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THE IMPACT OF SMART HOME TECHNOLOGIES ON WELL-BEING

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Dissertation presented as partial requirement for obtaining the Master's degree in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

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by

Gonçalo da Fonseca Miranda

Dissertation presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in knowledge management and business intelligence

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"Each of us has heaven and hell in him..."

-Oscar Wilde

To my grandparents.

In memoriam

ACKNOWLEDGEMENTS

A chapter is ending. An evidence of that achievement is this document. I can't say it has been the most difficult thing I have done. Nonetheless it has been one of the most troublesome. It is a personal achievement that "We" completed. Many say this is a solo work. However, there are numerous ways someone can contribute. I may have written the text, but each of you is in every word.

To my grandparents, for all the love and joy. Without you, this project wouldn't be possible. Without you I wouldn't have "dreamed the dream". Thank you for every opportunity you provided me and for helping me find light even in the darkest hours.

To my friends who kept me motivated through it all. To them who listened when I was about to give up. To them who understood the struggles of this project. To them who are with me cheering and cherishing my accomplishment and our victory in another success.

To my advisor and lecturer, for all the availability, counseling and candor during this period.

ABSTRACT

Most studies on technology innovation lack research on well-being, focusing mainly on innovation for wealth. Research has shown that smart home technologies will be one of EU's top priorities and are expected to increase user's quality of life. This study aims to understand how the adoption/use of smart home technologies can influence user's well-being. To understand this phenomenon, we combined two prominent theories in IS studies: the expectation-confirmation theory (ECT) and the unified theory of acceptance of technology 2 (UTAUT2). This study is based on an online survey with a sample of 309 responses. Findings suggest that satisfaction moderates the relationship between user's adoption of smart home technology and their well-being. Results indicate that the adoption of smart home technologies alone does not directly influence user's well-being, being necessary to measure user's smart home technologies satisfaction to understand this phenomenon.

KEYWORDS

Smart Homes; Well-being; Satisfaction; ECT; UTAUT 2

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LIST OF ABBREVIATIONS AND ACRONYMS

EU	European union
SHT	Smart home technologies
UTAUT	Unified theory of acceptance and use of technology
ECT	Expectation-confirmation theory
SWB	Subjective well-being
OWB	Objective well-being
IOT	Internet of Things
HTMT	Heterotrait-Monotrait
VIF	Variance Inflation Factor
PLS	Pooled Least Squares
AVE	Average Variance Extracted

1. INTRODUCTION

Smart homes are a top priority to EU's priority action areas in its Strategic Energy Technology Plan (Wilson, Hargreaves, & Hauxwell-Baldwin, 2017), it is estimated that by 2022 exists a 22.1% household penetration worldwide, having a market value of 53 B$(U.S) (Statista, 2019). Smart homes can enhance life quality and promote independent living (Marikyan, Papagiannidis, & Alamanos, 2019). As so it is of major importance to understand the technological capabilities and impact on people's lives.

Most of the studies done on smart homes have seen it from a technological perspective (Marikyan et al., 2019) meaning that the studies were focused on the electrical impacts (Wilson et al., 2017), management solutions (Perumal et al., 2013), IoT (Risteska Stojkoska & Trivodaliev, 2017), smart appliances adoption determinants (Kowalczuk, 2018). Additionally, a smart home is defined by the interconnectedness among devices that are able to acquire information from the environment and act accordingly (Gram-Hanssen & Darby, 2018; Marikyan et al., 2019), as so, when we mention smart homes we have to include technologies such as smart-speakers (Kowalczuk, 2018; Park et al., 2018) or other self-service technologies (Chen et al., 2009), even so, by broadening the scope of the technology, a gap clearly exists if we perceive technology as a promoter of well-being and satisfaction.

As stated, we can see that today's research paradigm is focused on innovation for wealth. Hence, we imply that new technologies foster economic growth and competitiveness, resulting in an increase in individual's well-being, however that's not necessarily true (Castellacci & Tveito, 2018). Martin (2016) proposed 20 challenges for the future, being one of them "to shift the focus of our empirical work from innovation for wealth to innovation for well-being". To help shift the focus of innovation studies, we enclose that gap by understanding the moderating effect of satisfaction on the different stages of smart home technologies' adoption (intention, use and continuance) towards explaining well-being. This is utterly important, has it helps us understand the relationship between innovation, well-being and economic performance.

In the next section is present the background and theoretical foundations used on this research. In Section 3, we present the conceptual model and hypotheses. In section 4 and 5 we describe the methodology and model implications. In the sixth section we discuss the major findings and last section is our main conclusions.

2. LITERATURE REVIEW

2.1. SMART HOMES

“A smart home is an intelligent environment that is able to acquire and apply knowledge about its inhabitants and their surroundings to adapt and meet the goals of comfort and efficiency” (Perumal et al., 2013, p.15). Smart homes are residences with smart appliances that can be remotely monitored and controlled and are interacting elements of an energy system (Gram-Hanssen & Darby, 2018). “[A smart home is] a residence equipped with a communications network, linking sensors, domestic appliances, and devices, that can be remotely monitored, accessed or controlled and which provides services that respond to the needs of its inhabitants”(Balta-Ozkan, Boteler, & Amerighi, 2014, p. 66). To the extension of this paper, we will use the definition proposed by Perumal et al. (2013) due to the broader concept of smart home. To our knowledge from 2002 to 2017, there were a total of 44 papers mentioning smart home technologies, and 36 articles related to smart technologies (Marikyan et al., 2019). In depth, more recent studies have focused on smart speakers (Kowalczuk, 2018; Park et al., 2018), the interconnection with IoT (Risteska Stojkoska & Trivodaliev, 2017), and smart grids (Wilson et al., 2017).

2.2. WELL-BEING

Well-being is a broad concept and can be rather difficult to define. Diener (2009) describes well-being as a self-evaluation of life by measuring the pleasant affects and unpleasant affects. Furthermore, according to Ryan & Deci (2001) is the “optimal psychological functioning and experience”. Therefore, both authors describe the phenomena as a measure of satisfaction correlated with both extrinsic and intrinsic factors in the individual life present on social environments. Respecting psychological well-being we can find two major philosophical currents: hedonism (Kahneman, Diener, & Schwarz, 1999) and eudemonism (Waterman, 1993). Hedonism believes that well-being consists of pleasure and happiness, it is also defined as subjective well-being (SWB) (Castellacci & Tveito, 2018). On the other hand eudemonism, rooted in Aristotle’s ethics, believes that well-being consists on the “actualization of the human potentials” and how individuals can realize their own inner potential, defining it as objective well-being (OWB) (Castellacci & Tveito, 2018; Ryan & Deci, 2001).

Ryan and Deci (2000) proposed the self-determination theory which allows to account for the causes of human behavior, allowing a deeper comprehension on the *“design of social environments that optimize people’s development, performance, and well-being”* (Ryan & Deci, 2000, p. 68). This theory suggests that individuals have three basic needs (autonomy, competence and relatedness) to stimulate psychological growth, integrity, vitality and well-being (Castellacci & Tveito, 2018). Therefore, this theory excludes the social, cultural and contextual factors that characterize the different domains of life as posited by SWB (Castellacci & Tveito, 2018). Additionally, Ryff & Singer (2008) described well-being as a product of six interconnected dimensions: self-acceptance, purpose in life, autonomy, personal growth, positive relationships and environmental mastery (please, see Figure 2.1). Meaning that well-being depends on the individuals’ attitude and abilities to cultivate these characteristics (Castellacci & Tveito, 2018). Therefore, well-being is a measure of self-awareness and self-accomplishment with ones’ life.

Furthermore, this study is concerned about the psychological welfare induced on individuals through the use of technology. Nonetheless, instead of pursuing happiness and pleasure as proxy to well-being – that is dependent of social, cultural and contextual factors – , we are concerned about their psychological growth and development and how technology affects their potential, therefore we will measure well-being using the scale proposed by Ryff & Singer (2008). Purpose in life and personal growth have not been included in this study due to their overlapping dimension with other constructs.

Figure 2.1 – Well-being dimensions [adapted from Ryff & Singer(2008)]

2.3. EXPECTATION-CONFIRMATION THEORY

The expectation-confirmation/disconfirmation theory poses a paradigm in which the individual's expectation largely determines the satisfaction with a given subject (person, product, service, etc.) (Lowry, Gaskin, & Moody, 2015). This model was first introduced by Oliver (1980) and used many times in literature to explain IT continuance use in different technologies such as wearable health information systems (Shen, Li, & Sun, 2018), mobile apps (Tam, Santos, & Oliveira, 2018), smart watches, (Nascimento, Oliveira, & Tam, 2018), etc. The ECT involves four major constructs: satisfaction, confirmation, performance and expectation. Hence, it accounts for two moments of observation, the pre-consumption (t_1) and the post-consumption(t_2). In this model, however, we have adapted the model proposed by Bhattacherjee (2001) that accounts only for the post-consumption, meaning that the effects of the pre-consumption are contained within the satisfaction and confirmation constructs. Furthermore, by measuring satisfaction and the perceived benefits of the technology use the theory suggests that satisfaction is an predecessor of well-being (Ryan & Deci, 2001).

2.4. UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY 2 (UTAUT2)

The Unified theory of acceptance and use of technology 2 (UTAUT 2) (Venkatesh, Thong, & Xu, 2012) is an expansion of the UTAUT (Venkatesh, Morris, Davis, & Davis, 2003). This first theory version was developed to assess employee's technology use and acceptance that combined 8 prominent theories used to explain use and behavioral intention to use a technology, being supported by four main constructs: social influence, facilitating conditions, performance expectancy and effort expectancy (Venkatesh et al., 2003). Moreover, UTAUT 2 was tailored to explain consumer's use context, broadening the scope of the original model (UTAUT), with the addition of habit, hedonic motivation, and price value as constructs (Venkatesh et al., 2012).

3. RESEARCH MODEL

Being a set of technologies that adapt to individual's needs (Perumal et al., 2013), smart home technologies convey the ability to automate our daily activities, affecting one's well-being by stimulating the dimensions proposed by Ryff & Singer (2008) through their use. Therefore, we used UTAUT2 to comprehend the factors that explain consumer's use context. Moreover, well-being literature describes this phenomenon as a measure of satisfaction, correlated with other factors that exist on individual's life. For this purpose, we elected ECT to help determine how smart home technologies satisfaction impacts well-being. Accordingly, we theorized a model by combining the UTAUT2 and ECT in which we can measure all IS adoption stages (intention, use and continuance) and IT satisfaction to understand the complex phenomena that is well-being, regarding the OWB theory, as shown in Figure 3.1. The innovation of this study resides in the paradigm change proposed by Martin (2016).

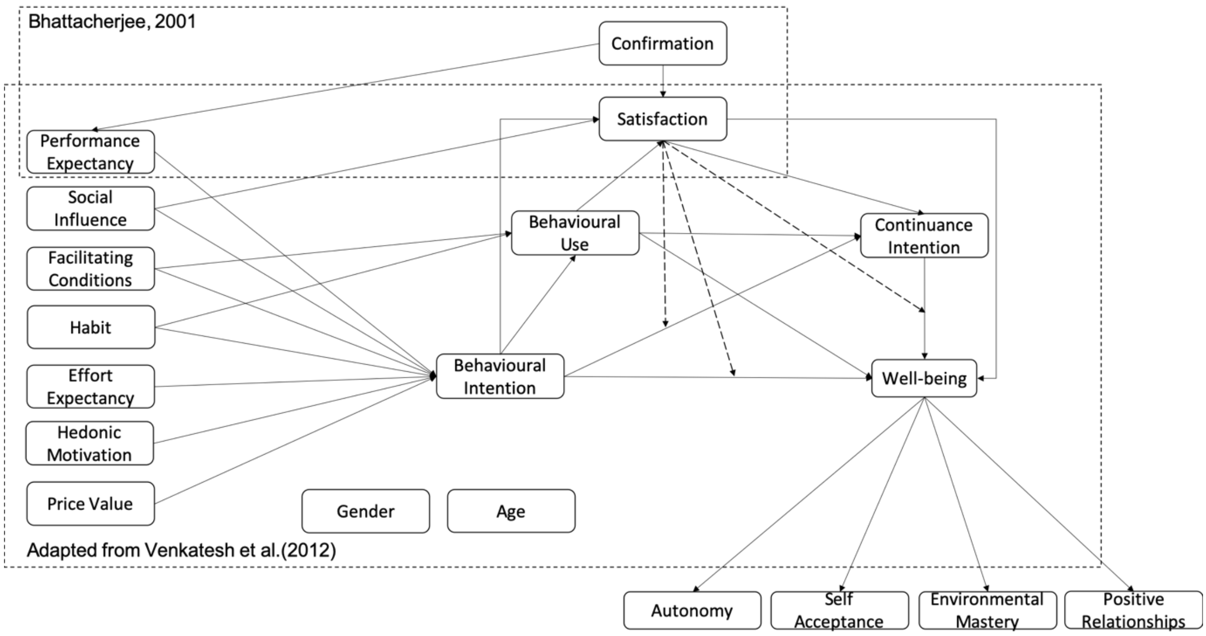

Figure 3.1 – Theoretical Model

Confirmation (CONF)

Confirmation results from the previously conceived expectations (Bhattacherjee, 2001) and its positively related with satisfaction and the perceived performance of the technology, as also observed during the study of continuance use of mobile apps Ding (2019), and smart watches (Nascimento et al., 2018). Confirmation occurs when perceived expected pre-consumption expectancies are met during the post-consumption stage. When expectancy is not met, consumers are likely to adjust their usefulness perceptions to match reality (Bhattacherjee, 2001). Hence, when expectancy is met and confirmation occurs, we are likely to have an increased usability perception and satisfaction. Smart home technologies are very susceptible to expectancy as they are likely to adapt to our needs. Therefore, research led us to propose the following hypotheses:

- ***H1:*** *Confirmation positively affects satisfaction*
- ***H2:*** *Confirmation positively affects perceived expectancy*

Satisfaction (SAT)

According to Bhattacherjee (2001) satisfaction is the result of the disconfirmed expectation about the consumption experience. Consequentially, resulting as the summary of the experience, a positive disconfirmation leads to a state of "wellness" (Ryan & Deci, 2001), therefore satisfaction can be perceived as a well-being antecedent. Moreover, being a result of user's expectancy, it directly influences the user's continuance intention to use a technology. Thus, the following hypotheses are formulated:

- ***H3:*** *Well-being is positively affected by satisfaction*
- ***H4:*** *Satisfaction positively influences Continuance Intention*
- ***H5a****: Satisfaction moderates the relationship between BI and WB*
- ***H5b:*** *Satisfaction moderates the relationship between USE and WB*
- ***H5c:*** *Satisfaction moderates the relationship between CI and WB*

Perceived expectancy (PE)

Perceived expectancy or perceived usefulness can be understood as the performance expectation that the individual will acquire from the technological use (Davis, 1989; Goodhue & Thompson, 1995). Research has proven a positive and hedonic motivation impact within the perceived usefulness, as seen in different studies such has the continuance use of smartwatches (Nascimento et al., 2018)or the consumer's acceptance of smart speakers (Kowalczuk, 2018). An increase in usability/usefulness users may find in smart home technologies suggests a bigger set of benefits. Therefore, with an increased set of benefits we are likely to have higher levels of satisfaction which can increase their intention to use smart home technologies. As such, we hypothesize:

- ***H6:*** *PE positively influences BI*

Social influence (SI)

Social influence "is the degree to which an individual considers important how others believe he or she should use a technology"(Chiu & Wang, 2008, p. 196). Research has shown that social influence affects the user's desire to use technology and has a significant effect on continuance usage (Tam et al., 2018). Moreover, the concretization of the user's desire to be in agreement with the "social expectancies", can also have an effect in their satisfaction. Henceforth, we hypothesize:

- ***H7:*** *SI negatively influences BI*
- ***H8:*** *SI positively affects SAT*

Facilitating conditions (FC)

Facilitating conditions is the "degree to which an individual believes that organizational and technical infrastructure exist to support use of the IS" (Venkatesh et al., 2003). According to Tam et al. (2018) an individual whose perception of a favorable set of facilitating conditions is more likely to adopt a technology. Therefore, if users believe they can get support whenever they need, it is expected an increase in their intention to use. As so, we suggest:

- ***H9:*** *FC positively influences BI*
- ***H10:*** *FC positively influences USE*

Habit (HT)

Limayem, Hirt, & Cheung (2007) explains habit as the automation of behavioural action (IS use) due to learning, because repeating actions aids users to perform better. Meaning that, by repeating activities users become more comfortable performing those tasks (due to learning), which, ultimately results in repeating them (behaviour automation). Hence, by using smart home technologies more often, they are expected to perform better, promoting their intention to use and continue using. Consequently, we theorize:

- ***H11****: Habit positively influences BI*
- ***H12:*** *Habit positively influences USE*

Effort expectancy (EE)

Contrarily on perceived expectancy, perceived ease of use or effort expectancy is described as an extension to the user's beliefs to determine the lack of effort needed to use the system (Davis, 1989). Thus, if the user's perceive smart home technologies as "easy to use" then they are more likely to want to use them. This has been shown in the adoption of smart speakers (Kowalczuk, 2018) and smart home adoption studies (Shin et al., 2018). Hence, we posit:

- ***H13:*** *EE positively affects BI*

Hedonic Motivation (HM)

Hedonic motivation is defined as the fun or pleasure derived from using a technology, and it has been shown to play an important role in determining technology acceptance and use (Venkatesh et al., 2012). Adapted to our study, increasing the pleasure that smart home technologies provide, users will likely be continuing using them and enjoying them, theorizing the following hypothesis:

- ***H14:*** *Hedonic Motivation positively influences BI*

Price Value (PV)

Price value is defined as the tradeoff between the financial cost and the benefit of using the technology (Venkatesh et al., 2012). Hence, if the benefits of using smart home technologies are high then the users will be more eager to use them. Nevertheless, this is only true if they believe the financial costs are adequate to the benefits they offer. Thus, we postulate:

- ***H15:*** *PV negatively influences BI*

Behavioral intention (BI)

Followed by the underlying theories of intention models it is expected that behavioral intention posits a positive influence over technological use (Venkatesh et al., 2003). It is the likelihood of engaging in some behavior. Therefore, a higher intention to use smart home technologies will promote user's use and continuance. Furthermore, it is expected that a higher intention leads to an increase in user's perceived expectancy and possible growth, leading to a positive relationship with satisfaction and well-being. Therefore, we posit:

- ***H16:*** *BI positively influences CI*
- ***H17:*** *BI positively influences well-being*
- ***H18:*** *BI positively influences USE*
- ***H19:*** *BI positively influences SAT*

Behavioral use (BU)

Similar to the innovation diffusion theory (Rogers, 2010) in its 5 stage adoption decision process, there is a confirmatory phase where users reevaluate their decisions confirming/disconfirming their beliefs, in moments of pre/post consumption , as discussed by Bhattacherjee (2001). Consequentially, this appraisal poses that continuance use co-varies with technological acceptance, but also the satisfaction of the individual towards technology. Moreover, the use of smart home technologies spurs the user's psychological development (Ryff & Singer, 2008) by meeting to one's needs.

- ***H20:*** *BU Positively influences CI*
- ***H21:*** *BU Positively influences SAT*
- ***H22:*** *BU positively influences well-being*

Continuance intention (CI)

Continuance intention is a post-acceptance stage when IS use becomes part of our normal routine activity (Bhattacherjee, 2001). This continuance intention is a consequence of the user's beliefs confirmation of the technology use. Therefore, by meeting/confirming the user's expectancy, smart home technologies are fulfilling user's needs and therefore inducing their psychological growth, as proposed by Ryff & Singer (2008). Hence, we theorize:

- ***H23:*** *CI positively influences well-being*

Well-being (WB)

According to Diener (2009) PWB is achieved by measuring life satisfaction, frequent pleasant emotion and infrequent unpleasant emotions. Moreover, by grasping well-being as a complex phenomenon (Ryan & Deci, 2001) that is achieved by the state of eudaimonia (Lowry et al., 2015). Consequentially, eudaimonia (Kahneman et al., 1999) is achieved by the realization of ones' inner potential. Hence, we propose the following hypotheses accordingly to (Ryff & Singer, 2008).

- ***H24a****: Well-being is positively affected by Autonomy*
- ***H24b****: Well-being is positively affected by Self-Acceptance*
- ***H24c****: Well-being is positively affected by Environmental Mastery*
- ***H24d****: Well-being is positively affected by Positive Relationships*

4. METHODS

4.1. MEASUREMENT INSTRUMENTS

The measurement items were adapted from literature. The items for CONF were adapted from Nascimento et al. (2018), Samar et all (2019) and Huang (2019); BI, USE, PE, EE, SI FC, HM, PV and HT where adapted from Venkatesh et al. (2012); The items for AUT, EM, PG, PR, PL and SA where adapted from Ryff et al. (2008); SAT was adapted from Nascimento et al. (2018). All measurement items used can be found in Appendix. The questionnaire was developed in English and hosted on a free platform. All items with exception of the ones respecting well-being (Ryff & Singer, 2008) were measured using a seven-point Likert scale, ranging from “Strongly Disagree” (1) to “Strongly Agree” (7).

4.2. DATA COLLECTION

A pilot survey was conducted to polish questions and retrieve comments over the content and structure of the questionnaire. There were no changes to the items and pilot survey data was used in the main survey. The main survey was hosted on a free platform and was conducted online. Concerning demographic data 88.5% of the respondents had a higher level of education and average age of 28 years. More than half of our sample has a higher level of education as seen in Table 1.

Age			Gender			Education		
<18	0	0.0%	Male	165	53.4%	N/A	6	1.9%
18-24	93	32.3%	Female	144	46.6%	Basic School	3	1.0%
25-34	132	45.8%				High School	27	8.7%
35-44	39	13.5%				Bachelor Degree	129	41.3%
45-55	24	8.3%				Master Degree	138	44.2%
56-65	0	0.0%				PhD	9	2.9%

Table 1 - Sample's demographic data

5. RESULTS

Structural equation modelling (SEM) is a statistical method for testing and estimating causal relationships using a combination of statistical data and qualitative causal assumptions. Because some of our items were not normally distributed ($p < 0.01$ using the Kolmogorov-Smirnov test), our model was estimated using the partial least squares (PLS), this research model has not been yet tested in the literature and is regarded as complex. Smart PLS v.3.2.8 was used to analyse the relationships defined in the theoretical model (Ringle, Wende, & Becker, 2015).

5.1. MEASUREMENT MODEL

To access the measurement validity and reliability we must ensure construct reliability, indicator reliability, convergent validity and discriminant Validity. Construct reliability was achieved by the observation of the composite reliability (CR) and Cronbach's alpha (CA). According to literature, these values should be greater than 0.7, nonetheless, for exploratory purposes a range between [0.6 ; 0.7] is considered acceptable. In a preliminary assessment of the model, personal growth and purpose in life didn't meet these criteria and were removed. Therefore, after a re-estimation of the model, as shown in Table 2 (Appendix), all constructs meet these criteria. Indicator reliability was tested recurring to a criterion in which the outer loadings should be greater than 0.7 and that every loading smaller than 0.4 should be removed. However, to constructs between [0.4,0.7[should be removed if their deletion poses an increase of the average variance explained (AVE) or CR. Hence AUT1, EM1, PL2, PR2 and HT3 were removed. To assess the convergent validity of the constructs, following the literature we posed the AVE should be greater than 0.5.

After all the previous validation criteria were met, discriminant validity was assessed using the cross loadings and the *Fornell-Larcker* criteria. The first criterion poses that all the loadings of each indicator should be greater than all cross-loadings, which can be observed in Table 3 (Appendix). The *Fornell-Larcker* criterion stances that the square-root of the AVE should be greater than the correlation between the construct, as seen in Table 2 (Appendix). Consequently, both criteria are met. Furthermore, to confirm discriminant validity we also assessed the HTMT method, which has proven better results than the previous ones (Ringle et al., 2015). This test poses that the observed value should be lesser than 0.9, to indicate discriminant validity. The criteria were met for the HTMT test, confirming the results from the previous test.

All the reflective measurement items were validated. Moreover, this model includes formative measurement items, USE1 to USE6. To validate these measures validity and reliability we should evaluate the collinearity of the indicators, their relative importance and absolute importance. Since the construct is explained 100% by the indicator's we used the bootstrapping method to understand the indicator's relative contribution. As seen in Table 4 (Appendix) the indicators all have a VIF < 5 meaning there are no collinearity issues with the items. On the other hand, after applying a bootstrapping method of 5000 iterations (Hair, 2014), and analysing the outer weights and loadings, of the items, all were statistically significant, and therefore significance and relevance were verified.

5.2. STRUCTURAL MODEL

The structural model was estimated using R^2 measures and path coefficients' level of significance. Figure 5.1 shows the model results. The R^2 of dependent variables are 0.39, 0.42, 0.69, 0.64,0.23 and 0.31 for performance expectancy, satisfaction, behavioural intention, continuance intention, behavioural use and well-being respectively. The significance was assessed based on similar criterion used for formative measurement instruments using a bootstrapping procedure (Hair, 2014), with 5000 resamples.

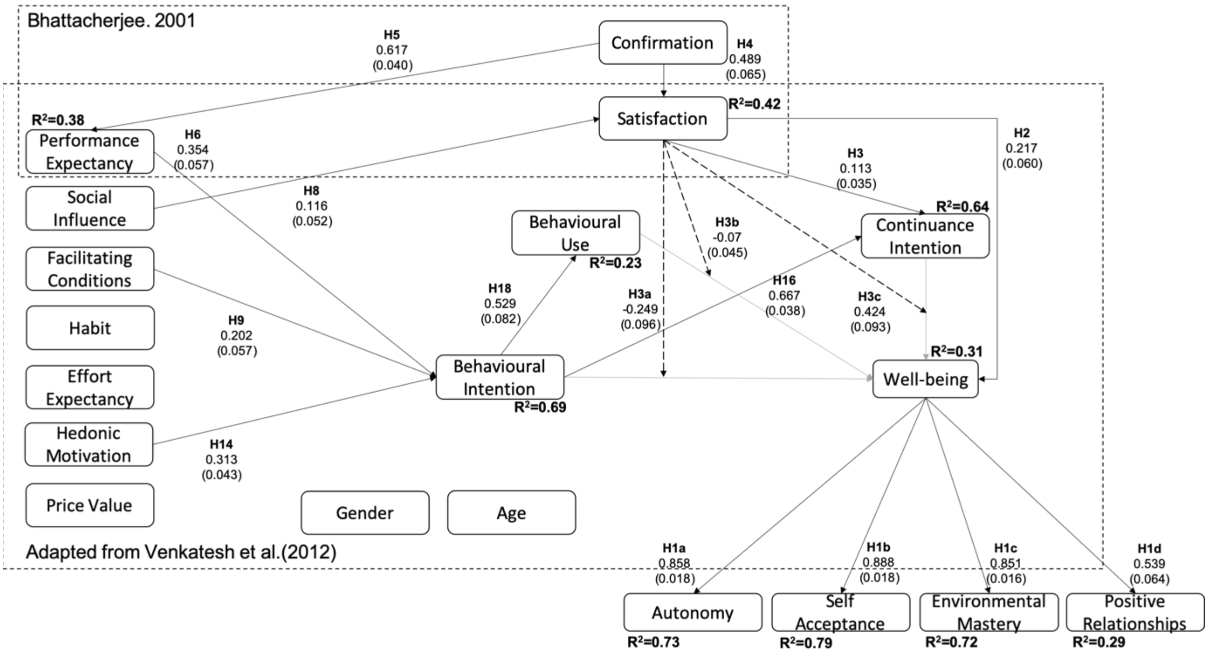

Figure 5.1 – Results

The model explains 38.5% of the variation in performance expectancy and all variables are statistically significant. Confirmation ($\hat{\beta}$ = 0.62; $p < 0.01$). Respectively H5 is confirmed.

The model explains 41.5% of satisfaction. Confirmation ($\hat{\beta}$ = 0.55; $p < 0.01$) and social influence ($\hat{\beta}$ = 0.12; $p < 0.01$) are statistically significant. Thus, H1 and H8 are confirmed.

The model explains 69.1% of the variance in behavioural intention. Hedonic motivation ($\hat{\beta}$= 0.31; $p < 0.01$), performance expectancy ($\hat{\beta}$ = 0.35; $p < 0.01$) and facilitating conditions ($\hat{\beta}$ = 0.19; $p < 0.01$) are statistically significant therefore, H6, H9 and H14 are confirmed.

The model explains 64% of the variance in continuance intention. Behavioural intention ($\hat{\beta}$ = 0.71; $p < 0.01$) and satisfaction ($\hat{\beta}$ = 0.11; $p < 0.01$) are statistically significant. As so, H4 and H16 are confirmed.

The model explains 23.2% of the variance in behavioural use. Behavioural intention ($\hat{\beta}$ = 0.54; $p < 0.01$) is statistically significant. Henceforth H18 is confirmed

The model explains 31.4% of the variance in well-being. From all the hypothesis only satisfaction ($\hat{\beta}$ = 0.22; $p < 0.01$) is statistically significant. Thus, H3 is confirmed.

The modelling paths between well-being and the proposed dimensions are all statistically significant. Autonomy ($\hat{\beta}$ = 0.84; $p < 0.01$), environmental mastery ($\hat{\beta}$ = 0,86; p < 0,01), positive relationships ($\hat{\beta}$ = 0.73; $p < 0.01$) , self-acceptance ($\hat{\beta}$ = 0.89; $p < 0.01$). Therefore, H24a to H24d are confirmed.

5.3. MODERATING EFFECT

Moderation occurs when a variable alters a relationship between two constructs. Therefore, to measure it we applied the PLS product-indicator approach (Chin, Marcolin, & Newsted, 2003) to evaluate satisfaction as a moderator of behavioural Intention, use behaviour and continuance-intention on well-being, as shown below in the Figures 5.2, 5.3 and 5.4, respectively.

Figure 5.2 shows that the relationship between well-being and behaviour intention is weaker on individuals with high satisfaction levels rather than individuals with low satisfaction levels. Figure 5.3 illustrates that the relationship between well-being and use behaviour is weaker on individuals with high satisfaction levels than for people with low satisfaction levels. Figure 5.4 indicates that the relationship between well-being and continuance use is stronger on individuals with high satisfaction rather than low satisfaction. Therefore, well-being encouraged by technology adoption/use is not a direct proxy, meaning they are influenced other proxies such as satisfaction.

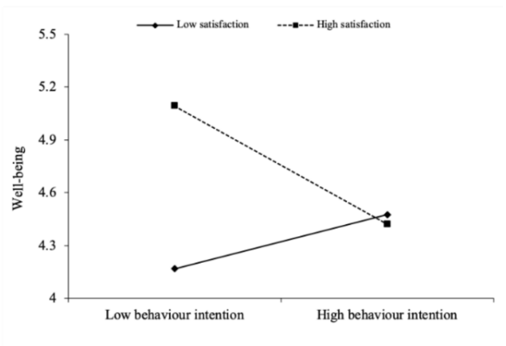

Figure 5.2 – Well-being moderation between satisfaction and behaviour intention

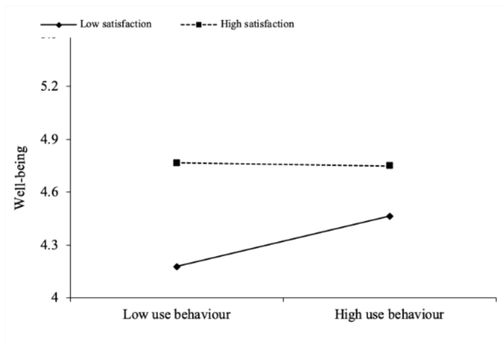

Figure 5.3 – Well-being moderation between satisfaction and use behaviour

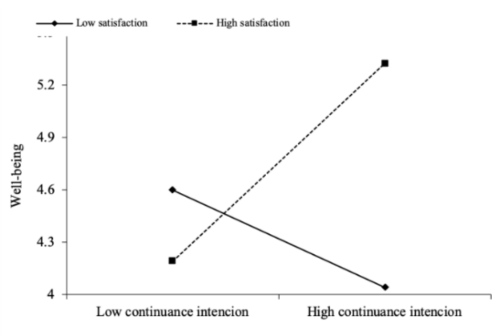

Figure 5.4 – Well-being moderation between satisfaction and continuance intention

6. DISCUSSION

6.1. THEORETICAL IMPLICATIONS

The theoretical framework proposed in this study aims to comprehend the effect of smart home technologies on well-being by understanding the consumer's use context [by using UTAUT2 (Venkatesh et al., 2012)] and technology satisfaction [by using ECT (Bhattacherjee, 2001)]. Additionally, we proposed two new hypotheses. First, that behavioral intention (BI) has a positive impact on continuance intention (CI). Second, that behavioral use (BU) has a positive impact in CI. These new hypotheses increased the explanatory power of CI by 19 p.p. when compared with Bhattacherjee (2001) ECT model, as illustrated in Table 5 (Appendix). Hence, proposing this modification to the ECT ultimately leads to a better understanding of smart home technologies continuance intention.

Moreover, the model we theorized proposed that the different adoption stages (intention, use and routinization) impact well-being, shifting the actual paradigm "innovation for wealth" to "innovation for well-being" (Martin, 2016). Nonetheless, the findings in this study suggest that the relationship between IS adoption stages and well-being is not direct, since this relationship is moderated by SAT. This is of major importance because, to our knowledge, no studies have understood how technology innovation can impact well-being. Therefore, this model gives us a starting point to continue research on "innovation for well-being".

6.2. PRACTICAL IMPLICATIONS

The findings of this study showed that the user's continuance intention to use smart home technologies was the most important factor in explaining well-being, especially in users with high levels of satisfaction, as shown in Figure 5.4. This is a product of the user's beliefs confirmation as defined by Bhattacherjee (2001). Consequently, satisfaction also plays an important role in respecting smart home technologies and well-being. Hence, given the purpose of this study regarding innovation for wellness, smart home technologies should aim to maximize the satisfaction of the individual's use. For this to happen, smart home technologies should be able to meet user expectations, by confirming their beliefs. This occurs when companies "over-deliver" or "under-promise" their product, leading to higher levels of confirmation and also satisfaction (Limayem et al., 2007). Moreover, in smart home context, individuals expect their technologies to create an integrated environment that adapts to their needs (Perumal et al., 2013). Therefore, following the innovation paradigm proposed by Martin (2016), smart home technologies should evolve to fulfil these purposes, responding to user's needs by being integrated and capable of acquiring knowledge from their surroundings.

6.3. LIMITATIONS AND FUTURE RESEARCH

Despite the increase to the current knowledge, we understand the limitations of this study. The first is related to sampling, since the study was applied in Portugal. Hence, this study may not be generalizable. Another limitation of this study is related with the panoply of sub-technologies that smart home technologies include. This could affect user's responses due to a lack of smart home technologies penetration in Portugal. Finally, this was an early attempt to measure well-being in IS studies, this proved difficult being such a subjective item. Therefore, the measuring items may need some adjustment.

We recommend increasing the geographical application of the questionnaire to disclose possible significant changes. Additionally, we propose in the next studies to measure other technologies impact on individual's well-being and compare their possible differences. Other suggestions may be to extend this theory by adding new constructs/relationships that may help increase technological impact on well-being perception, and the possibility for some underlying relationships between variables as satisfaction with intention, use and continuance.

7. CONCLUSION

Most IS studies have been focused on innovation for wealth, studying IT acceptance or IT continuance, neglecting "innovation for wellness" as a paradigm. To our knowledge well-being hasn't been studied in IS context. By addressing this gap, this study contributes by creating a framework to help us disclosure how technology can influence individual's well-being, promoting a change in the existing paradigm.

This framework also contributes to the expansion of IT adoption and continuance theories, by combining the ECT with UTAUT2, broadening the applicability of these theories concerning smart home technologies. Our findings indicate that technology adoption/use does not directly affect individual's well-being, being moderated by one's satisfaction. Hence, the confirmation/disconfirmation of user's expectancy have an important role in understanding the impact of smart home technology on individual's well-being.

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9. APPENDIX

Construct Operationalization

Construct	Acronym	Description	Adapted from
Performance Expectancy	PE	The extent to which a person believes that a system enhances his or her performance	Venkatesh et al. (2012)
Expected Effort	EE	The extent to which a learner believes that using a system is free of effort	Venkatesh et al. (2012)
Social Influence	SI	Is the degree to which an individual considers important how others believe he or she should use a technology	Venkatesh et al. (2012)
Facilitating Conditions	FC	Is the degree to which an individual believes that organizational and technical infrastructure exist to support use of the IS	Venkatesh et al. (2012)
Hedonic Motivation	HM	Hedonic motivation is defined as the fun or pleasure derived from using a technology	Venkatesh et al. (2012)
Price Value	PV	Is the financial cost required to obtain and use a product	Venkatesh et al. (2012)
Habit	H	Is the extent to which people tend to perform behaviours (use IS) automatically because of learning	Venkatesh et al. (2012)
Confirmation	CONF	Cognitive appraisal of the expectation-performance discrepancy	Bhattacherjee (2001)
Satisfaction	SAT	The summary psychological state resulting when the emotion surrounding disconfirmed expectations is coupled with the consumer's prior feelings about the consumption experience	Bhattacherjee (2001)
Well-being	WB	well-being is a measure of self-awareness and self-accomplishment with ones' life	Ryff et al. (2008)
Self-acceptance	SA	Is the self-evaluation of awareness and acceptance of ones' strengths and weaknesses	Ryff et al. (2008)
Autonomy	A	Is defined as the autonomous functioning and resistance to enculturation through a sense of freedom of the norms governing everyday life	Ryff et al. (2008)
Purpose in Life	PL	Having a clear comprehension of life's purpose through a sense of directness and intentionality	Ryff et al. (2008)
Environmental Mastery	EM	Is defined as the individual's ability to choose or create environments suitable to his/her psychic conditions	Ryff et al. (2008)
Positive Relationships	PR	The capacity for great love, deep friendship, and close identification with others	Ryff et al. (2008)
Personal Growth	PG	Is the self-realization of the individual through self-actualization	Ryff et al. (2008)

Construct Items:

Construct		Item	Adapted from
Confirmation	CONF1	My experience using smart house technologies is better than I expected	Nascimento et al. (2018)
	CONF2	Overall, most of my expectations from using smart house technologies were confirmed	
	CONF3	The various features of smart home technologies were better than what I expected	Samar Rahi, Mazuri Abd. Ghani, (2019)
	CONF4	I think that the virtual desktop is more useful than I expected	Huang (2019)
Behavioral Intention	BI1	I intend to continue using smart home technologies in the future	Venkatesh et al. (2012)
	BI2	I will always try to use smart home technologies in my daily life	
	B3	I plan to continue to use smart home technologies frequentely	
Use	U1	Please choose your usage frequency for each of the following: a) Speakers b) Voice Activated Personal Assistants c) Lighting d) Domestic Robots e) Thermostats f) Door locks	Venkatesh et al. (2012)
Continuance Intention	CI1	I intend to continue using the smart home technologies, rather than discontinue its use	Nascimento et al. (2018)
	CI2	I plan to continue using smart home technologies	
	CI3	I will continue using smart home technologies	
	CI4	I predict I will continue using smart home technologies in the future	
Satisfaction	SAT1	How do you feel about your overall experience of smart house technology use: Very dissatisfied / Very Satisfied	Nascimento et al. (2018)
	SAT2	Very displeased/Very pleased	
	SAT3	Very frustrated/Very contended	
	SAT4	Absolutely terrible /Absolutely delighted	
Performance Expectancy	PE1	I find smart home technologies useful in my daily life	Venkatesh et al. (2012)
	PE2	Using smart home technologies help me accomplish things more quickly	
	PE3	Using smart home technologies increase my productivity	
Effort Expectancy	EE1	Learning how to use smart home technologies is easy for me	Venkatesh et al. (2012)
	EE2	My interaction with smart home technologies is clear and understandable	
	EE3	I find smart home technologies easy to use	
	EE4	It is easy for me to become skillful at using smart home technologies	
Social Influence	SI1	People who are important to me think that I should use smart home technologies	Venkatesh et al. (2012)
	SI2	People who influence my behavior think that I should use smart home technologies	
	SI3	People whose opinions that I value prefer that I use smart home technologies	
Facilitating Conditions	FC1	I have the resources necessary to use smart home technologies	Venkatesh et al. (2012)
	FC2	I have the knowledge to use smart home technologies	
	FC3	Smart home technologies are compatible with other technologies I use	
	FC4	I can get help from others when I have difficulties using smart home technologies	

Hedonic Motivation		HM1	Using smart home technologies is fun	Venkatesh et al. (2012)
		HM2	Using smart home technologies is enjoyable	
		HM3	Using smart home technologies is very entertaining	
Price Value		PV1	Smart home technologies are reasonably priced	Venkatesh et al. (2012)
		PV2	Smart home technologies are a good value for the money	
		PV3	At the current price, smart home technologies provide a good value	
Habit		HT1	The use of smart home technologies has become a habit for me	Venkatesh et al. (2012)
		HT2	I am addicted to using smart home technologies	
		HT3	I must use smart home technologies	
Well-being	Autonomy	A1	I tend to be influenced by people with strong opinions	Ryff et al. (2008)
		A2	I have confidence in my own opinions, even if they are different from the way most other people think	
		A3	I judge myself by what I think is important, not by the values of what others think is important	
	Environmental Mastery	EM1	The demands of everyday life often get me down	Ryff et al. (2008)
		EM2	In general, I feel I am in charge of the situation in which I live	
		EM3	I am good at managing the responsibilities of daily life	
	Personal Growth	PG1	For me, life has been a continuous process of learning, changing, and growth	Ryff et al. (2008)
		PG2	I think it is important to have new experiences that challenge how I think about myself and the world	
		PG3	I gave up trying to make big improvements or changes in my life a long time ago	
	Positive Relationships	PR1	Maintaining close relationships has been difficult and frustrating for me	Ryff et al. (2008)
		PR2	People would describe me as a giving person, willing to share my time with others	
		PR3	I have not experienced many warm and trusting relationships with others	
	Purpose in life	PL1	Some people wander aimlessly through life, but I am not one of them	Ryff et al. (2008)
		PL2	I live life one day at a time and don't really think about the future	
		PL3	I think it is important to have new experiences that challenge how I think about myself and the world	
	Self-acceptance	SA1	I like most parts of my personality	Ryff et al. (2008)
		SA2	When I look at the story of my life, I am pleased with how things have turned out so far	
		SA3	In many ways I feel disappointed about my achievements in life	

Measurement tables

	Mean	**SD**	**CA**	CR	Aut	BI	BU	CI	Conf	EE	EM	FC	Gen	HM	HT	PE	PR	PV	SA	SI	Sat
Aut	4.428	1.904	0.90	0.95	0.95																
BI	4.976	1.403	0.92	0.95	-0.09	0.93															
BU	3.160	1.580	NA	NA	0.04	0.45	NA														
CI	5.299	1.512	0.97	0.98	-0.02	0.78	0.40	0.96													
Conf	4.528	1.388	0.91	0.94	-0.12	0.69	0.54	0.65	0.89												
EE	5.337	1.500	0.96	0.97	-0.28	0.67	0.29	0.59	0.61	0.95											
EM	4.443	1.843	0.89	0.95	0.75	-0.03	0.17	0.04	-0.05	-0.23	0.95										
FC	5.028	1.349	0.87	0.91	-0.17	0.69	0.23	0.66	0.68	0.82	-0.17	0.85									
HM	5.098	1.551	0.95	0.97	-0.09	0.69	0.24	0.64	0.59	0.61	-0.22	0.61	-0.04	0.95							
HT	5.086	1.130	0.47	0.79	0.08	0.02	0.05	0.03	0.08	0.01	0.02	0.01	0.06	0.04	0.81						
PE	4.970	1.459	0.94	0.96	-0.21	0.74	0.34	0.60	0.62	0.62	-0.19	0.62	-0.12	0.60	0.05	0.95					
PR	4.493	1.893	0.80	0.91	0.22	0.14	0.32	0.21	0.20	0.06	0.26	0.13	-0.05	0.18	-0.06	0.08	0.91				
PV	3.307	1.234	0.91	0.94	-0.34	0.33	0.28	0.27	0.31	0.34	-0.29	0.36	0.00	0.13	-0.11	0.30	0.16	0.92			
SA	4.539	1.728	0.81	0.89	0.64	-0.01	0.14	0.02	0.03	-0.19	0.61	-0.10	0.05	0.00	0.03	-0.07	0.50	-0.10	0.85		
SI	3.639	1.632	0.90	0.93	-0.10	0.44	0.27	0.35	0.44	0.37	-0.12	0.35	-0.10	0.30	0.10	0.50	0.27	0.38	0.30	0.94	
SAT	5.187	1.071	0.93	0.96	0.04	0.50	0.36	0.48	0.61	0.43	0.12	0.43	-0.17	0.37	0.04	0.44	0.16	0.19	0.17	0.40	0.88

Table 2 - Cronbach's alpha (CA), composite reliability (CR) and square root of AVEs.

	Item	Aut	BI	CI	Conf	EE	EM	FC	HM	HT	PE	PR	PV	SA	Sat	SI	BU
Aut	AUT2R	**0.950**	-0.124	-0.052	-0.156	-0.253	0.709	-0.178	-0.119	0.116	-0.244	0.233	-0.343	0.550	-0.003	-0.103	0.016
	AUT3R	**0.955**	-0.044	0.013	-0.079	-0.278	0.718	-0.150	-0.047	0.032	-0.159	0.190	-0.304	0.669	0.080	-0.091	0.067
BI	BI1	-0.064	**0.915**	0.755	0.717	0.695	0.007	0.750	0.644	0.000	0.705	0.123	0.377	-0.022	0.501	0.340	0.342
	BI2	-0.109	**0.919**	0.667	0.555	0.532	-0.023	0.489	0.631	0.080	0.655	0.169	0.245	-0.032	0.413	0.409	0.490
	BI3	-0.072	**0.948**	0.752	0.644	0.620	-0.055	0.667	0.650	-0.022	0.693	0.114	0.284	0.014	0.480	0.476	0.424
CI	CI1	0.040	0.757	**0.934**	0.612	0.564	0.015	0.651	0.638	0.030	0.562	0.226	0.245	0.094	0.464	0.354	0.347
	CI2	-0.036	0.762	**0.967**	0.590	0.541	0.030	0.601	0.598	-0.021	0.575	0.209	0.280	-0.007	0.429	0.321	0.389
	CI3	-0.062	0.726	**0.960**	0.661	0.614	0.025	0.639	0.580	0.074	0.576	0.146	0.250	-0.042	0.455	0.321	0.396
	CI4	-0.018	0.758	**0.975**	0.647	0.560	0.066	0.647	0.629	0.030	0.597	0.228	0.250	0.018	0.481	0.349	0.385
Conf	CONF1	-0.189	0.633	0.647	**0.924**	0.573	-0.020	0.586	0.499	0.071	0.593	0.101	0.290	-0.066	0.579	0.396	0.563
	CONF2	0.052	0.728	0.639	**0.873**	0.556	0.048	0.632	0.620	0.080	0.570	0.298	0.271	0.159	0.617	0.451	0.492
	CONF3	-0.155	0.543	0.555	**0.887**	0.535	-0.149	0.620	0.476	0.051	0.514	0.149	0.289	0.035	0.520	0.426	0.448
	CONF4	-0.161	0.540	0.470	**0.883**	0.514	-0.085	0.585	0.508	0.073	0.525	0.173	0.267	-0.043	0.441	0.294	0.417
EE	EE1	-0.319	0.577	0.552	0.584	**0.961**	-0.252	0.770	0.557	0.004	0.561	0.080	0.334	-0.186	0.420	0.354	0.253
	EE2	-0.224	0.696	0.562	0.585	**0.931**	-0.165	0.767	0.633	0.057	0.645	0.024	0.283	-0.130	0.435	0.378	0.263
	EE3	-0.216	0.642	0.552	0.552	**0.945**	-0.233	0.775	0.594	-0.035	0.576	0.086	0.308	-0.188	0.372	0.339	0.253
	EE4	-0.312	0.592	0.581	0.599	**0.952**	-0.243	0.812	0.530	-0.002	0.574	0.050	0.374	-0.227	0.395	0.344	0.323
EM	EM2R	0.705	-0.030	-0.007	-0.072	-0.194	**0.951**	-0.169	-0.227	0.035	-0.194	0.262	-0.319	0.613	0.070	-0.072	0.158
	EM3R	0.718	-0.019	0.076	-0.027	-0.251	**0.947**	-0.154	-0.184	0.003	-0.174	0.226	-0.233	0.545	0.163	-0.151	0.159
FC	FC1	-0.059	0.544	0.513	0.578	0.602	-0.132	**0.870**	0.446	-0.050	0.483	0.129	0.337	-0.028	0.394	0.301	0.237
	FC2	-0.096	0.632	0.548	0.530	0.847	-0.183	**0.872**	0.643	0.009	0.575	0.018	0.264	-0.091	0.343	0.320	0.156
	FC3	-0.222	0.525	0.577	0.602	0.661	-0.120	**0.841**	0.486	-0.029	0.486	0.082	0.321	-0.157	0.430	0.153	0.131
	FC4	-0.210	0.626	0.606	0.603	0.679	-0.139	**0.817**	0.478	0.099	0.557	0.219	0.293	-0.083	0.302	0.384	0.257
HM	HM1	-0.068	0.662	0.590	0.560	0.557	-0.216	0.560	**0.975**	0.023	0.548	0.171	0.080	0.017	0.365	0.307	0.174
	HM2	-0.092	0.680	0.676	0.603	0.622	-0.173	0.611	**0.954**	0.066	0.588	0.189	0.084	0.044	0.417	0.364	0.246
	HM3	-0.088	0.638	0.553	0.530	0.577	-0.235	0.564	**0.931**	0.035	0.579	0.163	0.207	-0.074	0.268	0.181	0.266
HT	HT1	0.052	-0.005	0.028	0.072	-0.017	0.017	0.021	0.008	**0.787**	0.054	-0.070	-0.071	0.024	0.053	0.078	0.044
	HT2	0.071	0.034	0.019	0.054	0.028	0.016	0.001	0.061	**0.827**	0.024	-0.028	-0.112	0.019	0.017	0.078	0.033
PE	PE1	-0.148	0.727	0.597	0.601	0.607	-0.134	0.648	0.583	0.047	**0.955**	0.118	0.309	-0.055	0.412	0.412	0.348
	PE2	-0.216	0.710	0.589	0.611	0.601	-0.175	0.592	0.552	0.019	**0.960**	0.062	0.273	-0.110	0.421	0.409	0.342
	PE3	-0.237	0.662	0.523	0.548	0.568	-0.248	0.523	0.571	0.071	**0.929**	0.055	0.259	-0.036	0.419	0.622	0.275
PR	PR1	0.194	0.164	0.186	0.187	0.036	0.221	0.074	0.221	-0.063	0.118	**0.915**	0.121	0.486	0.185	0.263	0.305

	PR3	0.210	0.100	0.200	0.185	0.079	0.249	0.172	0.111	-0.045	0.033	**0.911**	0.179	0.419	0.105	0.224	0.283
PV	PV1	-0.361	0.290	0.179	0.233	0.302	-0.312	0.262	0.166	-0.179	0.282	0.188	**0.902**	-0.103	0.079	0.304	0.251
	PV2	-0.256	0.334	0.337	0.317	0.307	-0.274	0.375	0.110	-0.041	0.306	0.120	**0.911**	-0.131	0.247	0.396	0.281
	PV3	-0.324	0.269	0.202	0.308	0.329	-0.212	0.334	0.073	-0.106	0.217	0.146	**0.937**	-0.029	0.171	0.336	0.232
SA	SA1R	0.716	-0.038	-0.055	-0.020	-0.171	0.601	-0.087	-0.004	0.047	-0.100	0.398	-0.145	**0.893**	0.145	0.153	0.136
	SA2R	0.558	-0.120	-0.094	-0.072	-0.268	0.601	-0.222	-0.146	0.063	-0.182	0.262	-0.180	**0.901**	0.134	0.208	0.047
	SA3	0.307	0.158	0.244	0.202	-0.021	0.314	0.076	0.179	-0.060	0.143	0.663	0.116	**0.746**	0.153	0.446	0.197
Sat	SAT1	0.108	0.495	0.436	0.635	0.382	0.164	0.415	0.339	0.079	0.419	0.171	0.214	0.190	**0.868**	0.404	0.451
	SAT2	0.061	0.506	0.493	0.556	0.410	0.095	0.429	0.421	0.024	0.429	0.107	0.099	0.188	**0.933**	0.353	0.255
	SAT3	-0.053	0.318	0.317	0.369	0.297	0.054	0.283	0.156	0.004	0.285	0.201	0.239	0.049	**0.801**	0.307	0.226
	SAT4	-0.008	0.405	0.399	0.533	0.400	0.094	0.344	0.328	0.027	0.382	0.096	0.117	0.127	**0.903**	0.338	0.288
SI	SI1	-0.055	0.390	0.321	0.364	0.313	-0.103	0.322	0.234	0.074	0.446	0.284	0.360	0.305	0.391	**0.920**	0.234
	SI2	-0.121	0.415	0.273	0.440	0.350	-0.073	0.277	0.295	0.098	0.455	0.268	0.359	0.284	0.339	**0.929**	0.313
	SI3	-0.110	0.433	0.388	0.442	0.389	-0.149	0.377	0.313	0.100	0.511	0.204	0.352	0.245	0.401	**0.965**	0.227
BU	USE1	-0.012	0.357	0.386	0.367	0.282	0.142	0.241	0.118	0.104	0.180	0.114	0.294	0.042	0.241	0.228	0.771
	USE2	0.056	0.391	0.369	0.488	0.268	0.184	0.189	0.270	0.063	0.317	0.161	0.167	0.187	0.273	0.257	**0.841**
	USE3	-0.028	0.233	0.225	0.302	0.163	0.109	0.123	0.068	0.062	0.176	-0.136	0.156	0.021	0.114	0.263	**0.438**
	USE4	-0.022	0.216	0.103	0.320	0.011	0.012	-0.001	0.068	-0.091	0.233	0.349	0.117	0.042	0.292	0.198	**0.539**
	USE5	-0.002	0.308	0.183	0.334	0.203	0.060	0.210	0.162	-0.017	0.277	0.149	0.138	-0.061	0.182	0.039	**0.583**
	USE6	0.084	0.157	0.136	0.308	0.106	0.102	0.098	0.002	0.060	0.123	0.162	0.326	0.141	0.153	0.332	**0.422**

Table 3 - Loadings and cross-loadings for the measurement model

Indicator	VIF
USE1	1.956
USE2	2.129
USE3	2.809
USE4	1.424
USE5	1.622
USE6	2.372

Table 4 - VIF Formative Measure Items

Bhattacherjee (2001) ECM			Research Model		
Construct	**R2**	**R2 Adj**	**Construct**	**R2**	**R2 Adj.**
Continuance Intention	0.45	0.44	Continuance Intention	0.64	0.63
Performance Expectancy	0.27	0.27	Performance Expectancy	0.38	0.37
Satisfaction	0.57	0.47	Satisfaction	0.42	0.40
			Behavioural Intention	0.70	0.68
			Use	0.23	0.21
			Well-being	0.31	0.29

Table 5 - Comparison between research model and Bhattacherjee ECT