Do smart homes deliver the promised benefits?

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Abstract

This study focuses on smart homes and explores the personal and family factors behind the individual's continuous intention to use smart home technologies. In particular, the study examines the correlation of individuals' satisfaction with smart home technologies, hedonic and utilitarian values, trust, innovativeness, family and house size and socio-demographic factors (i.e. age, gender, education and income) with continuous intention of use. For the analysis of the proposed relationships, multiple regression analysis was used. The results of the analysis confirmed the significant correlation of smart home and family factors with the intention to continue to use technology, whereas the effects of all personal factors except age were insignificant. Theoretical and practical implications of the results are discussed.

Keywords: Smart home, technology acceptance, continuance intention to use, social demographic factors

1. Introduction

The smart home is the intelligent system of interconnected devices which are capable of responding to the information collected from the surrounding environment, and which can potentially bring health-related, environmental and financial benefits to its residents (Aldrich, 2003, Chan et al., 2009). The segment of smart home technology is increasing in the market, contributing to the global recognition and turnover of these devices (Khedekar et al., 2017). The total number of smart home technologies distributed globally is reaching 14 billion pieces. In terms of market revenue, the sale of smart home appliances brought $53,235 billion to companies in 2018 with a forecast revenue of $143,434 billion for 2023. However, the current rate of smart home technology acceptance is as low as 7.1% (Statista, 2018). The low acceptance rate hinders the implementation of the benefits that smart home technology is capable of offering users (Marikyan et al., 2019). Given the above there is a need for further examination of the factors that influence the use of smart home technology from a long-term perspective. A few studies have discussed the use of smart home technology (Gaul and Ziefle, 2009, Bao et al., 2014, Balta-Ozkan et al., 2014, Yang et al., 2017, Baudier et al., 2018), but none of them empirically examined whether smart homes deliver the promised benefits and in turn whether users intend to continue using the technology. Given the gap in the literature and the practical importance of the promotion of the smart home technology in the market, this study aims to explore the factors that trigger continuous intention to use this technology. More specifically we examine how factors related to smart technology, personal attributes and house/family attributes relate to the intention to continue using smart homes.

2. Literature Review: Smart Homes

Smart Home Technology

There are numerous definitions of smart home technologies provided in the literature. The early definition by Lutolf (1992) conceptualised the smart home as "*the integration of different services within a home by employing a common communication system. It assures an economical, secure and comfortable operation of the home and includes a high degree of intelligent functionality and flexibility*". A similar definition is provided by Aldrich (2003), who stated that a smart home is "*a residence equipped with computing and information, which anticipated and responds to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond*". The definitions share a high degree of similarity by stressing the services and technological capabilities. Technical attributes reflect the level of technology sophistication and the services accordingly (Marikyan et al., 2019). Continuous advancements in the technology called for revisiting early definitions. After systematically analysing up-to-date literature about services and benefits, Marikyan et al. (2019) defined the smart home as "*smart devices and sensors that are integrated into an intelligent system, offering management, monitoring, support and responsive services and embracing a range of economic, social, health-related, emotional, sustainability and security benefits*".

The conceptualisation of smart homes is rooted in the technical attributes, which can be grouped into four dimensions: a) a single platform that makes possible the communications among the devices, b) the presence of artificial intelligence in the devices, c) sensors that collect information from surrounding information, d) devices with smart functionality (e.g. smart heating and lighting systems) that independently function based on the information gathered from the surrounding environment (Balta-Ozkan et al., 2013). Similarly the overwhelming variety of smart home services identified in the literature (Marikyan et al., 2019) can be categorised into three dimensions; a) security and safety, b) energy and water consumption management and c) lifestyle support. Within the first-dimension, smart home technologies recognise imminent threats and react accordingly. For instance, in the case of a medical emergency smart home technology provides real-time health diagnostics, it creates an opportunity for virtual doctor visits, provides necessary medical treatment, recognises sudden changes in occupants' health and alerts relevant agents. These services have been brought to life by embedded cameras, motion sensors and recognition systems in smart homes (Ding et al., 2011, Chan et al., 2009). Energy and water consumption services through smart home technologies made it possible to monitor and make use of resources more efficiently by not overloading the grid, switching to more economic providers or gaining energy from solar panels (Sosa and Siem, 2004). A number of studies have pointed out that smart home technologies are capable of improving the user's lifestyle by contributing to residents' well-being through the promotion of social inclusion, assisting independent living both for vulnerable people and an ageing population (Coughlin et al., 2007, Chan et al., 2009).

The benefits that smart home services make possible have been widely discussed by the academic community, policymakers and industry practitioners (Balta-Ozkan et al., 2014, Chan et al., 2009). A number of studies explored the perceived and potential benefits in terms of both short and long-term impacts (Peek et al., 2014, Czaja, 2016, Kim and Shin, 2015, Paetz et al., 2012). The functional benefits that smart home technologies offer can be categorised into three dimensions: environmental, financial and health-related (Marikyan et al., 2019). Such ongoing threats as global warming, fluctuations in energy prices and climate change have made the smart home technologies the centre of interest due to the potential environmental benefits. The devices utilised in smart homes have made it possible to efficiently manage both water and energy consumption (Balta-Ozkan et al., 2014, Chen et al., 2017, Zhou et al., 2016, Kiesling, 2016). The embedded smart lightning system, water heating and house heating automatically choose the cheaper supplier and terminate the overloading of the national grid, which in the long term positively contributes to environmental sustainability (Chen et al., 2017, Elkhorchani and Grayaa, 2016, Balta-Ozkan et al., 2014). The financial benefits of smart home technology are usually linked with environmental benefits (Marikyan et al., 2019). The short-term benefits of efficient management of energy and water inside the house can potentially reduce the utility bills (Darby and McKenna, 2012, Hargreaves et al., 2013). The smart home health-related benefits are the most discussed dimension in the smart home technology literature (Marikyan et al., 2019). There has been strong focus on such aspects as automatic management, consultancy and the monitoring of the residents with potential health issues. The smart home technologies promote independent living (Alam et al., 2012, Alaiad and Zhou, 2017). The support and assistance of the residents in daily tasks can promote psychological well-being by overcoming the feeling of isolation (Kim et al., 2013, Ehrenhard et al., 2014).

3. Research Model and Hypotheses

This study aims to explore the factors that influence individuals' intention to continue the use of smart home technology. We categorised these factors into three groups: a) smart home factors, b) personal factors, and c) family factors (Figure 1). The smart home group includes such factors as satisfaction with smart home use, individuals' hedonic and utilitarian values, trust towards smart home technologies and smartness. The personal group includes such factors as income, age, education, gender and innovativeness. The family factors include family size and house size.

3.1 Smart Home Factors

Satisfaction: The continuous intention to use (CIU) construct originated from the Expectation-Confirmation Theory (ECT) (Bhattacherjee, 2001). ECT takes satisfaction as a core factor that triggers the intention to continuously use technology (Bhattacherjee, 2001). In the consumption context, satisfaction is defined as "*the summary psychological state resulting when the emotion surrounding disconfirmed expectations is coupled with the consumer's prior feeling about the consumption experience*" (Oliver, 1981). Based on the Expectation-Confirmation theory and the definition of satisfaction, a higher performance has a positive influence on satisfaction and consequent continuous usage intention (Bhattacherjee, 2001). Later, the predictive power of satisfaction was validated by several scholars (Stone and Baker-Eveleth, 2013, Baker-Eveleth and Stone, 2015, Roca et al., 2006, Chen et al., 2009). These findings correspond with other research that found that dissatisfaction and negative experience with a service led to usage discontinuation (Inteco, 1998).

Smartness: "Smartness" is defined in this study as the degree of interaction/experience with smart home technology and the objective knowledge accumulated with it. Interaction/experience derives from the prior usage of the product (Brucks, 1985). Objective knowledge refers to individuals' actual knowledge about the product, which can be the main trigger of positive intention to use the product (Moorman et al., 2004, Flynn and Goldsmith, 1999). An individual equipped with objective knowledge is more likely to evaluate the product using intrinsic cues (e.g. physical product), while users without objective knowledge use extrinsic cues (e.g. packaging, brand name). Demeritt (2002) argued that the lack of objective knowledge inhibits purchase intention. Conversely, if users are aware of the benefits, they will be willing to purchase and use the product even at a premium price (Fotopoulos and Krystallis, 2002). Consequently, this research will explore how the smartness of individuals correlates with continuous intention to use.

Trust: Trust can be conceptualised as individuals' readiness to be vulnerable in return for expected benefits (Mayer et al., 1995). Ability, benevolence and integrity are the crucial pillars of trust (Kim et al., 2008, McKnight et al., 2002). The pillars of trust in the context of the smart home can be conceptualised as follows: a) benevolence indicates that smart home providers provide genuine care for the users, not solely focusing on profit-making, b) integrity means that smart home technology providers do not engage in deception with the users, and c) ability highlights the skills and knowledge of smart home technology providers to deliver quality services for the users. Trust has been shown to have an impact on behaviour by facilitating the intention, whereas the lack of trust inhibits behavioural intention (Pavlou, 2003, Featherman and Pavlou, 2003). Trust had a crucial effect on consumers' intention to purchase a given product (Pavlou, 2003, Gefen, 2000). In addition, trust has an indirect effect on behaviour through perceived risks. The theoretical justification stems from the trust-based consumer decision-making model by Kim et al. (2008), which was applied to examine purchasing behaviour in e-commerce settings. The findings confirmed a significant negative effect of trust on perceived risk and its positive effect on behaviour. A few studies have showed that trust can have an influence on continuous usage intention (Zhou, 2013, Susanto et al., 2016, Wu et al., 2014). In the context of smart homes, users still have no trust that these technologies are capable of delivering economic benefits (Martin et al., 2008). The above mentioned findings lead us to hypothesise that the lack of trust may increase the perception of risks and inhibit the individuals' intention to continue using smart home technologies.

Hedonic and Utilitarian Beliefs: Studies claim that the intention to consume a product is heavily contingent on the hedonic and utilitarian values that drive users towards accepting the technology (Van der Heijden, 2004, Babin et al., 1994). Hedonic belief denotes a self-fulfilment value. In the context of information systems, hedonic beliefs can refer to the degree to which the use of a system brings enjoyment and fun (Van der Heijden, 2004, Brown and Venkatesh, 2005). In contrast, utilitarian beliefs are rooted in the idea that the product brings instrumental value, such as increased task performance (Van der Heijden, 2004). Venkatesh and Vitalari (1992) found that users employ the information technology in homes to satisfy utilitarian values. For example, smart home technologies can lead to financial savings and support health (Balta-Ozkan et al., 2014, Martin et al., 2008). Van der Heijden (2004) and Chen et al. (2017) also confirmed the dominance of hedonic motives in the acceptance of home technology. Particularly, the employment of smart technologies in the home context is triggered by the stimuli of personal satisfaction, self-education, entertainment and interaction with family and friends (Kraut et al., 1999, Brown and Venkatesh, 2005). Another stream of research highlighted the link between hedonic/utilitarian values and continuous intention to use (Barnes, 2011, Hong et al., 2017, Chang et al., 2014). Drawing on the above, we can hypothesise that hedonic and utilitarian beliefs not only correlate with the acceptance, but affect the intention to use smart home technologies continuously.

Following on the discussion above we advance the first hypothesis related to smart home related factors:

Hypotheses 1: *a) satisfaction, b) hedonic values, c) utilitarian values, d) smartness and e) trust correlate positively with the intention to continue using smart home technology.*

3.2. Personal and Family Factors

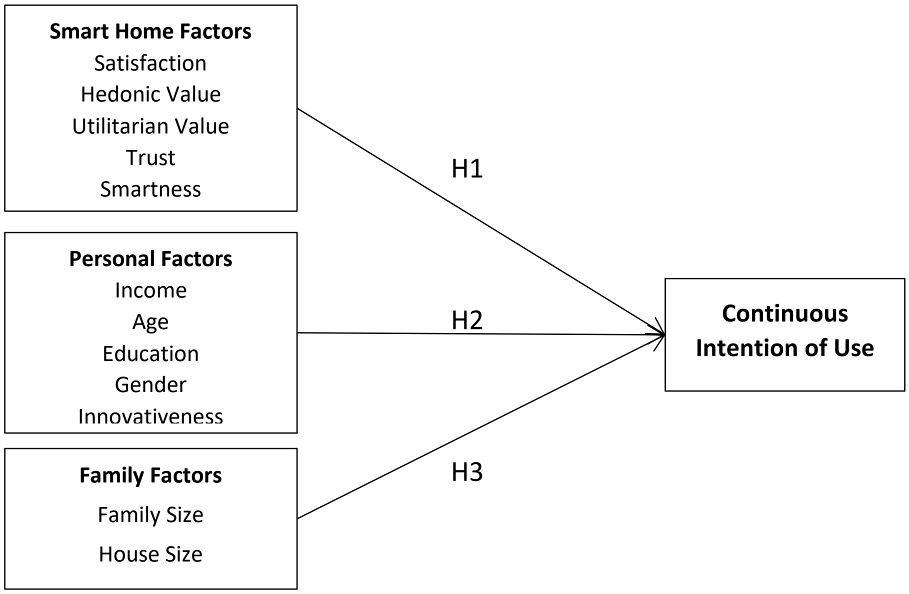
Technology acceptance and intention has received significant attention from the academic community (Venkatesh and Vitalari, 1992, Venkatesh and Davis, 1996, Venkatesh and Davis, 2000, Shih and Venkatesh, 2004, Venkatesh and Zhang, 2010, Venkatesh et al., 2012). Dominant theoretical models were based on the technology acceptance model (TAM), which aimed to examine the individuals' acceptance of technology (Venkatesh and Morris, 2000). The technology acceptance model provided theoretical lenses to understand the factors that drive individuals to use and continue to use technology. However, some studies suggested that the research overlooked the role of socio-demographic factors (e.g. Gender, age, income) (Venkatesh and Morris, 2000, Gefen, 2000). The inclusion of socio-demographic factors is important to explain individuals' technology acceptance or intention to continuously use it (Venkatesh and Morris, 2000, Gefen, 2000). To support the aforementioned statement, the literature from different disciplines suggests that socio-demographic factors can influence individuals' behaviour (Venkatesh and Morris, 2000, Gefen, 2000, Ong and Lai, 2006). Some scholars have argued that age plays a crucial role in technology acceptance as it influences decision making (Chung et al., 2010, Morris and Venkatesh, 2000, Niehaves and Plattfaut, 2014). In addition, education, income and innovativeness are significant in technology acceptance (Ong and Lai, 2006, Sun and Jeyaraj, 2013, Agarwal and Prasad, 1998). For example, innovative and creative users are more likely to adopt new technology (Agarwal and Prasad, 1998), such as smart homes. In addition, the operationalisation of smart home devices may require more effort, and thus can be contingent on the educational background. Finally, the high purchase and maintenance price of technology call for examining the relationship between income and continuous intention to use.

Hypothesis 2: *Personal factors, such as a) income, b) age, c) education, d) gender and e) innovativeness correlate with individuals'* continuous *intention to use smart home technology.*

The effect of family size and house size on the continuous intention to use technology has not been examined yet. However, we can assume the relationship between constructs, based on two arguments. Firstly, smart home technology is aimed at increasing the efficiency of technology performance, thus decreasing energy consumption and costs (Balta-Ozkan et al., 2014, Chen et al., 2017, Zhou et al., 2016, Kiesling, 2016). We can assume that inhabitants of bigger houses are more concerned with energy and water consumption due to the relatively potentially higher gains, and more likely to be interested in the long-term use of smart home technology. Secondly, the utilisation of technology is the result of the decision-making by all members of a family. Hence, we propose the correlation of the family size with the continuous intention to use. Based on the above, the third hypothesis states that:

Hypothesis 3: *Family factors, such as a) family size and b) house size, correlate with individuals'* continuous *intention to use smart home technology.*

Figure 1: Theoretical Model



4. Methodology

4.1. Data Collection and Sampling

This study adopted a quantitative approach using an online survey as a data collection tool. A pilot study was conducted before starting the distribution of questionnaires with the aim of testing the feasibility of the survey design and approach. The questionnaire incorporated screening questions to filter out individuals who did not use smart home technology at the time of data collection and had never used it in the past. The second part of the questionnaire consisted of questions related to the three groups of factors being examined in the study. Responses were collected from a consumer panel located in the United States. The group of 457 respondents was balanced in terms of gender, with 53.6% of females and 46.4% of males respectively. Of those who participated, the majority were Non-Hispanic White or Euro-American (83.6%), older people of the age between 60-69 (39.2%), full-time employed (43.3%), holding a college degree or at least attending some college courses (50%) and living in urban or urbanized areas (71.3 %). More than half of the respondents were married (59.3%) and had an annual income ranging from 25,000 to 74,999 US dollars (53.6%).

4.2. Measures

Smart Home Factors: Smart home factors included four multi-item scales and one continuous variable. Hedonic value and utilitarian value items were adapted from the study by Babin et al. (1994), while the trust items were adapted from the study by Jarvenpaa et al. (1999). They were measured using 7-point Likert scales, ranging from 1=strongly disagree to 7=strongly agree. The study used a satisfaction scale developed by Spreng and Mackoy (1996), which measures four dimensions of satisfaction using 7-point Likert scales ranging from a) 1=very dissatisfied to 7=very satisfied, b) 1=very displeased to 7=very pleased, c) 1=very frustrated to 7=very contented, and d) 1=absolutely terrible to 7=absolutely delighted. All scales were transformed into single item variables by summing the values of each item. To measure the level of smartness, respondents were provided the list of 29 smart home devices available on the market (e.g. smart meters, Amazon Echo, Amazon Dot, smart lighting, doorbell, plug, look etc.) (Table 1). Participants had to select those that they used at the moment of data collection or had used in the past. A higher value represented a higher degree of users' smartness.

Table 1 presents the list of devices that are classified based on the functional benefits that they can deliver. Fourteen devices refer to the environmental category, such as a smart light that can save energy by automatically turning on/off, a smoke alarm that detects smoke and informs the user accordingly, or a waste bin that distinguishes and counts recyclable/nonrecyclable waste. Nineteen devices refer to the financial category, including air conditioning, a thermostat or meter that makes the use of resources more efficient. Fourteen devices refer to health benefits, such as motion sensors, wearable devices or toothbrushes. They detect changes in the health condition, report it to the user along with suggestions on health improvement.

Table 1: Classification of smart home devices by functional characteristics

Device	Environmental	Financial	Health
Light	x	x	
Meter	x	x	
Bridge			
Switch		x	
Motion Sensor	x	x	x
Amazon Echo			
Amazon Dot			
Google Home		x	
Thermostat	x	x	
Home camera		x	x
Pet camera			x
Smoke alarm	x	x	x
Alarm System	x	x	x
Vacuum cleaner	x	x	x
Kitchen	x	x	x
Doorbell			
Plug	x	x	
Speaker			
TV	x	x	
Wearable (e.g. smart watch)		x	x
Lock			
Blind	x	x	x
Air Conditioner	x	x	x
Toothbrush			x
Bottle	x		x
Tag		x	
Scale			x
Waste bin	x	x	
Fitness equipment			x
	14	19	14

Personal Factors: Personal factors included socio-demographic data, such as income, age, education, gender, as well as innovativeness personal traits. Innovativeness was measured by a 7-point Likert scale (1=strongly disagree to 7=strongly agree) with items adapted from the study by Agarwal and Prasad (1998). The total value of four items was calculated for further use in the analysis. Socio-demographic variables were created by clustering respondents into two gender groups (i.e. male/female), six age groups (i.e. 1= 20 to 29; 2=30 to 39; 3=40 to 49; 4=50 to 59; 5=60 to 69; 6=70 to 79), five income clusters (i.e. 1=$0-$24,999; 2=$25,000-$49,999; 3=$50,000-$74,999; 4=$75,000-$99,999; 5=more than $100,000). The education level of participants was assessed by using a continuous variable with eight values (i.e. attended some high school or less; graduated high school or equivalent; attended a two-year technical/vocational programme; attended some college courses; graduated college; attended graduate school; received graduate degree; received professional degree).

Family Factors and Dependent Variable: Family factors included family size and house size. Family size was measured by a continuous scale with anchors 1=one child and 7=more than six children. House size was assessed using a five-point scale with values ranging from 1=1 room to 5=more than four rooms. To measure the dependent variable, this study used a multi-item scale developed by Bhattacherjee (2001) which was summed for the purpose of this study.

Table 2 presents all the items representing our latent variables with factor loadings and Cronbach's Alpha values above 0.7, which suggests a good reliability of the adapted scales. Seven-point Likert scales were utilised for all items, which offered an effective way to measure the accuracy and precision of the latent variables (Churchill, 2002).

Table 2: Measurement Items of Latent Variables

Measurement Items	Loading	Cronbach's α
Hedonic Value		**0.971**
The use of smart home technology is a joy.	0.874	
I use smart home technology, not because I had to, but because I wanted to.	0.661	
The use of smart home technology feels really like an escape	0.868	
Compared to other things I could have done, the time spent using smart home technology is truly enjoyable.	0.9	
I enjoyed being immersed in exciting new smart home products.	0.914	
I enjoyed the use of smart home technology for its own sake, not just for the items I may have purchased.	0.897	
I have a good time because I am able to act on the "spur-of-the-moment"	0.909	
During the use of smart home technology, I felt the excitement.	0.929	
While using smart home technology, I am able to forget my problems.	0.818	
While using the smart home technology, I feel a sense of adventure.	0.855	
Utilitarian Value		**0.944**
I accomplished just what I wanted to during the use of the smart home technology.	0.902	
I could not use the smart home services in regard to what I really needed.	0.889	
While using the smart home technology, I found just the service(s) I was looking for.	0.858	
Satisfaction		**0.945**
How satisfied are you with your overall experience with smart technology?	0.865	
How much pleasure do you get from your overall experience with smart technology?	0.895	
Given your overall experience with smart technologies, do you feel terrible or delighted by them?	0.812	
Given your overall experience with smart technologies, do you get frustrated or contented?	0.901	
Trust		**0.875**
The smart home technology I use is trustworthy.	0.809	

The provider of smart home technology I use wants to be known as one who keeps promises and commitments	0.705	
I trust that the smart home technology provider keeps my best interests in mind.	0.781	
I find it necessary to be cautious with the provider of smart home technology I use.	0.477	
The provider of smart home technology I use has more to lose than to gain by not delivering on their promises.	0.496	
The service(s) delivered by smart home technology provider meet my expectations.	0.798	
Continuous Intention of Use		**0.945**
I intend to continue using smart home technology rather than discontinue its use	0.895	
My intentions are to continue using than use any alternative means	0.895	
Innovativeness		**0.935**
If I heard about a new information technology, I would look for ways to experiment with it	0.908	
Among my peers, I am usually the first to try out new information technologies	0.855	
I like to experiment with new information technologies	0.834	

5. Results

Table 3 presents the means, standard deviations and correlation coefficients between the variables. Table 4 tabulates the results of the multiple regression analysis that was conducted using IBM SPSS version 24. The results show that the first hypothesis was accepted, confirming a positive significant effect of satisfaction (β= .37, $p < .000$), hedonic value (β= .19, $p < .002$), utilitarian value (β= .27, $p < .000$) and trust (β= .12, $p < .009$) on continuous intention of use. In contrast, the effect of smartness on intention was negative and significant (β= -.12, $p < .001$). The majority of the relationships between socio-demographic factors and continuous intention of use proposed by the second hypothesis were insignificant, such as the effect of income (β= -.01, $p < .685$), gender (β= .01, $p < .724$), education (β= .02, $p < .458$) and individual's innovativeness (β= .002, $p < .975$). Age was the only personal factor that had a significant positive influence on the intention of users to use smart home technology (β= .08, $p < .039$). The third hypothesis was supported as well. The effect of family size was negative and significant (β= -.10, $p < .002$), whereas the effect of home size was positive and significant (β= .10, $p < .005$).

Table 3: Means, standard deviations and correlations between variables

	Means	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Con Intention Use	14.449	4.062	1.000												
2. Satisfaction	19.547	5.288	0.698 ***	1.000											
3. Hedonic Value	44.337	15.898	0.644***	0.732***	1.000										
4. Utilitarian Value	17.838	4.671	0.689 ***	0.734***	0.769***	1.000									
5. Smartness	36.309	9.617	0.208***	0.411***	0.446***	0.357***	1.000								
6. Trust	29.856	7.226	0.600***	0.675***	0.733***	0.699***	0.399***	1.000							
7. Age	4.832	1.320	-0.115**	-0.284***	-0.407***	-0.276***	-0.295***	-0.320***	1.000						
8. Income	2.915	1.297	0.097*	0.153***	0.144**	0.168***	0.254***	0.113**	-0.026	1.000					
9. Family Size	2.455	1.297	-0.019	0.117**	0.142**	0.107*	0.174***	0.141**	-0.289***	0.227***	1.000				
10. Home Size	4.381	1.066	0.017	-0.116**	-0.184***	-0.113**	-0.178***	-0.158***	0.437***	0.145**	0.064	1.000			
11. Gender	1.536	0.499	-0.036	-0.048	0.0216	-0.017*	0.000	-0.019	-0.188***	-0.010	0.113**	0.015	1.000		
12. Education	4.328	1.660	0.068	0.076	0.097*	0.097*	0.169***	0.058	-0.075	0.335***	0.049	0.012	-0.080*	1.000	
13. Innovative	15.015	6.281	0.527***	0.652***	0.761***	0.659***	0.458***	0.578***	-0.346***	0.242***	0.135**	-0.143**	-0.094*	0.155***	1.000

Table 4: Regression Analysis

	IV		DV	Beta	t	Sig.
H1	Satisfaction	→	CIU	0.373	7.580	***
	Hedonic Value	→	CIU	0.189	3.066	**
	Utilitarian Value	→	CIU	0.269	5.133	***
	Smartness	→	CIU	-0.118	-3.338	**
	Trust	→	CIU	0.123	2.606	**
H2	Age	→	CIU	0.080	2.068	*
	Income	→	CIU	-0.014	-0.406	ns
	Gender	→	CIU	0.011	0.354	ns
	Education	→	CIU	0.024	0.743	ns
	Innovativeness	→	CIU	0.002	0.031	ns
H3	Family Size	→	CIU	-0.099	-3.046	**
	Home Size	→	CIU	0.098	2.838	**

6. Discussion

The study examined the effect of smart home factors, personal factors and family factors on the intention to continue to use smart home technology. The results suggest that the intention to use smart home technology in the future is dependent on smart home factors and family factors (H1 and H3), and independent of most of the personal factors presented in the study except age (H2). The relationship between satisfaction and continuous intention of use was confirmed in line with the prior literature (Stone and Baker-Eveleth, 2013, Baker-Eveleth and Stone, 2015, Roca et al., 2006, Chen et al., 2009, Bhattacherjee, 2001). Satisfaction is the strongest predictor compared to other examined variables. This means that the match between outcomes and expected services of smart home technology defines the likelihood of the technology being used in the future. The positive effect of utilitarian and hedonic value on intention confirms the findings of earlier studies (Van der Heijden, 2004, Babin et al., 1994). The effect of the utilitarian value is stronger. This can be explained by the fact that the utilisation of smart home technology is mostly related to the satisfaction of needs, such as reduction of costs on energy, operational convenience and the reduction of waste (Baudier et al., 2018). Only few studies showed that some users' attitude was underpinned by the hedonic value, such as fun and enjoyment (Van der Heijden, 2004, Babin et al., 1994, Turel et al., 2010). The positive effect of trust is confirmed in line with the findings of the prior research (Zhou, 2013, Susanto et al., 2016, Wu et al., 2014). This is explained by the fact that trust towards technology downplays potential risks associated with the technology use, thus increasing the positive attitude towards further technology utilisation. The negative effect of smartness on the intention is a surprising finding, meaning that the more devices an individual uses/has used, the less likely he/she will use them again in the future. The possible explanation could be that the first few devices add value to consumers' life. But they do not want to switch all traditional devices into smart ones, as this might entail complications. When it comes to personal factors, such as gender, education, income and innovativeness, the findings of this study contradict previous literature that provides evidence of the dependence of technology usage on socio-demographic and individual factors (Venkatesh and Morris, 2000, Gefen, 2000, Ong and Lai, 2006). However, although the effect of age is significant, it is very weak. This means that there is no real difference in the continuous usage intention in terms of age. Due to health-related benefits and services that the smart home is able to offer, the older population is one of the primary segments for the technology promotion (Marikyan et al., 2019, Chan et al., 2009). Finally, the positive correlation of house size with intention demonstrates that the larger the house, the more likely users will keep on using smart home technology. An opposite correlation was observed with the family size variable. The finding suggests that the likelihood of the continuous use of smart home devices increases as the number of children in the family decreases.

7. Conclusion

This paper has examined the continuous intention to use smart home technology by exploring the effect of smart home factors, personal factors and family factors. The paper addressed the gap in the literature since there little evidence on that front so far. The findings of the study contribute to the current body of knowledge by exploring the factors that the continuous intention is contingent upon. The findings of the study may inform practitioners that benefits should not focus on the individual but the home/family. To improve technology acceptance, practitioners need to consider more social aspects, rather than individual attitudes or characteristics.

This paper has some limitations. Further examination of additional factors that may underpin the intention to continuously use smart home products is required. Future studies may adopt a more theoretical approach by integrating technology acceptance models with psychological, social and behavioural factors, which would give a more comprehensive insight. For example, scholars may examine the direct and indirect effect of additional psychological variables, such as normative (e.g. social norms), control beliefs (e.g. perceived behavioural control), attitudinal and behavioural beliefs (e.g. ease of use, perceived usefulness) on the adoption of smart home technology from the long-term perspective. The data for this study were collected in the USA; to ensure the generalisability of findings, the model could be tested in other geographical contexts.

Reference List:

AGARWAL, R. & PRASAD, J. 1998. A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information systems research,* 9**,** 204-215.

ALAIAD, A. & ZHOU, L. 2017. Patients' Adoption of WSN-Based Smart Home Healthcare Systems: An Integrated Model of Facilitators and Barriers. *IEEE Transactions on Professional Communication,* 60**,** 4-23.

ALAM, M. R., REAZ, M. B. I. & ALI, M. A. M. 2012. A review of smart homes—Past, present, and future. *IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews),* 42**,** 1190-1203.

ALDRICH, F. K. 2003. Smart homes: Past, present and future. *Inside the Smart Home***,** 17-39.

BABIN, B. J., DARDEN, W. R. & GRIFFIN, M. 1994. Work and/or fun: measuring hedonic and utilitarian shopping value. *Journal of consumer research,* 20**,** 644-656.

BAKER-EVELETH, L. & STONE, R. W. 2015. Usability, expectation, confirmation, and continuance intentions to use electronic textbooks. *Behaviour & Information Technology,* 34**,** 992-1004.

BALTA-OZKAN, N., AMERIGHI, O. & BOTELER, B. 2014. A comparison of consumer perceptions towards smart homes in the UK, Germany and Italy: reflections for policy and future research. *Technology Analysis & Strategic Management,* 26**,** 1176-1195.

BALTA-OZKAN, N., DAVIDSON, R., BICKET, M. & WHITMARSH, L. 2013. Social barriers to the adoption of smart homes. *Energy Policy,* 63**,** 363-374.

BAO, H., CHONG, A. Y.-L., OOI, K.-B. & LIN, B. 2014. Are Chinese consumers ready to adopt mobile smart home? An empirical analysis. *International Journal of Mobile Communications,* 12**,** 496-511.

BARNES, S. J. 2011. Understanding use continuance in virtual worlds: Empirical test of a research model. *Information & Management,* 48**,** 313-319.

BAUDIER, P., AMMI, C. & DEBOEUF-ROUCHON, M. 2018. Smart home: Highly-educated students' acceptance. *Technological Forecasting and Social Change*.

BHATTACHERJEE, A. 2001. Understanding information systems continuance: an expectation-confirmation model. *MIS quarterly***,** 351-370.

BROWN, S. A. & VENKATESH, V. 2005. Model of adoption of technology in households: A baseline model test and extension incorporating household life cycle. *MIS quarterly***,** 399-426.

BRUCKS, M. 1985. The effects of product class knowledge on information search behavior. *Journal of consumer research***,** 1-16.

CHAN, M., CAMPO, E., ESTÈVE, D. & FOURNIOLS, J.-Y. 2009. Smart homes — Current features and future perspectives. *Maturitas,* 64**,** 90-97.

CHANG, I.-C., LIU, C.-C. & CHEN, K. 2014. The effects of hedonic/utilitarian expectations and social influence on continuance intention to play online games. *Internet Research,* 24**,** 21-45.

CHEN, S.-C., CHEN, H.-H. & CHEN, M.-F. 2009. Determinants of satisfaction and continuance intention towards self-service technologies. *Industrial Management & Data Systems,* 109**,** 1248-1263.

CHEN, S., LIU, T., GAO, F., JI, J., XU, Z., QIAN, B., WU, H. & GUAN, X. 2017. Butler, Not Servant: A Human-Centric Smart Home Energy Management System. *IEEE Communications Magazine,* 55**,** 27-33.

CHUNG, J. E., PARK, N., WANG, H., FULK, J. & MCLAUGHLIN, M. 2010. Age differences in perceptions of online community participation among non-users: An extension of the Technology Acceptance Model. *Computers in Human Behavior,* 26**,** 1674-1684.

CHURCHILL, G. A. 2002. & Iacobucci, D.(2002). *Marketing Research-Methodological Foundations***,** 14.

COUGHLIN, J. F., D'AMBROSIO, L. A., REIMER, B. & PRATT, M. R. Older adult perceptions of smart home technologies: Implications for research, policy & market innovations in healthcare. Annual International Conference of the IEEE Engineering in Medicine and Biology - Proceedings, 2007. 1810-1815.

CZAJA, S. J. 2016. Long-term care services and support systems for older adults: The role of technology. *American Psychologist,* 71**,** 294-301.

DARBY, S. J. & MCKENNA, E. 2012. Social implications of residential demand response in cool temperate climates. *Energy Policy,* 49**,** 759-769.

DEMERITT, L. 2002. All things organic 2002: A look at the organic consumer. *The Hartman Group, Bellevue, WA*.

DING, D., COOPER, R. A., PASQUINA, P. F. & FICI-PASQUINA, L. 2011. Sensor technology for smart homes. *Maturitas,* 69**,** 131-136.

EHRENHARD, M., KIJL, B. & NIEUWENHUIS, L. 2014. Market adoption barriers of multi-stakeholder technology: Smart homes for the aging population. *Technological Forecasting and Social Change,* 89**,** 306-315.

ELKHORCHANI, H. & GRAYAA, K. 2016. Novel home energy management system using wireless communication technologies for carbon emission reduction within a smart grid. *Journal of Cleaner Production,* 135**,** 950-962.

FEATHERMAN, M. S. & PAVLOU, P. A. 2003. Predicting e-services adoption: a perceived risk facets perspective. *International Journal of Human-Computer Studies,* 59**,** 451-474.

FLYNN, L. R. & GOLDSMITH, R. E. 1999. A Short, Reliable Measure of Subjective Knowledge. *Journal of Business Research,* 46**,** 57-66.

FOTOPOULOS, C. & KRYSTALLIS, A. 2002. Purchasing motives and profile of the Greek organic consumer: a countrywide survey. *British Food Journal,* 104**,** 730-765.

GAUL, S. & ZIEFLE, M. Smart home technologies: Insights into generation-specific acceptance motives. Symposium of the Austrian HCI and Usability Engineering Group, 2009. Springer, 312-332.

GEFEN, D. 2000. E-commerce: the role of familiarity and trust. *Omega,* 28**,** 725-737.

HARGREAVES, T., NYE, M. & BURGESS, J. 2013. Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term. *Energy Policy,* 52**,** 126-134.

HONG, J.-C., LIN, P.-H. & HSIEH, P.-C. 2017. The effect of consumer innovativeness on perceived value and continuance intention to use smartwatch. *Computers in Human Behavior,* 67**,** 264-272.

JARVENPAA, S. L., TRACTINSKY, N. & SAARINEN, L. 1999. Consumer trust in an internet store: a cross-cultural validation. *Journal of Computer-Mediated Communication,* 5**,** 0-0.

KHEDEKAR, D. C., TRUCO, A. C., OTEYZA, D. A. & HUERTAS, G. F. 2017. Home Automation—A Fast - Expanding Market. *Thunderbird International Business Review,* 59**,** 79-91.

KIESLING, L. L. 2016. The Connected Home and an Electricity-Market Platform for the Twenty-First Century. *Independent Review,* 20**,** 405-409.

KIM, D. J., FERRIN, D. L. & RAO, H. R. 2008. A trust-based consumer decision-making model in electronic commerce: The role of trust, perceived risk, and their antecedents. *Decision support systems,* 44**,** 544-564.

KIM, K. J. & SHIN, D. H. 2015. An acceptance model for smart watches: Implications for the adoption of future wearable technology. *Internet Research,* 25**,** 527-541.

KIM, M. J., OH, M. W., CHO, M. E., LEE, H. & KIM, J. T. 2013. A critical review of user studies on healthy smart homes. *Indoor and Built Environment,* 22**,** 260-270.

KRAUT, R., MUKHOPADHYAY, T., SZCZYPULA, J., KIESLER, S. & SCHERLIS, B. 1999. Information and communication: Alternative uses of the Internet in households. *Information Systems Research,* 10**,** 287-303.

LUTOLF, R. Smart home concept and the integration of energy meters into a home based system. Metering Apparatus and Tariffs for Electricity Supply, 1992., Seventh International Conference on, 1992. IET, 277-278.

MARIKYAN, D., PAPAGIANNIDIS, S. & ALAMANOS, E. 2019. A systematic review of the smart home literature: A user perspective. *Technological Forecasting and Social Change,* 138**,** 139-154.

MARTIN, S., KELLY, G., KERNOHAN, W. G., MCCREIGHT, B. & NUGENT, C. 2008. Smart home technologies for health and social care support. *Cochrane Database Syst Rev***,** CD006412.

MAYER, R. C., DAVIS, J. H. & SCHOORMAN, F. D. 1995. An integrative model of organizational trust. *Academy of management review,* 20**,** 709-734.

MCKNIGHT, D. H., CHOUDHURY, V. & KACMAR, C. 2002. Developing and validating trust measures for e-commerce: An integrative typology. *Information systems research,* 13**,** 334-359.

MOORMAN, C., DIEHL, K., BRINBERG, D. & KIDWELL, B. 2004. Subjective knowledge, search locations, and consumer choice. *Journal of Consumer Research,* 31**,** 673-680.

MORRIS, M. G. & VENKATESH, V. 2000. Age differences in technology adoption decisions: Implications for a changing work force. *Personnel psychology,* 53**,** 375-403.

NIEHAVES, B. & PLATTFAUT, R. 2014. Internet adoption by the elderly: employing IS technology acceptance theories for understanding the age-related digital divide. *European Journal of Information Systems,* 23**,** 708-726.

OLIVER, R. L. 1981. Measurement and evaluation of satisfaction processes in retail settings. *Journal of retailing*.

ONG, C.-S. & LAI, J.-Y. 2006. Gender differences in perceptions and relationships among dominants of e-learning acceptance. *Computers in human behavior,* 22**,** 816-829.

PAETZ, A. G., DÜTSCHKE, E. & FICHTNER, W. 2012. Smart Homes as a Means to Sustainable Energy Consumption: A Study of Consumer Perceptions. *Journal of Consumer Policy,* 35**,** 23-41.

PAVLOU, P. A. 2003. Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International journal of electronic commerce,* 7**,** 101-134.

PEEK, S. T. M., WOUTERS, E. J. M., VAN HOOF, J., LUIJKX, K. G., BOEIJE, H. R. & VRIJHOEF, H. J. M. 2014. Factors influencing acceptance of technology for aging in place: A systematic review. International Journal of Medical Informatics. [Online]. 83 (4). pp. 235–248. *Available from:*.

ROCA, J. C., CHIU, C.-M. & MARTÍNEZ, F. J. 2006. Understanding e-learning continuance intention: An extension of the Technology Acceptance Model. *International Journal of human-computer studies,* 64**,** 683-696.

SHIH, C.-F. & VENKATESH, A. 2004. Beyond adoption: Development and application of a use-diffusion model. *Journal of marketing,* 68**,** 59-72.

SOSA, M. E. & SIEM, G. 2004. Design criteria for energy efficient buildings in venezuela. *Revista de la Facultad de Ingenieria,* 19**,** 71-81.

SPRENG, R. A. & MACKOY, R. D. 1996. An empirical examination of a model of perceived service quality and satisfaction. *Journal of retailing,* 72**,** 201-214.

STONE, R. W. & BAKER-EVELETH, L. 2013. Students' expectation, confirmation, and continuance intention to use electronic textbooks. *Computers in Human Behavior,* 29**,** 984-990.

SUN, Y. & JEYARAJ, A. 2013. Information technology adoption and continuance: A longitudinal study of individuals' behavioral intentions. *Information & Management,* 50**,** 457-465.

SUSANTO, A., CHANG, Y. & HA, Y. 2016. Determinants of continuance intention to use the smartphone banking services: an extension to the expectation-confirmation model. *Industrial Management & Data Systems,* 116**,** 508-525.

VAN DER HEIJDEN, H. 2004. User acceptance of hedonic information systems. *MIS quarterly***,** 695-704.

VENKATESH, A. & VITALARI, N. P. 1992. An emerging distributed work arrangement: An investigation of computer-based supplemental work at home. *Management Science,* 38**,** 1687-1706.

VENKATESH, V. & DAVIS, F. D. 1996. A model of the antecedents of perceived ease of use: Development and test. *Decision sciences,* 27**,** 451-481.

VENKATESH, V. & DAVIS, F. D. 2000. A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science,* 46**,** 186-204.

VENKATESH, V. & MORRIS, M. G. 2000. Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. *MIS quarterly***,** 115-139.

VENKATESH, V., THONG, J. Y. & XU, X. 2012. Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS quarterly***,** 157-178.

VENKATESH, V. & ZHANG, X. 2010. Unified theory of acceptance and use of technology: US vs. China. *Journal of global information technology management,* 13**,** 5-27.

WU, C.-C., HUANG, Y. & HSU, C.-L. 2014. Benevolence trust: a key determinant of user continuance use of online social networks. *Information Systems and e-Business Management,* 12**,** 189-211.

YANG, H., LEE, H. & ZO, H. 2017. User acceptance of smart home services: an extension of the theory of planned behavior. *Industrial Management & Data Systems,* 117**,** 68-89.

ZHOU, B., LI, W., CHAN, K. W., CAO, Y., KUANG, Y., LIU, X. & WANG, X. 2016. Smart home energy management systems: Concept, configurations, and scheduling strategies. *Renewable & Sustainable Energy Reviews,* 61**,** 30-40.

ZHOU, T. 2013. An empirical examination of continuance intention of mobile payment services. *Decision support systems,* 54**,** 1085-1091.

Statista. (2018). *Smart Home - United States | Statista Market Forecast*. (Chung et al.) Available at: https://www.statista.com/outlook/279/109/smart-home/united-states.