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# The Adoption of Pervasive Technology in Private Spaces: Exploring Pre-Exposure Beliefs and Post-Exposure Outcomes Using Cognitive Dissonance Theory

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# Abstract

The development of pervasive technology for homes has always revolved around ever-growing consumer needs for comfort, a better home experience and the convenience of technology operation. Smart home technologies promise to deliver financial, environmental and health-related benefits through real-time control and management of resource consumption, remote monitoring and support, and other tailored services for users. However, despite the benefits of the technology for its users, the adoption rate is still low. Low adoption incurs the risk that the technology's potential will never be realised, decreasing its positive implications for individuals and society in general. Against the backdrop of the low implementation of smart homes and their fast-paced development, it is important to examine technology utilisation from the user's perspective, focusing on beliefs that underpin the acceptance and the perceived outcomes of performance. Given that new technology raises high expectations, which may undermine post-performance evaluation, it is important to consider the psychological factors that the perception and experiences of the promised performance entail. This will provide valuable evidence about the conditions which lead people to continue with or abandon the technology.

The academic community has intensified its efforts to examine the concept of the smart home, its technological capabilities, its implications and the impact on people's lives, but the literature still lacks empirical evidence about the users' perspective on the utilisation of technology. Users' beliefs, such as the expected benefits and risks which may facilitate or inhibit trialling the technology in private spaces have been under-researched. Studies have examined interaction with technologies irrespective of the context, thus decreasing the validity of the analysis of situational behaviour. However, the utilisation of technology in private settings is contingent on psychological factors, the perception of outcomes, motives and beliefs. Those factors affect the perception of the values and risks that the use of the technology might entail. Secondly, there is still a lack of insight into the outcomes of the use of technology when the performance falls short of initial expectations. The behavioural and cognitive responses following poor technology performance and the coping mechanisms that users deploy to ameliorate negative consequences are under-researched.

Given the gaps in the literature, the first focus of the thesis was to examine the user's perspective on smart home utilisation by examining the beliefs that underpin the adoption of the technology. The research adopted the Task Technology Fit (TTF) model, integrated

with the constructs that pertain to the users' perception of technology performance, such as perceived usefulness and perceived ease of use. While TTF stresses the importance of the "fit" factor when it comes to task-related behaviour, perceived usefulness and perceived ease of use explain the attitudinal underpinnings of the behaviour. Additionally, the model aimed to explain whether utilitarian, hedonic values, privacy and financial risks influence the users' perception of task-fit. The second focus of this thesis was to explore individuals' behaviour when technology performance falls short of expectations. The hypotheses were drawn from the literature in the confirmation-satisfaction and cognitive dissonance domains. Such an approach made it possible to examine psychological, behavioural and cognitive factors following a negative experience with technology. Post-performance dissonance arousal reflecting the psychological discomfort induced by the discrepancy between performance and expectations was examined. Furthermore, the adoption of cognitive dissonance theory aimed to explore the role of different types of emotions associated with dissonance and their role in post-dissonance behaviour. The motivational roles of each emotion in predicting coping strategies for reducing dissonance, such as behaviour change, attitude change and information seeking, were investigated.

Two online surveys were conducted to address the objectives of the thesis. The first survey focused on examining the antecedents of pervasive technology adoption by smart home users. The data for the first survey was collected from 422 respondents located in the United States. The focus of the second questionnaire was to examine the behaviour following disconfirmed expectations. Therefore, only smart home users who had had a negative experience with using smart home technologies were eligible to participate in the survey. After filtering non-eligible cases, the final sample consisted of 387 responses. Both questionnaires consisted of two parts: 1) questions related to the socio-demographic characteristics of the respondents, and 2) questions designed to measure the variables for the model. For the analysis of the data, structural equation modelling was utilised.

Results indicated that hedonic and utilitarian beliefs are critical for the perception of task fit, whereas privacy and financial factors were found not to be significant. The fit between tasks and technology demonstrated its significant role in predicting perceived usefulness, perceived ease of use, use behaviour and satisfaction. Lastly, use behaviour showed a positive correlation with satisfaction. When it came to examining the outcomes of performance following disconfirmed expectations, results indicated that weak technology performance induces dissonance due to the discrepancy between expected and actual technology performance. Dissonance triggered feelings of anger, guilt and regret. The arousal of those emotions activated distinctive dissonance reduction mechanisms aimed at reducing psychological discomfort through attitude change, behaviour change or information-seeking mechanisms. Behaviour change was selected when people felt anger and regret, while consonant information-seeking and attitude change were selected when people felt guilt. The coping mechanisms, in turn, had different effects on satisfaction and wellbeing. Satisfaction and wellbeing were achieved when people coped with dissonance by changing their attitude to the technology or searching for information to justify the use of the technology. The withdrawal of behaviour increased the likelihood of feeling dissatisfaction and reduced the likelihood of perceiving wellbeing.

The results of this thesis make several contributions. The findings contribute to the literature on the acceptance of pervasive technology in private spaces. Evidence on the role of beliefs pertaining to technology utilisation (i.e. task-technology fit, perceived usefulness and perceived ease) in private spaces moves forward the theoretical front in the domain of smart homes. In addition, the examination of psychological beliefs (i.e. hedonic value, utilitarian value, privacy and financial risks) with the task-technology fit factor explained the facilitating and inhibiting conditions in which the technology is most likely to be perceived to be compatible with users' needs. Secondly, insight into consumer experience after technology widens the boundaries of the research on innovative technology acceptance, which has predominantly focused on the underpinnings of adoption as opposed to the outcomes of initial use. The results of the thesis provide evidence about behavioural outcomes following the utilisation of technology when performance falls short of expectations. Such an approach adds to the literature adopting the expectation disconfirmation paradigm, by providing a different perspective on the behavioural outcomes of disconfirmed expectations. In contrast to prior research, the results indicate that the disconfirmation of expectations can lead to positive outcomes, such as satisfaction and perceived wellbeing. Thirdly, the results widen the application of cognitive dissonance theory, by identifying the complex psychological, cognitive and behavioural processes following the evaluation of technology performance. As far as practical implications are concerned, the results inform practitioners about the factors to focus on when developing technology to satisfy a broader user segment. Also, they provide suggestions on marketing and communication strategies that may eliminate the likelihood or the consequences of disconfirmed expectations.

**Keywords:** Technology Acceptance, Cognitive Dissonance, Coping Mechanisms, Emotions, Smart Home

## Declaration

Part of the data and results presented in this thesis have been submitted to conferences and journals as per below

**Published Articles**

1. Marikyan, D., Papagiannidis, S. and Alamanos, E., 2019, A systematic review of the smart home literature: A user perspective. *Technological Forecasting and Social* Change, 138, pp.139-154.

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3. Marikyan, D., Papagiannidis, S. and Alamanos, E., 2020. Cognitive Dissonance in Technology Adoption: A Study of Smart Home Users. Information Systems Frontiers, pp.1-23.

**Conference Proceedings**

1. Marikyan, D., Papagiannidis, S. and Alamanos, E., 2018, Smart Homes Acceptance: An empirical study. *British Academy of Management 2018 Conference*.

2. Marikyan, D., Papagiannidis, S. and Alamanos, E., 2019, Do smart homes deliver the promised benefits? *British Academy of Management 2019 Conference*.

3. Marikyan, D., Papagiannidis, S. and Alamanos, E., 2019, "The Effect of Behavioural Beliefs on Smart Home Technology Adoption", *UK Academy for Information Systems Conference Proceedings 2019*. 19.

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# 1. Introduction

Home is a private space, in which residents perform different roles while carrying out their daily routines (Venkatesh, 1996, Kraybill, 2005). Individuals need to feel secure and enjoy emotional and physical comfort when they are inside their house (Kraybill, 2005). This may explain why homes have remained relatively untouched by the advent of online technologies and we have only just started experiencing a significant wave of change, namely their transformation into smart homes. The smart home is defined as a "*residence equipped with computing and information technology, which anticipates 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*" (Aldrich, 2003). Despite the rigorousness of the aforementioned definition, a recent systematic literature review that analysed most of the available definitions of smart home technologies identified the overlapping elements and proposed an up-to-date definition: a "*smart home represents 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*" (Marikyan et al., 2019). The key attributes of a smart home technology are the ability to acquire information from the surrounding environment, react accordingly (Chan *et al.*, 2008, Balta-Ozkan *et al.*, 2014) and provide tailored services to meet users' needs. Although the promises of smart homes revolve around user benefits and well-being, technology adoption is still low. The innovations do not go beyond the project mode, indicating the failure of many companies in ensuring the acceptance of the technology by consumers (Ahuja and Patel, 2016). The significant discrepancy between the expected and actual growth in the smart home technology adoption in households means that the full potential of connected home devices has not been unlocked (Darby, 2018, Mordor Intelligence, 2019).

According to McKinsey's report, many consumers do not fully realise the value offered by smart homes. Having interviewed 3000 households, users' attitude and perception of connected home devices were found to be controversial (Ahuja and Patel, 2016). On one hand, smart homes are capable of encouraging independent living, promoting environmental sustainability and offering financial benefits through daily support, monitoring and consultancy services. On the other hand, they raise serious privacy and trust issues that go well-beyond other technologies, due to their pervasive nature (Balta-Ozkan et al., 2013a, Chang et al., 2009). Therefore, technology acceptance can play a relatively more important role compared to others when examined in the context of other digital technologies, especially when it comes to examining potential risks vs the benefits a user may obtain. When it comes to the literature, the narratives on smart homes are slightly divergent. From the technical point of view, smart homes are designed to satisfy users' needs (Aldrich, 2003), although industry insights suggest the actual struggles that users have while using the technology (Ahuja and Patel, 2016).

In addition, adopting smart homes promises opportunities that raise high expectations which may even undermine post-performance evaluation (Dwivedi et al., 2019, Sun and Medaglia, 2019, Fan and Suh, 2014). When using a technology users form perception when it comes to performance and in turn, the benefits the technology brings (Susarla et al., 2003, Oliver, 1980, Qazi et al., 2017). The evaluation of performance is contingent on beliefs that people hold about the technology (Fan and Suh, 2014), while the perception of performance determines its long-term utilisation (Bhattacherjee, 2001). Hence, it is important to consider the psychological factors that perception and experiences of the promised performance entail. The literature provides useful insights into the cognition and behaviour of users after the evaluation of the performance of the technology, which exceeds expectations (e.g. Innovation diffusion Theory and Expectation-Confirmation Theory) (Hsieh et al., 2010, McKinney et al., 2002). Still, we do not have enough evidence about the psychological consequences following the negative disconfirmation of expectations (i.e. when performance falls short of expectations), as well as behavioural and cognitive mechanisms that users may resort to in such circumstances.

Given the above, it is important not only to look into the capability of a smart home but examine users' perspective on how the technology integrates into peoples' lives. Therefore, the focus of this theses is to examine the factors of acceptance and the utilisation of smart homes following disconfirmed expectations. The following sections in this chapter will provide a brief overview of the external factors that triggered the development of the smart home concept. Then, the thesis will explain the importance of the research by describing the current state of the smart home market and an overview of the research on technology acceptance, followed by the aims, gaps and objectives of the thesis.

## 1.1. Smart Homes: Background

The introduction of smart technologies in households is the reflection of three main economic, technological and demographic trends. First, the development of smart homes was triggered by the need for efficient energy management. Smart home devices were aimed at managing electricity consumption and their popularity contributed to the evolution of energy management systems at the late 1970s. At that time, energy management raised governmental concern about increasing energy costs, the energy crisis and the arising idea of energy conservation. The first analogues of modern smart systems were aimed to monitor, optimise and control energy flow (Asare-Bediako et al., 2012). With the advent of the internet and the development of embedded systems, the energy management facilities and technologies were redesigned at the system (grids) and at the end-user levels (Asare-Bediako et al., 2012, Lee et al., 1999). That transformation contributed to the introduction of the modern prototypes of smart home technologies and appliances. The change of software and hardware standards paved the path towards market-oriented home automation products (Tidd, 1994). Technological solutions enabled communication between different types of home equipment and computers (Sheppard, 1992, Nunn et al., 1992). The implementation of low-power wireless sensors pushed forward the smart grid concept in such a way that while managing energy efficiently it also provided greater comfort for users through automation (JordA et al., 2011, Tang and Venables, 2000). Hence, the capability and complexity of smart home energy systems have been evolving to address the environmental and economic challenges and the needs of consumers. However, the smart energy concept represents only a fraction of smart home solutions designed to tackle environmental and economic issues. Recently, the awareness of increasing pollution and climate change has triggered more interest in technologies, such as smart water and smart bins, as their functions enable people to control and reduce the use of natural resources and manage waste (Khedekar et al., 2017, Martins et al., 2014).

The second trigger of the development of smart homes is the change in people's lifestyle. With the increasing number of information communication technologies, people, in general, have become more aware of emerging technologies. The high penetration rate of smartphones, tablets and portable personal computers has made individuals more dependent on ICT devices. As per reports (e.g. (Accenture, 2014)), individuals have dramatically increased the time they spend on using smart technologies. Such an observed change in consumer mindset towards technology promotes the digital lifestyle that smart home technologies are the part of. The facilitator of the digital lifestyle is the development of the Internet of Things. The Internet of Things is the phenomenon referring to the new of form of human-computer interaction enabling the exchange of data in real-time by the connectivity of different computing devices and people (Guillemin and Friess, 2009). The increase in the numbers and use of IoT devices have had a direct impact on smart home technology use. Robotic technology enables automation and higher efficiency without human involvement, while cloud computing enables the connectivity of devices and the transfer of data. For example, a smart vacuum cleaner takes a load off users' mind, by automating household tasks. (Luenendonk, 2014, Khedekar et al., 2017).

The third driver of smart home development is the increasing life expectancy of the population and low fertility rate, which are changing the demographic profile of the population globally. The percentage of people aged 65 and older is projected to dramatically increase in the next few decades (Tang and Venables, 2000, Lê et al., 2012). This demographic change entails increases in healthcare spending, as older people are more prone to hospitalisation and vulnerable to illnesses. This raises the need for higher investment in disability support, healthcare and health risk minimisation measures (Lê et al., 2012). Against the backdrop of increased healthcare bills, older people have become more educated and determined in terms of the needs they have and they are striving for more independent living (Tang and Venables, 2000). The compilation of socio-demographic factors necessitated a need for technologically led home-based care. Smart home technologies have become a viable alternative, offering efficient means to support the life of elderly and disabled people, empowering independent living, while increasing their wellbeing and the quality of life (Lê et al., 2012). For example, smart home solutions include telecare systems, which refer to "*remotely delivered care and support; this might include rapid responses to emergencies in the home, treatment and medical advice, and continual monitoring*" (Tang and Venables, 2000). The multifunctionality, the automation of household tasks, higher security and instant communication solutions are contributing to the enhancement of the lives of the ageing population (Lê et al., 2012).

Under the influence of economic, demographic and technological drivers, the smart home market has become very diversified. Currently, the global market is segmented into technology representing control and connectivity (e.g. environment control), security (e.g. smart door locks), home entertainment (e.g. voice assistant and smart TV), energy management (e.g. smart meters), smart appliances (e.g. smart refrigerators), and comfort and lighting (smart lighting) (Blumtritt, 2019). Control and connectivity devices are the main contributors to the market volume. They are represented by environment control devices, comprising sensors, smart actuators, control valves, air conditioning and smart thermal systems and other systems, integrated into united connected systems. Due to increasing government regulations, new buildings are mostly built with embedded smart heating and cooling systems, which facilitate the growth of the market share (Mordor Intelligence, 2019). The market for control and connected devices is estimated at 162.9 million devices, while the penetration rate of this type of technology into households is 8.6%. The second largest segment is comprised of home entertainment technology, accounting for 120.9 million devices, with a penetration rate of 6.4%. The comfort and lighting market share is represented by 119.4 million devices, followed by energy management (94.4 million), security (88 million) and smart appliances (79.1 million) (Blumtritt, 2019). The lion's share of the above technologies is produced by five key global players, such as ABB Ltd, Schneider Electric SE, Honeywell International Inc., Emerson Electric Co, Siemens AG. Honeywell and ABB are focused on the production of automated solutions for homes (Mordor Intelligence, 2019, Fortune Business Insights, 2018).

The smart home market is growing. In 2019, it was estimated at €64.6 billion (Mordor Intelligence, 2019), while in 2020 it is estimated to be €80.6 billion. The annual revenue growth is 20.3%, thus by 2024, the total revenue is projected to be €140.7 billion (Blumtritt, 2019). The largest share by revenue is accounted for by Northern America, which is estimated at €26,531.0 million (Blumtritt, 2019). The share growth is owing to a high demand for energy management systems, security, the high penetration of smart devices and tablets. The growth is also fuelled by factors such as economic growth, the demographic surge, rapid urbanization leading to improved infrastructure, and the overall improved standards of living (Research and Markets, 2019). The remaining leading regions in the world by revenue stream are Eastern Asia (€25,737.0 million), China (€18,500.0 million), Central and Western Europe (€13,302.0 million). However, the largest contribution to the growth of the smart home market is down to a few geographical locations, such as the United States, Norway, Sweden, Denmark and other countries of Northern America. The average penetration percentage of those countries is 29.12%, compared to the average penetration rate of all smart home technologies globally at only 9%. However, the penetration rate globally is increasing and by 2024 it is estimated that it will be 19.3% (Blumtritt, 2019).

Although the projected revenue growth and penetration rate dynamics are positive, the smart home market is observably slowing down as the average revenue has been falling year by year. The revenue growth curve went from 32.2% in 2018, to 23.4% in 2020, and is forecast to decline to 12.5 % in 2024. The average revenue per smart home is demonstrating a negative dynamic. It was €522.270 in 2017, €460.410 in 2020 and is forecast to be €374.920 in 2024 calculated at an average annual growth rate of -4.6 (Blumtritt, 2019). The statistics demonstrate that at first glance, the future of smart homes is promising, but the statistics need to be analysed in conjunction with other market growth indicators. For example, the leading market (US) demonstrated an increase in connected homes over the last years and the expected growth to come. However, the growth of the actual sales rate lags behind the expected growth (Ahuja and

Patel, 2016). The smart home market is at the transitional stage, whereby the technology is neither for early adopters nor for the mass market (Greenough, 2016). The potential problems could be that the technology does not sufficiently resonate with consumers' needs. According to the McKinsey report, people buy technology to solve their problems, such as price, reliability, ease of use, ease of installation. However, consumers still face some issues with technology performance or utilisation (Ahuja and Patel, 2016). According to the recent research conducted by Accenture, the user-dominant research should prevail to understand users' needs, attitudes and perceptions (Accenture, 2019).Therefore, it is necessary to undertake and encourage research looking at the acceptance of smart homes by users – i.e. users' intentions to adopt smart homes, the factors influencing adoption and further exploitation of the technology and user behaviour when smart homes do not perform as expected.

## 1.2. Technology Acceptance and Utilisation in Private Spaces

The published technology acceptance research mostly focuses on the technology usage in public and mixed settings. For example, the constructs from the technology acceptance model (i.e. perceived usefulness and perceived ease of use) have been used in a number of studies to explain the utilisation of technology in organisational contexts (Igbaria et al., 1997, Carter and Bélanger, 2005) and investigate the antecedents of the use of mobile technology, personal computers and e-commerce platforms (Agarwal and Karahanna, 2000, Venkatesh et al., 2012, Gefen et al., 2003b). To adapt TAM to workplace settings, the model has been extended with intraorganizational and extraorganisational factors, such as internal and external computing support, internal and external computing training and management support (Igbaria et al., 1997). For the examination of the usage of e-learning systems, TAM was extended with context-specific factors, such as network externality, social and system factors. Those were found to have a significant effect on the perceived ease of the system's operationalisation, usefulness and use enjoyment (Cheng, 2011). The adoption of technology in public and mixed contexts was also examined by integrating technology acceptance models with personal factors, such as cognitive absorption, self-efficacy, goal orientations (Wang, 2008, Agarwal and Karahanna, 2000, Cheng, 2011) and subjective norms (Venkatesh and Morris, 2000, Venkatesh et al., 2003), which affect the perception of technology utility and use intention.

Few studies have examined the utilisation of technology in the private context. Early research on technology adoption in household settings focused on portable and intangible services produced by ICT, such as personal computers and the internet (Venkatesh and Brown, 2001, Brown and Venkatesh, 2005). Some papers focused on the social and personal factors contributing to the adoption, such as self-efficacy, trust and personality traits (Hsieh et al., 2008, Shih and Venkatesh, 2004). Others focused on energy consumption and the adoption of energy-efficient technology (Wunderlich et al., 2019). The review of these studies identified several peculiarities across the literature on the technology acceptance. First, research studies set a blurry line between private and public spaces since they mostly investigate the utilisation of intangible services and devices which can be used both inside and outside household settings (Venkatesh and Brown, 2001, Brown and Venkatesh, 2005, Hsieh et al., 2008). However, it is important to delineate private and public contexts by setting both physical and virtual boundaries. The lack of physical presence and the applicability of technologies to public settings make the interaction with technologies universal in different contexts, thus decreasing the validity of the analysis of situational behaviour (Shapiro, 1998). Second, due to the inability to recognise the permeability of physical and virtual boundaries of private spaces (Shapiro, 1998), the current research overlooks the potential adverse consequences that the utilisation of technologies implies, such as perceived risks (e.g. privacy). Third, although the prior literature noted that users' roles, behavioural and attitudinal patterns vary in public vs private contexts (Brown et al., 2006, Venkatesh, 1996), the research did not examine to what degree the technology services correspond to the household requirements of users. Fourth, the research focuses on particular devices, performing a specific service (Wunderlich et al., 2019). Hence, certain factors can be manifested only in the context of specific behaviour.

The literature on the adoption of technology following initial exposure has widely used two main theoretical frameworks. The first one is Expectation-Confirmation Theory, which postulates that individuals' evaluation of the experience with technology is based on the perceived technology performance compared against prior expectations (Bhattacherjee, 2001, Bhattacherjee and Premkumar, 2004). Expectations refer to pre-exposure beliefs about a service or product (Susarla et al., 2003). The evaluation of pre-purchase expectations with actual performance can lead either to the confirmation or disconfirmation of the expectation. Research in the expectation-(dis)confirmation domain has focused on confirmation (Gong et al., 2018) or the positive disconfirmation front, whereby technology outperforms initial expectations, e.g. with studies focusing on the correlation between positive disconfirmation and satisfaction (Hsieh et al., 2010, McKinney et al., 2002). Another perspective on the utilisation of technology following initial trial is proposed by the Diffusion of Innovations Theory. Based on the theory, the implementation of innovative technology may either end up in the confirmation or disconfirmation of an initial decision to adopt the technology. The decision is dependent on the perceived characteristics of innovation (i.e. relative advantage, triability, observability, compatibility and complexity), while the confirmation process reflects the degree to which technology performance produces perceptions consistent to prior beliefs (Rogers, 1995).

## 1.3. Research Gaps, Aims and Objectives

There are three main gaps in the literature on technology acceptance and utilisation in private spaces. First, technology acceptance research has typically been considered with regards to technologies that are used in public/mixed settings (Venkatesh and Davis, 2000, Anandarajan et al., 2000, Stam and Stanton, 2010, Schmidthuber et al., 2018). However, the findings of those studies cannot be applicable to the fully private context. The use of smart homes may be heavily dependent on the psychological factors of house residents, the perception of outcomes, motives and beliefs (Choe *et al.*, 2011). For example, the perception of hedonic and utilitarian values differs across people using the technology publicly and privately. Values reflect the needs and judgement of technology utility that are peculiar to the context (E. Collier *et al.*, 2014). In terms of services, there is a divergence in tasks and the purpose of technology utilisation in private versus public settings. Technology compatibility act as a boundary condition in adopting the technology (Shih and Venkatesh, 2004, Brown and Venkatesh, 2005). The studies extend the implications beyond residential settings (Brown and Venkatesh, 2005, Venkatesh and Brown, 2001), which limits the understanding of technology utilisation in a purely private context. Scholarly works that have examined the technology acceptance in the private context (Brown and Venkatesh, 2005, Venkatesh and Brown, 2001, Balta-Ozkan et al., 2013b, Balta-Ozkan et al., 2014), provided prospective qualitative insight into the potential implementation of pervasive technology in houses (Balta-Ozkan et al., 2013b, Balta-Ozkan et al., 2014), without explaining the perception of technology by actual users. In addition, the studies ignored the role of the perceived fit of technology capabilities to user demands (Goodhue and Thompson, 1995). The fit is superior when it comes to the private use of technology, because it defines the degree of the situational applicability to the tasks that users may have, in contrast to attitudinal factors measuring the overall usefulness of the technology. The role of potential risks pertinent to the use of technology in private spaces has not been tested either (Marikyan *et al.*, 2019, Balta-Ozkan *et al.*, 2013b, Aldrich, 2003), although the use of technology in private spaces poses higher risks in terms of personal data leakage and monetary spending (Marikyan *et al.*, 2019, Balta-Ozkan *et al.*, 2013b, Aldrich, 2003).

Therefore, the acceptance and use of technology in private spaces may be based on beliefs that are manifested differently to those in a public/mixed environment.

Secondly, the overwhelming majority of the literature focusing on smart homes consists of technical papers, aiming to address how to develop smart home technologies. The literature lacks evidence about the behaviour of users when smart homes do not perform as expected. Such a focus of the research is important when it comes to the utilisation of innovative technology. Adopting a new technology promises opportunities that raise high expectations which may even undermine post-performance evaluation (Dwivedi et al., 2019, Sun and Medaglia, 2019, Fan and Suh, 2014). Following the expectation-disconfirmation and innovation diffusion perspectives, the negative disconfirmation of initial beliefs about technology performance is expected to result in dissatisfaction (Bhattacherjee, 2001, Bhattacherjee and Premkumar, 2004) and discontinuous use intention (Rogers, 1995, Huang et al., 2013). However, another perspective suggests that a negative disconfirmation may induce an affective state that drives the reduction of perceived discrepancy between expectation and performance, thus potentially leading to satisfaction (Festinger, 1962, Harmon-Jones and Mills, 2019, Sparks et al., 2012). This suggests that the "disconfirmation-satisfaction" relationship is still under-researched.

Thirdly, the cognitive perspective on the outcomes of disconfirmation points at the complexity of cognitive and behavioural processes that negative disconfirmation entails (Festinger, 1962). However, the literature does not offer any insights into the psychological factors and behavioural responses following disconfirmation. The exploration of those factors would explain the conditions in which satisfaction can be achieved. Previous research studies highlighted the role of situational factors in attenuating the strength of disconfirmation and dissatisfaction, such as the magnitude of the discrepancy between perception and expectation (Oliver, 1980, Khurana, 2011), the importance of the outcome and the level of involvement with the product (Patterson, 1993), and the regulatory role of reputation on the formation of expectation and perception (Walsh et al., 2016). Such findings either illustrated the potential moderation effect on the disconfirmation-satisfaction relationship or investigated the factors decreasing the likelihood of negative disconfirmation.  Still, they did not provide an explanation of behavioural and cognitive patterns of individuals experiencing the disconfirmation of expectations. When it comes to psychological consequences of disconfirmation, prior research has postulated that emotions motivates users to adopt behaviours that reduce the perceived discrepancy between the two types of cognitions (i.e.

expectation and perceived performance) (Festinger, 1962). The studies have examined negative emotions, such as anger, regret and guilt, but they treated them as a single construct (Jean Tsang, 2019, Gosling et al., 2006). However, if each type of emotion is examined independently, the results may demonstrate how they relate to different behavioural responses (Beaudry and Pinsonneault, 2010). In addition, the findings on the effect of some types of emotions are conflicting in terms of their strength in motivating approach versus avoidance behaviours (Miller, 1977, Davvetas and Diamantopoulos, 2017).

Given the gaps in the literature, the goal of this research is to examine the adoption of pervasive technology in private spaces by exploring pre-exposure beliefs and post-exposure outcomes. There are five objectives this research aims to address.

The first objective of the thesis is to conduct a comprehensive review of the literature on a pervasive technology used exclusively in private settings – i.e. smart homes – to understand the users' perspective on the utilisation of the technology. Therefore, the first research question for the thesis is:

*RQ1: What empirical evidence exists about the users' perspective on smart home technology utilisation?*

To answer this research question, a systematic literature review is conducted that provides a comprehensive synthesis of knowledge about the implications of smart home technology in the key spheres of users' lives. Smart home functions, services, benefits and implementation are reviewed in a critical and comprehensive way. This helps review the factors that play an important role in the technology implementation in the private context and identify evidence that is lacking to further the research on technology adoption by individuals.

The second objective of the research is to study smart home acceptance as a case of technology used in a private setting and provide more empirical evidence from a user perspective. The objective aims to address the following research questions:

*RQ2: What behavioural beliefs underpin satisfaction with smart homes?*

*RQ3: What perceived benefits and risks underpin the perception of technology performance?*

This thesis proposes a research model using the constructs from the Task-Technology Fit Model and TAM. This approach makes it possible to explain the acceptance by examining the role of the "fit" of technology to users' household requirements and the attitudinal underpinnings of behaviour. Furthermore, this thesis analyses the effect of the main groups of beliefs about behavioural outcomes - utilitarian, hedonic values, privacy and financial risks – on the users' perception of task-fit. Those beliefs were shown to be significant in various frameworks in the technology acceptance context (Turel *et al.*, 2010, Van der Heijden, 2004, Xu *et al.*, 2012).

The third objective of the research is: To examine the effect of negative disconfirmation of initial expectations about technology performance on satisfaction.

*RQ4: Do people feel satisfaction after the performance of technology was worse than expected?*

*RQ5: Are there any psychological factors and emotions mediating the relationship between negative disconfirmation and satisfaction?*

To address this objective, the thesis adopts the cognitive dissonance framework, which gives an overview of the psychological, cognitive and behavioural processes following a negative situation, such as a negative experience with technology. The research examines the effect of disconfirmation of expectations on post-performance dissonance arousal, assuming that dissonance reflects the psychological discomfort induced by the discrepancy between performance and expectations.

The fourth objective of this thesis is: To explore how people attenuate the psychological discomfort following a negative disconfirmation of initial expectations about smart homes performance.

*RQ7: What cognitive and behavioural patterns do users exhibit following weak technology performance?*

*RQ8: How do negative emotions affect users' selection of a cognitive dissonance strategy?*

By using the cognitive dissonance framework, the thesis aims to examine potential strategies that individuals use to attenuate the negative feelings rooted in the perceived discrepancy between performance and expectations. The adoption of this framework makes it possible to explore how behavioural and cognitive responses to negative disconfirmation relate to satisfaction. In addition, the correlation of emotions with behavioural and cognitive strategies following disconfirmation is explored. The thesis examines the regret, guilt and anger associated with dissonance and their role in predicting particular dissonance reduction strategies – i.e. attitude change, consonant information search and behaviour change. The examination of different types of emotions makes it possible to explore their motivational role in inhibiting or facilitating the behaviour causing psychological discomfort.

## 1.4. Theoretical and Practical Implications

The thesis makes several theoretical and practical contributions. First, the thesis provides a systematic review of the literature from the user perspective. This review provides a detailed account of the users' insight into the technology utilisation in the private context, using the case of smart homes. In addition, this contributes to the research by giving a different view on the smart home literature, which has previously been dominated by reviews focusing on technical characteristics (Alam et al., 2012, De Silva et al., 2012), the implications of smart homes in healthcare (e.g. (Chang et al., 2009, Ranasinghe et al., 2016, Amiribesheli et al., 2015)), energy management (Hosseini et al., 2017) and applications by elderly people (Demiris and Hensel, 2008). Given the lack of review papers covering the users' insight into the utilisation of smart homes, a comprehensive systematic synthesis of the literature provides the agenda for future research to move forward the research on that front.

Second, the findings of the research aim to give insight into the acceptance of technology in private spaces and contribute to the current literature by focusing on the pervasive technology that is used only in the private context. This approach is different from the prior research, which has examined stand-alone devices delivering a specific service or technologies applicable for both private and public settings. With few papers in the domain of the acceptance of pervasive technology embedded in private residential areas (Anderson and Agarwal, 2010, Brown *et al.*, 2006, Brown and Venkatesh, 2005, Venkatesh and Brown, 2001), this research aims to shed light on the effect of task-technology fit, perceived usefulness and perceived ease of use. The examination of the correlation of the hedonic value, utilitarian value, privacy and financial risks with TTF, provides a richer understanding of the psychological underpinnings of behaviour, which have been discussed in the literature, but not empirically tested (Marikyan et al., 2019, Chan et al., 2008, Balta-Ozkan et al., 2013b, Balta-Ozkan et al., 2014, Aldrich, 2003).

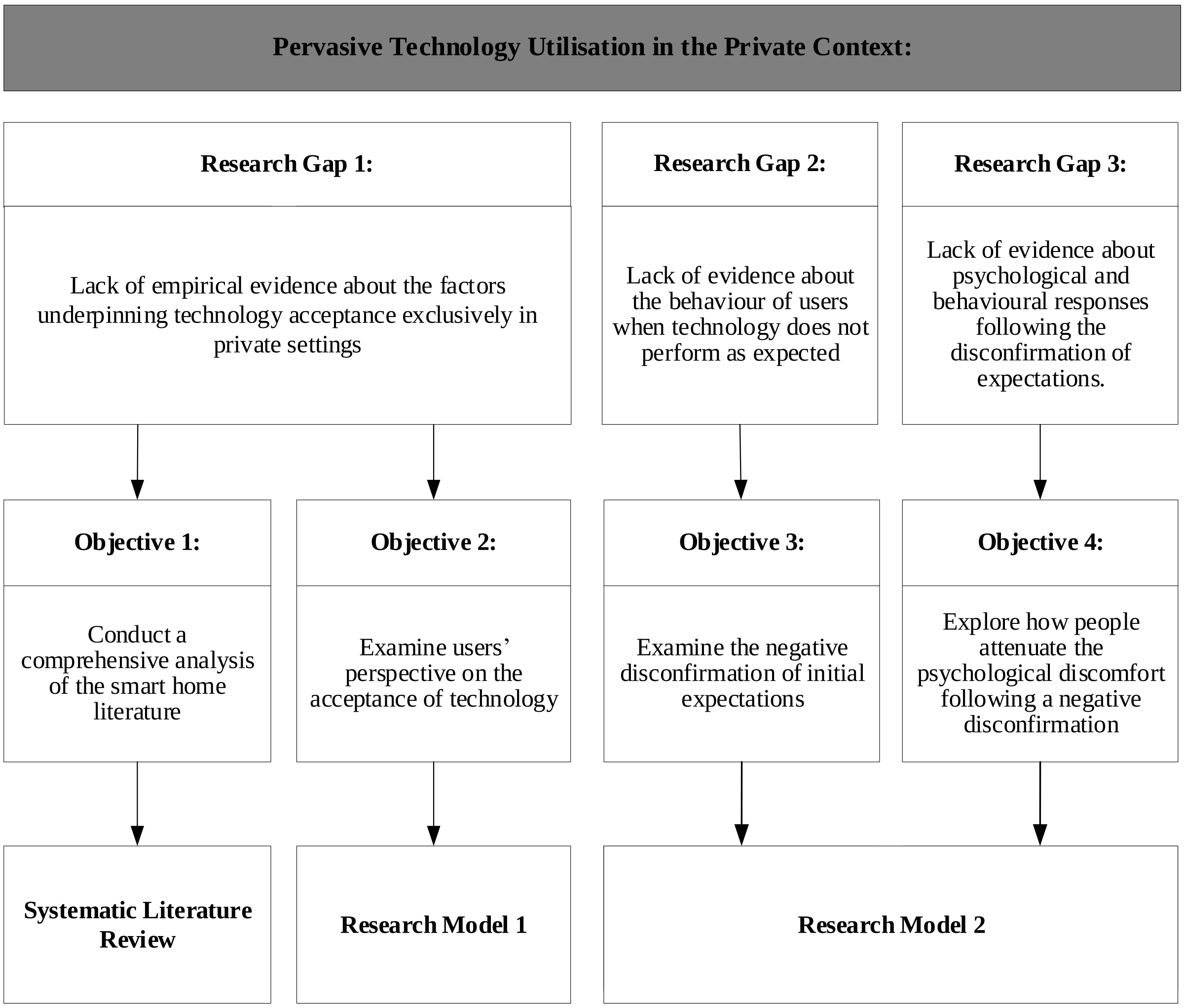
Third, the examination of the user experience after the performance of smart homes falls short of expectations contributes to the literature adopting the expectation-disconfirmation paradigm. Prior literature postulated that satisfaction is the outcome of the utilisation of technology when performance exceeds prior expectations (Hsieh et al., 2010, McKinney et al., 2002). The findings of this thesis provide a different perspective by confirming a positive outcome following a weak performance of the technology. In addition, the results of the study add to the discussion by illustrating complex psychological processes following the evaluation of technology performance, which has not been explored before.

Fourth, the research aims to contribute to the cognitive dissonance literature by providing evidence on the relationship between three types of negative emotions and three dissonance reduction strategies. In contrast to prior literature, examining negative emotions as a unidimensional construct (Jean Tsang, 2019, Gosling et al., 2006), the thesis examines the effect that each has on the attitude change, consonant information seeking and behaviour change. This approach enables to distinguish the motivational role of each type of emotion in approach or avoidance behaviour. In addition, the findings of the research contribute to the literature on the utilisation of innovative technology by providing evidence on psychological factors affecting consumer experience with smart homes. The approach adopted by this thesis is different from prior literature (Manis and Choi, 2019, Rauschnabel et al., 2015, Pizzi et al., 2019) in a way that it takes a further step in examining innovative technology adoption and investigates the behaviour of users after the appraisal of technology performance. The results are important, because the utilisation of technology is contingent on the perception of technology performance, which is often undermined by high expectations when it comes to innovative technology (Dwivedi et al., 2019, Sun and Medaglia, 2019, Fan and Suh, 2014). In terms of the smart home literature, the research provides evidence about the consequences of smart homes utilisation following the weak performance, which has been lacking to date.

This research brings some practical implications too. The examination of the determinants of use behaviour will potentially provide guidelines for practitioners as to what factors they need to focus on when developing and marketing smart home products. Also, the investigation of users' experience following disconfirmed expectations gives suggestions as to which customer relationship and communication strategies practitioners need to use in order to retain customers. Finally, evidence about the correlation of emotions and dissonance reduction strategies can be helpful for practitioners in predicting emotional, cognitive and behavioural reactions in situations when technology performance falls short of expectations.

Figure 1 schematically presents the relation between the research gaps, objectives and the steps undertaken to address those objectives.

**FIGURE 1.1: RESEARCH GAPS, OBJECTIVES AND MILESTONES**




## 1.5. Structure of the thesis

The thesis consists of eight chapters. Chapter 1 introduces the research. It provides a brief background on smart homes concept development, it explains the rationale for undertaking the research, and sets out the research gaps, aims and objectives. A brief outline of theoretical contributions and practical implications is provided. Chapter 2 provides a systematic review of the smart home literature with the aim of addressing the first objective. To review the literature, a user perspective was adopted, by focusing on the user as the unit of analysis and the recipient of smart home technology services and capabilities. The chapter provides the results of the analysis of emerging themes in the literature which are pertinent to the area of the implications of smart home technology in the key spheres of users' lives. The chapter provides an overview of smart home functions, services, benefits and implementation in a critical and comprehensive way. The systematic review concludes with a summary of the findings on the current state of smart home literature, the gaps and future research suggestions. Chapter 3 presents two research models. Section 3.1 discusses the first research model to address the second research objective, namely examining the underpinning factors of the acceptance of smart homes. The justification of the research model and hypotheses are explained. Section 3.2 presents the second research model, which addresses the third and fourth objectives, which are aimed at examining users' emotional, cognitive and behavioural responses following poor technology performance. In this chapter, the authors provide a theoretical justification and provide supporting arguments for the proposed hypotheses. Chapter 4 describes the methodology adopted by the thesis. This chapter discusses and justifies the adopted philosophical assumptions, research strategy, data collection techniques and procedures, data analysis procedures and descriptive statistics of the sample. In Chapter 5, the results and findings of two surveys are provided. The section includes the results of the CFA and SEM analyses of the two tested research models. The thesis proceeds with Chapter 6, in which the author discusses the findings of the research. Finally, Chapter 7 concludes the thesis with a summary, an explanation of the theoretical and practical contributions, the limitations and future research suggestions.

# 2. Literature Review: Smart Homes

In the past few years smart home technology has been rapidly advancing and it has finally reached mainstream markets and user segments. Along with increasing investments of enterprises into the smart home sector, the academic community has intensified its efforts in examining the concept of the smart home, the technological capabilities, its implications and the impact on people's life. A number of review papers have been published covering smart technologies from different angles (Chang et al., 2009, Patel et al., 2012, Ranasinghe et al., 2016, Amiribesheli et al., 2015, Peetoom et al., 2015, Kim et al., 2013, De Silva et al., 2012, Hosseini et al., 2017, Demiris and Hensel, 2008, Alam et al., 2012). Despite the increasing number of reviews and beyond the narrow scope of the context examined, research in this domain is confined within the boundaries of three themes. Firstly, papers do not typically consider the multidimensionality of the concept of the smart home, thus leading to a one-sided representation of its implications, services and user segments (Balta-Ozkan et al., 2014). Secondly, papers tend to examine smart homes through a technological perspective, by focusing on the functions of devices, the infrastructure and the architecture of automated homes (Peine, 2009, Chan et al., 2008). Third, the majority of studies propose potential benefits that smart home technology is capable of capturing, while providing little empirical evidence regarding the users' perception of the challenges and benefits of the smart home technology use. Given the above limitations and the fact that it has been almost a decade since the literature was more holistically reviewed (Chan et al., 2008), there is a strong need to revisit and review the current state of the literature in a systematic and holistic way. Therefore, this thesis reviews the literature by adopting a user perspective to explore the implications of smart home technology in the key spheres of users' lives. In this part of the thesis, the literature on smart home functions, services, benefits and implementation are reviewed in a critical and comprehensive way. The next sections will outline the review of the relevant literature and offer future research avenues.

## 2.1. Definition and Characteristics of Smart Homes

Various definitions have been used to conceptualise and define smart homes (Table 2.1). Among the different approaches, the definitions by Aldrich (FK, 2003) and Lutolf (Lutolf, 1992) covered the nature of smart homes in a pervasive way. Aldrich (FK, 2003) defined a smart home as *"a residence equipped with computing and information technology, which anticipates 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".* Their definition embraced the technological component of the phenomenon, the services and functions it provides and the types of user needs that smart homes aim to meet. A similar approach was followed by Lutolf's (Lutolf, 1992) definition, which described smart homes as *"the integration of different services within a home by employing a common communication system. It assures an economic, secure and comfortable operation of the home and includes a high degree of intelligent functionality and flexibility".* Although the two definitions share similar principles, they differ in the services that the technology provides and the types of user needs it aims to satisfy. More broadly, the majority of scholars refer to technological attributes when defining smart homes. Balta-Ozkan's (Balta-Ozkan et al., 2013b) definition states that the *"smart home is a residence equipped with a high-tech network, linking sensors and domestic devices, appliances, and features that can be remotely monitored, accessed or controlled, and provide services that respond to the needs of its inhabitants".* De Silva *et al*. (De Silva et al., 2012) followed a similar approach without specifying the technological elements of smart homes. The authors stated that it is "*a home-like environment that possesses ambient intelligence and automatic control, which allows it to respond to the behaviour of residents and provide them with various facilities*". The definitions by Balta-Ozkan (Balta-Ozkan et al., 2013b) and De Silva *et al*. (De Silva et al., 2012) share the idea of the capability to respond to residents' needs through automated technology. The technological perspective was also supported by Diegel *et al.* (Diegel et al., 2005), who described it as a system, enhanced with four levels of smartness, namely smart appliances, smart control, smart management and smart sensors. Integration and collaboration of these four levels of smartness creates a living environment in the house.

The service/context-led definition is another approach to defining the smart home. From the perspectives of Kofler *et al.* (Reinisch et al., 2011) and Scott (Scott, 2007) the main service a smart home provides is the management of energy consumption. The vision of Kofler *et al.* (Reinisch et al., 2011) is that an intelligent house is equipped with multiple devices that cooperate with each other as a homogeneous system to monitor electronic appliances, promote efficient energy management and sustainability. Scott (Scott, 2007) clarified that the service is enabled by the integration of technological features, such as smart heating and smart meters. This group of definitions place more emphasis on sustainability and energy consumption and promote the potential of smart home services to improve users' comfort. Focusing on a different context, Chan *et al.* (Chan et al., 2008) emphasised healthcare needs from the perspective of ageing users. This definition states that a *"smart home is a house, which promises to provide cost effective home care for the ageing population and vulnerable users"*. There are a number of other conceptual explanations that support the concept of smart home technology to meet the needs ageing people, enhance the quality of life and promote independent living for residents (Blaschke et al., 2009, Dorsten et al., 2009, Ehrenhard et al., 2014, Alam et al., 2012). Remotely controllable assistive technology made it possible to propose services that would meet the demands of an elderly population (Alam et al., 2012) .

There is significant overlap among the above-mentioned definitions, which share three characteristics in common: technology, services and the ability to satisfy users' needs. The core of the smart home is the technology, which consists of hardware and software components, including sensors and home appliances. Being represented as objects or electronic devices, sensors are capable of detecting changes in human behaviour and other stimuli from the environment (Arunvivek et al., 2015, Orwat et al., 2008). Sensors are integrated into home appliances through wireless and wired systems that make it possible to monitor and track residents' when they are watching TV, cooking, sleeping, cleaning and doing a range of other activities (Orwat et al., 2008). The system represents configurations of appliances and sensors that produce the variability of functions and services, tailored to residents' needs (Chang et al., 2009). Put differently, the architecture of technology determines the services and the benefits the smart home aims to provide (Chan et al., 2008). When it comes to lifestyle support, a smart home represents a house with sensors and domestic devices, linked through a communication network. It empowers users to remotely control household appliances and decrease the burden of everyday household activities (Amiribesheli et al., 2015, Chang et al., 2009). Connected devices provide an opportunity for smart home residents to effectively manage their energy usage, while enhancing their convenience and comfort in their daily routine (Scott, 2007). Fully-automated devices have the potential to improve the quality of life and encourage the independent living of residents, especially for an ageing population through constant health management, and they even provide virtual medical assistance in cases of need (Orwat et al., 2008). The smart home represents 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.

**TABLE 2.1: DEFINITIONS AND CHARACTERISTICS OF SMART HOMES**

| Definition based on theme | Technology | | | | | Services | | | | Needs | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Authors** | **Sensors** | **Devices** | **Integrated systems** | **Control/monitor** | **Energy management** | **Support and assist** | **Anticipate and respond** | **Cost-efficiency** | **Comfort** | **Emotional** | **Security** | **healthcare** | **Quality of life** | **Sustainability** |
| **Aldrich (FK, 2003)** | | | x | | x | | x | | x | x | x | | x | |
| **Lutolf (Lutolf, 1992)** | | | x | | x | | | x | x | | x | | x | |
| **De Silva *et al.* (De Silva et al., 2012)** | | | x | x | | | | | | | | | x | |
| **Reinisch and Kofler (Reinisch et al., 2011)** | | | x | x | x | | | x | x | | | x | x | x |
| **Scott (Scott, 2007)** | | x | x | | x | | | x | x | | | | x | x |
| **Balta-Ozkan (Balta-Ozkan et al., 2014)** | x | x | x | x | | | | | | | | | x | |
| **Chan *et al*. (Chan et al., 2008)** | | | | | | x | | x | | | | x | x | |
| **Diegel *et al.* (Diegel et al., 2005)** | x | x | | x | x | | | | | | | | x | |
| **Alam *et al*. (Alam** | | x | | | | x | | | | | | x | x | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **et al., 2012)** | | | | | | | | | | | | | | |

## 2.2. Types of Smart Home Technology Services

This section presents the two main typologies of smart home technologies covered in the literature. De Silva *et al.* (De Silva et al., 2012) came up with three types of smart homes, classifying them based on the types of services they promote. The first category of smart homes provides assistance to occupants by recognising their actions. This type of home promotes the well-being of occupants inside the house. The services that these smart homes provide are divided into three types: homes providing care for the ageing population, assisting in child care and overall health care. The second type aims to detect and gather multi-media information in the form of videos and photos of the occupants' lives. This type of smart home concept may raise privacy concerns and a feeling of intrusion. The third type is the "surveillance home". This aims to process data to forecast and alert residents in case of upcoming natural disasters or security interventions. The function of these smart homes is to capture the data from the environment to detect and make people aware of burglary threats. Hardly any project has succeeded in combining all the services that the surveillance home is meant to offer (De Silva et al., 2012). The typology of smart homes provided by De Silva *et al.* (De Silva et al., 2012) can be potentially extended by an additional category. A number of scholars recognised that the emergent drive for ecological awareness has led the way to a special type of smart home (Chen et al., 2017, Bhati et al., 2017, Elkhorchani and Grayaa, 2016, Zhou et al., 2016, Beaudin and Zareipour, 2015, Balta-Ozkan et al., 2014, Zhou et al., 2014, Balta-Ozkan et al., 2013b). These smart homes aim to promote environmental sustainability by enabling residents to monitor and control their energy supply against demand. The literature presents the smart home as a novel and profound solution to reducing energy usage and promoting environmental sustainability (Balta-Ozkan et al., 2013a, Chen et al., 2017, Zhou et al., 2016, Bhati et al., 2017, Paetz et al., 2011, Balta-Ozkan et al., 2014). Special sensors and automatic monitoring systems in smart homes make it possible to achieve a reduction of energy usage without intrusion into residents' lives and the need to change behavior (Lach and Punchihewa, 2007).

Following the studies developed by Doughty *et al*. (Doughty et al., 1996) and Brownsell and Bradley (Brownsell and Bradley, 2003), Bowes *et al*. (Bowes et al., 2012) classified the smart home technology and telecare systems into four generations based on the level of technological sophistication. The categorisation enabled to see the evolution of smart home technology and telecare services. The *first-generation* smart home systems represented the technologies not embedded with artificial intelligence (AI) but which were activated by the motions of residents. The *second-generation* home technology employed elementary forms of AI-based devices. They were designed to detect changes in the surrounding environment through sensors, to monitor health conditions and detect body inconsistency through wearable devices, and assist in daily tasks through in-house appliances with built-in function programmes. Whereas the *second-generation* home technology had stand-alone devices, the *third-generation* marked the era of technology interoperability and multifunctionality. This was possible due to the introduction of the voice-activated control and the connectivity with other devices that made it possible to capture, process and transmit data within the network of devices. The *fourth generation* of smart home technologies is predicted to come into effect by 2020, and will replace existing sensors by ones that are embedded under the skin. These sensors have great potential for remote health monitoring and management (Brownsell and Hawley, 2005).

Smart home services can be added to homes gradually, effectively creating a spectrum beyond a “traditional home” and a “fully smart” one. Having this in mind, academic researchers and smart home service providers sought to observe and examine occupants’ activities in traditional houses. Through practical research studies and smart home projects, scholars provided guidelines on the development of smart home technologies that would generate different services, to improve the living standards of inhabitants. For the purpose of systematising smart home services, a relevant literature was analysed by identifying commonly recurring patterns. The identification of common patterns enabled to classify the services based on underpinning smart devices and the functions they provide. Table 2.2 presents the services and enabling technologies, grouped into five categories, which are *support, monitoring, health therapy, comfort* and *consultancy.*

**TABLE 2.2: SMART HOME FUNCTIONS AND DEVICES**

| Type of service | Function | Device |
|---|---|---|
| **To support** (Rantz et al., 2005, Yamazaki, 2006, Masuda et al., 2005, Chang et al., 2009) | Support patients with hearing issues | Alarm system based on visual signs |
| | | Teletype machine |
| | | Special electronic display screen for hearing-impaired people |
| | | Special display screen |

| | | |
|---|---|---|
| | Support during home rehabilitation | Robotic devices for rehabilitation |
| | Assist patients with mobility issues | Tailored interface |
| | | Companion robot |
| | | Mobility devices (e.g. electronic wheelchair) |
| | | Computerised voice generation (in order to communicate) |
| | Support with socialisation | Robots |
| | Patients with Visual disabilities | Audible beacon |
| | | Tailored screen |
| | | Specially designed remote control (e.g. voice recognition) |
| **To monitor** (Shults et al., 1994, Suzuki and Doi, 2001, Andoh et al., 2004, Chang et al., 2009, Patel et al., 2012, Ranasinghe et al., 2016, Amiribesheli et al., 2015, Peetoom et al., 2015, Kim et al., 2013, Demiris and Hensel, 2008) | Health and Lifestyle monitoring | Infrared Sensors |
| | | Wearable sensors |
| | | Wearable accelerometer |
| | | Internal sensors (to monitor physiological signs) |
| | | EGG (epileptic seizure, sleep disorder) |
| | | Heart rate |
| | | Blood oxygen level |
| | | Blood pressure |
| | | Blood glucose level |
| | | Temperature |
| **To deliver therapy** (Moore, 1999, Eysenbach, 2001, Demiris, 2004, Alam et al., 2012) | Remote interaction Remote therapy | Telehealthcare |
| | | Tremor delivery |
| | | Drug delivery |
| | | Hormone delivery |
| **Comfort** (Das et al., 2002, Arunvivek et al., 2015, Alam et al., 2012, Chan et al., 2008, Lutolf, 1992, De Silva et al., 2012, Scott, 2007, FK, 2003) | Automation of daily routines | Dishwasher |
| | | Washing machine |
| | | Refrigerator |
| | | Cooker |
| | Remote home management | Closet/drawer/mirror |
| | | Window/door/gate |
| | | Mailbox/garden devices |
| | Intelligent environmental and sustainable services | Heat/gas/electricity/light |
| | Smart Leisure | TV/Radio/home cinema |
| **Consultancy** (De Silva and Darussalam, 2008) | Suggestions | Sensors |

A number of research studies have attempted to practically understand the technical side of the smart home. Over the years, there has been a gradual move from the examination of the technical side of smart homes towards the user perspective. This has offered a richer insight into the implications of smart homes in users' lives and raised the need to summarise the emerging perspective in the review. The review will now turn towards the user perspective and examine the potential benefits and implications for adopting and accepting smart home technologies.

## 2.3. Potential User Benefits of Smart Homes

The literature suggests many potential benefits that technology services and functions could offer (e.g. (Kim and Shin, 2015, Balta-Ozkan et al., 2014, Peek et al., 2014, Paetz et al., 2012, Mayer et al., 2011, Gaul and Ziefle, 2009)). There are also studies about the perceived benefits and their motivational influence on the acceptance of technologies by users (Chung et al., 2016, Courtney et al., 2008, Balta-Ozkan et al., 2014, Ziefle, 2011, Chan et al., 2008, Demiris and Hensel, 2008, Demiris et al., 2008a). The juxtaposition of the perceived benefits against the potential ones reveals the discrepancies and overlaps between the two perspectives. The user perspective makes it possible to understand the factors underpinning the promotion of smart homes in the mainstream market. The rest of the review will examine the benefits, categorised into health-related, environmental, financial benefits and psychological ones related to wellbeing and users' social Inclusion (Table 2.3).

### *Health-Related Benefits*

Smart home technology can support the ageing population, vulnerable people and people with chronic conditions both inside and outside of the house (Reeder et al., 2013, Demiris and Hensel, 2009, Demiris et al., 2008b, Demiris et al., 2008a, Courtney et al., 2008, Hensel et al., 2006, Rantz et al., 2005, Demiris et al., 2004, Finkelstein et al., 2004, Demiris, 2004, Chan et al., 2008). Health-related benefits can be achieved when technology performs the services of operational efficiency (comfort), monitoring and management, and consultancy. The core advantages of such technology for people with health problems are the operational functions, care accessibility and availability, and users' safety, resulting in quality health care (Chang et al., 2009, Mynatt et al., 2004, Celler et al., 2003, Demiris, 2004, Finkelstein et al., 2004, Finch et al., 2008, Walsh and Callan, 2011, Czaja, 2016, Anderson, 2007). The second function of the smart home when it comes to users' health is monitoring and disease management. The cognitive state of elderly people can be monitored through smart home devices, which can alert users in case of any health inconsistency (Czaja, 2016). These innovative actions enable professionals to monitor health remotely, detect life threatening changes at an early stage and even provide distant medical care when necessary (Chang et al., 2009, Mynatt et al., 2004, Celler et al., 2003, Demiris, 2004, Finkelstein et al., 2004, Finch et al., 2008, Walsh and Callan, 2011). When monitoring chronic illnesses, the use of e-health records, remote management and electronic e-prescriptions optimise the data and help to keep a register, potentially leading to a reduction in medical errors (Anderson, 2007). Finally, the consultancy function of smart home applications implemented during the virtual medical visits aims to promote well-being for an ageing population through replacing physical visits to clinics and hospitals with remote medical therapy or consultation (Czaja, 2016).

From the users' perspective, the health-related services of comfort, remote consultancy and monitoring are not always perceived to be benefits and have an ambiguous influence on the intentions to use smart home technology. On the one hand, empirical studies have reported that respondents were generally positive towards the smart home technology, outlining a number of benefits (Finch et al., 2008, Matlabi et al., 2012, Rahimpour et al., 2008). Among the benefits that participants preferred most were the time and cost efficiency that telecare can provide compared to physical visits to hospitals (Chang et al., 2009, Mynatt et al., 2004, Celler et al., 2003, Demiris, 2004, Finkelstein et al., 2004, Finch et al., 2008, Walsh and Callan, 2011). Kerbler's study (Kerbler, 2013), on the other hand, revealed that older users are sceptical towards the benefits that smart home technology can bring (Finch et al., 2008, Matlabi et al., 2012, Rahimpour et al., 2008). The difference in the results of Kebler's research (Kerbler, 2013) can be explained by the geographical location where the research took place, which might reflect the variety of the level of technological awareness. These factors can potentially moderate the variety in the perceptions regarding assistive technology in smart homes across countries.

***Environmental Benefits***

Smart homes have become the state of the art in the reduction and monitoring of energy usage within a residential setting. Emerging threats such as climate change, global warming and volatility in energy prices have fuelled the interest in smart systems. The use of energy efficient devices and innovative technologies has made it possible to reduce energy consumption, which is vital in order to meet the growing electricity demand and utilisation (Coughlan et al., 2013, Balta-Ozkan et al., 2014, Chen et al., 2017, Kyriakopoulos and Arabatzis, 2016, Elkhorchani and Grayaa, 2016, Zhou et al., 2016, Kiesling, 2016, Beaudin and Zareipour, 2015, Aye and Fujiwara, 2014, El-hawary, 2014, Rahimi et al., 2011). The benefit of energy efficiency has become possible through the implementation of four services: 1) monitoring the information on energy consumption, 2) controlling the consumption patterns through remote devices and direct control, 3) management of the service, aimed at achieving efficiency and optimisation, and 4) consultancy (Zhou et al., 2016, El-hawary, 2014). On a nationwide scale, greater control over energy usage can eliminate carbon emissions and lead the way to a transformation of the traditional energy systems into renewable sources of electricity generation (Aye and Fujiwara, 2014, Elkhorchani and Grayaa, 2016). Research effort has already been invested in studying the implementation of wind, solar, biomass and geothermal energy in the smart home energy systems (Zhou et al., 2016) The embeddedness of renewable systems into smart houses could speed up the outcome of wise electricity and demand management.

Despite the on-going discussion about the role of smart home technology in ecological sustainability, a number of studies adopt a users' perspective by differentiating perceived benefits from the potential ones (Balta-Ozkan et al., 2014, Balta-Ozkan et al., 2013b, Paetz et al., 2012, Paetz et al., 2011). A comparative study revealed that amongst users from different countries, rural and urban areas have different attitudes towards the environmental benefit (Balta-Ozkan et al., 2014). Accordingly, the influencing power of this factor in the intention to shift to smart home technology varies. The study revealed that environmental sustainability has become a more significant factor for users in rural areas. This result is explained by the stronger role of economic benefit for urban citizens, which outweighs the environmental concern. The variety of consumption patterns, attitudes and values could potentially be explained by diverse factors, including the housing type, the availability of services, social contact among others (Balta-Ozkan et al., 2014).

***Financial Benefit***

The financial benefits of smart homes are typically associated with the environmental and health-related benefits. While in the long-term perspective the utilisation of energy saving devices leads to environmental sustainability, the immediate benefit of efficient energy consumption management is the reduction of electricity expenses. The financial benefits can be realised in two ways. First, the use of smart electric appliances and smart meters leads to higher awareness of the consumption habits, by regular monitoring of the energy use (Balta-Ozkan et al., 2013b, Darby and McKenna, 2012, Hargreaves et al., 2013, Paetz et al., 2012). Second, the transparency of the energy consumption makes it possible to compare tariffs against other energy providers (Darby and McKenna, 2012, Faruqui et al., 2010). In contrast to the potential benefits, perceived financial benefits have been studied as a distinctive group of factors underpinning users' motivation and intention to switch from traditional home appliances to smart ones. Despite the commonly-stated financial benefits of smart homes use, consumer studies have hardly confirmed this assumption. For example, due to perceived maintenance costs and relatively low savings, users do not find financial benefits a reason for adoption (Balta-Ozkan et al., 2013b). Another empirical study about perceived barriers to and drivers of smart homes revealed that users are generally interested in acquiring smart home technology, due to its ability to reduce expenses on energy consumption. However, the opinion that investing in such technologies does not result in the expected return on investment underline the reluctance of users to adopt smart home technologies (Balta-Ozkan et al., 2014, Balta-Ozkan et al., 2013a, Paetz et al., 2011). In addition, the strength of the motivational power of financial benefit depends on the two conditions that need to be looked at when analysing the perception of the financial benefits of smart homes: the location where the technology is implemented and the relative importance of other motives (Balta-Ozkan et al., 2014, Balta-Ozkan et al., 2013b, Park et al., 2017). The geographical differences of users may have a positive relation with the socio-economic status, thus resulting in different perceptions of the cost factor. For example, users from the countries with higher utilitarian mentality and non-urban areas could be more sensitive towards the cost-saving benefit of the technology (Park et al., 2017, Balta-Ozkan et al., 2014).

In relation to other benefits, the financial factor may play a leading or a secondary role (Steele et al., 2009, Balta-Ozkan et al., 2013b, Park et al., 2017). The convenience and the compatability of the technology in some instances may outweigh the dominance of the financial benefit. These factors refer to the connectivity of the smart home technology with other components of the house that increase the reliability of the service and improve the user experience (Balta-Ozkan et al., 2013b, Park et al., 2017). Potential financial benefits are also associated with health-related benefits, whereby the shift towards homecare can result in economic savings both for users and hospitals. Acknowledging the increasing interest in and debates regarding home-care cost efficiency compared to traditional medical care, the studies concluded that the cost efficiency is dependent on the health condition of the patient and the package of services he or she needs to receive (Kun, 2001, Wiles and Jayasinha, 2013, Wimo et al., 2007). This finding suggests that the financial benefit is a context-dependent factor that may or may not affect the decision to use the technology.

***Psychological wellbeing and Social Inclusion***

Smart homes can improve socialisation and even help users overcome the feeling of isolation (Demiris et al., 2004, Percival and Hanson, 2006, Chan et al., 2008). This can be achieved by the implementation of services related to support and assistance (Chan et al., 2008). The enabling power of the smart home technology to assist and support people with everyday activities has an effect on the self-perception in terms of self-esteem, adaptability and competence. Self-perception is defined as a psychosocial impact, and refers to the evaluation of one's own position in life within the context, culture and values and relative to their expectations (Brandt et al., 2011). However, studies on perceived benefits rarely support this statement. As an example, users may not wish to use assistive technologies, due to concerns that they will be stigmatised and labelled as vulnerable people (Demiris et al., 2004, Gaul and Ziefle, 2009, Damodaran and Olphert, 2010). Additionally, it has been reported that smart home technologies may negatively affect their social life, by replacing actual face-to-face communication (Damodaran and Olphert, 2010). The isolation from social and physical interaction could be an effect of the support-independency of elderly and vulnerable users enhanced by technology (Kim et al., 2013). The aforementioned findings suggest that the role of the technology in physical or operational independence represents a coin with two sides.

Balta-Ozkan *et al.* (Balta-Ozkan et al., 2013a, Balta-Ozkan et al., 2013b) have raised a concern regarding the impact of the financial factor on users' socialisation. According to these authors there is a threat that only higher-income users may benefit from smart home technology and experience social inclusion in the society of luxury technology holders. The technology would have a divisive impact and would create a social gap between technology beneficiaries and financial outsiders (Balta-Ozkan et al., 2013a, Balta-Ozkan et al., 2013b). Still, given the rapid advance of the technology and orientation of the technology producers on a mainstream market, smart home technologies are expected to become more affordable over time (Khedekar et al., 2017) and this may not be an issue in the future.

**TABLE 2.3: SUMMARY OF POTENTIAL USER BENEFITS OF SMART HOME**

| Benefit | Service | Short-term advantage | Long-term impact |
|---|---|---|---|
| **Environmental Benefits** (Coughlan et al., 2013, Balta-Ozkan et al., | Monitor<br>Consultancy | Reduce energy usage<br>Feedbacks on consumption | Environmental sustainability<br>Reduction of carbon emissions |

| | | | |
|---|---|---|---|
| 2014, Chen et al., 2017, Kyriakopoulos and Arabatzis, 2016, Elkhorchani and Grayaa, 2016, Zhou et al., 2016, Kiesling, 2016, Beaudin and Zareipour, 2015, Aye and Fujiwara, 2014, El-hawary, 2014, Rahimi et al., 2011) | | Suggestions how to use electricity efficiently | |
| **Health-Related Benefits** (Reeder et al., 2013, Demiris and Hensel, 2009, Demiris et al., 2008b, Demiris et al., 2008a, Courtney et al., 2008, Hensel et al., 2006, Rantz et al., 2005, Demiris et al., 2004, Finkelstein et al., 2004, Demiris, 2004, Chang et al., 2009, Martin et al., 2008, Chan et al., 2008) | Comfort<br>Monitor<br>Consultancy<br>Support<br>Deliver therapy | Care accessibility and availability<br>Users' safety<br>Social connectivity and communication<br>Detection of life-threatening events<br>Reduction of medical errors | Promote well-being of ageing and vulnerable people |
| **Financial Benefit** (Balta-Ozkan et al., 2013b, Darby and McKenna, 2012, Hargreaves et al., 2013, Paetz et al., 2012, Balta-Ozkan et al., 2014, Balta-Ozkan et al., 2013a) | Consultancy<br>Monitor | Cheaper cost of virtual visits | Affordability of health care<br>Sustainable consumption |
| **Psychological Wellbeing and Social Inclusion** (Demiris et al., 2004, Percival and Hanson, 2006, Chan et al., 2008, Balta-Ozkan et al., 2014, Balta-Ozkan et al., 2013b) | Support | Entertainment,<br>Virtual interaction | Overcome the feeling of isolation |

## 2.4. Smart Home Implementation and Barriers

Despite the potential benefits of smart homes the adoption and diffusion rate remains low (Balta-Ozkan et al., 2013b, Yang et al., 2017, Kim and Yeo, 2015, Jacobsson et al., 2016, Ehrenhard et al., 2014, Anderson, 2007, Chan et al., 2008). It is therefore important to examine smart home acceptance and adoption and the barriers (Table 2.4) which may hinder the implementation of smart homes. The sections below discuss the main technological, human, financial, legal and ethical barriers.

**TABLE 2.4: BARRIERS TO SMART HOME ADOPTION**

| Perspective | Barriers | Examples |
|---|---|---|
| **Users' perspective** | **Technological**<br>(Balta-Ozkan et al., 2013b, Keith Edwards and Grinter, 2001, Park et al., 2017, Yang et al., 2017, Alsulami and Atkins, 2016, Bevan, 1995, Sun et al., 2010, Peruzzini and Germani, 2016, Czaja, 2016, Chen et al., 2017) | Lack of knowledge and experience<br>Security<br>Usability<br>Privacy intrusion |
| | **Knowledge Gap and Resistance to Change**<br>(Kerbler, 2013, Keith Edwards and Grinter, 2001, Balta-Ozkan et al., 2013b, Chen et al., 2017, Kim and Shcherbakova, 2011, Hu et al., 2003, Yang et al., 2017, Mani and Chouk, 2017, Fuchsberger, 2008) | Lack of human interaction<br>Resistance to using innovative technology |
| | **Financial, Ethical and Legal**<br>(Chan et al., 2012, Steele et al., 2009, Balta-Ozkan et al., 2013b, Chang et al., 2009, Jacobsson et al., 2016, Friedewald et al., 2005, Kotz et al., 2009) | Price<br>Cost of installation<br>Cost of repair and maintenance<br>Concern about misuse of private data<br>The requirement for formal consent from patients<br>Lack of legal conduct<br>Uncertainty with regulation conflicts between smart home service providers and users |

***Technological Barriers***

Technology fit is the most important factor to address when developing smart homes (Balta-Ozkan et al., 2013b, Keith Edwards and Grinter, 2001). It can be described as the users' perception of the technology compatibility, connectedness and the system's reliability. These three factors are strongly associated with the perception of the technology's usefulness (Yang et al., 2017, Park et al., 2017). In line with this perspective, smart home technology adoption studies have been gradually increasing their focus on the features of technology that could potentially pose threats to users and influence the perception of the technology.

Technology automation, mobility and interoperability are considered to be facilitating factors of adoption (Yang et al., 2017). In addition, the usability barrier, which refers to the reliability and ease of use, was shown to have a crucial role in the acceptance of the smart home technology (Alsulami and Atkins, 2016, Balta-Ozkan et al., 2013b), whereby the complexity of the technology leads to refusal to adopt it (Bevan, 1995, Sun et al., 2010, Peruzzini and Germani, 2016). However, there are a number of current smart home devices which are complex to use. Since the majority of smart home projects used to be purely technical, the user's perspective on the ease of use was under-researched (Diegel, 2005, Czaja, 2016). The reliability factor relates to the potential of the technology to serve users for a long time, with expectations of a product's lifecycle typically being at least five to ten years (Balta-Ozkan et al., 2013b). Users expect smart homes to recognise their needs and provide tailored assistance (Kim and Shcherbakova, 2011). However, it was found that people are generally sceptical about the reliability of smart home products (Balta-Ozkan et al., 2013b). Given the fact that smart homes have started to move towards the mass market it is important to ensure reliability, by providing safe and secure services to potential users.

***Knowledge Gap and Resistance to Change***

The low rate of the perceived usefulness of smart homes can be explained by the lack of knowledge, trust and experience to embrace the benefits of the technology (Kerbler, 2013, Keith Edwards and Grinter, 2001, Balta-Ozkan et al., 2013b). As smart home technologies are emerging technologies, people are not fully aware of their functions, potential risks and benefits. Lack of knowledge regarding smart home technologies impedes the wider implementation of smart homes in the mass market (Balta-Ozkan et al., 2013b). For instance, a study examining the perception of smart meters indicated that people are used to traditional flat electricity rates and that there is a lack of knowledge regarding the benefits that smart technologies could create (Kim and Shcherbakova, 2011). Also the perception of emergent technologies is heavily affected by the feedback of technology adopters, which may not always be positive (Hu et al., 2003). Thus, the lack of users' awareness coupled with negative word-of-mouth can play a negative role in smart home technology acceptance by potential users (Yang et al., 2017) .

Mani and Chouk (Mani and Chouk, 2017) attempted to explore the challenges of the smart technology acceptance, through the theory of innovation resistance originally proposed by Ram and Sheth (Ram and Sheth, 1989). The findings of the aforementioned study suggest that perceived novelty and usefulness has a significant negative effect on the consumers' resistance to accepting smart products. In line with this finding the study by Alam *et al.* (Alam et al., 2011) confirmed that an innovative product that does not fit the pre-existing environment and requires a change in the lifestyle and behaviour of users might fail to enter the mass market. Users are more committed to the already established habits and strongly resist changing their behaviour and living style to accept the smart home technology (Sun et al., 2010, Fuchsberger, 2008, Kleinberger et al., 2007). To overcome the psychological barrier and knowledge gap, technology design can tackle users' lifestyles and norms (Stringer et al., 2006). The low perception of usefulness results in a feeling of losing control over the technology, which brings about resistance to accepting the technology. To overcome with this barrier, smart home products could feature software systems that are adjustable and flexible to users' habits (Keith Edwards and Grinter, 2001, Hu et al., 2011a).

The notion of becoming isolated and lacking human interaction could pose a challenge for smart home acceptance (Meng and Lee, 2006, Wu and Fu, 2012). Social exclusion may result in two scenarios. In the first one, the technology replaces human interaction by virtual communication, gradually excluding users from the society within the physical environment (Meng and Lee, 2006, Wu and Fu, 2012). In the second one, the adoption of the technology by one cluster of wealthy users would leave non-users excluded and stigmatised by socio-economic status (Balta-Ozkan et al., 2013b). The two perspectives are contradictory, leaving room for further examination.

***Financial, Ethical and Legal Concerns***

The third group of barriers comprises financial, ethical and legal concerns. The financial factors include the price of the technology, the cost of installation, repair and maintenance, which discourages users from adopting smart home technology (Chan et al., 2012, Steele et al., 2009, Balta-Ozkan et al., 2013b). Some people expressed a lack of understanding of how smart homes could help them save money, which triggers mistrust towards the technology (Balta-Ozkan et al., 2013b). Healthcare related literature indicated that the implementation of the technology in the health industry is cost-intensive. This finding does not support the assumption that assistive home devices can financially benefit both the users and hospitals, by replacing a traditional visit with virtual therapy (Chan et al., 2008) . However, Wells (Wells, 2003) claimed that the implementation of the smart home concept in healthcare would require high investments, as financial investment and the training of a medical staff will be necessary to safely and ethically utilise smart home technologies, such as e-prescribing and EMR technologies in the health industry.

The ability of smart homes to collect and store a vast amount of private data raises ethical concerns, such as privacy and security (Balta-Ozkan et al., 2013b, Friedewald et al., 2005, Chang et al., 2009, Jacobsson et al., 2016, Kotz et al., 2009). In a number of countries, smart home technologies cannot be practised in healthcare without the consent of the patient, who should be fully informed regarding the service procedure (Sundström et al., 2002). This exemplifies an overwhelming distrust of users to allow the collection of personal data (Hanson et al., 2007, Coughlan et al., 2013). The risk of privacy intrusion acts as a major inhibitor to smart home acceptance and adoption, which is confirmed by a number of studies (Yang et al., 2017, Wilson et al., 2017, Chung et al., 2016, Jacobsson et al., 2016, Theoharidou et al., 2016, Paetz et al., 2012, Paetz et al., 2011). A breach of privacy of users may happen as a result of unwilling information disclosure, and the inability to control the interference of automation systems in private life (Zwijsen et al., 2011, Courtney, 2008, Yang et al., 2017, Chang et al., 2009). As for the perception of the privacy and security risk, the opinions of users are split. Some people seemed to be able to embrace the benefits of the technology without being bothered by privacy issues (Lorenzen-Huber et al., 2011). Others saw that home automation and remote control may pose security threats when disclosed and used by third parties (Balta-Ozkan et al., 2013b). As the solution to this challenge, the development and implementation of sophisticated safety protocols aims to eliminate the risks of fraudulent intrusion and misuse of the technology (Chan and Perrig, 2003).

Legal issues are a stumbling block in smart home technology acceptance, especially in relation to the medical and social care industries (Chiang and Wang, 2016, Anderson, 2007, Downs, 2005, Harkke et al., 2003, Chan et al., 2008). Smart home technology, including the concept of e-health, is a relatively new discipline with a lack of written legal conduct regarding the use of smart home technology. In order to ensure wide acceptance of this technology, governments should adjust laws on the practices. Given the gap in legislation, policy makers could introduce laws to regulate conflicts between smart home service providers and users over the obtained product (Balta-Ozkan et al., 2014). Policy makers also need to address privacy law in order to guarantee users' data protection and security and avoid any intentional or accidental privacy law breach. However, when the health-related data of smart home users are shared with a hospital or individual physician, the assumption of data privacy changes (Chan et al., 2008). Therefore, it is vital to delineate the boundaries between privacy intrusion and data protection, especially in the healthcare sector.

## 2.5. Research Avenues

The review has made it possible to identify the gaps in the literature, which are summarised in Table 2.5.

Despite the numerous potential benefits, there is a dearth of research from the user perspective. Studies predominantly focus on technical characteristics of smart homes (Toschi et al., 2017, Das et al., 2016, Jacobsson et al., 2016, Yang et al., 2016a, Vastardis et al., 2016, Pennick et al., 2016, Yang et al., 2016b, Kim et al., 2016, Xu et al., 2016, Zhou et al., 2016, Park and Shin, 2015, Ahvar et al., 2016), which means that there is a need for the adoption of the user perspective in research on the development of technologies. Studies that employed users' perspectives focused on the needs of an ageing population (Alsulami and Atkins, 2016, Harris and Hunter, 2016, Gauld, 2014, Atoyebi et al., 2014, Morris et al., 2014, Peine et al., 2014, Blaschke et al., 2009), overlooking other user segments. However, it is important to explore and understand the role of different stakeholders that could potentially partake in smart home acceptance. The shift from the technology-driven research to the consumer-centric approach will enable researchers to explore the potential development of a wider spectrum of services to satisfy broader user segments and embrace all the potential advantages of smart home technology. Given the above, it is needed to focus on the functions and services of smart home technology from the perspective of mainstream users.

There has been little empirical evidence when it comes to issues of acceptance and adoption of smart home technology. Such empirical studies may provide potentially different insights given the personal and pervasive nature that the technology is used in. The literature can be enriched by tackling both the psychological and technological factors that could drive the adoption of smart home technology. The exploration of the change of pre-adoption and post-adoption perceptions of the technology will help in understanding the cognitive process of technology adoption. The examination and understanding of the behavioural change would help to promote implementation of the technology in the mass market. In addition, the behaviour of users following weak smart home performance has not been examined before. Hence, future research may adopt the expectation-disconfirmation perspective to examine affective factors and behavioural responses following negative experience with technology. The focus on the disconfirmation is important considering that smart home is an innovative technology, which often creates unrealistic expectation, undermining post-performance evaluation (Dwivedi et al., 2019, Sun and Medaglia, 2019, Fan and Suh, 2014).

The few studies that adopted a consumer perspective to examine the perceived benefits of and barriers to smart home technology adoption provided contradictory results (Alsulami and Atkins, 2016, Ehrenhard et al., 2014, Kerbler, 2013). The contradictions of previous findings demand further examination of users' perceptions. Therefore, there is a need to examine the emotional, psychological, symbolical, functional and financial antecedents that trigger users to accept or reject smart home products. In addition, it is important to explore the constructs that underline users' value perception, because they influence the intention to use technology. For example, further to the study by Babalta-Ozkan (Balta-Ozkan et al., 2014), the control of the geographical difference between respondents and socio-demographic factors is an important variable to measure, which may reveal the influence of individual factors, economic and social status on the perception. The individual and financial factors may define the relative importance of the benefits for the particular group of users, which may be an important condition to control in future research (Balta-Ozkan et al., 2014). Secondly, following the study by Mani and Chouk(Mani and Chouk, 2017) , the role of psychological resistance is an important factor to examine. Therefore, the examination of variables that underline the cognitive state of mind of users and the perception of technology usefulness is imperative. It may offer novel insights into the difference in attitudes among users and the factors that underline the resistance.

Current studies have attempted to examine users' perceptions towards specific technology and services, which creates another gap to be addressed in future research. For example, some scholars have investigated users' needs, the usability and the perception of values of the standalone devices rather than the fully-connected smart homes (e.g. (Hale, 2005, Chan et al., 2008, Ehrenhard et al., 2014, Bregman and Korman, 2009)). The focus on a single device might not give an adequate picture. First of all, such a perspective does not fit the evolutionary stage the smart home is currently in, reflected by the interoperability and multifunctionality of devices. Secondly, research on particular devices touched upon a very narrow pack of services. Given the fast-paced development of the smart homes market the research needs to turn from single—devices to integrated systems. Moreover, there is a need to take into account the types of smart homes. The contextual difference may underpin the distinctive factors to be exhibited in the acceptance and the adoption process.

When it comes to the methodologies used by empirical papers in this review, these utilised qualitative methodologies, including focus groups, case studies and interviews (Paetz et al., 2012, Paetz et al., 2011, Balta-Ozkan et al., 2014, Balta-Ozkan et al., 2013b). A quantitative approach could be used to study consumers' attitudes and preferences. Finally, the majority of the research studies have been conducted in the UK and USA. Further to Kebler's study [92], the cultural, economic and geo-political contexts influence norms, attitudes and beliefs. They might reveal new variables that underpin or control the intention to adopt the smart home technology. To test the context-dependence of the perception of the benefits and services of smart homes, the research needs to shift the focus to Eastern countries.

**TABLE 2.5: SUMMARY OF CURRENT RESEARCH GAPS AND SUGGESTIONS**

| Future research suggestions | References |
|---|---|
| **Users' perspective** | |
| Users' intention to employ smart homes | (Bowes et al., 2012) (Vilas et al., 2010) (Dorsten et al., 2009) |
| User perception of smart home technology | (Alam et al., 2012) (Bowes et al., 2012) (Coughlan et al., 2013) (Vilas et al., 2010) (Diegel et al., 2005) (Hale, 2005) (Hamill, 2006) (Hong et al., 2016) (Kerbler, 2013) (Mani and Chouk, 2017) (Walsh and Callan, 2011) |
| Demographics and Geographic change | (Balta-Ozkan et al., 2014) (Blaschke et al., 2009) (Cassarino and Setti, 2016) (Hong et al., 2016, Mani and Chouk, 2017) |
| Focus on ageing | (Coughlan et al., 2013) (Czaja, 2016) (Damodaran and Olphert, 2010) (Dankl, 2012) (Lorenzen-Huber et al., 2011) |
| **Technology Acceptance and Adoption** | |
| Smart home technology adoption and acceptance barriers | (Alsulami and Atkins, 2016) (Ehrenhard et al., 2014) (Kerbler, 2013) (Mani and Chouk, 2017) |
| Smart home acceptance factors | (Alsulami and Atkins, 2016) (Dawid et al., 2017) (Dorsten et al., 2009) (Ehrenhard et al., 2014) (Mani and Chouk, 2017) (Matlabi et al., 2012) (Sugihara et al., 2015) |
| Employing specific theory to study smart home acceptance and adoption | (Aye and Fujiwara, 2014) (Mani and Chouk, 2017) |
| **Methodology** | |
| Need for quantitative research on (smart home technology acceptance) | (Alsulami and Atkins, 2016) (Ehrenhard et al., 2014) (Kerbler, 2013) |
| **Types of Smart Homes** | |

| | |
|---|---|
| Focus on different types of smart home (i.e. healthcare, energy management and convenience) | (Balta-Ozkan et al., 2014) (Denti, 2014) (Loviscach, 2011) (Singh, 2010) |

## 2.6. Smart Home Acceptance and Adoption

In the domain of smart home technology acceptance and adoption, the major focus so far has revolved around the benefits that smart homes make possible (Chan et al., 2008, Balta-Ozkan et al., 2014, Ehrenhard et al., 2014, Lee et al., 2017, Palanca et al., 2018). Such benefits can be classified into four categories: a) health-related benefits, b) environmental benefits, c) financial benefits and d) psychological wellbeing and social inclusion. Smart home devices are capable of providing home care, virtual medical consultancy and the management of residents' health. These services promote independent living, increase the quality of health care and care accessibility for the ageing population, which has been the dominant segment for smart home technology so far (Chan et al., 2008, Dong et al., 2017, Shin et al., 2018, Raad and Yang, 2009). In the residential context, smart home technologies can help towards the reduction and monitoring of energy usage (Marikyan *et al.*, 2019, Balta-Ozkan *et al.*, 2013a). These benefits became of interest due to growing environmental concerns of users with regards to emerging threats, such as global warming and climate change (Balta-Ozkan *et al.*, 2013b). The financial benefits of smart home technology are associated with environmental and health-related benefits. Specifically, the effect of smart home technology acceptance on environmental sustainability is a long-term goal, while short-term benefits come from the savings in utility bills (Balta-Ozkan *et al.*, 2013a, Marikyan *et al.*, 2019). The last group of potential benefits that is associated with the use of smart home technology is psychological well-being and social inclusion by helping users relate to the outside world (Chan et al., 2008, Marikyan et al., 2019, Raad and Yang, 2009).

Despite the fact that an overwhelming number of papers have discussed the potential benefits of smart homes technology usage, the promised benefits have not always been manifested. Smart home technologies might not be fully embraced or might be perceived differently by users (Geels and Smit, 2000). A review of the literature makes evident that the published research mostly focuses on the technology usage in public and mixed settings (Table 3.1). There is a dearth of empirical investigation on the pervasive technology acceptance and use behaviour in the private context from users' perspective (Marikyan et al., 2019, Venkatesh, 2008). The following chapter will discuss the theoretical foundation of the research and provide the justification for the research model and hypotheses.

**TABLE 2.6: EMPIRICAL CONTRIBUTION ON TECHNOLOGY ACCEPTANCE/USAGE IN PUBLIC, MIXED OR PRIVATE CONTEXT**

| Study | Context | Sample | Method | Theory | Findings | Constructs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | PR | FR | HV | UV | TTF | PEOU | PU | B/BI | SAT |
| **(Igbaria et al., 1997)** | Public (PC in work settings) | 358 (employees from different organisations) | Cross-sectional | TAM extended with intraorganisational and extraorganisational factors. | The drivers of PU and PEOU were identified. In the context of small firms, the effect of PEOU was greater than PU. | | | | | | X | X | X | |
| **(Agarwal and Karahanna, 2000)** | Mixed (WWW) | 288 (students) | Cross-sectional | TAM extended with cognitive absorption | The direct relation between cognitive absorption and behavioural intention was identified. | | | X | | | X | X | X | |
| **(Venkatesh and Morris, 2000)** | Public (software/technology usage in workplace) | 342 (employees from different organisations) | Longitudinal survey | TAM extended with subjective norms | The technology acceptance in workplaces differed depending on gender. | | | | | | X | X | X | |
| **(Venkatesh et al., 2003)** | Public (technology usage in workplace) | 645 (employees from different organisations) | Longitudinal survey | Integrated model, based on TRA, TAM, TAM2, MM, TPB, C-TAM-TPB, MPCU, IDT and SCT | After reviewing eight technology acceptance models and their extensions, the study developed and empirically validated the unified theory of acceptance and use of technology (UTAUT). | | | | | | X | X | X | |
| **(Gefen et al., 2003b)** | Mixed (online shopping platform) | 213 (students) | Cross-sectional | TAM integrated with trust and its antecedents | Trust in TAM was found to be significant in explaining individuals' intention to use technology. | | | | | | X | X | X | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(Van der Heijden, 2004)** | Mixed (online movie platform) | 1144 (random sampling) | Cross-sectional | The model integrating hedonic values and TAM | Hedonic factors were good predictors of the intention to accept technology | | | X | | | X | X | X | |
| **(Carter and Bélanger, 2005)** | Public (e-government ) | 105 (random sampling) | Cross-sectional | Integrated model based on TAM, IDT and web trust model | The proposed e-governance models were found to be robust in explaining the variance in individuals' intention to adopt e-governance. | | | | | | X | X | X | |
| **(Wang et al., 2006)** | Mixed (m-services) | 258 (users of m-services) | Cross-sectional | Integrated model based on TAM, TPB, mobile acceptance banking model, perceived credibility, self-efficacy and perceived financial resources | M-banking acceptance model was validated. Perceived credibility, self-efficacy and perceived financial resources were significant in IS acceptance. | | | | | | X | X | X | |
| **(Wang et al., 2006)** | Mixed (m-services) | 258 (users of m-services) | Cross-sectional | Integrated model based on TAM, TPB, mobile acceptance banking model, perceived credibility, self-efficacy and perceived financial resources | M-banking acceptance model was validated. Perceived credibility, self-efficacy and perceived financial resources were significant in IS acceptance. | | | | | | X | X | X | |
| **(Karahanna et al., 2006)** | Public (customer relationship manageme nt system (CRMS) in banks) | 278 (bank employees) | Cross-sectional | TAM integrated with individual beliefs | The causal influence of compatibility beliefs on perceived usefulness and perceived ease of use. | | | | | | X | X | X | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **(Srite and Karahanna, 2006)** | Mixed (PC) & (PDAs) | Sample 1: 223 (students) Sample 2: 116 (students) | Cross-sectional | TAM incorporated with cultural moderators | Social norms (SN) predicted behaviour; significant moderating effect of femininity and high uncertainty avoidance on the paths between SN and behaviour, as well as PEOU and BI; insignificant moderation effect of masculinity and femininity on the path between PU and BI. | | | | | | X | X | X | |
| **(Bhattacherjee and Sanford, 2006)** | Public (document management systems (DMS) for employees) | 81 (city administrators and staff members) | Cross-sectional | Integrated ELM-based influence model and TAM | Both central and peripheral routes were critical in new IT acceptance. | | | | | | X | X | X | |
| **(Wang, 2008, Irani et al., 2009)** | Public (e-commerce systems) | 240 (users of e-commerce) | Cross-sectional | Delone and McLean (2003) IS success model extended with satisfaction, reuse intention, information quality, systems quality, service quality and perceived value. | E-commerce success model was validated. Perceived value and user satisfaction were significant predictors of intention to use. Service quality, system quality and information quality had significant correlation with both perceived value and user satisfaction. | | | | | | | | | X |
| **(Irani et al., 2009, Gefen et al., 2003b)** | Mixed (public and private Broadband) | 358 (random sampling) | Cross-sectional | TAM extended with perceived resources, self-efficacy and social influence | Perceived resources, self-efficacy and social influence significantly correlated with BI. | | | | X | | | | X | |
| **(Beaudry and Pinsonneault, 2010)** | Public (software system for | 249 (bank account managers) | Interviews and surveys | The role of emotions in IT use. | Aroused emotions played a critical role in IT use | | | | | | | | X | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | bank employees) | | | | | | | | | | | | | |
| **(Cheng, 2011, Venkatesh and Morris, 2000)** | Public (Systems usage in workplace) | 328 (employees of financial services companies) | Cross-sectional | TAM extended with individual factors, system factors, social factors, and network externality factors | PE, PU, PEOU and network externality factors had significant correlations with IS acceptance. System factors and individual factors affected IS acceptance indirectly through PE, PU and PEOU. Network externality factor affected employees' acceptance of IS indirectly through PEOU. Social factors had an effect on the acceptance of IS indirectly through PU. | | | X | | | X | X | X | |
| **(Venkatesh et al., 2012, Venkatesh et al., 2003)** | Mixed (mobile internet technology) | 1512 (random sampling) | Longitudinal survey | UTAUT model extended with hedonic motivation and price value. | Price vale and hedonic motivations were significant in IS use context. | | | X | X | | X | X | X | |
| **(Miltgen et al., 2013)** | Public (biometric systems) | 326 (random sampling) | Cross-sectional | A model integrating the constructs from TAM, DOI, UTAUT and trust-privacy literature. | Factors from well-established acceptance models, along with trust and privacy were found to be significant in explaining the acceptance of new and radical technologies. | X | X | | | | X | X | X | |
| **(Althuizen, 2018)** | Public (technology usage in workplace) | Sample 1: 93 employees. Sample 2: 172 employees | Cross-sectional | The model integrating TAM and UTAUT | A new segment-specific analysis of technology acceptance was proposed. It explained variance in behaviours, intentions and attitudes. | | | | | | X | X | X | |

# 3. Conceptual Models and Hypothesis Development

To address the gaps in the smart home literature on the user perspective and the lack of evidence on technology acceptance and adoption, this chapter proposes two research models. The first model examines the beliefs and attitudes that predict the use of technology and satisfaction. The second model investigates the affective, cognitive and behavioural factors that follow the utilisation of smart homes if initial expectations about technology are not confirmed. While the first model mostly focuses on pre-exposure beliefs contributing to use behaviour, it does not measure the degree to which pre-exposure beliefs are met during the utilisation of technology. Therefore, the second model is developed to explain the set of post-exposure beliefs, tackling the scenario when technology performance is worse than expected. The model explains the role of certain emotions, cognitions and behaviours correlating with perceived positive outcomes, such as satisfaction and wellbeing. The two models provide a holistic view of the adoption of smart homes and innovative technology in general.

Given the above, this chapter provides a theoretical justification for the two proposed models. Section 3.1 provides the theoretical foundation for investigating the antecedents of the acceptance of pervasive technology in private spaces. This section discusses the two main theories adopted to build the model, namely the Task-Technology Fit Model (TTF) and the Technology Acceptance Model (TAM) and describes the first conceptual model. The section proceeds with supportive evidence to justify the hypotheses proposed in the research model. Section 3.2. presents the second research model about the utilisation of technology when performance falls short of initial expectations. The research model is based on the Cognitive Dissonance Theory, which is why the section provides a summary of the theory and a justification for its adoption as a theoretical framework for the research. The section continues with evidence from prior research, which is used to support the hypotheses that are put forward for the second strand of the research.

## 3.1. Research Model 1: The Acceptance of Pervasive Technology in Private Spaces

### 3.1.1. Task-Technology Fit Model

The Task-Technology Fit (TTF) model was introduced by Goodhue and Thompsons (1995) to explain the utilisation of technology by examining the fit of technology to users' tasks/requirements. TTF is a powerful theory in the domain of technology utilisation due to its dissimilar approach to exploring the acceptance of technology from users' perceptive. The model conceptualised and validated the interdependence between technology performance, different technology characteristics and task requirements (e.g. training, help). It postulates that the utilisation of information systems results in increased performance only on condition that their functionality corresponds to users' task requirements (Goodhue and Thompsons, 1995). Before the introduction of the model, a few studies had examined the correlation between the increases in technology performance and the task-technology fit. Among them are experimental research studies confirming the difference in performance outcome of the same technology depending on different task requirements (Benbasat et al. 1986, Dickson et al. 1986). Several other studies had confirmed the correlation between the technology fit factor and technology adoption both in the organisational and private settings (e.g. Cooper and Zmud 1990, Tornatzky and Klein 1982). Also, it had been found that the mismatch between technology characteristics and tasks hinders the decision-making process (Vessey 1991). However, the reliability of the findings of prior studies was questionable as the studies did not measure performance per se. For example, some studies used the utilisation construct as a proxy (e.g. Lucas 1975, 1981), although it was confirmed that utilisation does not have strong power to predict performance (Goodhue and Thompsons, 1995).

Originally, there were five constructs that represented the model: task characteristics, technology characteristics, task-technology fit, technology utilisation and performance impact. While task characteristics and technology characteristics reflect the specific dimensions of the technology and its utilisation, the general task-technology fit factor captures individuals' perception of task-technology fit (Goodhue and Thompson, 1995). The TTF model has three propositions. The first proposition states that the users' evaluation of task-technology fit is determined by both task characteristics and characteristics of the technology. The degree to which a system assists an individual in performing his or her portfolio of tasks is measured by users' rating of eight dimensions: quality, locatability, authorisation, compatibility, production timeliness, system reliability, ease of use/training and relationship with users. Task characteristics are measured by task non-routineness, interdependence and job title. Those are the factors that might make a user rely more heavily on certain aspects of the information technology. Technology characteristics refer to technology-specific attributes or functions (Goodhue and Thompson, 1995). However, the validation of the hypothesised relationship and the role of construct dimensions did not bring consistent results. The factors representing task-technology fit exhibit different strength and significance across studies. For example, when examining the adoption of computing technology, the production timeliness, system reliability, authorization to access data, training and automation were identified by users (Tripathi and Jigeesh, 2015). When examining enterprise architecture management systems, only four fit dimensions were supported: locatability, system reliability, production timelines and ease-of-use (Eybers et al., 2019). However,  a study on the adoption of an electronic health-record system supported the role of each TTF dimension (Gan and Cao, 2014). In addition, not all the factors representing task and technology characteristics have a significant effect on the perceived match of technology to user requirements (Goodhue and Thompson, 1995).

The second proposition of the theory states that the utilisation of information systems by individuals is dependent on perceived fit.  The empirical validation partly supported this proposition by demonstrating 0.02 per cent of the total variance explained in the utilisation variable. It was found that different dimensions affect technology utilisation differently, with some of them having a negative effect on the dependent construct, such as reliability, relationship with IS (Goodhue and Thompson, 1995) and locatability (Im, 2014). Apart from the negative effect of the TTF dimensions, the applications of the theory demonstrate the insignificant role of some factors on information system utilisation. For example, an examination of the use of knowledge management technology found that only output quality and compatibility determine the utilisation of the technology (Teo and Men, 2008). In the enterprise system management context, locatability, system reliability, production timelines and ease-of-use motivate users' behaviour (Eybers et al., 2019).

The third proposition of the theory postulates that a positive evaluation of task-technology fit not only predicts utilisation, but positively influences perceived performance (the accomplishment of a portfolio of tasks by an individual). The empirical analysis of the proposed relationship demonstrates that TTF and utilisation explain 16 per cent of the variance in perceived performance. If examined separately, TTF alone accounts for 14 per cent, while utilisation accounts only for 2 per cent (Goodhue and Thompsons 1995). The main conclusion of the TTF model is that utilisation alone is not a strong predictor of performance. Given this, it is common practice to test the direct effect of TTF on performance (D'Ambra and Rice, 2001).

The complexity and multidimensionality of TTF has hindered the applicability of the model for measuring users' perceptions in technology utilisation. Therefore, many studies avoided complexities with operationalising the model by adopting a fit-as-match approach. Such an approach implies that TTF has become a first-order construct and users are simply asked whether technology suits their tasks (Furneaux, 2012). Multi-item first-order constructs have become widely adopted across studies, which contributed to the wide application of the theory in examining technology utilisation and adoption (e.g. (Lin, 2012, Wu and Chen, 2017, Lin and Huang, 2008)). For example, the adoption of knowledge management systems was examined by employing the TTF scale with eight items (Lin and Huang, 2008). A one-dimensional TTF scale was used to explore the direct and indirect effect of the construct on continuous intention to use (Lin, 2012, Ouyang et al., 2017, Wu and Chen, 2017). In addition, TTF has implications in practice. The application of the TTF model makes it possible to decide whether there is a need to redesign or discontinue the use of specific systems or technologies. By testing the dimensions of TTF, it is possible to understand what should be done to improve the users' experience with technology in terms of ease of use and concerns about the reliability of the system (Goodhue and Thompsons 1995).

### 3.1.2. Technology Acceptance Model

For three decades, the technology acceptance model has been considered as one of the most influential models in the IS domain (Benbasat and Barki, 2007, Lee et al., 2003). The application of the model for testing IS usability makes it possible to evaluate the motivation of users to adopt a range of technologies (Hwang, 2005, Gefen and Straub, 2005, Araújo and Casais, 2020). According to TAM, technology acceptance represents a three-stage process, whereby external factors (system design features) trigger cognitive responses (perceived ease of use and perceived usefulness), which, in turn, form an affective response (attitude toward using technology/intention) influencing use behaviour (Davis, 1989b, Davis, 1993). Parsimoniously, TAM represents the behaviour, as the outcome predicted by perceived ease of use, perceived usefulness and behavioural intention. Perceived ease of use and perceived usefulness capture the expectations of positive behavioural outcomes and the belief that behaviour will not be labour-consuming (Davis, 1989b). Behavioural intention can be substituted with attitude toward behaviour (Davis, 1993), which is an affective evaluation of the potential consequences of the behaviour (Fishbein and Ajzen, 1975). The higher the affective response, the higher is the likelihood that behaviour will take place. The effect of perceived usefulness on actual use can be direct, which underscores the importance of the variable in predicting behaviour. Although perceived ease of use does not affect use behaviour directly, it underpins the effect of perceived usefulness (Davis, 1993). The model implies that if an application is expected to be easier to use, the more likely it will be considered useful for the user and more likely it will stimulate the acceptance of technology (Davis, 1989b, Davis, 1993).

TAM has had a wide range of applications in different disciplines, contexts and geographical locations, offering an important theoretical tool when it comes to predicting user behaviour (Gefen and Straub, 2005, Gefen et al., 2003a, Dabholkar and Bagozzi, 2002, Gentry and Calantone, 2002). Given that information systems solutions have gained extensive use in the marketing of products, TAM became a handy tool to examine the attitude of consumers towards technologies, such as chatbots, e-commerce platforms and online shopping tools, enabling online trading (Gefen and Straub, 2005, Araújo and Casais, 2020, Gefen et al., 2003a). For example, TAM was used to investigate the assessment of online shopping tools by consumers, underpinning their intention to purchase through e-commerce platforms. It was confirmed that, along with trust, TAM constructs contribute to a considerable proportion of the variance in the attitude towards IS tools and subsequent consumer behaviour (Gefen and Straub, 2005). In addition, TAM was successful in explaining the acceptance of e-commerce chatbots, which contributed to purchasing intention (Araújo and Casais, 2020). However, when the model was tested on both potential and repeated customers of online stores, the model predicted the behaviour of only the customers who had already had prior experience with the stores (Gefen et al., 2003a).

Scholars tested the models of technology acceptance in different contexts and explored the acceptance of different technologies, such as mobile banking, telecommunication technology, virtual reality, e-learning systems to name a few (Adams and Nelson, 1992, Venkatesh and Davis, 1996, Wilson and Lankton, 2004, Al-Gahtani, 2016). While the effect of perceived usefulness was almost invariantly significant in relation to all types of technologies, the findings of the effect of ease of use were not consistent. For example, for adopting text-mining tools, it was important that users feel that software is both useful and easy to use (Demoulin and Coussement, 2018). Also, the contribution of TAM constructs to behavioural intention was significant when studying the acceptance of the world wide web (Lin and Lu, 2000). When TAM was adapted to test the acceptance of virtual reality, intention was predicted by perceived usefulness, although perceived ease of use was not significant for potential users (Sagnier et al., 2020).

The model was also tested in different settings – e.g. agriculture/farming, healthcare institutions and the use of natural resources (Arkesteijn and Oerlemans, 2005, Flett et al., 2004, Kummer et al., 2013). TAM could adequately explain the adoption of dairy farming technologies (Flett et al., 2004). However, when assessing the adoption of telemedicine technology by physicians, only perceived usefulness determined the intention of hospital workers to use the technology (Hu et al., 1999). This inconsistent finding can be interpreted in two ways: 1) the effect of perceived ease of using technology is mitigated when technology has a less functional value, and 2) when the study employs a specific sample of users which has certain skills required to use the technology. In addition, the strength of TAM variables in predicting behaviour was tested in different cultures and geographical contexts, like the U.S, Japan, India and Netherlands to name a few (Straub, 1994, Singh et al., 2020).

TAM is important for application in practice. From a practical point of view, TAM is useful for vendors to estimate the potential demand or stock supplies of new information technology products. Practitioners can use TAM to facilitate the acceptance of technology by understanding the degree to which technology is useful and easy to operate by consumers and designing consumer-oriented IT products (Davis, 1989b). Although the development of the model and measures for technology acceptance have had significant theoretical and practical value, the simplicity of TAM and the lack of understanding of the antecedents of technology acceptance (perceived usefulness and perceived ease of use) have been the subject of criticism (Venkatesh et al., 2007, Lee et al., 2003). The parsimoniousness of the original TAM drove a number of scholars towards identifying and measuring the predictive power of additional constructs which could be integrated into the model, such as trust, technology fit, external variables (e.g. subjective norms, social influence), technology-specific variables (e.g. compatibility, relevance) to name a few (Venkatesh and Davis, Gefen and Straub, 2005, Gefen et al., 2003a, Venkatesh, 2000, Karahanna and Straub, 1999, Kuofaris, 2002). In addition, TAM measures the attitudinal factor, without explaining the role of technology and task-specific factors. Therefore, this thesis puts forward the research model discussed in the following sections.

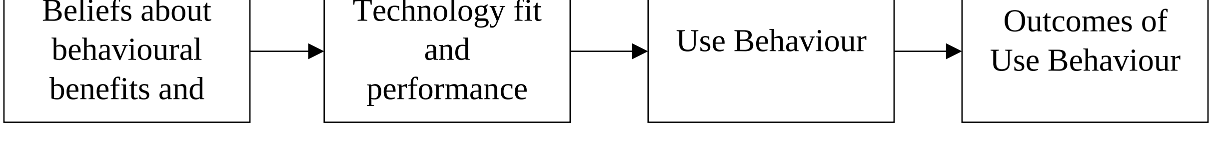
### 3.1.3. Conceptual Model

This research is based on the Task Technology Fit (TTF) model and TAM. The utilisation of the TTF model made it possible to examine whether the use behaviour of residents of private spaces is conditioned by the fit between their tasks and the characteristics of the technology. In this thesis, the authors use the “fit” factor as it is argued that it is a crucial construct that is implicit in a lot of research (Goodhue and Thompson, 1995). The rationale for focusing on the

TTF construct is that the present research aims to develop an insight into users' perception of fit, rather than identifying task requirements and specific services that facilitate the technology utilisation. A similar approach has been adopted by a number of studies that examined the users' perspective on the adoption of technology (Wu and Chen, 2017, Larsen et al., 2009, Fuller and Dennis, 2009).

TTF is integrated with the constructs that pertain to the users' perception of technology performance, such as perceived usefulness and perceived ease of use from the Technology Acceptance Model (TAM) (Davis, 1989a). TTF and TAM factors have been used in a number of studies aiming to explain the acceptance of technology from two different perspectives (Zhou et al., 2010, Goodhue and Thompson, 1995, Goodhue, 1995, Razmak and Bélanger, 2018, Naicker and Van Der Merwe, 2018). While TTF stresses the importance of the "fit" factor when it comes to task-related behaviour, perceived usefulness and perceived ease of use explain the attitudinal underpinnings of the behaviour. The model proposed in this thesis reconciles these two approaches. The main justification for combining attitudinal factors with TTF derives from research findings that users can positively perceive the technology, but not adopt it due to a lack of fit (Junglas *et al.*, 2008, Lee *et al.*, 2007). Given that smart home technologies are still not widely utilised, the TTF can shed new light on whether low acceptance of smart home technology is due to the lack of fit and associated beliefs about performance. Additionally, this research analyses whether utilitarian, hedonic values, privacy and financial risks influence the users' perception of task-fit. These are the four main groups of behavioural beliefs whose significance has been tested in the combination of various frameworks in the technology acceptance context (Turel *et al.*, 2010, Van der Heijden, 2004, Xu *et al.*, 2012). The overview of the model is presented in Figure 3.1. The following section will discuss the theoretical foundation of each relationship proposed in the research model.

**FIGURE 3.1: OVERVIEW OF THE CONCEPTUAL MODEL 1**



### 3.1.4. Hypothesis Development

**Beliefs About Behavioural Benefits and Costs**

TTF is defined as "*the degree to which technology assists an individual in performing his or her portfolio of tasks*" (Goodhue and Thompson, 1995). Following the underlying theory of task-technology fit, individuals' determination of the technology fit is based on their hedonic or utilitarian needs (Goodhue and Thompson, 1995, Van der Heijden, 2004). Perceived hedonic and utilitarian values matching individuals' needs can affect the perception of the technology (Van der Heijden, 2004, Babin *et al.*, 1994). The achievement of self-fulfilment is the core of the hedonic value. Specifically, hedonic value in the information systems context can be defined as an individual's perception of the enjoyment and fun related to the product (Van der Heijden, 2004, Brown and Venkatesh, 2005). On the other hand, consumers possessing utilitarian value expect to gain instrumental utility, like improved task performance (Van der Heijden, 2004). Therefore, it is proposed that behavioural beliefs are linked to the individuals' perception of task-technology fit. The first hypothesis is drawn from the findings of the literature on smart homes. Smart home technology can generate utilitarian values for users, such as financial savings on utility bills (Balta-Ozkan *et al.*, 2013b, Marikyan *et al.*, 2019), and hedonic values, such as enjoyment, comfort and fun (Marikyan *et al.*, 2019). Based on the above, the first hypothesis states that:

**Hypothesis 1:** a) Hedonic and b) utilitarian values have a positive effect on individuals' perceptions of task technology fit.

The literature has paid significant attention to perceived risks (Featherman and Pavlou, 2003, Pavlou, 2003, Bélanger and Crossler, 2011, Li and Huang, 2009, Im et al., 2008, Ozturk et al., 2017, Bourlakis et al., 2008). Privacy and financial risks are considered to be the main categories of perceived risks (Featherman and Pavlou, 2003, Pavlou, 2003). The perception of high risk is associated with the consumer's uncertainty about the outcome of behaviour (Bauer, 1960). A number of studies have highlighted the importance of perceived risk in explaining consumer behaviour in the context of innovative technology usage (Im et al., 2008, Featherman and Pavlou, 2003, Pavlou, 2003, Schaupp and Carter, 2010). Financial and privacy risks can negatively influence individuals' perception of technology, its acceptance and future use (Taneja et al., 2014, Martins et al., 2014). Several scholars have integrated perceived risk constructs with technology acceptance models (Kesharwani and Singh Bisht, 2012, Im *et al.*, 2008). Driven by the definition that the technology is perceived to fit the task if it is in consistency with the individual's needs, requirements and capable of assisting in a particular task (Goodhue, 1995, Van der Heijden, 2004), high perceived risk can be an inhibiting factor in perceived task-technology fit. Similarly, users have raised concerns about privacy intrusion and expressed distrust of promised savings on utility bills (Marikyan et al., 2019, Aldrich, 2003). Therefore, the next hypothesis states that:

**Hypothesis 2:** a) Privacy risk and b) financial risk have a negative effect on individuals' perceptions of task technology fit.

### Technology Fit and Performance

A number of studies combined various technology acceptance models with TTF to explain individuals' attitudes towards adoption, perceived performance and continuance intention to use (Dishaw and Strong, 1999, Wu and Chen, 2017, Lu and Yang, 2014, Abbas *et al.*, 2018, Oliveira *et al.*, 2014, Tam and Oliveira, 2016, Tarhini *et al.*, 2016). Perceived fit between technology and task is the precondition for the adoption of innovative services offered by online platforms (Dishaw and Strong, 1999, Wu and Chen, 2017). TTF model has been applied to different contexts, such as mobile banking, online learning systems and mobile insurance (Junglas *et al.*, 2008, Tam and Oliveira, 2016, Lee *et al.*, 2007, Wu and Chen, 2017). Users of online learning courses found TTF to be an important factor preceding perceived usefulness and perceived ease of use (Wu and Chen, 2017). However, not all dimensions of TTF (i.e. data quality, localability, authorisation, timeliness, compatibility, training, system reliability and relationship with users) were shown to be equally significant. Lee *et al.* (2007) concluded that data quality was the only indicator of fit and the predictor of service adoption in the context of insurance services. Another study found conflicting results about the effect of TTF on the performance impacts of mobile banking across younger and older respondents. The effect of the performance of banking services was insignificant for younger users, but not the older ones (Tam and Oliveira, 2016). The purpose of the use of online systems and the level of skilfulness of users may be two possible explanations for the inconsistency among previous findings. The fit of online systems for learning purposes can be more imperative, as users do not have an alternative way to fulfil the task. In contrast, mobile banking is an optional choice that is aimed at increasing the effectiveness of traditional banking services. Secondly, younger people might be more self-efficient and less dependent on the characteristics of the systems used. The literature has also discussed the effect of TTF on the outcomes of use behaviour, such as satisfaction. There is evidence that satisfaction is influenced by TTF both directly and indirectly (Lin and Wang, 2012, Chen *et al.*, 2016, Lin, 2012, Isaac *et al.*, 2017). For example, a study confirmed the effect of perceived fit on the satisfaction mediated by the use of online systems (Lin and Wang, 2012). It explains the situation whereby the performance of services that match pre-use expectation of technology fit is perceived as fair and a rewarding investment of users' resources (Chen *et al.*, 2016). The examination of the direct effect of perceived fit on satisfaction demonstrated that satisfaction is strongly correlated with TTF and acts as a good predictor of the long-term adoption of online learning systems (Lin, 2012, Isaac *et al.*, 2017). Based on the above, the next hypothesis is put forward:

**Hypothesis 3:** The perceived task technology fit has a positive effect on a) use behaviour, and b) satisfaction.

TTF has a strong influence on PEOU (Dishaw and Strong, 1999, Chang, 2008). In addition, when comparing the original model and the model integrated with TAM, the effect of TTF as a standalone model predicting use behaviour is not strong enough (Dishaw and Strong, 1999, Shih and Chen, 2013). The same conclusion was reached by a recent study that postulated that the integration of TTF with TAM gives a better explanation for the utilisation of innovative technologies (Wu and Chen, 2017). Also, the strong explanatory power of TTF constructs was examined in other research studies that integrated the TTF framework with performance expectancy and effort expectancy from UTAUT (Abbas *et al.*, 2018, Oliveira *et al.*, 2014, Zhou *et al.*, 2010). Performance expectancy pertains to perceived usefulness, whereas effort expectancy implies the perceived degree of ease directed at the utilisation of information systems (Venkatesh et al., 2003, Davis et al., 1992). The findings of the research suggested that combined behavioural belief constructs and TTF had a strong predictive power in relation to information system adoption. The study confirmed a strong relationship between performance expectancy and effort expectancy, TTF and technology characteristics constructs. The latter construct had an effect on effort expectancy, while TTF had a direct strong effect on perceived usefulness (Zhou *et al.*, 2010). Applying the findings of the research to the smart home literature, there could be a strong relationship between TTF, performance expectancy and effort expectancy. The embedded artificial intelligence in smart homes makes individuals' tasks easier and more effective. Smart home technologies can increase users' productivity and comfort in day to day tasks (Marikyan *et al.*, 2019, Aldrich, 2003). User-friendly smart devices can be perceived as having the potential of high task productivity due to lower effort expectancy.

**Hypothesis 4:** The perceived task technology fit has a positive effect on a) perceived usefulness and b) perceived ease of use.

Perceived usefulness can be defined "*as the degree to which an individual believes that using the system will help him or her attain gains in job performance*" (Venkatesh et al., 2003, Davis et al., 1989). Perceived usefulness and performance expectancy owe their wide implication to TAM and UTAUT theories. The two constructs share a high degree of similarity (Davis, 1989a, Thompson et al., 1991). A number of studies stress that perceived usefulness is a significant predictor of an intention and use of technology (Agarwal and Prasad, 1998, Davis et al., 1992, Venkatesh et al., 2012, Al-Gahtani et al., 2007). Moreover, the higher the perception of the usefulness of IT systems the higher the likelihood that the performance will be perceived positively by users. That means that perceived usefulness encourages actual use behaviour and also defines the perceived outcome of performance (Shih, 2004) . The construct has been applied and tested in different geographical and cultural settings. The results were consistent with the original findings, confirming the invariant effect of perceived usefulness on intention and use behaviour (Al-Gahtani et al., 2007, Wang and Shih, 2009, Venkatesh and Zhang, 2010). Based on the past literature our next hypothesis is:

**Hypothesis 5:** Perceived usefulness has a positive effect on use behaviour.

Perceived ease of use can be defined "*as the degree of ease associated with the use of the system*" (Venkatesh et al., 2003, Davis et al., 1989). Similar to perceived usefulness, perceived ease of use is a fundamental psychological belief facilitating technology acceptance (Davis et al., 1989, Davis, 1989a, Venkatesh and Davis, 2000). A vast number of studies have confirmed the significant effect of the construct on behavioural intention, both in voluntary and mandatory settings (Davis, 1989a, Thompson et al., 1991). In addition, perceived ease of use has both a direct and indirect effect on the use behaviour. One stream of research found robust evidence of the predictive power of perceived ease of use on actual use behaviour (Venkatesh et al., 2012, Al-Gahtani et al., 2007, Venkatesh and Zhang, 2010, Martins et al., 2014, Kumar et al., 2016). However, the major thread in the literature shows evidence that the influence of the factor on actual use is mediated by perceived usefulness (Park et al., 2016, Calisir and Calisir, 2004, Miranda et al., 2014). For example, the correlation of perceived ease of use and perceived usefulness was found when examining motivational predictors of the expected relevance of IT systems and subsequent satisfaction (Calisir and Calisir, 2004). Drawing upon the aforementioned findings, this thesis hypothesises the following:

**Hypothesis 6:** Perceived ease of use has a positive effect on perceived usefulness.

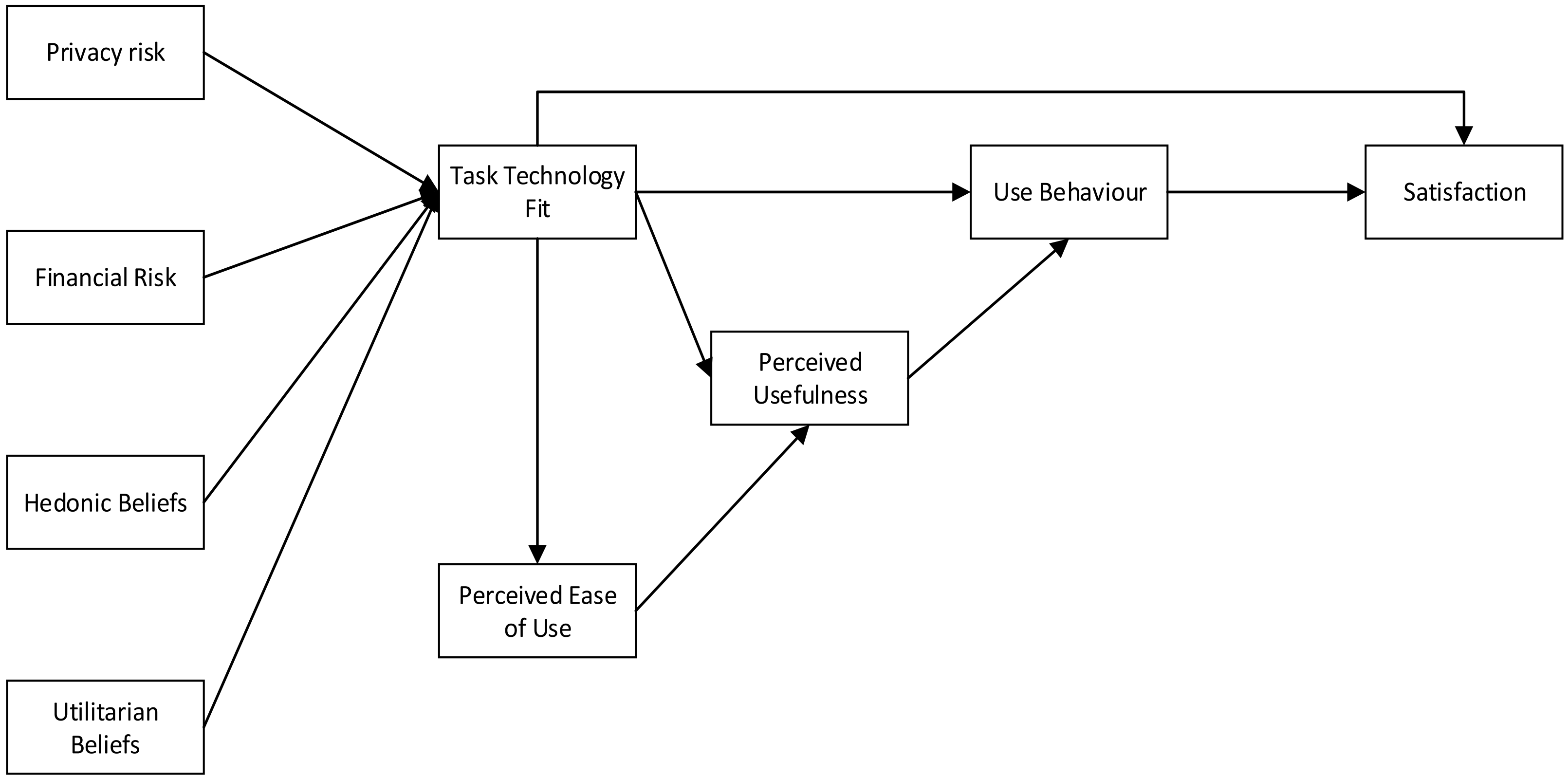
### The Outcome of Use Behaviour

Over the years, research has been carried out to study the relation between satisfaction and technology use (Román *et al.*, 2018, Vlahos and Ferratt, 1995, Calisir and Calisir, 2004). In particular, the influence of the technology use on employees' satisfaction in the workplace has been tested (Vlahos and Ferratt, 1995, Isaac et al., 2017). It was found that the use of technology in a work-related environment has a positive influence on decision-making efficiency and operations in organisations, and it increases the employees' satisfaction (Vlahos and Ferratt, 1995, Román *et al.*, 2018). The effect of actual use on user satisfaction was also tested in the context of private use of information systems (Chiu *et al.*, 2007, Deng *et al.*, 2010). It was found that the successful adoption of web-based platforms by consumers is the result of the direct effect of actual use on satisfaction (Chiu *et al.*, 2007). Another study used a multidimensional construct to test the effect of different aspects of user experience on satisfaction with mobile internet services. Experience was measured as the degree to which users meet functional, hedonic and overall performance expectations. The strongest correlation was between confirmed expectations and satisfaction, which in turn affected intention to use mobile internet services again (Deng *et al.*, 2010). Several studies developed conceptual models to explain the individual's satisfaction and antecedents (Calisir and Calisir, 2004, Mawhinney and Lederer, 1990). Recent literature provided inconsistent findings when investigating the relationship between technology use, satisfaction and stress (Román et al., 2018, Yueh et al., 2016). The findings revealed that technology use had a significant effect on satisfaction, but the effect of the frequency of use was insignificant (Vlahos and Ferratt, 1995). In addition, the satisfaction level among respondents was not consistent. Also, it has been argued that instead of satisfaction the use of technology positively influenced the level of stress (Ahearne *et al.*, 2005, Sundaram *et al.*, 2007, Tarafdar *et al.*, 2014). For instance, the acceptance of technology in higher education can lead to anxiety and it further negatively influenced satisfaction (Lepp *et al.*, 2014). In contrast, another stream in the literature pointed out that the use of technology had a positive effect on satisfaction levels (Wright *et al.*, 2014, Apostolou *et al.*, 2017, Román *et al.*, 2018). Drawing on the literature in the smart home domain, it is more likely that the enjoyment of health-related, financial and environmental benefits of the use of smart home technology (Marikyan *et al.*, 2019) will result in a positive outcome. Therefore:

**Hypothesis 7:** Smart home technology use has a positive effect on satisfaction.

The research model with hypothesised relationships is presented in Figure 3.2.

**FIGURE 3.2: RESEARCH MODEL 1**



## 3.2. Research Model 2: Technology Adoption Following Disconfirmed Expectations

### 3.2.1. Post-disconfirmation Technology Adoption

The technology adoption literature in the post-disconfirmation domain mostly uses the expectation-(dis)confirmation (Bhattacherjee, 2001, Bhattacherjee and Premkumar, 2004, Oliver, 1980) and innovation diffusion perspectives (Rogers, 1995, Huang et al., 2013). The Expectation Confirmation Model (ECM) is popular for studying IS users' continuance intention. It postulates that satisfaction and post-adoption behaviour is predicted by the degree to which pre-exposure expectations are confirmed by the post-exposure experience (Bhattacherjee, 2001, Bhattacherjee and Premkumar, 2004). The theory is rooted in the expectation-disconfirmation theory, which posits that better than expected outcomes lead to satisfaction, which, in turn, contribute to continuous use intention (Oliver, 1980). The second perspective in the IS adoption research is put forward by Innovation Diffusion Theory, which postulates that the adoption of innovation is contingent on the degree to which the characteristics of the innovation (i.e. relative advantage, compatibility, complexity, observability, triability) are confirmed after its utilisation. Users reappraise innovation attributes during the confirmation stage, so they could reconsider the decision to continuously use innovation (Rogers, 1995, Huang et al., 2013). Given the above perspectives, the negative disconfirmation of initial beliefs about technology characteristics and performance is expected to result in dissatisfaction and discontinuous use intention. Table 3.2 provides the findings of key papers, which illustrate the focus of the current research. However, Cognitive Dissonance Theory provides a competing perspective, suggesting that the negative disconfirmation might initiate a reduction of perceived discrepancy between expectation and performance, thus potentially leading to satisfaction. The rationale and the justification for the proposed argument are provided further in the chapter.

**TABLE 3.1: EMPIRICAL CONTRIBUTION ON TECHNOLOGY ADOPTION FOLLOWING DISCONFIRMED EXPECTATIONS**

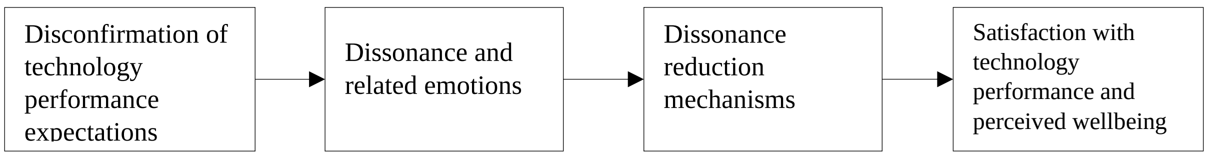
| Study | Sample | Method | Theory | Findings | Constructs | | |
|---|---|---|---|---|---|---|---|
| | | | | | **Expectations** | **Confirmation/Disconfirmation** | **Behavioural Outcomes** |
| **(Lin et al., 2005)** | N = 254 | Cross-Sectional | Expectation-Confirmation Theory | The results indicated that the confirmation of perceived playfulness leads to satisfaction, which, in turn, contributes to the users' intent to reuse a web site. | Perceived Playfulness | Confirmation | Satisfaction, Continuous Intention to Use |
| **(Zhou, 2011)** | N = 269 | Cross-Sectional | Expectation-Confirmation Theory | The results confirm that expectation confirmation, perceived usefulness, perceived ease of use and usage cost affect users' satisfaction and subsequent post-adoption behaviour | Perceived usefulness, usage cost | Confirmation | Satisfaction |
| **(Lee, 2004)** | N = 71 | Cross-Sectional | Innovation Diffusion Theory | The results demonstrate the strong relationship between confirmed expectations about the characteristics of innovation and Internet technology adoption. | Compatibility, image, financial slack and relative advantage | Confirmation | Adoption |
| **(Alamgir Hossain and Quaddus, 2011)** | N = 8 | Qualitative | Innovation Diffusion Theory, Expectation-Confirmation Theory | The findings show that RFID adoption is dependent on technological, organizational, and environmental factors, prior expectations and self-efficacy. Moreover, the process of continued usage intention involves satisfaction from current use and a degree of self-efficacy | Prior expectations | Confirmation | Adoption |
| **(Venkatesh and Goyal, 2010)** | N = 1143 | Longitudinal approach | Expectation-Disconfirmation Theory | Both positive and negative disconfirmation of initial expectations have negative effects on the intention to adopt technology | Expectation, Perceived performance | Disconfirmation | Low intention to adopt technology |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **(Bhattacherjee, 2001)** | N = 122 | Field Survey | Expectation-Confirmation Theory | Continuance intention is determined by users' satisfaction with IS use and perceived usefulness of continued IS | Perceived Usefulness, Expectations about perceived usefulness | Confirmation | Satisfaction, Behavioural Intention |
| **(Hsieh et al., 2010)** | N = 459 | Online Field Survey | Expectation-Disconfirmation Theory | Perceived performance and expectation affect disconfirmation (positive), while the effect of the former is much higher. Disconfirmation affects satisfaction | Expectation of information and system quality, perceived performance | Positive Disconfirmation | Satisfaction |
| **(McKinney et al., 2002)** | N = 568 | Cross-Sectional | Expectation-Disconfirmation | Perceived performance and expectation affect disconfirmation (positive), while the effect of the former is much higher. Disconfirmation affects satisfaction | Web information and services quality expectation, Perception of web information and service quality | Positive Disconfirmation | Satisfaction |
| **(Thong, 1999)** | $N_{Adopters} = 120$ $N_{Nonadopters} = 46$ | Cross - Sectional | Innovation Diffusion Theory | Innovation characteristics (relative advantage, compatibility, and complexity of IS) have no significant effect on IS adoption, while their effect on the likelihood of adoption is significant | Relative advantage, compatibility, complexity | Usage | The likelihood of adoption |
| **(Fan and Suh, 2014)** | N = 266 | Longitudinal Approach | Expectation-Disconfirmation | Expectations regarding the disruptive technology and dissatisfaction with the incumbent technology affect users' switching intention | Performance | Negative Disconfirmation | Switching behaviour |

### 3.2.2. Cognitive Dissonance Theory

Cognitive Dissonance Theory has been used in IS research to explain the dissatisfaction of individuals when they experience disparity between pre-service and post-service perception of products’ performance (Park et al., 2015, Venkatesh and Goyal, 2010). The theory postulates that the state of dissonance is triggered when an individual possesses two or more contradictory cognitions (Festinger, 1962). Dissonance, induced by disconfirmed expectations, triggers the psychological state associated with negative emotions and discomfort. The affective state influences the motivation of individuals to resolve the aroused dissonance (Festinger, 1962, Sweeney et al., 2000). The reduction of cognitive dissonance attenuates negative emotions and might result in the restoration of a positive psychological state. Given the above, the process users go through can be conceptualised as a four-stage process (Figure 3.3). First, the disconfirmation of technology performance vs initial expectations occurs; second, individuals start experiencing emotional discomfort; third, emotional discomfort induces behavioural or attitudinal actions to reduce dissonance; the fourth stage is the outcome of cognitive dissonance actions. In addition to the testing the relationships among the above, the facilitating role of dissonance reduction in achieving satisfaction and perceived wellbeing is also tested.

FIGURE 3.3: OVERVIEW OF THE CONCEPTUAL MODEL 2




This thesis uses Cognitive Dissonance Theory, as it suggests which measures users employ when they experience dissonance following the disconfirmation of technology performance expectations. Those measures can be categorised into three main types, namely attitude change, consonant information-seeking and behaviour change (Festinger, 1962). Attitude change is defined as the modification of initial expectations or the perception of performance (O'Neill M, 2004, Festinger, 1962, Harmon-Jones and Harmon-Jones, 2007). Individuals’ preferences towards a specific choice are strengthened and alternatives are rejected, increasing the consonant state of mind. Attitude change represents the post-factum justification of the product purchase or the rationalisation of the product performance, which are aimed at maintaining the integrity of someone's own decisions and their outcomes (Stephens, 2017, E. Ashforth et al., 2007, Harmon-Jones and Harmon-Jones, 2007). The consonant information seeking mode occurs when individuals selectively search for reaffirming information about the decision through different channels, such as advertising (Liang, 2016) or word-of-mouth (Kim, 2011). Behaviour change represents the withdrawal of the behaviour causing dissonance (Festinger, 1962). This reduction strategy is an aversive measure to eliminate the possibility of negative outcomes occurring in the future (McGrath, 2017). For example, the negative experience might result in the cancellation of the use of a particular good/service (Lindsey-Mullikin, 2003). Similarly, exposure to negative word-of-mouth can result in the discontinuation of product use (Kim, 2011). However, behaviour change is a less documented strategy to reduce dissonance (McGrath, 2017). Table 3.3. provides a list of the main publications examining dissonance reduction strategies, which demonstrates unbalanced research in terms of the mechanisms that people employ to attenuate a negative psychological state.

**TABLE 3.2: COGNITIVE DISSONANCE REDUCTION STRATEGIES**

| Authors | Attitude Change | Behaviour Change | Seeking Consonant Information |
|---|---|---|---|
| **Lindsey-Mullikin (2003)** | X | | X |
| **Festinger (1962)** | X | | X |
| **Ehrlich et al. (1957)** | X | | |
| **Zanna and Cooper (1976)** | X | | |
| **Elliot and Devine (1994)** | X | | |
| **Jarcho et al. (2011)** | X | | |
| **(Schewe, 1973)** | X | | X |
| **Aronson (1968)** | X | | X |
| **Cummings and Venkatesan (1976)** | X | | X |
| **Oshikawa (1969)** | X | | X |
| **Hunt (1970)** | X | | |
| **Kim (2011)** | X | X | X |
| **Dickinson and Oxoby (2011)** | | | X |
| **Harmon-Jones et al. (2009)** | X | | |
| **Engel (1963)** | | | X |
| **Stephens (2017)** | X | | |
| **Brehm (1956)** | X | | |
| **Harmon-Jones and Mills (1999)** | X | | |
| **Sharot et al. (2009)** | X | | |
| **Thibodeau and Aronson (1992)** | X | | |
| **Beauvois and Joule (1996)** | X | | |

| | | | |
|---|---|---|---|
| **Cooper and Fazio (1984)** | X | X | |
| **Gosling et al. (2006)** | X | | |
| **Maertz Jr et al. (2009)** | X | | |
| **Losciuto and Perloff (1967)** | X | | |
| **Elkin and Leippe (1986)** | | X | |
| **O'Neill M (2004)** | X | | |
| **McGrath (2018)** | | X | |
| **Dickerson et al. (1992)** | | X | |
| **Jonas et al. (2001)** | X | | |

Cognitive Dissonance Theory remains relatively under-researched and the role of the construct misunderstood. Table 3.4. provides a list of studies focusing on cognitive dissonance arousal and reduction, which illustrates how a handful of studies have investigated the conditions and factors that influence the arousal and the reduction of cognitive dissonance. Evidence mainly derived from the marketing literature. The studies informed about the role of the decision's importance, the familiarity with a product, brand name and image, price and involvement, among other factors. Those variables are associated with the intended or unconscious selection of cognitive dissonance strategies (e.g. (Brehm, 2007, Namin et al., 2017, Gbadamosi, 2009, Lindsey-Mullikin, 2003, Sweeney et al., 2000, Oliver, 1997). For example, it was found that marketing communication targeted at consumers after a product purchase can effectively reduce psychological discomfort (Hunt, 1970). The psychological discomfort motivates consumers' willingness to engage in post-consumption advertising exposure, which plays an important role in the reduction of dissonance and, in turn, leads to satisfaction (Engel, 1963). The way in which brands communicate their image and the level of attachment they can secure (i.e. brand image, brand loyalty) affect the success of the attitude change and information-seeking strategies (Brehm, 2007, Namin et al., 2017, Gbadamosi, 2009, Lindsey-Mullikin, 2003). Apart from advertising, word-of-mouth can be an effective way to reaffirm oneself in the decision made by strengthening attitudes to favour the choice (Kim, 2011). The post-dissonance coping strategy selection can also be influenced by regulating price and the degree of consumers' involvement with products (Gbadamosi, 2009, Soutar and Sweeney, 2003). Product price and involvement reflect the degree of importance it holds for the consumer and the interest attached to the behaviour. In conditions of high product involvement, an unexpected outcome of behaviour causes stronger dissonance and a willingness to rationalise it (Sweeney et al., 2000), although the relationship between this factor and a specific dissonance reduction strategy is inconclusive. In addition, the literature points to the findings about the role of the level of brand relationship and trust in the behaviour following dissonance arousal. A positive attitude to brand and trustworthiness were found to reduce cognitive dissonance and predict satisfaction (Shahin Sharifi and Rahim Esfidani, 2014).

Given the above, the literature mostly focuses on the external interventions consumers can be exposed to. Those factors make people justify their behaviour and continue using products or services, thus downplaying the effect of dissonance. The research that has been conducted to date signals the need to explore the psychological antecedents that are associated with cognitive dissonance and trigger people to select a certain path/method to reduce it. Given that, this thesis proposes the research model discussed in the following sections.

**TABLE 3.3: STUDIES ON COGNITIVE DISSONANCE**

| Author | Context | Methodology | Findings | Future Research Avenues |
|---|---|---|---|---|
| **Voisin et al. (2013)** | Investigated the influence of personal norms and beliefs on dissonance arousal and reduction. Investigated favourable choices of individuals and the reduction of cognitive dissonance. | Experimental (2): Longitudinal: Survey: N=133 | Subjective norms significantly influence dissonance arousal and reduction. The study reported that people are inclined to trivialise the outcome of the behaviour rather than change attitude. | The study indicated a further need to investigate the strategies that people use for dissonant reduction in different settings. |
| **Maertz Jr et al. (2009)** | Explored the cognitive dissonance process and reduction after the adoption of different cultural behaviour. | Conceptual paper | The authors proposed a theoretical model which explains the cross-cultural dissonance and dissonance reduction. | Test the model in different settings. |
| **Stephens (2017)** | Scrutinised the process of cognitive reduction, particularly through the attribution theory and social norms theory. | Conceptual paper | The study confirmed dissonance reduction in situations when people experience dissonance arousal. The study found that people tend to avoid dissonance frequently. | Further research on the process of cognitive dissonance reduction (using attribution theory and social norms theory) |
| **Karagözoğlu (2014)** | 1) Attempts to find the boundary conditions when individuals are ready to engage in dissonance reduction.<br>2) Investigates the decision-making behaviour of people who experience cognitive dissonance.<br>3) Attempted to find the optimal way of how | Conceptual paper | Presented the dynamic model of peoples' decision-making under cognitive dissonance. Under certain conditions (i.e. individuals' openness or resistance to habituation) individuals tend not to seek the reduction of cognitive dissonance. | Look at short term cognitive dissonance reduction. Focus on the general exploration of cognitive dissonance reduction through a graph theory (mathematical techniques need to be applied) |

| | | | | |
|---|---|---|---|---|
| | individuals reduce cognitive dissonance. 4) Investigated the antecedents that trigger the reduction of cognitive dissonance. | | | |
| **Egan et al. (2007)** | Investigated the origins of the cognitive dissonance and the process of the reduction of cognitive dissonance | Experimental (2) N=30 | Confirmed that children and monkeys experience cognitive dissonance | Further investigation on the strategies of reducing cognitive dissonance. |
| **Coppin et al. (2010)** | Investigated the cognitive reduction techniques after decision-making. | Experimental N=37 | Confirmed the presence of post-decision dissonance. | Need to investigate the antecedents that trigger cognitive dissonance reduction. |
| **George and Edward (2009)** | Scrutinised the link between high purchase decision involvement and cognitive dissonance. | Survey: Around N=600 potential respondents. Only N=267 of them completed the questionnaire. | The degree of involvement predicts the degree of aroused dissonance. Additionally, authors pointed out that dissonance linked to high involvement purchase is more difficult to overcome compared to low involvement purchase. | Further need to investigate the strategies of cognitive dissonance reduction. |
| **Gbadamosi (2009)** | Studied the consumption of low involvement products and cognitive dissonance. | Qualitative study: In depth interviews N=30 | Consumers having low involvement with products tend to change their attitudes (look at different brands) | The study is limited in terms of generalisability. Future studies need to look at both high involvement and low involvement products, and examine the relationship to cognitive dissonance arousal/ reduction. |
| **Shahin Sharifi and Rahim Esfidani (2014)** | Investigated the relationship of marketing effect on the reduction of cognitive dissonance; the path from | Survey N=400 SEM | Strong brand relationship and trustworthiness reduce cognitive dissonance and predict satisfaction. | Investigate the relationship between cognitive dissonance reduction and satisfaction. |

| | | | | |
|---|---|---|---|---|
| | dissonance reduction to satisfaction and loyalty | | | |
| **Bawa and Kansal (2008)** | Based on the literature of cognitive dissonance and service marketing, the authors investigated the characteristics of services that can cause the arousal of dissonance. They explored the arousal of dissonance and reduction in different service contexts and examined the role of advertisements in cognitive dissonance. | Conceptual | The study provided a number of propositions. (e.g. perceived risk acts as an antecedent of cognitive dissonance, service characteristics influence cognitive dissonance, etc) | Developed propositions should be empirically tested. Additionally, there is a need to examine the antecedents of the cognitive dissonance and the reduction strategies of cognitive dissonance. |
| **Kim (2011)** | Examined the antecedents of cognitive dissonance (trust and value). Based on the theory of cognitive dissonance, the authors developed a theoretical model to examine consumer behaviour when they face negative word-of-mouth (WOM). | Survey N=214 (originally there was N=3000 mails sent so response rate was only 7%) | Confirmed that individuals experiencing cognitive dissonance modify their behaviour to reduce dissonance. | Further research to investigate the variables that influence cognitive dissonance. There is also a need to investigate the effect of the cognitive dissonance on the WOM response. |
| **O'Neill M (2004)** | Investigated the relationship between dissonance and after-use perception of service quality | Longitudinal: Survey (t1, t2). The effects were measures at two points in time: right after consumption and a month later.<br>N=657 | Individuals’ perception of the service quality changes after time, which is directly linked to cognitive dissonance. Individuals experiencing dissonance try to reduce or eliminate it. | Need to perform a longitudinal study by measuring effects at more than 2 points in time |
| **Soutar and Sweeney (2003)** | 1) Investigated the concept of cognitive dissonance and tested the scale of the cognitive dissonance. | Survey: Two samples. N=323, N=313 | 1) Confirmed the presence of dissonance after purchase. It was concluded that | Due to the low level of response rate (only 44% and 31%), cognitive dissonance should be measured in a |

| | | | | |
|---|---|---|---|---|
| | 2) Investigated the quality of products, loyalty and switching behaviour in the context of cognitive dissonance. | | dissonance is not eliminated as time passes.<br>2) Tested the antecedents of cognitive dissonance (e.g. price)<br>3) Confirmed that demographic factors played a significant role in the context of cognitive dissonance. | different context (a different product). |
| **Koller and Salzberger (2012)** | Investigated cognitive dissonance and its reduction in the context of low involvement. Revealed the link between cognitive dissonance, satisfaction and loyalty. | Longitudinal (t1, t2) N=207 | Low involvement products can cause cognitive dissonance.<br>Passion can negatively influence cognitive dissonance (low dissonance) and serves as a motivation factor to reduce cognitive dissonance through attitude change (by lowering initial expectations) | Validate the research findings by using a larger sample size. Need to investigate the antecedents of cognitive dissonance (e.g. passion) |
| **Jarcho et al. (2011)** | Explored the reduction of cognitive dissonance during the decision making process. The study employed analyses of brain activity (FMRI). The study explored the neural mechanism linked to decision making. | Experimental study: Using FMRI (to check the brain activities of respondents). N=21 | Individuals adjust their behaviour to support an initial choice. | Investigate the evaluation process, emotions, conflict and decision-related attitudes in the context of cognitive dissonance. |
| **Lindsey-Mullikin (2003)** | Examined the reduction of dissonance and the individual's behaviour in case of encountering an unexpected price. | Qualitative Study: In-depth interviews, N=13 | When individuals encountered an unexpected price, they experienced dissonance and attempted to reduce it. | Need to generalise the study findings.<br>Investigate individual differences in adopting strategies of dissonance reduction. |

| | | | | |
|---|---|---|---|---|
| **Simon et al. (1995)** | Investigated the reduction of cognitive dissonance. | Experimental study: N=47 | When individuals fail to reduce dissonance through attitude change, they tend to employ trivialisation. | The need to understand in which circumstances individuals choose to trivialise the outcome of the behaviour |
| **Pallak and Pittman (1972)** | Examined the arousal and reduction of cognitive dissonance | Experimental Study: N=61 | Individuals can tolerate the aroused dissonance. | Investigate the motivation for engaging in dissonance reduction behaviour |
| **Elkin and Leippe (1986)** | Examined the strategies of reducing cognitive dissonance | Experimental Study: N=40 | Sometimes individuals engaging in dissonance reduction can accelerate existing dissonance. | Further need to investigate the arousal of cognitive dissonance. |
| **Jonas et al. (2001)** | Investigated the consequences of engaging in information seeking activity | Experimental Study: N=36 | Seeking biased information (as a method to reduce dissonance) can lead to negative consequences. | Investigate the process of seeking information in the context of cognitive dissonance. |

### 3.2.3. Hypothesis Development

**Disconfirmation of Technology Performance Expectations**

Drawing on the Theory of Expectation-Confirmation, the individuals' evaluation and satisfaction of the experience with technology is the result of the comparison of expectations and the performance (Bhattacherjee, 2001, Dai et al., 2015). Expectations refer to pre-exposure beliefs about a service or product (Susarla et al., 2003). The evaluation of pre-purchase expectations with actual performance can lead either to the confirmation or disconfirmation of the expectation. Confirmation results from the match between pre-exposure expectations and actual performance, while disconfirmation is the outcome of performance which is inconsistent with expectations. Disconfirmation can be either positive, when actual experience with the use exceeds prior beliefs about the use, or negative, when performance falls short of expectations (Oliver, 1980, Kopalle and Lehmann, 2001). The inconsistency between the degree of perceived performance and prior beliefs represents the conflict of the two types of cognition that can be explained by the Cognitive Dissonance Theory. The inconsistency causes dissonance that is associated with psychological discomfort (Festinger, 1962). The intensity of dissonance differs depending on the degree of discrepancy between initial cognition and the cognition after the exposure to technology use. The discrepancy can be small, falling within the zone of tolerance, without triggering dissonance arousal. As the magnitude of the discrepancy increases, the probability and the magnitude of dissonance arousal increases too (Szajna and Scamell, 1993). Dissonance can arise not only due to the discrepancy between expectation and performance, but the comparison of pre-service and post-service performance of technology or IS system (Park et al., 2015). Pre-service performance may include the quality of pre-service customer service or website design. Post-service performance includes the evaluation of the object's attributes related specifically to the use of the technology or IS system (Park et al., 2015). Based on the above, our first hypothesis is put forward:

**Hypothesis 1:** The disconfirmation of technology performance with prior expectations has a positive effect on dissonance arousal

**Dissonance and Related Emotions**

Dissonance is associated with discomfort and uneasiness which reflect negative emotions. The strength of emotions demonstrates the degree of dissonance arousal (Festinger, 1962). Past research identifies three emotions that can be associated with cognitive dissonance. The first is anger, occurring when people feel not responsible for the situation causing dissonance and/or incapable to fulfil the task (Harmon-Jones, 2004, Harmon-Jones et al., 2017). Anger is defined as a basic emotion, holding a number of other underlying similar, yet different emotions, like frustration, irritation or bitterness (Shaver et al., 1987). It has been reported that people who experience stronger cognitive dissonance have a stronger perception of anger and aggression (Soutar and Sweeney, 2003). The relationship between dissonance and anger can be used to explain the negative outcome of service performance and use of technology. For example, the failure in technology performance raises anger and withdrawal behaviour, such as boycotting the retailer of the product (Donoghue and de Klerk, 2013). The use of technology contributes to the experience of anger and anxiety in the condition when people have low self-efficacy in the use of computers (Wilfong, 2006). Self-efficacy represents the state when technology users feel incapable of realising the expected services (Bandura, 1977). Therefore, it can be suggested that dissonance caused by the disconfirmed belief about the competent use of technology is more likely to associate with anger.

The second emotion is guilt (Gosling et al., 2006, Turel, 2016). Guilt is associated with a feeling of shame and self-disappointment and can explain the psychological state between cognitive dissonance and the intention to discontinue the use of technology. Guilt is a response to the behaviour that causes moral dilemmas, such as the inconsistency with personal norms, values and self-standards (Harmon-Jones et al., 2017). Guilt can be experienced when a person feels responsible for the failure of technology performance causing the inconsistency with internal norms. The higher the control over the behaviour, the higher is the perception of guilt (Burnett and Lunsford, 1994). For example, IT addiction raises the self-attributed negative emotion (i.e. guilt), which reflects the perception that a person is not capable of rationally utilising the technology and realising desired goals (Vaghefi and Qahri-Saremi, 2017). Other incidents with technology inducing guilt may include the excessive use of technology at the expense of important tasks (Turel et al., 2011) or ethical implications of the use of technology (Harrington, 1996).

The third emotion related to dissonance is regret (Roese and Summerville, 2005, Gilovich et al., 1995b). Regret reflects self-blame for the behaviour that should have not been performed (Connolly and Zeelenberg, 2002, Gilovich et al., 1995b). Regret can be experienced when individuals choose a particular technology out of similar alternatives. It is one of the negative outcomes of purchase decisions that is strongly associated with disconfirmation and dissonance (Oliver, 2014b). The strength of regret is conditioned by the degree to which non-selected alternatives represent the value for the individual. In post-purchase situations, regret occurs when the evaluation of the foregone alternative is increasing (Croyle and Cooper, 1983). For example, regret is experienced when the use of technology causes problems. Negative implications devalue the chosen technology and induce considerations about alternatives that could have been acquired instead (Dhir et al., 2016). Regret may occur not only as a result of issues with the utilisation of technology, but after the exposure to positive information about the services of an alternative technology (Kang et al., 2009). Also, individuals can feel regret when they realise that an alternative product could have been acquired at a lower cost (McConnell et al., 2000). Based on the above, the next hypothesis is proposed:

**Hypothesis 2:** Dissonance caused by the disconfirmation of technology performance with prior expectations has a positive effect on the arousal of a) anger, b) guilt and c) regret

**Dissonance Reduction Mechanisms**

Emotions mediate the dissonance arousal and reduction processes (Festinger, 1962) because emotions are able to motivate and organise cognitions and actions (Izard, 2010). Emotions help interpret the signals of social interaction, communication and feeling states, which underpin cognitive appraisals (Izard, 2010). Prior research has examined negative emotions in dissonance reduction as a unidimensional construct, embracing anger, fear, regret and anxiety (Jean Tsang, 2019, Gosling et al., 2006). However, this approach can be questioned given that emotions represent a complex process that guides people differently in various situations (Izard, 2010). Emotions can be differentiated by three aspects, which are a) affective valence, b) motivational direction and c) arousal. Affective valence refers to the degree to which people are positive or negative about the felt emotion and the state (Harmon-Jones et al., 2011, Harmon-Jones et al., 2017). Motivational direction refers to the degree that the emotion plays in approach (behaviour aimed at reaching the goal) or avoidance (aversion from the goal achievement) behaviour (Harmon-Jones et al., 2017). The commitment to the behaviour by changing attitude and strengthening positive attitude through the exposure to consonant information falls into the approach behaviour. The lack of commitment, such as the change of behaviour as a result of dissonance, refers to the withdrawal behaviour (Harmon-Jones, 2004). Arousal is the intensity of the feeling and psychological response to it (Harmon-Jones et al., 2017). In terms of affective valence, anger, guilt and regret refer to negative emotions. It is considered that negative emotions inhibit behaviour, which indicates withdrawal motivation (Harmon-Jones, 2004, Watson, 2000). However, when it comes to motivational direction, these types of emotions have a distinctive role in the cognitive dissonance strategies as they contribute differently to the commitment to the behaviour causing dissonance (Harmon-Jones, 2004, Harmon-Jones et al., 2017). The distinctive motivational role of emotions is explained by different conditions in which emotions are manifested. The conditions include the degree of control over behaviour, the extent of responsibility for behavioural outcome, the justifiability of behaviour, the availability of better behavioural alternatives and the degree to which behaviour violates personal or social norms (Smith and Lazarus, 1993, Harmon-Jones et al., 2017, Harmon-Jones et al., 2003, Amodio et al., 2007, Connolly and Zeelenberg, 2002, Gilovich et al., 1995a).

Evidence suggests that anger resulting from the use of technology negatively affects its continuous use (Beaudry and Pinsonneault, 2010), which indicates the role of emotion in motivating avoidance behaviour. However, the findings on the motivational direction of anger are conflicting (Harmon-Jones, 2004, Harmon-Jones et al., 2004, Harmon-Jones et al., 2017, Carver, 2004). The inconsistency may be rooted in two reasons. First, the feeling of anger is often associated with other related emotions (e.g. irritation, shame, anxiety) motivating approach or avoidance behaviour. The interrelationship with other emotions affects the motivational direction of anger. For example, anger coupled with anxiety facilitates behaviour withdrawal (Harmon-Jones et al., 2017). Secondly, the motivational direction of anger depends on whether individuals feel responsible for the anger-inducing event and whether they have opportunities to undo the event. In situations of being intentionally harmed by another party, anger activates an approach-behaviour (Harmon-Jones et al., 2017). The common response in such situations is to punish the responsible party (Smith and Lazarus, 1993). However, the motivation to initiate any response is mitigated when there is no opportunity to ameliorate the situation causing anger (Harmon-Jones et al., 2003). Such anger is association with feeling incapable to achieve the initial goal. It triggers the desire to change the goal orientation and switch to alternative options (Harmon-Jones, 2004, Carver, 2004). For example, anger is manifested when the use of technology inflicts security threats (Liang et al., 2019, Beaudry and Pinsonneault, 2010). When security threats occur, reduced commitment to technology and a subsequent behaviour withdrawal represent a defensive mechanism to overcome the occurrence of a similar negative outcome (Beaudry and Pinsonneault, 2010). Anger has a pro-active role in users' behaviour, as it encourages individuals to seek out external means to cope with the emotion, which leads to the derogation of the behaviour causing anger (Liang et al., 2019). Also, it has been found that the failure of appliance induces different levels of anger with the highest one being correlated with the intention to redress the experience and discontinue behaviour (Donoghue and de Klerk, 2013). As such, users who experience anger induced by unexpected and unsatisfactory result of the use of technology are more likely to switch to another behaviour, rather than try to justify the negative outcome.

**Hypothesis 3:** Feeling anger negatively affects a) attitude change and b) consonant information search, and positively affects c) behaviour change

Guilt is considered to be a self-regulatory emotion (Amodio et al., 2007). There are two theoretical perspectives on the role of guilt in motivating behaviour (Turel, 2016, Amodio et al., 2007, Harmon-Jones et al., 2017). There is evidence that guilt motivates avoidance mechanisms, namely, discontinues use of technology (Turel, 2016). Another perspective postulates an opposite role of guilt in behaviour (Harmon-Jones et al., 2017, Amodio et al., 2007). In morally violating situations, people tend to look for the means to resolve guilt, which contribute to approach-motivational orientation (Harmon-Jones et al., 2017, Amodio et al., 2007). The cognitive dissonance reduction through attitude change and consonant information-seeking represent the means to resolve guilt. They reflect the way to justify an action retrospectively and continue the behaviour by subduing negative emotions (Ghingold, 1981b, Kelman, 1979). For example, people, who engage in conversations to reduce psychological tension, have a lower level of regret than people, who do not try relief dissonance through communication (Stice, 1992). Such conversations represent the form of cognitive adjustment. Given the above, it is hypothesised that:

**Hypothesis 4:** Feeling guilt positively affects a) attitude change and b) consonant information search, and negatively affects c) behaviour change

The literature provides evidence about the effect of regret on avoidance motivation (Gilovich et al., 1995b, Davvetas and Diamantopoulos, 2017). There are two reasons to suggest that regret has a negative effect on the continuous use of technology. The motivation for withdrawal behaviour stems from cognitive processes associated with regret, such as weak self-esteem and strong self-blame. Regret is a painful feeling, since it implies a personal fault in the negative outcome and raises counterfactual thinking (Connolly and Zeelenberg, 2002, Gilovich et al., 1995b). Counterfactual thinking refers to the ruminations about alternative decisions and potential consequences (Roese, 1997). Counterfactual thinking is conditioned by the availability of alternative options and opportunities accordingly. When an individual does not have any opportunities or opportunities imply inevitable negative consequences, the individual either mitigates or terminates the feeling of regret through attitude change, thus maintaining behaviour. In contrast, strong opportunities in a positive outcome facilitate the feeling of regret (Roese and Summerville, 2005) and predict switching behaviour (Lee and Lee, 2012). Feeling regret often results in corrective actions, the change of decision and behaviour, such as switching service providers if they fail to meet service requirements (Zeelenberg and Pieters, 1999). For example, the scenario-based experiment found that regretful decisions positively affect the intention to discontinue the use of technology and negatively affects satisfaction (Davvetas and Diamantopoulos, 2017). Regret experienced after the appraisal of service performance mediates the relationship between dissatisfaction and switching behaviour (Mattila and Ro, 2008, Sánchez-García and Currás-Pérez, 2011). Regret is a stronger predictor of behaviour modification when individuals compare the actual outcomes with better alternatives (Roese and Morrison, 2009). In addition, prior research provides evidence on the correlation between information-seeking and regret. It is suggested that the exposure to information about alternatives increases experienced regret (Keaveney et al., 2007), which potentially leads to a higher dissonance and the motivation to avert behaviour in order to reduce dissonance. Hence, this research proposes that:

**Hypothesis 5:** Feeling regret negatively affects a) attitude change and b) consonant information search, and positively affects c) behaviour change

**Satisfaction with technology performance and perceived wellbeing**

According to Cognitive Dissonance Theory, the behaviour that arouses dissonance is associated with a negative affective state (e.g. dissatisfaction). In conditions when dissonance is aroused, satisfaction with the behaviour can be achieved if the psychological discomfort caused by disconfirmed expectations is eliminated. That happens by reducing the discrepancy between prior expectations and perceived performance using one of the dissonance reduction strategies (Shahin Sharifi and Rahim Esfidani, 2014, Dutta and Biswas, 2005, Festinger, 1962). Although all three dissonance reduction mechanisms (attitude change, consonant information search and behaviour change) reduce psychological tension, they trigger different levels of satisfaction with the behaviour causing dissonance. Specifically, attitude change and consonant information search refer to the cognitive dissonance reduction mechanisms that change the cognition (i.e. reinforcing positive beliefs about the behaviour), thus encouraging individuals to carry on the behaviour that initially caused dissonance (Harmon-Jones and Mills, 2019). By changing their attitude and seeking consonant information, users increase the likelihood of experiencing satisfaction and perceived wellbeing (Festinger, 1962). In contrast, behaviour change reduces the psychological tension by eliminating the source causing dissonance (i.e. the behaviour). That means that although the psychological tension is eliminated, the individual stays unsatisfied with the behaviour (Festinger, 1962). Such a theoretical explanation of the relationship between behaviour change and dissatisfaction is different from the stream of research which focuses on the relationship between disconfirmation – dissatisfaction – switching behaviour (Fan and Suh, 2014, Zhang et al., 2016, Lu et al., 2012) and overlooks the role of dissonance and dissonance reduction strategies. In this research, given the established dissonant state, withdrawal behaviour is one of the measures that people employ before evaluating satisfaction. The supporting arguments can be drawn from prior research, which found that users who are more committed to the behaviour are more likely to view the selected choice favourably and in turn experience higher satisfaction (Brehm and Cohen, 1962). For example, when individuals are engaged in interactive reflection on the behaviour, they change their cognition by strengthening their positive attitude to the behaviour and improving self-perception (e.g. self-confidence, self-awareness and self-knowledge) (Jones and Oswick, 2007). Sparks et al. (2012) examined a correlation between personality traits, reduction strategies and perceived satisfaction. They found that people, who tend to maximise outcomes (maximisers), tend to withdraw behaviour, which results in less satisfaction. In contrast, non-maximisers tend to change the attitude towards the choice and perceive a stronger level of satisfaction. The study by Vroom and Deci (1971) provides evidence about the positive effect of the cognitive adjustment on satisfaction. The findings of the research postulated that when people do not engage in dissonance reduction through the change of cognition following the perception of discrepancy between expectation and the actual outcome, they show stronger dissatisfaction (Vroom and Deci, 1971). Given that satisfaction is a predictor of perceived wellbeing (Lee et al., 2002), discontinuous behaviour can be negatively associated with perceived wellbeing. Hence, the following hypotheses are put forward in relation to the cognitive dissonance coping mechanisms users may be deploy:

**Hypothesis 6:** Attitude change has a positive effect on a) perceived wellbeing and b) satisfaction with technology performance

**Hypothesis 7:** Consonant information seeking has a positive effect on a) perceived wellbeing and b) satisfaction with technology performance

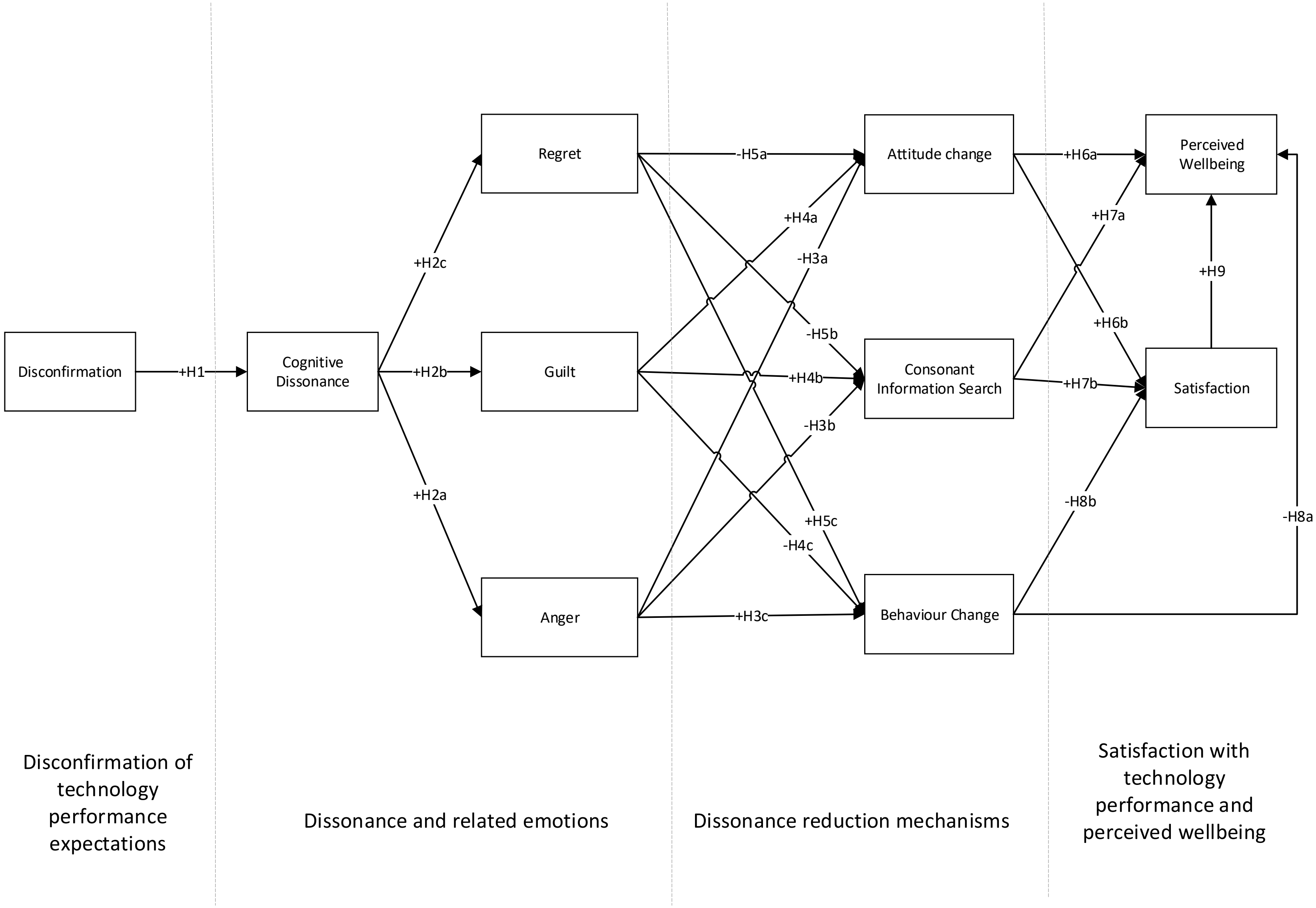
**Hypothesis 8:** Behaviour change has a negative effect on a) perceived wellbeing and b) satisfaction with technology performance

Perceived wellbeing is a perceived impact on important life domains, which underpins the evaluation of the overall quality of life (El Hedhli et al., 2013). Perceived wellbeing reflect experiences with consumer goods and services (Lee et al., 2002). It the result of satisfaction with the acquisition, consumption, possession and disposition of a product or service. Satisfaction in consumer life domain has a spill over effect on other life domains (Lee et al., 2002). Wellbeing captures the cumulative satisfaction with the product and the positive experience that it has on user life, social life, leisure life and community life (El Hedhli et al., 2013). In other words, wellbeing is predicted by the satisfaction experiences, such as family relationships, the status in society, material possessions and education (Lee et al., 2002). This is of particular importance to the empirical setting of this work namely smart homes. Smart homes aim to deliver individual and societal benefits by assisting in daily routines, delivering comfort, decreasing natural resources consumption (energy and water) and in turn reducing utility bills (Marikyan et al., 2019). Given that the aim of technology is to satisfy users' needs, which tackle different aspects of life, a strong perception of fulfilled needs can contribute to the user perceived wellbeing.

**Hypothesis 9:** Satisfaction with technology performance has a positive effect on perceived wellbeing

Figure 4.2. presents the research model of the hypothesised relationships

**FIGURE 3.4: RESEARCH MODEL 2**



# 4. Methodology

This chapter explains the methodological approach adopted by the thesis. Section 4.1 discusses the philosophical assumptions underpinning the methodological choices made. Section 4.2. discusses the quantitative research design adopted by providing a detailed explanation of different competing methods available for a researcher. Section 4.3. highlights the steps undertaken to conduct the research. Section 4.4 presents the steps undertaken to develop a systematic literature review. Section 4.5 discusses data collection procedures, including the survey approach, questionnaire design and sample selection. Section 4.6 provides a summary of data analysis techniques. The chapter concludes with section 4.7, explaining ethical issues and considerations.

## 4.1. Research Philosophy

All research studies are based on the *research pyramid,* which encompasses four levels. The first one is the research paradigm, which identifies how a researcher perceives and views reality. The second level is the research methodology, which deals with the avenue that the researcher utilises to conduct the study. This avenue derives from the research paradigm. The third one is research methods, which refer to specific procedures that are undertaken to implement the research. The fourth level is the research technique, which refers to specific tools and instruments that the researcher uses to collect the required data and analyse it. The research pyramid informs the steps in the research and makes the procedures transparent, which helps justify the actions taken by the researcher (Jonker and Pennink, 2010, David et al., 1999).

A research paradigm is a term which is used to conceptualise and define the nature of knowledge (Johnson and Onwuegbuzie, 2004, Ochieng, 2009). The research paradigm reflects the researchers' viewpoints as to how they perceive the surrounding world (Ochieng, 2009, Golafshani, 2003). The adopted research paradigm acts as a backbone for the overall research strategy, which has a footprint on the researchers' understanding of the proposed assumptions and findings (Johnson and Clark, 2006). In the process of research development, the researcher proposes assumptions about the knowledge and encountered realities that reflect the way in which the researcher perceives a research question and consequently develops methods of data analysis (Crotty, 1998).

The pillars that form research paradigm are ontology, epistemology, human nature and methodology (Table 4.1). The ontological consideration of research forms the pathway for research epistemology, which in turn fuels the methodological considerations (Grix, 2002, Hitchcock and Hughes, 1995, Tuli, 2010, Scotland, 2012). Blaikie and Priest (2019) pointed out that "*ontological claims are claims and assumptions that are made about the nature of social reality, claims about what exists, what it looks like, what units make it up and how these units interact with each other. In short, ontological assumptions are concerned with what we believe constitutes social reality*". Ontology mirrors the essence and the perception of reality (Crotty, 1998, Slevitch, 2011). It is concerned with views and assumptions about how the world operates (how things work). Particularly, research ontology deals with the essence of the nature of the social phenomenon that is being explored and investigated by the researcher (Burrell and Morgan, 2017). Ontological strings challenge the views depicted by the researcher's standpoint. In the domain of social science, the core of the ontology is whether the social reality operates independently from the social actors and interpretations (Ritchie et al., 2013).

Epistemology emphasises the avenues from where the knowledge is generated about the social world (Ritchie et al., 2013). The main questions to address are "*what can be regarded as acceptable knowledge?*" (Saunders, 2011) and "*what are the forms and the nature of acceptable knowledge?*" (Cohen and Morrison, 2004). Epistemological assumptions deal with the processes as to how acceptable knowledge can be obtained, produced and shared (Scotland, 2012). The central point of the epistemology is to divulge the nature of the relationship between "what can be known" and "what can be evaluated" (Guba and Lincoln, 1994). In basic terms, epistemology makes it possible to embrace and justify the produced knowledge.

Human nature deals with the way in which the researcher sees human beings in relationship with the external environment. This is an essential question to raise, as people are the subjects and objects of the research in social science. Some social science standpoints view human experiences as being produced by the environment and people are fully dependent on the conditions of the environment they are situated in. Another perspective in social science research considers that human beings create and control their experiences irrespective of the external factors and circumstances. Despite the existence of the above two perspectives, in the majority of instances, research in social science reflects assumptions that are positioned between the two extremes (Burrell and Morgan, 2017).

The design of methodology is guided by the assumptions of epistemology, ontology and the nature of human beings. Each philosophical element has a direct effect on the way in which the researcher pursues the scientific inquiry. Therefore, different epistemological and ontological assumptions and considerations of the role of human beings in the social world will result in different methodological choices utilised to pursue the inquiry (Burrell and Morgan, 2017). For example, some researchers examine the social world as hard and external to an individual, while others treat it as a soft and subjective phenomenon. The former stance is more applicable for exploring universal laws that govern the reality under investigation. The latter stance stresses the importance of methodological approaches that emphasise the relative nature of the world and the subjective experiences of individuals within it (Burrell and Morgan, 2017).

There are two main philosophical approaches in social science: subjectivism and objectivism. Subjectivism reflects the ontological position that believes in the inseparable role of social actors in the formation of social entities (Scotland, 2012, Crotty, 1998). The research rooted in subjectivist views follows the assumption that social phenomena are drawn from social actors' perceptions and actions (Morey and Luthans, 1984, Endres and Woods, 2007). According to this position, social phenomena continually change, which is linked to the belief that actors can change their perception or action towards the phenomenon. The subjectivist approach is linked to the epistemological approach of constructionism or social constructionism. The social constructionism position is based on the ideas that reality is formed by actors. Researchers examining individuals' perceptions regarding a certain situation should take into account that social actors might have a different perception of the situation and different interpretations, thus forming a bespoke view of the world. This perception can be linked to relativism, which describes the bond between the situation and an individual's relationship to it, ignoring the unconditioned view of the world (Crotty, 1998). Given these peculiarities, the researcher should take into account the reality drawn by individuals to understand and provide a conclusion regarding the social phenomenon. The subjectivist approach often has implications in qualitative research (Newman et al., 1998). Qualitative research is a method that is used to understand social phenomena through the transcription of meaning that people assign to them. The process of investigation is iterative, whereby questions emerge along the process of investigation. Data is usually collected in the context, while the analysis is inductive. An inductive analytical approach refers to the process of exploring data to generating theory by rigorous interpretation of the emerging knowledge (Creswell and Poth, 2017). Scholars point out that qualitative-based research lacks objectivity in its findings, which is due to the fact that different individuals can interpret "things" differently.

In contrast to subjectivism, the objectivist approach deals with entities that are independent and exist in external reality (Crotty, 1998, Saunders, 2011, Scotland, 2012). The objectivist approach to social science reflects the ontology of realism or objectivism, which postulates that the real world exists independently of human beings (Crotty, 1998). It is external, tangible and unchangeable, depending on peoples' perceptions. Objectivism entails a positivistic approach to conducting research. In line with this assumption, researchers seek to predict things and explain the social world (Burrell and Morgan, 2017, Weber, 2004, Wicks and Freeman, 1998). Researchers usually adopt a quantitative research methodology that aims to test hypotheses derived from theories by investigating the relationships between variables. This approach is close to natural science, because all the variables are believed to be measurable and analysed using statistical procedures. Thus the theories are developed deductively and are free from bias, which makes it possible to generalise and replicate findings (Creswell and Poth, 2017).

This thesis follows the ontological position of objectivism and the epistemological position of positivism. This philosophical assumption is explained by the objectives of the research. The objective of this thesis is to produce evidence about consumer behaviour in the context of the utilisation of information systems. Ontologically, this thesis adopts a stance according to which smart home users' behaviour represents an objective reality, which exists independently from researchers' experience. Smart home user behaviour is not socially-constructed and is not subjected to change in the course of human-researcher interaction. From the epistemological perspective, the thesis advocates the hypothetic-deductive testability of theories. To derive testable hypotheses, a review of the literature on smart homes and the adoption of pervasive technology in private spaces is conducted. The thesis provides analyses of a number of theoretical frameworks, such as Technology Acceptance Model, Task-Technology Fit model, Cognitive Dissonance Theory, Innovation Diffusion Theory and Expectation-(Dis)confirmation theory. The literature adopting these theories which is relevant to the focus of the current research is also examined. The theoretical underpinnings are analysed to identify how they can be utilised to address the research questions set by this thesis. For example, the findings of prior literature using TAM and TTF, as well as behavioural research, made it possible to build the behavioural model of smart home users. By testing the hypotheses, it is possible to verify the knowledge and generalise the results, which would explain the antecedents underpinning the use of smart homes. The Cognitive Dissonance Framework is tested in the second research model. By analysing the correlation between theoretically driven constructs, the model helps understand how negative experience with smart homes affects adjustments in individuals' cognition or behaviour. Methodologically, this thesis adopts a value-free position, whereby the researcher has no influence on the measurement, analysis and the interpretation of the findings. The data collection follows a structural approach to ensure that no bias resulting from the interaction between the subject of the investigation and the researcher takes place. The measurement of generalisable evidence is achieved by adopting verified scales, which make it possible to process the data statistically. In line with positivist behavioural research in information systems (Lee and Hubona, 2009), the collected data enable researchers to use inferential statistics and multivariate analysis, which ensures the impartial drawing of conclusions.

This thesis falls into the stream of research in the IS discipline, which predominantly focuses on predicting and explaining the behaviour of humans (Hevner et al., 2004, Hevner et al., 2008). This research followed the example of the majority of studies in the domain of information systems, which adopt a positivistic approach (Chen and Hirschheim, 2004). The studies use positivistic philosophy to explain and predict the acceptance and the utilisation of technology by testing the role of user-perceived factors, such as perceived performance, perceived ease of use, social factors, technology characteristics and others (Venkatesh et al., 2003, Davis, 1985, Goodhue, 1995, Goodhue and Thompson, 1995, Venkatesh and Bala, 2008). Similar to that stream of research, this thesis provides box-and-arrow models to depict theories, theory-driven constructs and relationships among them (Lee and Hubona, 2009).

**TABLE 4.1: CORE ASSUMPTIONS ABOUT THE NATURE OF SOCIAL SCIENCE (BURRELL AND MORGAN, 2017, HUDSON AND OZANNE, 1988)**

| | Subjectivist approach to social science | Objectivist approach to social science |
|---|---|---|
| **Ontological Assumptions** | | |
| Nature of Reality | Socially constructed<br>Multiple<br>Holistic | Tangible<br>Single<br>Fragmentable |
| Nature of Human Beings | Contextual<br>Voluntaristic<br>Proactive | Divisible<br>Deterministic<br>Reactive |
| **Epistemological Assumptions** | | |
| Knowledge | Idiographic | Nomothetic |

| | | |
|---|---|---|
| View of causality<br>Research relationship | Time-bound<br>Context-dependent<br>Multiple-simultaneous shaping<br>Interactive-cooperative<br>No privileged point of observation | Time-free<br>Context-independent<br>Real causes exist<br>Dualism-separation<br>Privileged point of observation |
| **Methodological Assumptions** | | |
| Inductive versus Deductive | Understand meanings that people attach to the world<br>Understand research context<br>Flexible structure of research<br>Researcher is a part of what is being investigated | Guided by scientific principles<br>Investigate causal relationships between variables<br>Hypotheses derived from the theory<br>Structured research<br>Research is independent of what is being investigated |

## 4.2. Research Methods

Once the philosophical position is determined, tentative methodological choices become evident, because philosophical assumptions guide the way in which research is carried out (Morgan, 2007). Research methodology or research design is the way in which a researcher approaches and solves the research problem. It is not only the research method, but "*the logic behind the methods we use in the context of our research study and explain why we are using a particular method or technique and why we are not using others so that research results are capable of being evaluated either by the researcher himself or by others*" (Kothari, 2004a). There are three main decisions concerning research methodology (Creswell and Creswell, 2017, Saunders, 2011) (Table 4.2). The first one refers to the methodological approach, which is an umbrella for different practices in social research. It is a useful means of categorising different social research methods and procedures. The second decision refers to the research strategy. This represents general procedures of conducting research, which can fall into any of the categories of the research approach. The third one is the research method. This is a detailed procedure of how the research is conducted in terms of data collection, the analysis of results and writing (Creswell and Creswell, 2017).

The decision regarding research design should be clear and justified from the point of the nature of the research, objectives of the study and the consistency with the philosophical assumptions underpinning the research. The objectives of the research fall into four main categories. The first one is descriptive research, which aims to discover the facts about particular events or subjects. Data is usually quantitative, including percentages, ratios, means and medians that can be statistically analysed (Hildreth and Aytac, 2007). The most common methods are systematic observations of the single measurable variable or a survey. The second type is exploratory research, which is characterised by a subjective investigation of the phenomenon through in-depth immersion into the complexity of the event, situation or a subject. The phenomenon under investigation is understood and interpreted through the eyes of the researcher. It is typically qualitative by nature, and participant observations, focus groups and open-ended questions represent the common methods. The third research type is explanatory research. The main agenda of explanatory research is to find the answer to the question "Why?". The research focuses on the investigation of the cause of particular events and situations. The research is typically highly structured, following a rigorous protocol on the data collection and the measurement of the relationships between variables. Data is quantitative and analysed using inferential statistical methods, whereby the results can be generalisable. Therefore, the application of all sorts of experiments and descriptive surveys are common in research adopting the explanatory stance (Hildreth and Aytac, 2007, Mitchell and Jolley, 2012). The last type of research is evaluative. Scientific methods in this research are used to evaluate specific techniques, policies or programmes. The research can encompass both quantitative and qualitative elements (Hildreth and Aytac, 2007). Given the above, the current research can be classified as explanatory in nature. It is justified by the objective of the research to examine the effect of a group of factors on the individuals' use of smart home technologies and the subsequent psychological and behavioural outcomes following the use of those technologies. The data was quantitative, and inferential statistics was used for the analysis of the data. The results of the research can be applicable to a more general population, in line with the principles of explanatory research, which is grounded on the deductive approach to knowledge production (Kothari, 2004b).

The three main methodological approaches are qualitative, quantitative and mixed-method (Ghauri and Grønhaug, 2010, Morgan, 2007). Qualitative research is typically underpinned by interpretivism because the researcher studies the social reality through the prism of his or her own understanding and subjective interpretation of the phenomenon being studied (Newman et al., 1998, Denzin and Lincoln, 2005). The research is conducted in natural premises. The aim is to build a connection with the participants of the study and analyse their subject against the social settings they are placed in. Qualitative research often results in conceptual frameworks that are operationalised using various data collection and analysis techniques. The questions are not pre-defined and the procedures are not structured, which enables unexpected findings to emerge (Creswell and Clark, 2017). The most common data collection techniques include narratives, case study, phenomenologies, ethnographies and grounded theories (Morgan, 2007, Brannen, 2017).

In contrast to qualitative research, the quantitative approach is strictly objective in nature, as it is typically associated with positivism (Saunders, 2011, Crotty, 1998). The aim of quantitative research is to deduce knowledge by testing hypotheses about the relationships between variables. Therefore, the values in the analysis are numeric and measurable. The data is analysed using various statistical techniques and validated using a number of reliability and validity tests. The common methods of collecting data are experiments, cross-sectional research and longitudinal strategies (Creswell and Creswell, 2017). While all of the above methods make it possible to test the relationships between variables, the validity of the experiments is much stronger because of the possibility of introducing control conditions (Kothari, 2004b, Mitchell and Jolley, 2012).

Mixed-method research shares both quantitative and qualitative characteristics. Such research does not fall into the interpretivist or positivist research paradigm. The research is pragmatic in the sense that the selection of the research methods is situation-specific. The researcher is liberated to select the method that is most applicable in a given situation to solve the research problem (Creswell and Creswell, 2017, Patton, 1990). The decision to combine research methods should be justified (Cherryholmes, 1992, Creswell and Clark, 2017). The reasons could be different, such as to complement findings, to provide a deeper insight into the phenomenon being investigated or to bring a transformative agenda to the research (Creswell et al., 2003). Mixed method research varies depending on how two opposite methodologies are combined. The combination can occur at the same stages and refers to a partial integration. Alternatively, the combination of research methods happening at different stages refers to full integration (Nastasi et al., 2010, Leech and Onwuegbuzie, 2009). In addition, the use of qualitative and quantitative research methods can be concurrent (at one phase/point in time) or sequential (at different phases) (Creswell and Clark, 2017).

The current research employs a cross-sectional strategy utilising quantitative data. The reason is that the aim of the research is to examine the interaction of a set of variables and infer the possible conditions that predict individuals' attitudinal and behavioural patterns while using smart home technologies. The practical contribution of the study was to inform practitioners about the factors of smart home acceptance and adoption, which should be generalisable to a wider population.

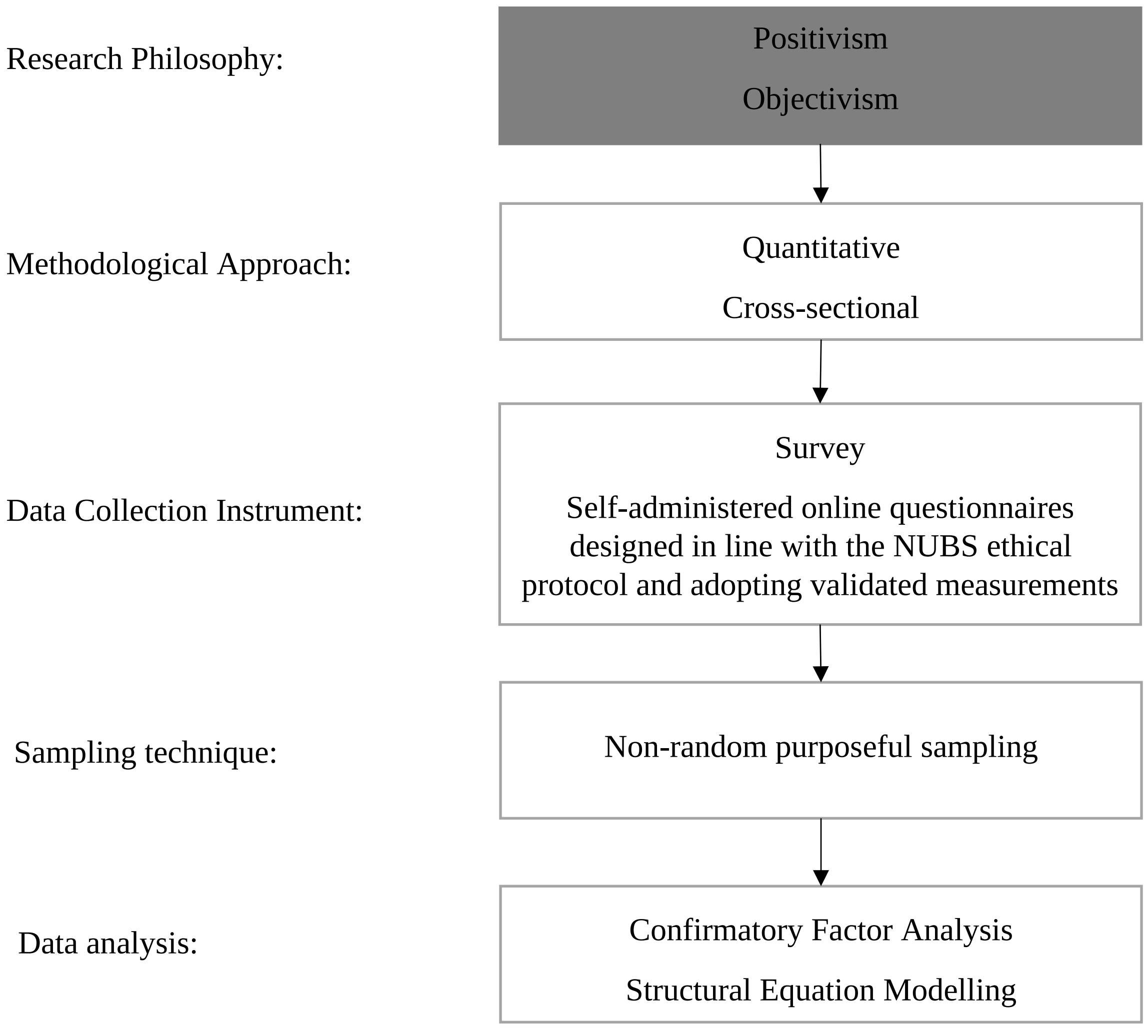
**TABLE 4.2: KEY ELEMENTS OF RESEARCH APPROACHES (CRESWELL AND POTH, 2017, SAUNDERS, 2011, KOTHARI, 2004A, MORGAN, 2007)**

| | Quantitative | Qualitative | Mixed Method |
|---|---|---|---|
| **Connection of theory and data**<br>**Research Process**<br>**Inference from data** | Deduction<br>Objective<br>Context | Induction<br>Subjective<br>Generality | Abduction<br>Intersubjective<br>Transferability |
| **Strategies** | Experiments<br>surveys | Narratives<br>Phenomenologies<br>Grounded theory<br>Case studies<br>Ethnographies | Sequential<br>Concurrent<br>transformative |
| **Procedures** | Predetermined<br>Structured<br>Statistical analysis | Emerging<br>Unstructured<br>Analysis of texts and images | Both predetermined and emerging<br>Both structured and unstructured<br>Statistical and text analysis |

## 4.3. Research Design

The research design steps and processes were undertaken in accordance with a cross-sectional strategy rooted in the positivist philosophical view. Given the deductive nature of the objectives pursued by this thesis, the first step in implementing the research was a review of the literature on smart homes. The literature enabled researchers to identify gaps that inform the selection of theoretical approaches and the development of the research models. After the theorisation of the research, the second step was to develop a survey - a data collection instrument - that would make it possible to measure the perceptions and beliefs of the users of smart homes before technology adoption, as well as explore the behaviour and coping mechanisms after the use. The data collection stage consisted of the questionnaire design, the selection of a sampling strategy and the adaptation of measurements. Prior to embarking on data collection, ethical issues were considered to ensure that the research ethics protocol developed by Newcastle University Business School was followed. Then, the next step was to evaluate and employ appropriate data analysis techniques and tools to make sure that the researchers arrive at valid and reliable conclusions (i.e. the analysis of the measurements and paths). Figure 4.1. illustrates all the steps undertaken to design the research, starting from philosophical considerations up until the data analysis choices.

**FIGURE 4.1: METHODOLOGICAL STEPS AND PROCESSES**




## 4.4. Methodology of the literature review

As a first step of the current research, the literature on smart homes was analysed from a user perspective to inform the development of the research model. A systematic approach was adopted to review and analyse the existing body of knowledge. In order to ensure that the findings were reached in a reliable and valid manner the review followed a three-stage approach, as proposed by Tranfield (Tranfield et al., 2003), namely: planning the review, conducting the review by analysing papers and reporting emerging themes and recommendations. These stages are further discussed in this section.

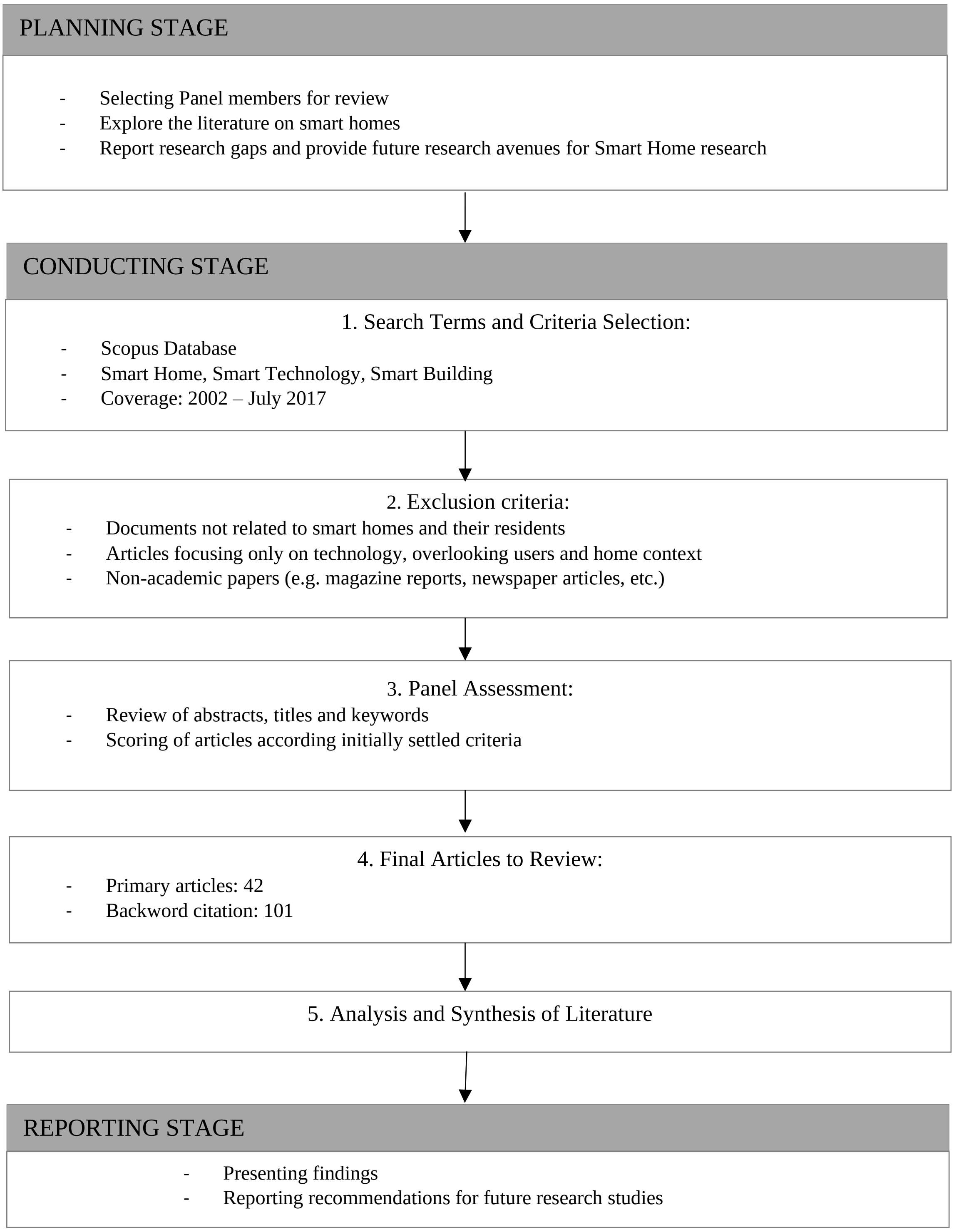
### 4.4.1. Planning Stage

The planning stage of the review, which included the preliminary scoping of the literature aiming to identify and refine the objectives of the study and develop review protocols, was undertaken by 3 reviewers. The expertise of the reviewers on the topic facilitated and enhanced the potential of the study to derive novel themes and extend the insights into the topic(Hasson et al., 2000). An initial search of the literature demonstrated a number of gaps, which signalled the need to explore the smart home use from the user perspectives systematically, especially when it came to the challenges of acceptance and adoption. Having identified the topic of the study, the next step was to develop the protocol for the review, which included the search criteria, the papers selected for the review and the method of conducting the analysis used in the next stage.

### 4.4.2. Conducting Stage

The conducting stage of the review involved the systematic search, based on relevant search terms. The electronic database Scopus was selected as it represents the largest database of citations and abstracts of the research literature and provided a wide coverage of the review topic. (Bar-Ilan, 2008). The key word selection revolved around the term "*smart home*". The selection of the phrase was justified by the requirement to cover the whole area of the smart home technology implications inside the house and beyond, and aspects such as acceptance of smart home technology. The keyword formulation started from the broader literature and was narrowed down to more specific terms (e.g. smart home, smart homes, smart building, smart home technology and smart technology). The starting point was to review the findings based on the aforementioned keywords search. During the extraction of articles, an advanced search option was enabled that limited results to publications in the form of "articles", "book chapters", "reviews" and "articles in press" published in the English language. The restriction of the search criteria to papers published between 2002 till 2017 was applied, referring to the period when the research in the field became systematic, which is reflected in a steep increase in the literature in 2002 compared to sporadic studies that had been published before. Since then the research on the topic has been gradually intensifying. Given the domain of our literature review, the subject area of the search was limited to such disciplines as "social science”, “multidisciplinary”, “business, management and accounting”, “art and humanities”, “psychology” and “decision science”. The search revealed 457 documents. The panel members reviewed the keywords, titles and abstracts of all the downloaded documents to determine the selection of articles for the review. Given the objective of this study, only academic articles relevant to smart homes, smart technologies and their users were included. Non-academic papers, such as newspapers, company reports, magazine articles, interview transcripts and presentations were excluded. Panel members scored papers based on their potential relevance to the topic in a binary manner (yes=1/no=0), resulting in scores from 0 (min) to 3 (max). 35 articles gained the highest score 3, whereas only 7 articles obtained a score of 2. Given the limited number of articles the reviewers decided to include both clusters for further analysis. As a result of the systematic literature search and selection process, a total of 42 articles was selected. In order to increase the number of studies for the review and its coverage, a backward citation search was utilised. Proposed by Croom (Croom, 2009) and Thome *et al.* (Thomé et al., 2016), backward citation is a method of retrieving deeper knowledge about the topic of interest, beyond selected keywords. It is defined as a process of screening and exploring the references cited in the selected articles (Hu et al., 2011b). Backward citation screening was applied to the 42 selected articles and resulted in 101 documents being added to the papers downloaded from the database. Combining the list of papers that was compiled by the electronic database search and the backward citation screening, a total of 143 papers was downloaded for the review (Figure 4.2).

**FIGURE 4.2: SUMMARY OF SMART HOME LITERATURE REVIEW (ADAPTED FROM TRANFIELD, 2003)**

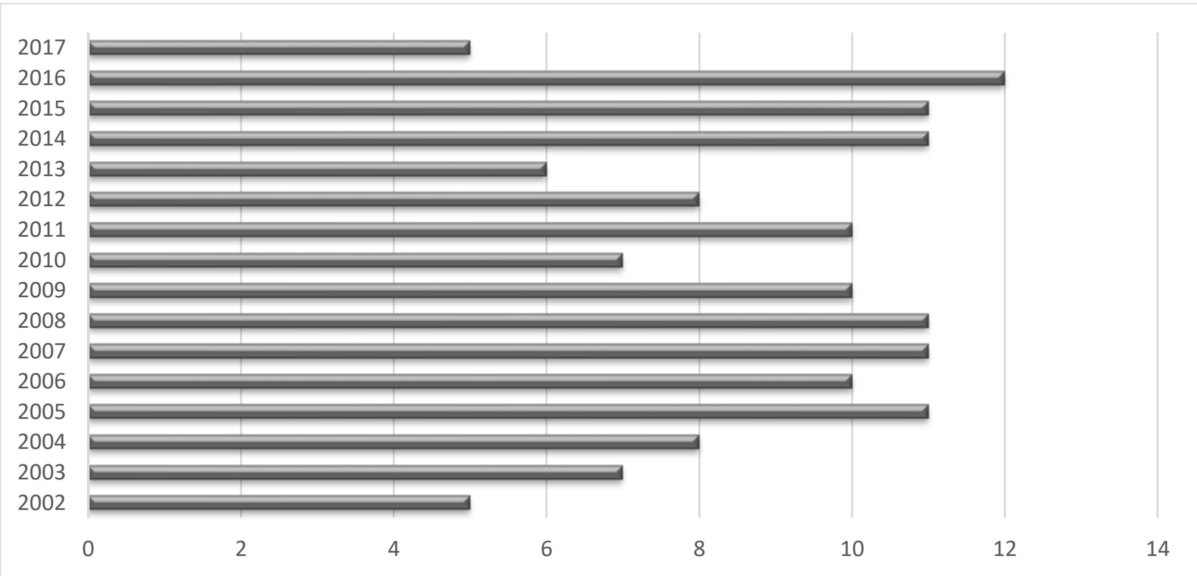



In order to ensure the rigorousness of the review and eliminate the risks of bias related to inappropriate use of methodology, subjective exclusion of articles and the selectivity of findings, this study adhered to the three following procedures (Thomé et al., 2016). First, a systematic approach of protocol development and database search was closely followed. Second, the involvement of more than one reviewer and clearly identified exclusion criteria minimised the risk of bias in the paper selection process. Lastly, to eliminate the selectivity of findings, the documents extracted from the electronic database were organised in such a way as to provide the opportunity for panel members to review and assign relevance scores independently. The aforementioned procedure made it possible to finalise the relevance of the downloaded articles and increase reliability (Tranfield et al., 2003).

### 4.4.3. Reporting stage

The final stage of the review process was to report the descriptive statistics of the literature used in the review, the findings of the analysis undertaken and develop recommendations for future research. The frequency analysis demonstrated the publication year of the studies, the research methods employed, the technological domains covered and the keywords used. The final scope of literature consisted of papers published in 2014, 2015, and 2016, whereas only 20 papers were produced before 2005 (Figure 4.3.). The highest frequency of produced papers was observed in the period from 2014 till 2017, while the lowest number of papers was published in 2002.

**FIGURE 4.3: PUBLICATION PERIOD**




The majority of authors tended to generate theoretical/conceptual papers. Other types of publications included 9 review papers, 32 papers adopting a survey method, 15 case study-design papers, 2 papers adopting an experimental approach, 10 papers based on interviews and only one ethnography study (Figure 4.4). The majority of the studies (74 out of 143 articles) contextualised their approach towards a specific technological domain. The primary domain was assistive technology applications inside the house (Figure 4.5). Among other broad research themes are the benefits and challenges of smart homes and smart technologies, whereas two articles focused on smart vehicles and the smart grid.

**FIGURE 4.4: RESEARCH METHODS ADOPTED BY THE REVIEWED ARTICLES**

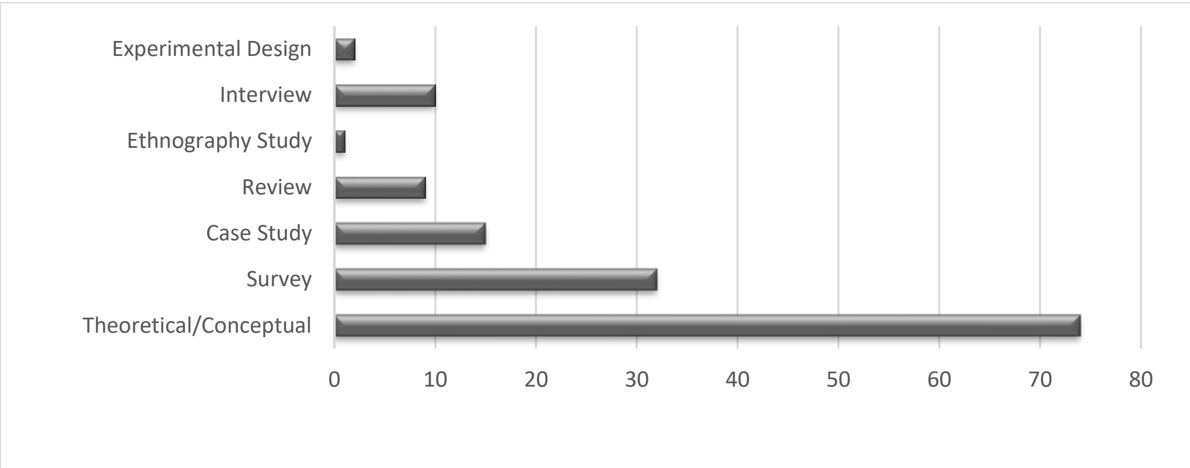
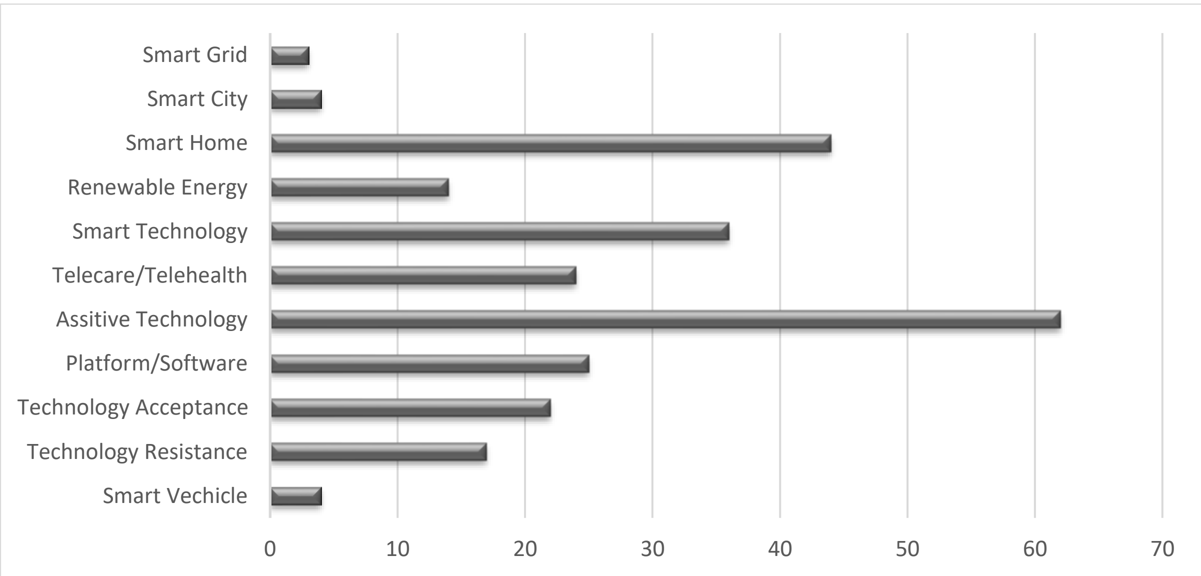
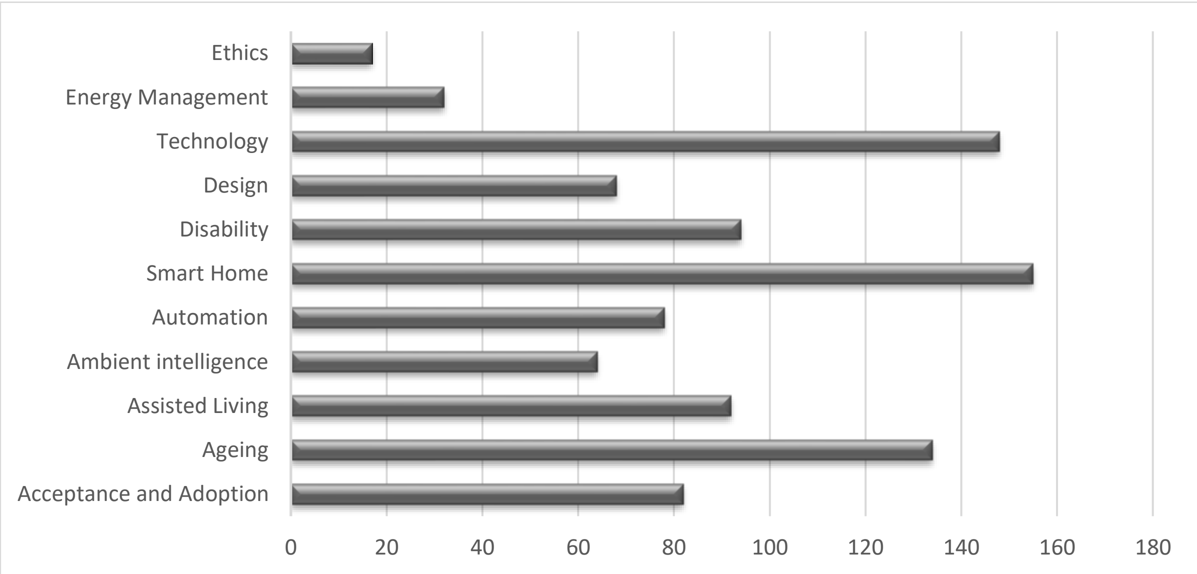



**FIGURE 4.5: PRIMARY THEMES**




To identify specific focus of the reviewed papers across broad domains, a semantic categorisation of keywords was applied. The semantic analysis enabled the identification of the nature of text and visually presenting the concepts discussed in the papers (Li et al., 2011, Goddard, 2011). Having utilised the statistical approach proposed by Baker *et al.* (Baker, 2004), the most frequently mentioned keywords were extracted from a single or a group of documents. After the extraction process, keywords with synonymous meanings were grouped and calculated, resulting in a number of frequently-mentioned key words, such as technology (148), smart home (155) and ageing (134) (Figure 4.6). Basic semantic clusters acted as a touchstone for developing themes for this review.

**FIGURE 4.6: FREQUENCY OF KEYWORDS DETECTED IN THE REVIEWED ARTICLES**




After providing descriptive statistics of the papers used for the review, the methodologies employed and the frequency of keywords, the study performed the reporting of topics that emerged in the literature by employing thematic analysis (Tranfield et al., 2003). Thematic analysis was defined by Clarke and Braun (Terry et al., 2017) "*as a method for identifying, analysing, and interpreting patterns of meaning ("themes") within data*". The results of the analysis were presented through interpreting and aggregating data, which served as a comprehensive framework for organising and reporting analytic observations. In order to avoid bias, this review adopted the six-phase process (Braun and Clarke, 2006, Ely, 1997). During the first phase, initial notes were taken and preliminary codes were developed. In the second phase, the codes were clustered into groups, which were categorised into themes and sub-themes in the next phase of the analysis. In the fourth phase, themes were finalised, enabling them to be defined in the subsequent phase. In the final phase, the study reported the narrative based on established themes derived from the literature. The review made it possible to identify research gaps, which formed the basis for the research models of this thesis.

## 4.5. Data Collection

### 4.5.1. Survey Approach

The thesis adopted the survey research strategy to collect data for examining the research models proposed in the thesis. The survey research strategy has its roots in the quantitative research design and the deductive approach to generating knowledge (De Vaus and de Vaus, 2013). The survey makes it possilbe to collect data only from primary resources (Ghauri and Grønhaug, 2010). Therefore, it is one of the main approaches to measuring individuals' feelings, cognitions and behaviour. Since independent variable cannot be manipulated, the findings of the research cannot explain the reason as to why people feel, think and behave in a particular way (Mitchell and Jolley, 2012). However, by employing a survey, the researcher can measure the variables under investigation to predict the condition of a certain psychological, physical or behavioural state. The application of inferential statistical methods makes it possible to identify the strength and direction (positive or negative) of the relationships between those variables (Saunders, 2011). The most important condition to establish before embarking on survey-based research is to develop theoretically driven hypotheses. The deduction of hypotheses should be based on a rigorous analysis of the literature, which will help reduce the focus of the study to a number of measurable variables (Mitchell and Jolley, 2012). The purpose of this research is a) to examine the relationship of beliefs, values and perceived risks that will help predict the use behaviour and satisfaction, and also b) to explore the cognitive and behavioural outcomes following poor technology performance. The control condition is not used. Therefore, the survey is the optimal approach given the focus of the research.

Structured interviews and self-administered questionnaires are the two main instruments to collect data that are used in survey-based research (Mitchell and Jolley, 2012, Blackmon and Maylor, 2005). The structured interview, also known as a standardised interview, implies that the interview is administered by the interviewer and conducted by telephone or in-person (Blackmon and Maylor, 2005). The interview is structured in such a way that all questions and response options are fixed for all the respondents. The sequence of questions read by the interviewer is supposed to be consistent across all the sample. The answers are predominantly closed-ended. The standardised questions and response options increase the reliability of the research findings by reducing the error rate and increasing accuracy (Mitchell and Jolley, 2012). However, self-administered interviews have a disadvantage, associated with social desirability bias. This refers to the respondents' tendency to give an answer that is perceived to be more desirable by society (De Leeuw, 1992). The risk of social desirability is eliminated in a self-completion questionnaire because respondents have no direct interaction with the researcher, thus the responses are more anonymous. The main channels through which questionnaires are distributed are posted and delivered through email or web URL. Online distribution is more efficient and cheaper (Blackmon and Maylor, 2005). For the selection of the research instrument, four main criteria were taken into account: 1) wider access to a sample, 2) a shorter time of completion, 3) lower financial implications, and 4) the automatisation of data entry. Internet-mediated questionnaires predefine the sample, which by default is more computer and internet-literate. In addition, it is more financially feasible, it gives access to a larger sample and requires less time for implementation (Baruch and Holtom, 2008, De Vaus and de Vaus, 2013, Oppenheim, 2000). Considering the above, the distribution of the questionnaires through email and URL was deemed appropriate for this research.

### 4.5.2. Questionnaire design

The rigorousness of procedures and measurement techniques in the questionnaire is the key to the implementation of the survey. To ensure the validity and reliability of the research findings, the questions and scales should measure what the researcher intends to measure (Mitchell and Jolley, 2012). Demographic data (Table 4.3) and the main constructs were measured using closed-ended questions. There are three advantages of employing closed-ended questions. First, in contrast to open-ended questions, the completion of such questions is easier for participants, which may potentially increase the response rate. Secondly, closed–ended scales are higher in reliability and validity. Therefore, in this research, construct measurements that have been validated in the prior literature are utilised. Thirdly, the error rate is lower, as participants are provided with a list of answers that are consistent across the entire population (Saunders, 2011).

The four common types of scales used in the research are nominal (in which each response option is assigned to a particular category), ordinal (in which response options are put in order), interval (in which responses are ranked in such a way that the distance between each response option is equal) and ratio (in which response options are ranked and at the same distance from each other, but the minimum value is equal to zero) (Hair et al. 2011, Zikmund et al, 2012). There are two types of scales employed in this thesis. Nominal scales were employed to measure the demographic profile of participants, such as age, gender, education. Interval scales were used to measure the main constructs from the theoretical model, such as beliefs, values and behaviour. Likert-type items ranging from 1 to 7 were used, where 1=strongly disagree, 2=disagree, 3=slightly disagree, 4=neither agree nor disagree, 5=slightly agree, 6=agree, 7=strongly agree. Likert-type items are a good measurement for interval data and constructs pertinent to individuals' cognitions, feelings and behaviours. It provides more extensive information than dichotomous items (Mitchell and Jolley, 2012).

The questionnaire was split into three sections. The first section contained the introduction to the survey with the definitions of the concepts being investigated, information about the anonymity of the survey and consent to participate in the survey. The second section included the demographics-related questions, while the third section consisted of questions to measure the main constructs of the model.

The questionnaires were distributed to a panel of consumers of smart home technologies located in the USA. To downplay the risk of a low response rate, which is inherent in any self-completion questionnaires (Mitchell and Jolley, 2012), the participation in the survey was incentivised. This approach is considered to be the most common in the procedure of the recruitment of respondents (Bryman, 2011). In addition, the validity of the responses in self-completion questionnaires can be jeopardised by the high risk of missing data (Mitchell and Jolley, 2012). Hence, the forced-response function was enabled, which does not allow respondents to progress to another page of the survey without answering all the questions.

**TABLE 4.3: MEASUREMENTS: DEMOGRAPHIC VARIABLES**

| Variable | Answer Options |
|---|---|
| **Gender** | Male |
| | Female |
| **Age** | under 20 |
| | 20 - 29 |
| | 30 - 39 |
| | 40 -49 |
| | 50 - 59 |
| | Over 60 |

| | |
|---|---|
| **Employment Status** | Full time employed |
| | Part time employed |
| | Out of work (but looking for) |
| | Out of work (but not looking for) |
| | Homemaker |
| | Student |
| | Retired |
| | Unable to work |
| **Ethnicity** | Non-Hispanic White or Euro-American |
| | Black, Afro-Caribbean, or African American |
| | Latino or Hispanic American |
| | East Asian or Asian American |
| | South Asian or Indian American |
| | Middle Eastern or Arab American |
| | Native American or Alaskan Native |
| | Mixed |
| | Other |
| **Education** | Some high school or less |
| | High school graduate or equivalent |
| | Vocational/technical school (two year program) |
| | Some college, but no degree |
| | College graduate (four-year program) |
| | Some graduate school, but not degree. |
| | Graduate degree (MSc, MBA, PhD, etc.) |
| | Professional degree (M.D., J.D., etc.) |
| **Area of residence** | Urbanized Area (50,000 or more people) |
| | Urban Cluster (at least 2,500 and less than 50,000 people) |
| | Rural (all other areas) |
| **Income** | \$0 - \$24,999 |
| | \$25,000 - \$49,999 |
| | \$50,000 - \$74,999 |
| | \$75,000 - \$99,999 |
| | More than \$100,000 |
| **Marital Status** | Single (never married)<br>Married |
| | Separated |
| | Widowed |
| | Divorced |

Prior to the distribution of the survey to a consumer panel, a pilot study was conducted. The importance of the pilot test is that it enables the researcher to check the feasibility of the survey and the adequacy of the research instruments using a small sample of respondents with the purpose of preventing any validity and reliability issues (Boudreau et al., 2001, Alreck and Settle, 1994, Van Teijlingen and Hundley, 2001). In line with the guidelines provided by (Peat, 2001), to ensure the internal validity of the questionnaire, 1) the survey was administered in the same way as to the subjects of the pilot study, 2) the subjects were requested to provide feedback on the wording, comprehension, clarity and applicability of the questions and response options, and 3) completion time was recorded. The link to the questionnaire was sent to fourteen people who had the experience of using smart home technologies. As a result of the pilot test, minor corrections were made in the questionnaire in terms of the wording and clarity of some questions.

### 4.5.3. Sampling

For this thesis, the sampling technique was considered rigorously, as it is an important condition for the results of the survey to be a valid representation of the phenomenon being investigated and applicable to a wider population (Mitchell and Jolley, 2012). An improper selection of the sample entails the risk of sampling bias. The sample is biased when it does not represent the population from which the sample derives. The potential implication of sampling bias is that the findings of the study will not have validity for the population the study is focused on. Before embarking on a sample selection it is important to distinguish seven types of sampling methods, which fall into two broad categories: probability and non-probability sampling methods (Berk, 1983).

Probability samples refer to methods of selecting the sample whereby each unit of the population has a chance of being recruited in the study. This group includes a simple random sample, a systematic sample, a stratified random sample and multi-stage cluster sampling. Simple random sampling is the most common form of probability sampling. It is a simple procedure for selecting the participants, whereby each unit of the population is given an equal chance of being selected. A systematic sample is a subcategory of a simple random sample, whereby the participants are selected not from the population, but its subdivision which is of interest to the researcher (i.e. sampling frame) (Uprichard, 2013). When employing a stratified random sampling technique, the researcher divides the population into strata and randomly selects a proportional number of participants from each group (Trochim and Donnelly, 2008). Multi-stage cluster sampling can be used when the population is large. The procedure implies a random selection of the clusters of population units and a subsequent random selection of units within clusters (De Vaus and de Vaus, 2013).

Non-probability sampling includes techniques for selecting samples which are not representative of the population. They refer to methods such as convenience sampling, snowball sampling, purposeful sampling and quota sampling (Bryman, 2011, Schreuder et al., 2001, Patton, 1990, Suri, 2011). Convenience sampling is the selection of the population based on the convenience or personal judgement of the researcher (Blackmon and Maylor, 2005). Purposeful sampling is used when researchers need to collect data from the sample that represents the group importance to the inquiry (Patton, 1990, Suri, 2011). When employing snowball sampling, the researcher makes contact with a few units of the population that best fit the focus of the study and uses those units and their networks for further distribution of the questionnaires. Quota sampling is similar to stratified sampling with the difference that the selection of units within quotas is not random, but based on the judgement of the researcher (Saunders, 2011).

Data for both research models were collected from non-probability purposeful samples. There were several reasons that justified the selection of this sampling technique. Any probability sampling was not possible given the focus of the study, because the units of analysis were not the general population. To examine the antecedents of smart home usage and the outcomes of the technology utilisation, the respondents needed to be former or current users of smart homes. Given that the selection of respondents for the first survey was made by a market intelligence company that had access to the sample of users of smart home devices in the US, the purposeful sample was the most appropriate technique. The utilisation of the purposeful sampling technique enabled the researchers to control for the eligibility criteria and monitor the degree to which the samples met them. The URL for the survey was distributed by the company to the general population. To make sure that only smart home users were recruited, the questionnaire included one screening question to retain only the required sample. The filtering question was on the first page of the survey, which requested an answer as to whether respondents a) used any of the smart home technologies, b) had used any smart home technology in the past or c) never used them. If individuals had former or current experience with the utilisation of the technology, they were deemed eligible to participate in the survey. The final sample of respondents for testing the first research model comprised 422 people. To recruit the respondents for the second survey, another market intelligent company was employed. They gave access to the online tool enabling the researcher to send survey links to samples meeting the pre-defined criteria. Therefore, the URL with the questionnaire was sent out through the platform to smart home users. Given the objective of the survey to measure the consequences of disconfirmed expectations with technology, those respondents had to pass the filtering question indicating whether they had had any negative experience with the utilisation of smart homes. The final sample of smart home users having a negative experience included 387 people. Tables 4.4 and 4.5 present the demographic profile of the respondents for the two models. The sample sizes were deemed adequate to run inferential analysis about the strength of the relationships between the variables in the research models (Hair et al., 2006).

**TABLE 4.4: DEMOGRAPHIC PROFILE OF RESPONDENTS – RESEARCH MODEL 1**

| Attribute | Type | Frequency (n=422) | Percentages (%) |
|---|---|---|---|
| **Gender** | Male | 195 | 46.20% |
| | Female | 227 | 53.80% |
| **Age** | 20-29 | 29 | 6.90% |
| | 30-39 | 50 | 11.80% |
| | 40-49 | 67 | 15.90% |
| | 50-59 | 96 | 22.70% |
| | 60-69 | 170 | 40.30% |
| | 70-79 | 10 | 2.40% |
| **Employment** | Full time employed | 183 | 43.40% |
| | Part time employed | 46 | 10.90% |
| | Out of Work (but looking for) | 12 | 2.80% |
| | Out of Work (but not looking for) | 3 | 0.70% |
| | Homemaker | 39 | 9.20% |
| | Student | 7 | 1.70% |
| | Retired | 111 | 26.30% |
| | Unable to Work | 21 | 5% |
| **Ethnicity** | Non-Hispanic White or Euro-American | 352 | 83.40% |
| | Black, Afro-Caribbean, or African American | 32 | 7.60% |
| | Latino or Hispanic American | 19 | 4.50% |
| | East Asian or Asian American | 8 | 1.90% |
| | South Asian or Indian American | 4 | 0.90% |
| | Native American or Alaskan Native | 2 | 0.50% |
| | Mixed | 3 | 0.70% |
| | Other | 2 | 0.50% |
| **Education** | Some high school or less | 3 | 0.70% |
| | High school graduate or equivalent | 75 | 17.80% |
| | Vocational/technical school (two-year program) | 49 | 11.60% |
| | Some college, but no degree | 100 | 23.70% |
| | College graduate (four-year program) | 113 | 26.80% |
| | Some graduate school, but not degree | 9 | 2.10% |
| | Graduate degree (MSc, MBA, PhD, etc.) | 67 | 15.90% |
| | Professional degree (M.D., J.D., etc.) | 6 | 1.40% |
| **Geographical location** | Urbanized Area (50,000 or more people) | 175 | 41.50% |
| | Urban Cluster (at least 2,500 and less than 50,000) | 128 | 30.30% |
| | Rural (all other areas) | 119 | 28.20% |
| **Household Income** | $0-$24,999 | 58 | 13.70% |
| | $25,000-$49,999 | 115 | 27.30% |
| | $50,000-$74,999 | 110 | 26.10% |

| | | | |
|---|---|---|---|
| | $75,000-$99,999 | 68 | 16.10% |
| | More than $100,000 | 71 | 16.80% |
| **Marital Status** | Single (never married) | 101 | 23.90% |
| | Married | 252 | 59.70% |
| | Separated | 2 | 0.50% |
| | Widowed | 15 | 3.60% |
| | Divorced | 52 | 12.30% |

**TABLE 4.5: DEMOGRAPHIC PROFILE OF RESPONDENTS – RESEARCH MODEL 2**

| Demographic Characteristic | Type | Frequency (n=387) | Percentage |
|---|---|---|---|
| **Age** | 18 to 24 years | 111 | 28.7 |
| | 25 to 34 years | 154 | 39.8 |
| | 35 to 44 years | 80 | 20.7 |
| | 45 to 54 years | 29 | 7.5 |
| | 55 to 64 years | 11 | 2.8 |
| | Age 65 or older | 2 | 0.5 |
| **Gender** | Male | 186 | 48.1 |
| | Female | 185 | 47.8 |
| | Other | 11 | 2.8 |
| **Education** | Completed some high school | 27 | 7 |
| | Completed some college (AS-A-Levels) | 116 | 30 |
| | Bachelor’s degree | 156 | 40.3 |
| | Master’s degree | 72 | 18.6 |
| | Ph.D. | 6 | 1.6 |
| | Other advanced degree beyond a Master’s degree | 10 | 2.6 |
| **Income** | Less than $25,000 | 89 | 23 |
| | $25,000 to $ 34,999 | 78 | 20.2 |
| | $35,000 to $ 49,999 | 70 | 18.1 |
| | $50,000 to $ 74,999 | 64 | 16.5 |
| | $75,000 to $99,999 | 48 | 12.4 |
| | $100,000 to $149,999 | 26 | 6.7 |
| | $150,000 to $199,999 | 7 | 1.8 |
| | $200,000 or more | 5 | 1.3 |
| **Marital Status** | Single | 221 | 57.1 |
| | Married | 142 | 36.7 |
| | Separated | 6 | 1.6 |
| | Widowed | 4 | 1 |
| | Divorced | 14 | 3.6 |
| **Negative Experiences** | Technical issues during installation | 100 | 25.8 |
| | Technical issues during usage | 119 | 30.7 |
| | Ease of use | 95 | 24.5 |
| | Financial costs | 16 | 4.1 |
| | Privacy and security issues | 26 | 6.7 |
| | Other factors | 31 | 8 |
| **Smart Home Technology** | Visual assistant | 289 | 77 |
| | Smart home security | 174 | 45 |
| | Smart alarms or leak sensors | 153 | 39.5 |

| | | | |
|---|---|---|---|
| | Smart lighting | 241 | 62.3 |
| | Smart plugs/switches | 216 | 55.8 |
| | Smart thermostat | 131 | 33.9 |
| | Smart home camera | 147 | 38 |
| | Smart vacuum cleaner | 113 | 29.2 |
| | Smart lock | 68 | 17.6 |
| | Smart kitchen | 92 | 23.8 |
| | Smart tag | 70 | 18.1 |
| | Smart entertainment systems | 216 | 55.8 |
| **Subjective Expertise** | Low perceived expertise | 138 | 35.7 |
| | High perceived expertise | 249 | 64.3 |
| **Length of usage** | More than 10 years | 11 | 2.8 |
| | 7 – 10 years | 27 | 7 |
| | 4 – 6 years | 141 | 36.5 |
| | 2 – 3 years | 189 | 48.8 |
| | Around 1 year | 19 | 4.9 |

### 4.5.4. Measurements

The first research model contained nine constructs measured by multiple items. Table 4.6 presents all items representing latent variables, which were adapted from prior literature to ensure content validity. Seven-point Likert scales were utilised to measure the items (strongly agree to strongly disagree). The aforementioned approach offered an effective way to measure the accuracy and precision of the latent variables (Churchill, 2002). To analyse the data for this research, the strategy proposed by Hair Jr and Lukas (2014) and Gaskin (2016) was followed.

**TABLE 4.6: MEASUREMENT ITEMS FOR RESEARCH MODEL 1**

| Measurement Item | Loading | C.R. | AVE | Cronbach's α |
|---|---|---|---|---|
| **Privacy Risk** (Featherman and Pavlou, 2003)<br><br>**Please read below and select the options that apply to the statements:** | | 0.925 | 0.863 | 0.923 |
| What are the chances that using smart home technology will cause you to lose control over the privacy of your payment information. | .881 | | | |
| My signing up for and using a smart home technology would lead to a loss of privacy for me because my personal information would be used without my knowledge. | .973 | | | |
| **Financial Risk** (Featherman and Pavlou, 2003)<br><br>**Please read below and select the options that apply to the statements:** | | 0.869 | 0.769 | 0.866 |

| | | | | |
|---|---|---|---|---|
| What are the chances that you stand to lose money if you use the smart home technology? | .820 | | | |
| Using a smart home technology services subjects your checking account to financial risk. | .931 | | | |
| **Hedonic Beliefs** (Babin, Darden, and Griffin 1994)<br><br>**Please read below and select the options that apply to the statements:** | | 0.976 | 0.855 | 0.976 |
| The use of smart product was a joy. | .898 | | | |
| Using smart home technology truly felt like an escape | .890 | | | |
| Compared to other things I could have done, the time spent using the smart product was truly enjoyable. | .938 | | | |
| I enjoyed being immersed in exciting new products. | .944 | | | |
| I enjoyed the use of smart product for its own sake, not just for the items I may have purchased. | .918 | | | |
| I had a good time because I was able to act on the "spur-of-the-moment" | .941 | | | |
| During the use of smart product, I felt the excitement. | .942 | | | |
| **Utilitarian Beliefs** (Babin, Darden, and Griffin 1994)<br><br>**Please read below and select the options that apply to the statements:** | | 0.950 | 0.863 | 0.949 |
| I accomplished just what I wanted to during the use of the smart product. | .948 | | | |
| I could not use the smart home services in regard to what I really needed. | .951 | | | |
| While using the smart product, I found just the service(s) I was looking for. | .886 | | | |
| **Task Technology Fit** (Lin and Huang 2008)<br><br>**Please read below and select the options that apply to the statements considering your house tasks:** | | 0.972 | 0.919 | 0.923 |
| Smart technologies fit my requirements in a daily life. | .969 | | | |
| Using smart technologies fits with my daily routine tasks. | .969 | | | |
| Smart technologies are suitable to complete my daily routine tasks. | .930 | | | |
| **Perceived Usefulness** (Venkatesh et al. 2003a, Venkatesh and Morris 2000)<br><br>**Please read below and select the options that apply to the statements:** | | 0.966 | 0.876 | 0.965 |
| I would find smart technologies useful in my daily life. | .904 | | | |
| Using smart technologies enables me to accomplish tasks more quickly. | .948 | | | |
| Using smart technologies increases my productivity in the house. | .958 | | | |
| If I use smart technologies, I increase my chances of achieving things that are important to me. | .931 | | | |
| **Perceived Ease of Use** (Venkatesh et al. 2003a, Venkatesh and Morris 2000) | | 0.963 | 0.867 | 0.962 |

| | | | | |
|---|---|---|---|---|
| **Please read below and select the options that apply to the statements:** | | | | |
| My interaction with smart technologies is clear and understandable. | .887 | | | |
| It is easy for me to become skilful at using smart technologies. | .933 | | | |
| I find smart technologies easy to use. | .951 | | | |
| Learning to operate smart technologies is easy for me. | .952 | | | |
| **Use Behaviour** (Ajzen and Fishbein 1980, Taylor and Todd 1995a, Taylor and Todd 1995b, Riemenschneider and McKinney 2002, Huang and Chuang 2007)<br><br>**Please read below and select the options that apply to the statements:** | | 0.885 | 0.794 | 0.881 |
| I believe I could communicate to others the consequence of using smart technologies. | .824 | | | |
| The results of using smart technologies are apparent to me. | .958 | | | |
| **Satisfaction** (Spreng and Mackoy 1996) | | 0.950 | 0.863 | 0.949 |
| How satisfied are you with your overall experience with smart technology? | .909 | | | |
| How much pleasure do you get from your overall experience with smart technology? | .957 | | | |
| Given your overall experience with smart technologies, do you feel terrible or delighted by them? | .921 | | | |
| **Continuance Intention to Use** (Bhattacherhee (2001))<br><br>**Please read below and select the options that apply to the statements:** | | 0.940 | 0.886 | 0.940 |
| I intend to continue using smart technology rather than discontinue its use. | .947 | | | |
| My intentions are to continue using smart technologies than use any alternatives. | .935 | | | |

The questionnaire to measure the second research model consisted of ten multi-items scales validated by prior studies (Table 4.7). Respondents were asked to answer questions by referring to their own specific incident when smart home technology did not perform as expected, that was captured at the beginning of the questionnaire. Items were measured by a 7-point Likert scale ranging between “1 - strongly disagree” to “7 – strongly agree”.

**TABLE 4.7: MEASUREMENT ITEMS FOR RESEARCH MODEL 2**

| Measurement Item | Loading | C.R. | AVE | α |
|---|---|---|---|---|
| **Disconfirmation** (Bhattacherjee and Premkumar, 2004) **When compared to my initial expectations, smart home technologies involved in that incident...** | | 0.915 | 0.731 | 0.927 |
| increased my productivity when undertaking household tasks | 0.927 | | | |
| enhanced my effectiveness to undertake household tasks | 0.938 | | | |
| were useful in my daily routine at home when undertaking household tasks | 0.847 | | | |
| Cognitive Dissonance**: Wisdom of Purchase** Sweeney et al. (2000) **Considering the instance where smart home technologies did not work as expected...** | | 0.911 | 0.720 | 0.906 |
| I wondered if I really needed those technologies | 0.719 | | | |
| I wondered whether I should have bought something else | 0.876 | | | |
| I wondered if I had made the right choice | 0.902 | | | |
| I wondered if I had done the right thing in buying those technologies | 0.877 | | | |
| **Anger** Harmon-Jones et al. (2004) **After using smart home technologies in that incident, I felt...** | | 0.896 | 0.684 | 0.893 |
| Angry | 0.793 | | | |
| Agitated | 0.778 | | | |
| Irritated | 0.889 | | | |
| Frustrated | 0.843 | | | |
| **Guilt** Coulter and Pinto (1995) **After using smart home technologies in that incident, I felt...** | | 0.905 | 0.657 | 0.901 |
| Accountable | 0.763 | | | |
| Guilty | 0.878 | | | |
| Ashamed | 0.864 | | | |
| Bad | 0.740 | | | |
| Irresponsible | 0.797 | | | |
| **Regret** Tsiros and Mittal (2000) **After using smart home technologies in that incident, I felt...** | | 0.931 | 0.819 | 0.928 |
| I feel sorry for purchasing smart home technologies | 0.895 | | | |
| I regret purchasing smart home technologies | 0.970 | | | |
| I should have purchased traditional technologies for home instead of smart home technologies | 0.843 | | | |
| **Attitude Change** Tussyadiah et al. (2018) **After using smart home technologies in that incident...** | | 0.911 | 0.774 | 0.903 |
| My liking toward them has been... | 0.900 | | | |
| My preference toward them has been... | 0.934 | | | |
| My interest in them has been... | 0.822 | | | |

| | | | | |
|---|---|---|---|---|
| Consonant Information Search Keng and Liao (2009) **After using smart home technologies in that incident...** | | 0.823 | 0.608 | 0.823 |
| I searched for information supporting my original positive beliefs about those smart home technologies on the Internet, on TV, radio, in newspapers, magazines, or reports | 0.806 | | | |
| I searched for information supporting my original positive beliefs about those smart home technologies through retail stores | 0.791 | | | |
| I asked people I know for positive comments about those smart home technologies | 0.738 | | | |
| **Behaviour Change** Cho (2015), Chen et al. (2019) and Maier et al. (2015) **After using smart home technologies in that incident...** | | 0.878 | 0.707 | 0.872 |
| I temporarily stopped using them at home | 0.850 | | | |
| I used one or more alternatives to smart home technologies | 0.791 | | | |
| I used other technologies, instead of smart home technologies | 0.738 | | | |
| **Satisfaction** McKinney et al. (2002) **Overall after using smart home technologies, I felt...** | | 0.955 | 0.781 | 0.953 |
| Satisfied | 0.950 | | | |
| Pleased | 0.956 | | | |
| Contented | 0.912 | | | |
| Delighted | 0.849 | | | |
| Will definitely recommend it to my friends | 0.837 | | | |
| Will definitely continue using it | 0.772 | | | |
| **Well-being** El Hedhli et al. (2013) **Overall, smart home technologies...** | | 0.898 | 0.687 | 0.898 |
| Have satisfied my overall household needs | 0.819 | | | |
| Have played a very important role in my social well-being | 0.778 | | | |
| Have played a very important role in my leisure well-being | 0.846 | | | |
| Have played an important role in enhancing the quality of life in my household | 0.861 | | | |

## 4.6. Data Analysis

### 4.6.1. Structural Equation Modelling

There are a few analysis techniques that can be used in research to examine the relationship between variables, such as simple regression, multiple regression, logistics regressions, and correlation techniques to name a few. They are powerful tools in analysing data and providing an answer to a variety of questions while creating both theoretical and practical contributions

(Hair et al., 2014). However, they do not assess the path between multiple dependent and independent variables. In contrast, structural equation modelling (SEM; a.k.a. latent variable analysis and covariance structure analysis) makes it possible to test the theory by examining multiple relationships simultaneously in one research model. SEM is mainly based on multiple regression analysis and factor analysis and "estimates a series of separate, but interdependent, multiple regression equations simultaneously by specifying the structural model used by the statistical software package" (p. 547). The structural model is defined as a "set of one or more dependence relationships linking the hypothesised model's constructs" (p. 546). In addition, SEM makes it possible to include latent variables in the theoretical model. A latent variable (a.k.a. latent construct, latent factor) is an unobserved variable that cannot be measured directly but can be accessed through one or more observable variables. There are two main ways to assess the structural model: the Covariance Based-SEM and Partial Least Squares structural equation modelling (PLS-SEM). PLS-SEM is considered to be a more appropriate approach when the theoretical model is less developed, and the objective of the study is to develop theory rather than to test/extend already established theories. Also, PLS-SEM is useful when the sample size is relatively small (Rigdon, 2012, Hair Jr et al., 2016). Given that the objective of the study was to test and extend the already established theories, and the sizes of the two samples were relatively large, it was appropriate to employ CB-SEM (Rigdon, 2012, Hair Jr et al., 2016).

There are a number of software packages that enable researchers to run CB-SEM analysis (e.g. AMOS and LISREL). These software tools share three characteristics: a) they estimate multiple and interrelated relationships, b) they represent unobserved concepts and account for measurement error in the estimation process, and c) they define a model that makes it possible to explain the set of proposed relationships in the model (Hair et al., 2014). For the analysis, this thesis will employ SPSS AMOS v 24.

SEM analysis was conducted in several stages, which refer to defining individual constructs, developing the overall measurement model, designing the study to produce empirical results, assessing the measurement model's validity, drawing the structural model and assessing the structural model fit. The first stage started with the analyses of the literature to identify the scales required to test the model. In order to ensure the validity and reliability of the measures, the definitions and measurement items were taken from well-established studies. When necessary, the questions were adapted to the context to satisfy the objectives of this thesis. Extra measures were taken to ensure the reliability and validity of the used scales. For instance, before each survey, comprehensive pilot testing had taken place. After selecting the scales, the measurement models were developed by drawing intra-construct (the relationships between construct observed variables and latent constructs) and inter-construct (between latent variables) relationships, as well as identifying measurement errors (Hair et al., 2014). The third step was about the selection of the type of analysis in SEM, dealing with missing data and identifying an appropriate sample size. Following the suggestions by Hair et al. (2014), the SEM analysis was chosen to be based on covariance matrices (automatically chosen by the software). In contrast to correlation matrices in SEM, covariance matrices are more accurate in terms of standard error computations (Cudeck, 1989). Developing a protocol for how to deal with missing data is described in Table 4.8. Given that the missing data comprised less than 10% across the two surveys, all the procedures described in the table were a viable option (Enders and Bandalos, 2001). However, following the guidelines by Hair et al. (2014), "all available (pairwise)" procedure was selected, as the sample exceeded 250 respondents in both surveys. Although there are a number of approaches to identifying the appropriate sample size (MacCallum et al., 1999, MacCallum et al., 2001, MacCallum, 2003), there is no definite answer as to which sample enables researchers to produce trustworthy results. In line with the suggestion of Hair et al. (2014), the samples for both surveys included more than 380 respondents.

**TABLE 4.8: ADVANTAGES AND DISADVANTAGES OF DIFFERENT MISSING DATA PROCEDURES**

| Method | Advantages | Disadvantages |
|---|---|---|
| **Complete case (listwise)** | $X^2$ shows little bias under most conditions. | Increase the likelihood of nonconvergence (SEM program cannot find a solution) unless factor loadings are high (>0.6) and sample sizes are large (>250). |
| | Effective sample size is known. | Increased likelihood of factor loading bias. |
| | Easy to implement using any program. | Increased likelihood of bias in estimates of relationship among factors. |
| **All-available (pairwise)** | Fewer problems with convergence. | $X^2$ is biased upward when amount of missing data exceeds 10%, factor loadings are high, and sample size is high. |
| | Factor loading estimates relatively free of bias. | Effective sample size is uncertain. |
| | Easy to implement using any program. | Not as well known. |

| | | |
|---|---|---|
| **Model-based (ML/EM)** | Fewer problems with convergence. | Not available on older SEM programs. |
| | $X^2$ shows little bias under most conditions. | Effective sample size is uncertain for EM. |
| | Least bias under conditions of random missing data. | |
| **Full information maximum likelihood (FIML)** | Remedy directly in estimation process. | Researcher has no control over how missing data is remedied. |
| | In most situations has less bias than other methods. | No knowledge of how missing data impacts on estimates. |
| | | Typically, only a subset of fit indices available. |

After finalising the development of the measurement model, the fourth stage is the assessment of the measurement model's validity. The two common techniques to test research measurements are exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). These make it possible to examine how the measured variables represent the latent constructs in the model. EFA *"explores the data and provides the researcher with information about how many factors are needed to best represent the data",* while CFA "*specifies how measured variables logically and systematically represent constructs involved in a theoretical model*" (Hair et al., 2014). CFA and EFA have fundamental differences rooted in philosophical assumptions. CFA is mostly used for theory testing, while EFA is used for theory development. For the purposes of this thesis, CFA was utilised because the purpose was to test research models that had been built based on theories.

There are two CFA procedures that are required to ensure the measurement model's validity: the evaluation of the goodness of fit and the test of the validity and reliability of the constructs. *"Goodness-of-fit indicates how well the specified model reproduces the observed covariance matrix among the indicator items (i.e., the similarity of the observed and estimated covariance matrices)"* (Hair et al., 2014).The model fit advises as to what degree the theory correspondents to the data for the measured model. This is made possible by evaluating the differences between the covariance matrix (theory) and reality (observed covariance matrix). If the theory and reality match, there should be no difference between the observed and estimated covariance matrices. The goodness of fit is communicated by model fit indices falling into three groups: absolute fit indices, incremental fit indices and parsimony fit indices. The absolute fit indices are defined as *"a direct measure of how well the model specified by the researcher reproduces the observed data"* (Kenny and McCoach, 2003). In other words, absolute fit indices show how well the proposed theory fits the collected data. The absolute fit indices are represented by the goodness of fit index (GFI), root mean square error of approximation (RMSEA), root mean square residual (RMR) and standardised root mean residual (SRMR). The next group is the incremental fit indices. They show how well the proposed model differs from the baseline model. The incremental fit indices comprise the normed fit index (NFI), Tucker Lewis index (TLI), comparative fit index (CFI) and relative noncentrality index (RNI). The last group are parsimony fit indices, which explain which model from the set fits well. Typically, simple models with fewer paths will have better parsimony fit indices. The parsimony fit indices are the adjusted goodness of fit index (AGFI) and parsimony normed fir index (PNFI) (Hair et al., 2014). There is still ongoing discussion among scholars (Hu and Bentler, 1999, Fan et al., 1999, Sharma et al., 2005, Hair et al., 2014) about the selection of the fit indices. This thesis reports the fit indices which are recommended by Hair et al. (2014) and summarised in Table 4.9.

**TABLE 4.9: MODEL FIT INDICES**

| | **No. of observations < 250** | | | **No. of observations > 250** | | |
|---|---|---|---|---|---|---|
| **No. of observed variables (m)** | **m ≤ 12** | **12 < m < 30** | **m ≥ 30** | **m ≤ 12** | **12 < m < 30** | **m ≥ 30** |
| **χ2** | Insignificant p-values expected | Significant p-values even with good fit | Significant p-values expected | Insignificant p-values even with good fit | Significant p-values expected | Significant p-values expected |
| **CFI** | .97 or better | .95 or better | Above .92 | .95 or better | Above .92 | Above .90 |
| **RMSEA** | Values < .08 with CFI = .97 or higher | Values < .08 with CFI = .95 or higher | Values < .08 with CFI above .92 | Values < .07 with CFI of .97 or higher | Values < .07 with CFI of .92 or higher | Values < .07 with CFI of .90 or higher |

The fifth and sixth stages in SEM refer to the specification of the structural model and the assessment of its fit. Specifically, the researcher needs to decide how to draw the paths between the variables, identify exogenous and endogenous constructs and evaluate how well the model represents the theory. Then, the structural model fit needs to be evaluated by comparing the structural model indices with CFA model indices (i.e. χ2, CFI, RMSEA). By comparing the indices, the researchers can see how the specification of relationships between constructs decreases the model fit. It is important to have all model fit indices equal/above the acceptable threshold (Hair et al., 2014).

### 4.6.2. Reliability and Validity Tests

The analysis of the constructs' reliability and validity is an important step prior to testing the structural paths of the research model. Construct validity is required to evaluate "*the extent to which a set of measured items actually reflects the theoretical latent construct those items are designed to measure*" (p 618) (Hair et al., 2014). Construct reliability demonstrates how well the construct produces consistent error-free results (Rogers, 1995). CFA implies a number of construct validity tests that are conducted to confirm that the measured variables actually represent the latent constructs. Construct validity analysis encompasses convergent validity, discriminant validity, face validity and nomological validity tests (Hair et al., 2014, Bagozzi, 1993). Convergent validity ensures that the items related to a specific construct share a high proportion of variance. Convergent validity is estimated by factor loadings, average variance extracted (AVE) values, composite reliability and/or Cronbach's alpha. All factor loadings should be significant and the standardised loadings should not be below 0.5, but ideally, they should be above 0.7 (Hair et al., 2014, Anderson and Gerbing, 1988). The average variance extracted *"is calculated as the mean variance extracted for the items loading on a construct and is a summary indicator of convergence"* (Fornell and Larcker, 1981). AVE makes it possible to explain the average amount of variation in observed variables by a latent factor (Farrell, 2010). The value should be equal to .5 or above to confirm that the factors converge within the latent construct (Hair et al., 2014). Construct reliability is often estimated by Cronbach's alpha or by a composite reliability test. To receive the composite reliability value, *"the squared sum of factor loadings (Li) for each construct and the sum of the error variance terms for a construct (ei)"* are computed (Hair et al., 2014). Cronbach's alpha is produced from the analyses of average covariance between item-pairs assuming that all factor loadings are the same (Cronbach, 1951). The threshold for the values of both tests is .7 or above.

Discriminant validity is an important measure to assess the internal consistency in latent variables (Fornell and Larcker, 1981, Farrell, 2010, Bollen, 1989, Howell et al., 2007), which shows how unique and distinct one construct is from others (Hair et al., 2014). Without establishing discriminant validity, one cannot confirm whether the results supporting the proposed hypothesis are truly representative of reality (Farrell, 2010). The most common approach to testing discriminant validity is to fix the correlation coefficient of two constructs as equal to one. In case there is a significant discrepancy between the fit of the two-construct model and one-construct model, it is safe to assume that the items discriminate (Anderson and Gerbing, 1988, Bagozzi and Phillips, 1982). Discriminant validity can be confirmed when average variance-extracted estimates are greater than the square of the correlation estimates between two variables (Fornell and Larcker, 1981).

Prior to testing the theoretical model, it is also important to have support for face validity. Face validity can only be reached when the meaning of each used item is clear and understandable (Nevo, 1985, Hardesty and Bearden, 2004). Face validity for this thesis was ensured by taking measurement items from prior studies that had previously been validated. In addition, the meaning of each item was thoroughly checked. Correlations among the constructs in the theoretical models are used to establish nomological validity (Hair et al., 2014). Nomological validity was assured by checking the matrix of construct correlations.

## 4.7. Research Ethics

The data collection for this thesis was conducted in line with research ethics procedures, whose importance has been raised in a large body of literature (Payne, 2000, Diener and Crandall, 1978, Haggerty, 2004, Fisher and Anushko, 2008). A number of regulatory codes for practice in various research domains have been introduced and continuously updated (Israel and Hay, 2006, Wallace and Sheldon, 2015, Nosek et al., 2002, Wiles et al., 2006, Pye and Warren, 2006). Ethics implies that researchers should always attempt to find avenues to satisfy the need for the "pursuit of truth" without violating the regulatory codes of research practice. Put differently, researchers should discover new knowledge without violating ethical principles of conducting research. However, it is not always easy to strike a balance. The assessment of the degree to which research is being conducted in line with the regulatory codes of practice is regarded as the assessment of the "cost-benefit ratio". This is a critical evaluation of the potential benefits that the study may bring against the personal costs borne by the respondents. The benefits may be of a social and personal nature. At an individual level, participation in the research may cause a positive emotional state of respondents, such as a feeling of pride and satisfaction. At the societal scale, social science research findings can contribute to theoretical knowledge and practice for the benefit of society. Respondents' costs may include moral threat, such as a feeling of embarrassment and harm self-esteem (Cohen and Morrison, 2004). The first fundamental step to comply with the code of research ethics is to obtain informed consent from the respondents. Although in some organisations and countries, it is not always strictly required to obtain the consent from the participants of the research, it is an important step to perform (Ogloff and Otto, 1991). The consent is especially required in research where respondents might be exposed to any privacy invasion, physical and emotional pain, stress or loss of the control over the situation (e.g. drug-related studies). In addition, individuals have a right to refuse to participate in any study and withdraw at any point in the research. The right to know the purpose, procedures and potential impact, as well as have the freedom to choose whether to participate in the research, is rooted in the constitutional right to freedom. If there is a necessity to limit or restrict the individual's freedom, it should be fully explained and justified, even in research studies. The consent obtained from respondents is a manifestation of the protection of respondents' rights and respect for their choice (Cohen and Morrison, 2004).

Given the importance of ethical considerations, this thesis followed and complied with the research ethics protocol developed by Newcastle University Business School. The ethics forms were completed and assessed prior to the data collection. The forms contained a number of questions regarding the nature of this thesis, objectives, the kind of questions that will be asked from respondents and some demographic details of the samples to evaluate potential ethical implications. Ethical implications may be specific to the chosen research problem and the objectives of the study. Ethical concerns may be related to the method of data collection, analysis and communication with respondents. An analysis of the "cost-benefit" ratio was undertaken for both surveys conducted for this thesis. Given the context and the type of questions, both data collection procedures were assessed to be low-risk. To minimise the associated costs of participating in the surveys (e.g. time spent on filling in the questionnaires), respondents were given monetary incentives after completing the surveys. Also, although the questionnaires did not raise ethical concerns, still some questions could be sensitive for some respondents (e.g gender, age, marital status, employment status and household income). To eliminate psychological discomfort, the surveys were anonymous and any published material, including but not limited to this thesis, guaranteed the respondents' anonymity.

# 5. Results and Findings

The chapter provides the results of the analysis of the two research models. Section 5.1 provides the results of the reliability and validity test, and the path analysis of the model examining the acceptance of pervasive technology in private spaces. Section 5.2. reports the results of the reliability/validity analysis and structural equation modelling of the model focusing on technology adoption following disconfirmed expectations

## 5.1. The Acceptance of Pervasive Technology in Private Spaces

### 5.1.1. Reliability and Validity Tests

The CFA analysis of the first model showed a satisfactory model fit: $\chi^{2(288)}$ =605.198 CMIN/DF= 2.101, CFI = .980, RMSEA = .0.51. The results of the reliability test for each examined variable, including the factor loading (>0.8), construct reliability (C.R. >0.8), average variance expected (AVE > 0.7) and Cronbach's α (>0.8), were satisfactory (Hair *et al.* 2014). A convergent validity test demonstrated no validity concerns (Table 5.1).

**TABLE 5.1: CONVERGENT VALIDITY - RESEARCH MODEL 1**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| **Use Behaviour** | 0.891 | | | | | | | | |
| **Privacy Risk** | -0.095 | 0.928 | | | | | | | |
| **Financial Risk** | -0.086 | 0.821 | 0.877 | | | | | | |
| **Hedonic Value** | 0.764 | -0.208 | -0.173 | 0.942 | | | | | |
| **Utilitarian Value** | 0.792 | -0.179 | -0.162 | 0.903 | 0.929 | | | | |
| **Task Technology Fit** | 0.770 | -0.244 | -0.224 | 0.852 | 0.874 | 0.959 | | | |
| **Ease of Use** | 0.787 | -0.147 | -0.171 | 0.797 | 0.787 | 0.745 | 0.932 | | |
| **Perceived Usefulness** | 0.736 | -0.213 | -0.178 | 0.864 | 0.845 | 0.869 | 0.815 | 0.936 | |
| **Satisfaction** | 0.724 | -0.264 | -0.241 | 0.79 | 0.808 | 0.834 | 0.714 | 0.747 | 0.930 |

Note: Figure in the diagonal represents the square root of the average variance extracted (AVE); those below the diagonal represent the correlations between the constructs.

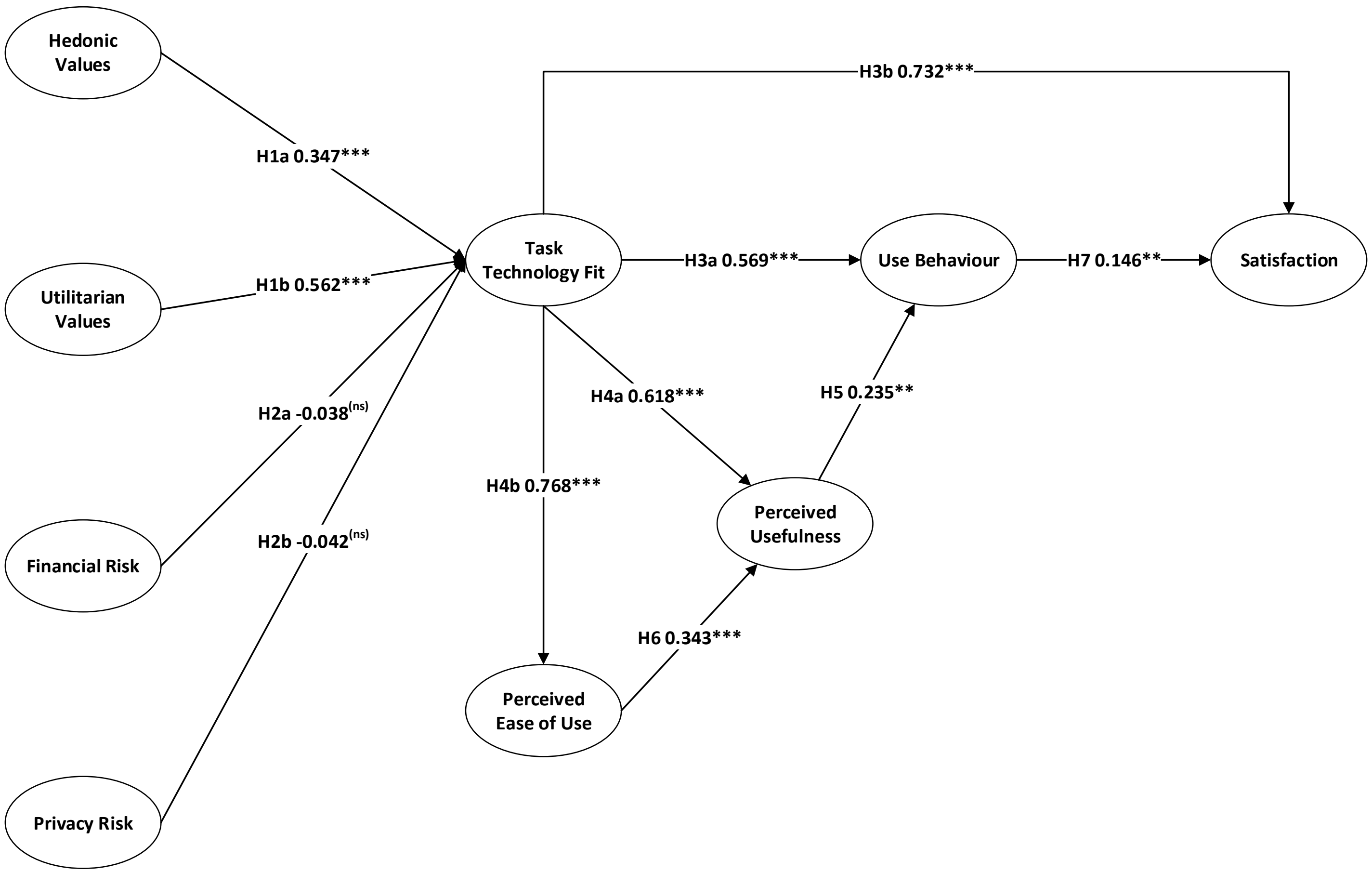
### 5.1.2. Path analysis

The proposed model examined the behaviour of smart home technology users and subsequent outcomes of use. The results showed that the tested model satisfied all model fit criteria and explained sufficient variance, represented by the coefficients of the $R^2$ ($\chi^{2\ (307)}$ = 850.025 CMIN/DF = 2.769, CFI = 0.966, RMSEA = 0.065). All the hypotheses, apart from 2a and 2b, were supported (Table 5.2, Figure 5.1). Specifically, all the perceived task-technology fit effects were statistically verified and supported (H3a,b,c and H4a,b). Perceived task-technology fit demonstrated a significant positive effect on smart home use behaviour (H3a), satisfaction (H3b), perceived usefulness (H4a) and perceived ease of use (H4b). Two out of four hypothesised antecedents of task-technology fit were not significant, whereas all outcomes had positive and statistically significant effects. Particularly, the effect of privacy risk (H2a) and financial risk (H2b) on task-technology fit were not statistically significant. The influences of both hedonic (H1a) and utilitarian values (H1b) on task-technology fit were positive and statistically significant. The utilitarian value had a stronger effect on task-technology fit than hedonic ones. Task-technology fit had a strong and statistically significant effect on both perceived usefulness (H4a) and perceived ease of use (H4b). Perceived ease of use (H6) had a strong and significant effect on perceived usefulness, but perceived usefulness (H5) had a weaker effect on use behaviour. Finally, use behaviour had a statistically significant effect on use satisfaction (H7).

**TABLE 5.2: THE RESULTS OF TESTING RESEARCH MODEL 1**

| Hypotheses | $R^2$ | Standardised Path Coefficient | t-values |
|---|---|---|---|
| **H1a: Hedonic value -> Task technology fit** | 0.821 | 0.347 | 5.402$^{(***)}$ |
| **H1b: Utilitarian value -> Task technology fit** | | 0.562 | 8.525$^{(***)}$ |
| **H2a: Privacy risk -> Task technology fit** | | -0.038 | -0.794$^{(ns)}$ |
| **H2b: Financial risk -> Task technology fit** | | -0.042 | -0.866$^{(ns)}$ |
| **H3a: Task technology fit -> Use behaviour** | 0.615 | 0.569 | 7.134$^{(***)}$ |
| **H3b: Task technology fit -> Satisfaction** | 0.723 | 0.732 | 13.752$^{(***)}$ |
| **H4a: Task technology fit -> Perceived usefulness** | 0.824 | 0.618 | 15.267$^{(***)}$ |
| **H4b: Task technology fit -> Perceived ease of use** | 0.590 | 0.768 | 20.397$^{(***)}$ |
| **H5: Perceived usefulness -> Use behaviour** | | 0.235 | 2.968 $^{(**)}$ |
| **H6: Perceived ease of use -> Perceived usefulness** | | 0.343 | 8.759$^{(***)}$ |
| **H7: Use behaviour -> Satisfaction** | | 0.146 | 2.827 $^{(**)}$ |

**FIGURE 5.1: SEM RESULTS - RESEARCH MODEL 1**




(*) p-value < 0.05,
(**) p-value < 0.01
(***) p-value < 0.001

## 5.2. Technology Adoption Following Disconfirmed Expectations

### 5.2.1. Reliability and Validity Tests

As a result of the confirmatory factor analysis of the second research model, model fit indices were satisfactory, as suggested by Hair (2014): $\chi^{2(657)}$ = 1666.193, CMIN/DF = 2.536, CFI = 0.923, RMSEA = 0.063. Factor loading (>0.7), Cronbach's α (>0.7), average variance extracted (AVE>0.5) and construct reliability (C.R.>0.7) were above the acceptable thresholds (Hair, 2014) (Table 5.3).

**TABLE 5.3: CONVERGENT VALIDITY - RESEARCH MODEL 2**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Satisfaction** | 0.884 | | | | | | | | | |
| **Wellbeing** | 0.811 | 0.829 | | | | | | | | |
| **Cognitive Dissonance** | -0.332 | -0.281 | 0.848 | | | | | | | |
| **Anger** | -0.282 | -0.128 | 0.439 | 0.827 | | | | | | |
| **Guilt** | -0.129 | -0.016 | 0.271 | 0.368 | 0.811 | | | | | |
| **Regret** | -0.492 | -0.421 | 0.617 | 0.489 | 0.527 | 0.905 | | | | |
| **Attitude Change** | 0.646 | 0.626 | -0.368 | -0.327 | -0.016 | -0.430 | 0.880 | | | |
| **Consonant Info Seeking** | 0.110 | 0.229 | 0.202 | 0.156 | 0.313 | 0.185 | 0.247 | 0.780 | | |
| **Behaviour Change** | -0.514 | -0.438 | 0.445 | 0.403 | 0.420 | 0.656 | -0.413 | 0.292 | 0.841 | |
| **Disconfirma tion** | -0.463 | -0.499 | 0.176 | 0.189 | -0.010 | 0.274 | -0.481 | -0.247 | 0.308 | 0.855 |

Notes: Diagonal figures represent the square root of the average variance extracted (AVE) and the figures below represent the between-constructs correlations

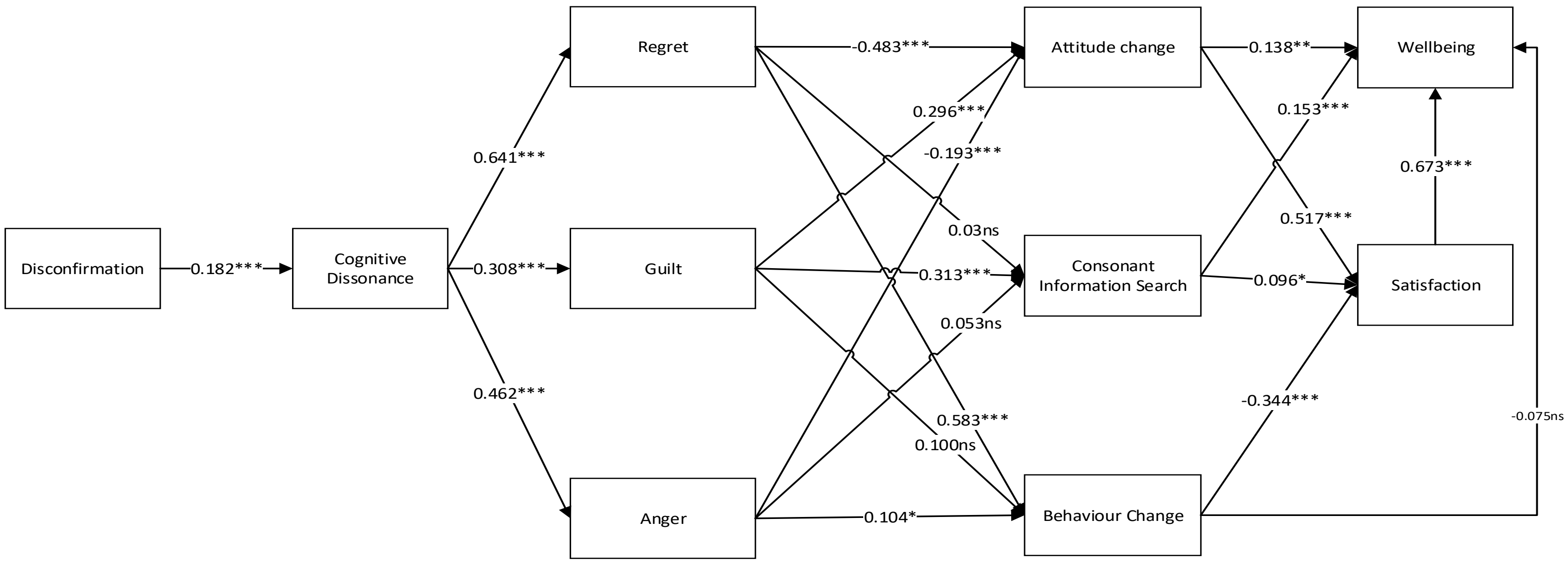
### 5.2.2. Path Analysis

The model fit indices were satisfactory ($\chi^{2(645)}$ = 1874.935, CMIN/DF = 2.907, CFI = 0.904, RMSEA = 0.07), which enabled to proceed with path analysis (Table 5.4 and Figure 5.2). Out of twenty paths, four were non-significant. As hypothesised, the relationships between disconfirmation, cognitive dissonance and the three emotions were positive (H1 – H2c). When it came to the relationships between emotions and dissonance reduction strategies, there was a negative effect of anger on attitude change (H3a), a nonsignificant effect of anger on consonant information seeking (H3b) and a positive effect of anger on behaviour change (H3c). The effect of guilt on attitude change and consonant information seeking (H4a and H4b) was supported, but the relationship between guilt and behaviour change was not significant (H4c). The hypothesised relationships between regret and dissonance reduction strategies were confirmed (H5a and H5c), but the effect of regret on consonant information seeking was not supported (H5b). All relationships between dissonance reduction mechanisms and outcomes (i.e. satisfaction and wellbeing) were significant (H6a, H6b, H7a, H7b, H8b), except the effect of behaviour change on wellbeing (H8a). The hypothesis H9 was supported too, confirming a positive correlation between satisfaction and wellbeing.

**TABLE 5.4: THE RESULTS OF TESTING - RESEARCH MODEL 2**

| Hypotheses | Coef. | t-test, sig | R2 |
|---|---|---|---|
| **H1: Disconfirmation -> Cognitive Dissonance** | 0.182 | (3.308***) | CD = 0.03 |
| **H2a: Cognitive Dissonance -> Anger** | 0.462 | (7.735***) | Anger = 0.21 |
| **H2b: Cognitive Dissonance -> Guilt** | 0.308 | (5.363***) | Guilt = 0.09 |
| **H2c: Cognitive Dissonance -> Regret** | 0.641 | (11.604***) | Regret = 0.41 |
| **H3a: Anger -> Attitude Change** | -0.193 | (-3.527***) | Attitude Ch = 0.34 |
| **H3b: Anger -> Consonant Info. Seek** | 0.053 | (0.804ns) | Cons Info. Seek = 0.11 |
| **H3c: Anger -> Behaviour Change** | 0.104 | (2.007*) | Behaviour Ch = 0.42 |
| **H4a: Guilt -> Attitude Change** | 0.296 | (5.242***) | Satisfaction = 0.50 |
| **H4b: Guilt -> Consonant Info. Seek** | 0.313 | (4.565***) | Wellbeing = 0.69 |
| **H4c: Guilt -> Behaviour Change** | 0.100 | (1.884ns) | |
| **H5a: Regret -> Attitude Change** | -0.483 | (-8.118***) | |
| **H5b: Regret -> Consonant Info. Seek** | 0.003 | (0.039ns) | |
| **H5c: Regret -> Behaviour Change** | 0.583 | (9.914***) | |
| **H6a: Attitude Change -> Wellbeing** | 0.138 | (2.672**) | |
| **H6b: Attitude Change -> Satisfaction** | 0.517 | (10.15***) | |
| **H7a: Consonant Info. Seek -> Wellbeing** | 0.153 | (3.549***) | |
| **H7b: Consonant Info. Seek ->Satisfaction** | 0.096 | (2.039*) | |
| **H8a: Behaviour Change -> Wellbeing** | -0.075 | (-1.633ns) | |
| **H8b: Behaviour Change -> Satisfaction** | -0.344 | (-7.078***) | |
| **H9: Satisfaction -> Wellbeing** | 0.673 | (11.163***) | |

**FIGURE 5.2: SEM RESULTS - RESEARCH MODEL**




(*) p-value < 0.05,
(**) p-value < 0.01
(***) p-value < 0.001

# 6. Discussion

The current chapter provides a discussion of the findings of the thesis. Section 6.1. discusses the findings of the research model on the acceptance of technology, while Section 6.2. discusses the findings of the research model about the cognitive and behavioural consequences of disconfirmed expectations.

## 6.1. The Acceptance of Pervasive Technology in Private Spaces

### 6.1.1. Beliefs About Behavioural Benefits and Costs

The thesis examined the effect of hedonic and utilitarian values as antecedents of task-technology fit, with perceived risks (privacy risk and financial risk) as inhibiting factors. The path analysis of the first hypothesis suggests that values have a moderate and significant effect on task-technology fit. In particular, it suggests that prior beliefs about perceived outcomes have a direct effect on the perceived degree of fit between the task and technology and an indirect effect on use behaviour. However, 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 the reduction of cost on energy, operational convenience and the reduction of waste (Baudier *et al.*, 2018). For example, by measuring energy consumption, smart meters provide information about power utilities, which enables customers to schedule electricity usage and optimise the utilisation of energy (Zhou et al., 2016). The embedded smart sensors in water tanks can help control water heating and save energy (Saad al-sumaiti et al., 2014). The control and management over resources brings greater comfort to house residents (Elma and Selamogullari, 2015), which, in turn, is the main motivator for smart home adoption (Baudier *et al.*, 2018). Although the IS literature provides extensive evidence about the role of hedonic motivation in systems' acceptance, (Van der Heijden, 2004, Babin *et al.*, 1994, Turel *et al.*, 2010), only few studies in the domain of smart homes have confirmed the positive role of hedonic value in the intention to use smart homes (Park et al., 2017, Aldossari and Sidorova, 2018). Another explanation of the difference in the effect sizes of hedonic and utilitarian values is suggested by the demographic profile of the sample. Evidence exists that young people are more motivated by hedonic outcomes (Kim and Hwang, 2012). Therefore, the preferences of individuals could be skewed towards the utilitarian outcomes, because the majority of respondents represented the elder cluster between 50 and 69 years old (63%), while young respondents between 20 and 29-year-old comprised only 6.9% of the sample. This finding adds to the current literature by presenting the indirect effect of hedonic and utilitarian values on use behaviour through the task-technology fit. Previous research on the task-technology fit domain did not examine hedonic and utilitarian values as antecedents of task-technology fit (Wu and Chen, 2017, Zhou *et al.*, 2010) or focused only on their direct effect on use behaviour (Van der Heijden, 2004, Babin *et al.*, 1994, Turel *et al.*, 2010). This finding gives insight into a more complex relationship between variables, indicating the perceived utility of the technology. The interpretation of the findings can be from the perspective of cognitive theories. The findings suggest that the cognitive consistency between the initial perception of values and performance is the key to determining the success of the technology utilisation in household settings. Therefore, the perceived fit between technology and tasks could be insignificant if utilitarian and hedonic values are not perceived positively.

The second hypothesis about the effect of perceived risks (financial and privacy) was not supported. This means that smart home users do not feel uncertain that the investment in the technology will be returned and the technology represents a good fit to the household tasks in hand. Similarly, the smart home technology users are not concerned with the potential privacy issues, either, but seem to believe that the personal data will not be misused. Although the results are not consistent with prior research (Balta-Ozkan et al., 2013b, Balta-Ozkan et al., 2014), the results can be explained and have some implications. There are two possible interpretations of the inconsistent findings. First, the technology that house inhabitants used could have been designed to overcome financial losses. Against the backdrop of the significant effect of utilitarian and hedonic values, the findings indicate that the pervasive technology in household settings is associated with the certainty in the technology utility, thus negating the perception of potential risks. The second interpretation is rooted in the profile of respondents. Considering that almost the half of respondents were full-time employed (43.4%), having some college education or college degree (50.5%), with an average income level and above (53.4%), they might be less open to the potential financial losses that they might incur. The findings of the study investigating the correlation between socio-economic status and financial concerns shed light on the confirmed relationship. It was found that the higher the level of education, the higher is the financial literacy of individuals. Financial literacy is positively associated with financial wellbeing, which is negatively associated with financial concerns (Taft et al., 2013). The findings on the insignificant effect of financial and privacy concerns provide two contributions. First, the findings add to the literature on the adoption of pervasive technology in the private context, which postulated about privacy and financial barriers of technology adoption based on the interviews with experts and potential users (Balta-Ozkan et al., 2013b, Balta-Ozkan et al., 2014). In contrast to the prospective view that previous studies provided (Balta-Ozkan et al., 2013b, Balta-Ozkan et al., 2014), the quantitative approach adopted by this research enabled to measure the actual role of those factors in adoption by users. Second, the findings contribute to the existing literature on technology adoption in public and mixed contexts, which has provided evidence of the significant negative effect of perceived risks (Taneja et al., 2014, Martins et al., 2014).

### 6.1.2. Technology Fit and Performance

This thesis provided evidence of a strong relationship between task-technology fit, use behaviour, perceived usefulness and satisfaction. By accepting hypotheses 3 and 4, this research confirmed a strong effect of task-technology fit on use behaviour. This means that the users of smart home technology expect the technology to satisfy their specific needs/requirements. Similarly, task-technology fit has a strong effect on perceived usefulness. This result is logical considering that previous research found a high correlation between these constructs (Abbas et al., 2018, Oliver, 2014a, Zhou et al., 2010). The path analysis of task-technology fit on PEOU was also significant. However, the effect of task-technology fit on PEOU is stronger than on perceived usefulness. The interpretation could be that the needs of smart home users are underlinded by the desire to increase the quality of living and productivity by simplifying their daily routine (Marikyan *et al.*, 2019, Aldrich, 2003). In addition, considering that the majority of respondents were elderly people, who are considered to have lower technological self-efficacy (Reed et al., 2005), the ease of use factor may play a more important role. Lastly, the path analysis demonstrates that satisfaction is predicted by the perceived technology fit. This is in line with the study by Lin (2012) and in contrast with the paper by Lu and Yang (2014).

This thesis supported the effect of perceived usefulness on use behaviour and PEOU on perceived usefulness in line with the findings of previous literature (Al-Gahtani et al., 2007, Wang and Shih, 2009, Venkatesh and Zhang, 2010, Martins et al., 2014). The coefficients of the path analysis suggest a moderate effect of PEOU, while the predictive power of perceived usefulness is lower. A higher effect of PEOU can be explained by the context of the research. Given that the essence of the smart homes is to operationalise technology performance and make it more efficient (Marikyan *et al.*, 2019, Aldrich, 2003), the perceived usefulness of users should be strongly associated with the low degree of perceived effort that needs to be employed to perform a task. Overall, the findings on the relationship between the fit and technology performance factors are consistent with the previous literature. The studies demonstrated that the cumulative effect of the fit and perception factors produce higher variance in the use behaviour than the fit factor alone (Dishaw and Strong, 1999, Zhou *et al.*, 2010). It was confirmed that task-technology fit has a direct and indirect effect on behaviour through performance expectancy (Zhou *et al.*, 2010). In addition, the fit factor was found to be positively associated with PEOU, which, in turn, positively correlates with perceived usefulness (Dishaw and Strong, 1999).

### 6.1.3. The Outcome of Use Behaviour

The literature has extensively discussed the potential outcomes of use behaviour, providing contradictory results (Vlahos and Ferratt, 1995, Isaac et al., 2017, Sundaram et al., 2007, Tarafdar et al., 2014). On the one hand, IS use is positively associated with individuals' performance and a positive affective state. For example, it was found that a specific type of the use of technology by a customer service team in organisations helps achieve increased performance in administrative and sales tasks (Sundaram et al., 2007). The use of technology has a correlation with user satisfaction, which facilitates performance impact in terms of improved processes, knowledge acquisition and communication and decision quality (Isaac et al., 2017). On the other hand, the findings of prior literature demonstrated that the use of technology does not always bring positive outcomes. The utilisation of a self-directed learning tool in academia negatively affects students' performance (Rashid and Asghar, 2016). The use of technology might trigger technostress, which undermines productivity (Tarafdar et al., 2014, Tarafdar et al., 2011). Based on the path analysis results, this research adopts the stance in the research confirming a positive outcome of use behaviour. In contrast to the stream of research that found the effect of technology use on dissatisfaction and stress (Sundaram et al., 2007, Tarafdar et al., 2014), this thesis provides evidence that the effect of use behaviour on satisfaction in the smart home context is significant. One possible interpretation could be the difference in the context and the preconditions of the technology use. For example, it was proved that the use of advanced technologies caused stress in organisational settings (Duxbury *et al.*, 2014, Román *et al.*, 2018). That means that the use of technology was mandatory and not underpinned by an individual's needs or beliefs. Given that smart homes imply the voluntary use and purchase of technology, driven by needs be they hedonic or utilitarian ones, satisfaction of use is a more likely outcome.

## 6.2. Technology Adoption Following Disconfirmed Expectations

### 6.2.1. Disconfirmation of Technology Performance Expectations

The results of the analysis showed a significant and positive relationship between negative disconfirmation and dissonance (H1). Disconfirmation reflects the inconsistency between prior beliefs about technology performance and the actual perception of performance, thus inducing a psychological state of dissonance (Szajna and Scamell, 1993). Disconfirmation can be explained by the Expectation-(Dis)confirmation theoretical frameworks (Bhattacherjee, 2001, Bhattacherjee and Premkumar, 2004), which were widely used to examine the effect of the discrepancy between pre- and post-exposure beliefs on individuals' affective state and behaviour (Hsieh et al., 2010, McKinney et al., 2002). For example, disconfirmation can manifest itself when the physical characteristics of the product packaging are not consistent with the expectations that individuals held before the product purchase (Wilkins et al., 2016). It may also happen when the expectations about the characteristics of innovative technology are not confirmed after the initial trial of technology (Lee, 2004), which is in line with Innovation Diffusion Theory (Rogers, 1995). The positive effect of disconfirmation on dissonance arousal is consistent with the Cognitive Dissonance Theory (Festinger, 1962) and the associated literature (Wilkins et al., 2016, Keng and Liao, 2013). Post-purchase dissonance was found when the visual characteristics of the purchased product were worse than expected (Wilkins et al., 2016). Given the profile of the respondents, the majority of the sample considered that they had high expertise in technology (64.3%) and had actual utilisation experience of more than 2 years (95.1%). The higher the experience, the more critical is the ease of use factor (Al-Gahtani et al., 2007) and the easier is the use of more complex technologies (Beckers and Schmidt, 2003). The established relationship between disconfirmation and dissonance and the insight into the users' characteristics suggests that performance issues were critical and the expectation-perception discrepancy could not be tolerated by users. The confirmed effect of negative disconfirmation on dissonance adds to the discussion raised by Park et al. (2015) and Park et al. (2012), who examined the consequences of inconsistency between the perception of pre-service and post-service performance. While, they examined the discrepancy between the perception of services at different stages of technology use, the finding of this thesis provided evidence on the consequence of the incongruity between expectations and perceptions.

### 6.2.2. Dissonance and Related Emotions

The positive effect of dissonance on anger, guilt and regret supported evidence from prior literature (Harmon-Jones, 2004, Harmon-Jones et al., 2017, Gosling et al., 2006, Gilovich et al., 1995b, Roese and Summerville, 2005). These findings made it possible to differentiate to which degree dissonance was related to each emotion independently, unlike the majority of prior studies, which focused on negative emotions in general (Jean Tsang, 2019, Gosling et al., 2006). The strength of relationships demonstrated that the strongest feeling associated with dissonance was regret. The established effect of emotion suggests that individuals might have engaged in counterfactual thinking about a potential positive outcome had the behaviour not been performed (Croyle and Cooper, 1983). The effect of dissonance on anger was moderate. A significant relationship between dissonance and anger demonstrated that users did not feel in control and capable of using the technology the way they had initially expected (Harmon-Jones, 2004, Harmon-Jones et al., 2017). Given that anger is mostly experienced when people have low self-efficacy (Wilfong, 2006), the established relationship between dissonance and anger might suggest that weak technology performance was due to the personal inefficacy to perform the task. The explanation is also drawn from the profile of the respondents, who were mostly experienced users with high perceived expertise. This finding indicates that anger resulting from technology performance was not associated with a lack of experience with novel technology use, which could be accumulated along with the utilisation of technology. Rather, anger is related to the subjective evaluation of users' incapability of dealing with the issue. The effect of dissonance on guilt was moderate too. Feeling guilt represents the state when people blame themselves in the violation of personal standards and norms (Harmon-Jones et al., 2017). The results suggest that improper technology performance might have disappointed users. They might have felt that they could not realise the potential of technology, they were fully in control of. Users might have had self-standards about technological self-efficacy, but they could not match up to those standards.

### 6.2.3. Dissonance Reduction Mechanisms

The majority of the relationships between emotions and dissonance reduction strategies were significant. Findings supported the hypotheses that dissonance reduction strategies are predicted by emotions (Festinger, 1962). The differentiated effect of each emotion on reduction strategies was confirmed (Table 6.1.). The correlation of emotions with different coping mechanisms demonstrated the complexity of negative emotions, dissimilarity in motivational direction (approach vs avoidance) and arousal strength (intensity in psychological response). When it came to the analysis of the role of each emotion in relation to a particular dissonance reduction strategy, the findings demonstrated that anger was negatively associated with attitude change and positively associated with behaviour change (H3a, H3c). This suggested that when users felt angry after experiencing weak technology performance, they tended to discontinue the use of those technologies manifesting avoidance behaviour. That finding shed light onto the motivational role of anger, which has been disputed to date (Harmon-Jones, 2004, Carver, 2004, Smith and Lazarus, 1993, Harmon-Jones et al., 2017). Particularly, the findings contribute to the understanding of the approach and avoidance role of anger depending on the context. Based on the descriptive statistics, the majority of incidents reported by respondents (67.4%) were rooted in the design of appliances (e.g. operation faults, integration issues, not robust security and privacy features) and only 24.5% of issues were due to low personal efficacy in utilising technology (i.e. ease of use). When an incident is the result of the appliance fault, anger motivates to redress experience by discontinuing behaviour (Donoghue and de Klerk, 2013). Hence, behaviour change served as a pro-active action reflecting the external mean to cope with anger (Liang et al., 2019). Since anger is a very strong emotion, people tent to overcome future situations when they might be subjected to the same feeling. The insignificant effect of anger on consonant information seeking (H3b) showed that anger did not motivate people to balance the psychological state by adding consonant information to justify the choice.

The relationships between guilt and dissonance reduction strategies confirmed a positive effect of guilt on attitude change and consonant information-seeking (H4a, H4b). The results are consistent with the perspective, according to which guilt motivates approach behaviour (Kelman, 1979, Harmon-Jones et al., 2017, Ghingold, 1981a). Feeling guilt triggers the psychological coping mechanism, aimed to subdue the feeling of guilt. However, the results are inconsistent with the study by Turel (2016), who found that feeling guilt associated with the use of technology bringing intrinsic rewards results in discontinued use. Given that guilt undermines personal self-standards (Harmon-Jones et al., 2017), such as the belief in technological self-efficacy, this emotion predicts the change of cognition. The cognitive adjustment represents a coping mechanism reducing the feeling of inconsistency with one’s prior beliefs. By strengthening the positive attitude towards technology and seeking positive information about the technology, users justified the adoption and reduced dissonance. Although a negative effect of guilt on behaviour change was not confirmed, the lack of an established relationship may be explained in that there was no tendency to discontinue the use of technology when the use of technology triggered guilt.

Feeling regret had a moderate positive effect on behaviour change and a moderate negative effect on attitude change (H5a and H5c). The established effects were consistent with the findings of recent studies postulating that regret facilitates avoidance behaviour (Gilovich et al., 1995b, Davvetas and Diamantopoulos, 2017). In the context of the current research, regret is similar to anger in the way that these two emotions reflect a personal responsibility for the fault. However, regret is dissimilar from anger by the degree of counterfactual thinking that regretful decision implies (Connolly and Zeelenberg, 2002, Gilovich et al., 1995b). In line with the study by Roese and Summerville (2005), the established correlations between regret and reduction strategies demonstrated that self-blame and the thinking of forgone alternatives decreased the value of the selected technology and demotivated for continuous use. Given the effect size, out of all emotions, regret had the strongest power in regulating post-dissonance behaviour, suggesting that users gave much thought about opportunities that had been lost by refusing other alternative technologies. Similar to anger, the effect of regret on consonant information search was not supported (H5b), suggesting that there was no negative relationship between avoidance-directed behaviour and seeking consonant information.

**TABLE 6.1: RELATIONSHIPS BETWEEN EMOTIONS AND DISSONANCE REDUCTION MECHANISMS**

| | Anger | Guilt | Regret |
|---|---|---|---|
| Attitude Change | - | + | - |
| Consonant Information Seeking | none | + | none |
| Behaviour Change | + | none | + |

### 6.2.4. Satisfaction with technology performance and perceived wellbeing

The analysis of dissonance reduction outcomes demonstrated that all relationships except the one between behaviour change and subjective wellbeing (H8a) were supported. The confirmed paths from attitude change and consonant information-seeking to perceived wellbeing and satisfaction confirmed the assumption that the positive outcome of weak technology performance can be achieved by adjusting cognitions. Those relationships confirmed the assumption that the reduction/elimination of cognitive discrepancy and psychological tension

(Festinger, 1962) contributes to satisfaction (Vroom and Deci, 1971) and potentially increases perceived wellbeing. The findings were consistent with prior literature, which found a positive correlation between the tendency to favour a selected choice and satisfaction (Brehm and Cohen, 1962). The negative effect of behaviour change on satisfaction was supported too. In line with the study by Sparks et al. (2012), the withdrawal of behaviour was negatively associated with satisfaction. The lack of commitment towards the behaviour decreases the favourable attitude towards that behaviour, which is reflected by low satisfaction (Brehm and Cohen, 1962). However, the negative effect of behaviour change on perceived well-being was not supported. The finding suggests that when users discontinue the use of technology, they do not evaluate the degree to which smart homes improve the overall quality of life. The positive effect of satisfaction on perceived wellbeing adds to the research postulating that subjective wellbeing can be explained as the result of satisfaction with the use of product or services, having a spillover effect on consumer life domains (Lee et al., 2002). Given that 95.1% of the respondents had more than two-years of experience with smart home technologies, the evaluation of the effect on satisfaction and well-being is based on long-term technology utilisation.

## 6.3. Overall Discussion

In line with the first objective of the thesis, the findings explain the underpinnings of pervasive technology acceptance in private spaces. The results of hypothesis testing empirically confirm the role of the three types of factors in use behaviour. The first type is task-technology fit, which acts as a direct antecedent of use behaviour. The second type of antecedents is represented by perceived usefulness and perceived ease of use, whereby perceived usefulness has a direct effect on the dependent variable. Perceived usefulness is affected by task-technology fit and perceived ease of use, which means that the perception of usefulness is associated with the degree to which the technology is effort-free to operate, as well as the extent to which users find a match between technology and task characteristics. The third type of factors is values, which reflect the perception of the hedonic and utilitarian benefits of technology. The values are the antecedents of perceived task-technology fit. The primary perceived benefits, which lead to the perception of technology fit to the household, have a utilitarian nature, explained by the effect strength of the relationship. Since the acceptance of technology is not limited to its trial use, the thesis confirmed the effect of use behaviour on satisfaction.

To address the second objective of the thesis, the effect of negative disconfirmation of initial expectations about technology performance on satisfaction was explored. By adopting the cognitive dissonance framework, the thesis explored post-disconfirmation behavioural outcomes the feeling of satisfaction may depend upon. The path analysis tested a) the effect of disconfirmation on dissonance and b) the effect of dissonance on dissonance reduction behaviours. The findings suggested that the discrepancy between initial expectations and actual performance correlate with cognitive dissonance. That means that the inconsistency between the two types of cognitions causes psychological discomfort. Then, it was found that psychological discomfort triggers dissonance reduction. Dissonance reduction represents the behaviour that individuals exhibit to cope with an unpleasant emotional state. Dissonance reduction results in a positive affective state, expressed through feelings of satisfaction with technology and overall quality of life.

In line with the third objective, the thesis explored how people attenuate the psychological discomfort following a negative disconfirmation of initial expectations about smart home performance. To shed light on the complexity of the behavioural processes following dissonance, the thesis examined the three types of emotions (regret, guilt, anger) associated with dissonance and their role in inducing dissonance reduction behaviours, namely, the change of attitude, search for consonant information and behaviour withdrawal. The findings demonstrated that regret and anger positively affect behavioural withdrawal, while guilt affects attitude change and search for consonant information. Each of the reduction strategies has a different effect on the feelings of satisfaction with technology and the overall quality of life. The findings explain that disconfirmation may result in satisfaction and wellbeing if the post-disconfirmation psychological state induces a feeling of guilt, which motivates users towards cognitive adjustments (i.e. attitude change and need for consonance information).

# 7. Conclusion

This chapter provides the conclusions of the thesis. Section 7.1. summarises the main conclusions of the analysis of the two research models on the acceptance of pervasive technology in private spaces and technology adoption following disconfirmed expectations. Section 7.2. discusses theoretical contributions of the research findings. Section 7.3. explains how the findings of the thesis may be applicable in practice. The chapter concludes with Section 7.4 discussing the limitations and future research suggestions.

## 7.1. Main Conclusions

The analysis of the research model on the use of pervasive technology in private spaces helped understand the beliefs users hold about technology performance and outcomes in relation to their behaviour. The relationship of integrated task-technology fit and attitudinal factors with use behaviour and satisfaction, as well as the effect of the antecedents of task-technology fit, were tested. The analysis resulted in the majority of the hypotheses being accepted. In particular, the results suggested that the beliefs about the benefits and risks of technology use have a direct effect on the perceived degree of fit between the task and technology and an indirect effect on use behaviour. To evaluate the capability of the technology to perform household tasks, individuals consider the hedonic and utilitarian values that the technology will deliver. However, the perceived fit of technology is not contingent on the perceived financial risk and privacy concerns. The confirmed relationships between the fit factor and satisfaction means that that the users of smart home technology expect the technology to satisfy their specific needs/requirements. The effect of task-technology fit on use behavior and satisfaction can also be indirect through perceived usefulness and perceived ease of use. The strength of relationships in the model in general confirmed that it is has good power in explaining users' factors underpinning the use of technology in private settings, such as smart homes.

The thesis explored the outcome of the use of innovative technology in the condition when the performance of technology did not meet expectations based on the sample of smart home users. The research model theorised and confirmed that the disconfirmation of expectations can result in satisfaction and wellbeing when dissonance-induced emotions activate coping mechanisms aimed at reducing dissonance. The model established a positive correlation between dissonance, anger, regret and guilt. The distinctive effects of the three types of emotions on the reduction of cognitive dissonance through attitude change, consonant information-seeking and behaviour change were found. Finally, the effect of dissonance reduction through cognitive adjustment (consonant information seeking and attitude change) on satisfaction and perceived wellbeing was confirmed. These results illustrate the psychological and behavioural responses of individuals, which may happen when technology performs not as expected. The emotional profile of users indicates that the performance of technology makes people question the purchase decision and makes users think that nothing can be done to improve the use of technology. Those feelings are more likely to end up in the switching product for another alternative. However, when people think that by using technology, they have transgressed their values, they try to justify their purchase decision, which is likely to contribute to continuous use, satisfaction and perceived wellbeing.

## 7.2. Theoretical contributions

The results of the research make theoretical contributions related to the four objectives set by the thesis, discussed below.

**Objective 1:** To conduct a comprehensive review of the literature on a pervasive technology in private settings, using the case of smart homes.

The systematic review of the research on smart homes contributes to the existing body of review papers that were dominated by technical insights (Alam et al., 2012, De Silva et al., 2012) and the perspective on utilisation for energy management (Hosseini et al., 2017), healthcare (Chang et al., 2009, Ranasinghe et al., 2016, Amiribesheli et al., 2015) and assisting elderly people (Demiris and Hensel, 2008). The users' view on smart home benefits, services and implications enabled the researchers to understand what empirical evidence has been generated about the acceptance and adoption of the pervasive technology utilised in private settings. That made it possible to provide an agenda for future research and paved the way towards objectives empirically addressed further in the thesis.

**Objective 2:** To study smart home acceptance and provide more empirical evidence from a user perspective.

To address the users' side of the acceptance of technology, the relationships of factors that are imperative in the private context were theorised and validated. The factors relate to individual attitudinal and behavioural beliefs, and the compatibility of technology with users' tasks (Shih and Venkatesh, 2004, Brown and Venkatesh, 2005, Choe *et al.*, 2011). In addition, to tackle the limitation of existing models on the acceptance of technology, this thesis combined and explored the correlation of task-technology fit, perceived usefulness and perceived ease of use.

The individual psychological beliefs have also been examined by testing the correlation of the hedonic value, utilitarian value, privacy and financial risks with TTF. The model provided robust results confirming the correlation between the proposed constructs. In addition, the research provides an empirical validation of the effect of the potential benefits and barriers that have been discussed in the literature (Marikyan et al., 2019, Chan et al., 2008, Balta-Ozkan et al., 2013b, Balta-Ozkan et al., 2014, Aldrich, 2003). The examination of relationships between perceived values, risks and technology performance beliefs has provided a new insight into the technology adoption in private spaces.

The findings of the thesis contribute to the current literature by focusing on the pervasive technology that is used only in the private context. This approach is different to the current research, which has examined stand-alone devices delivering a specific service or technologies applicable for both private and public settings. In addition, with few papers about the acceptance of pervasive technology embedded in private residential areas (Anderson and Agarwal, 2010, Brown *et al.*, 2006, Brown and Venkatesh, 2005, Venkatesh and Brown, 2001), there has been no research exploring the technology-based and behavioural determinants of acceptance. Hence, the findings enriched the literature by suggesting that users of smart home technology are likely to be motivated by utilitarian outcomes, such as monitoring and reducing energy consumption, support in the daily routine and health care to name but a few. People are less interested in hedonic benefits, such as the enjoyment and fun of using the technology. A new perspective on the attitudinal beliefs underlining adoption is provided by the findings that people are not concerned with the risk that the investment will not be justified, and the use of technology might entail data misuse and privacy intrusion. Also, it was found that the utilisation of technology is most likely to result in the satisfaction with technology, which has long been disputed in the literature.

**Objective 3:** To examine the effect of negative disconfirmation of initial expectations about technology performance on satisfaction.

The investigation of use behaviour following the disconfirmation of technology performance adds to the literature adopting the expectation-disconfirmation paradigm. That literature postulated that satisfaction is the outcome of the utilisation of technology, when performance exceeds prior expectations (Hsieh et al., 2010, McKinney et al., 2002). The findings of this research provide a different perspective by confirming a positive outcome following a weak performance of the technology. In addition, the results add to the discussion by illustrating complex psychological processes following the evaluation of technology performance, which has not been explored before. A new insight into the disconfirmation-satisfaction relationship was made possible by extending the use of the Cognitive Dissonance Theory. Prior research used cognitive dissonance to explain the discrepancy between expectation and performance underpinning satisfaction/dissatisfaction (Elkhani and Bakri, 2012, Olson and Dover, 1979). This research used the cognitive dissonance framework, to explain the conditions under which users facilitate their positive attitude, affective state about the technology and continuous use.

**Objective 4:** To explore how people attenuate the psychological discomfort following a negative disconfirmation of initial expectations about smart homes performance.

The results of the thesis contribute to the cognitive dissonance literature by providing evidence on the relationship between three distinctive negative emotions and three strategies to reduce dissonance. The results add to the discussion of the underlying mechanisms of individuals' behaviour in dissonant situations, such as rationalisation of behaviour or adjustment of perception to expectations (Fineman, 1997, Walsh et al., 2016). This research takes a further step and explains the interrelation of emotional, cognitive and behavioural factors underpinning the reduction of dissonance. While prior literature examined negative emotions including anger, guilt and regret, as a unidimensional construct (Jean Tsang, 2019, Gosling et al., 2006), this thesis tested the effect that each has on the attitude change, consonant information seeking and behaviour change. The research breaks down the characteristics and dimensions of each emotion and distinguishes their motivational role in approach or avoidance behaviour. By doing that, the research theorised and confirmed the significant role of guilt in dissonance reduction through cognitive adjustments, which in turn leads to satisfaction and perceived wellbeing. The role of regret and anger was confirmed to be a predictor of behaviour change and dissatisfaction.

Apart from the contribution to the technology acceptance literature, the findings of the thesis contribute to the literature on the utilisation of innovative technology. This is made possible by focusing on smart homes and providing evidence on psychological factors affecting users' experience. The focus adopted by the thesis is different from other research, which mostly examines the factors underpinning the adoption of innovative technologies (Manis and Choi, 2019, Rauschnabel et al., 2015, Pizzi et al., 2019). While prior literature examined the predictors of the decision and processes of innovative technology adoption (Rogers, 1995, Dang et al., 2017, Oni and Papazafeiropoulou, 2014, Sabi et al., 2018), this research investigated the behaviour of users after the appraisal of technology performance. The results are important to the literature, because the utilisation of technology is contingent on the perception of technology performance, which is often undermined by high expectations when it comes to innovative technology (Dwivedi et al., 2019, Sun and Medaglia, 2019, Fan and Suh, 2014). Also, the findings have a contribution to the smart home literature specifically. Prior studies discussed the use of smart home technology, its benefits and factors underpinning behavioural intention to use (Balta-Ozkan et al., 2013b, Yang et al., 2017), but none examined how people utilise the technology following a negative performance. This research provides insights into the psychological and behavioural factors following the evaluation of the performance of the technology.

## 7.3. Practical Implications

The findings of this thesis have a number of useful practical implications for the developers and marketers of smart homes and other technology for private spaces. Evidence provided by this research is especially valuable considering the huge investments that companies make to develop new technology. It is important to understand how consumers perceive technology and how their beliefs and attitudes correlate with their intention to adopt technology prior to the mass introduction of technology into the market. The analysis of the technology acceptance model informs developers about three groups of factors that need to be taken into account when designing a product. First, the significance of the perceived fit factor suggests that practitioners need to analyse the market to learn potential users' needs, requirements and behavioural patterns in households. There are two tools which may be of particular importance, namely, surveys and focus groups. The employment of a survey may provide key areas of household tasks which can be generalisable to the wider population. The recruitment potential users for focus groups may provide a more in-depth understanding of human-technology interaction and ideas on the design and features of the technology which would fit users' requirements. In addition, focus groups are helpful for testing prototypes to evaluate the degree to which technology corresponds to individuals' task characteristics. The second group of factors is values, which have a very high correlation with the perception of technology, demonstrated by 81 per cent of the variance in the perceived task-technology fit variable. Although the results suggest that both hedonic and utilitarian benefits have a significant effect on perceived fit, the effect of utilitarian value is stronger. That means that practitioners need to focus on functions and services which bring higher utility to users, rather than hedonic outcomes, such as fun or enjoyment. Among potential utilitarian benefits could be the operational convenience, financial efficiency, technology responsiveness to users' needs, high integration with other technologies in the household, activity monitoring and protection from third-party intrusion. Less important are the benefits, such as the need for status expression through the purchase of the latest and newest version of the technology, experiential satisfaction from using technology and the exploration of novel products. This may advise practitioners that the development of technology without a substantial upgrade of functionality will probably not pay-off and trigger users' interest. The third group of factors which needs to be considered by practitioners are the beliefs about usefulness and ease of use. Given the high correlation of perceived ease of use with usefulness and perceived fit, technology does not raise any complexity concerns when it matches with users' requirements.

Evidence about the role of perceived task-technology fit, values and technology performance beliefs provides some guidance for technology marketers too. In order to emphasise the capability of technology to satisfy users' tasks, smart home technologies need to be promoted through channels enabling higher interaction with potential consumers. For example, marketers can feed information about technology functions through online communities and forums designed specifically for smart home users. Brand managers may use such marketing channels to ensure wider brand recognition, increase brand audience and retain customers through two-way communication. In addition, the role of utilitarian benefits in perceiving technology fit suggests that marketing campaigns should revolve more around functions and usefulness for the household, rather than focus on cues about the symbolic value of the product. Practitioners may also consider product bundling offerings (e.g. coupled with internet routers), which increases the utility of smart homes and may trigger higher interest in the technology.

Evidence resulted from the analysis of the second research model demonstrates practitioners a users' perspective on the utilisation of technology following disconfirmed expectations. Findings suggest that people might continue using technology and even report satisfaction with technology, despite the issues that they might face during use. However, when technology performance induces the feeling of regret and anger, people might cope with dissonance by discontinuing the use of smart homes. Therefore, practitioners need to receive customers' feedback in order to improve the technology. This can be done by developing a platform for all potential queries related to the utilisation of technology. The majority of smart home producers have webpages with product descriptions and information on how to solve issues with technologies, without, though, providing users with the opportunity to receive personalised responses. A customised approach may be valued by smart homes users who have had a negative experience with the technology, as it demonstrates empathy and care. Such an approach may turn negative emotions into positive ones. This is crucial in a competitive market, as negative experience makes people switch to alternatives to smart home technologies. In addition, the established strong feeling of regret and the effect it plays in behaviour change indicates that there is a retrospective consideration of alternatives involved. This rumination often ends up in the better evaluation of alternatives compared to the purchased product. Given that in regretful decisions people do not try to justify the decision by a consonant information search, the post-factum communications with customers seem to be an ineffective tool in retaining customers. Therefore, the marketing and sale of innovative technology should encompass trustworthy and comprehensive information about technology services, functions and benefits in order to set realistic expectations. Finally, the reported feeling of anger and the following abandonment of technology indicates that people perceive the fault in technology performance to be irreversible. Practitioners need to investigate all possible instances of poor technology performance to change or eliminate the likelihood of the arousal of this emotion.

## 7.4. Limitations and Future Research Suggestions

The research on the acceptance of a pervasive technology in private settings has some limitations inherent in the research design choices made. Due to the cross-sectional design of the thesis, the causality between the constructs remains uncertain. Future research could pursue a longitudinal approach to examine the causal effect of perceived values, risks, technology fit and performance on use behaviour and resulting satisfaction. Alternatively, the effect of antecedents could be tested in relation to behavioural intention, using a sample of prospective users of smart home technology. The findings would enable researchers to compare whether the perceptions of current users differ from prospective ones. Another potential avenue for future research is to use a comparative design to examine the acceptance from the perspective of different user segments. The segments can be profiled based on the types of services and benefits (e.g. financial, health-related, environmental, psychological) that the utilised technologies provide. Such an examination may help identify the heterogeneity across individuals with regards to the relative strength of behavioural beliefs. Also, future research could look at the moderating effects of personality traits and demographic characteristics that have not been tested in this thesis. For example, individuals can perceive the hedonic and utilitarian values of smart homes differently depending on the level of innovativeness and technology readiness. The younger the users, the more innovative they can be and more entertaining the use of technology can be. In contrast, the usage of smart homes by the older generation can reflect some degree of technophobia or scepticism. The sample of respondents for this survey was located in the USA. The geographical context is characterised by high innovativeness and pervasive technological embeddedness, an ageing population and high economic development. The abovementioned factors define the values and risks that might underpin consumer behaviour. Particularly, users with high economic status and early adopters of innovative technologies tend to mitigate the significance of financial and privacy risks (Wilson et al., 2017), while ageing of the population increases health-related value and operational dependence on smart home technology (Chung, 2017). To ensure the generalisability of the findings, the model can be tested in other contexts, with different demographic, economic and technological profiles.

The survey on technology adoption following the negative disconfirmation of initial expectations about technology performance is not without limitations either. First, the examination of the relationship between cognitive dissonance, emotions and dissonance reduction longitudinally is also left to be the agenda for future research. A longitudinal approach would make it possible to observe the change of emotions and behaviour over time, thus increasing the accuracy of results about the proposed relationships. Second, this thesis did not examine the role of moderating factors in the relationships between the variables. Future studies could look at the moderating effects of the psychological traits and socio-demographic characteristics that have not been tested in this thesis. For example, factors such as self-efficacy, perceived behavioural control or the tendency to outcome maximization, at the post-dissonance stage of technology utilisation, could provide a more precise picture about the contingency of coping mechanisms on individual characteristics. Also, the interaction effect of demographic differences with psychological traits would explain whether self-efficacy, perceived behavioural control and tendency to maximisation vary across different age, gender and income groups. Third, to ensure the generalisability of the findings, the research model focusing on the disconfirmation of technology performance can also be tested in other contexts, which differ by demographic, economic and technological profiles. Finally, future research could use a mixed-method approach to explore qualitatively and test quantitatively all specific behaviours that smart home users employ to attenuate post-adoption negative feelings.

# 8. Appendices

## 8.1. Survey 1 – Technology Acceptance in Private Spaces

**We would like to welcome you to the "Smart Technology Use Behaviour Survey".** The purpose of the research is to explore the conditions that trigger the motivation to use smart technology. Further, we are interested in studying the outcomes of the use of smart technology, such as the effect on individuals' satisfaction and well-being. Please be assured that all the answers you provide will be kept confidential. Any information provided will be used solely for the purpose of this research. It is very important that you provide answers to all questions. Please provide answers that suit your circumstances best. The survey will take approximately 15 minutes. We would like to thank you in advance for considering to participate in our survey study. This research study is supervised by D. Marikyan, Prof. S. Papagiannidis and Dr. E. Alamanos. If you have any questions or suggestions, please do not hesitate to contact us at D.Marikyan2@newcastle.ac.uk

**Q1:** Please go through the smart device list below and select the option that applies, depending on whether you have never used them, you have used them in the past or your currently use them.

| | Never used (1) | Had in the past (2) | Use currently (3) |
|---|---|---|---|
| Smart lightning | ○ | ○ | ○ |
| Smart meter | ○ | ○ | ○ |
| Bridge | ○ | ○ | ○ |
| Smart switch | ○ | ○ | ○ |
| Motion sensor | ○ | ○ | ○ |
| Eco (Amazon) | ○ | ○ | ○ |
| Dot (Amazon) | ○ | ○ | ○ |
| Google Home | ○ | ○ | ○ |
| Smart thermostat | ○ | ○ | ○ |
| Smart (home) camera | ○ | ○ | ○ |
| Smart pet camera | ○ | ○ | ○ |
| Smart smoke and carbon monoxide alarm | ○ | ○ | ○ |
| Smart alarm system | ○ | ○ | ○ |
| Smart vacuum | ○ | ○ | ○ |
| Smart kitchen devices | ○ | ○ | ○ |
| Smart doorbell | ○ | ○ | ○ |
| Smart plug | ○ | ○ | ○ |
| Smart speaker (E.g Amazon Alexa) | ○ | ○ | ○ |

| | | | |
|---|---|---|---|
| Smart TV | ○ | ○ | ○ |
| Smart wearable (E.g Smart watch) | ○ | ○ | ○ |
| Smart lock | ○ | ○ | ○ |
| Smart blind | ○ | ○ | ○ |
| Smart air conditioner | ○ | ○ | ○ |
| Smart toothbrush | ○ | ○ | ○ |
| Smart bottle | ○ | ○ | ○ |
| Smart tag | ○ | ○ | ○ |
| Smart scale | ○ | ○ | ○ |
| Smart waste bin | ○ | ○ | ○ |
| Smart fitness equipment | ○ | ○ | ○ |

**In this section, you will be asked to answer general questions about you (gender, age, employment status, education etc.)**

**Q2 What is your gender?**

- ○ Male
- ○ Female
- ○ Other

**Q3 How old are you?**

- ○ under 20
- ○ 20-29
- ○ 30-39
- ○ 40-49
- ○ 50-59
- ○ 60-69
- ○ 70-79
- ○ over 80

**Q4 What is your employment status?**

- ○ Full time employed
- ○ Part time employed
- ○ Out of work (but looking for)
- ○ Out of work (but not looking for)
- ○ Homemaker
- ○ Student
- ○ Retired
- ○ Unable to work

**Q5 What is your ethnicity?**

- ○ Non-Hispanic White or Euro-American
- ○ Black, Afro-Caribbean, or African American
- ○ Latino or Hispanic American
- ○ East Asian or Asian American

- ◯ South Asian or Indian American
- ◯ Middle Eastern or Arab American
- ◯ Native American or Alaskan Native
- ◯ Mixed
- ◯ Other

**Q6 What is the highest level of education you have completed?**

- ◯ Some high school or less
- ◯ High school graduate or equivalent
- ◯ Vocational/technical school (two year program)
- ◯ Some college, but no degree
- ◯ College graduate (four year program)
- ◯ Some graduate school, but not degree.
- ◯ Graduate degree (MSc, MBA, PhD, etc.)
- ◯ Professional degree (M.D., J.D., etc.)

**Q7 What is your geographical location?**

- ◯ Urbanized Area (50,000 or more people)
- ◯ Urban Cluster (at least 2,500 and less than 50,000 people)
- ◯ Rural (all other areas)

**Q8 It would be helpful for analysis, to know the income bracket of your household (annual household income before tax).**

- ◯ $0 - $24,999
- ◯ $25,000 - $49,999
- ◯ $50,000 - $74,999
- ◯ $75,000 - $99,999
- ◯ More than $100,000

**Q9 What is your marital status?**

- ◯ Single (never married)
- ◯ Married

- Separated
- Widowed
- Divorced

**Q10 Please read below and select the options that apply to the statements:**

| | strongly disagree (1) | disagree (2) | somewhat disagree (3) | neither agree nor disagree (4) | somewhat agree (5) | agree (6) | strongly agree (7) |
|---|---|---|---|---|---|---|---|
| I would find smart technologies useful in my daily life. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Using smart technologies enables me to accomplish tasks more quickly. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Using smart technologies increases my productivity in the house. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| If I use smart technologies, I increase my chances of achieving things that are important to me | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| My interaction with smart technologies is clear and understandable. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| It is easy for me to become skillful at using smart technologies. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I find smart technologies easy to use. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Learning to operate smart technologies is easy for me. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q11 Please read below and select the options that apply to the statements:**

| | strongly disagree (1) | disagree (2) | somewhat disagree (3) | neither agree nor disagree (4) | somewhat agree (5) | agree (6) | strongly agree (7) |
|---|---|---|---|---|---|---|---|
| The use of smart technologies is a joy. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I use smart technologies not because I have to, but because I want to. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Using smart technologies truly feels like an escape. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Compared to other things I could have done, the time I spend using smart technologies is truly enjoyable. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I enjoye being immersed in exciting new smart products. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I enjoy the use of smart technologies for its own sake, not just for the services that they provide. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I have a good time using smart technologies, because I am able to act on the "spur-of-the-moment" | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| During the use of smart technologies, I feel the excitement. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| While using smart technologies, I am able to forget my problems. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| While using smart technologies, I feel a sense of adventure. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The use of smart technologies is not a good way to spend my time | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q12 Please read below and select the options that apply to the statements:**

| | strongly disagree (1) | disagree (2) | somewhat disagree (3) | neither agree nor disagree (4) | somewhat agree (5) | agree (6) | strongly agree (7) |
|---|---|---|---|---|---|---|---|
| I accomplish just what I want when using smart technologies. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I can achieve what I really need when using smart technologies. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| When using smart technologies, I find just the services I am looking for. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| When using smart technologies, I am disappointed because I have to resort to the services of another provider to complete my needs. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q22 Please read below and select the options that apply to the statements:**

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| Using smart technologies causes me to lose control over the privacy of my payment information. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Using smart technologies leads to a loss of my privacy because my personal information is used without my knowledge. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Internet hackers (criminals) might take control of my smart technologies and I can suffer financial loss as a result. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q23 Please read below and select the options that apply to the statements:**

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| There is a potential that I lose money when using smart technologies. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Using smart technologies subjects my account to a potential fraud. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Signing up for and using smart technologies lead to a financial loss for me. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Using smart technologies subjects my account to a financial risk. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q24 Please read below and select the options that apply to the statements considering your house tasks:**

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| Smart technologies fit my requirements in a daily life. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Using smart technologies fits with my daily routine tasks. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| It is easy to understand which smart technology tools I need to use. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Smart technologies are suitable to complete my daily routine tasks. | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q25 Please read below and select the options that apply to each of the questions:**

How satisfied are you with your overall experience with smart technology?

- ○ Very dissatisfied
- ○ Moderately dissatisfied
- ○ Slightly dissatisfied
- ○ Neither satisfied nor dissatisfied
- ○ Slightly satisfied
- ○ Moderately satisfied
- ○ Very satisfied

**Q26 How much pleasure do you get from your overall experience with smart technology?**

- ○ Very displeased
- ○ Moderately displeased
- ○ Slightly displeased
- ○ Neither pleased nor displeased
- ○ Slightly pleased
- ○ Moderately pleased
- ○ Very pleased

**Q27 Given your overall experience with smart technologies, do you get frustrated or contented?**

- ○ Very frustrated
- ○ Moderately frustrated
- ○ Slightly frustrated
- ○ Neither frustrated nor contented
- ○ Slightly contented
- ○ Moderately contented
- ○ Very contented

**Q28 Given your overall experience with smart technologies, do you feel terrible or delighted by them?**

- ○ Very terrible
- ○ Moderately terrible
- ○ Slightly terrible
- ○ Neither positive nor delighted
- ○ Slightly delighted
- ○ Moderately delighted
- ○ Very delighted

**Q29 Please read below and select the options that apply to each of the statements.**

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| I intend to continue using smart technology rather than discontinue its use. (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| My intentions are to continue using smart technologies than use any alternatives (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| If I could, I would like to discontinue the use of smart technologies (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

## 8.2. Survey 2 - Technology Adoption Following Disconfirmed Expectations

**We would like to welcome you to the "Smart home Technology Use Experience" survey.** A smart home is a residence equipped with smart technologies (internet-connected devices) which made possible to remotely monitor and manage appliances and systems inside the house. Examples of smart home technologies are smart lighting, smart camera, smart assistant (Amazon Alexa, Google Home).

The purpose of this research is to explore the smart home technology use experience and subsequent behaviour. This study aims to explore behaviour of individuals who experienced discomfort after the smart home technology use. Particularly, we want to understand how individuals behaved in incidents when smart home technologies did not perform as expected. For example, the incidents include but are not limited to malfunctioning of smart home technologies, unauthorised order of expensive products through devices with linked bank accounts, untimely software updates disrupting the technology functioning, cloud/system failures, private data leakage and etc.. Further, we want to understand how people dealt with those incidents to address disconfirmed expectations and achieve overall satisfaction.

Please be assured that all the answers you provide will be kept confidential. Any information provided will be used solely for the purpose of this research. It is very important that you provide answers to all questions. Please provide answers that suit your circumstances best. The survey will take approximately 15 minutes.

We would like to thank you in advance for considering to participate in our survey study. This research study is supervised by D. Marikyan, Prof. S. Papagiannidis and Dr. E. Alamanos.

If you have any questions or suggestions, please do not hesitate to contact us at D.Marikyan2@newcastle.ac.uk

By clicking on the arrow (next) you agree to take part in the study.

**Please go through the list of smart home technologies below and select the options that best apply, depending on whether you have never used them, used them in the past or are currently using them.**

| | Never used (1) | Used in the past but not anymore (2) | Use currently (3) |
|---|---|---|---|
| Virtual assistant (e.g. Amazon Alexa, Eco, Google Home) | ○ | ○ | ○ |
| Smart home security (e.g. motion sensors etc.) | ○ | ○ | ○ |
| Smart smoke and carbon monoxide alarm or leak sensors | ○ | ○ | ○ |
| Smart lightning (e.g. smart bulbs, strips, lamp, chandelier) | ○ | ○ | ○ |
| Smart plugs/switches (e.g. dimmer, power plug, power switch) | ○ | ○ | ○ |
| Smart thermostat (e.g. Nest, Elgato) | ○ | ○ | ○ |
| Smart home camera (e.g. Nest home camera, pet camera) | ○ | ○ | ○ |
| Smart vacuum cleaner | ○ | ○ | ○ |
| Smart lock (door, window) | ○ | ○ | ○ |
| Smart kitchen (oven, fridge, kettle, waste bin) | ○ | ○ | ○ |
| Smart tag (tracker) | ○ | ○ | ○ |
| Smart entertainment systems (e.g. smart speakers) | ○ | ○ | ○ |

**FILTER**

**Overall, how satisfied have you been with your smart home installation?**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Not satisfied at all | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | Very satisfied |

**Below is a list of potential incidents that might happen to smart home users. Please note that these are only examples and the incidents are not limited to this list.**

1. Smart home technologies do not work at all or do the opposite of expected functions. For example, a smart vacuum cleaner starts the cleaning process without any command and scatter dust across a flat.

2. Smart home technologies cause financial loss. For instance, children use Amazon Alexa (Smart assistant) to make an order of expensive products without parents' knowledge and approval.

3. Software updates disrupt the function of smart home technologies. For instance, smart locks stop functioning and leave house doors unlocked.

4. Cloud services go down and the smart home system does not function. That requires extra effort to reconnect each device individually after such incidents.

5. Smart home technologies provide insufficient cyber-security and safety, causing private data leakage.

**Please think of a specific instance where smart home technologies used in your household did not perform as expected. Answer the questions below keeping in mind that incident.**

**What was the nature of the worst issue experienced?**

- ○ I never had any issues with smart home installation
- ○ Installation was more complex than expected
- ○ Did not work as expected (e.g. motion detector gave many false alarms)
- ○ Was not as easy to integrate with my smart home platform/other devices as expected
- ○ Security/privacy was not as robust as expected
- ○ It was not as easy to use as expected
- ○ It required more effort to operate than expected
- ○ The cost of running/maintaining was higher than expected
- ○ It was more difficult to share the functionality with other household members than expected
- ○ Other negative incident

**Q1 The questions following are concerned with how you evaluate smart home technologies after dealing with the incident (${INCIDENT}) mentioned above in which smart home technologies did not perform as expected. Please pick the answers that correspond to your case.**

Smart home technologies in the incident considered were expected to.....

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| increase my productivity in conducting daily routine at home | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| increase my performance in conducting daily routine at home | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| enhance my effectiveness in conducting daily routine at home | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| be useful in conducting daily routine at home | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q2 For the question following, please think of the incident (${INCIDENT}) mentioned above in which smart home technologies did not perform as expected and pick the answers that correspond to your case.**

When compared to my initial expectations, smart home technologies involved in that incident...

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| performed as expected (1) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| increased my productivity when undertaking household tasks (2) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| enhanced my effectiveness to undertake household tasks (3) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| were useful in my daily routine at home when undertaking household tasks (4) | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q3 For the question following, please think of the incident (${INCIDENT}) mentioned above in which smart home technologies did not perform as you expected and pick the answers that correspond to your case.**

Considering the instance where smart home technologies did not work as expected...

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| I was in despair | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I resented them | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt disappointed with myself | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt scared | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt hollow | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt angry | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt uneasy | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt I'd let myself down | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt annoyed | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt frustrated | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I was in pain | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt depressed | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt furious with myself | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt sick | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I was in agony | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I wondered if I really needed those technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I wondered whether I should have bought something else | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I wondered if I had made the right choice | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I wondered if I had done the right thing in buying those technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I wondered if I had been fooled | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I wondered if vendors had tricked me | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I wondered whether there was something wrong with the deal I got | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**4 The questions following are concerned with how you felt about the incident (${INCIDENT}) mentioned above in which smart home technologies did not perform as expected. Please pick the answers that correspond to your case.**

**After using smart home technologies in that incident, I felt...**

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| Angry | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Agitated | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Irritated | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Frustrated | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Hostile | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Frightened | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Tense | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Nervous | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Anxious | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Uncomfortable | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Nauseous | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Accountable | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Guilty | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Ashamed | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Bad | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Irresponsible | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Uneasy | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Upset | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I feel sorry for purchasing smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I regret purchasing smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I should have purchased traditional technologies for home instead of smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q5 The questions following are concerned with how you responded to the incident (${INCIDENT}) mentioned above in which smart home technologies did not perform as expected. Please pick the answers that correspond to your case related to how you dealt with the incident.**

**After using smart home technologies in that incident...**

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| I temporarily stopped using them at home | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I reduced the use of smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I used one or more alternatives to smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I used other technologies, instead of smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q6 The questions following are concerned with how you responded to the incident (${INCIDENT}) mentioned above in which smart home technologies did not perform as expected. Please pick the answers that correspond to your case related to how you dealt with the incident.**

| | Much weaker (1) | Weaker (2) | Slightly weaker (3) | Neither weaker nor stronger (4) | Slightly stronger (5) | Moderately stronger (6) | Much stronger (7) |
|---|---|---|---|---|---|---|---|
| My liking toward them has been... | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| My interest in them has been... | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| My preference toward them has been... | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q7 The questions following are concerned with how you responded to the incident (${INCIDENT}) mentioned above in which smart home technologies did not perform as expected. Please pick the answers that correspond to your case related to how you dealt with the incident.**

**After using smart home technologies in that incident...**

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| I searched for information supporting my original positive beliefs about those smart home technologies on the Internet, on TV, radio, in newspapers, magazines, or reports | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I searched for information supporting my original positive beliefs about those smart home technologies through retail stores | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I asked people I know for positive comments about those smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q8 The questions following are concerned with how you evaluate smart home technologies after dealing with the incident (${INCIDENT}) mentioned above in which smart home technologies did not perform as expected. Please pick the answers that correspond to your case.**

**Overall, smart home technologies...**

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| Have satisfied my overall household needs | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Have played a very important role in my social well-being | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Have played a very important role in my leisure well-being | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Have played an important role in enhancing the quality of life in my household | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q9 Please pick the answers that best apply to the statements:**

| | Strongly disagree (1) | Disagree (2) | Somewhat disagree (3) | Neither agree nor disagree (4) | Somewhat agree (5) | Agree (6) | Strongly agree (7) |
|---|---|---|---|---|---|---|---|
| I am very familiar with smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I have a clear idea about which characteristics of smart home technologies are important in providing me maximum usage satisfaction | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I know a lot about smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I consider myself an expert about smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I have a lot of experience with smart home technologies | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Q10 What is your age?**

- ◯ Under 18 years
- ◯ 18 to 24 years
- ◯ 25 to 34 years
- ◯ 35 to 44 years
- ◯ 45 to 54 years
- ◯ 55 to 64 years
- ◯ Age 65 or older

**Q11 What is your gender?**

- ◯ Male
- ◯ Female
- ◯ Other

**Q12 What is your educational level?**

- ◯ Completed some high school
- ◯ Completed some college (GCSE/AS/A-Level)
- ◯ Bachelor's degree
- ◯ Master's degree
- ◯ Ph.D.
- ◯ Other advanced degree beyond a Master's degree

**Q13 What was your total household income before taxes during the past 12 months?**

- ◯ Less than $25,000
- ◯ $25,000 to $34,999
- ◯ $35,000 to $49,999
- ◯ $50,000 to $74,999
- ◯ $75,000 to $99,999
- ◯ $100,000 to $149,999
- ◯ $150,000 to $199,999
- ◯ $200,000 or more

**Q14 What is your marital status?**

- ○ Single (never married)
- ○ Married
- ○ Separated
- ○ Widowed
- ○ Divorced

**Q15 When did you start your smart home technology installation?**

- ○ Before 2010
- ○ 2011
- ○ 2012
- ○ 2013
- ○ 2014
- ○ 2015
- ○ 2016
- ○ 2017
- ○ 2018
- ○ 2019

**Q16 Do you have any comments about this survey?**

________________________________________________________________

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