2020-1097 IJOI
http://www.ijoi-online.org/

AN INTEGRATED TECHNOLOGY ACCEPTANCE MODEL TO APPROACH THE BEHAVIORAL INTENTION OF SMART HOME APPLIANCE

An-Chi Liu
College of Business Administration,
Fujian Business University,
Fuzhou, R.C.A.
e-mail : goforangela@qq.com

Tsung-Yu Chou*
Department of Distribution Management,
National Chin -Yi University of Technology,
Taichung, Taiwan
e-mail: arthur@ncut.edu.tw
*Corresponding author

Abstract

Smart home appliances are equipment programmed to run from a central system that can be remotely controlled by users, often by a mobile app. Base on the technology acceptance model (TAM), this study explores the impact of innovation adoption (IA) and computer self-efficacy (SE) of smart home appliances on behavioral intention (BI).

Users and potential users of smart home appliances are the survey respondents of this study. By the internet questionnaires, 282 out of 326 valid respondents are gathered, from June to August in 2019. The results indicate that innovation adoption and computer self-efficacy exhibited significantly positive effects on perceived ease of use (PEU) and perceived usefulness (PU). PEU and PU positively affect attitude (AT) and

AT positively affect BI significantly.

Keywords: Smart home appliance, Technology acceptance model, Innovation adoption, Computer self-efficacy, Attitude, Behavioral intention

Introduction

Smart home appliances enable consumers to live casual and smart lifestyles. Examples of such appliances includes automatic coffee maker brewing coffee once the consumer awakes, Siri (Apple's virtual assistant) providing information about room temperature and electricity consumption, and others like refrigerators, washing machines, heating and air conditioning units, and lighting devices, connecting to the internet through Wi-Fi. Even without being home, consumers can view home appliance statues through apps on mobile devices and remotely control those devices, including switching them on and off, setting them to turn on at a certain time, and commanding these devices to complete certain operations. According to a report by the market analyst that smart home appliances market is expected to reach $38.35 billion by 2020, with the compound annual growth rate of 16.6% during the forecast period of 2015-2020. Smart home appliances are next generation conventional home appliances, equipped with advanced features for receiving, processing, and transmitting information via smart phones, tablets, and laptops (Rajput, 2018).

Many studies used TAM as the prediction of technology acceptance (Purnomo & Lee, 2013; Persico et al., 2014), because TAM had been proved to be an excellent model to verify technology adoption (Park, Kim, & Kim 2014; Purnomo & Lee 2013). Multiple theoretical models had attempted to explain consumer's attitude, perception, beliefs, and behavior, including theory of reasoned action (TRA) (Ajzen & Fishbein, 1980), theory of planned behavior (Ajzen & Madden,1986), and technology acceptance model (TAM) (Davis, 1986). TAM is most commonly used in research about system science, and has been employed to evaluate consumer's acceptance, adoption, and behavioral intention toward online learning (Lee, 2008; Persico et al., 2014), smartphone (Park & Chen, 2007; Joo & Sang, 2013), and electronic medical system (Holden & Karsh, 2010). TAM is also used to conduct consumer behavior analyses of e-shopping (Ha & Stoel, 2009) and wearable technology (Turhan, 2012; Nasir & Yurder, 2015). The common usage of TAM is because

it is simple and been supported by empirical studies. Researches also find out the study of TAM could assist with business process applications. Thus, the result by evaluating the promotion of innovative products based on TAM can assist businesses in establishing marketing strategies for new products and prompt higher consumer acceptance of new technology products. So, this study use TAM in the prediction of consumer's acceptance and behavioral intention to adopt smart home appliances.

Innovative consumers are defined as those who have higher product expectation, more sensitive toward technology innovation, and exhibit a greater desire to purchase new product. Holak (1998) stated that when evaluating consumer acceptance of new product, product attributes and consumer traits should also be considered. This is because innovative features and consumer's acceptance level is influenced by product attributes. The consumer's traits are the major factor for adoption and usage of innovative product. The diffusion of innovation theory focuses on how consumer perceive innovation, and can be used to help managers to understand, identify, and respond to early innovative consumer (Bartels & Reinders, 2011; Rogers, 2003). Common factors that influence consumer adoption include relative advantage, compatibility, complexity, and measurability (Vowles et al., 2011). Therefore, for the adoption model of new product, consumers' purchase intention not only influenced by perceived product attributes and external variables but also by consumers' traits. This paper discusses the traits and technology literacy level of consumers that adopt smart home appliances.

Self-efficacy is that people believe in their abilities to organize and complete the task which require achieving certain performance (Bandura, 1995). Computer self-efficacy is based on Bandura's (1977) theory of self-efficacy. Computer self- efficacy involves individual's self confidence in computer-related works and how comfortable they feel when using new technologies (Cheng & Huang, 2013; Jeng & Tseng, 2018). In addition, computer self-efficacy also plays an important part in the influencing of PU and PEU of new technology systems. In this study, we will try to find out if the computer self-efficacy affects PU and PEU of smart home appliances.

Research on the consumer behavior of smart home appliances catch much less attention comparing with other types of consumer behavior re-

search. Therefore, research on the behavior model of consumers' acceptance of smart home appliances is critical. Further investigation should be conducted to figure out factors that influence consumers' acceptance of innovative products to assist the promotion of new products and understand consumer perception. This study employs the TAM to analyze consumer behavior.

The research objectives of this study are as follows:

1. Establishing the consumer acceptance model for smart home appliances.

2. Evaluating the consumer acceptance model established in this study.

Literature Review

Literature Related To Smart Home Appliances

Smart home appliances are appliances or home use–related electronics that have one or more smart functions. Smart home appliances must have smart attributes that are perceivable to consumer. Smart technology involves communication between artificial intelligence and control devices. The most commonly used smart technologies include fuzzy control, neural network control, and expert control.

The smart home is a fully automated residence, using computing device and home appliance that conform to a common internet standard so that everything may be controlled by a computer (Noh & Kim, 2010). It is a place with fully digitalized home appliance where people obtain audio, data, and images directly through the Internet. The aim of a smart home is to provide the consumer with all digitalized content through digitalized products at any place and time. This allows consumers to connect different devices through a network (e.g., computer, audio and video entertainment system, camera and security facility, and other electronic mobile device) even when the consumer is not home. studies suggest that future home will feature an Internet gateway that connects to the outside network. The gateway would also provide home communication function, connect home-use smart home appliance, and monitor home appliance.

Innovation Adoption (IA)

Rogers (2003) defines innovation as an idea, practice, or object that is perceived as new by an individual or individuals. Innovation adoption and

the diffusion of innovation theory have been commonly used in many areas, especially in evaluating user behavior for innovation, technology, and new system. Many innovation-related variables have been proposed and verified. Among those proposed variables, the perception of innovation characteristic (Rogers, 2003;Greco & Fields, 1991) and individual difference (Dickerson & Gentry, 1983; Greco & Fields, 1991; Eastlick, 1996) have been verified as effective predictors for consumer behavior for innovations.

Rogers (2003)," Diffusion is the process through which an innovation (an idea perceived as new) is communicated through channels over time among the members or social system." And the innovation decision process of the decision-maker consists five stages: knowledge, persuasion, decision, implementation, and confirmation stages. After recognizing and perceiving the innovation, the decision-maker decides whether to adopt or reject the innovation in the implementation stage. If negative information regarding the innovation is received in the confirmation stage, the decision-maker may change his or her attitude toward the innovative product. Regarding technology, the more the consumer understands an innovative technology, and more oversight the consumer has of the technology will influence his or her future usage behavior. Numerous studies have proven the characteristics of an innovative technology influence consumers' confidence in using the technology (Eastlick, 1996). Rogers (2003) states that when the individual perceives that the innovation is relative advantage, compatible, not complex, observable, and divisible for trial use, the individual would adopt the innovative technology more easily.

Computer Self-Efficacy (CS)

Compeau and Higgins (1995) develops the measurement of Computer self-efficacy based on Bandura's (1986) self-efficacy theory. Longstreet, Xiao, and Sarker (2016) refer computer self-efficacy as a perception which reflects an individual's confidence of personal computing technology related capabilities. Computer self-efficacy refers to judge one's computer skills (Oostrom, Linden, Born, & Molen, 2013; Compeau & Higgins, 1995). It is concerned what a person could do in the future rather than what this person has done in the past. Furthermore, this theory does not refer to judge one's subskills to perform simple tasks, such as entering formulas in a spreadsheet or formatting diskettes. Rather, it measures one's skills to perform broader tasks, such as analyzing finan-

cial data or preparing written reports.

There are three dimensions in the context of computer self-efficacy (Compeau & Higgins, 1995), which are magnitude, strength, and generalizability. Magnitude of computer self-efficacy reflects to the expected level of capability. People with a high computer self-efficacy magnitude would perceive themselves could accomplish more difficult computing related works than those with lower computer self-efficacy magnitude. Strength of computer self-efficacy means the level of believes about the confidence an individual perceives regarding to his or her ability to do the computing related tasks discussed above. That is, individuals with high computer self-efficacy would believe themselves could fulfill more difficult jobs (high magnitude), and they would also show more confidence about their capability to accomplish those tasks successfully. Self-efficacy generalizability means a person's judgement about his or her ability to do the works in different domains. Regarding to computing context, these domains are about different hardware and software structure. This means, people with higher computer self-efficacy generalizability would also have more confidence to use different kind of computer system and software.

Technology Acceptance Model

Origin of the TAM.

The core of the TAM is to evaluate technology acceptance and the usage behavior of users. Numerous theoretical models have been constructed to explain users' attitude, perception, belief, and behavior. These models include the diffusion of innovation, Theory of Reasoned Action (TRA), theory of planned behavior, and TAM. Among those, TAM is the most commonly used in the literature on information systems and technology (Morosana & Jeong, 2008).

TAM is developed from TRA (Fishbein & Ajzen, 1975) to discuss the relationship between behavioral intention and actual behavior. The purpose of TAM is to simplify TRA. Through simplified TRA, TAM explains common usage behavior of user related to the information technology and systems (Davis, 1989). In addition, TAM can explain the usage behavior of user who accept the new information technology and systems and factors influencing this acceptance.

TRA is used to explain and predict behavior under special circumstance (Legris et al., 2003). There are

two crucial assumptions in TRA (Ajzen & Fishbein, 1980). The first is that most people can control their behaviors, and those actions are rational. The second assumption is that individual's behavioral intention influences the actual behavior. Behavioral intention is defined as the willingness of an individual to perform a certain behavior and is influenced by two factors, individual's attitude and subjective norm (Ajzen & Fishbein, 1980). Individual's attitude is his or her feelings about performing the behavior, and subjective norm is a person's perception about what important people to him or her would expect him or her to do.

Variables of the TAM.

The following are explanations of each variable of the TAM (Davis, 1989):

Perceived Usefulness(PU)

Perceived usefulness refers to the degree to which users believe that using a system would improve job performance (Davis, 1989). If users believe that using a system would help them to perform better, their attitude toward using the system would be positively influenced.

Perceived Ease of Use(PEU)

Perceived ease of use refers to the degree to which users believe that a system is easy to use and would not require many efforts to use (Davis, 1989). When users believe that a system is easy to use, they would be more willing to work with the system. As a result, users will present positive attitude toward using the technology.

Attitude Toward Using (AT)

Attitude toward using refers to the response of a user when facing a specific concept or target (Vijayasarathy, 2004). The attitude toward a behavior is defined as an individual's evaluation of a behavior which involves an object or outcome. If the user has a positive attitude toward a new system, then he or she will exhibit stronger intentions to use it (Shih, 2004).

Behavioral Intention to Use (BI)

There are plenty of researches have proven that behavioral intention is positively correlated with actual behavior, and behavioral intention is the measurement of an individual's acceptance of new technology or media (Morosana & Jeong, 2008). TAM suggests that behavioral intention is

mainly influenced by perceived usefulness and ease of use.

TAM assumes that usage of a technology is decided by consumer behavioral intention. In addition, TAM explains the relationship between perceived usefulness, perceived ease of use, attitude toward using, and behavioral intention on using technology. According to TAM, consumer behavioral intention is mainly influenced by AT (AT = PU + PEU), and PU to the system is also connected to BI (PU-BI link). Additionally, different external variables (e.g., personal factors and group factors) influence PU and PEU in a system, which in turn indirectly affect AT and BI, and BI would influence individual's actual usage of the system (Davis, 1993).

Methodology

Research Structure

According to the research objectives and related literature review, smart home appliances are classified as new technological products, which require more involvement of consumers' behavior. Therefore, this study first uses innovation adoption and self- efficacy as the external variables that influence user perception of the usefulness and ease of use of a new technological system (Figure 1). Definitions and hypotheses of variables in this study are as follows.

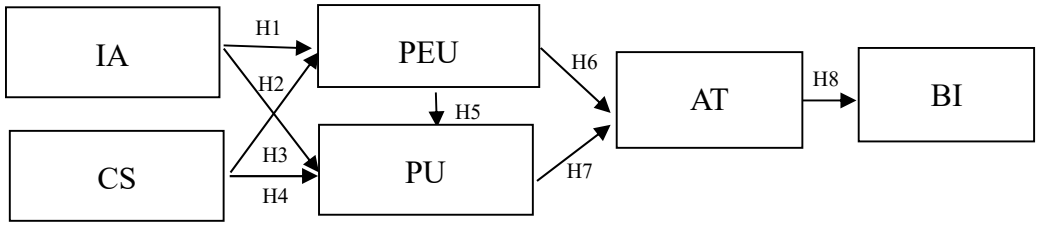


Figure 1. Research Structure

Research Hypothesis

This study adds two variables, consumer innovation adoption and computer self-efficacy into the TAM for two reasons. First, smart home appliances are innovative products for most consumers, so their acceptance for innovations would affect their behavior. Second, most smart home appliances require smart phones or computers to work with, so consumers' self-efficacy would decide if they have enough confidence to work on the new system connected to devices. Many researches have proven that PEU in-

fluences PU on the acceptance of new technology, and both PEU and PU for new technology would affect consumers' attitude and behavioral intention directly or indirectly (Davis, 1989; Moon & Kim, 2001).

Innovation Adoption (IA)

According to Rogers (2003), when an individual perceives an innovative technology has relative advantage, compatibility, trialability, and observability in addition to less complexity, the individual will show more interest to adopt the technology. In this study, innovation adoption is defined as consumer's evaluation of perceived relative advantage, compatibility, triability, observability, and complexity of a product. Researches also have proven IA is positively related to PEU and PU (Hubert et al., 2019; Al-Rahmi et al., 2019; Nasir & Yurder,2015; Godoe & Johansen, 2012). Therefore, we propose the following hypotheses:

H1: IA has a significantly positive influence on PEU

H2: IA has a significantly positive influence on PU

Computer Self-Efficacy (CS)

Scholars have found computer self-efficacy plays an important part for individuals to adopt new technology. Additionally, studies have pointed out that computer self-efficacy has a positive impact on PEU and PU in technology adoption (Jeng & Tseng, 2018; Zainab, Bhatti, & Alshagawi, 2017; Mensah, 2016). This means, individuals with more computer self- efficacy would accept new technology easier, because they have more confidence in their ability when using new technology (Oostrom, Linden, Born, & Molen, 2013). Cazan, Cocoradă and Maican (2016) states that computer self-efficacy is a good predictor for the PEU of computer use. Consequently, the following hypothesizes derived:

H3: CS have a significantly positive influence on PEU

H4: CS have a significantly positive influence on PU

Perceived Ease of Use (PEU)

Davis (1989)," Perceived ease of use (PEU) refers to the degree to which the prospective user expects the target system to be free of effort." As this study aims on the discussion of consumers' using intention to smart home appliances, PEU is defined herein as the degree of ease of use perceived by customers on smart home appliances.

If consumers perceive that an appliance is easy to use, they will be more willing to explore the system's functions, thereby positively influencing their attitude toward using that system.

Perceived Usefulness (PU)

Davis (1989) defines perceived usefulness as "the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context." This study discusses consumer usage intention toward smart home appliances, and defines perceived usefulness as the deal that smart home appliances provide on improving daily life. If individuals perceive smart home appliances could improve their life qualities, they would express a more positive attitude toward using smart home appliances.

Davis (1998) has proven there is a positive relationship between PEU and PU. So do other researches also have verified that PEU relates to PU positively (Hubert et al., 2019; Al-Rahmi et al., 2019; Park et al., 2017; Zainab, Bhatti & Alshagawi, 2017; Mensah, 2016; Avcilar & Ozsoy, 2015; Joo & Sang ,2013; Venkatesh et al., 2003; Szajna, 1996). If users perceive a system is ease of using, they will also perceive the system is usefulness. Based on the arguments, it is hypothesized that:

H5: PEU has a significantly positive influence on PU

Attitude (AT)

Vijayasarathy (2004) defined attitude as a person's tendency to show a certain response towards a concept or object. According to Babin and Harries (2014), "attribute is relatively enduring overall evaluations of objects, products, services, issues, behavior, or people". For the evaluation of consumers' attitude toward using smart home appliances, this study defines attitude toward using smart home appliances as "consumers' evaluation on using new smart home appliances."

Davis et al. (1989) uses the TAM to analyze corporation employee behavior. They reveal there is significantly positive correlation between PEU and system usage, and discovers that PEU influences AT directly. Many studies have also proven that PEU has a positive effect on customers attitude (Al-Rahmi et al., 2019; Park et al., 2017; Hsu & Lin, 2016; Avcilar & Ozsoy, 2015; Lin, 2007; Pavlou, 2003). This indicates that the more suppleness perceived by users, the more they per-

ceive that the technology is easy to use, when adopting the technology, this will lead to a positive attitude toward using the technology. From above, the following hypothesis is proposed:

H6: PEU has a significantly positive influence on AT

According to Davis et al. (1989), there is a significantly positive correlation between consumers' system usage and PU, which indicates PU directly influences AT. Oher researchers also agree that there is a positive association between PU and AT (Al-Rahmi et al., 2019; Park et al., 2017; Hsu & Lin, 2016; Avcilar & Ozsoy, 2015; Lin, 2007; Pavlou, 2003; Adams et al., 1992). In summary, when users comport more positive attitude toward a technology, they will have greater intention to use it. Thus, we hypothesize:

H7: PU has a significantly positive influence on AT

Behavioral intention (BI)

Ajzen and Madden (1986) defines behavioral intention as a person's affirmed likelihood that he or she will perform a certain behavior. To discuss consumers' BI to using smart home appliances, this study defines BI as "the affirmed likelihood that the consumer is willing and intending to use smart home appliances."

Davis et al. (1989) indicates that when users' BI is derived by their positive attitude toward a technology, they will be more willing to use it. Some other researches also have proven the favorable attitude towards the system will positively affect behavior (Park et al., 2017; Avcilar & Ozsoy, 2015; Shin, 2013; Ajzen, 2005). Therefore, we propose the following hypothesis:

H8: AT has a significantly positive influence on BI

Questionnaire Design

This study evaluates the relationship between consumer's innovation adoption, self-efficacy, PEU, PU, AT and BI on the using of smart home appliances. The instruments in this study contain 7 parts, all of them are modified from prior studies. Five-point Likert scales are adopted to measure the items in this survey, ranging from 1 meaning (strongly disagree) to 5 (strongly agree). All measurement items are adapted from previous studies (See Table 1). A pretest was conducted among 6 experts in the field to verify all items in questionnaire. The comments collected from these experts

Table 1. Research Instruments

Variables	Definition	Items	Sources
IA	Consumer's perception of adoption new ideas or objects.	2	Rogers (1995)
CS	Consumer's perception of computing technology related capabilities.	6	Compeau and Higgins（1995）
PEU	Consumer's perception of efforts to use smart home appliances	4	Davis （1989）
PU	Consumer's perception of the probability of improving job performance by using smart home appliances.	4	Davis （1989）
AT	Consumer's evaluation of using smart home appliances.	6	Davis （1989）
BI	Consumer's intention to use smart home appliances.	5	Davis （1989）

led to several minor modifications of writing and sequence of items. Furthermore, a pilot study was conducted involving 20 customers having experiences in using smart home appliances. The purpose of pilot test is to make sure that the survey is explicit and understandable to responds. The questionnaire was further modified based on the comments and suggestions from pilot study. Besides, a preliminary reliability analysis was conducted and exhibited that the Cronbach's alpha values of all constructs exceeded 0.8. Which supports further proceeding of data collection.

Data Collection.

The data were gathered from customers who have experiences in using smart home appliances through an online survey, during three months period. There were 282 valid respondents from 326 origins, 44 respondents with miss values were deleted.

The demographic profile of the

respondents is summarized in Table 2. Among the respondents, 60.7% are male, 37.3% are between 31 to 40 years old. In terms of education, with 70.7% of the respondents are graduated from college, which indicates this survey is composed by highly educated respondents, and 42.9% of the respondents' monthly income is under 30,000 New Taiwan (NT) dollars.

Table 2. Demographic Characteristics of Respondents

Measure	Items	Frequency	Percentage
Gender	Male	184	60.7%
	Female	119	39.3%
Age	< 30	98	32.3%
	31-40	113	37.3%
	41-50	71	23.5%
	> 50	21	6.9%
Education	Graduate or above	49	16.2%
	College	212	70.0%
	High school or below	42	13.8%
Monthly income (NT dollars)	< 30K	130	42.9%
	31-45K	88	29.0%
	46-60K	53	17.5%
	60-80K	19	6.3%
	>80K	13	4.3%

Results

Validity Tests

Convergent validity of the scales was verified using two criteria suggested by Fornell and Larcker (1981). According to Table 3, the 6 variables of the research model, IA, CS, PU, PEU, ATT and BI are cognitive. The factor loading is between 0.77 and 0.95 (exceed 0.7 threshold). The composition reliability is between 0.87 and 0.95, and the average variance extracted is between 0.73 and 0.82 (exceed 0.50). Therefore, both the

Table 3. Construct Reliability and Validity

Constructs	Items	Standard-ized esti-mates	C.R. (t-value)	S.E.	SMC	C.R.	AVE
Innovation adoption	IA 1	0.95			0.92	0.87	0.77
	IA 2	0.80	15.85	0.05	0.64		
Computer Self-efficacy	SA 1	0.86			0.74	0.94	0.73
	SA 2	0.86	20.09	0.05	0.75		
	SA 3	0.87	20.78	0.05	0.77		
	SA 4	0.84	19.83	0.05	0.72		
	SA 5	0.86	19.56	0.05	0.74		
	SA 6	0.85	19.35	0.05	0.73		
PU	PU 1	0.91			0.84	0.94	0.81
	PU 2	0.90	25.92	0.04	0.81		
	PU 3	0.89	25.51	0.04	0.81		
	PU 4	0.91	26.75	0.04	0.84		
PEU	PEU 1	0.91			0.84	0.92	0.75
	PEU 2	0.91	26.07	0.04	0.83		
	PEU 3	0.88	24.29	0.04	0.79		
	PEU 4	0.77	17.86	0.05	0.60		
AT	AT 1	0.87			0.76	0.95	0.78
	AT 2	0.89	22.37	0.04	0.79		
	AT 3	0.90	23.06	0.05	0.81		
	AT 4	0.93	24.55	0.04	0.86		
	AT 5	0.83	19.50	0.05	0.69		
	AT 6	0.90	23.32	0.04	0.82		
BI	BI 1	0.90			0.82	0.95	0.82
	BI 2	0.87	23.75	0.04	0.77		
	BI 3	0.88	24.02	0.04	0.78		
	BI 4	0.94	28.87	0.04	0.89		
	BI 5	0.94	29.41	0.04	0.90		

conditions for convergent validity were met.

To achieve the discriminant validity, the square root of AVE between reflective constructs should be higher than the correlations of the constructs with other variables in the model (Fornell & Larcker ,1981). This is presented in Table 4.

Table 5 presents the fitness indexes and acceptable references based on Hair et al. (2011). The six-overall model-fit indexes were tested, chi-square normalized by degree of

Table 4. Discriminant Validity

Construct	AVE	IA	CS	PU	PEU	AT	BI
IA	0.77	0.86					
CS	0.73	0.61	0.85				
PU	0.81	0.66	0.71	0.88			
PEU	0.75	0.71	0.83	0.75	0.87		
AT	0.78	0.70	0.70	0.86	0.80	0.87	
BI	0.82	0.69	0.71	0.87	0.78	0.86	0.89

Table 5. Results of Fitness

Fit indices	Measurement model	Recommended values
X^2/df	2.96	< 3.0
GFI	0.81	>0.80
AGFI	0.80	>0.80
RMSEA	0.08	<0.08
CFI	0.93	>0.90
PGFI	0.84	>0.50

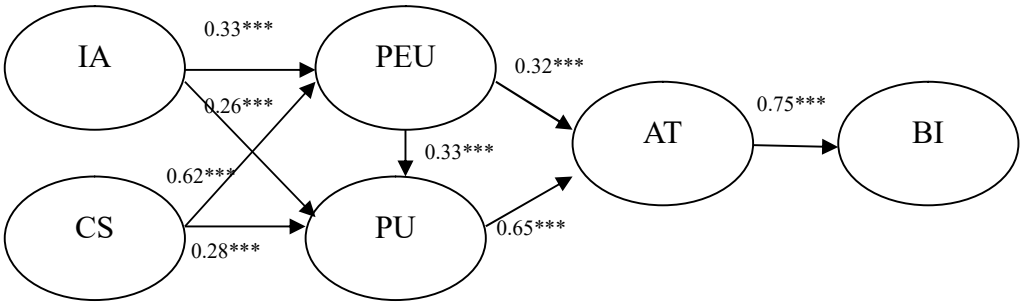
Fit statistics: x^2=932.4, df = 315; All measures are significant at P<0.01

freedom (X^2/df), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), root mean square error of approximation (RMSEA), comparative fit index (CFI), parsimonious goodness-fit-index (PGFI). All the fit indices are within accepted thresholds, which indicates that the research model is an acceptable model.

Results of Fitness

Structural Model and Hypothesis Testing.

The results of hypothesis testing on the research model are summarized in Figure 2 and Table 6. The effects of innovation adoption (β=0.33, t=6.41, p<0.001) and computer self-efficacy (β=0.62, t=11.45, p<0.001) on perceived ease of use were significant. Three factors, innovation adoption (β=0.26, t=4.10, p<0.001), computer self-efficacy (β=0.28, t=4.54, p<0.001), and perceived ease of use (β=0.33, t=4.58, p<0.001) were shown to determine the perceived usefulness. In addition, the attitude was determined by perceived ease of use (β=0.32, t=0.68, p<0.001) and perceived usefulness (β=0.65, t=12.39, p<0.001). Furthermore, the attitude toward smart home appliances (β=0.75, t=22.68, p<0.001) had a significant effect on



Note: ***P<0.001

Figure 2. Research model with standardized path coefficients

Table 6. Results of Hypotheses Testing

Hypotheses	Path	Standardized path coefficient(β)	t-value	Test Results
H1	IA → PEU	0.33***	6.41	Supported
H2	IA → PU	0.26***	4.10	Supported
H3	CS → PEU	0.62***	11.45	Supported
H4	CS → PU	0.28***	4.54	Supported
H5	PEU → PU	0.33***	4.58	Supported
H6	PEU→ AT	0.32***	6.80	Supported
H7	PU → AT	0.65***	12.39	Supported
H8	AT → BI	0.75***	22.68	Supported

Note: ***P<0.001

behavioral intention. In sum, all hypotheses were supported.

Discussion

The purpose of this study is to evaluate customer's behavioral intention to adopt smart home appliances based on TAM. To make TAM suitable for smart home appliances field, this research adds two variables, IA and SE into the model for evaluate consumer's complex mind processing on adopting smart home devices. TAM explains the outer factors influencing user's behavioral intention, but not the

inner factors. That is the reason why this study brings in IA and SE into the model for explaining the inner factors for customer's behavioral intention. Smart home appliances are innovative products, so users would think over a lot before they really adopt those devices. For this reason, this study integrates IA and SE into TAM to predict and explain use's attitude and behavioral intention toward smart home appliances.

IA means an individual's evaluation of new products, the evaluation includes the relative advantage, compatibility, simplicity, and tryability of those advanced devises. Most of the consumers who adopt innovations would spend more time on reviewing and analyzing new products. This will help them to think this product is useful and easy of using.

From the finding of this study, IA positively influences PU and PEU on smart home appliances. This supports the previous study (Turhan, 2012; Nasir & Yurder, 2015). Which means consumers with more IA tendency would also pay more attention on innovative products and tend to think those innovations are easy to work with and could improve their life quality.

The current study also confirms that SE positively affects PEU and PU, which is consistent with previous researches (Mensah, 2016; Terzis & Economides, 2011), that is SE has a positive effect on PEU and PU on the acceptance of new technologies. This also indicates that consumers who have more confidence in their ability would tend to think the innovate products is easy to work with and helpful for their daily life or jobs.

From our study, customer's positive PEU and PE on smart home appliances would increase the probability of using smart home appliances. So, firms should make sure that customers understand all the benefits they could get form adopting smart home appliances, and convenience them that those devices are both useful and easy of using, or the consumers would lose their interests and passions on smart home appliances. The PEU and PE on smart home appliances could be increased by providing detail information, operation training and total solution for customers after evaluating their needs.
In addition, from the finding of this study, IA and SE affects PEU more than PU on customers' evaluation of smart home appliances. Therefore, by providing more information, contacting opportunity, and testing use of the new appliances for customers who

have higher level of IA and SE would increase their acceptances of smart home appliances.

Our study also proves that if customers have stronger PEU and PU on smart home appliances, they would also have more positive attitude towards these devices. This matches previous research by Davis et al. (1989). As shown in the result of our research model, PE have more positive influence than PEU on individual's attitude toward smart home appliances. To enhance customers' positive attitude towards smart home appliances, companies should provide more information about the attributes of new products. By analyzing customers' pattern on adopting smart home appliances, we suggest companies should emphasize on the usefulness and user-friendly characters of smart home appliances. This would enhance customers' positive attitude toward those new products, and increase the tendency of adoption. Furthermore, for arousing the purchasing intention, firms should emphasis on how those innovations could improve customers' life quality, with usefulness and easy of using characteristics.

Conclusions

This research concludes two major contributions on both theory and practice on customers' adoption of smart home appliances.

From a theoretical aspect, this study provides a complete model which confirms that consumer's IA and SE are the predecessors for purchasing smart home appliances. The model we provided expands the concept of IA and SE to the area of customer's adoption of smart home appliances. We also find out that customer's attitude toward smart home appliances would be indirectly influenced by IA and SE, and further influence the purchasing behavior.

From a practical aspect, this research indicates the importance of increasing customer's PEU and PU in the process of purchasing smart home appliances. This implies that firms should provide more communication channels and products information for customers, and output more special and personalized quality products. By this way, customer's attitude toward smart home appliances and purchase intention would be evoked.

Disclosure Statement: The authors report no conflict of interest.

Reference

Adams, D.A., Nelson, R.R., & Todd, P.A. (1992). Perceived usefulness, ease of use and usage of information technology: A replication. *MIS Quarterly*,16(2), 227-247.

Al-Rahmi, W.M., Yahaya, N., Aldraiweesh, A.A., Alamir, M.M, Aljarboa, N.A., Alturki, U., & Aljeraiwi, A.A. (2019). Integrating technology acceptance model with innovation diffusion theory: An empirical investigation in students' intention to use e-learning systems. *IEEE Access*, 7,26797-26809.

Ajzen, I. (2005). *Attitudes, personality, and behavior*; McGraw-Hill Education: London, UK.

Avcilar, M.Y., & Özsoy, T. (2015). Determining the effects of perceived utilitarian and hedonic value on online shopping intentions. *International Journal of Marketing Studies*,7(6), 27-48.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Prentice-Hall: Englewood Cliffs, NJ, USA.

Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. *Journal of Experimental Social Psychology*, 22, 453-474.

Babin, B. J., & Harris, E. G. (2014). *Consumer behavior*, 6th Student ed.; South-Western Cengage Learning: Mason, Ohio, USA.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84 (2), 191-215.

Bandura, A. (1995). Exercise of personal and collective efficacy in changing societies. In *Self-efficacy in changing societies* (1-45). Cambridge University Press: New York, USA.

Bartels, J., & Reinders, M. J. (2011). Consumer innovativeness and its correlates: a propositional inventory for future research. *Journal of Business Research*, 64 (6), 601-609.

Cazan, A.M., Cocoradă, E., & Maican, C.I. (2016). Computer anxiety and attitudes towards the computer and the internet with Romanian high-school and university students. *Computers in Hu-*

man Behavior, 55, 258-267.

Cheng, H.H., & Huang, S.W. (2013). Exploring antecedents and consequence of online groupbuying intention: An extended perspective on theory of planned behavior. *International Journal of Information Management*, 33,185-198.

Compeau, D., & Higgins, C. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 19 (2), 189-211.

Davis, F. D. (1986). A technology acceptance for empirically testing new end user information systems: Theory and results. *Doctoral dissertation*. Sloan School of Management, Massachusetts Institute of Technology, MA, USA.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly,* 13(3), 319-340.

Davis, F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies*, 38(3),475-487.

Dickerson, M. D., & Gentry, J. W. (1983). Characteristics of adopters and non-adopters of home computers., *Journal of Consumer Research,* 10(2), 225-235.

Eastlick, M. A. (1996). Consumer intention to adopt interactive teleshopping (96-113). Marketing Science Institute. Cambridge, MA, USA.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention, and behavior: An introduction to theory and research. Addison-Wesley, Reading, MA, USA.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18, 39–50.

Godoe, P., & Johansen, T.S. (2012). Understanding adoption of new technologies: Technology readiness and technology acceptance as an integrated concept. *Journal of European Psychology Students*, 3, 38-52.

Greco, A. J., & Fields, D. M. (1991). Profiling early triers of service innovations: A Look at interactive home video ordering services. *Journal of Services Marketing*, 5(3),19-26.

Ha, S., & Stoel, L. (2009). Consumer e-shopping acceptance: Antecedents in a technology acceptance model. *Journal of Business Research*, 62, 565-571.

Hair, J. F., Ringle, C.M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice,* 19, 139–152.

Holak, S. L. (1988). Determinants of innovative durables adoption an empirical study with implications for early product screening. *Journal of Product Innovation Management*, 5(1), 59-73.

Holden, R. J., & Karsh, B. T. (2010). The technology acceptance model: its past and its future in health care. *Journal of Biomed Information*, 43(1), 159-72.

Hsu, C.L., & Lin, J.C.C. (2016). An empirical examination of consumer adoption of internet of things services: Network externalities and concern for information privacy perspectives. *Computers in Human Behavior*, 62, 516–527.

Hubert, M., Blut, M., Brock, C., Zhang, R.W., Koch, V., & Riedl, R. (2019). The influence of acceptance and adoption drivers on smart home usage. *European Journal of Marketing*, 53(6), 1073-1098.

Jeng, R., & Tseng, S.M. (2018). The relative importance of computer self-efficacy, perceived ease-of-use and reducing search cost in determining consumers' online group-buying intention. *International Journal of Human & Technology Interaction*, 2 (1), 1-12.

Joo, J., & Sang, Y. (2013). Exploring Koreans' smartphone usage: An integrated model of the technology acceptance model and uses and gratifications theory. *Computers in Human Behavior*, 29, 2512-2518.

Lee, Y. C. (2008). The role of perceived resources in online learning adoption. *Computers & Education*, 50, 1423-1438.

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & Managemen*, 40, 191−204.

Lin, H. F. (2007). The role of online and offline features in sustaining virtual communities: an empirical study. *Internet Research*, 17(2),119-138.

Longstreet, P., Xiao, X., & Sarker, S. (2016). Computer-related task performance: A new perspective. *Information & Management*, 53(4), 517-527.

Mensah, I.K. (2016). Perceived ease of use (PEOU) and perceived usefulness (PU) of e-government services in Ghana: The moderation role of computer self-efficacy. *European Journal of Research and Reflection in Management Sciences*, 4(5), 1-12.

Moon, J. W., & Kim, Y. G. (2001). Extending the TAM for a world-wide-web context. *Information and Management*, 38(4), 217-230.

Morosana, C., & Jeong, M. (2008). Users' perceptions of two types of hotel reservation Web sites. *International Journal of Hospitality Management*, 27, 284-292.

Nasir, S., & Yurder, Y. (2015). Consumers' and physicians' perceptions about high tech wearable health products. *Procedia -Social and Behavioral Sciences*, 195(3), 1261-1267.

Noh, M.J., & Kim, J.S. (2010). Factors influencing the user acceptance of digital home service. *Telecommunications Policy*, 34, 672–68.

Oostrom, J.K., Linden, D., Born, M.P., & Molen, H.T. (2013). New technology in personnel selection: How recruiter characteristics affect the adoption of new selection technology. *Computers in Human Behavior*, 29, 2404-2415.

Park, Y., & Chen, J. V. (2007). Acceptance and adoption of the innovative use of smartphone. *Industrial Management & Data Systems*, 107(9), 1349-1365.

Purnomo, S. H., & Lee, Y. H. (2013). E-learning adoption in the banking workplace in indonesia an

empirical study. *Information Development*, 29 (2),138–153.

Persico, D., Manca, S., & Pozzi F. (2014). Adapting the technology acceptance model to evaluate the innovative potential of e-learning systems. *Computers in Human Behavior*, 30, 614-622.

Park, C. K., Kim, H. J., & Kim, Y. S. (2014). A study of factors enhancing smart grid consumer engagement. *Energy Policy*, 72,211–218.

Park, E., Cho, Y., Han, J., & Kwon, S.J. (2017). Comprehensive approaches to user acceptance of internet of things in a smart home environment. *IEEE Internet of Things Journal*, 4(6), 2342-2350.

Pavlou, P. A. (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International Journal of Electronic Commerce,* 7(3), 101-134.

Rajput N. (2014). World smart home appliances market opportunity and forecasts, 2014- 2020, *Allied Market Research*, Portland.

Rogers, E. M. (2003). Elements of diffusion, In *Diffusion of innovations* (1-38), 5th ed.. Free Press, Simon & Schuster, NY, USA.

Shih, H.P. (2004). Extended technology acceptance model of internet utilization behavior. *Information & Management*, 41 (6), 719–729.

Shih, T.Y. (2013). Determinates of consumer adoption attitudes: An empirical study of smart home services. *International Journal of E-Adoption*, 5(2), 40-56.

Szajna, B. (1996). Empirical evaluation of the revised technology acceptance model., 42(1), 85-92.

Terzis, V., & Economides, A.A. (2011). The Acceptance and Use of Computer Based Assessment. *Computers & Education*, 56(4), 1032-1044.

Turhan, G. (2012). An assessment towards the acceptance of wearable technology to consumers in Turkey: The application to smart bra and t-shirt products. *The Journal of the Textile Institute*, 104 (4), 375-395.

Venkatesh, V., Morris, M.G., Davis, G.B., & Davis, F.D. (2003). User acceptance of information technology: toward a unified view.

MIS Quarterly, 27 (3), 425-478.

Vijayasarathy, L.R. (2004). Predicting consumer intentions to use online shopping: the case for an augmented technology acceptance model. *Information and Management*, 41(6), 747–762.

Vowles, N., Thirkell, P., & Sinha, A. (2011). Different determinants at different times: B2B adoption of a radical innovation. *Journal of Business Research*, 64(11),1162-1168.

Zainab, B., Bhatti, M.A., & Alshagawi, M. (2017). Factors affecting e-training adoption: An examination of perceived cost, computer self-efficacy and the technology acceptance model. *Behaviour & Information Technology*, 36(12), 1261-1273.