A Study on Factors Influencing Elderly Intention to Use Smart Home in Thailand : A Pilot Study

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***Abstract*— Thailand has become an aging society because of the growing number of the elderly. This change has reduced the welfare of older persons which has resulted in a decreased quality of life. To improve the elderly's quality of life, a smart home with advanced technology could solve this problem. The objective of this study was to examine the factors that influence Thai elderly intention to use a smart home. The technology acceptance model and the aging characteristic variables were applied to develop the conceptual model. Six factors, namely Perceived Usefulness, Attitude, Perceived Physical condition, Computer Self-efficacy, Perceived Reliability and Subjective norm were tested. The data was gathered from 41 Thai elderly citizens by using an online questionnaire and regression analysis was conducted to analyze the data. The results showed that computer self-efficacy was the most dominant factor that influenced the elderly intention to use smart home, and the preliminary research model was modified from the results of statistical testing. The implications of this study and future research were discussed.**

Keywords—Smart home; technology adoption; Older user; adoption factors; Aging characteristic factors;

I. INTRODUCTION

In recent years, there has been increasing development of the Internet and technologies that lead to enhanced human quality of living. Merging networks with regular household life can initiate smart home technologies. Robles and Kim [1] claim that the definition of smart home technology is the integration of technology and services through home networking for a better quality of living. Dewsbury [2] presented that a smart home can facilitate a person by assisting in daily activities and enable the individual to complete tasks. In more detail, Wang, Saboune, and Saddik [3] defined that smart home refers a home where devices are smart enough to acquire information from the users and their living environment, and use this collected information to serve people better.

Smart home technology gives enormous benefits to elders living alone. For example, smart homes can inform the elderly about their schedule to take medicine, automatically alert a hospital when it detects' the elderly fell down, and also maintain solid relations between elderly and descendants who do not stay with their aging parent by aid or take care of them through this instrument [1].

Diffusion of smart home is evident from smart home business growth. The smart home business model which can provide entertainment, security monitoring, control, and health, will push this emerging market segment from a $25 billion market in 2012 to a $60 billion market by 2017 [4]. In more detail, RnRMarketResearch.com [5] reported that the smart home market share in European countries and America in the coming years is expected to be remarkable and by 2020 the revenue growth is estimated to reach $13.81 billion and $22.4 billion, respectively. They expect the Asia Pacific countries (APAC) smart homes market which operates across APAC that include China, India, South Korea, Japan, Indonesia, Malaysia, Thailand and Vietnam, is projected to have a steady growth in the near future. The revenue growth estimated to reach $9.23 billion by 2020. It is apparent that smart homes in APAC area are not widely used the same as in European countries or America. There are many reasons why the APAC market growth is restrained such as lack of awareness, high price of systems, and complexity of systems. These factors are restricting the market growth [6]. In addition, the reasons which may motivate people in the APAC market to acceptance and adoption of smart homes are the increase in the percentage of ageing population across APAC, saving and management in consumption of energy, assisted living, comfort and convenient lifestyle [7]. Furthermore, continuing development in technology will lead to future smart home systems that will increase in functionality. The new applications will have more utility and compatible with a user's daily life. In 2015 there has been an increase in the types of applications in market, such as healthcare (health alert systems, patient monitoring, etc.), energy management (lighting controls, shading, intelligent thermostats, smart metering and grid-connected controls, etc.), as well as some smart domestic appliances (refrigerators, washing machines, dishwashers, etc.) [8].

This advancement in smart home technologies can be particularly useful for elders who are growing in the number and have an extended life expectancy. According to National Statistical Office, the total population of Thai elderly residents was 10,014,699 in 2014 (about 14.9 per cent of the population) [9]. The proportion of elderly people in the total population will increase to 19.8 per cent in 2025 and to nearly 30 per cent by 2050. This change may imply a reduction in income per capita, savings and investments, as well as an increase in public expenditures for social security, healthcare and welfare of older persons [10]. Moreover, the changing family structures show a decline in family support of the elderly from 7.7 per cent in 2007, These numbers increase 8.6 per cent in 2011 until approximately 10.4 per cent by 2014[9]. Taking care of the

elderly has become more costly in current times. The problem will be especially more significant in developing countries. In Thailand, the government subsidizes money for elderly healthcare expenditure, but it is still not enough. One way to reduce of care expenditures is applying technology in the care process, and one technology is the smart home. In the case of seniors who like to live independently and preferably in their own homes, a smart home is the best way to serve them properly.

In fact, age has numerous effects on technology acceptance and use [11, 12]. For some aging people, they know that smart home technology has the potential to prolong their independent living, but they are still not using it because their perception in the adoption of an innovation depends on how attitudes are influenced by individual perceptions of the characteristics of the innovation [13]. A person's attitude is important for the person to live happily with certain technology. For example, perceived usefulness was defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" [14]. In this case, the effect of usefulness conditions in the form of assisted living and technological infrastructure might be positively influenced by age. So, this study focused on the attitude factors of people that influence elderly intention to use smart home.

II. LITERATURE REVIEW

A. *Smart homes*

The concepts of smart homes have been defined as smart technology in homes to support daily living or have the main objective to provide a comfortable home environment [13]. Moreover, previous studies have defined it in many ways. For example, Cook and Das [15] defined a smart home as acquiring and applying knowledge about the environment and its inhabitants in order to improve their experience in that environment. Ding and his colleagues [16] asserted that a smart home concept was originally developed with objective of providing convenience, improving security, and saving energy. In addition, Demiris and his associates [17] claimed that smart homes use sensors, devices and telecommunication features to enhance residents' safety and monitor their health condition and overall well-being. The smart home was invented to serve the users' needs which can be evaluated in terms of the desired physical, cognitive, functional and social outcomes of the technology intervention and how the technology suits the user's daily routines [18].

Innovations in technologies, such as remote sensors, embedded systems, robotics, wireless mobile networks, supply components to create intelligent ambient systems that can support elderly staying in their home while being medically treated [19]. Smart home technologies' design for elderly can be divided into two types. The first type is self-care technologies which enhance individuals' self-confidence concerning their ability to perform desired tasks. The second type includes telecare technologies designed to support a declined capacity to perform daily routines safely, which includes assistive devices, modifications in the home environment and increasing elderly' awareness of alternatives for the performance of tasks [14].

B. *Diffusion of smart home*

Berg Insight's M2M Research Series presents that smart homes technologies have emerged in the last two or three decades. These technologies have been a niche market either for very rich people or extreme technophiles who wanted to monitor their home or control their lights or window shades remotely [20]. Initial smart home systems focused on security and utility management. However, the newer systems provide users, while at home or away home, with real-time control of almost all the systems in the house. As a result, these systems can support a homeowner's lifestyle with a smarter and more energy efficient home [20].

M2M Research reports that smart homes in North America are the most advanced in the world and 3.5 million systems had been installed by the end of 2012. During the first three quarters of 2014, the smart home market grew strongly and by the end of the year the number of smart home that have been installed reached 10.6 million systems in North America house. Between 2012 and 2019 the number of smart home installation in North America household has been predicted to rise further and it has been projected that it will reach to 38.2 million smart home systems, which is roughly 28 percent of all North American households. In addition, the U.S. will be the major market of smart homes for the whole forecasted period, because of the high adoption rate and continuous development [21].

The smart home systems in European market are still in an early stages and are approximately three years behind North America in terms of penetration and market maturity [22]. The number of smart home usage in the EU27+2 countries (European Union with 27 Members plus Switzerland and Norway) was 1.06 million systems at the end of 2012 [23]. However, the smart home market in the EU grew continuously reach to 2.7 million systems by the end of 2014. Berg Insight M2M forecasted that in the next five years the number of smart homes will reach 29.7 million by 2019, which is about 13 percent of all European households [23].

MarketsandMarkets reports that North America has the highest market share now because smart home systems in this region have the maximum adoption rate [24]. However, there are few reports about smart home adoption in the Asia-Pacific region. This is because of the lacks of awareness, high price of systems, and complexity of systems. These factors restrain the market growth [6]. Nevertheless, there has been predicted that the smart homes market in Asia-Pacific will rise at the highest growth rate amongst all regions, because it is favored by its resilient GDP growth and growing real estate market [24].

C. *Benefits of smart homes for elderly*

Smart home technologies can play an important key role in helping elderly to live independently in their home. Because of the growing elderly population, smart home technologies will be required to support the demands of elderly healthcare and also control healthcare costs which have increased significantly in this era. In more detail, with the rising cost of healthcare, problems of a lack of caregivers or insufficient and inefficient care are more likely to happen. When the elderly person's health weakens depending on their increasing age, it results in

more demand for long-term care [25]. The expenditures for long-term care in Germany, Italy, Spain, United Kingdom and United States of America are predicted to rise markedly [26, 27]. Emerging technology such as monitoring systems, emergency sensor technologies systems, dangerous kitchen appliance detection, fall detection and communication systems can facilitate self-care for the ageing population which should reduce healthcare costs with a good quality of care as caregivers [25].

Moreover, smart homes can support the elderly who have chronic illness and disabled people living alone at home [28]. In case of the elderly who got a chronic diseases, (cardiovascular diseases, diabetes, Parkinson's disease), smart home technologies can provide the infrastructure for coordinating healthcare outside the hospital (scheduling visits with health staff, automating collection of clinical findings and test results) [29]. Home telemonitoring of chronic diseases provides accurate and reliable data, empowers patients, influences their attitudes and behaviors, and potentially improves their medical condition [7]. A few studies claim that some patients emphasized the importance of options in cases of appointments and ways of accessing services which meant that technology can facilitate in providing nursing services in their home [30-32]. So, patients can save time spent on transportation and waiting in long queues in hospitals.

Smart home technologies can be used not only in treatment and healthcare for older people but also to support fitness activities and social interaction which play an important role in elderly peoples' living [19]. Research has shown that socially interaction can help the elderly maintain good physical, emotional health, and cognitive function; hence, staying social active and maintaining relationships are an important part of healthy aging [33]. New technology can encourage the elderly to develop social contacts, interact by new methods with family and friends, share learning, skills, and experience with others in their communities [19].

III. THE RESEARCH MODEL AND HYPOTHESES

Drawing upon the prior empirical findings, this study proposed a conceptual model that combines the strength of TAM theory, Subjective Norm, Perceived Reliability and the additional constructs that capture the uniqueness of the aging characteristic variables namely, Perceived Physical Condition and Computer Self-efficacy.

A. Theory of Technology Acceptance

The adoption of an innovation depends on how attitudes are influenced by individual perceptions of the characteristics of the innovation. The Technology Acceptance Model (TAM) proposed by Bagozzi and Davis [34] has become the most widely used model. This model has been used in many studies to explore the factors affecting an individual's use of new technology [35]. Davis [13] illustrates that the sequential relationship of belief attitude-intention-behavior in TAM. This enables researchers to predict the use of new technologies by users. In fact, TAM was extended from Theory of Reasoned Action (TRA) in terms of Information System (IS) by adding perceived usefulness and perceived ease of use and removing subjective norm to evaluate user adoption [13].

Due to the perceived innovation characteristics of TAM, the perceived usefulness has often been used for modeling consumer intentions. According to Salovaara and his associates study [36], senior citizens willingness to adopt technology depends strongly on its perceived usefulness. Previous studies on Information Communications Technology (ICT) of elderly groups have demonstrated that economic aspects may not be a significant factor in influencing the adoption of new technologies if the benefits of technology for a user are well presented [37]. Thus, the first hypothesis is proposed for Perceived Usefulness and Intention to use a smart home:

Hypothesis 1: Perceived usefulness increases the intention to adopt smart home services.

Previous studies of technology acceptance theory [38, 39] have identified attitudes as a factor of behavioral intention, which in turn determines behavior. So, attitudes refer to individual feelings regarding specific behaviors [40]. Because smart home is an innovative technology, the behavior intention of consumers should be influenced by the attitude of users. Applying the TAM model to this study, if users have a high perceived usefulness of a smart home, they should have a positive attitude toward acceptance of the smart home and be more likely to adopt it. Therefore, the next two hypotheses are:

Hypothesis 2: Perceived usefulness positively affects attitude toward smart home service.

Hypothesis 3: Attitude positively affects behavior intention to adopt smart home service.

B. Perceived Reliability

Information technology services associated with humans usually involve personal information transmission, which can cause doubt in users about risks related to service reliability and privacy protection. Regarding previous stuies, perceived risk has two main elements related to using technology services. The first concerns the technical performance or functional reliability of the service delivery systems, and the second concerns issues of personal privacy and security [41].

According to previous research by Vijayasarathy[42], privacy in the case of online shopping processes as defined means the extent to which a consumer believes that shopping online will not compromise his or her privacy, and security is the extent to which a consumer believes that making payments online is secure. The reliability aspect was referred to in the previous study [43], as the degree to which a consumer believes that a new technology will perform a job consistently and accurately. In the same study, perceived security indicated concerns about transaction security in terms of cybercrime or errors in transactions. This type of security includes the aspect of feeling safe when transmitting personal information through the network. Thus, reliability is hypothesized that:

Hypothesis 4: Perceived reliability increases intention to adopt smart home services.

C. Subjective norm

Subjective norm is the degree to which an individual believes that people who are important to them think they should perform the recommended behavior. This has been found to be positively associated with perceptions of usefulness and intention to use a system [44]. Li, Valacich, and Hess [45] demonstrated that Subjective Norm is the social perception of pressures which are put on individuals to trust or distrust in a particular context. According to study of Venkatesh and Morris [44], when co-workers thought that a system was useful, a person was likely to think it the same way. Thus, the next hypothesis is:

Hypothesis 5: Subjective norm positively affects behavior intention to adopt smart home service.

D. Perceived Physical Condition

Aging consists of bio-physical and psychosocial continuous changes [46, 47]. During the aging process, individuals face gradual changes that affect the way they interact with and respond to their environment. For example, regarding the physical aging process, it leads to gradual losses to the sensory and motor systems and a decline in physical and cognitive capabilities, which may cause the elderly to experience greater difficulties in adopting innovative technologies[48]. In more detail, there is much previous research related to the effect of physical conditions on the elderly adoption behavior. For instance, research by Ryu, Kim, and Lee [49] explained that perceived physical condition had a significant negative influence on the intention to participate in video UCC services. Then, in this study, perceived physical condition is used as inhibiting conditions that decrease the expectancy of elderly to use smart home services. This is the basis of the following hypothesis is:

Hypothesis 6: Perceived Physical Condition is negatively related to smart home service behavioral intention

E. Computer Self-efficacy

Computer Self-efficacy is specified as the extent to which an individual has confidence to perform a specific task or accomplish a specific goal [50]. Bandura [51] defined self-efficacy as ‘‘People’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performance. It is concerned not with the skills one has but with judgments of what one can do with whatever skills one possesses”. Also, Compeau and Higgins [52] identified that computer self-efficacy as a belief in one's capability to use the computer. Another definition states that Computer Self-efficacy refers to a judgment of one's capability to use a computer. It is not concerned with what one has done in the past, but rather with judgments of what could be done in the future [53]. When an individual has more experience of computer use, they will have more concerns of control over personal information. Then Computer Self-efficacy has a positive effect on the behavioral intention to use IT system. The following hypothesis is proposed:

Hypothesis 7: Computer Self-efficacy positively affects behavioral intention to adopt smart home service.

F. The Proposed Research Model

This research applied TAM as a fundamental theory into the concept of the behavioral intention to use an IT system. Based on theory, an individual’s belief is usually presented by result of the behaviors to determine their attitudes. Moreover this study views the aging characteristic as a consumer’s belief that impacts behaviors. In addition, previous studies attempted to find the factors which play important roles in terms of consumers’ reliability in electronic health care service because these characteristics have effects on the level of consumers’ acceptance [14]. Therefore, this study will implement these characteristics in this research model Fig. 1 and Table I show the constructs and their operational definitions.

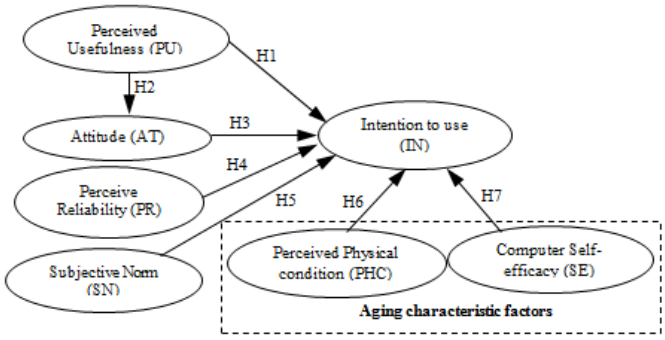

Fig. 1. The research model with hypotheses

TABLE I. RESEARCH CONSTRUCTS AND MEASUREMENTS

Construct	Operational definition	Source
Perceived Usefulness (PU)	The degree to which a person believes that using smart home services would enhance his or her job performance.	Davis, 1989 [13]
Attitude (AT)	This represents an individual’s attitude toward smart home services.	Fishbein and Ajzen, 1975 [40]
Perceived Reliability (PR)	The degree to which a consumer believes that smart home services will perform a job consistently and accurately.	Lee s and his associates, 2003 [43]
Subjective Norm (SN)	This represents an individual’s perception that most people who are important to him think he should or should not use smart home services.	Venkatesh V. & Morris M. G. ,2000 [44]
Perceived Physical Condition (PHC)	These represent the beliefs of one’s physical difficulties of vision, hearing, and motion that may be faced in everyday life using smart home services.	Deng, Mo and Liu,2014 [48]
Computer Self Efficacy (SE)	This is the extent to which an individual has confidence to perform a specific task or accomplish a specific goal.	Bandura,1997 [50]
User intention to use (IN)	This represents an individual’s intention to use smart home services.	Davis, 1989 [13]

IV. RESEARCH METHODOLOGY

A. Participants

The population sample for this research consisted of Thai elderly citizens. To investigate the diversity of older people's perception, the age of this study starts with people who are in the period of pre-retirement (55-60 years) and ends with the period of dependent living up to the end of life (more than 70)[54].

B. Measurement instruments

The design and development of the questionnaire followed structured steps adapted from Zikmund [55] and Frazer and Lawley [56]. The measurements were based on the literature review. It used a 5-points Likert scale ranging from 1 for strongly disagree to 5 for strongly agree to measure agreement or disagreement with statements regarding the measurement items. The final questionnaire consisted of 26 questions, including the definition and concept of smart home. In more detail, the features, functionalities, and advantages of smart home were also explained. The detailed questions of each construct are listed in Table II.

C. Data collections

The questionnaires were pilot tested online to ensure feasibility and compliance with the objectives of the research and to make sure of the content validity of the questionnaire. It was conducted for one week and distributed to colleagues and acquaintances who were more than 54 years old. Those elderly people were accessible by using the snowball sampling technique. Online social media was used to distribute online questionnaires. Sampled participants were requested to send the online questionnaire to other friends and family members through online social media to increase the sample size. This data collection is volunteer-based. Only the participants who voluntarily answered the questionnaires were studied.

TABLE II. Measurement Items

No.	Quest. No.	Items	Mean	Std. Dev.	Corrected item-total Correlation
Perceived Usefulness					
1	C1	A smart home would be useful in Assisted living.	4.27	0.775	0.625
2	C2	I expect my interaction with and information from a smart home would be clear and understandable.	3.85	0.727	0.704
3	C3	Using a smart home might result in clear benefits for following up my own health and treatment.	4.10	0.800	0.780
4	C4	A smart home would be an efficient way to communicate with health professionals.	3.85	0.823	0.849
N of Cases = 41.0		**N of Items = 4**	**Alpha = 0.877**		
Attitude					
1	C5	Using smart home services is a good idea.	4.24	0.734	0.695
2	C6	Using smart home services will encourage me to manage my health more actively.	3.98	0.851	0.755
3	C7	I like the idea of using smart home services.	4.22	0.759	0.834
N of Cases = 41.0		**N of Items = 3**	**Alpha = 0. 875**		
Perceived Reliability					
1	C8	Using a smart home would not frustrate me because it would have effective performance.	3.68	0.650	0.731
2	C9	I would not worry, whether a smart home would be as effective as I think is uncertain.	3.63	0.698	0.756
3	C10	I believe that smart home services are reliable.	3.76	0.663	0.703
4	C11	Information received through smart home services is as reliable as it would be on paper.	3.73	0.672	0.729
N of Cases = 41.0		**N of Items = 4**	**Alpha = 0. 924**		
Subjective Norm					
1	C12	I will install a smart home in my house if those who influence my behavior think I should.	3.83	0.771	0.731
2	C13	I will install a smart home in my house if my colleagues who are important to me think I should.	3.85	0.727	0.756
3	C14	I will install a smart home in my house if people in my social network do.	3.73	0.742	0.703
4	C15	I will install a smart home in my house if people whose opinions I value prefer that I use one.	3.83	0.667	0.729
N of Cases = 41.0		**N of Items = 4**	**Alpha = 0. 874**		
Perceived Physical Condition					
1	C16	Using smart home services would require me to exert more effort to perform usual daily activities.	3.32	0.789	0.710
2	C17	Using smart home services would limit the kind of activities I can perform.	3.34	0.617	0.637
3	C18	Using smart home services would cause me to have difficulty in performing daily activities.	3.05	0.773	0.600
N of Cases = 41.0		**N of Items = 3**	**Alpha = 0. 802**		
Computer Self- efficacy					
1	C19	I could complete jobs by using a smart home, if I had never used a system like it before.	4.00	0.632	0.745
2	C20	I could complete jobs by using a smart home, if I had only the manuals for the reference.	3.78	.0652	0.730
3	C21	I could complete jobs by using a smart home, if I had just the built-in help facility for assistance	3.66	0.693	0.788
4	C22	I could complete jobs by using a smart home, if I had used similar systems before to do the same work	4.02	0.570	0.612
N of Cases = 41.0		**N of Items = 4**	**Alpha = 0. 865**		
User intention to use					
1	C23	I would like to install a smart home in my house.	3.63	0.799	0.759
2	C24	Using a smart home in my house would be a wise idea.	3.85	0.691	0.773
3	C25	Using a smart home in my house would be pleasant.	3.68	0.850	0.694
4	C26	Given that I have access to Smart home, I predict that I would use them.	3.85	0.727	0.739
N of Cases = 41.0		**N of Items = 4**	**Alpha = 0. 881**		

V. . RESEARCH FINDINGS

This research used SPSS 11.5 to analyze the collected data such as descriptive statistics, reliability tests and regression analysis. There were 41 eligible respondents who passed the post screening questions and they were used for further analysis in this study.

A. Content validity

The measurement items in the questionnaire were adapted from previous studies. To ensure content validity, a preliminary test with two experts was performed to assess its logical consistency, comprehension, order of items and contextual significance after the necessary changes were made to improve both the content and clarity of the questionnaire.

B. Reliability Test

The assessment of the measurement model was examined by the internal consistency of the measure. Internal consistency for reliability was calculated using Cronbach's alpha.

As shown in Table III, all variables were tested for reliability. The Cronbach's Alpha of all variables exceed the recommended lowest limit (0.7) [57, 58]. In addition, Hinton and his colleagues [58] have suggested four cut-off scores for reliability, which included excellent reliability (0.90 and above), high reliability (0.70-0.90), moderate reliability (0.50-0.70) and low reliability (0.50 and below). As seen in Table III, Perceived Physical Condition (PHC) showed a Cronbach's Alpha at 0.797 which was the lowest score among all variables. For five constructs, namely Perceived Usefulness (PU), Attitude (AT), Subjective Norm (SN), Computer Self-efficacy (SE) and User Intention to Use (IN), each had a Cronbach's Alpha of more than 0.80. All of these variables had high reliability. Accept the alpha value of Perceive Reliability (PR) had excellent reliability at 0. 924. Therefore, all items were acceptable and reliable to measure the constructs.

TABLE III. RELIABILITY OF INSTRUMENT

Construct Criteria	Item Num.	Cronbach's Alpha >=0.7
Perceived Usefulness (PU)	4	0.878
Attitude (AT)	3	0.873
Perceive Reliability (PR)	4	0.924
Subjective Norm (SN)	4	0.873
Perceived Physical condition (PHC)	3	0.797
Computer Self-efficacy (SE)	4	0.866
User intention to use (IN)	4	0.878

C. Descriptive Statistics

The important demographic characteristics of the respondents are presented in Table IV. The respondents were mostly female (80.5%) and aged between 55 to 60 years (87.8%).The majority of respondents was married and had children (65.9%), had graduated with a bachelor's degree (56.1%), and had an income in the range of more than 45,001 baht per month (50.3%).

TABLE IV. PROFILE OF RESPONDENTS IN THIS SURVEY

Characteristics	Number (persons)	Percentage
Gender		
• Male	8	19.5
• Female	33	80.5
Age		
• 55-60 years	36	87.8
• 61-65 years	3	7.3
• 66-70 years	2	4.9
• >70 years	0	0
Marital status		
• Single	5	12.2
• Married without children	27	65.9
• Married and had children	3	7.3
• Others	6	14.6
Educational level		
• Primary school (P1-P6)	0	0
• Secondary school (M1-M3)	0	0
• Vocational school or equivalent	2	4.9
• High school (M4-M5)	2	4.9
• Bachelor degree	23	56.1
• Master degree or higher	12	29.3
• Others	2	4.9
Personal income (Baht / month)		
• Not more than 15,000 baht	2	4.9
• 15,001-25,000 baht	6	14.6
• 25,001-35,000 baht	7	17.1
• 35,001-45,000 baht	6	14.6
• More than 45,001 baht	20	48.8

The means of all measurement items were well above the neutral position (m > 2.5) as detailed in Table II, which indicate a strong level of agreement among respondents on each of the statements used for measuring variables in this survey. All items of measurement were accurate and had an appropriate description of each construct as shown by their high and positive corrected item- total correlation. All items were above 0.3. The Cronbach's Alpha coefficients of all constructs were close to 0.8 or higher which indicated a high internal consistency of the scales used in measuring different observed variables in this study.

D. Hypothesis Testing

Correlations among study variables are reported in Table V. As can be seen from the table, there was a significant relationship between Perceived Usefulness (PU) and Attitude (AT). The Pearson correlation coefficient (r) was high at 0.909 more than 0.8. Hinton and his colleagues [59] have advised that if there is high relationship between variables (correlation >0.8), one of these variables should be eliminated from study. This is because a high correlation between the different items will indicate the same thing; hence, there will be small error.

For the rest of constructs, there were no high correlation values between variables, so they were not the same variables.

TABLE V. CORRELATION MATRIX

Construct	PU	AT	PR	SN	PHC	SE	IN
PU	1	.909	.721	.595	-.003	.664	.688
AT		1	.674	.682	-.094	.519	.686
PR			1	.661	-.008	.634	.642
SN				1	-.041	.560	.679
PHC					1	.240	-.002
SE						1	.700
IN							1

The measurement model was performed by the regression analysis with a total of 41 cases. The hypotheses testing, the results of the hypotheses related to the constructs, and relationships in the structural model are summarized in Table VI. The relationships between six exogenous constructs, namely, Perceived Usefulness, Attitude, Perceived Physical Condition, Computer Self-efficacy, Perceived Reliability and Subjective Norm with one endogenous construct: Intention to use, were tested by multiple regressions. The results of these relationship, which is shown as model (a) in Table VI revealed that 72.4 % of the variance in Intention to Use can be explained by variance in the six constructs (R^2 = 0.724, F = 14.840, p < .001). Computer Self-efficacy was the greatest influence on Intention to Use (β = 0.431, t = 2.875, p < .01). The rest of the postulated constructs with Intention to Use smart home were rejected in this study, namely Perceived Reliability (β = 0.293, t = 1.735, p >.01), Attitude (β = 0.192, t = 0.710, p > .01). Relationships of the other three constructs, namely Perceived Usefulness (PR), Subjective Norm (SN) and Perceived Physical Condition (PHC) with Intention to Use smart home had low coefficients (β = 0.03, β = 0.02,β = -0.029, respectively). However, model (a) was supported.

The results of Model (b) in Table VI show that Perceived Usefulness had an influenced on Attitude. The findings indicated that about 86.2 % of the variation in Attitude can be significantly explained by Perceived Usefulness (R^2 = .862, F = 244.276, p < .001; β =. 929, t = 15.629, p < .001). Therefore, hypothesis 2 was supported. The research model with the analysis results is illustrated in Fig. 2.

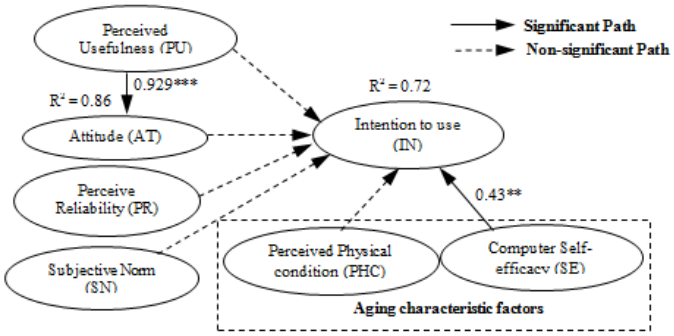

Fig. 2. Research model with factor loading and significane

TABLE VI. REGRESSION ANALYSIS RESULTS

Model	R^2	Hypothesis	Relationship	β	Significance at p<0.01
(a) IN = PU+AT+PR+SN+PHC+SE	0.724	H1	Perceived Usefulness (PU)→ Intention to use (IN)	0.030	X
		H3	Attitude (AT)→ Intention to use (IN)	0.192	X
		H4	Perceive Reliability (PR)→ Intention to Use (IN)	0.293	X
		H5	Subjective Norm (SN) → Intention to use (IN)	0.020	X
		H6	Perceived Physical Condition (PHC) → Intention to Use (IN)	-0.029	X
		H7	Computer Self-efficacy (SE) → Intention to use (IN)	0.431	√
(b) PU=AT	0.862	H2	Perceived Usefulness (PU)→ Attitude (AT)	0.929	√

VI. DISCUSSION

This study was conducted to explore the factors influencing Thai elderly Intention to Use smart home. The predictive of the regression model of this research was significant in both models a and b (Table VI), R^2 value (0.724, 0.862) demonstrates that all independent variables can explain variation in dependent variables [59]. Therefore, the factors in this study are important for understanding elderly Intention to Use smart home in Thailand.

In more detail, the outcome of this pilot study found that Computer Self-efficacy (SE) had a strong, direct and positive relationship with Intention to Use (IN). The results of this study are consistent with a previous study, Barbeite and Weissm[60] presented that Self-efficacy for specific activities was a very powerful construct for predicting behavior, especially for advanced activities. It was the most consistent predictor of use and comfort. In this case, as using smart home in daily life is quite new in Thailand, Self-efficacy is one factor to motivate elderly adopt it. It can imply that Thai elderly respondents who have confidence to use new technology will be highly possible to adopt smart home in their lives.

Even though, the results of this study showed that there was not a significant relationship between Perceive Reliability (PR) and the Intention to Use a smart home (IN), Standardized Coefficients (β = 0.293) of two variables was the second high of postulated constructs. Therefore, this factor is meaningful for this research. Due to the study of Lee, Lee, and Eastwood [61] presented that the reliability aspect referred to the degree of a user believes that a new technology will perform a task consistently and accurately. In the pilot study, the majority of participants were aged between 55 to 60 years. This age group is still working, so they have chances to use new technology related to their jobs. According to their experience, they would be more likely to make decision to adopt smart home.

Perceived Usefulness (PU) had significant effects on Attitude (AT) (β=.929, p<0.001). This result was similar to the finding reported in Taylor and Todd [39], which indicated that

Perceived Usefulness had indirect influences on Behavioral Intentions towards system use. It demonstrated that the more useful older users perceived from the adoption of a smart home, the more likely that they would have a more positive attitude toward smart home. Then they would be more likely to use these services. However, in the stage of correlation analysis, there was high relationship between Perceived Usefulness variables and Attitude (r =0.909, correlation >0.8), so the Attitude variable was removed from this research. According to a previous study, Davis [62] argued that two distinct beliefs, Perceived Usefulness and Perceived Ease of Use, were sufficient enough to predict the user attitude towards the use of a system. Afterward, Davis [63] found that Attitude did not fully mediate the Perceived Usefulness and the Perceived Ease of Use, so a modified TAM removed the Attitude construct from the model. Furthermore, Davis and his colleagues [64] claimed that an individual might have a strong behavioral intention to use the system without forming any attitude when the given system was Perceived Useful. Then the new version of TAM has the Perceived Usefulness of the system influenced directly to Behavioral Intention.

Finally, both Subjective Norm and Perceived Physical Condition had no significant relationships on the Intention to Use a smart home (IN). Subjective Norm is contrary to previous study [65, 66], the suggestion from relatives and close friends does not influence respondents to adopt a smart home. Even if these services are available, they would be too expensive to afford. In this case, people who have financial condition might dominate over the influence of other factors. Moreover, if their attitude is negative to use smart home, it is strongly possible to refuse using a smart home. For the aspect of Perceived Physical Condition, elderly who have difficulties in physical such as movement or hearing that may be accustomed in everyday life. Then this problem might not affect their Behavioral Intention. However, Carpenter and Buday [67] suggested that smart homes should be properly designed living environments particularly for users have physical limitations. In fact, healthy persons are more likely to adopt a smart home if this technology can support their independence and delay the need for regular nursing [68]. In summary, the smart home is a new technology for respondents. Most of them expressed their willingness to learn to use this technology, and believed that if they were trained properly, they could learn quickly.

VII. Conclusion

Due to the advancement of technologies such as smart homes, it can make life easier and more convenient. The advantage of a smart home is that it can improve the quality of life. Especially, aging people can take benefit from this technology which allows the elderly to maintain living independently such as saving healthcare cost. However, to successfully adopt a smart home the elderly's attitude and perception must be concerns. This study was conducted to identify factors of elder acceptance of smart homes. The research applies the TAM variables (Perceived Usefulness, and Attitude towards use of new technology), the Aging characteristic variables (Perceived Physical Condition and Computer Self-efficacy) together with two research variables (Subjective Norm and Perceived Reliability). This pilot study found that Computer Self-efficacy were critical factors that influenced elderly Behavioral Intention towards the use of a smart home in Thailand.

The results presented in this paper will benefit both academics and practitioners. For the academics, the paper sketches out a conceptual model of elderly adoption of smart homes in Thailand. The constructs and their relationships identified from this pilot study are illustrated in modified model (Fig. 3.) For practitioners, according to the results, Computer Self-efficacy was the most dominant factor that influenced elderly Intention to Use smart homes. The definition of Computer self-efficacy is said to be, "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performance. It is concerned not with the skills one has but with judgments of what one can do with whatever skills one possesses" [51]. It can imply that elderly will have confidence to use new technology when they have experienced or are familiar with existing technology. So, the developers should design a user-friendly familiar interface and provide a help function such as a voice menu for aging users. These features have a special importance for elderly users who have limited cognitive abilities.

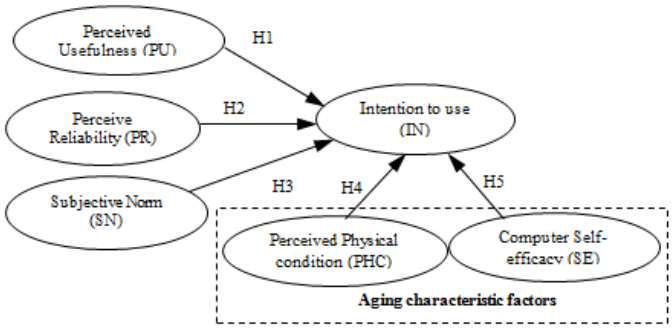

Fig. 3. The modified research model with hypotheses

VIII. Limitations and Directs of Future Studies

This study was conducted to examine the factors influencing Thai elderly Intention to Use smart homes. As the limited numbers of the sample might not be the correct representatives of the real situation in Thailand. There are some recommendations for future studies. First, the sample should be increased to gather more data and should be draw in more respondents from different regions in the country by using different sampling techniques such as Cluster Sampling to get more diversity of traits and characteristics from different respondents. This may enhance the validity and generalization of the research finding which can represent the true behavior of elderly in Thailand. Second, this paper represents a pilot study to examine that the survey was properly developed corresponding to objectives of the research. Consequently, the survey will be modified based on the feedback obtained from the pre-test such as eliminating redundant and ambiguous questions, adding clarity or examining the consistency of some items. Then all the questions will be clear and concise. In more

detail for future study, to ensure the perception or understanding toward Smart Home concept of participants who will answer the questionnaire, they will be instructed to watch the sample film about smart home through website. Subsequently, the participants will be asked to answer the questionnaire. Finally, this study focused on people's attitude factors influencing elderly Intention to Use a smart home. However, the results revealed that the attitude variable was not significant in the relationship between Attitude and the Intention to Use a smart home. It can imply that there may be other factors affecting the elderly's intention to use a smart home. For the future research, the study should not only focus on people's attitudes but also on external factors such as financial influence should be considered to further find out what factors that influence the elderly to use a smart home in Thailand.

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