems monitoring and maintenance, which could be an entry point for hacking the users' information. Weber (2010) stated that IoT can influence the security and privacy of the users as the IoT infrastructure is based on the internet and he further

stated to establish legislation and Electronic Product Code (EPC) based IoT infrastructure. According to Sicari et al. (2015, p. 146) security and privacy requirement of IoT should include "data confidentiality and authentication, access control within the IoT network, privacy and trust among users and things, and the enforcement of security and privacy policies". Li et al. (2016) identified four layers of security requirements i.e. sensing layer, network layer, service layer and application interfaces layer and their possible threats for IoT infrastructure.

2.3 Smart Homes

According to Ding et al. (2011, p. 131), "A smart home is a residence equipped with technology that observes the residents and provides proactive services". Robles and Kim (2010) defined smart home as a residence where a program is used to combine human behavior and numerous electronic devices. According to Lobaccaro et al. (2016), smart homes allow a link between the home appliances and the residents of the house and ensure ultimate comfort for the users. Khalid and Ahamed (2015, p. 3) defined that "Smart homes allow the users to control their household instruments remotely from anywhere in the world, schedule tasks and perform various functions that may require human intervention otherwise". According to Linskell and Hill (2010) smart homes can be an appropriate solution for the handicapped and elderly people.

2.4 Adoption of Smart Technology

Zhai et al. (2014), based on their study of 248 samples from Europe and Asia stated that people know about the smart home technology and are very much interested to adopt in their everyday life. Han and Tan (2003), based on their study on the condominium homebuyer's perceptions towards internet home in Singapore stated that they are interested in this new concept and many of them are accepting internet home concept. Petersen et al. (2001), conducted a research based on 110 responses in Melbourne, Australia to examine the value of smart home technology in new home and concluded that there is an interest for basic SHT in the new homes. Kim et al. (2014) stated that privacy issues and security have the most significant effect the adoption of Smart Water Grid (SWG) in South Korea. According to Dey et al. (2016), many hospitals in the USA have started using RFID technology and some are considering using this technology for ensuring operational efficiency and cost reduction. Mącik (2017) found in a study

conducted on the young people's adoption of IoT technology adoption that almost 80% of the respondents have used devices which are IoT enabled in Eastern Poland.

2.5 Factors Affecting the Adoption of Smart Home Technology

Yang et al. (2017) mentioned in a study in South Korea based on 216 samples that six factors, i.e., automation, mobility, interoperability, security and privacy, physical risk and trust influence the adoption of smart home technology the most and customers receive more values from remote networking access to the SHT. In another study Yang et al. (2018) found that controllability, interconnectedness and reliability significantly affected the users' behavioral intention to adopt IoT based smart home services. Wong and Leung (2016) studied the possibility of SHT adoption by the elderly people in Hong Kong and found that government support, backup service and user interface are very influential factors for SHT adoption by elderly people. Peek et al. (2014) stated that several factors for instance cost of the technology, privacy issues, usefulness, usability etc. influence the pre-implementation stage of smart home technology adoption for the older adults. Hojjati and Khodakarami (2016) found that the usefulness, attitude of the customers and the features of the technology are the most influential factors of the adoption of technology based smart buildings.

Balta-Ozkan et al. (2013), identified the factors such as lifestyle, trust, security, privacy, reliability etc. that challenge the adoption of smart home technology based on expert interviews and a survey conducted on the general people. In a further study by Balta-Ozkan et al. (2014) found that reliability, data safety and cost of adopting SHT are key factors in the adoption of smart home technology in the United Kingdom, Germany and Italy. According to Bhati et al. (2017), the SHT for energy conservation is in the development phase and they also found from a study conducted in Singapore that proper integration between governmental service and utility sectors is needed to save energy through smart technology. Mącik (2017) found that performance expectancy and habit influence young people's behavioral intention to adopt internet of things technology at homes in Poland. Courtney et al. (2008) found self-perception of need of the users was the critical factor in their study that influence the older adult in adopting the smart home technology. In a study Kim et al. (2017) found that perceived sacrifice is influential in adopting of smart home services while privacy risk resists potential users' in the adoption of smart home technology.

Thus, it can be concluded that mostly the security and privacy risk, performance expectancy, habit, cost of SHT adoption, reliability of the smart home technology etc. influence the users' adoption behavior.

3. Theoretical Background

In order to have better way of living, people are adopting technology in their daily life. Thus, it has become important to examine the users' adoption of smart home technology and assess the users' perception before SHT adoption. This resulted to the development of several conventional theories in Information Systems (IS) research field. This chapter incorporates the Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA), the Theory of Planned Behavior (TPB), Value-based Adoption Model (VAM), Ontological Theory of Informational Privacy (OTIP) and the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) which are the most relevant theories of technology acceptance and adoption also with the objectives of this thesis.

3.1 Technology Acceptance Model

Technology acceptance model is widely used to study the users' attitudes and acceptance of technology in the field of Information Systems (IS) research. TAM was developed by Davis (1989) from the Fishbein and Ajzen's (1975) theory of reasoned action. According to TAM, users' attitudes towards using a technology is influenced by usefulness of the technology and how easy the technology can be used. Lu et al. (2003) used TAM for their study of users' acceptance of wireless internet and stated Perceived Usefulness (PU) and Perceived Ease of Use (PEU) as "primary determinants of IS adoption (p. 207)". Davis (1989) defined PU as "the degree to which a person believes that using a particular system would enhance his or her job performance" (p. 320). According to Davis (1989, p. 320) "the degree to which a person believes that using a particular system would be free of effort". Figure 1 represents the technology acceptance model with the relationship among different attributes.

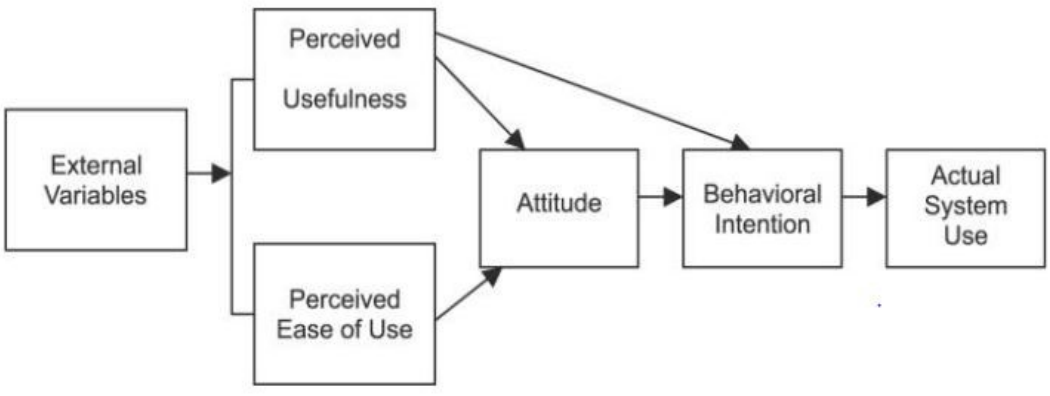

Figure 1: Technology Acceptance Model (Davis, 1989)

Many prior studies such as adoption of teaching assistant robot (Park and Kwon, 2016), wireless internet adoption (Lu et al. 2003), e-payment continuation (Tella and Olasina, 2014), social networks adoption (Pinho and Soares, 2011) used TAM as their primary research theoretical model.

3.2 Theory of Reasoned Action

Theory of reasoned action is also used widely to study the users' attitudes and behavioral intention to use technology in different contexts for example, consumers attitude and behavioral intention towards electronic commerce adoption (Barnes, 2014). The theory was introduced by Fishbein and Ajzen (1975) where they stated that the intention to use any technology depends on the attitude towards using the technology and subjective norm.

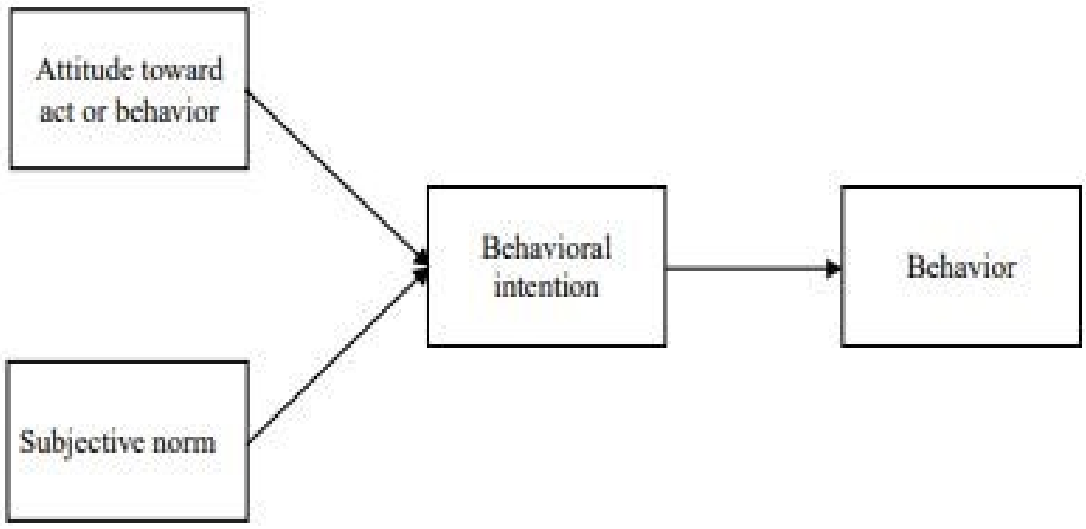

Figure 2: Theory of Reasoned Action (Fishbein and Ajzen, 1975)

Figure 2 presents the theory of reasoned action and the links among different attributes of this model. Attitude has already been mentioned in the earlier sub-section (3.1). Subjective norm is the influence that comes from the social environment. According to Fishbein and Ajzen (1975, p. 302) "The subjective norm is the person's perception that most people who are important to him think that he or she should or should not perform the behavior in question".

3.3 Theory of Planned Behavior

Theory of planned behavior is another theoretical framework that has been widely used to study users' attitude and behavior in technology adoption, for example, green information technology adoption (Dezdar, 2017), technology using intention by teachers and students (Teo and Lee, 2010). This theory was developed from the theory of reasoned action by Ajzen (1991). In TRA, behavioral intention of the users is influenced by their attitude and subjective norm. But in this extended model of TRA Ajzen (1991) stated that along with attitude and subjective norm, users' behavior to use technology can be controlled by Perceived Behavioral Control (PBC). According to Yang et al. (2017), PBC is "a person's perception of the ease or difficulty of performing the behavior, which is assumed to consider past experience and anticipated obstacles and impediments (p. 70)". Many prior studies used TPB as their primary model to conduct the study (Bhattacherjee, 2000; Jalilvand and Samiei, 2012; Yang et al. 2017).

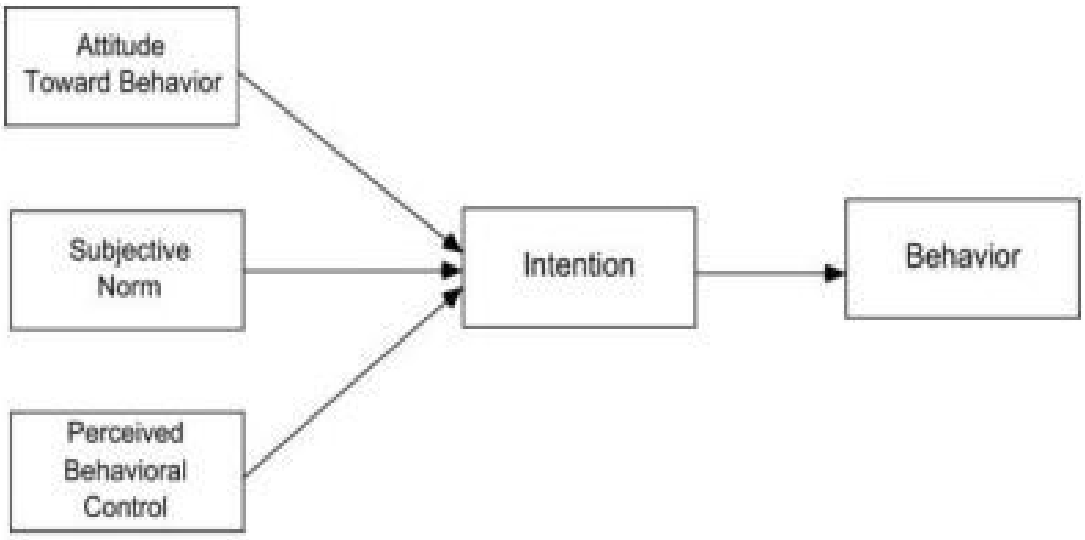

Figure 3: Theory of Planned Behavior (Ajzen, 1991)

Figure 3 represents the theory of planned behavior and the relationship among different attributes of this model.

3.4 Value-based Adoption Model

Value-based Adoption Model (VAM) is used to assess the benefits from the adoption of Information and Communication Technology (ICT) in respect to the sacrifices to achieve the benefits (Roostika, 2012). The model was developed by Kim et al. (2007) to assess

how the tradeoffs between cost and benefits affects the users' intention in the adoption of ICT such as mobile internet (Kim et al. 2012; Roostika, 2012), Enterprise 2.0 adoption (Lin et al. 2010). According to Roostika (2012), the motivation behind this model was "to capture and present adoption of ICT as a comparison between benefits and costs" (p. 21).

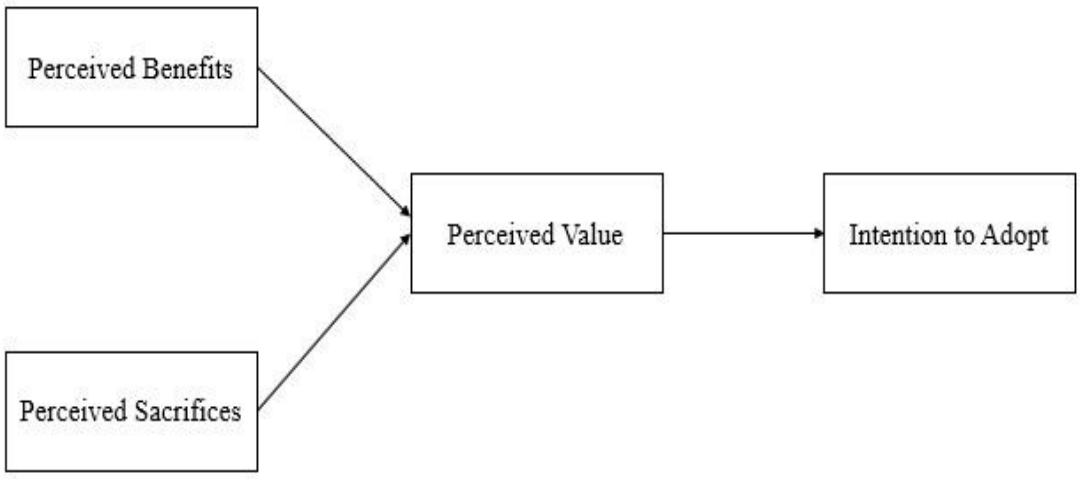

Figure 4:Value-based Adoption Model (Kim et al., 2007)

Figure 4 represents the VAM and the links between the attributes. According to the model when a potential user intends to adopt a technology, he/she must tradeoffs between benefits and cost of adopting the technology. Kim et al. (2007) stated that the tradeoffs between the costs and benefits affect the perception of the users and later, their intention to adopt the technology.

Benefits in the context of this thesis can be the remote access to the smart home technology. On the other hand, Roostika (2012) termed sacrifices as the physical costs or mental efforts for the adoption of the technology. Thus, remote access facility can be considered as a benefit and price for the technology can be considered as a sacrifice for the adoption of SHT.

3.5 Ontological Theory of Informational Privacy

The ontological theory of informational privacy was developed by Floridi (2006), previously known as ontological interpretation of informational privacy (2005). This theory is primarily used in assessing privacy of the users in a networked system. In this theory, Floridi (2006) discussed the term infosphere which is the informational

environment including "all informational entities (thus including informational agents as well), their properties, interactions, processes and mutual Relations" (p. 37). In case of a wireless network environment, information regarding users are available in the infosphere and informational agents might have access to that information. Information gap in the infosphere ensures more privacy of the users i.e. the service providers restricted access to the system or restricted public access to the system. In the context of this thesis, users' security/ privacy in SHT is related to the users' behavioral intention to use the technology. According to a study by Yang et al. (2017) stated that users' privacy i.e., users' personal data for instance, their choices and preferences could be leaked and hacked by the unwanted someone due to using smart home systems. Chou and Yutami (2014) also confirmed the users' concern for the informational privacy in smart meter adoption.

3.6 Unified Theory of Acceptance and Use of Technology 2

The Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) was developed by Venkatesh et al. (2012). The first unified theory UTAUT fits in the organizational context of technology adoption and may not be appropriate to analyze the technology adoption in the consumer context (Tak and Panwar, 2017 and Venkatesh et al. 2012). From this motivation UTAUT has been extended by adding three new constructs i.e. hedonic motivation, price value and habit, and developed UTAUT 2. This theory is also adopted extensively in several users' context of IS research including tourist adoption of smartphone apps (Gupta et al. 2017), mobile app based online shopping (Tak and Panwar, 2017), adoption of e-learning (Tarhini et al. 2017). Figure 5 represents the UTAUT 2 along with their relationship with the key constructs of the model.

According to this model, users' behavioral intention to adopt a technology is influenced by the seven key constructs of this model which later affect their actual adoption of a technology. "Performance expectancy is defined as the degree to which an individual believes that using the systems will help him or her to attain gains in job performance" (Venkatesh et al. 2003, p. 447). Here, in the context of this thesis *Performance Expectancy* (PE) is the users' belief towards the SHT services that by using the services in their everyday tasks, they will be benefitted. For example, in a study conducted by Engotoit et al. (2016) found that by using mobile communication technology farmers can access to their required agricultural marketing information in a faster way.

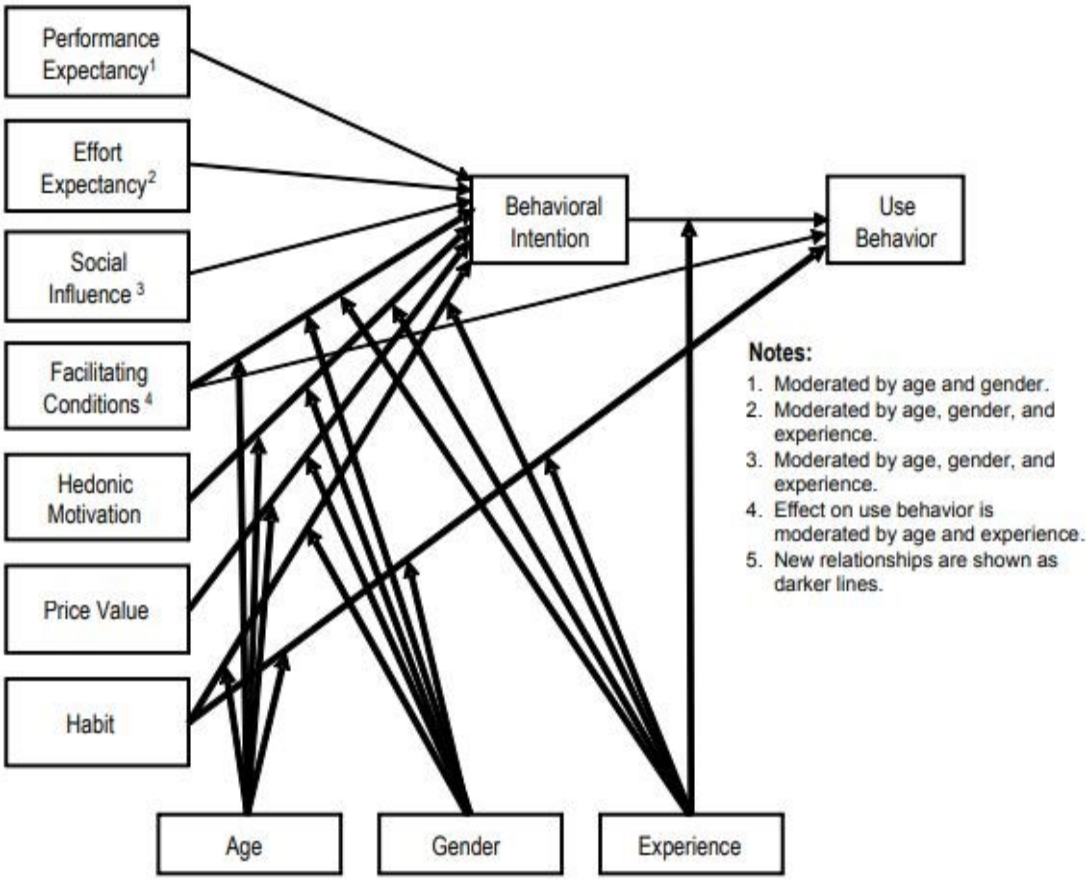

Figure 5: UTAUT 2 (Venkatesh et al. 2012)

Gupta et al. (2018) also found PE as a significant determinant of the adoption of smartphone apps by tourists. Venkatesh et al. (2003) defined, *Effort Expectancy* (EE) as how easily the users can use the technology. EE in this thesis indicates the easy user interface of the SHT technology so that the users can operate the technology with less effort. In an empirical study Davis et al. (1989) found that users of a technology prefer using technologies that is easy to use and provides advantages for its users. *Social Influence* (SI) can be defined as the degree where the people who are important to the users of a technology think that they should use the new technology (Venkatesh et al. 2003). Ajzen (1991) also thinks that the individual's peers have significant influence on the adoption of technology. According to Gupta et al. (2018), SI is a significant factor that affects tourists' behavior to adopt smartphone apps. SI in the context of this thesis is that users are influenced by their social surroundings to adopt SHT services for using. Venkatesh et al. (2003) defined *Facilitating Conditions* (FC) as availability of the infrastructural resources and knowledge to support the use of the new technology. FC in this thesis context are the internet connectivity, smartphones or other wireless devices, knowledge about using SHT etc. to operate SHT services at home. Users' expect pleasure

or enjoyment from the usage of technology. If they do not receive pleasure, they won't be interested to use the technology anymore. *Hedonic Motivation* (HM) indicates the users' pleasure or enjoyment that they receive by using a technology. Venkatesh et al. (2012) defined HM as fun or enjoyment that usually come from technology using. Davis et al (1992) also confirmed the enjoyment as a determinant of behavioral intention in technology usage. In the context of this thesis, hedonic motivation is users perceived pleasure or enjoyment from using smart home technology. When a user intends to adopt a technology, he/she must tradeoffs between benefits and cost of adopting the technology (Kim et al. 2007). Kim et al. (2007) further stated that the tradeoffs between the costs and benefits affect the behavioral intention of the users and later, their intention to adopt the technology. Venkatesh et al. (2012) also confirmed the effect of *Price Value* (PV) of the technology on the users' intention to adopt technology. Thus, cost of SHT and value from it in this thesis context has an effect on the users' behavioral intention to use smart home technology services at home. Limayem et al. (2007) defined "IS habit as the extent to which people tend to perform behaviors (use IS) automatically because of learning" p. 709). Venkatesh et al. (2003) also discusses different levels of experience of using technology where the users' initially start using a technology which later become the habit of technology usage through learning. Therefore, this thesis also considers habit as an antecedent of behavioral intention to use SHT.

The theories and models presented above are extensively used in assessing users' adoption of technologies and their perception towards adoption. In the context of this thesis, UTAUT 2 and OTIP are considered to build a strong theoretical base for the research model of this thesis and fulfill the objectives identified earlier. Because UTAUT 2 has been widely considered for the assessment of users' perception towards the technology adoption in recent years and OTIP is especially important informational privacy concern which presents in SHT services. From this motivation, these two theories have been applied in this thesis.

4. Conceptual Framework

This chapter proposes the research conceptual model based on the theoretical frameworks discussed in the previous chapter and develops several hypotheses in order to examine and assess the path relationships in the proposed model.

4.1 Research Model

Figure 6 presents a conceptual model, considering the factors that affect the adoption of smart home technology. The model aims to strengthen with strong theoretical background discussed in chapter three. UTAUT 2 has been adopted as the basic model along the privacy risk which is important while users consider to adopt the smart home technology. Previous studies also confirmed and validated the use of these theories (see sub-section 3.5 and 3.6) in technology adoption and users' perception towards the adoption.

Therefore, the proposed research model is developed in this sub-section and possible hypotheses will be postulated in the next sub-section. This thesis considers all the factors associated with the adoption behavior of smart home technology and builds a rationale relationship as in the following model. Demographic features of the potential respondents may also affect the respondent's adoption behavior of the smart home services and their perception towards the adoption as well. Thus, gender and age have been considered in the research model as control variable. The key constructs used in the research model are shown in the following table:

Table 1: Key constructs for this research

UTAUT 2	OTIP
• Performance Expectancy • Effort Expectancy • Social Influence • Facilitating Conditions • Hedonic Motivation • Price Value • Habit • Behavioral Intention	• Privacy risk

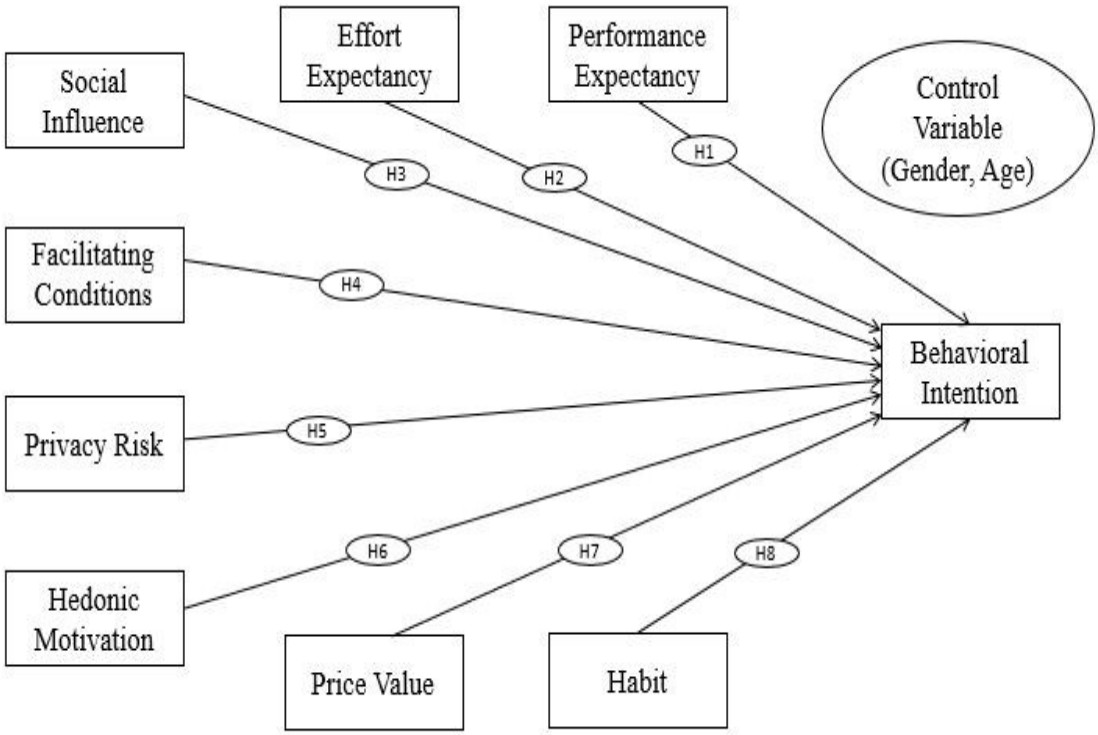

Figure 6: Proposed Research Model

4.2 Hypotheses Development

Performance Expectancy: refers to the benefits that a user will receive from using a technology. PE has a direct influence on the users' behavioral intention to adopt a technology. Mansoori et al. (2018) confirmed the strong effect of PE on the behavioral intention to use e-government services from their study on the adoption of e-government services in Abu Dhabi. Tak and Panwar (2017) also found that PE has a positive influence on the behavioral intention to adopt mobile apps-based shopping in India. In the context of this thesis, it is assumed that PE has an effect on the behavioral intention to adopt SHT services and the following hypothesis is developed:

H1: Performance Expectancy has a positive influence on the behavioral intention to adopt smart home technology.

Effort Expectancy: refers to the effort required by a user to use a technology. A study on 246 employees conducted by Venkatesh (2000) found that the ease of use has a strong effect on the users' intention to adopt information technologies. If a technology requires more effort to use then it will be less useful to its users (Venkatesh and Davis, 2000). Tan and Lau (2016) also confirmed the significant impact of effort expectancy on the

behavioral intention to adopt mobile banking. Thus, in this thesis it is assumed that effort expectancy has an influence on the users' behavioral intention to adopt smart home technology and the following hypothesis is proposed:

H2: Effort expectancy has a positive influence on the behavioral intention to adopt smart home technology.

Social Influence: It refers to the influence from the peers and societal pressure to adopt a technology. At the initial stage potential users of a technology do not have sufficient information regarding a new technology. In this case, they must be informed or influenced by their peers who think that "they should use aa particular technology" (Venkatesh et al. 2012, p. 159). Hu et al. (2003) states that peers' opinions or recommendations concerning a new technology can influence the adoption decision of the users. Theoretical models like TRA and TPB also confirms the effects of this attributes on the behavioral intention to use a technology. So, the following hypothesis is developed for this thesis.

H3: Social influence has a positive influence on the behavioral intention to adopt smart home technology.

Facilitating Conditions: refers to the availability of resources to support the adoption of a technology. If the users don't have the available infrastructures needed for the adoption of SHT, that may affect the users' behavioral intention to adopt and later, their actual adoption of a technology. In this thesis, the resources mentioned in the sub-section 3.6 are considered for the adoption of SHT. Previous studies also confirmed those resources and their impact on the behavioral intention, and actual adoption of technology (Keong et al. 2012; Kijsanayotin, 2009). Therefore, it is assumed that FC affects the behavioral intention to adopt the SHT.

H4: Facilitating condition has a positive influence on the behavioral intention to adopt smart home technology.

Privacy Risk: In case of smart home technology, privacy risk refers to the threats to the privacy of the users. According to Sharma and Sharma (2011, p. 325) a privacy risk is a "circumstance, condition, or event with the potential to cause economic hardship to data or network resources in the form of destruction, disclosure, modification of data, denial of service, and/or fraud, waste, and abuse". In the context of this thesis, privacy risk is

the chance that the users' personal information can be accessed by unwanted people. Maple (2017) stated that although smart home services provide numerous benefits to the users' and ensure efficiency in resource utilization, they also increase the risk which could influence potential users' the behavioral intention to use the services. Yang et al. (2017) stated that users' privacy i.e. users' personal data for instance, their choices and preferences could be leaked and hacked by the unwanted someone due to using smart home systems which could influence their behavior. Thus, with support from the OTIP theory and previous studies it is hypothesized that,

H5: Privacy risk has a negative influence on the behavioral intention to adopt smart home technology.

Hedonic Motivation: Users of a technology expect to have enjoyment while using a technology. This hedonic motivation influences the users' decision whether to adopt a technology or not. Brown and Venkatesh (2005) also stated the importance of hedonic motivation in the acceptance of technology in users' context. According to a study by Kim and Shim (2002), customers use online shopping for enjoyment purposes besides practical purposes. In this thesis, it assumed that hedonic motivation influences the users' behavioral intention to adopt smart home technology and the following hypothesis is proposed:

H6: Hedonic motivation has a positive influence on the behavioral intention to adopt smart home technology.

Price Value: It refers to the trade-off between the expenditure that must have to occur when adopting the technology and the value the users will receive while using the smart home technology. Cost and benefit analysis when adopting a technology has a direct influence on the users' behavioral intention to adopt a technology. Peek et al. (2014) confirmed that the excessive cost of smart technology affects the pre-implementation phase of the smart home technology. Pal et al. (2018) stated that the perceived cost of smart technology-based healthcare services can negatively affect the attitude of the elder people if the cost of adoption is high. In this thesis, it is assumed that cost of SHT can affect the users' behavioral intention to use SHT. Thus, the following hypotheses have been developed:

H7: Price has a positive influence on the behavioral intention to adopt smart home technology.

Habit: Habit refers to users' ways of behaving (Ouellette and Wood, 1998). As mentioned earlier (see sub-section 3.6), users of a certain technology start using that technology in a narrow scope which later, become their habit to use that technology regularly. Ouellette and Wood (1998) further mentioned that "one performed a behavior because of habit provides an understandable explanation for an act" (p. 54). Chen et al. (2015) confirmed the effect habit on the behavioral intention to adopt and actual adoption of teaching blogs. Thus, the following hypotheses is proposed:

H8: Habit has a positive influence on the behavioral intention to adopt smart home technology.

Behavioral Intention: It refers to the users' actual intention to adopt before the final adoption of the technology for using. At this point the users consider the potential value from the technology and then decide whether to adopt the technology or not. Kaufmann et al. (2013) stated that potential users' willingness to pay for smart meters depends largely on the behavioral intention to use the smart meters in Switzerland. In this thesis, it is hypothesized that users' behavioral intention is largely influenced by a number of factors which influences their actual use of SHT in the future.

5. Research Methodology

This chapter deals with the discussion of the methods used to conduct the empirical part of the thesis. First of all, data collection method and construction of the survey questionnaire are presented. Next to this, discussion related to sample and finally, the method for analyzing the survey data. Tools and methods used were chosen carefully by considering the objectives and predetermined research questions of the study.

5.1 Research Design and Data Collection

In this thesis, convenience sampling has been used which is categorized under non-probability sampling. Non-probability sampling method is widely used in different aspects of social science research such as measuring user's behavioral intention (Rowley, 2014). A questionnaire was developed to collect the responses from the potential users of the smart technology. This method helped to acquire detailed information about the users' view regarding the smart home technology. The questionnaire was administered using Webropol[1] online survey tool. The questionnaire has two main sections. In the first section, there are questions related to the demographic characteristics of the users and in the second section, there are 31 measurement items based on 9 constructs depicted in the research conceptual model. Many prior studies such as, Kesharwani and Radhakrishna (2013); Xu and Du (2018) have used 7-point Likert scale to measure users' adoption and perception in their study. Therefore, seven (7) point Likert scale [where "1" represents "strongly disagree" and "7" represents "strongly agree"] deems to be appropriate in this context and will be used to collect data from the potential respondents. After preparing the questionnaire, it was revised by the supervisor of this thesis and modified accordingly. To check the consistency and reliability of the questionnaire, a pilot study was conducted. Again, the questionnaire was revised based on the feedback of the pilot study and the final version of the questionnaire has been developed. The survey was distributed on Wednesday 27.06.2018 and closed on Monday 23.07.2018 with 175 responses. The final version of the questionnaire is attached in appendix B.

5.2 Pilot Study

In both quantitative and qualitative research context, pilot study has a very significant role to play. The aim of a pilot study is to analyze the feasibility of the actual study (Kim,

[1] www.webropol.fi

2010). Usually, a pilot study is done using the initial questionnaire on a limited number of respondents before conducting the actual survey of the study. According to Jalilvand (2012), a pilot study helps to ensure the internal reliability and consistency of the questionnaire. Moreover, Teijlingen and Hundley (2002) stated that a pilot study might help explore the problems in the research process. Pilot study in this thesis was conducted on 15 respondents. It was focused that all the questions in the questionnaire are answer so that a great accuracy can be achieved in the final study. After receiving the feedback from the pilot study, the questionnaire was then modified again and distributed for the final responses for the study.

5.3 Sample

The link to the questionnaire was sent to around 300 people through Facebook messenger. The link was also posted in 7 public Facebook groups for greater number of responses. Moreover, Gmail was used to send the link to some people who are barely active on social networking. In addition to this, the author contacted the marketing officer of Cozify Oy (Smart Home Technology service provider in Finland) to post the questionnaire link in Cozify's online forum. When the survey was closed, a total number of 175 responses were recorded which were sufficient for the study. Hair et al. (2011) recommended a sample size that is ten times bigger than the highest number of structural paths to a latent variable. In this thesis, the minimum sample size should be 80 according to the recommendation of Hair et al. (2011).

Table 2: Demographic features of the respondents

Characteristics	**Frequency (n=175)**	**Percentage (%)**
Gender		
Female	58	33.1
Male	115	65.7
Others	2	1.1
Age Group		
18-24 Years Old	59	33.7
25-44 Years Old	101	57.7
45-64 Years Old	15	8.6
65 Years or Older	0	0

Employment Status		
Student	61	34.9
Employed	78	44.6
Unemployed	22	12.6
Self-employed	14	8.0
Military	0	0
Retired	0	0
Smart Home Technology Usage		
Yes	95	54.3
No	80	45.7

Table 2 shows the demographic information of the respondents. A significant number of the respondents are male which is 65.7% of the total sample size. It is also notable that 57.7% of the respondents are in between 25 to 44 years old. Approximately 45% of the respondents are employed and around 35% are university students. Lastly, 54.3% of the respondents have used the smart home technology previously, indicating that more than 50% of the respondents are aware of the smart home technology.

5.4 Data Analysis

In the field of business research, Structural Equation Modelling (SEM) is a widely used method for analyzing the relationship among different constructs in a model (Ali et al. 2018). Hair et al. (2014) stated two different approaches using SEM which are Co-Variance Based SEM (CB-SEM) and Partial Least Square SEM (PLS-SEM) to test a hypothesized model in a research. To test the proposed research model and the hypotheses, Partial Least Squares (PLS) is applied using Structural Equation Modeling (SEM).

While choosing PLS-SEM in the context of this thesis, there are several considerations such as, according to Hair et al. (2011), the purpose of these approaches is different as CB-SEM is used to test and confirm a theory whereas PLS-SEM is used to predict and develop theory. Since, the goal of this thesis is to assess the effect of the factors towards the perception of SHT adoption therefore, it is appropriate to use PLS-SEM in this thesis context.

Before, applying CB-SEM there are some considerations e.g. normality of data, minimum sample size which must be met (Diamantopoulos and Siguaw, 2000) but in case of the

PLS-SEM there is no such restrictions. Gefen et al. (2000) also confirmed the application of PLS-SEM with small number of samples. Thus, by considering the nature of the data and number of samples, PLS-SEM is the best fit in this thesis context.

By considering the goal of the research and number of sample size, PLS-SEM is the most appropriated approach to be used for analyzing the data. In the next chapter, analysis of the data and results are presented.

6. Data Analyses

This chapter presents a detailed analysis of the data. SmartPLS 3.0 has been used to analyze the data collected from the survey. The analysis is performed in two steps on the proposed research model as presented in chapter 4 (see sub-section 4.1). In the first step of the analysis, the author performed an outer analysis of the research model by evaluating the loadings of the key measurement items. Here, the constructs are also analyzed to check the reliability and validity of the items. In the second step, an inner analysis of the model is performed to test the hypotheses presented in chapter 4 (see sub-section 4.2).

6.1 Outer Model Analysis

To start with the analysis, an assessment on the outer model is performed. Firstly, the factors loadings are computed for each constructs to assess the validity and reliability of the outer model. Hair et al. (2011) recommended a loading of 0.7 or higher for each indicator in the model to be accepted. *t*-Statistics measures the level of significance of the key indicators. Hair et al. (2011) suggested the value of *t*-statistics as 2.58 at 1% level of significance, 1.96 at 5% level of significance and 1.65 at 10% level of significance.

Next to this, assessing the internal consistency of reliability. So far, both Cronbach alpha and composite reliability are used to check the consistency reliability. According to Hair et al. (2014), composite reliability produces better results in assessing internal consistency reliability. Thus, to assess internal consistency reliability, composite reliability measure is used in addition to Cronbach alpha. In this case, the value of composite reliability should exceed 0.70; though in exploratory research the values in between 0.60 to 0.70 are acceptable (Hair et al., 2011). Therefore, higher values of composite reliability increase the internal consistency reliability. The next assessment on the outer model is to examine the convergent validity of each key constructs. Convergent validity is measured in terms of Average Variance Extract (AVE) for each construct. According to Hair et al. (2011), the acceptable value of AVE should be higher than 0.50.

After performing reliability and validity assessment of the key indicators, the next step is to examine the discriminant validity of the indicators of the research model. The discriminant validity is checked using Fornell Larcker criterion in PLS algorithm. According to Hamid et al. (2017), discriminant validity measures the extent of difference in the constructs from one another. The discriminant validity assessment can also be

performed using the cross loadings of the key measurement items in the model. In that case, “An indicator’s loadings should be higher than all of its cross loadings” (Hair et al., 2011; p. 145).

6.1.1 Results Analysis

Table 3 shows the results of validity and reliability of the outer model. While assessing the key measurement items, one item (i.e. FC 1) from facilitating conditions has been deleted as it was producing an outer loading of 0.559 < 0.70 which is unacceptable. According to Hair et al. (2011), if a measurement items produces a value that cannot be accepted should be eliminated from the model.

As it can be seen from the Table 3 that all the measurement items except FC 1 produced an acceptable value of more than 0.70. Hence, the result of the outer loadings indicates a strong reliability of the measurement items. In the next part of the analysis, Variance Inflation Factor (VIF) is examined. Hair et al. (2011) recommended a VIF value of less than 5 for all the key measurements. Here, the value of HT 2 had a VIF value (5.334) exceeding 5 that is why that item has been removed from the model and performed the analysis again. This time, all the VIF values were less than 5 which means the correlation among the indicators in this thesis is significant.

It can be noted from the statistics of the following table that all the measurement items *t*-statistics are significant as they exceeded the values recommended by Hair et al. (2011). Next, Cronbach’s alpha and composite reliability measure the internal consistency of the key constructs. In this thesis, both the values are greater (> 0.70) than the recommended value. Thus, it can be concluded that there is a high level of internal consistency among the key constructs of this thesis.

Finally, AVE values are also acceptable as the AVE values of the nine constructs have exceeded (> 0.50) the recommended value. Therefore, it can be said that convergent validity is highly acceptable.

Table 3: Validity and reliability

Constructs	Items	Factor Loading	VIF	*t*-Statistics	α	CR	AVE
PE	PE 1	0.800	2.283	8.016	0.881	0.918	0.737
	PE 2	0.887	2.867	12.907			
	PE 3	0.874	2.668	13.767			
	PE 4	0.870	2.538	10.602			
EE	EE 1	0.833	2.164	6.514	0.880	0.917	0.734
	EE 2	0.886	2.531	8.412			
	EE 3	0.868	2.424	7.996			
	EE 4	0.840	1.929	7.772			
SI	SI 1	0.913	3.194	12.724	0.904	0.940	0.838
	SI 2	0.932	3.731	13.657			
	SI 3	0.901	2.427	11.920			
FC	FC 2	0.742	1.617	2.542	0.773	0.859	0.671
	FC 3	0.906	1.598	7.923			
	FC 4	0.802	1.547	6.202			
PR	PR 1	0.943	3.516	3.292	0.905	0.940	0.840
	PR 2	0.918	3.346	2.987			
	PR 3	0.888	2.445	3.884			
HM	HM 1	0.924	3.001	15.286	0.868	0.918	0.789
	HM 2	0.927	2.804	10.981			
	HM 3	0.809	1.826	6.793			
PV	PV 1	0.819	1.744	13.350	0.852	0.910	0.771
	PV 2	0.903	2.447	15.939			
	PV 3	0.910	2.546	20.096			
HT	HT 1	0.911	2.769	19.281	0.895	0.934	0.826
	HT 3	0.901	2.489	18.471			
	HT 4	0.914	2.906	19.848			
BI	BI 1	0.883	2.180	22.749	0.861	0.915	0.782
	BI 2	0.894	2.410	21.307			
	BI 3	0.876	2.050	20.861			

Table 4 represents the discriminant validity values. Discriminant validity is assessed following the Fornell and Larcker criterion. According to this criterion, the square root of all AVE values must exceed the value of the correlation with other indicators which indicates that the constructs are not highly correlated to each other. In this thesis, all the discriminant validity scores (diagonal values) are higher than the other correlation values. Therefore, it can be said that indicators are not related to each other.

Table 4: Discriminant validity

	BI	EE	FC	HM	HT	PE	PR	PV	SI
BI	**0.884**								
EE	0.415	**0.857**							
FC	0.427	0.640	**0.819**						
HM	0.537	0.517	0.542	**0.888**					
HT	0.622	0.445	0.342	0.350	**0.909**				
PE	0.570	0.545	0.397	0.529	0.489	**0.858**			
PR	0.279	0.064	0.077	0.075	0.209	-0.039	**0.917**		
PV	0.598	0.484	0.346	0.359	0.716	0.491	0.288	**0.878**	
SI	0.443	0.507	0.467	0.519	0.467	0.628	0.006	0.377	**0.915**

Another method of assessing discriminant validity is to check the cross table of the items loading. The table is attached in appendix A. Here, the value of each indicator should exceed the value of other indicators. Cross loading results also satisfied the requirement. Therefore, it is concluded that the both methods are highly satisfied the assessment of discriminant validity.

6.2 Inner Model Analysis

In this phase of analysis, PLS-SEM analysis is performed to assess the inner model results on *t* values and *p* values. Wong (2013) recommended that the significant path coefficient among the indicators in the model should exceed 0.1 for the hypotheses to be supported. In this thesis, we found the inner model path coefficients using bootstrapping technique in SmartPLS 3.0. According to Hair et al. (2011) the minimum number of the sub-samples in the bootstrapping should be 5000. By considering the minimum number of sample, we have set 10000 as the number of sub-samples for this thesis for greater accuracy. According to Cohen (1994), a value of *p* which is less than 0.05 is significant.

While testing hypotheses, according to Hair et al. (2014) R^2 is another important consideration which indicates the level of variance in the dependent variable by explaining the key indicators those are connected to the dependent variable. Hair et al. (2011) stated that the R^2 value 0.20 or higher is considered as high in consumer behavior research whereas the value of 0.75, 0.50 and 0.25 are considered as substantial, moderate and weak in marketing research. Though Davis (1989) recommended a R^2 value of 0.49 or higher in information systems research. Hypotheses can be tested in bootstrapping as "Paths that are nonsignificant or show signs contrary to the hypothesized direction do not support a prior hypothesis, whereas significant paths showing the hypothesized direction empirically support the proposed causal relationship" Hair et al. (2011, p. 147).

6.2.1 Results Analysis and Hypotheses Testing

Table 5: Hypotheses Testing

Hypotheses	Path	Path Coefficients (β)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
H1	**PE -> BI**	0.281	0.074	3.802	0.000
H2	**EE -> BI**	-0.139	0.071	1.943	0.052
H3	**SI -> BI**	-0.045	0.073	0.616	0.538
H4	**FC -> BI**	0.126	0.075	1.687	0.092
H5	**PR -> BI**	0.165	0.058	2.861	0.004
H6	**HM -> BI**	0.244	0.077	3.172	0.002
H7	**PV -> BI**	0.155	0.087	1.780	0.075
H8	**HT -> BI**	0.294	0.098	2.993	0.003

Table 5 shows the results of the inner model analysis. From the table we can check the level of significance of the hypotheses and see whether they are supported or rejected. The dependent variable, i.e. behavioral intention has a R^2 value of 0.589 i.e. approximately 59% variance.

First of all, performance expectancy (H1: β = 0.281, t = 3.802, p < 0.001) indicates a significant positive influence on the behavioral intention to adopt smart home technology. Thus, H1 is supported by the model. Effort expectancy (H2: β = -0.139, t = 1.943, p = 0.052) means that it has no significant influence on the behavioral intention to adopt smart

home technology. So, H2 is rejected. Social influence (H3: β = -0.045, t = 0.616, p = 0.538) has no significant impact on the behavioral intention that is H3 is rejected. Facilitating conditions (H4: β = 0.126, t = 1.687, p = 0.092) has also no significant effect on the behavioral intention to adopt SHT. Therefore, H4 is also rejected. It is found that privacy risk's (H5: β = 0.165, t = 2.861, p < 0.01) effect on the intention to adopt SHT is significant, but negative, hence, H5 is supported by the model. Hedonic motivation (H6: β = 0.244, t = 3.172, p < 0.01) affects the behavioral intention to adopt SHT significantly. Thus, H6 is supported. Again, price value (H7: β = 0.155, t = 1.780, p = 0.075) indicates no significant effect on the behavioral intention to adopt smart home technology. Hence, H7 is rejected in this study. Lastly, habit (H8: β = 0.294, t = 2.993, p < 0.01) is found to have a significant positive influence on the behavioral intention to adopt smart home technology which means H8 is supported by the model.

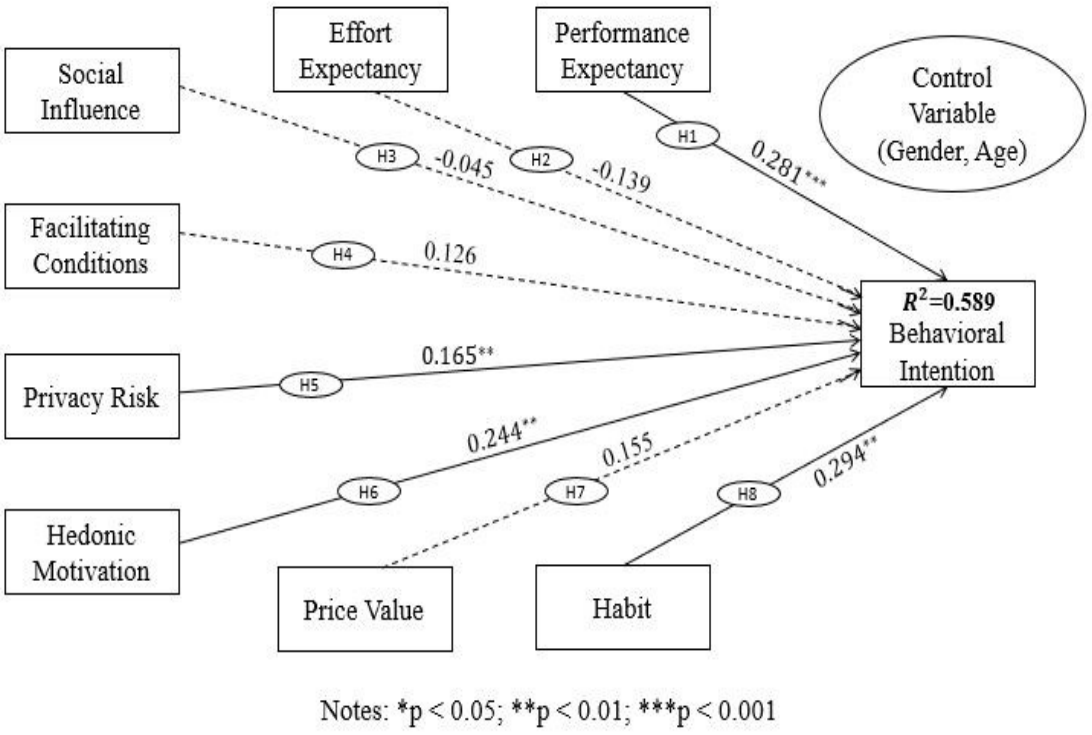

Figure 7: SEM results

Figure 7 presents the hypothesized research model along with the PLS-SEM results of this study.

At this point of analysis, Multi Group Analysis (MGA) is performed to examine whether there are any substantial effect of the gender and age on the behavioral intention to adopt SHT. Here, the effects of gender and age on all the supported hypotheses are checked.

Table 6: Results of MGA

Hx	Path	Path Coefficients (β)	Standard Deviation (STDEV)	T Statistics	P Values
H1	**PE -> BI_male**	0.301	0.094	3.216	0.001
	PE -> BI_female	0.231	0.160	1.440	0.150
	PE -> BI_18-24	0.276	0.115	2.395	0.017
	PE -> BI_ 25-64	0.271	0.110	2.472	0.013
H2	**EE -> BI**_male	-0.089	0.092	0.960	0.337
	EE -> BI_female	-0.208	0.143	1.454	0.146
	EE -> BI_18-24	-0.203	0.155	1.316	0.188
	EE -> BI_25-64	-0.111	0.088	1.253	0.210
H3	**SI -> BI**_male	-0.059	0.094	0.628	0.530
	SI -> BI_female	-0.025	0.180	0.139	0.889
	SI -> BI_18-24	0.141	0.128	1.101	0.271
	SI -> BI_25-64	-0.129	0.103	1.258	0.208
H4	**FC -> BI**_male	0.151	0.093	1.612	0.107
	FC -> BI_female	0.046	0.150	0.309	0.757
	FC -> BI_18-24	0.050	0.142	0.353	0.724
	FC -> BI_25-64	0.147	0.099	1.488	0.137
H5	**PR -> BI**_male	0.139	0.080	1.740	0.082
	PR -> BI_female	0.241	0.131	1.839	0.066
	PR -> BI_18-24	0.296	0.145	2.043	0.041
	PR -> BI_25-64	0.129	0.073	1.773	0.076
H6	**HM -> BI**_male	0.184	0.097	1.896	0.058
	HM -> BI_female	0.368	0.165	2.229	0.026
	HM -> BI_18-24	0.267	0.165	1.615	0.106
	HM -> BI_25-64	0.256	0.099	2.595	0.009
H7	**PV -> BI**_male	0.156	0.117	1.334	0.182
	PV -> BI_female	0.178	0.175	1.019	0.308
	PV -> BI_18-24	0.058	0.182	0.317	0.751
	PV -> BI_25-64	0.192	0.105	1.819	0.069
H8	**HT -> BI**_male	0.284	0.140	2.035	0.042
	HT -> BI_female	0.292	0.163	1.798	0.072
	HT -> BI_18-24	0.383	0.200	1.917	0.055
	HT -> BI_25-64	0.290	0.114	2.537	0.011

Table 6 shows the results of the multi group analysis among the sub-groups (gender and age) of the data. While performing MGA, due to limitation in data, for the third age group i.e. (45-64) and for the third gender category i.e. (others) we could not establish a separate group. Therefore, we have continued the MGA with the two groups with age and gender accordingly. The reason is the low number of responses in these categories which are 15 for (45-64) age group and 2 for others gender category. To solve this issue, we merged the third age group (45-64) with the second age group (25-44) and the third gender category (others) has been removed from the analysis and performed the MGA again. The results show that there are some significant differences in the path relationships when gender and age groups are used as control variables. For example, the result shows that males have a higher significant influence than females in paths between performance expectancy to the behavioral intention to adopt SHT and habit to the behavioral intention to adopt SHT: ($H1_{\_male:}$ $\beta = 0.301$, $t = 3.216$, $p < 0.01$ and $H8_{\_male:}$ $\beta = 0.284$, $t = 2.035$, $p < 0.05$). In case of hedonic motivation, females have higher significant paths than males in the behavioral intention to adopt SHT ($H6_{\_female:}$ $\beta = 0.368$, $t = 2.229$, $p < 0.05$). Again, privacy risk is significant with the age groups (18-24) on the behavioral intention to adopt smart home technology $H5_{\_18\text{-}24:}$ $\beta = 0.296$, $t = 2.043$, $p < 0.05$). According to MGA result, age group (25-64) has a higher significant path than the age group (18-24) in H1, H6 and H8 ($H1_{\_25\text{-}64:}$ $\beta = 0.271$, $t = 2.472$, $p < 0.05$; $H6_{\_25\text{-}64:}$ $\beta = 0.256$, $t = 2.595$, $p < 0.05$ and $H8_{\_25\text{-}64:}$ $\beta = 0.290$, $t = 2.537$, $p < 0.05$).

7. Discussion and Conclusion

In this chapter, discussion regarding the findings of this thesis is presented with concluding remarks. Firstly, key findings are discussed according to the analyses performed in chapter 6. Then the author aims to answer the research questions as mentioned in sub-section 1.5. After that theoretical contributions of this study have discussed and then, the practical implications are addressed. Finally, this study concluded by stating some limitations of this study and leaving some comments on the future research opportunities in this area.

7.1 Key Findings

The main objective of this thesis is to investigate the antecedent factors that influence the user's perception and the behavioral intention to adopt the smart home technology. In this thesis, UTAUT- 2 (Venkatesh et al. 2012) has been used as the basis of the research theoretical model. Performance expectancy, effort expectancy, social influence, facilitating conditions, privacy risk, hedonic motivation, price value and habit were used to assess the users' perception. Results of hypotheses testing can be seen in Table 6.

The findings show that performance expectancy, privacy risk, hedonic motivation and habit significantly influence the behavioral intention to adopt smart home technology. The results are also consistent with the prior studies conducted using UTAUT- 2 (such as Gupta et al. 2018; Tak and Panwar, 2017 and Venkatesh et al. 2012). A study conducted on the adoption of mobile shopping app revealed the significant influence of hedonic motivation and habit on the users' behavioral intention to adopt (Tak and Panwar, 2017). Thus, it can be said that users expect fun and pleasure while using a new technology, later this becomes their habit which influence users' behavioral intention to adopt a technology. On the other hand, Gupta et al. (2018) found performance expectancy, social influence, privacy risk and habit significant but hedonic motivation insignificant in the adoption of travel app by tourists. It is found that performance expectancy is the strongest determinant that influences the users' behavioral intention to adopt smart home technology i.e. users think that it they adopt SHT in their daily life, it will assist them in performing their daily tasks more efficiently. Moreover, privacy risk is another issue that a user considers while he/she thinks of adopting a technology which requires the disclosure of personal information. As in a smart home environment, users' personal data

can be hacked or misused by the criminals from the service providers' databases. Furthermore, it is found that the role of performance expectancy and habit are significant in case of male users' which are also found in Zhao et al. (2015) study. Again, the result shows that the role of hedonic motivation is significant for female users' and this result has consistency with the studies conducted by Talukder et al. (2018) and, Moscardelli and Divine (2007). Lastly, performance expectancy, hedonic motivation and habit were found to be significant determinants among the users' who are aged in between 25-64 years which is consistent with a prior study conducted on the mobile augmented reality adoption by users where it was found that young people are more interested in the adoption of mobile augmented reality (Paulo et al. 2018).

On the other hand, effort expectancy, facilitating conditions, social influence do not significantly affect the users' behavioral intention. The findings indicate that, presumably, the users do not want to put extra effort in case of adopting a new technology. Further, lack of knowledge and resources for using smart home technology are other plausible issues that influence the users' intention to adopt the technology in a negative way. A study conducted by Gupta et al. (2018) also supported the findings regarding effort expectancy and facilitating conditions in the tourists' adoption travel apps in the smartphones.

Finally, the behavioral intention has been explained by almost 59% of the variance, which is acceptable.

Table 7: List of Supported and Rejected Hypotheses

Hx	Hypotheses	Supported?
H1	Performance Expectancy has a positive influence on the behavioral intention to adopt smart home technology.	Yes
H2	Effort expectancy has a positive influence on the behavioral intention to adopt smart home technology.	No
H3	Social influence has a positive influence on the behavioral intention to adopt smart home technology.	No
H4	Facilitating condition has a positive influence on the behavioral intention to adopt smart home technology.	No

H5	Privacy risk has a negative influence on the behavioral intention to adopt smart home technology.	Yes
H6	Hedonic motivation has a positive influence on the behavioral intention to adopt smart home technology.	Yes
H7	Price has a positive influence on the behavioral intention to adopt smart home technology.	No
H8	Habit has a positive influence on the behavioral intention to adopt smart home technology.	Yes

Table 7 represents the list of hypotheses which are supported and rejected in this study.

7.1.1 Role of Performance Expectancy

This study revealed that performance expectancy has a very strong positive relationship with the behavioral intention to adopt. Venkatesh et al. (2003) developed performance expectancy from five constructs such as- perceived usefulness (Davis, 1989), extrinsic motivation (Davis et al. 1992), job fit (Thompson et al. 1991), relative advantage (Moore and Benbasat, 1991) and outcome expectations (Compeau and Higgins, 1995). In prior studies, these constructs had a very significant influence on the users' behavioral intention to adopt a technology. Before adopting a technology, a user usually assesses that how quickly and efficiently the technology would help him/her to finish a specific job. This factor is directly related to their adopting intentions and it is also evident from the results of this thesis as well as some prior studies (e.g. Arif et al. 2018; Isaias et al. 2017). In case of, gender specific effect PE has a greater influence on males than females. Therefore, it can be concluded that the result of this thesis regarding performance expectancy is strongly consistent with prior studies on technology acceptance.

7.1.2 Role of Privacy Risk

There is huge chance of personal data leakage and data misuse while using smart home services. In this thesis, it is found that, privacy risk in smart home technology negatively affects the users' behavioral intention to adopt. In fact, ensuring personal data security has become a concern in almost every digital service. Respondents of a study conducted by Yang et al. (2017) claimed their concerns about safety and security against personal data misuse. In this case, trust of service providers has a great role to play. The service providers of smart home technology can ensure their transparency by assuring the users' regarding their policies to prevent the users' personal data leakage. This study confirmed

that the users especially the females are much more concerned about their personal data security and it is also found that the relationship between privacy risk and behavioral intention to adopt smart home technology is significant. Hence, it is concluded that the results are very pertinent with the previous studies (Chou and Yutami, 2014; Lowry et al. 2014; Lallmahamood, 2007).

7.1.3 Role of Hedonic Motivation

While intending to adopt a technology, a user should consider the perceived enjoyment from using that technology. Venkatesh and Brown (2005) stated that hedonic motivation is an important factor in users' acceptance and use of a technology. In some prior studies (Tak and Panwar, 2017; Brown and Venkatesh, 2012), it has been found that users get influenced by the pleasure derived from using technology such as mobile shopping app, household technology etc. On the other hand, Gupta et al. (2018) stated that hedonic motivation has no influence on the tourists in adopting tourist's smartphone apps and they also found that the relationship between hedonic motivation and behavioral intention to adopt is insignificant. In this study, it is found that hedonic motivation is significantly influence the user's behavioral intention to adopt smart home technology and in case of female users' this influence is more significant than male users.

Finally, it is evident from this study as well as some previous studies (e.g. Tak and Panwar, 2017; Brown and Venkatesh, 2012) that hedonic motivation significantly affects the users' behavioral intention to adopt a technology.

7.1.4 Role of Habit

The role of habit to influence the behavioral intention to adopt smart home technology cannot be ignored. Prior use of a particular technology can motivate users to use that technology in the future. Gupta et al. (2018); Kim and Malhotra (2005) also found habit as a significant factor that influences behavioral intention of the users to adopt a technology. But, Jia et al. (2014) have a very contradictory view regarding the influence of habit on the behavioral intention as they did not find any significant impact of habit on the behavioral intention to adopt a technology. Moreover, we have also found that the habit of using a technology strongly affects the user's behavioral intention which is consistent with many previous studies (Gupta et al. 2018; Kim and Malhotra 2005). In MGA, it is also found that habit influences the behavioral intention of male users which

is higher than the female users'. Therefore, it can be concluded that habit of using a technology strongly motivate the behavioral intention to adopt smart home technology.

7.2 Research Questions

At this point of discussion, the research questions are presented by integrating the findings from this study and also following the literature of this study.

Research Question 1: How do the users evaluate their knowledge of smart home technology before adoption?

The users are mostly concerned about the facilities derived from smart home technology and privacy of their data while using the smart home technology. According to the responses, users think that smart technology will increase their efficiency and productivity in the daily lives.

Research Question 2: What factors affect the users' behavior towards adopting the smart home services?

This study employed all constructs from UTAUT-2 model as factors affecting users' behavioral intention to assess users' perception. It can be stated that performance expectancy, privacy risk, hedonic motivation and habit have been found as important factors that influence users' behavioral intention. Effort expectancy has no influence on the adoption behavior which is also theoretically correct as the users do not prefer to put more effort in learning new technology. Moreover, social influence and facilitating conditions do not also affect the users' behavior.

Research Question 3: To what extent households and individual users are aware of Smart Home Technology?

As previously mentioned that the concept of smart home technology is new, therefore the status of knowledge on this technology should be in the rudimentary level. But we have seen that more than 54% of the respondents have used the smart home technology previously. This means their state of knowledge is higher than what we assumed. Though they do not have sufficient resources to use the technology, they almost have knowledge about this technology which can be an indication of their interest in SHT.

7.3 Theoretical Contributions

This thesis contributes to the smart home technology adoption literature by showing the findings on the potential users' perceptions towards their behavioral intention to adopt. Some prior studies e.g. Yang et al. (2017) have studied the users' adoption of smart home technology or other technologies using theory of planned behavior, technology acceptance model, UTAUT etc. As this thesis applied UTAUT- 2 framework for investigating the users' perceptions therefore it added the following issues in smart home literature:

The findings of this thesis enrich the current smart home literature from a different point of view. Because here the author used UTAUT-2 constructs along with the privacy risk in investigating the users' perceptions towards behavioral intention to adopt smart home technology. Therefore, the success of this can be assessed by comparing with other technology acceptance studies conducted using UTAUT-2 framework. According to UTAUT-2 (Venkatesh et al. 2012) cost of adopting a technology and benefits from that affect the users' intention but in this thesis price value and facilitating conditions seem do not influence the users' behavioral intention to adopt smart home technology. Moreover, according to Talukder et al. (2018) social influence has a positive influence on the users' behavioral intention to adopt fitness wearable technology which in this thesis is found to have an insignificant influence on the users' behavioral intention to adopt smart home technology. Thus, it can be said that users' perceptions vary in different contexts of technology adoption which is evident from this thesis.

7.4 Practical Implications

Besides the theoretical implications, this research also provides some practical implications for the future smart home industry. It is evident from this study that the users prefer smart home technology in a way that it becomes helpful for them in their daily life i.e. performing daily tasks quickly and in an efficient manner. Therefore, while developing a smart technology for home the system developers should design the interface as appropriate as possible so that it can be useful for the users. This study also serves some necessary insights for the service providers as it explored that the users do not want to give more effort in learning new thing and to adopt technology that are not compatible with the existing technologies. Thus, the service providers should bring such

smart home technologies which are very easy to use and compatible with the existing home appliances of the potential users.

Apart from this, privacy of the personal data is a big concern in the smart home technology. This study confirmed the significant impact of the privacy risk in the adoption of SHT by the potential users. A good number of users are feared about the risk of disclosing their personal data to the service providers of the smart home technology. So, the service providers need to be extremely transparent to the users of the SHT regarding the ultimate protection of the users' personal data by ensuring proper security measures for the user database.

Moreover, this study found that the smart home is a matter of fun to its users. Therefore, smart home technology with mobility- related features can increase the user's pleasure and motivate them to use it more. Therefore, this could be a considerable feature in the future smart home services which SHT service providers should consider. In short, by ensuring efficiency in providing service, maintaining service providers trust, minimizing privacy risk and maximum value can increase the number of smart home technology adoption.

7.5 Conclusion

In this thesis, the impact of different factors on the users' behavioral intention to adopt smart home technology has been assessed, applying the UTAUT 2 framework by adding a new construct i.e. privacy risk in it and later, empirically tested. One of the core objectives was to present an overview of the potential users' smart home technology adoption behavior. The author of this thesis used PLS-SEM method, a widely used method in the field of consumer behavior research to conduct this study. The results matched the findings of prior studies. The outer model analysis showed significant loadings for all the measurement items except FC1 and HT2 which have been removed during confirmatory factor analysis (CFA). The inner model analysis confirmed a significant relationship among performance expectancy, privacy risk, hedonic motivation and habit to the users' behavioral intention to adopt SHT. A multi group analysis is also performed using age and gender of the respondents to check whether there is any effect of these variables on the behavioral intention of the users. In this case, performance expectancy confirmed to have the most significant influence on the male in adopting smart home technology. One of the noticeable issues in this thesis is that female users are

more concerned regarding the safety of their personal data while considering to adopt smart home technology. Therefore, ensuring maximum protection of the personal data can increase the number of user in the future.

This study would be useful in expanding the smart home technology marketing as this research has been conducted based on the primary data where potential users' choices and preferences are highly reflected. Service providers can consider these factors while developing smart home services with the goal of capturing a greater number of users for their services. There are some other factors which could be considered in assessing users' perception. Finally, it can be concluded that the adoption of smart home technology can be increased by ensuring safety and maximum satisfaction of its users.

7.6 Limitations and Future Research

Like other studies, this study has also some major limitations. Firstly, in this thesis the author used a biased sampling technique. Moreover, the respondents are mostly from 25-44 age group from which it can be assumed that more respondents from other age groups would give better result. This thesis used all UTAUT-2 framework constructs along with privacy risk in assessing users' perceptions towards SHT adoption. Therefore, it did not consider other important factors e.g. automation, service providers trust, physical risk etc. in the smart home technology adoption which is a major limitation of this thesis.

Smart home technology is growing trend of the present time. This research has been conducted considering the users' perspectives of the smart home technology adoption i.e. how the factors influence users' behavioral intention to adopt SHT. There are a lot of research opportunities in this part of information systems research and this research can be a base for the researchers and academicians of IS research field. This study has been conducted using quantitative data from the respondents thus, a further study can be conducted using qualitative information from the respondents. Future studies may be conducted on the actual users' value perception towards the smart home technology or the issue of trust of the service providers in smart home technology. Moreover, future researches can also be conducted on the adoption of SHT using the factors found significant in this research along with other factors such as, automation, trust, mobility etc. There are also research opportunities from service providers perspective i.e. what they consider while selling the SHT products and services to the potential users'.

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Appendix A: Cross Loadings

	BI	EE	FC	HM	HT	PE	PR	PV	SI
BI 1	**0.883**	0.355	0.375	0.578	0.470	0.490	0.294	0.490	0.368
BI 2	**0.894**	0.335	0.328	0.396	0.608	0.445	0.237	0.542	0.390
BI 3	**0.876**	0.408	0.428	0.446	0.543	0.572	0.209	0.555	0.418
EE 1	0.298	**0.833**	0.513	0.382	0.366	0.499	0.067	0.430	0.453
EE 2	0.385	**0.886**	0.542	0.432	0.440	0.515	0.015	0.510	0.407
EE 3	0.341	**0.868**	0.576	0.526	0.384	0.447	0.097	0.408	0.543
EE 4	0.385	**0.840**	0.560	0.430	0.264	0.413	0.050	0.315	0.351
FC 2	0.173	0.575	**0.742**	0.448	0.116	0.292	-0.173	0.146	0.301
FC 3	0.466	0.526	**0.906**	0.494	0.303	0.352	0.124	0.341	0.387
FC 4	0.302	0.538	**0.802**	0.403	0.307	0.330	0.110	0.300	0.456
HM 1	0.489	0.460	0.478	**0.924**	0.289	0.494	0.079	0.303	0.502
HM 2	0.557	0.481	0.508	**0.927**	0.311	0.523	0.099	0.356	0.480
HM 3	0.350	0.441	0.461	**0.809**	0.279	0.370	0.001	0.294	0.390
HT 1	0.570	0.422	0.315	0.336	**0.906**	0.430	0.179	0.634	0.418
HT 2	0.524	0.323	0.232	0.243	**0.940**	0.395	0.232	0.620	0.374
HT 3	0.577	0.302	0.243	0.270	**0.905**	0.429	0.248	0.652	0.418
HT 4	0.550	0.494	0.378	0.349	**0.897**	0.474	0.141	0.667	0.439
PE 1	0.377	0.521	0.353	0.402	0.414	**0.800**	-0.124	0.338	0.527
PE 2	0.526	0.524	0.309	0.409	0.488	**0.887**	-0.056	0.471	0.527
PE 3	0.466	0.429	0.340	0.480	0.336	**0.874**	-0.023	0.370	0.575
PE 4	0.556	0.417	0.367	0.518	0.393	**0.870**	0.040	0.481	0.535
PR 1	0.299	0.055	0.079	0.059	0.232	-0.014	**0.943**	0.286	0.018
PR 2	0.222	0.049	0.057	0.068	0.152	-0.067	**0.918**	0.228	-0.040
PR 3	0.234	0.074	0.075	0.084	0.210	-0.034	**0.888**	0.271	0.034
PV 1	0.449	0.408	0.266	0.256	0.648	0.302	0.225	**0.819**	0.252
PV 2	0.557	0.444	0.324	0.353	0.614	0.514	0.218	**0.903**	0.375
PV 3	0.560	0.425	0.318	0.329	0.610	0.457	0.313	**0.910**	0.355
SI 1	0.393	0.497	0.431	0.483	0.388	0.607	-0.017	0.320	**0.913**
SI 2	0.386	0.452	0.424	0.488	0.438	0.574	0.009	0.334	**0.932**
SI 3	0.434	0.443	0.427	0.456	0.416	0.544	0.024	0.377	**0.901**

Appendix B: Survey Questionnaire

Dear Participants!

This survey is a part of the master's thesis in Information Systems entitled as **"An Assessment on the Smart Home Technology Adoption: Users' Perspective"**. Your responses are very important and provide invaluable information to the quality of this research.

With the advancement of technology, smart home technology has brought about a revolutionary change in our everyday life. Moreover, the issue of energy conservation is also being focused while at the same time we are considering an improvement in our daily life. From this idea, smart home concept is becoming popular day by day. The main objective of this thesis is to assess the users' adoption of smart home technology, i.e., what antecedent factors influence users' behavioral intention to adopt smart home technology services and products at home.

Please think about the situation where you are considering to adopt the Internet-connected home appliances such as smart refrigerator or smart lighting system and answer the following questions. In order to make you familiar with smart home concept, a short YouTube video ("https://www.youtube.com/watch?v=EzCVpaEb0kQ") is provided, please watch this video before responding to this survey.

Answering this survey may take approximately 10-15 minutes. We follow the ethical rules defined by Åbo Akademi University. If you have any questions or need assistance for the survey, please contact:

Moinul Islam at: moislam@abo.fi or Shahrokh Nikou at: snikou@abo.fi

Thank you for your time and responses to this survey.

Sincerely,

Moinul Islam
Shahrokh Nikou

1. **What is your gender?**
   - □ Male
   - □ Female
   - □ Others
2. **How old are you?**
   - □ 18-24 years old
   - □ 25-44 years old
   - □ 45-64 years old
   - □ 65 years or older
3. **What is your employment status?**
   - □ Student
   - □ Employed
   - □ Unemployed
   - □ Self-employed
   - □ Military
   - □ Retired
4. **Have you ever used Smart Home Technology products or services before?**
   - □ Yes
   - □ No

7-point Likert scale questions: [Strongly disagree – Disagree – Slightly disagree – Neutral – Slightly agree – Agree – Strongly agree].

Concept	Items	References
Performance Expectancy	PE1: I find Smart Home Technology useful in my daily life. PE2: Using Smart Home Technology increases my chances of achieving things that are important to me. PE3: Using Smart Home Technology helps me accomplish things more quickly. PE4: Using Smart Home Technology increases my productivity	Venkatesh et al. (2012)

Effort Expectancy	EE1: Learning how to use Smart Home Technology is easy for me. EE2: My interaction with Smart Home Technology is clear and understandable. EE3: I find Smart Home Technology easy to use. EE4: It is easy for me to become skillful at using Smart Home Technology.	Venkatesh et al. (2012)
Social Influence	SI1: People who are important to me think that I should use Smart Home Technology. SI2: People who influence my behavior think that I should use Smart Home Technology. SI3: People whose opinions that I value prefer that I use Smart Home Technology.	Venkatesh et al. (2012)
Facilitating Conditions	FC1: I have the resources necessary to use Smart Home Technology. FC2: I have the knowledge necessary to use Smart Home Technology. FC3: Smart Home Technology is compatible with other technologies I use. FC4: I can get help from others when I have difficulties using Smart Home Technology	Venkatesh et al. (2012)
Privacy Risk	PR1: Providing the service provider with my personal information would involve many unexpected problems. PR2: It would be risky to disclose my personal information to the service provider. PR3: There would be high potential for loss in disclosing my personal information to the service provider.	Xu et al. (2009)

Hedonic Motivation	HM1: Using Smart Home Technology is fun. HM2: Using Smart Home Technology is enjoyable. HM3: Using Smart Home Technology is very entertaining.	Venkatesh et al. (2012)
Price Value	PV1: Smart Home Technology is reasonably priced. PV2: Smart Home Technology is a good value for the money. PV3: At the current price, Smart Home Technology provides a good value.	Venkatesh et al. (2012)
Habit	HT1: The use of Smart Home Technology has become a habit for me. HT2: I am addicted to using Smart Home Technology. HT3: I must use Smart Home Technology. HT4: Using Smart Home Technology has become natural to me.	Venkatesh et al. (2012)
Behavioral Intention	BI1: I intend to use Smart Home Technology in the future. BI2: I will always try to use Smart Home Technology in my daily life. BI3: I plan to continue to use Smart Home Technology frequently.	Venkatesh et al. (2012)