ACCEPTANCE AND ADOPTION OF THE INTERNET OF THINGS: A USER PERSPECTIVE

by

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Abstract

The Internet of Things promises a new technological paradigm that aims to connect anything and anyone at any time and any place, giving rise to a wide range of new services and applications. Such a grand vision will extend the scope of existing interactions between users and consumer electronics and bring about significant impacts on individuals and businesses. Enhancing user acceptance and adoption is one of the critical means of enlarging the business value of the Internet of Things. The objective of this doctoral work is to study the acceptance, adoption and use of pervasive technologies, as well as how predispositions based on an existing platform affect user attitudes toward its subsequent platform.

This thesis consists of three empirical studies, each of which theoretically constructed and empirically tested a framework depicting users' perceptions regarding technological paradigms, namely the Internet and the Internet of Things. Following the line of the Technology Acceptance Model, the first study started by exploring the antecedents and outcomes of Internet use from the psychological perspective. The second study conceptualised and tested the spillover effects of outcomes of Internet use into the user intention of the Internet of Things adoption. The third study incorporated and examined the perceived characteristics of innovation derived from Innovation Diffusion Theory, focusing on the user adoption of the Internet of Things. With data collected from 615 Internet users in the United States, structural equation modelling was used for data analysis.

Three research models have been successfully put forward. Statistical results suggested that, first of all, psychological factors significantly affect user acceptance and the adoption of technological platforms, which in turn lead to many emotional outcomes. The relationships between user beliefs and psychological factors vary depending on personal attributes. Secondly, the outcomes of using the Internet spill over into the users' acceptance of the Internet of Things, indicating that relevant technologies should not be considered separately. Lastly, in addition to the psychological factors, the characteristics of innovation influence the adoption intention of the Internet of Things.

This thesis provided insights into the latest state of play in relation to acceptance and adoption of the Internet of Things from the user perspective. This research made three contributions to the existing body of knowledge about information systems and technology management studies. Firstly, it investigated the user interaction with technology in four phases, i.e. the motivations of use, technology acceptance, technology adoption, and outcomes of use. Then, this research elaborated the effects of psychological and emotional factors on user beliefs about technological platforms. Lastly, this thesis examined the spillover effect from the Internet to the Internet of Things, suggesting that the influence of relevant technologies should be taken into consideration in technology acceptance studies.

IoT platform and technologies could enhance the “smartness” of future services, leveraging data collected by the context-aware objects, offering possibilities for service and product innovations for businesses. Also, given that the technologies arouse and are also affected by users’ emotions, businesses and policymakers should be concerned not only with technology affordance but also the psychological impact on users in order to maximise the benefits brought about by the Internet and Internet of Things. More specifically, through the diffusion of information technologies and the Internet in past decades, the users are seeking not only instrumental value but also the emotional value of new technology products and services. As such, the practitioners should take note of the target customers' attributes, preferences, and emotional responses toward relevant technologies in new product development and marketing strategies.

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Acknowledgement of Previous Publications

I have published five articles that are related to the contents of this thesis.

Journal Articles

Lu, Y., Papagiannidis, S. and Alamanos, E. (2018) 'Internet of Things: A systematic review of the business literature from the user and organisational perspectives', *Technological Forecasting and Social Change*, 136, pp. 285-297.

Lu, Y., Papagiannidis, S. and Alamanos, E. (2019) 'Exploring the emotional antecedents and outcomes of technology acceptance', *Computers in Human Behavior*, 90(1), pp. 153-169.

Conference Papers

Lu, Y., Papagiannidis, S. and Alamanos, E. (2016) 'A study of the Internet of Things from the user perspective'. *British Academy of Management 2016,* Newcastle, UK.

Lu, Y., Papagiannidis, S. and Alamanos, E. (2018) 'Psychological determinants and consequences of Internet usage: An extension of the Technology Acceptance Model'. *14th International Conference on Web Information Systems and Technologies*, Seville, Spain: SCITEPRESS Digital Library, 46-56.

Lu, Y., Papagiannidis, S. and Alamanos, E. (2019) 'The spill-over effect of the emotional reaction to the use of Internet on the intention to use Internet of Things (IoT) services'. *Academy of Marketing Science Annual Conference*, Vancouver, Canada.

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Chapter 1. Introduction

1.1 Internet of Things

The Internet of Things (IoT) promises a new technological paradigm, by connecting anything and anyone at any time and any place, using any path/network and any service (Guillemin and Friess, 2009; UK Research Council, 2013; Man et al., 2015; Baldini et al., 2016). The IoT vision is that of a *"smart world"* which is equipped with sensing technologies and smart components. The IoT features Web 3.0, which involves users much more deeply than its predecessor, Web 2.0, as they and their immediate physical environment are more heavily involved with the technology in ways that go far beyond content creation and sharing (Kreps and Kimppa, 2015). Not surprisingly, such a bold vision has captured the imagination and attention of both academics and practitioners, as the IoT could underpin innovative services and applications. The IoT is expected to have a significant impact on individuals, businesses, and policy as societal and business models will be challenged, and new services introduced (Shin, 2014; Stankovic, 2014).

As one of the top strategic technology trends (Spender, 2015), IoT is gaining importance in business studies. Much work has been carried out over the past few years on projects related to the IoT. Among the 11 important concepts depicting the future of information infrastructures and technologies (e.g. semantic web, ubiquitous computing, etc.), the number of publications related to the IoT stands out as it has been increasing consistently in recent years (Olson et al., 2015). A number of recent studies have been devoted to investigating issues regarding IoT enabling technologies, IoT security, and privacy invasion concerns (Yan et al., 2015; Mishra et al., 2016; Lu et al., 2018). However, in addition to the technology aspects that have been extensively pursued, problems regarding the IoT in the interaction between society and technologies need to be tackled (Shin, 2014). As such, the first objective of this thesis is to provide insights into the latest state of play of the IoT, specifically, from a business perspective.

IoT shows great potential in changing the existing industrial and business processes, and unlocking economic and market values (Dutton, 2014; Kim and Kim, 2016; Santoro et al., 2017). It is worth noting that the predecessor of IoT, i.e. the Internet, has changed its fundamental feature from a network of computers for military purposes to a network of people for knowledge and experience sharing purposes (Solima et al., 2016). IoT will further enhance the knowledge sharing function by connecting not only people but also objects with intelligence (Solima et al., 2016). In addition, this connected world has revealed great market potential when it comes to improving efficiency and transforming production (James, 2012). In the future economy driven by knowledge, innovations enabled by revitalised products and processes are potentially one of the driving factors which will strengthen financial and competitive advantage (Del Giudice, 2016). In organisations, the adoption, acceptance and use of the IoT-based applications are largely determined by the value created from the IoT (Del Giudice, 2016).

IoT can offer a number of innovative applications and services targeting different scopes of adoption, such as the smart city, which is applied at the infrastructural level, and the smart home, at the individual level (Lu et al., 2018). However, most of the early IoT products were developed by merely equipping existing objects with sensors or tags, aimed at facilitating the collection, processing and management of information (Lu et al., 2018). Despite the fact that only a small number of applications and services is currently available to individuals, the full potential impact of the IoT is enormous due to its pervasive nature and the rapid improvement of enabling technologies (Atzori et al., 2010; Shin, 2014). One of the future trends of IoT technologies is becoming user-oriented, which will further facilitate the developmental activities and satisfy the diverse needs of users (Sundmaeker et al., 2010; Shin, 2014; Lee and Lee, 2015; Vermesan et al., 2015). Given that IoT technologies and services are steadily progressing and reaching mainstream markets, it is high time to examine the IoT from the perspective of users.

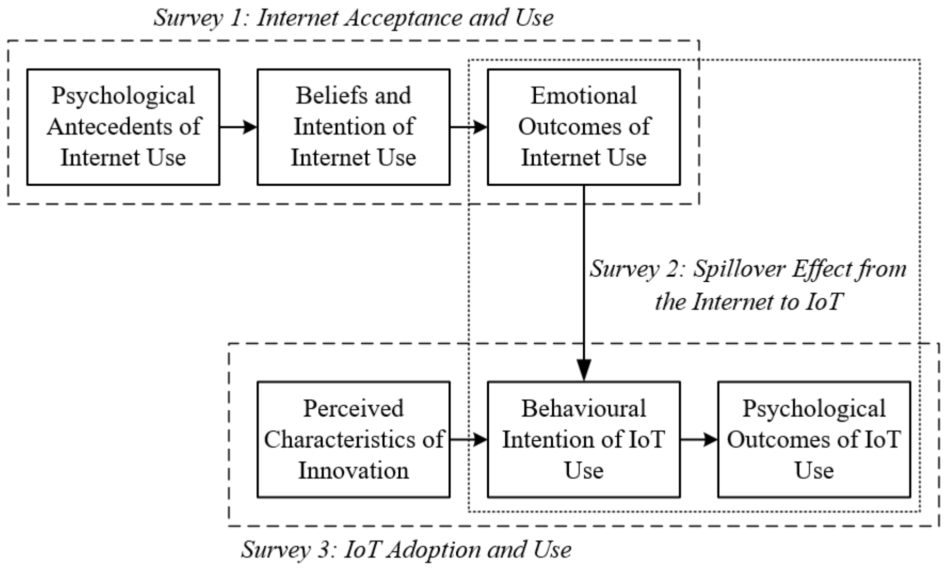
The viability and prospects of IoT applications and services are largely determined by the market demand and user acceptance (Kim and Kim, 2016). Taking lessons from information technology and systems (IT/IS) in their early stages, a low degree of user acceptance would hinder the progress IoT implementation (Kim and Kim, 2016). Prior studies from the user perspective mainly investigated factors influencing acceptance and use regarding a specific IoT service or application, and provided suggestions for practitioners in formulating business strategies to attract better adoption, e.g. (Bao et al., 2014; Gao and Bai, 2014; Chong et al., 2015). Although previous studies on IoT acceptance provided valuable insights, solely adapting mainstream information system management (MIS) theories for different contexts has limitations in providing comprehensive views of the IoT platform. As such, the second objective of this thesis is to study factors influencing user acceptance of the IoT as a technological paradigm.

IoT evolves from the existing technology platform that the users are familiar with, i.e. the Internet (Atzori et al., 2010; Evans, 2012; Shin, 2017; Falcone and Sapienza, 2018). Fundamentally, IoT refers to the pervasive presence of billions of intelligent communicating objects that are connected in an Internet-like structure, which is also part of the future Internet (Shin, 2014; Stankovic, 2014; Ng et al., 2015; Rau et al., 2015). In the scenario of the Internet of *"Things",* heterogeneous devices/objects would be connected to the Internet, providing data sensed from the physical world in addition to human inputting (Fleisch, 2010; Evans, 2012). These connected objects can communicate without human involvement, facilitating real-time information collection and sharing, thus making the Internet a more pervasive platform (Fleisch, 2010; James, 2012; Yang et al., 2013; Zanella et al., 2014). In the past, approaches to accessing the Internet evolved from using fixed devices such as desktop computers to using mobile devices that enabled connections at any time and any place (Evans, 2012). In the age of evolving from the Internet to the IoT, the users experience a fast development and transformation of the frequently used consumer electronics. Also, using the Internet may lead to many consequences that will potentially form the users' initial judgement on its successor, i.e. the IoT. Given this, acceptance of the IoT could be considered as a technology event interconnected with Internet use.

1.2 Technology Acceptance and Adoption: Research Gaps, Aims and Objectives

The main objective of this research is to understand the users' interaction with technological platforms in different phases, namely, the motivation, acceptance, adoption, and outcomes of technology use. Given the evolving nature of consumer technologies, the influence of relevant technologies should also be considered and examined as well. As such, the research context of this thesis is the two relevant pervasive technological paradigms, i.e. the Internet and IoT. The following sections proceed to elaborate on the research gaps and aims of this thesis. Three empirical studies were developed accordingly, as is presented in Figure 1.

Figure 1 Three Studies of User Acceptance and Adoption of the Internet and IoT



1.1.1 Research Aim 1

The research framework of technology acceptance has mainly been constructed on intention-based theories such as the Theory of Reasoned Action (Fishbein and Ajzen, 1975), the Technology Acceptance Model (Davis et al., 1989), and the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003). Fundamentally, mainstream technology acceptance theories hold that the users' attributes and beliefs determine their intention of using the technology, which consequently leads to their behaviour (Venkatesh et al., 2003; Tscherning, 2012). As such, technology acceptance studies have followed a common causal chain, i.e. beliefs and attitudes - intention - behaviour (Fishbein and Ajzen, 1975; Venkatesh et al., 2003). In addition, the users' motivations can act as antecedents that influence the users' beliefs and attitudes toward technology acceptance and use (Davis et al., 1989). Technology acceptance and use will also bring about many psychological and emotional impacts on users, which can be viewed as part of the outcomes of technology use. Given that, this research proposes that this intention-based common causal chain can be extended by adding the antecedents and outcomes of technology acceptance (discussed later in Chapter 2).

On the other hand, the epicentre of the process of innovation diffusion is the users' acceptance and adoption, which constitutes one of the mainstream questions of information technology and system (IS/IT) research (Venkatesh et al., 2003; Fichman et al., 2014). The majority of technology acceptance and adoption studies were drawn from MIS theories that were grounded on decomposing human behaviour and rooted in behavioural and cognitive psychology (Davis et al., 1989; Venkatesh et al., 2003). Also, many psychological theories and concepts have been introduced to technology acceptance studies, e.g. Flow Theory (Csikszentmihalyi and Csikszentmihalyi, 1992), Self-Determination Theory (Deci and Ryan, 1985), emotional responses (Beaudry and Pinsonneault, 2010), well-being (e.g. (Munzel et al., 2018), and social inclusion (e.g. (Andrade and Doolin, 2016). Given that psychological factors are gaining importance in technology acceptance studies, examining the influences of the individuals' psychological states and attributes on acceptance of the wider technology platforms is a meaningful research area.

Taking the above into account, the thesis aims to tackle the scarcity of examining the users' motivations and outcomes of technology acceptance, which will contribute to providing further insights into the MIS studies. More specifically,

Research aim 1 is: to explore and test the antecedents and outcomes of using technology platforms from the psychological and emotional perspectives.

To this end, the first study targets research aim 1. It aims to construct a comprehensive research framework on the users' beliefs and attitudes toward a well-developed and widely accepted technology platform, i.e. the Internet. This study modifies and extends the commonly adopted Technology Acceptance Model (TAM) through exploring and incorporating a number of psychological and emotional antecedents and outcomes, putting forward the Emotional Technology Acceptance Model (E-TAM). Nine factors of demographic characteristics and personal attributes are applied and tested as moderators of the established E-TAM framework. As such, study 1 contributes to extending the current body of knowledge about technology acceptance in terms of elaborating how psychological factors affect users' beliefs about information technologies and how these effects vary depending on the users' personal attributes.

1.1.2 Research Aim 2

User acceptance toward a new technology is usually conceptualised as an isolated event that is separated from the other technologies. However, according to the evolution path of technology, i.e. technology S-curve or technology life cycle, the diffusion of an existing technology overlaps with the growth of a new technology at some time points (Abernathy and Utterback, 1978; Utterback, 1994; Sood and Tellis, 2005). Also, innovation diffusion in a social system, such as upgrading the ICTs and technological platforms, brings about impacts on the current users (Fichman et al., 2014). The above implies that the impacts of relevant technologies warrant further investigation, which constitutes the second research topic of this thesis.

The IoT, which is evolving from the Internet, provides a context for studying how the users' attitude toward a new technology platform (i.e. IoT) can be affected by their predispositions based on their existing interaction with the precursor (i.e. Internet). In the past decades, the Internet has become an essential platform for communication and a vital approach to accessing information in people's daily life. Furthermore, the IoT can extend the users' experience with the Internet beyond the existing interactions using consumer electronic devices such as computers, mobile phones and televisions. In a future IoT scenario, the pervasive presence of smart objects integrated to the surrounding environments could provide services automatically adapting to human requirements instead of needing specific instructions, which further extends the scope of interactions between users and the Internet (Atzori et al., 2010; Falcone and Sapienza, 2018; Lu et al., 2018). Given the close relationship between the Internet and IoT, the individuals' prior experience with the Internet might be particularly important in influencing their acceptance of the IoT.

Although the wider psychological and emotional consequences that the Internet can have on the public remain an area that warrants further investigation, studies have implied that, in some cases, using the Internet arouses psychological responses. For instance, excessive Internet use can lead to negative effects such as social disinhibition and depression (Niemz et al., 2005; Kim et al., 2009; Tokunaga, 2017). What is more, for newly settled refugees, information and communication technologies (ICTs) can act as a vehicle for promoting their participation in social activities and offering opportunities for them to adapt to the new host society (Andrade and Doolin, 2016). In consequence, using the ICTs can enhance the refugees' degree of social inclusion and this further enhances their well-being (Andrade and Doolin, 2016). Following the above, using the Internet can result in a number of psychological outcomes, either positive or negative ones.

Referring to the concept of the spillover effect, which describes the within-person transference of psychological states and behaviour from one life domain to another (Edwards and Rothbard, 2000; Xanthopoulou and Papagiannidis, 2012), the users' experiences in Internet use may be transferred to the IoT domain. More specifically, the psychological outcomes of Internet use can spill over into the users' predispositions toward IoT acceptance. The second aim of this thesis is

Research aim 2: to examine the spillover effects of outcomes of Internet acceptance and use on IoT acceptance.

The second study addresses research aim 2 by investigating how technology acceptance in one setting can spill over to another. It starts with the premise that the users' psychological states and emotions can be transferred from the Internet to the IoT, thereby conceptualising and testing the effects of psychological outcomes of Internet use on IoT acceptance. In this way this study makes it possible to investigate the influence of an existing technology platform on the users' attitudes toward its successor. It contributes to facilitating the current understanding of the factors determining user acceptance of new technologies through taking the influence of using an existing technology into consideration.

1.1.3 Research Aim 3

Studies on user acceptance and adoption have sufficiently explored influential factors adapted from a number of MIS theories and have tested their effects on the users' behavioural intention of using the IoT. Also, the majority of IoT acceptance and adoption studies were conducted under a specified research context or targeting a specific IoT service, the details of which discussed in section 3.1. This thesis aims to provide further insights into IoT studies by investigating users' attitudes toward accepting and adopting the IoT as a platform.

Innovation Diffusion Theory (IDT) (Rogers, 1995), which investigates the process of diffusion, may offer valuable insights into understanding IoT adoption. IDT indicates that individuals with a social system have different degrees of willingness to adopt innovation and such willingness will be affected by the characteristics of the innovation (Rogers, 1995). Given the above, the third research aim of this thesis is

Research aim 3: to test the effects of innovation characteristics on user adoption of the IoT platform.

Accordingly, study 3 is devoted to examining the influence of the perceived characteristics of innovations on technology adoption. Drawing on TAM and IDT, this study incorporates six determinants, namely, perceived usefulness, perceived ease of use, compatibility, result demonstrability, visibility and trialability, and tests their effects on the users' intention toward IoT adoption. The diffusion of technology can be viewed as a process from technology creation, technology use, and the consequences of use (Karahanna et al., 1999; Delone and McLean, 2003). As such, study 3 explores the potential outcomes of IoT use as well. This study contributes to the technology acceptance and adoption studies in terms of providing a comprehensive view of users' attitude toward the IoT platform from the innovation diffusion perspective.

Overall, this research aims to shed light on the user interaction with the two broad technological paradigms. More specifically, it aims to explore and test a number of factors that potentially determine the user acceptance of, and act as the outcomes of, using the Internet and the IoT. Three research aims were developed targeting the research gaps identified in the technology acceptance and adoption literature. As shown in Figure 1, three empirical studies are proposed accordingly. The first study is conducted in the context of Internet use, aiming at extending technology acceptance studies from psychological and emotional perspectives. Taking into account the influence of relevant technologies, the second study examines the influence of using the Internet on IoT acceptance through theorising spillover effects. The third study explores the effect of innovation attributes on user adoption of the IoT. By successfully putting forward three research models, this thesis (a) elaborates the motivations driving user acceptance, the factors influencing technology acceptance and adoption, and potential outcomes of technology use, (b) provides a comprehensive view of technology acceptance and adoption of the Internet and IoT from the psychological perspective, and (c) offers further insights into the users' attitudes towards and beliefs about the evolution of technological paradigms.

1.3 Structure of the Thesis

This thesis consists of seven chapters. The first chapter presents an overall view of the research, introducing the potential research area in the literature and developing the research objectives accordingly. It first introduces the research background and then elaborates the research design, namely, three empirical studies each targets one research aim. As Figure 1 illustrated, this research is composed of three empirical studies concerning different phases of user interactions with the two technological platforms. Chapter 2 focuses on reviewing the theories and concepts underlying technology acceptance and studies. It first introduces the development of mainstream research models and definitions of constructs and then identifies topics that warrant further research. This chapter conceptualises the interaction between individuals and technology into four phases, and accordingly, discusses (a) the motivations driving user acceptance, the factors influencing (b) technology acceptance and (c) technology adoption, and (d) potential outcomes of technology use. By doing so, the research gaps in technology acceptance and adoption theories and concepts and the commonly followed causal chain of technology acceptance studies were identified, serving as the theoretical basis of the three studies of this thesis.

Chapter 3 introduces the research contexts and presents the development of hypotheses and the construction of research frameworks. It first examines the current status of studies on the Internet of Things through reviewing and summarising (a) the definitions and characteristics of IoT; (b) the development of IoT and its potential impacts on the future society, economy and users; (c) the IoT services and applications; and (d) the users' concerns regarding IoT development and their attitudes toward IoT acceptance and adoption. As such, a research gap in IoT acceptance and adoption studies was identified. Section 3.2, 3.3 and 3.4 go on to the literature review on relevant studies, providing details of the research gaps, objectives and aims of the three empirical studies. A number of research hypotheses are proposed and three operational research models are presented.

Chapter 4 begins with the philosophical foundations of the empirical studies and then explains how the hypotheses are to be tested. Specifically, it discusses the research methodology followed, the strategy of sampling and data collection, reliability and validity tests, and the process of data analysis. Chapter 5 presents the results and findings of the three studies, providing detailed statistical results, including the establishment of the research models and the test results of the main hypotheses and moderation effects. Chapter 6 consists of discussions on each study, synthesising the results of the hypotheses and performance of the research models. Lastly, chapter 7 summarises the three studies, presents the conclusion and contributions of the thesis, indicates limitations of this current research, and provides theoretical and practical implications and suggestions for future studies.

Chapter 2. Theories of Technology Acceptance and Adoption

The acceptance, adoption and diffusion and implementation of innovative technologies have been long emphasised in academic subjects such as business and management, marketing, social studies, etc. Digital innovations process in four stages, i.e. discovery, development, diffusion, and impact (Fichman et al., 2014). The epicentre of this process is research on user acceptance and adoption, which constitutes the dominant stream of information technology (IT) innovation research (Fichman et al., 2014). On the other hand, information system (IS) studies investigate two mainstream questions, which are (a) the individuals' acceptance, adoption, and behaviour regarding new technologies, and (b) the success of technology implementation and the fit between the technology and task at the organisational level (Venkatesh et al., 2003). This thesis primarily aims at investigating technology acceptance and use at the individual level.

Fundamentally, the mainstream management information system (MIS) theories concerning the individual level have suggested that the users' attitudes and beliefs determine their intention of using the technology, and this intention leads to their behaviour (Venkatesh et al., 2003; Tscherning, 2012). Given that this causal chain of user acceptance and adoption was rooted in behaviour and cognitive psychology, psychological factors such as motivations usually act as antecedents underlying individual beliefs about technology acceptance and use (Davis et al., 1989). In the meantime, according to the previously introduced digital innovation process, technology adoption and use would lead to many impacts on individuals, especially in emotional and psychological terms. Taking into account the above, user interaction with information systems and technologies comprises four phases: the motivations, acceptance, adoption, and outcomes. The following sections review the theories and concepts that have been widely applied in studying each of the phases.

2.1 Motivations

The majority of MIS theories was grounded in the stream of decomposing human behaviours (Venkatesh et al., 2003). Motivation theories in psychology can explain human behaviour (Venkatesh et al., 2003). The motivational theories shed light on the underlying factors that drive individuals' interactions with technologies, including acceptance, adoption, and use behaviours. Fundamentally, in the context of new technology adoption, the use of information and communication technologies (ICTs) is determined and predicted by extrinsic and intrinsic motivations (Davis, 1989; Davis et al., 1992; Venkatesh et al., 2003; Chung and Tan, 2004). A number of technology acceptance theories derived from behaviour psychology have integrated constructs based on these two types of motivations. For instance, the flow-based cognitive absorption constructs of the Hedonic-Motivation System Adoption Model are grounded in intrinsic motivation (Lowry et al., 2013). On the other hand, technology acceptance studies in workplace settings emphasise the technologies' instrumental value, which contributes to job performance and effectiveness. In hedonic contexts, the focuses are on hedonic values, which represent intrinsic motivational factors, such as the perceived enjoyment and cognitive absorption.

Given the above, this section reviews MIS theories that have incorporated motivational factors and the motivational concepts that have been applied in theoretical research and empirical studies of technology acceptance. Four motivational theories were included. Firstly, the Motivational Model was designed for application in ICT contexts, which indicated the fundamental concept of antecedents of technology acceptance, i.e. the intrinsic and extrinsic motivations, and elaborated the mechanism and relations between the determining factors (Davis et al., 1992). Then, studies have explored the individuals' holistic experience of technology use, i.e. flow and cognitive absorption (Csikszentmihalyi and Csikszentmihalyi, 1992; Agarwal and Karahanna, 2000). Furthermore, as MIS studies focused on the instrumental value of technology adoption and use, the Hedonic-Motivation System Adoption Model contributed to filling the insufficiency of explaining the hedonic value of IS/IT (Lowry et al., 2013). Lastly, Self-Determination Theory is a psychological theory that examines the mechanism and locus of causality between human behaviour and their motivations. This theory has been widely applied to technology acceptance studies (Lee et al., 2015; Hew and Kadir, 2016; Nikou and Economides, 2017). Self-Determination Theory incorporates individual characteristics and the basic psychological needs in current IS studies (Deci and Ryan, 1985). The following sections elaborate on the above-mentioned theories or concepts concerning the motivations for technology use.

2.1.1 Motivational Model

The Motivational Model (MM) introduced the concept of extrinsic and intrinsic motivations in explaining technology acceptance and use. The extrinsic motivation is defined as "*the performance of an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions*" (Davis et al., 1992). In other words, extrinsic motivation influences behaviours by reinforcing the value and outcomes of the activity, whereas the intrinsic motivation determines behaviours "*for no apparent reinforcement other than the process of performing the activity per se*" (Davis et al., 1992). The individuals' intrinsically motivated performance of certain behaviour concerns gaining the experience per se, while the extrinsically motivated activity concerns the outcomes (Davis et al., 1992).

In the context of MIS, extrinsic and intrinsic motivations could be represented by perceived usefulness (PU) and enjoyment respectively. Accordingly, PU is defined as "*a person's expectation that using the computer will result in improved job performance*" (Davis, 1989; Davis et al., 1989). Enjoyment refers to the individuals' perceived fun or pleasure derived from using technology in its own right, aside from the consequences from using the system (Venkatesh, 2000; Venkatesh et al., 2012b). As a representation of intrinsic motivations, perceived enjoyment plays a particularly important role in determining the behaviour in using hedonic systems and leading to outcomes such as immersion or flow (Davis et al., 1992; Lowry et al., 2013). Perceived enjoyment is an indicator of satisfaction with technology performance (Shin, 2017). A high degree of perceived enjoyment enhances the utilitarian value of the system (Agarwal and Karahanna, 2000). Also, perceived enjoyment affects users' beliefs, especially when users have gained experience in the system (Agarwal and Karahanna, 2000; Venkatesh and Bala, 2008). Computer playfulness, which shares a similar concept with enjoyment, represents one of the intrinsic motivational factors that anchor the users' decision-making process of technology adoption (Webster and Martocchio, 1992; Venkatesh, 2000).

Extrinsic motivations primarily determine IS/IT use and intrinsic motivation has a significant but smaller effect. These motivations together provide a powerful effect on the behavioural intention of use (Davis et al., 1992). The locus of causality between extrinsic and intrinsic motivations shifts. Introducing extrinsic motivation diminishes the effect of intrinsic motivation on the activities that were purely intrinsically motivated (Davis et al., 1992). This shift disappears when the initial motivation was not purely intrinsic (Davis et al., 1992).

2.1.2 Holistic Experience: Flow and Cognitive Absorption

The formation of the individuals' beliefs, which determine technology acceptance and use, is a valuable research area (Agarwal and Karahanna, 2000). A convergence of MIS theories captured the formation of beliefs such as attitudes and use by examining the influences of recurrence factors such as perceived usefulness (PU) and perceived ease of use (PEOU) (Agarwal and Karahanna, 2000). However, studies of individual psychology have suggested that individuals' beliefs and behaviours with an IS/IT are shaped by their holistic experience (Agarwal and Karahanna, 2000). As such, constructs captured the holistic experience, e.g. flow and cognitive absorption are potential influential factors in the interaction between users and technology (Agarwal and Karahanna, 2000; Hoffman and Novak, 2009).

Flow Theory is closely related to IS adoption behaviour (Hoffman and Novak, 2009). Flow describes an individual's deep level of engagement with and complete immersion in an activity (Hoffman and Novak, 2009). The concept of flow was initially introduced to describe the experience gained when people work hard on the work per se instead of external rewards (Csikszentmihalyi and Csikszentmihalyi, 1992). The definition of intrinsic motivation in mandatory computer use is in parallel with this concept of flow (Davis et al., 1992; Agarwal and Karahanna, 2000). Flow is most commonly experienced when people are operating in a challenging situation that requires high skills (Csikszentmihalyi, 1997; Csikszentmihalyi, 2014). In situations other than challenging activities, people are more likely to feel bored, anxious, or relaxed (Csikszentmihalyi, 1997; Csikszentmihalyi, 2014). The state of flow could be experienced in a range of daily activities such as sports, games, shopping, etc. (Hoffman and Novak, 2009). The likelihood of experiencing flow varies among individuals (Novak et al., 2000).

In the context of MIS, flow describes the optimal experience that affects users' acceptance and enhances their engagement with technologies (Chung and Tan, 2004). Studies of flow in IT/IS have put emphasis on exploring the antecedents, experience/process, and consequences of flow (Hoffman and Novak, 2009). Many antecedents of flow have been identified and empirically tested, for instance, personality traits and emotional stability (Woszczynski et al., 2002), playfulness (Agarwal and Karahanna, 2000), personal innovativeness (Agarwal and Karahanna, 2000), PU (Sanchez-Franco, 2006), PEOU (Hsu and Lu, 2004), attitude, etc. Flow has also been found to influence the individuals' attitudes, behaviour intentions, and use of ICTs (Hsu and Lu, 2004; Richard and Chandra, 2005; Sanchez-Franco, 2006), as well as their achievement and satisfaction (Woszczynski et al., 2002; Shin, 2006).

However, many studies have discussed the negative side of Internet addiction or pathological use, e.g. social disinhibition, depression, lower self-esteem, and greater loneliness (Niemz et al., 2005; Kim et al., 2009; Tokunaga, 2017). Deep engagement could also lead to positive outcomes, such as enhancing the users' degree of well-being and positive emotions (Lu et al., 2019) and the positive attitude toward and greater exploratory use of the technology (Agarwal and Karahanna, 2000). In addition, the study of Hoffman & Novak (2009) noted the importance of elaborating and examining the role of flow-based constructs in understanding the consumer experience of using Internet services. The flow was found to be a critical determinant of consumer use of the Internet and e-commerce (Hoffman and Novak, 2009). Therefore, practitioners in the online commercial area should aim to provide "*flow opportunities*" to facilitate customer experience (Hoffman and Novak, 2009).

Cognitive absorption refers to the state of deep involvement with IS/IT, which is defined as "*a deep state of involvement with software systems stemming from intrinsic motivation*" (Agarwal and Karahanna, 2000). It was derived from three theoretical streams, i.e. the state of flow, the personality trait dimension of absorption, and the notion of cognitive engagement (Agarwal and Karahanna, 2000). These three concepts comprised five dimensions that were integrated into the cognitive absorption, i.e. temporal dissociation, focused immersion, heightened enjoyment, control, and curiosity (Agarwal and Karahanna, 2000).

Temporal dissociation: This describes a transformation of time, which refers to the individual's lack of awareness of the passage of time when engaging in interaction (Csikszentmihalyi, 1990; Agarwal and Karahanna, 2000).

Focused immersion: This is also called attention focus and concentration, which describes the complete engagement with an activity while everything else is ignored (Csikszentmihalyi, 1990; Agarwal and Karahanna, 2000; Novak et al., 2000).

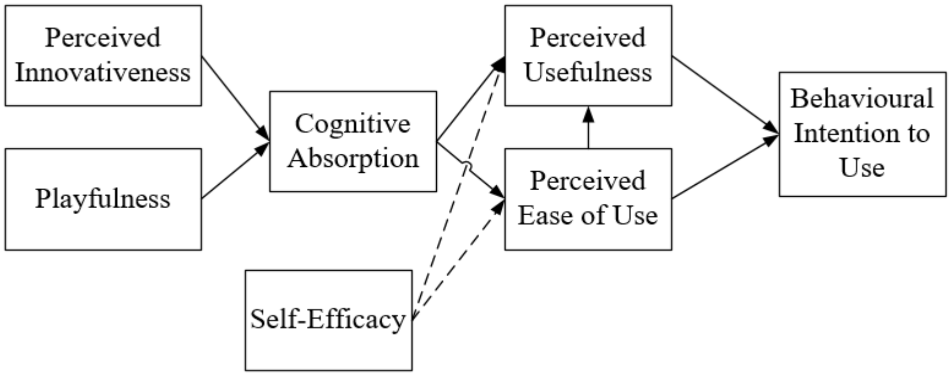
Heightened enjoyment: This is similar to enjoyment and intrinsic interests, which captures the pleasure, fun, and enjoyment in an interaction (Csikszentmihalyi, 1990; Webster and Hackley, 1997; Webster and Ho, 1997; Agarwal and Karahanna, 2000).

Control: This refers to an individual's skill or ability to manage the interaction (Agarwal and Karahanna, 2000; Novak et al., 2003).

Curiosity: This refers to the arousing experience of one's sensory and cognitive curiosity (Malone, 1981; Agarwal and Karahanna, 2000).

Cognitive absorption has been confirmed as an antecedent of salient beliefs and a situational intrinsic motivator of IT/IS use (Agarwal and Karahanna, 2000). A nomological framework was developed and tested aiming to explore the possible antecedents and outcomes of cognitive absorption, as Figure 2 presents. The empirical results supported the nomological net of antecedents and consequences of cognitive absorption and supported the suggestion that cognitive absorption directly influences the behavioural intention of technology use (BI) (Agarwal and Karahanna, 2000). Cognitive absorption, which comprises five dimensions, indirectly influenced BI via PU and PEOU (Agarwal and Karahanna, 2000). A high degree of self-efficacy together with cognitive absorption will create perceptions of lower cognitive burden in using ICTs, which positively increases PEOU (Agarwal and Karahanna, 2000). Regarding the instrumental value, the heightened enjoyment dimension of cognitive absorption leads to a positive perception of the usefulness (Agarwal and Karahanna, 2000). Self-efficacy, which exhibits a positive impact on outcome expectancy, determines PU together with cognitive absorption as well (Compeau et al., 1999; Agarwal and Karahanna, 2000). Lastly, computer playfulness, which comprises the notion of flow dimension, was included as an antecedent of cognitive absorption (Agarwal and Karahanna, 2000). People with a higher degree of innovativeness with new technologies are more likely to experience a state of cognitive absorption (Agarwal and Karahanna, 2000).

Figure 2 Nomological Net of Cognitive Absorption (adapted from Agarwal and Karahanna, 2000)



Overall, the introduction of the notions of flow and cognitive absorption facilitated MIS studies from the hedonic point of view. These two concepts shed light on the role of holistic experience and have encouraged further research to incorporate constructs of intrinsic motivation and psychological characteristics in explaining and predicting use.

2.1.3 Hedonic-Motivation System Adoption Model

A large number of MIS studies have focused on the utilitarian aspect of technology use, whereas intrinsic motivation drives IS/IT acceptance as well (Davis et al., 1992; Lowry et al., 2013). Theories contextualised to investigating the hedonic aspect of technology acceptance and use are insufficient. Also, although most voluntary use of the computer was driven by extrinsic motivation, the impact of intrinsic motivation was confirmed in the context of hedonic-motivation system use, e.g. computer games (Davis et al., 1992). Lowry et al. (2013) put forward the Hedonic-Motivation System Adoption Model (HMSAM) on the basis of the critical role of intrinsic motivations in driving IS/IT acceptance. HMSAM extended MIS theories by incorporating the constructs of cognitive absorption, which opened up avenues for explaining technology utilisation behaviour from the intrinsic motivation point of view (Lowry et al., 2013). The hedonic-motivation system refers to a system that was used primarily for entertainment and pleasure rather than for productivity, e.g. electronic games, social networking sites (SNS), etc. (Lowry et al., 2013). It differs from the utilitarian-motivation system by the ability to create a deep level of immersion and devotion for the users (Sherry, 2004; Jegers, 2009; Lowry et al., 2013).

Intrinsic motivation plays a primary role in driving use of the hedonic-motivation system due to which the users are concerned with the experience of use and seek intrinsic rewards rather than external outcomes (Davis et al., 1992; Lowry et al., 2013). In addition, increasing control over the environment is part of fundamental human needs (Bandura, 2001; Lowry et al., 2013). In this case, the impact of external rewards on individuals' satisfaction would eventually diminish. Intrinsic motivation outweighs extrinsic motivations in affecting and predicting behaviours and enhancing people's performance persistence, creativity, and self-esteem (Deci and Ryan, 1985; Lowry et al., 2013). Therefore, intrinsic motivations, as well as personal attributes, are expected to have a critical influence on the use of the hedonic-motivation system.

HMSAM was built on the Hedonic-System Acceptance Model (Van der Heijden, 2004) and the concept of cognitive absorption (Agarwal and Karahanna, 2000). The Hedonic-System Acceptance Model (Van der Heijden, 2004) extended TAM and hypothesised that joy (or enjoyment) would mediate the relationship between PEOU and BI (Van der Heijden, 2004; Lowry et al., 2013). The Hedonic-System Acceptance Model solely relied on joy as a representation of intrinsic motivations (Lowry et al., 2013). This is insufficient in explaining the intention and use of hedonic-motivation systems and it ignores other potential intrinsic motivational factors (Lowry et al., 2013). HMSAM replaced the enjoyment mediator with cognitive absorption, enabling HMSAM to be applicable in the context of hedonic-motivation system use (Burton-Jones and Straub, 2006; Lowry et al., 2013). In empirical tests, this revised model performed better than the Hedonic-System Acceptance Model, which explained BI reasonably from the hedonic perspective (Lowry et al., 2013).

The final HMSAM (Figure 3) revised the five sub-constructs to four variables, i.e. curiosity, joy, control, and immersion, and empirically justified the relationships. The five sub-constructs of cognitive absorption were included individually rather than integrated because each of the five sub-constructs of cognitive absorption has different causal mechanisms and their impacts occur separately (Lowry et al., 2013). Also, PU is modified to measure the users' expected "*usefulness of pursuing pleasure*" in the hedonic system context (Lowry et al., 2013).

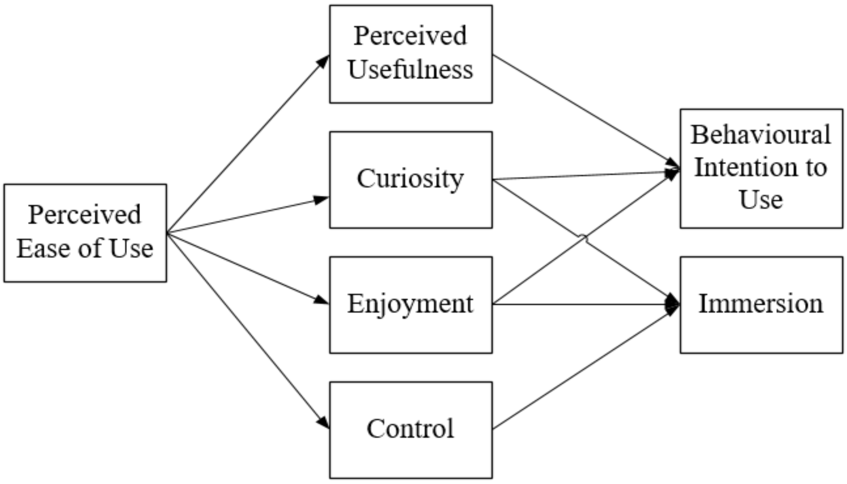
Immersion combined the concepts of focused immersion and temporal dissociation. This definition is identical to the state of flow, which describes the feeling of psychological immersion and concentration on a specific activity (i.e. focused immersion), disregarding ones' consciousness and awareness of external environmental factors (i.e. temporal dissociation) (Csikszentmihalyi, 1997; Lowry et al., 2013).

Joy refers to the extent of the individuals' perceived fun and enjoyment in interaction with hedonic systems (Lowry et al., 2013). Increases in the degree of joy will lead to psychological outcomes such as a state of immersion or flow (Lowry et al., 2013).

Curiosity is evoked by the heightened attention given to the users' interests (Lowry et al., 2013). The attention devoted to pursuing such curiosity will enhance a state of immersion and behavioural intention (Lowry et al., 2013).

Control is defined as the users' perceptions of the ability to manage the constraints on their behaviour (Taylor and Todd, 1995; Venkatesh et al., 2003; Lowry et al., 2013). Control is also known as perceived behaviour control (PBC), self-efficacy, compatibility, and facilitating conditions in MIS research, applied to many MIS theories such as the Theory of Planned Behaviour and the Unified Theory of Acceptance and Use of Technology (Lowry et al., 2013). A high level of Control and active engagement will increase the likelihood of a deeper level of immersion (Lowry et al., 2013).

Figure 3 Hedonic-Motivation System Adoption Model (adapted from Lowry et al., 2013)



2.1.4 Self-Determination Theory

Human motivation forms the individual's attitude and beliefs, and influences user engagement with IS/IT as well. In the past few decades, a number of psychological theories for explaining human motivation have been widely applied to business and management studies. For instance, the Self-Determination Theory (SDT) (Deci and Ryan, 1985), Maslow's Hierarchy of Needs Theory (Maslow, 1954), the Goal-Setting Theory (Locke and Latham, 1990), Action Regulation Theory (Frese and Sabini, 1991; Hacker, 1994), etc. Among them, SDT was distinguished from the other motivational theories, by clarifying that human motivation is a multidimensional concept rather than a unitary phenomenon (Ryan and Deci, 2000b; Gagné and Deci, 2005). According to SDT, human motivation varies in level, amount and types, and is associated with individual characteristics and environmental factors (Ryan and Deci, 2000b; Gagné and Deci, 2005; Roca and Gagné, 2008; Lee et al., 2015).

SDT consists of two sub-theories, namely the Cognitive Evaluation Theory (CET) and the Organismic Integration Theory (OIT), which accordingly focus on intrinsic motivation and extrinsic motivation respectively (Ryan and Deci, 2000b; Lee et al., 2015). The taxonomy of motivations concerns one's goal of, attitude toward, and reason for a particular behaviour, which accordingly distinguishes motivations as intrinsic and extrinsic (Ryan and Deci, 2000b). SDT assumes that intrinsic motivation can reflect the innate human propensities of assimilating and being integrated into the external social world (Ryan and Deci, 2000d; Ryan and Deci, 2000b), whereas extrinsic motivation mainly refers to the external control and self-regulation (Ryan and Deci, 2000d; Ryan and Deci, 2000b). Intrinsic motivation can increase the individual's willingness to devote more effort to a task or behaviour, which consequently leads to higher degrees of persistence, performance, and satisfaction than does extrinsic motivation (Ryan and Deci, 2000b; Roca and Gagné, 2008; Lee et al., 2015). Moreover, intrinsic motivation is more influential in predicting interesting activities, while extrinsic motivation determines uninteresting tasks more (Agarwal and Karahanna, 2000; Ryan and Deci, 2000b; Gagné and Deci, 2005; Roca and Gagné, 2008; Lowry et al., 2013). Accordingly, the CET applies to the tasks and activities that hold intrinsic interest for people, and OIT, which concerns the extrinsic motivation, is considered to apply to uninteresting activities (Ryan and Deci, 2000b).

2.1.4.1 Organismic Integration Theory

OIT examines different forms of extrinsic motivations and the contextual factors that are promoting or hindering the regulation of behaviours (Ryan and Deci, 2000c; Lee et al., 2015). Extrinsic motivations can be categorised into four forms, i.e. external regulation, introjected regulation, identified regulation, and integrated regulation (Ryan and Deci, 2000b; Ryan and Deci, 2000c; Gagné and Deci, 2005; Lee et al., 2015). When facing social regulations and external values, the individuals may (a) obey them, but exclude them as external, (b) partly internalise them, but not fully accept them, or (c) fully take in and accept them as their own (Ryan and Deci, 2000b). The extent of the degree of assimilating the external values, goals, and beliefs differentiates the four types of behaviour regulation of the individuals.

External regulation determines the behaviour being performed solely for external factors, such as obtaining rewards and/or avoiding punishments (Ryan and Deci, 2000b; Roca and Gagné, 2008; Lee et al., 2015).

Introjected regulation refers to performing a behaviour for external values which are partly internalised, but not fully accepted (Ryan and Deci, 2000b; Roca and Gagné, 2008; Lee et al., 2015).

Identified regulation makes an individual perceive an activity to be meaningful in achieving his/her own goals and values, though still potentially aiming for external rewards (Ryan and Deci, 2000b; Roca and Gagné, 2008).

Integrated regulation consequently makes a behaviour fully self-regulated and autonomous, usually for fun and enjoyment (Ryan and Deci, 2000b; Roca and Gagné, 2008).

OIT links the external and introjected regulations to the controlling aspect of extrinsic motivations, and the identified and integrated regulations to the autonomous aspect (Ryan and Deci, 2000d; Lee et al., 2015). Extrinsic motivation affects intrinsic motivation in different directions depending on the perceptions of the locus of causality (Ryan and Deci, 2000d; Lee et al., 2015). Therefore, as the controlling aspect of extrinsic motivation stems from external sources rather than from oneself, it might undermine intrinsic motivation (Ryan and Deci, 2000d; Lee et al., 2015). On the other hand, the autonomous aspect of extrinsic motivation enhances intrinsic motivation since it stems from internal sources within oneself (Ryan and Deci, 2000d; Lee et al., 2015).

2.1.4.2 Cognitive Evaluation Theory

CET defined intrinsic motivation as the satisfaction of psychological needs that people gained from engagement with self-selected tasks (Ryan and Deci, 2000b). One’s persistence, performance, and well-being will be enhanced when being intrinsically motivated and participating in activities that satisfy their innate psychological needs (Ryan and Deci, 2000b; Ryan and Deci, 2000c; Roca and Gagné, 2008). CET identified three universal psychological needs that facilitate human motivation, i.e. need for competence (NC), need for autonomy (NA), and need for relatedness (NR) (Ryan and Deci, 2000a). First of all, CET argues that individuals have a desire to interact with the environment. Their participation in interpersonal activities catalyses a feeling of competence (Ryan and Deci, 2000b). The need for autonomy refers to a sense of being self-determined, which will significantly enhance intrinsic motivation (Ryan and Deci, 2000b; Gagné and Deci, 2005). However, the environmental and social contextual conditions that support or control the needs for autonomy and competence could facilitate or undermine intrinsic motivation (Ryan and Deci, 2000b; Ryan and Deci, 2000c). More specifically, external factors that are perceived as controllers, such as rewards, threats, deadlines and competition pressure, will hinder the individual's experienced autonomy and consequently result in diminishing intrinsic motivation (Ryan and Deci, 2000b; Gagné and Deci, 2005). Lastly, in the case of not inherently interesting activities, people will be motivated by their need to feel connected, by a need for relatedness, and a need for a sense of belongingness (Ryan and Deci, 2000b).

Satisfying the fundamental psychological needs is a human motivational mechanism that decides behaviour, facilitates optimal functioning, nourishes motivational energy, and enhances personal well-being (Deci and Ryan, 2000; Ryan and Deci, 2000c; Van den Broeck et al., 2010). These three needs independently and separately affect human psychological well-being (Ryan and Deci, 2000a). In the workplace, the satisfaction of the three basic psychological needs can facilitate the employees' motivation and psychological well-being (Deci et al., 2001). Support from supervisors, management and the environment shapes an autonomy-supportive climate that predicts and further enhances the degree of need satisfaction (Deci et al., 2001). This finding has been validated across various cultural backgrounds (Deci et al., 2001). In addition, a large body of literature has supported the relationship between the individual's psychological need satisfaction and their personal well-being, e.g. (Deci and Ryan, 2000; Ryan and Deci, 2000b; Ryan and Deci, 2000c; Gagné and Deci, 2005). More specifically, fluctuations in the degree of need satisfaction can predict fluctuations of well-being on a daily basis (Reis et al., 2000; Gagné, 2003; Gagné and Deci, 2005). The study of (Gagné and Deci, 2005) suggested that, in the workplace, satisfying the three psychological needs significantly enhances the employees' intrinsic motivations and facilitates the internalisation process of extrinsic motivations. Such effects consequently lead to meaningful outcomes, such as promoting behaviour persistence, performance effectiveness, job satisfaction, positive attitudes toward work, organisational citizenship, and psychological well-being (Gagné and Deci, 2005).

2.1.4.3 Basic Psychological Needs

The need for competence is defined as the *"individuals' inherent desire to feel effective in interacting with the environment"*(Van den Broeck et al., 2010). It describes a human predisposition to experience a feeling of competence by effectively interacting with the environment and participating in social activities (Deci and Ryan, 2000; Lee et al., 2015). The need for competence encourages people to adapt to and manipulate the complex and changing environment, to engage in challenging tasks, and to extend their skills (Deci and Ryan, 2000; Van den Broeck et al., 2010). An unsatisfied need for competence results in one's feeling helpless and lacking motivation (Deci and Ryan, 2000; Van den Broeck et al., 2010). What is more, the need for competence is expected to correlate with self-efficacy in empirical studies (Deci and Ryan, 1985; Roca and Gagné, 2008; Van den Broeck et al., 2010). Self-efficacy represents "*acquired cognitions*" regarding the individual's ability to accomplish specific future tasks (Van den Broeck et al., 2010), whereas the need for competence is a more general and affective "*inborn need"* which could be satisfied when experiencing effectiveness in mastering a task (Van den Broeck et al., 2010).

The need for autonomy refers to individuals' inherent desire to experience psychological freedom and a sense of choice when carrying out an activity (Deci and Ryan, 2000; Van den Broeck et al., 2010). As one of the origins of human behaviour, the need for autonomy concerns one's desire to volitionally pursue their chosen activities and self-organising actions (Deci and Ryan, 1985; Roca and Gagné, 2008; Lee et al., 2015). As the satisfaction of the need for competence cannot solely motivate individuals, the feeling of psychological freedom and autonomy is another crucial source of intrinsic motivation (Ryan and Deci, 2000b). The individuals' perceived control ensures their feeling of being competent and being capable of decision-making, while a lack of control potentially causes negative effects such as psychological strain and depression (Lowry et al., 2013). Moreover, the existence of external controls in the workplace, e.g. contingent rewards, deadlines, and evaluation, may diminish one's intrinsic motivation, which in turn decreases their time spent on, and self-reported interest in, the activity (Ryan and Deci, 2000b; Roca and Gagné, 2008). In this case, an autonomy-supportive interaction style between the motivatee and people who are influential to them, such as their parents, teachers, trainers, and managers, potentially encourages the motivatee to be intrinsically motivated toward an activity (Ryan and Deci, 2000b; Roca and Gagné, 2008). On the other hand, a controlling style of interaction is likely to turn the motivatee into being extrinsically motivated (Ryan and Deci, 2000b; Roca and Gagné, 2008).

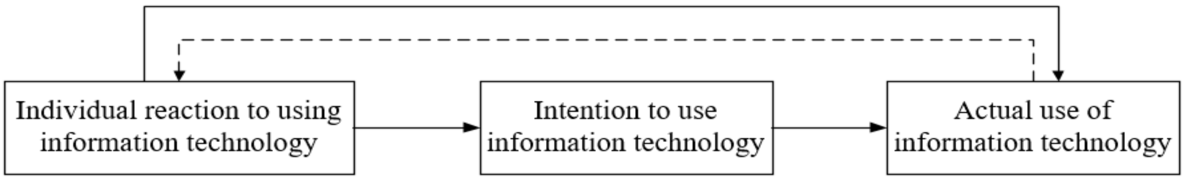
Differences in interaction style result in varieties in the motivatees' persistence, performance, and satisfaction (Ryan and Deci, 2000b; Roca and Gagné, 2008).

The need for relatedness describes a natural tendency to feel connected to other individuals or social communities, as well as being loved and supported by important people (Roca and Gagné, 2008; Van den Broeck et al., 2010; Lee et al., 2015). This need can be satisfied by experiencing a sense of communion and developing close relationships with important individuals (Van den Broeck et al., 2010). Furthermore, satisfying the need for relatedness is the main reason why people participate in some activities that are not inherently interesting or enjoyable but are valued by people who are connected to them (Deci and Ryan, 2000; Ryan and Deci, 2000b; Van den Broeck et al., 2010). In this case, the need for relatedness shares a similar concept with the social influence factors, i.e. subjective norm and social support (Roca and Gagné, 2008; Van den Broeck et al., 2010).

2.2 Acceptance of Technology

The epicentre of information technology innovation study is user acceptance and adoption (Fichman et al., 2014). Grounded in behavioural and cognitive psychology (Davis et al., 1989), a number of mainstream theories of user acceptance have been formulated and empirically tested. The following section examines four dominant theories regarding the user acceptance of information technology and systems, i.e. the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB), the Technology Acceptance Model (TAM), and the Unified Theory of Acceptance and Use of Technology (UTAUT). Notably, the primary predictor of actual use behaviour of an IS/IT has been the subject of long debate. Previous MIS studies have theorised and tested behavioural expectation (Warshaw and Davis, 1985), desires (Perugini and Bagozzi, 2001), attitude (Davis et al., 1989), and self-identity (Sparks, 2000) as the primary determinant of use behaviour. Based on TRA, the intention of performing a target behaviour outperformed the others and acted as a powerful precursor of use behaviour. The four dominant theories explaining individual technology acceptance underlined a basic conceptual framework, as Figure 4 illustrates. This basic framework has been employed in a wide range of technology acceptance studies.

Figure 4 Basic Concept Underlying User Acceptance Models (adapted from Venkatesh et al., 2003)

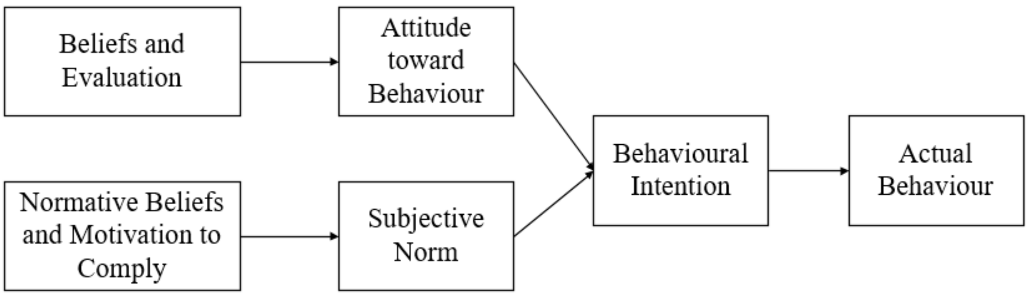


2.2.1 Theory of Reasoned Action

Understanding human behaviour is a complicated, challenging, and not yet clarified task (Al-Lozi and Papazafeiropoulou, 2012). One widely accepted explanation is that human behaviours are the results of attempting to satisfy needs or desires (Al-Lozi and Papazafeiropoulou, 2012). The mainstream understanding of human behaviour is the intention-based assumption, which conceptualises that an individual's behaviour is driven by their motivations and intentions and is influenced by extrinsic factors (Mathieson, 1991; Al-Lozi and Papazafeiropoulou, 2012). Among the mainstream theories, the Theory of Reasoned Action (TRA) is one of the most influential social psychological theories that have been used to predict a wide range of human behaviours (Venkatesh et al., 2003). Fundamentally, TRA distinguished four of the variables concerning human conduct, i.e. beliefs, attitudes, intentions, and behaviours (Fishbein and Ajzen, 1975; Hill, 1977). The seminal work of TRA by Fishbein and Ajzen (1975) regarded humans as rational processors of available information. Human beliefs, attitudes, intentions and behaviours are formed in such information processing (Fishbein and Ajzen, 1975; Hill, 1977). TRA identifies the determinants of *"consciously intended behaviour"*, which refers to the behaviour being performed due to one's intention (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980; Davis et al., 1989; Bradley, 2012). The study of (Davis et al., 1989) initially applied TRA to explaining user behaviour in the technology acceptance context. The amount of variances explained was consistent with other studies that applied TRA in different contexts (Davis et al., 1989; Venkatesh et al., 2003).

The theoretical framework of TRA is composed of two causal chains, as illustrated by Figure 5. The explanatory basis of TRA is that the user's behavioural intention, which is determined by the subjective norm and attitude, is the precursor of their actual behaviour (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980). Subjective norm refers to one's perception that most people who are important to them think they should or should not perform the behaviour (Fishbein and Ajzen, 1975; Davis et al., 1989). Attitude is the core construct and the primary antecedent of human behaviours in TRA. Although some have argued that attitude is "*a configuration of affects rather than a single evaluative continuum*" (Hill, 1977), Fishbein and Ajzen (1975) regarded the attitude as a bipolar variable that can be defined as *"an individual's positive or negative feelings (evaluative effect) about performing the target behaviour".* The individuals' salient beliefs about the consequences of performing the target behaviour and the evaluation of the expected consequences determine their attitude toward the behaviour (Fishbein and Ajzen, 1975). TRA defined beliefs as the individual's subjective probability of the consequence of performing the target behaviour (Davis et al., 1989). Evaluation refers to the implicit evaluative response to the consequence of performing the target behaviour (Davis et al., 1989). In addition, one's normative beliefs about the perceived expectations and the motivation to comply with these expectations in combination explain their subjective norm (Fishbein and Ajzen, 1975).

Figure 5 Theory of Reasoned Action (adapted from Davis et al., 1989)



TRA defined beliefs as the individual's subjective probability of the consequence of performing the target behaviour (Davis et al., 1989). Users' beliefs can be grouped into three categories, i.e. attitudinal, normative, and control beliefs (Brown and Venkatesh, 2005; Niehaves and Plattfaut, 2014). More specifically, attitudinal beliefs focus on the outcomes as utilitarian (e.g. utilitarian for personal or work purpose), hedonic (i.e. fun), or social (e.g. status and image) (Brown and Venkatesh, 2005; Niehaves and Plattfaut, 2014). Normative beliefs refer to the influences from other people, such as the users' friends, family, or workplace colleagues, as well as secondary information resources, such as television or newspapers (Brown and Venkatesh, 2005; Niehaves and Plattfaut, 2014). Lastly, constructs of control beliefs reflect personal efficacy, control, consisting of personal skills, requisite knowledge, perceived ease of use, and costs (Brown and Venkatesh, 2005; Niehaves and Plattfaut, 2014). TRA comprised the attitudinal and normative beliefs as influential factors of behaviour intention.

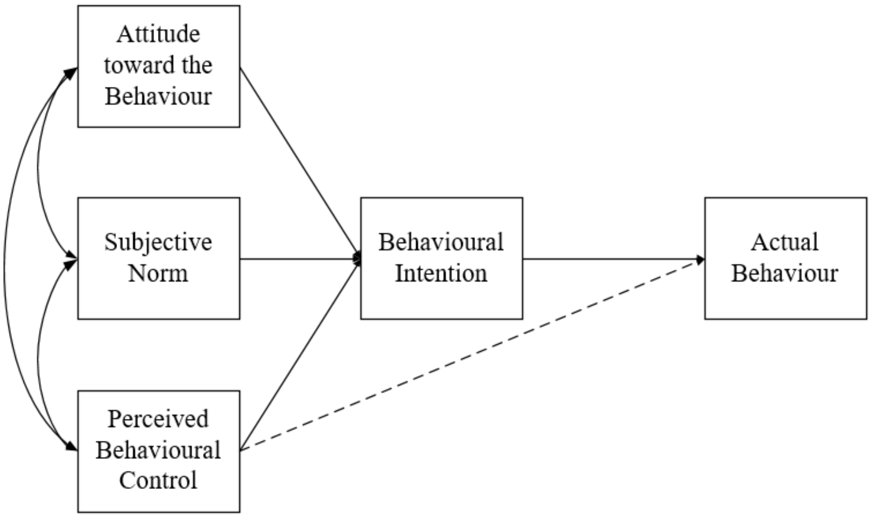
TRA posited that human behaviour is highly dependent on people's motivations and intentions (Al-Lozi and Papazafeiropoulou, 2012), which laid a solid foundation for a number of technology acceptance theories. Drawing upon TRA, the Theory of Planned Behaviour integrated the control beliefs in addition to the above-mentioned attitudinal beliefs (i.e. attitude) and normative beliefs (i.e. subjective norm). It theorised that the construct perceived behaviour control as another determinant of intention and behaviour (Venkatesh et al., 2003). On the other hand, the Technology Acceptance Theory (TAM) retained the attitudinal beliefs as determinants of behavioural intention of IS/IT acceptance and use (Davis et al., 1989). TAM was specifically designed for the IS/IT context, whereas TRA was developed as a rather general theory that explains human behaviour in a wide range of contexts (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980; Davis et al., 1989).

2.2.2 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) proposed that the individual's motivation is influenced by their perceived difficulty and likelihood of successfully performing a behaviour (Al-Lozi and Papazafeiropoulou, 2012). It extended and refined TRA by adding a third determinant of behavioural intention, i.e. the perceived behaviour control (PBC) (see Figure 6). PBC describes the users’ perceptions of the internal and external constraints on their behaviour (Taylor and Todd, 1995). TPB views the control over behaviour as a continuum from easily performed behaviours to those behaviours requiring considerable effort and resources (Eagly and Chaiken, 1993). Integrating PBC added one more aspect of influential information to explain the target behaviour, which improved the explanatory power of TPB (Ajzen, 1991; Mathieson, 1991; Taylor and Todd, 1995). Such an extension enabled TPB to be capable of being applied to unstable contexts, in which the individual's behaviours are not entirely controlled by their volitional intentions (Ajzen, 1991).

Application of TPB to study specific behaviours provides a more precise and complete understanding (Venkatesh et al., 2007). However, more significant theoretical contributions can be made by using TPB as a basis for substantive theoretical development and extending it with external variables that potentially affect the target behaviour (Venkatesh et al., 2007). TPB was first introduced to IS research by Taylor and Todd (1995). Then the decomposed TPB (DTPB) was put forward, with the aim of preserving the generality of TPB in the technology acceptance context (Venkatesh et al., 2007). DTPB decomposed the attitudinal, normative, and control beliefs into multi-dimensional constructs by incorporating variables from TAM and the innovation characteristics literature (Taylor and Todd, 1995). More specifically, the attitude was decomposed into perceived usefulness, ease of use, and compatibility; subjective norm was decomposed into peer influence and superior’s influence; PBC comprises self-efficacy, resource facilitating conditions, and technology facilitating conditions (Taylor and Todd, 1995). TPB, DTPB, and TAM explained 57%, 60%, and 52% of the variances in behavioural intention in the empirical test by (Taylor and Todd, 1995). This indicates that, compared with TAM, adding normative and control beliefs to attitudinal beliefs (i.e. TPB) and decomposing these beliefs (i.e. DTPB) can provide some additional insights into behavioural intention (Taylor and Todd, 1995).

Figure 6 Theory of Planned Behaviour (adapted from Ajzen, 1991)

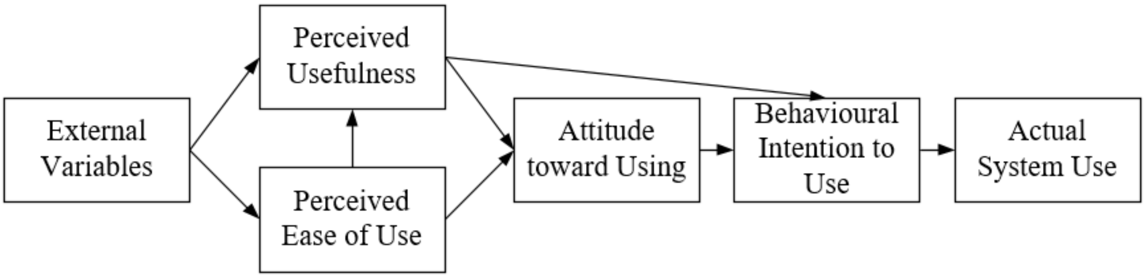


2.2.3 Technology Acceptance Model

2.2.3.1 TAM1

The Technology Acceptance Model (TAM) is one of the most influential theories in technology acceptance research. TAM is a parsimonious model aimed at predicting and explaining user behaviours across a broad range of end-user IS/IT and user populations (Davis et al., 1989). TAM was initially introduced by (Davis, 1986), who adapted and tailored TRA for modelling the user acceptance of technologies. As shown in Figure 7, the very first version of TAM retained attitudinal belief as a precursor of behavioural intention (BI) and BI predicted actual system use (USE) (Davis et al., 1989). In the specific context of IS/IT, TAM revised the factors influencing attitude to the perceived usefulness (PU) and perceived ease of use (PEOU). The theorised relationships between the four core constructs of TAM, i.e. PU, PEOU, BI, and USE, are supported by the empirical results of over half of the articles published by leading MIS journals and conferences (Lee et al., 2003).

Figure 7 Technology Acceptance Model 1 (adapted from Davis et al., 1989)



In addition to the four core constructs, TAM incorporated external variables as influential variables of PU and PEOU. External variables cover the characteristics of the system, user, and task, as well as influences from the implementation process, policy, organisation, etc. (Fishbein and Ajzen, 1975; Davis et al., 1989). The effects of PU and PEOU on BI were initially hypothesised to be partially mediated by the attitude toward using (Davis et al., 1989). It was argued that attitude may perform as a weak link toward accepting new technology (Bagozzi et al., 1992). However, attitude was finally omitted from the initial version of TAM since omitting attitude contributes to the parsimoniousness of TAM (Davis et al., 1989; Venkatesh et al., 2003), and PU and PEOU have direct effects on BI (Davis et al., 1989). The latter one can be interpreted as people may intend to use an IT because they perceived it is useful even without having a positive attitude toward using it (Venkatesh, 2000). This omission highlighted the necessity of ascertaining the explanatory power of PU and PEOU (Venkatesh, 2000).

PU and PEOU are two key variables of TAM, playing a fundamental role in analysing IS/IT acceptance and use (Davis, 1989). PU and PEOU represent the user's beliefs about the usefulness of and the effort required for using an IS/IT respectively (Davis, 1989; Venkatesh and Davis, 2000). Based on observation, ones' attitude toward using an IS/IT is dependent on whether they believe the use would be helpful to their job performance (Davis et al., 1989; Bradley, 2012). As such, PU was defined as the degree to which an individual believes that using the IS/IT would enhance performance in completing particular tasks (Davis, 1989; Davis et al., 1989). Additionally, one would use an application only if he or she perceived it was both useful and easy to use (Davis, 1989; Venkatesh and Davis, 2000; Bradley, 2012).

Thus, PEOU was introduced as another influential factor that refers to the expected effort required in using the target IS/IT (Davis et al., 1989).

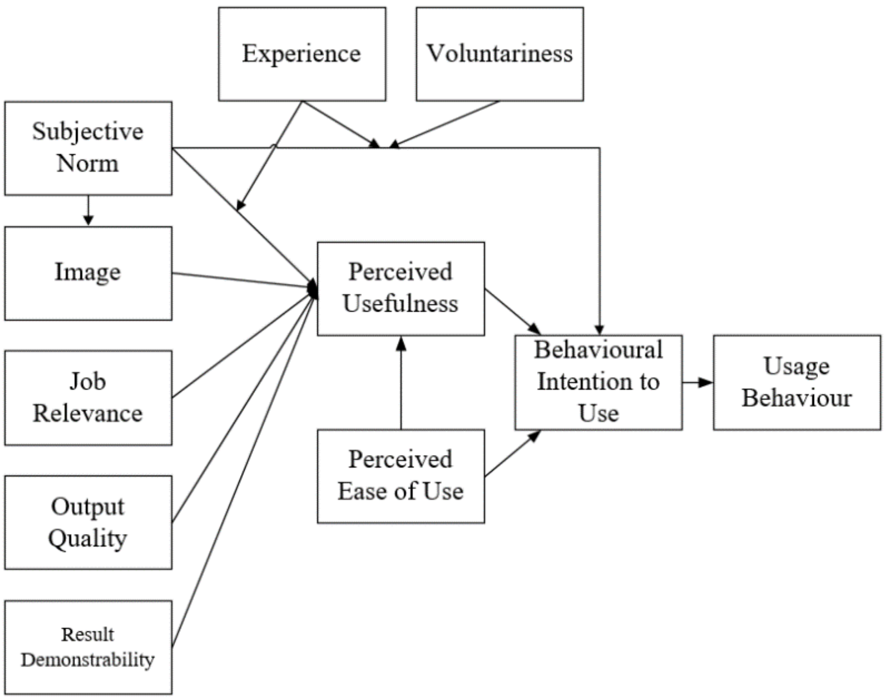
Evidence from empirical studies supported the effects of PU and PEOU on BI across different organisational settings (i.e. voluntary use and mandatory use) and different phases (i.e. pre-implementation, one-month post-implementation, and three-month post-implementation) (Venkatesh and Davis, 2000). Literature suggested that PU is a strong primary determinant of BI, while PEOU is a significant secondary determinant (Davis et al., 1989; Chau, 1996; Venkatesh and Davis, 2000). Additionally, PEOU was found to be a causal antecedent of PU that can affect BI indirectly via PU (Davis, 1989; Davis et al., 1992). This indirect effect has been retained in the majority of TAM-based MIS studies, including the updated versions of TAM (discussed below).

2.2.3.2 TAM2

The second version of the Technology Acceptance Model, namely TAM2, aimed to further explain the variances in the behavioural intention of use (Venkatesh and Davis, 2000), as previous TAM-based studies suggested that PU plays a leading role in determining BI, more specifically, with approximately 0.60 of the standardised regression coefficient (Venkatesh and Davis, 2000). As such, TAM2 further elaborates the determinants of PU, as well as their effects changing over time with the increase of user experience (Venkatesh and Davis, 2000). TAM2 included five constructs as external variables and two moderating variables (see Figure 8). More specifically, the external variables, i.e. subjective norm, image, job relevance, output quality and result demonstrability, would influence PU and BI. Experience and voluntariness of use would moderate the effects of subjective norm. Empirical results suggested that TAM2 explained 40-60% of variances in PU and 37%-52% of variances in BI (Venkatesh and Davis, 2000).

TAM2 encompasses the social influence process (i.e. subjective norm, voluntariness, and image) and the cognitive instrumental process (i.e. job relevance, output quality, result demonstrability, and PEOU) to explain PU and BI (Venkatesh and Davis, 2000). The social influence process describes the social forces impinging on an individual when facing the opportunity to accept or reject a new IS/IT, even if this individual does not consider the use or the consequences favourably (Venkatesh and Davis, 2000). Subjective norm was omitted in the first version of TAM, since its effect was not statistically significant (Davis et al., 1989). (Davis et al., 1989) argued that this may have occurred because of the lack of sophisticated measures assessing specific types of social influence process or societal factors have a limited impact on personal applications compared to multi-person applications. In TAM2, the effects of the social influence process may diminish over time when the referred IS/IT has been applied whilst the effects of the cognitive instrumental process would remain significant over time (Venkatesh and Davis, 2000).

Figure 8 Extension of TAM: Technology Acceptance Model 2 (adapted from Venkatesh and Davis, 2000)



2.2.3.3 TAM3

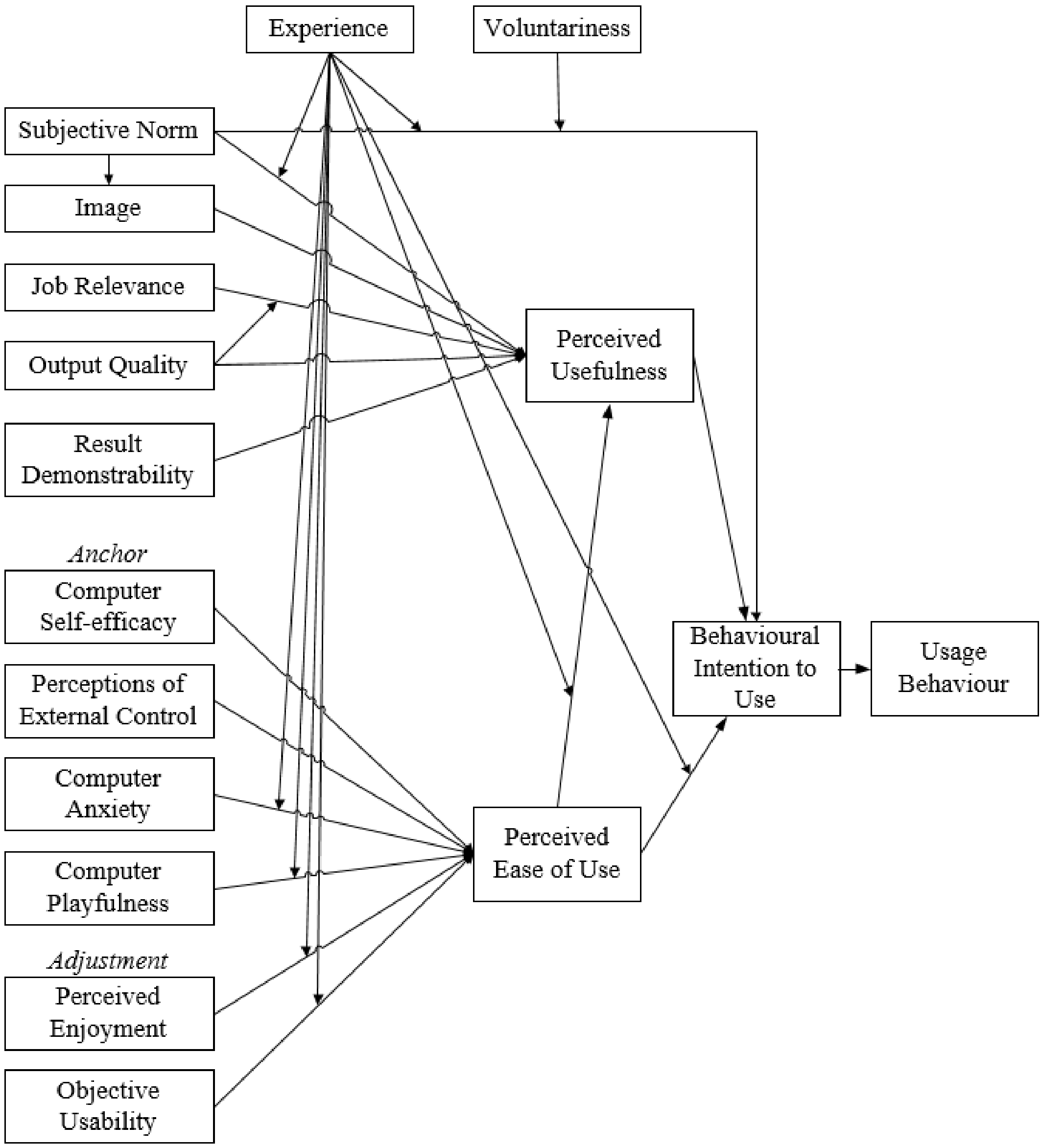
TAM-based studies focused on providing explanations for how and why the users decide to adopt and use an IS/IT (Venkatesh and Bala, 2008). Previous studies employing TAM focused on three areas, i.e. (a) replicating TAM and providing psychometric measures of the TAM constructs, (b) underpinning the importance of PU and PEOU, and (c) adding determinants for TAM constructs (Venkatesh and Bala, 2008). Four types of variables were added to determine PU and PEOU: individual differences (e.g. personality traits and demographic characteristics), system characteristics (i.e. salient features of a system), social influence (i.e. social influence processes and mechanisms), and facilitating conditions (e.g. organisational support) (Venkatesh and Bala, 2008).

TAM3 extended TAM2 by adding determinants of PEOU following the above-listed four types of constructs and the two aspects framing human decision-making, i.e. anchoring and adjustment. The individuals have initial judgments of the ease-of-use regarding a new IS/IT (i.e. anchoring), and these judgments will be adjusted after they gain more hands-on experience with the IS/IT (i.e. adjustment) (Venkatesh, 2000; Venkatesh and Bala, 2008). More specifically, as shown by Figure 9, six variables that directly affect PEOU were incorporated into TAM3. These variables were categorised as the aspects of anchoring (i.e. computer self-efficacy, perceptions of external control, computer anxiety, computer playfulness) and adjustment (i.e. perceived enjoyment, and objective usability). Three of the anchoring factors, namely the computer self-efficacy, computer anxiety, and computer playfulness, fall into individual differences (Venkatesh and Bala, 2008). The perception of external control falls into facilitating conditions (Venkatesh and Bala, 2008). The two adjustment factors fall into system characteristics (Venkatesh and Bala, 2008). Factors representing social influence were incorporated in TAM2, i.e. subjective norm and image.

The success of technology adoption is not only determined by the first acceptance but is also profoundly influenced by long-term use and continuance intentions (Venkatesh, 2000; Venkatesh and Bala, 2008). As such the user's experience and knowledge gained by use are critical to MIS theories. TAM3 retained experience as a moderator which affects eight effects, as illustrated by Figure 9 (Venkatesh, 2000; Venkatesh and Bala, 2008). Empirical results suggested that the effects of two anchoring factors (i.e. computer playfulness and computer anxiety) diminish by time whilst the effects of adjustment factors on PEOU strengthen by gaining experience of use(Venkatesh, 2000; Venkatesh and Bala, 2008).

TAM3 provided a more comprehensive understanding of user acceptance and use of IS/IT, by which the explanatory power was significantly increased (Venkatesh and Bala, 2008). Specifically, results of the empirical tests across three time-points indicated that TAM3 explained 52-67% of the variance in PU, 43-52% of variance in PEOU, and 31-36% of variance in use behaviour (Venkatesh and Bala, 2008). TAM3 also contributes to enhancing user acceptance and encourages effective utilisation of a new IS/IT (Venkatesh, 2000; Venkatesh and Bala, 2008). Previous versions of TAM have been criticised for their weakness in providing practical guidance in such aspects as system development, implementation, and efficiency of use (Chen and Tan, 2004). However, TAM3 provided implications for practitioners in term of guidance for interventions in both the pre-implementation and post-implementation phases (Venkatesh and Bala, 2008). More specifically, pre-implementation interventions can be made in the areas of system design, user participation, management support, and incentive alignment, while post-implementation interventions can be made in terms of providing user training and encouraging organisational and peer support (Venkatesh and Bala, 2008; Bradley, 2012).

Figure 9 Technology Acceptance Model 3 (adapted from Venkatesh and Bala, 2008)



2.2.4 The Unified Theory of Acceptance and Use of Technology

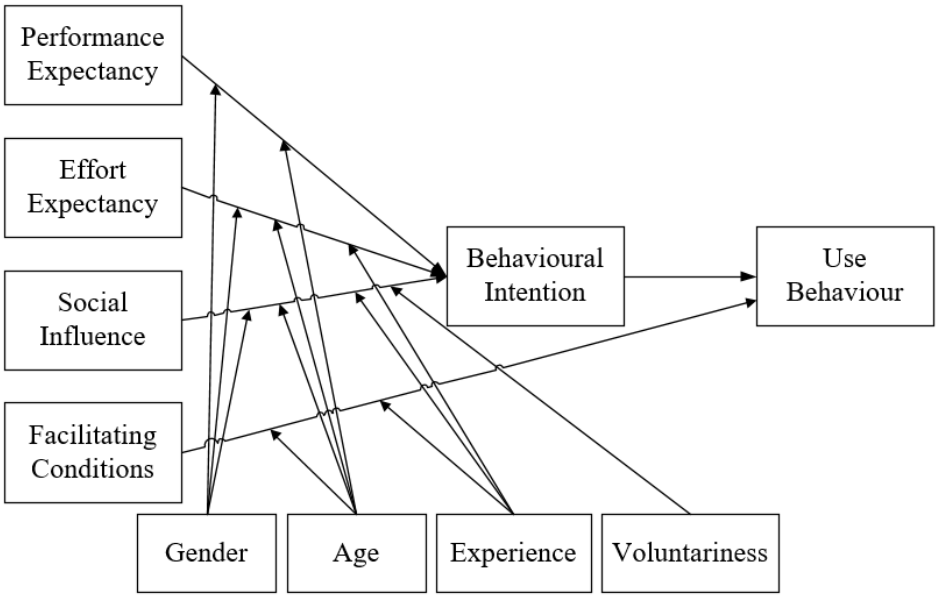
2.2.4.1 UTAUT1

The Unified Theory of Acceptance and Use of Technology (UTAUT) was developed and empirically validated by (Venkatesh et al., 2003). UTAUT was constructed by reviewing, mapping, and integrating the constructs of eight prominent MIS theories, i.e. TRA, TAM/TAM2, MM, TPB/DTPB, Combined TAM and TPB (C-TAM-TPB), the Model of PC

Utilization (MPCU), Innovation Diffusion Theory (IDT), and Social Cognitive Theory (SCT) (Venkatesh et al., 2003). These eight theories have been examined by a range of studies not only in the domains of technology acceptance, but also in disciplines such as innovation diffusion, marketing, social psychology, and management (Williams et al., 2012). Some of the constructs in these theories are similar in nature, making it possible to integrate them comprehensively and logically and create a unified theoretical basis (Venkatesh et al., 2003; Williams et al., 2012). Tested with longitudinal data from four organisations, UTAUT outperformed the eight prominent models in explaining variances in user intentions to use information technology (Venkatesh et al., 2003). UTAUT also enables the managers to assess the likelihood of successfully introducing new technology and to understand the driving factors of acceptance with the aim of proactively designing interventions for the users that are less-inclined to accept a new IS/IT (Venkatesh et al., 2003).

UTAUT consists of four core constructs determining behavioural intention and use behaviour, as well as four moderators affecting the main effects (see Figure 10). Performance expectancy is defined as the "*the degree to which an individual believes that using the system will help him or her to attain gains in job performance*", which integrated the concepts of five variables, i.e. perceived usefulness from TAM, extrinsic motivations from MM, job-fit from MPCU, relative advantage from IDT, and outcome expectations from SCT (Venkatesh et al., 2003). The effect of performance expectancy on behavioural intention is significant and strong in both mandatory and voluntary settings but is stronger for users who are younger in age and being male (Venkatesh et al., 2003). Effort expectancy refers to the perceived degree of ease concerning using the target system (Venkatesh et al., 2003). It comprises perceived ease of use from TAM, complexity from MPCU, and ease of use from IDT (Venkatesh et al., 2003). Effort expectancy is particularly influential on behavioural intention among younger female users at the early stage of use experience (Venkatesh et al., 2003). Social influence measures *"the degree to which an individual perceives that important others believe he or she should use the new system"* (Venkatesh et al., 2003). This construct integrated subjective norm (TRA, TPB/DTPB, TAM2, and C-TAM-TPB), social factors (MPCU), and image (IDT) (Venkatesh et al., 2003). The effect of social influence on behavioural intention is particularly significant in mandatory settings, among populations with less experience on the target system, being female, and older in age (Venkatesh et al., 2003). Facilitating conditions represent the users' beliefs in the supportive organisational and technical infrastructures available to them (Venkatesh et al., 2003). It was composed by perceived behavioural control (TPB/DTPB and C-TAM-TPB), compatibility (IDT), and facilitating conditions (MPCU) (Venkatesh et al., 2003). Venkatesh et al. (2003) argued that issues regarding supportive infrastructure are largely captured by effort expectancy. As such facilitating conditions would predict behavioural intention when effort expectancy was not included in the research model (Venkatesh et al., 2003). With the presence of effort expectancy, facilitating conditions is expected to directly determine actual use behaviour (Venkatesh et al., 2003). Moreover, this effect would be stronger for older users with more experience on the system (Venkatesh et al., 2003).

Figure 10 The Unified Theory of Acceptance and Use of Technology (adapted from Venkatesh et al., 2003)



2.2.4.2 UTAUT2

The acceptance and use of information technology and systems have been sufficiently investigated in the organisational context (Benbasat and Barki, 2007; Venkatesh et al., 2007). In the meantime, explaining the acceptance and adoption of IS/IT from the perspective of individuals was considered to be a vital research area. As such, UTAUT2 has been put forward with the aim of adapting it to the consumer technology use context (Venkatesh et al., 2012b). UTAUT2 incorporated three additional constructs, i.e. hedonic motivation, price value, and habit, and dropped the voluntariness moderator.

Hedonic motivations is defined as "*the fun or pleasure derived from using a technology*", and was employed as perceived enjoyment in previous MIS theories (Venkatesh et al., 2012b). The perceived fun and enjoyment of an IS/IT is expected to be particularly influential in the context of consumer technology use. Also, individual consumers usually need to bear the monetary cost of adopting an IS/IT outside the workplace (Venkatesh et al., 2012b). Price value, which refers to the consumer's cognitive trade-off between the monetary cost and perceived benefits of using an IS/IT, was incorporated (Venkatesh et al., 2012b). In addition, prior experience affects one's decision-making about technology acceptance as well. Experience differs from habit in two ways. Firstly, experience reflects an opportunity to use the target IS/IT, which is necessary but not sufficient for shaping a habit (Venkatesh et al., 2012b). Then, experience is typically operationalised by measuring the passage of time since the initial use of the IS/IT, while habit is viewed as the levels of automatic use behaviour depending on one's interaction with and familiarity with the IS/IT (Venkatesh et al., 2012b). Given the above, habit was conceptualised as a self-reported perception of the level of automatic use as a result of prior experiences (Venkatesh et al., 2012b). Empirical results suggested that performance expectancy is the most influential determinant of behavioural intention in an organisational context, whereas hedonic motivation and price value have stronger effects in a consumer context (Venkatesh et al., 2012b).

2.3 Adoption of Technology

As previously noted, technology acceptance theories commonly employed users' intention of use or actual use behaviour as the dependent variable. However, simply adding the factors driving technology acceptance and adoption to the existing theories hindered MIS studies when it came to exploring the consequences brought about by a new technology. As such, some argued that technology adoption and use can be viewed as a process that is made up of technology creation, technology use, and the consequences of use (Karahanna et al., 1999; Delone and McLean, 2003). The following sections introduce first the Innovation Diffusion

Theory, which views the diffusion of a new technology as the process of being communicated through certain channels over time among the individuals (Rogers, 1995). These individuals possess different degrees of willingness to adopt the innovation. Such willingness would be influenced by many characteristics of the technology. Then, the Task-Technology Fit Model further incorporated the task aspect in addition to the technology characteristics. The fit between the characteristics of the technology and the tasks it targets determines the impact brought about by technology adoption on the users and the organisation. Lastly, the Information System Success Model suggested that the characteristics of the service provided by the technology affect technology use and consequences as well.

2.3.1 Innovation Diffusion Theory and Perceived Characteristics of Innovating

Innovations, especially those related to technological evolution, are triggers of social change (Cua, 2012). Innovation refers to the "*idea, object or practice that is perceived to be new by members of the social system*" (Rogers, 1995). The diffusion of innovation can be viewed as a social process, which is defined as *"the process by which an innovation is communicated through certain channels over time among the members of a social system"* (Rogers, 1995; Cua, 2012; Tscherning, 2012). Grounded on sociology, the Innovation Diffusion Theory (IDT) or the Diffusion of Innovations Theory concerns the process and attributes of innovations and their diffusion through levels of the organisation, society, or country (Rogers, 1995; Venkatesh et al., 2003; Cua, 2012). IDT has been applied to explain the diffusion of innovation and complex social phenomena such as the interactions among people, organisations and technology (Cua, 2012).

The individuals within a social system have different degrees of willingness to adopt an innovation (Rogers, 1995). This willingness will be determined by the perceived attributes of innovation (Tornatzky and Klein, 1982). The seminal work of exploring innovation characteristics, namely IDT, proposed five primary characteristics affecting innovation adoption, i.e. relative advantage, compatibility, observability, complexity, and trialability (Rogers, 1962). In addition to these five characteristics, studies of innovation characteristics also frequently addressed a few others, such as the cost of adopting an innovation, communicability, divisibility, profitability, and social approval (Tornatzky and Klein, 1982).

Among these, relative advantage, compatibility, and complexity were identified as three characteristics that consistently and significantly influence the implementation and adoption of innovations (Tornatzky and Klein, 1982). Relative advantage and compatibility have positive effects on innovation adoption, whereas complexity has negative effects (Tornatzky and Klein, 1982).

Moore and Benbasat (1991) introduced the perceived characteristics of innovation into studies of initial adoption and even diffusion of information technology. With the aim of adapting to the context of IS/IT innovations, the five characteristics of IDT were extended and revised into eight user perceived characteristics of innovating (Moore and Benbasat, 1991). More specifically, two additional characteristics (i.e. voluntariness and image) were added to IDT. Observability was separated into result demonstrability and visibility, and complexity was renamed as ease of use in order to be consistent with MIS theories (Moore and Benbasat, 1991; Plouffe et al., 2001). These eight characteristics were examined and tested by Venkatesh et al. (2003), and they performed advantageously in explaining variances of intention of using an IS/IT. IDT was compared with TAM in terms of parsimoniousness and explanatory power (Plouffe et al., 2001). Results indicated that IDT sacrificed parsimoniousness, but explained more variances in users' adoption intention and also provided much detailed information for practitioners (Plouffe et al., 2001). On the other hand, many studies introduced the variables of IDT to extend their research models based on MIS theories, such as TAM, with the aim of increasing the predictive and explanatory abilities of their research model (Chen and Tan, 2004).

Drawing from IDT, six innovation characteristics are frequently employed in MIS studies, i.e. relative advantage, complexity, compatibility, result demonstrability, visibility, and trialability. First of all, relative advantage refers to *"the degree to which an innovation is perceived as being better than the idea it supersedes"* (Rogers, 1983). This characteristic describes the perceived benefits that are superior to its precursor in terms of economic profitability, time and effort saving, lower cost, less discomfort, and immediacy of reward (Abu-Khadra and Ziadat, 2012). This construct is related to the attribute of PU, which also measures the advantages of using an IS/IT (Abu-Khadra and Ziadat, 2012). Among the IDT variables, relative advantage is a leading determinant of ICT adoption and growth (Rogers, 1995; Gemino et al., 2006; Abu-Khadra and Ziadat, 2012). Complexity refers to *“the degree to which an innovation is perceived as relatively difficult to understand and use”* (Rogers, 1983). The concept and measure items of complexity and PEOU have a resemblance (Moore and Benbasat, 1996; Venkatesh et al., 2003). The ICTs that are perceived as easy to use and less complicated to understand are more likely to be accepted and adopted by potential users than those that require new skills (Davis et al., 1989; Rogers, 1995). Thirdly, compatibility is defined as the *“degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters”* (Rogers, 1983). Integrating compatibility to the research framework of IS/IT adoption enables the model to address part of the social contextual attributes, such as the individual's previous concepts, existing values and beliefs, and potential needs (Moore and Benbasat, 1996; Chen and Tan, 2004). Compatibility is related to PU because the individuals perceive an IS/IT as a useful tool if it matches their needs (Chen and Tan, 2004; Abu-Khadra and Ziadat, 2012).

Observability was separated into result demonstrability and visibility. Result demonstrability refers to the degree to which the results of using an innovation are visible and communicable to others (Moore and Benbasat, 1991; Moore and Benbasat, 1996). Visibility describes the degree to which an innovation is apparent to the sense of sight (Moore and Benbasat, 1991; Moore and Benbasat, 1996). Result demonstrability has been included in TAM2 and TAM3 and it significantly influences PU and BI (Venkatesh and Davis, 2000). These relationships indicated that the result of a work activity is a key factor underlying the work motivation of individuals (Venkatesh and Davis, 2000). Consequently, the degree of acceptance and adoption can be low if the users find it is difficult in gaining performance in their job by using the IS/IT, even if the system per se is effective (Venkatesh and Davis, 2000). Lastly, trialability is defined as *“the degree to which an innovation may be experimented with on a limited basis”* (Rogers, 1983).

2.3.2 Task-Technology Fit Theory

The Task-Technology Fit (TTF) theory focuses on understanding the linkage between information systems and individual performance (Goodhue and Thompson, 1995). TTF theory holds that an IS/IT will be utilised if it is well-suited to the task that the individuals have to perform, which consequently increased the individuals' performance (Goodhue and Thompson, 1995; Furneaux, 2012). More specifically, the positive impact of an IS/IT on individual performance would be achieved under two conditions, i.e. the IS/IT must be utilised and must fit with the target task (Goodhue and Thompson, 1995). TTF theory has its roots in Contingency Theory, which argues that the effectiveness of an organisation depends upon the degree of fit between the characteristics of the organisation and the circumstances it faces (Goodhue, 1995; Furneaux, 2012). The core construct, namely TTF, measures the fit between the users' task and the target technology, which is a primary predictor of the improved job performance and effectiveness that is attributed to the system use (Goodhue and Thompson, 1995). Also, TTF theory can be used as a diagnostic tool examining the level of applicability and to ensure the appropriateness of technology adoption (Goodhue, 1995).

The general model of TTF theory, as Figure 11 illustrates, is constructed on the basis of the propositions that the characteristics of task and technology determine the user evaluated TTF, and the TTF further influences the use of IS/IT and predicts the performance impacts (Goodhue and Thompson, 1995). TTF theory defined the *"technology"* as tools that goal-directed individuals use in carrying out their tasks (Goodhue, 1995; Goodhue and Thompson, 1995). Specifically, in MIS contexts, technology refers to the IS/IT and user support services such as training and helplines (Goodhue and Thompson, 1995). Tasks are defined as the individuals' actions in turning inputs into outputs (Goodhue and Thompson, 1995). As such, TTF refers to *"the degree to which a technology assists an individual in performing his or her portfolio of tasks"* (Goodhue and Thompson, 1995). In other words, TTF is dependent on the degree of correspondence between the requirements of tasks, the ability of individuals, and the functionality of technology (Goodhue and Thompson, 1995). The degree of TTF will decrease if the requirement of task demands are greater than the functionality a technology can offer (Goodhue and Thompson, 1995). As illustrated, the behaviour of technology use and the TTF would affect one's performance in completing a portfolio of tasks (Goodhue and Thompson, 1995). The TTF constructs consist of eight dimensions, which fall into three categories (Goodhue and Thompson, 1995):

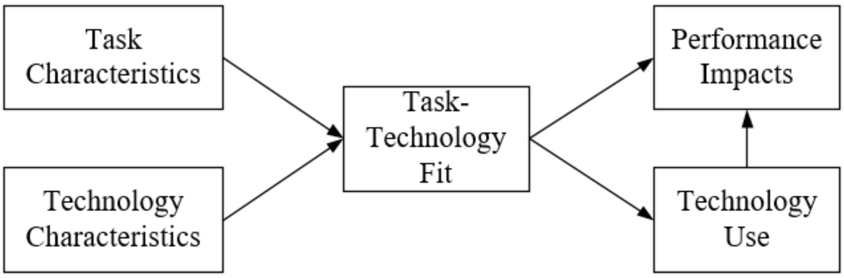
(a) meeting task needs for using data in decision making, i.e. data quality, data locatability, authorization to access data, data compatibility between systems, and ease of use/training;

(b) meeting operational needs, i.e. production timeliness and systems reliability;

(c) responding to a changed business need, i.e. IS relationship with users.

A higher degree of technology use does not necessarily lead to higher performance in completing tasks. As such, TTF theory is distinguished from technology acceptance theories by focusing on the performance impact, which is manifested as improvements in efficiency, effectiveness, and quality rather than behavioural intention (Goodhue and Thompson, 1995). TTF has been used to overcome the insufficiency of TAM in understanding technology use and impacts from the task perspective (Dishaw and Strong, 1999). This combined TAM-TTF model provides a better explanation of variances in actual technology use than either TAM or TTF alone (Dishaw and Strong, 1999).

Figure 11 General Model of Task-Technology Fit (adapted from Goodhue and Thompson, 1995)

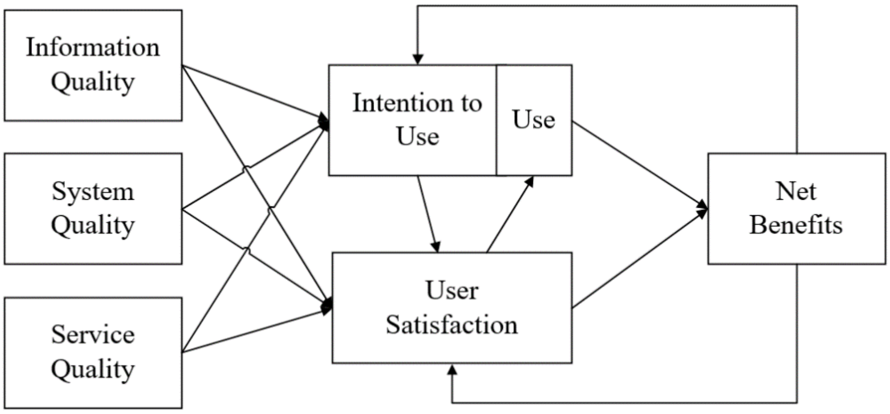


2.3.3 Information Systems Success Model

The key issue of MIS research has been discussed in the past few years. One of the most critical questions is which dependent variable could represent technology adoption best (Urbach and Müller, 2012). Some argued that the surrogate variables such as technology use and user satisfaction may not sufficiently represent the success of technology adoption (Urbach and Müller, 2012). The DeLone and McLean Model of Information Systems Success, also known as the IS Success Model (ISSM), proposed six major dimensions of IS success and created a process model that provided a comprehensive view of the concept of IS success (DeLone and McLean, 1992). More specifically, the six components of IS success, i.e. system quality, information quality, technology use, user satisfaction, individual impact, and organisational impact, were integrated into ISSM by theorising the interdependencies in between (DeLone and McLean, 1992; Delone and McLean, 2003; Urbach and Müller, 2012). The first version of ISSM proposed that the system quality and information quality influence technology use and user satisfaction, which in turn result in impacts on individuals and, consequently and eventually, have impacts on the organisation (DeLone and McLean, 1992). Technology use interacts with user satisfaction as well (DeLone and McLean, 1992). The ISSM has received great appreciations in MIS research since its propositions in explaining the IS success have been widely supported in the past few years (Urbach and Müller, 2012).

Delone and McLean updated the ISSM due to the rapid growth of e-business and dramatic changes in IS practice (Delone and McLean, 2003). The updated ISSM, as illustrated by Figure 12, included service quality in addition to the aspects of system quality and information quality. It added behavioural intention as an alternative to technology use, and replaced individual impact and organisational impact with the net benefit construct (Delone and McLean, 2003; Urbach and Müller, 2012). System quality refers to the desired characteristics of the system per se and it typically focuses on the system performance regarding providing information, such as the ease of use, reliability, and interactivity (DeLone and McLean, 1992; Urbach and Müller, 2012). Information quality consists of the desired characteristics of the output of the IS, more specifically, the information provided (DeLone and McLean, 1992; Urbach and Müller, 2012). Service quality refers to the quality of the service provided by IS functions (Delone and McLean, 2003), which are usually measured by SERVQUAL (e.g. tangible, assurance, etc.) (Pitt et al., 1995). Moreover, the technology use and/or intention to use represents the degree to which the system is utilised or has been intended to be used by the users (Urbach and Müller, 2012). User satisfaction refers to the degree of users' satisfaction when using the IS (Urbach and Müller, 2012). Lastly, net benefits is defined as the impacts brought about by using an IS on different stakeholders, including impacts on individuals, work groups, organisations, or even the society (Delone and McLean, 2003). Notably, the updated ISSM included the feedback loop, that is, the net benefits would affect the use and user satisfaction, either positively or negatively (Delone and McLean, 2003). For instance, the lack of positive benefits may cause decreased use and lower user satisfaction (Delone and McLean, 2003).

Figure 12 The Updated Delone and McLean Model of Information System Success (adapted from DeLone and McLean, 1992)



2.4 Outcomes

Technology use can lead to a number of outcomes, e.g. triggering emotional responses (Beaudry and Pinsonneault, 2005; Beaudry and Pinsonneault, 2010), enhancing the degree of social inclusion (Andrade and Doolin, 2016), increasing the degree of well-being (Munzel et al., 2018), and possessing value in someone's daily life (Wang, 2014; Yu et al., 2015a). In the meantime, the evolutionary path of technology, i.e. technology S-curve or technology life cycle, indicated that the diffusion of existing technologies and growth of new technologies overlap at some time points (Abernathy and Utterback, 1978; Utterback, 1994; Sood and Tellis, 2005). With the diffusion of innovations in a social system, information technologies and technological platforms will be upgraded and bring about further impacts on the current users (Fichman et al., 2014). This phenomenon in technology diffusion implies a potential spillover effect from the existing technological platform to a novel one. In other words, the outcomes of using an existing technology may affect the user's predispositions to accept a new technology. The following section proceeds to introduce four categories of outcomes of technology use and the potential spillover effect, bridging the existing technology and a novel one.

2.4.1 Emotional Responses

Investigating the role of emotions has facilitated the understanding of user behaviour with IS/IT in the past few years. Prior studies provide evidence that users' emotions critically affect beliefs, intentions, and behaviours in technology acceptance and adoption contexts (Beaudry and Pinsonneault, 2010; Kim and Lennon, 2013; Chang et al., 2014). For instance, positive emotions, such as the enjoyment and flow that have been used as motivational constructs and capture the quality of experience, were confirmed as predictors of technology use intentions, behaviours, and use outcomes (Agarwal and Karahanna, 2000; Hoffman and Novak, 2009; Beaudry and Pinsonneault, 2010). Negative emotions such as technology anxiety also significantly influence technology acceptance (Venkatesh, 2000; Venkatesh and Bala, 2008). On the other hand, external stimulation, such as adoption and the use of certain technologies, can also trigger and influence users' emotional responses (Chang et al., 2014; Partala and Kujala, 2015; Partala and Saari, 2015). The emotional response is defined as a set of emotional reactions elicited during IT/IS use or by use experiences (Westbrook and Oliver, 1991; Beaudry and Pinsonneault, 2010).

The study by (Beaudry and Pinsonneault, 2010) provided a classification of emotional responses in the MIS context. This classification combined two appraisals and classified the user emotions into four types. The primary appraisal is the user's perceptions of the consequences of accepting new technology, whether the new technology constitutes an opportunity or a threat (Beaudry and Pinsonneault, 2005; Beaudry and Pinsonneault, 2010). This appraisal originates from the individual's goal achievement (Bagozzi, 1992; Beaudry and Pinsonneault, 2010). Fundamentally, the goal or outcome of an individual can be either achieved or not, which in turn triggers pleasant or unpleasant feelings toward events in both planned and unplanned cases (Bagozzi, 1992). This primary appraisal determines the user's emotional reactions as positive (they perceive the technology as an opportunity, they achieve the goal) or negative (they perceive the technology as a threat, and do not achieve the goal). Notably, individuals can experience both positive and negative emotions, triggered by the same external stimulation. Thus the levels of these two dimensions of emotions can be measured separately (Russell and Carroll, 1999; Chang et al., 2014; Partala and Kujala, 2015). The emotions aroused by the adoption of a given IT may vary among individuals, depending on their unique psychological evaluations (Beaudry and Pinsonneault, 2010).

The second appraisal refers to the degree of the user's perceived control over the achievement of the expected outcome of accepting a technology (Lazarus and Folkman, 1984; Beaudry and

Pinsonneault, 2010). This dimension shared a similar concept with the perceived behaviour control, self-efficacy, compatibility, and facilitating conditions in IS research (Taylor and Todd, 1995; Venkatesh et al., 2003; Lowry et al., 2013). Users perceive more control over an easy-to-use system, which in turn alters their psychological feelings and enhances the intention of performing the behaviour (Lowry et al., 2013). When individuals believe that they have little control over the behaviour due to a lack of imperative opportunity or capacity, they are unlikely to perform the behaviour though they have strong intentions (Liew et al., 2017). Additionally, feeling a lack of control might cause negative consequences, such as low competence, psychological strain, and depression (Lowry et al., 2013).

The two appraisals classified users' emotions into four types, i.e. achievement, challenge, loss, and deterrence emotions (Beaudry and Pinsonneault, 2010). The achievement and challenge emotions are experienced when the users believe that using the new technology will generate positive outcomes; while the loss and deterrence emotions would be caused by perceived negative consequences (Beaudry and Pinsonneault, 2010). Challenge and deterrence emotions are more likely to be aroused when the users feel they have control over the expected outcomes; whereas the achievement and loss emotions are caused by a perceived lack of control (Beaudry and Pinsonneault, 2010). More specifically, the achievement emotion refers to the users' pleasant feeling when they are able to achieve their goal by using the IT with some effort, e.g. happiness, satisfaction and enjoyment (Beaudry and Pinsonneault, 2010; Lee et al., 2012). The challenge emotion is defined as the users’ excitement emotions toward the technology, which helps them achieve their goals, e.g. excitement, playfulness and flow (Beaudry and Pinsonneault, 2005; Beaudry and Pinsonneault, 2010). The loss emotion refers to the users’ anger emotions when they feel a lack of control over the consequences of using a technology, e.g. anger, frustration and dissatisfaction (Beaudry and Pinsonneault, 2010). Lastly, the deterrence emotion refers to the users’ negative feeling when they believe a technology constitutes a threat, though they have some control over it, e.g. anxiety, fear and worry (Beaudry and Pinsonneault, 2010).

2.4.2 Social Inclusion

Social inclusion (SI) is a multi-dimensional phenomenon that has been defined in various ways, e.g. (Sayce, 2001; The Charity Commission, 2001; Secker et al., 2009; Huxley et al., 2012). For instance, (Sayce, 2001) defined social inclusion as "a virtuous circle of improved rights of access to the social and economic world, new opportunities, recovery of status and meaning, and reduced impact of disability". Social inclusion comprises four dimensions: (a) bonding and bridging social capital; (b) social acceptance, neighbourhood cohesion and engagement in leisure and cultural activity; (c) citizenship; and (d) perceived security of housing tenure (Secker et al., 2009). Although social inclusion is based on the concept of social exclusion, social inclusion cannot be simply viewed as "non-exclusion", but rather as creating opportunities proactively and having freedom in making choices (Phipps, 2000; Selwyn, 2002; Andrade and Doolin, 2016). Accordingly, social inclusion relates to the emotional and health benefits generated by access to social capital, social acceptance and social activity, as well as the positive actions taken by the individuals to deal with social exclusion, which consequently enables people to fully participate in the society (Sayce, 2001; The Charity Commission, 2001; Secker et al., 2009; Andrade and Doolin, 2016). Being included in a group is a fundamental need, and fulfilling this need enhances one's well-being (Deci and Ryan, 2000; Ryan and Deci, 2000c; Tay and Diener, 2011). A low degree of social inclusion may limit an individual's access to social support and public services (Kennan et al., 2011).

Recent studies have regarded social inclusion as one of the factors encouraging or hindering the acceptance and use of ICTs. Social inclusion is tightly related to the well-being of citizens, especially of the ICT-engaged individuals, as ICT use promotes their participation in the communities with valued relationships and collective social capital (Gurstein, 2000; Van Winden, 2001; Broadbent and Papadopoulos, 2013; Hill et al., 2015). Moreover, with the diffusion of information technology and online services, digital inclusion has become a critical issue concerning how ICTs could serve the society and promote social inclusion (Tapia et al., 2011; Hill et al., 2015). More specifically, social inclusion/exclusion is believed to closely relate to digital inclusion/exclusion. A high degree of digital inclusion was found to be a catalyst for social inclusion (Tapia et al., 2011; Hill et al., 2015). On the other hand, the diffusion of new forms of technological breakthrough could potentially exacerbate existing social exclusion or even create new possibilities for digital exclusion (Andrade and Doolin, 2016). An opinion concerning the prospective social change brought about by the Internet of Things argued that "*there will be new ways for people to connect, as well as new pathways towards isolation, misanthropy, and depression"* (Thibodeau, 2014).

The role of ICTs in enhancing the degree of social inclusion was elaborated by Andrade and Doolin's (2016). The ICTs were found to be a resource providing five valuable capabilities contributing to the social involvement of newly resettled refugees (Andrade and Doolin, 2016). Specifically, the well-being of newly resettled refugees in a new society can be increased with the aid of five capabilities offered by ICTs, i.e. (a) participating in an information society; (b) communicating effectively; (c) understanding a new society; (d) being socially connected; and (e) expressing a cultural identity (Andrade and Doolin, 2016). Notably, ICTs do not increase social inclusion automatically but enhance the individual's manner of use, in which the ICTs can act as a vehicle of promoting the individual's participation in social activities and communities, and dynamically transform social inclusion into well-being (Castells, 2001; Andrade and Doolin, 2016). As such, the afore-mentioned five capabilities of ICTs can enhance refugees' degree of being socially included by offering them opportunities to adapt to the new host society, which in turn increases their well-being and further benefits the general public (Andrade and Doolin, 2016).

2.4.3 Well-Being

Well-being is a superordinate concept that refers to both short-term and long-term experiences of pleasure (Ong and Lin, 2016). Well-being can be viewed as an overall assessment of life satisfaction and experiences of both positive and negative affect (Diener et al., 1999). Although user satisfaction is one of the dominant factors measuring the success of technology implementation, many studies also incorporated and tested well-being as one of the outcomes of technology use. For instance, the study of (Ong and Lin, 2016) suggested that, compared with user satisfaction, well-being has greater positive impacts on the users' loyalty and continuance intention of using the social networking website. Another study showed that the influences of using IT on children's psychological well-being are dependent on the type of IT being used (Jackson et al., 2008). More specifically, children who are heavier users of video games and communication services usually experience a lower degree of psychological well-being, whereas those who use the Internet for purposes other than communication reported a higher degree of well-being (Jackson et al., 2008). However, a more recent study suggested that technology overload (e.g. overuse) did not directly influence the users' psychological well-being, but the addiction to social networking services mediated this relationship and conveyed a negative impact (Choi and Lim, 2016). Another study investigated the moderating role of technology use on the relationships between the individuals' well-being and role balance in the workplace and the family (Gözü et al., 2015). Results suggested that the employees' attitude toward personal web use weakened the negative effect of work-family conflict on their well-being, and such attitudes also strengthened the positive effect of work-family facilitation on well-being (Gözü et al., 2015). These findings indicated that technology use potentially contributes to managing the spillover effect between workplace and family and enhanced the users' personal well-being (Gözü et al., 2015).

2.4.4 Perceived Value

Taking into account that IS/IT plays a critical role in people's daily life nowadays, it is believed to possess value for individuals. MIS studies proposed a number of constructs to represent different values affecting technology acceptance and use, such as performance/utilitarian value (e.g. PU and PEOU), hedonic value (e.g. cognitive absorption, perceived enjoyment, and playfulness), social value (e.g. subjective norm and social influence), and monetary value (e.g. price value) (Davis et al., 1989; Agarwal and Karahanna, 2000; Venkatesh et al., 2012b; Lowry et al., 2013). Perceived value has roots in behavioural decision theory and social psychology, and it can be defined as the users' justification for the experience of using the IS/IT in their daily life, regardless of whether this is for work or personal purposes (Okada, 2005). Moreover, the users' perceived value of an IS/IT is a cognitive trade-off between the perceived benefits and sacrifice of accepting the technology (Kim et al., 2017; Shin, 2017). The perceived benefits consist of increased job effectiveness, individual productivity and task innovation, and decreased effort devoted to task completion (Urbach and Müller, 2012). On the other hand, perceived sacrifices consist of the monetary cost (e.g. price value), privacy risk, and difficulties in use (e.g. complexity) that would hinder the users' acceptance (Moore and Benbasat, 1991; Venkatesh et al., 2012b).

2.4.5 Spillover Effect

Spillover refers to the within-person transference of psychological states and behaviour from one life domain to another, which is a mechanism that links various areas of one's everyday life (Edwards and Rothbard, 2000; Xanthopoulou and Papagiannidis, 2012). The spillover effects of the originating domain on the receiving domain generate similarities between them, usually described as one's affect, values, skills, and behaviours (Edwards and Rothbard, 2000; Hanson et al., 2006). (Hanson et al., 2006) developed and validated three types of work-family positive spillovers, namely the behaviour-based instrumental spillover, value-based instrumental spillover, and affective spillover. Skills, behaviours, and values are likely to spill over through the instrumental path, which is a direct transfer from one role to another, leading to better performance in the receiving domain (Greenhaus and Powell, 2006; Hanson et al., 2006). Affect can be transferred in one of two ways, i.e. indirect spillover via influencing the individuals' performance, or direct spillover into one's general affect (Judge et al., 2000; Hanson et al., 2006).

The instrumental spillover effects comprise the transference of skills, values, and behaviours, as various studies have demonstrated. For example, a longitudinal study supported the positive spillover of active learning and transformational leadership from an online game to real-life work under the condition of enhanced game performance (Xanthopoulou and Papagiannidis, 2012). Although it requires time to transmit these skills gained in the online game to the work domains, putting these skills into practice within the business environment can improve organisational effectiveness (Xanthopoulou and Papagiannidis, 2012). Similarly, an experimental study provided evidence that the products' functional, economic, emotional, and social values can spill over into other service subsystems, and vice versa (Arne et al., 2017). These spillover effects further affect the consumers' loyalty and value perceptions in other service subsystems (Arne et al., 2017). Specifically, the emotional value of a well-performing wireless service significantly spills over into the consumer loyalty of a cell phone manufacturer, even though the cell phone per se performed poorly (Arne et al., 2017). Lastly, the effects of behavioural spillover can be beneficial or harmful, e.g. promoting better performance or interfering with performance (Edwards and Rothbard, 2000; Hanson et al., 2006; Pierce et al., 2016). For instance, the employees who are high in positive affectivity or with high job involvement may experience a greater spillover of positive mood and job satisfaction, consequently enhancing their performance (Carlson et al., 2011). However, when the pressures experienced in the workplace and home are incompatible, the individuals are likely to encounter negative work-family interferences (Bellavia and Frone, 2005). The negative work-family and family-work interferences would increase one's perceived stress and decrease their job satisfaction (Lourel et al., 2009). This negative spillover effect indicates that lower job satisfaction reduces psychological well-being and job performance (Sok et al., 2014). A flexible work-home arrangement can enhance the beneficial spillover effects and alleviate the harmful effects (Sok et al., 2014).

Affect is an umbrella term that covers *"a wide range of dispositions, moods, emotions, and generalised affective reactions to events, objects, and daily experiences"* (Eby et al., 2010). The spillover of affect refers to the idea that one's affect in one domain can be influenced by his/her functioning and experiences in another domain (Lambert, 1990; Pierce et al., 2016). Affective spillover involves the transference of an individual's attitudes, emotions, and psychological states (Lambert, 1990; Xanthopoulou and Papagiannidis, 2012; Pierce et al., 2016). Affect spills over in either an indirect or a direct way. Firstly, the transference of affect can be achieved indirectly via one's performance. Specifically, the positive affect experienced in the originating domain may directly increase one's motivation, self-efficacy, and interpersonal interactions in the receiving domain (Edwards and Rothbard, 2000; Hanson et al., 2006). Such an increase improves one's performance in the receiving domain and thereby results in feelings of personal accomplishment or recognition from other people, which consequently elevates one's mood (Edwards and Rothbard, 2000; Hanson et al., 2006). For instance, the individuals' feelings of satisfaction and pride in their family can increase their satisfaction with the job and boost their self-efficacy at work (Eby et al., 2010). Also, the frustration experienced at work may influence one's mood at home after work (Eby et al., 2010). Secondly, affect can be transferred directly via affect generalisation (Judge et al., 2000; Hanson et al., 2006). The affect experienced in one role may influence one's general affect thereby influencing their affect in the receiving domain (Edwards and Rothbard, 2000; Judge et al., 2000; Hanson et al., 2006). For instance, a recent study indicated that the work-family conflict experienced by the employees may be reflected in emotional exhaustion, which spills over into the work domain and results in low work engagement and low job success (Wayne et al., 2017).

2.5 Research Gaps and Objectives

In the past few decades, a number of technology acceptance and adoption studies have been conducted based on the above-mentioned theories, especially TAM. However, it is necessary to move outside the limited confines of the traditional models and to extend the current theories from a broader perspective (Benbasat and Barki, 2007). One possible avenue is going back to the original social and psychological theories to identify more possible antecedents, which makes going beyond the technology acceptance theories possible and allows for novelty (Benbasat and Barki, 2007). On the other hand, the influencing factors examined in the previous theories indicated an excessive focus on the system characteristics (discussed later). Following the above, section 2.1 explored a number of psychological factors that potentially act as motivations of technology acceptance and use. This thesis aims to explore the roles of users' attributes and to extend the current causal chain of technology acceptance theories from psychological and emotional perspectives.

As previously discussed, the fundamental causal chain of technology acceptance theories suggested that the users' attitudes and beliefs determine their behavioural intention, and this intention further leads to actual technology use (Venkatesh et al., 2003; Tscherning, 2012). With the aim of facilitating technology and adoption theories, the majority of previous studies concerned the antecedents of the users' behavioural intention. Very few of the existing theories examined the outcomes of technology use. For instance, TTF introduced the fit between a specific task and the target technology that potentially influences the users' job performance and effectiveness (Goodhue and Thompson, 1995). Also, ISSM incorporated technology acceptance outcomes such as user satisfaction and net benefits (Delone and McLean, 2003). However, the outcomes incorporated by these theories can only be applied to a relatively narrow context and target a specific task (Goodhue and Thompson, 1995). Given that, this thesis aims to explore and test the outcomes of general technology use from a broad perspective, e.g. the users' well-being enhanced by using technological platforms, and the possible spillover effect from one platform to its subsequent version.

In addition to the acceptance of an innovative technology, adoption is also a critical stage in the process of diffusion. Previous studies in technology adoption have usually targeted a specific system and investigated the factors determining the adoption. There is a scarcity of studies investigating the adoption of a technological platform form a comprehensive viewpoint. As such, the third research aim of this thesis is to test the effects of the users' perceived characteristics of innovation on IoT adoption, as well as the potential psychological outcomes brought about by the IoT.

Chapter 3. Research Framework and Hypothesis Development

This chapter firstly presents the research context of this thesis, i.e. the Internet of Things (IoT). Then, section 3.2-3.4 proceed to introduce the research gaps, aims and objectives of the three empirical studies. On the basis of reviewing findings of previous studies, a number of hypotheses were developed and three research frameworks were put forward.

3.1 Exploring the Internet of Things

This section offers a review of business-related IoT studies, especially studies from the user perspective. The first part presents the main definitions of IoT and identified a number of distinctive characteristics. Then, it discusses the development of IoT and introduces 14 categories of IoT services and applications, falling into four types according to their target and scope of adoption. The characteristics of IoT products are summarised as well. Lastly, section 3.1.5 identifies 19 empirical studies on IoT acceptance and adoption, providing a description of the research design and reporting their main findings.

3.1.1 IoT Definitions and Characteristics

This section embarks on the analysis of frequently employed definitions of the IoT. The first definition was proposed by (Atzori et al., 2010), who stated that IoT is a result of the convergence of three visions, namely *"things-oriented"*, *"internet-oriented"*, and *"semantic-oriented"* visions. The study of (Atzori et al., 2010) introduced the IoT semantically as *"a world-wide network of interconnected objects"* and approached the IoT from the viewpoint of the *"pervasive presence"* of uniquely addressed objects around people that are able to interact with the other objects and react to the physical environment and thus reach common goals. The second definition put forward by ITU (ITU Strategy and Policy Unit, 2005; ITU-T, 2012) suggested that the IoT is every object of the physical or virtual world which *"is capable of being identified and integrated into communication networks"*. Finally, one of the most representative definitions was proposed by the European Commission (Guillemin and Friess, 2009), conceptualising the IoT as a dynamic global network infrastructure that will be integrated into and act as an extension of the future internet, in which various *"things"* have unique identities, physical attributes, virtual personalities, and intelligent interfaces. Put differently, *"the Internet of Things will allow people and things to be connected any time, any place, with anything and anyone, ideally using any path/network and any service"* (Guillemin and Friess, 2009). The term "*things*" acts as a new dimension of the extension of current existing human and application interaction, thus enabling people and objects to be connected, exchanging real-time information via any path (Guillemin and Friess, 2009; UK Research Council, 2013; Man et al., 2015; Baldini et al., 2016).

The identified definitions have a great deal of overlap in that they share a few common characteristics as follows:

The pervasive presence of connected objects: The purpose of IoT is to make possible the efficient sharing of real-time information among autonomous networked actors (Yang et al., 2013). IoT refers to the pervasive presence of billions of intelligent communicating objects that are connected in an Internet-like structure which can be considered as part of the future Internet, cities and the world itself, which will be overlaid with smart objects that can sense and react (a smart world) (Shin, 2014; Stankovic, 2014; Ng et al., 2015; Rau et al., 2015). Objects in a future smart world will be uniquely identified, accessed and verified over the Internet. These items will have a virtual representation or digital shadow that will be stored in cyberspace, enabling communication and interaction between humans and objects or machine to machine (Evdokimov et al., 2011; Popescul and Georgescu, 2013; Jara et al., 2014; Ng, 2014; Andersson and Mattsson, 2015; Salim and Haque, 2015; Zhou and Piramuthu, 2015). The objects can communicate with computers without human involvement, making the Internet more immersive and pervasive as a communication paradigm (Fleisch, 2010; James, 2012; Zanella et al., 2014).

Interconnection, interaction, and dynamic network: Based on the object-oriented viewpoint, IoT is envisioned as a ubiquitous global network of connections of machines and devices that are capable of interacting and interconnecting with each other (Chang et al., 2014; Jin et al., 2014; Lee and Lee, 2015). This network enhances an increasingly connected world that achieves the goal of intelligently identifying, locating, tracking, monitoring, and managing things in real-time (Wang et al., 2013; Bradley et al., 2014; Chen et al., 2014). The interconnected objects form a network that can not only harvest information from the environment but also interact with the physical world. Such interactions merge the physical and digital world and extend the benefits of the Internet to the physical world, such as constant connectivity, remote control, and data sharing (Jin et al., 2014; Shin, 2014; Sofronijević et al., 2014; Bremer, 2015).

Global infrastructure: IoT describes an emerging global information service infrastructure that extends the Internet into the physical world, fusing the borders between physical entities and virtual components (Boos et al., 2013; Popescul and Georgescu, 2013; Winter, 2014). The realisation of the infrastructure requires the use and integration of almost all information technologies in implementing the process of information acquisition, transmission, and application (Tuters and Varnelis, 2006; Zhao et al., 2013; Jara et al., 2014).

Smartness and service innovation: The social, environmental, and user context-aware objects will be able to cooperate with other things and communicate with their physical and virtual surroundings to execute tasks and meet personal needs in a way that does not incur the same limitations as people (Bassi and Horn, 2008; Atzori et al., 2010; O'Leary, 2013; Gretzel et al., 2015). The intelligence enhanced by IoT global architecture facilitates the exchange of goods and services. The interaction between smart objects creates the availability of services, and the emergence of IoT concept brings opportunities for service innovations (Dlodlo et al., 2012; Winter, 2014; Baldini et al., 2016).

Social impacts: Social systems are on their path towards full connectivity, creating a society where every device is connected, which is why IoT has been considered to be a technological revolution and a process of social change (Speed, 2010; Sundmaeker et al., 2010; Xu, 2012; Quigley and Burke, 2013; Elmaghraby and Losavio, 2014). As the world is becoming data-rich, the supersets of connecting devices and associated processes will lead to sharing and exposing more information and keeping fewer secrets, leading to considerations of privacy protection and security issues (Brill, 2014; Weinberg et al., 2015).

3.1.2 Development of the IoT

The vision of IoT can be regarded as a smart world enabled by sensing technologies and smart components (Sundmaeker et al., 2010; Stankovic, 2014). IoT will serve society as a well-developed information structure aiming to fulfil the requirements of the future knowledge economy (Shin, 2014). The steady growth of the density and coverage of sensing and actuation embedded objects at the early stage of the IoT will bring a qualitative change to the world at a later stage (Stankovic, 2014). The future world will be filled with data and information, in which digital contents and potential opportunities grow exponentially (James, 2012). The future scenario of the IoT will challenge the assumptions of the electronic business, market, policy, and societal models, and actualise innovative and unpredictable services (Schindler et al., 2012; Shin, 2014; Stankovic, 2014).

From the socio-economic perspective, IoT can be viewed as an extension of the existing information infrastructure or computing realities, i.e. the Internet (Atzori et al., 2010; Evans, 2012; Shin, 2017; Falcone and Sapienza, 2018). Fundamentally, IoT adds one more dimension of data resource to the Internet, i.e. the information automatically sensed from the physical world in addition to human inputting (Fleisch, 2010; Evans, 2012). There are many challenges that need to be tackled in the evolution from the Internet to the Internet of Things (Fleisch, 2010). Firstly, the nerve ends are small or invisible devices in the IoT scenario instead of the comparatively big devices in the Internet world (Fleisch, 2010). Then, the number of connected nodes in IoT is estimated to outweigh the Internet by far (Fleisch, 2010). The speed of data transfer and bandwidth of communication links will be largely improved in the IoT scenario (Fleisch, 2010). Regarding addressing and identifying items, the Internet standards and protocols require too many capacities whereas it is proposed that the IoT will follow a globally standardised protocol. Lastly, the target audience will be transferred from the user to the machines because the IoT aims at communicating fully automatically without human intervention (Fleisch, 2010).

From the individual's perspective, the pervasiveness of digital devices and Internet access enriches the citizens, allowing them to be instrumented with smart devices, be interconnected between objects and humans, and be intelligent in analysis and decision-making (Elmaghraby and Losavio, 2014). Their daily activities will be continuously tracked by connected devices due to the deployment of ubiquitous computing technologies (Salim and Haque, 2015). In this scenario, the data will be collected from the activities of personal life, work/school, home, transport, and commercial/social life, constituting a recursive cycle of data generation and usage in a smart city (Elmaghraby and Losavio, 2014).

3.1.3 IoT Applications and Services

Most of the early IoT products have been developed by merely equipping existing objects with sensors or tags, thus facilitating the collection, processing and management of information. Even though only a small number of applications and services is currently available, it is very challenging to predict the full potential impact of IoT due to the pervasive nature and the rapid improvement of enabling technologies which facilitate different activities and satisfy the diverse needs of users (Atzori et al., 2010; Shin, 2014). Table 1 summarises IoT applications in 14 service domains, by categorising them into four types according to their target and scope of adoption. Similarly, an analytic hierarchy process (AHP) model has been proposed to assess and compare the viability and prospect of many IoT applications oriented to the customer, business, and public (Kim and Kim, 2016). The model includes three main criteria and 11 sub-criteria in a hierarchy: technological prospects (i.e. technical practicality, technical reliability, cost efficiency, and standardisation), market potential (i.e. market demand, user acceptance, business model, and ecosystem building), and regulatory environment (i.e. industrial regulation, consumer protection, and government support). Among these, the market potential weighs most, and the four sub-criteria ranked in the top 4. By applying the AHP model, researchers found that IoT logistics is the most promising IoT application, followed by IoT healthcare and IoT energy management respectively (Kim and Kim, 2016).

IoT technologies, such as those listed in the table, have the potential to shift the marketplace from a technology innovation experiment to a compelling business strategy by: (a) unlocking the excess capacity of physical assets; (b) creating a liquid and transparent marketplace; (c) enabling radical re-pricing of credit and risk; (d) improving operational efficiency; and (e) digitally integrating value chains (Brody and Pureswaran, 2015). For the business-related IoT prospects, recognising the importance of opportunities and adjusting their strategies according to the market and users' preferences will improve the performance of organisations. In addition, business operations will be transformed as, by digitalising and connecting physical assets to the IoT; it will become feasible to search, utilise and engage with them (Brody and Pureswaran, 2015).

Table 1 IoT Services and Applications

Service Domains	**Descriptions and Functions**
Infrastructural Level	
Smart Environment	Concentrates on environment monitoring and protection. Wireless sensors measure environmental indicators (e.g. pollution, water quality, temperatures, humidity) and proceed to the information platform, which triggers alerts and actions (Dlodlo et al., 2012; Chen et al., 2014).
Smart City	City equipped with various IoT devices and systems, aimed at monitoring, analysing and sharing information and coordination within a city system (Chen et al., 2014; Shin, 2014). Helps governments and other stakeholders to improve city planning (Atzori et al., 2010; Chen et al., 2014).
Smart Energy	Enhances users' awareness of usage control by services such as smart power grid, smart meter, and remote meter reading (Dlodlo et al., 2012; Chen et al., 2014; Shin, 2014).
Smart Tourism	A networked system of tourism destination including industries, services, and visitors in emerging forms of technological infrastructure that facilitates data transformation into value propositions, supports cooperation, knowledge sharing, and open innovation (Del Chiappa and Baggio, 2015; Gretzel et al., 2015). The tourism supply chain management can be enhanced with geospatial data enabled by IoT technologies, thus improving sustainability in tourism destinations (Babu and Subramoniam, 2016).
Organisational Level	
Smart Logistics and Supply Chain Management	Contributes to shortening process and reaction period by obtaining real-time information monitoring for enterprises (Atzori et al., 2010; Chen et al., 2014). It also facilitates resource utilisation, quality management, safety and traceability (Dlodlo et al., 2012).
Smart Agriculture	Conservation status monitoring and transportation management facilitating inventory control, distribution management, and logistics of perishable agricultural products (Atzori et al., 2010; Dlodlo et al., 2012; Chen et al., 2014; Shin, 2014).
Industrial Plants and Manufacturing	Optimising the production process in digitalised industrial plants by the deployment of identification tags and interaction with the intelligent network (Atzori et al., 2010; Dlodlo et al., 2012). This enhances process controlling and tracking, industrial environment monitoring, product lifecycle monitoring (PLM), safety and security, energy saving, and pollution control in production processes (Chen et al., 2014).
Individual Level	
Smart Home	Enabled by connecting items and devices at home which form a wireless sensor network to enhance applications in security, intelligent indoor environment control, household appliance control, smart metering and

	energy saving, thus creating a smart and comfortable private space (Atzori et al., 2010; Dlodlo et al., 2012; Chen et al., 2014; Stojkoska and Trivodaliev, 2017). The devices network, data processing hubs, the cloud, and third-party applications constitute a general smart home management system/platform that clarifies the specific tasks and requirements for smart homes (Kiesling, 2016; Stojkoska and Trivodaliev, 2017).
Entertainment and Gaming	An intelligent system that can adjust the game activity and difficulty level with the excitement and energy levels of the gamer by sensing the parameters of the players (Atzori et al., 2010).
Social Networking	Smart devices automatically update information about the users' real-time location, mutual friends' meeting, and attendance at events or social web pages, which reduces effort (Atzori et al., 2010; Dlodlo et al., 2012).
Smart Safety	Protects personal and community property by reading identification tags to alert owners or security guards when an item is moved without authorisation and recording location information of the movement to help users track items (Atzori et al., 2010; Dlodlo et al., 2012). Ensures safety in both public and private spaces by controlling the accessibility of critical information which requires personal identification, monitoring dangerous cargo, food and water safety, alerting and responding to emergencies in communal facilities (Dlodlo et al., 2012; Chen et al., 2014).
All-Inclusive Level	
Smart Transportation	Auto-control and intelligent regulation of connected vehicles effectively reduce time spent on commuting and energy consumption. Provides real-time road status, navigation, and assisted driving to the users and improves road safety and transportation efficiency (Atzori et al., 2010; Dlodlo et al., 2012; Chen et al., 2014; Shin, 2014).
Medical and Healthcare	Devices provide opportunities for remote and participatory medical services by monitoring personal health conditions and alerting for possible disease (Dlodlo et al., 2012; Amendola et al., 2014; Chen et al., 2014; Shin, 2014). Patient and medical resource management systems in hospitals and pharmacies, contribute to more efficient and effective treatments (Atzori et al., 2010; Dlodlo et al., 2012; Chen et al., 2014; Shin, 2014).
Education	Applications facilitate learning by controlling the class environment (measuring physical environment parameters), and by embedding knowledge within objects and automatically adjusting local conditions to improve the effectiveness of study (Atzori et al., 2010; Adorni et al., 2012; Dlodlo et al., 2012; Uzelac et al., 2015).

3.1.4 Users' Perception and Product Design

As the IoT leads social shifts in human life by offering products with various functions and target scope, the characteristics that have a significant impact on consumer purchase intention and good-practice principles in product design are discussed in this section. Purchase intentions are determined by six characteristics and are mediated by customer experiences

(Chang et al., 2014). The characteristics are: (a) IoT Connectivity: *“the degree to which things are interconnected”*; (b) IoT Interactivity: the customers’ feeling that occurs when information communication is bidirectional and response is timely; (c) IoT Telepresence: the subjective feelings of customers about *“the extent to which media represent the physical and social environment”*; (d) IoT Intelligence: intricate and accurate recognition functions, correct thinking and judgment capabilities; (e) IoT Convenience: *“the degree to which consumers save time and effort in the process of planning, purchasing, and using a product”*; (f) IoT Security: the damage avoidance in any vulnerable and valuable assets. The mediator between IoT characteristics and purchase intentions is the experience which refers to the customers’ overall impression of external marketing incentives that can have a profound impact on their behaviour. The experience can be categorised into two types: (a) the functional experience, which refers to objective cognition, and (b) the emotional experience, which represents the subjective emotions of IoT consumers. All product characteristics were found to have a positive impact on consumer purchase intention via functional and/or emotional experience (Chang et al., 2014). Findings suggest that IoT product design, promotion, and management should focus on improving customer experience (Chang et al., 2014).

The study by (Rau et al., 2015) presented a design of an interactive IoT application on a mobile platform based on the Social Web of Things concept, which made it possible for users to interact with the IoT in the same way they interact with the social network services. It revealed three additional characteristics related to IoT application design that may affect users' choice, namely effectiveness and consistency, flexibility, and privacy. When designing interaction systems, effectiveness and consistency are always important considerations, since users prefer applications that are able to improve the convenience of their life by clearly and simply solving the decision-making problems (Gao and Bai, 2014; Rau et al., 2015). Then, as different customers hold different values and choose preferences, the functions and features have to be flexible and tailored to their preferences (these can vary based on demographics, such as age and education). Privacy, information authorisation, and customers’ values should also be considered by product developers, as users need to control their private and personal information and protect it from other people or entities (Rau et al., 2015). Privacy of information and authorisation of content usage are critical issues because most users regard

IoT applications as private tools (Rau et al., 2015). The following seven ground principles could help provide a working design framework for building in security and privacy in IoT applications: (a) proactive and preventative protection of privacy; (b) default instead of optional privacy protection; (c) embedded rather than add-on privacy protection in the product or service; (d) functionality of the product should not be obstructed by privacy; (e) security should be applied to the entire system; (f) accountability and trust should be supported by visible and transparent privacy procedures; (g) respect and empower the users' management of their data by privacy design (Weinberg et al., 2015).

3.1.5 IoT Acceptance and Adoption

IoT services have attracted interest from both business organisations and end-users. Given the technological nature of IoT services, the user's acceptance of the technological platform is crucial when it comes to adopting the application or service. A low degree of user acceptance is one of the potential obstacles to enlarging the business value of the IoT (Kim and Kim, 2016). As such, this section presents a review of IoT acceptance and adoption studies as listed in Table 2. As a whole, most of the studies focused on exploring and examining potential influential factors of acceptance and adoption of the IoT technologies or the IoT products in a specific business sector, e.g. IoT healthcare, smart homes, the retail industry. The majority constructed their theoretical framework based on intention-based technology acceptance theories, e.g. TAM, UTAUT, TRA and TPB, incorporating and testing factors featuring the specified research objectives and contexts.

The intention-based causal chain, i.e. users' attitude determines their behaviour intention, is employed as the theoretical basis by most of the IoT acceptance and adoption studies. That is, the users' intention and behaviour of using IoT services is a typical dependent variable in previous studies. Then, the utilitarian value of IoT technologies and services that were expressed by variables such as perceived usefulness, performance expectancy and relative advantage played a leading role in determining the users' acceptance and adoption. Evidence supported the significant and positive effects of utilitarian value (e.g. Bao et al., 2014; Gao and Bai, 2014; Chong et al., 2015; Jang and Yu, 2017; Karahoca et al., 2017; Liew et al., 2017; Mital et al., 2017; Park et al., 2017; Shin, 2017; Pal et al., 2018). As a fundamental construct of theories such as TAM and UTAUT, perceived ease of use is another commonly examined influencing factor of IoT acceptance. However, a number of studies supported the suggestion that the effect of perceived ease of use (or effort expectancy) was usually mediated by perceived usefulness in the early stage of the diffusion of IoT (e.g. Bao et al., 2014; Mital et al., 2017; Pal et al., 2018).

Potential users are concerned not only with the utilitarian value and ease-of-use of IoT services but also the characteristics of IoT technologies. Firstly, variables regarding the diffusion of innovation showed significant effects on users' beliefs and intentions toward accepting the IoT. For instance, the compatibility (Bao et al., 2014; Hsu and Lin, 2016; Karahoca et al., 2017; Park et al., 2017) and relative advantage (Karahoca et al., 2017) of IoT products significantly influence the users' adoption rate. Then, technology characteristics such as the quality of the content, system and service determine the hedonic and utilitarian value of IoT services, and they consequently influence the users' satisfaction and experience (Shin, 2017). Last but not least, the intangible nature and intensive technology involvement of the IoT lead to a higher level of perceived risks for early adopters (Gao and Bai, 2014). Information privacy protection is of high concern for users since the data collected by the service providers may be erroneous and may be accessed and used without authorisation or beyond the users' control (Hsu and Yeh, 2017). Therefore, the users' adoption intention of the IoT is highly influenced by their perceived uncertainty and risks (Gao and Bai, 2014; Hubert et al., 2018).

As far as the users' experience is concerned, perceived enjoyment was confirmed as a significant determinant of users' intention and behaviour (e.g. Gao and Bai, 2014; Chong et al., 2015; Leong et al., 2017; Liew et al., 2017; Caputo et al., 2018). Their findings suggested that the IoT potentially contributes to enhancing the interactive experience for users and the early adopters may use the IoT products for an entertainment purpose that makes it possible for them to escape their daily lives (Caputo et al., 2018). On the other hand, emerging technologies may also bring about negative experiences such as anxiety. (Pal et al., 2018) suggested that anxiety has strong negative effects on the behaviour intention of switching over to new technology and platforms, especially for the elderly. What is more, IoT technologies that contribute to increasing the perceived ease of use, superior functionality, presence, and the aesthetic appeal of retail technology can improve the consumers' shopping experience and satisfaction (Balaji and Roy, 2016).

In addition to the IoT functionalities and system characteristics that are vital in determining user acceptance and adoption, the role of personal attributes was also explored. Notably, (Chong et al., 2015) surveyed RFID adoption in the healthcare supply chain, suggesting that the individual attributes (i.e. personality traits and demographic characteristics) can better predict the adoption of IoT technology than those factors derived from technology acceptance theories. Moreover, social factors, i.e. social influence, subjective norm, image, and social interaction, were considered to play a particularly important role in an early stage of technology diffusion (Bao et al., 2014; Gao and Bai, 2014; Karahoca et al., 2017; Mital et al., 2017). Also, the positive effect of personal innovativeness was empirically supported (Karahoca et al., 2017; Caputo et al., 2018; Martínez-Caro et al., 2018). These findings implied that most users lack reliable information about the new product or service, thus early adopters should be identified and their use should be stimulated with the aim of facilitating the broad diffusion of IoT services (Bao et al., 2014; Gao and Bai, 2014). However, with the diffusion of IoT concepts, studies published in recent years reported have limited the influences of social factors (e.g. Leong et al., 2017; Liew et al., 2017; Pal et al., 2018).

Overall, previous IoT acceptance and adoption studies have sufficiently explored the influencing factors derived from popular technology acceptance theories. Factors concerning utilitarian value largely determine the early adopters' beliefs and attitudes toward the acceptance and use of IoT technologies and services, which further affect their continuance intention, use experience, and satisfaction with the IoT. Although some of the studies incorporated personal attributes as either predictors or moderators of IoT acceptance and use, none of them investigated the role of general users' psychological and emotional factors. Furthermore, current studies on IoT from the users' perspectives usually adopted a specific IoT technology or service as a proxy for the IoT platform. A comprehensive understanding of the IoT platform has not yet been developed.

Table 2 Summary of Empirical Studies of IoT Acceptance and Use

Source	Theory	Research Description	Analysis Technique	Findings
(Pal et al., 2018)	UTAUT and TAM	Studying the acceptance of IoT smart home healthcare services. Participants are 254 elderly people (>55 years) in India, Thailand, Indonesia, and Malaysia.	PLS-SEM	Performance expectancy, effort expectancy, perceived trust, and expert advice have positive effects on behavioural intention; perceived costs have a negative effect on behavioural intention.
(Hubert et al., 2018)	TAM, IDT and Risk Theory	Studying users' adoption intention of smart home applications by developing e comprehensive model. The sample size is 409.	SEM	Factors from IDT and risk theory indirectly influence smart home adoption via TAM variables. Risk perception, compatibility and usefulness are important determinants of adoption intention.
(Martínez-Caro et al., 2018)	Effective Use of ICTs	Exploring the relationship between patients' capabilities for effective use of information and communication technologies and the success of IoT healthcare services. The participants are 256 Internet healthcare service users in Spain.	LISREL-SEM	Personal innovativeness and self-efficacy positively influence perceived usefulness; perceived usefulness positively influences user satisfaction; user satisfaction positively determines eLoyalty.
(Caputo et al., 2018)	Motivation Theories	Studying the relationships among motivational factors and users' willingness and decisions to use IoT-based products. The participants are 782 early-adopter customers in Italy.	AMOS-SEM	Entertainment, social interaction, privacy risk, and technology readiness have positive effects on user behaviour.
(Shin, 2017)	TRA, TPB and Quality of Experience	Developing a conceptual model for the quality of experience of users, which examines the relationship between consumer experience and quality perception of the IoT. This research used a combination of	PLS	Quality of content, system and service positively influence the hedonic and utilitarian value; hedonic and utilitarian value positively determines users satisfaction; users satisfaction has positive effects on

	Model	qualitative observation and interview and a quantitative survey. Data collected from 490 participants who have used or experienced IoT services.		IoT coolness and affordance; the IoT coolness and affordance positively influence quality experience.
(Park et al., 2017)	TAM	Exploring determinants of user acceptance of IoT technologies in the smart home environment. The respondents are 1057 IoT smart home users in Korea.	SEM	Perceived connectedness, perceived compatibility, and perceived control positively influence users' beliefs and intention; perceived cost negatively affects behavioural intention.
(Mital et al., 2017)	TRA, TPB and TAM	Exploring the adoption of the IoT-based smart device from a multiple theory perspective. Testing the TRA, TPB, and TAM models in the context of the Internet of Things in India. The sample size is 314.	PLS-SEM	TRA, TPB, and TAM explained only medium to low percentages of variances of behavioural intentions, 28.6%, 28.8%, 30.3% respectively.
(Liew et al., 2017)	TAM	Examining factors influencing consumer acceptance of IoT technology. Data collected from 204 participants in Malaysian public higher learning institution.	Multiple regression	Perceived usefulness, perceived ease of use, and enjoyment have positive effects on behavioural intention.
(Leong et al., 2017)	UTAUT2	Examining the antecedents of IoT adoption intention and the moderating role of experience in the context of the smart city in Malaysia (N=289).	SPSS	Performance expectancy, effort expectancy, hedonic motivation, trust, and cost have positive effects on behavioural intention.
(Kim et al., 2017)	TAM, VAM, ELM and UTAUT	Examining the adoption of IoT smart home services using a theoretical framework based on TAM, the Value-based Adoption Model (VAM), the Elaboration Likelihood Model (ELM), and UTAUT (N=269).	PLS-SEM	Perceived sacrifice and benefit significantly influence perceived value; perceived value has positive effects on attitude and behavioural intention.
(Karahoca et al., 2017)	TAM, IDT, TI, PMT and PCT	Investigating the factors affecting adoption intention of IoT healthcare products In Turkey (N=426), using an integrated model of TAM, Innovation Diffusion	PLS-SEM /MGA	Technological innovativeness, compatibility, trialability, image, and perceived advantage significantly influence users' beliefs and behavioural

		Theory (IDT), Technological Innovativeness (TI), Protection Motivation Theory (PMT), and Privacy Calculus Theory (PCT).		intention.
(Jang and Yu, 2017)	TAM	Testing the consumers' reuse intention of the IoT in Korea (N=225), extending TAM with demographic attributes of individuals and technical characteristics of the IoT.	AMOS-SEM	Perceived cost, innovativeness, and demographic attributes positively influence the users' beliefs and reuse intention.
(Hsu and Yeh, 2017)	TAM	Understanding the motivations driving the continued use of IoT services from the perspectives of network externalities, benefits, and privacy. Participants are 508 IoT service users in Taiwan.	AMOS-SEM	Perceived critical mass, compatibility, and complementarity positively determine perceived benefits; perceived benefits and privacy concern significantly influence continuance intention.
(Balaji and Roy, 2016)	Service-Dominant Logic	Exploring the relationships between IoT technology adoption, value co-creation, and consumer experiences in the retail industry (N=289).	PLS-SEM	Perceived ease of use, presence, aesthetic appeal and superior functionality have positive effects on value co-creation, which in turn influences continuance intention.
(Chong et al., 2015)	UTAUT	Studying RFID adoption by nurses and physicians (N=252) in supply chain of healthcare industry.	Neural network analysis	Individual differences such as personality traits and demographics can better predict the adoption of RFID compared to variables derived from UTAUT.
(Yu et al., 2015b)	Asset–Process–Performance Framework	Developing a conceptual model to study the relationship between delivery service provider selection and customer satisfaction in the e-retailing industry in the era of IoT. The respondents are 148 e-retailers in China.	AMOS-SEM	The soft and hard infrastructure positively influences the flexibility of the service, which in turn influences consumer satisfaction.
(Gao and Bai, 2014)	TAM	Studying the factors determining consumers' acceptance of IoT technology by developing and	SEM	Trust, social influence, enjoyment, and perceived behavioural control positively influence users'

		testing an integrative model. Participants are 368 Chinese users of the electronic toll collection application.		beliefs and behavioural intention.
(Bao et al., 2014)	TAM	Investigating the determinants of mobile smart home adoption. The respondents are 310 potential smart home users in China.	AMOS-SEM	Social influence, perceived security, and compatibility have positive effects on users' beliefs and behavioural intention.
(Yang et al., 2013)	TTF	Using a modified task-technology fit approach to investigate how IoT technology enhances emergency response operations.	Case study	In emergency response operations, IoT technology fits the identified information requirements and adds value to obtaining efficient cooperation, accurate situational awareness, and complete visibility of resources.

Notes: N=sample size, Value-based Adoption Model (VAM); Elaboration Likelihood Model (ELM); Technological Innovativeness (TI), Protection Motivation Theory (PMT); Privacy Calculus Theory (PCT)

3.2 Study 1: Emotional Antecedents and Outcomes of Internet Use

3.2.1 Research Objectives and Study Design

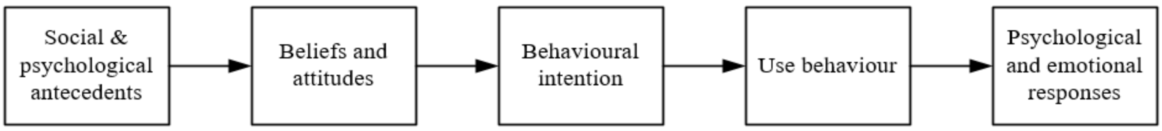
Over the years, there has been an increasing interest in exploring the potential emotional influence of pervasive technologies, such as the Internet. For instance, the Internet has been shown to work as an intervention technique which contributes to health-related behaviour change, e.g. in cognitive behaviour therapy toward anxiety disorders (Spence et al., 2006; Andersson, 2009; Webb et al., 2010). On the other hand, pre-existing psychopathology and social isolation can develop and reinforce symptoms of pathological Internet use (Davis, 2001; LaRose, 2010; Munno et al., 2017). In turn, this can lead to negative effects, such as social disinhibition, depression, lower self-esteem, and greater loneliness (Niemz et al., 2005; Kim et al., 2009; Tokunaga, 2017). Studies from a psychological perspective have largely been focused on the impact of excessive Internet use, especially its negative causes and effects (e.g. problematic Internet use, Internet addiction, compulsive Internet use). However, there has been little discussion about the wider emotional consequences that the Internet can bring to the public. As such the first objective of study 1 is to make a contribution by exploring the emotional antecedents and outcomes of using the Internet.

By tackling this objective this study aims to make a second significant contribution related to technology acceptance. Over the years, TAM has facilitated understanding of technology acceptance and has made possible extensions and elaborations for the contextualisation of information technology (IT) studies (Lee et al., 2003). At the same time, though, excessive focus on replication and the subtle adaptation of popular models such as TAM could restrict the progress of information system (IS) research (Venkatesh et al., 2007; Venkatesh et al., 2012b). Integrating individual characteristics, rather than over-emphasising system and design characteristics, may offer a way to enhance IS and IT studies (Venkatesh, 2000; Ajzen, 2005; Benbasat and Barki, 2007). To this end, a number of studies have incorporated psychological factors, such as cognitive absorption (Mohd Suki et al., 2008), flow (Hausman and Siekpe, 2009), psychological needs and self-determination (Partala, 2011; Partala and Saari, 2015), and emotions (Beaudry and Pinsonneault, 2010), etc. Still, there is more much scope for considering psychological factors as antecedents and outcomes of acceptance. Given that psychological states and individual differences are gaining importance in technology acceptance studies, this study extends TAM by incorporating emotional constructs, i.e. social inclusion, basic psychological needs, well-being, perceived value, and emotions. A number of moderating effects have also highlighted the changes in the hypothesised causal relationships when personal attributes are taken into consideration.

3.2.2 Hypotheses Development and Research Framework

TAM has been longitudinally found at the centre of technology acceptance. Compared with other technology acceptance theories, TAM is considered appropriate as a baseline model for this study for three reasons. First, TAM is parsimonious, making extending it in a number of different ways possible, without resulting in a very complicated model (Taylor and Todd, 1995; Venkatesh et al., 2003; Bagozzi, 2007). In addition, the "*beliefs and attitudes – intention – behaviour*" causal chain underlies popular theories and models such as the Theory of Planned Behaviour (TPB) or the Unified Theory of Acceptance and Use of Technology (UTAUT) (Davis et al., 1989; Bagozzi et al., 1992; Taylor and Todd, 1995; Venkatesh et al., 2003). As such it offers sufficient theoretical representativeness. Finally, TAM is robust, reliable, operationally efficient, and offers sufficient explanatory power (Davis, 1989; Mathieson, 1991; Venkatesh et al., 2003). Based on the above, TAM was adopted as a starting point of this study, to which a number of extensions were added, as Figure 13 illustrates. The outline model is operationalised below by testing hypotheses that are presented in the sections following.

Figure 13 Conceptual Framework of Study 1



The first version of TAM includes five main constructs, namely, perceived usefulness (PU), perceived ease of use (PEOU), attitude toward using (Attitude), behavioural intention to use (BI), and actual system use (USE) (Davis et al., 1989). (Davis et al., 1989) showed that PU and PEOU have direct effects on BI instead of being mediated by attitude. The authors suggested omitting attitude to explain intention more concisely (Davis et al., 1989; Venkatesh et al., 2003). PU and PEOU are grounded on behavioural psychology and the observation of technology adoption (Davis et al., 1989). They are the two most influential determinants that represent human beliefs and represent the foundation of technology acceptance theories (Davis, 1989; Davis et al., 1989; Venkatesh and Davis, 2000). PEOU is the degree to which a person believes that using the Internet would be free of effort (Davis, 1989; Davis et al., 1989). PU refers to the degree to which a person believes that using the Internet would enhance performance in completing particular tasks (Davis, 1989; Davis et al., 1989). The relationships between PU, PEOU, and Intention have been retained in most TAM-based empirical studies (Lee et al., 2003). Additionally, a meta-analysis by (Lee et al., 2003) showed that the majority of the studies support the idea that PEOU affects PU, and both PU and PEOU have influences on Intention or USE. This study examines the psychological impact on existing users, hence focusing on the intentions to continue using the internet (continuance intention (CI).

This leads to the first set of hypotheses:

H1.1: An individual's (a) perceived ease of use, and (b) perceived usefulness of using the Internet has a significant positive influence on the intention to continue using it, while (c) perceived ease of use positively affects the perceived usefulness of the Internet.

3.2.2.1 Social Inclusion and Information and Communication Technologies

Social inclusion is defined as "*a virtuous circle of improved rights of access to the social and economic world, new opportunities, recovery of status and meaning, and reduced impact of disability*" (Sayce, 2001). When it comes to the relationship between social inclusion and information and communication technologies (ICTs), studies have shown that the diffusion of innovative technology and implementation of ICTs closely relate to people's perceived social inclusion, either positively or negatively (Tapia et al., 2011; Broadbent and Papadopoulos, 2013; Hill et al., 2015; Andrade and Doolin, 2016). Social isolation, depression, and social anxiety have been found to relate to Internet addiction (Davis, 2001; Casale and Fioravanti, 2011). Not surprisingly, social inclusion/exclusion closely relates to digital inclusion/exclusion, with high digital inclusion being a catalyst for social inclusion (Selwyn, 2002; Tapia et al., 2011; Hill et al., 2015). With the proliferation of ICTs, digital inclusion has become an increasingly important issue as it describes how ICTs serve society and promote social inclusion (Tapia et al., 2011; Hill et al., 2015). Diffusion of new forms of technological breakthrough could potentially exacerbate existing social exclusion or even create new ways through which digital exclusion can be manifested (Andrade and Doolin, 2016).

On the other hand, technology diffusion can also bring many advantages. First of all, social inclusion motivates people to use connecting technologies such as mobile phones, social networking sites, and e-learning systems (Park, 2010; Smith and Sivo, 2012; Choi and Chung, 2013; Park et al., 2013). Empirical results suggest that social inclusion has positive effects on one's PU, PEOU, and CI of using mobile phones (Park et al., 2013). Social capital is a key element of social inclusion, which is generated through individuals' social activities and interactions, and offers benefits for their social participation (Secker et al., 2009; Choi and Chung, 2013). Perceived social capital positively and significantly correlates to perceived usefulness and ease-of-use on SNS among graduate students (Choi and Chung, 2013). Social presence and sociability facilitate users' degree of social inclusion as well, which has been found to positively correlate with PU, PEOU, and CI on using e-learning systems (Smith and Sivo, 2012). Moreover, the beneficial impact of social inclusion is also reflected in enhancing the well-being of citizens (especially those ICT-engaged individuals) via technology use. For instance, socially excluded people tend to shop online via computer or cell phone rather than in-store (Dennis et al., 2016). Such preferences can potentially mitigate the negative effects of social exclusion on well-being and the happiness of individuals with mobility difficulties (Dennis et al., 2016). It is worth noting that ICTs do not increase social inclusion automatically. They promote participation in social activities and communities, and in turn can help transform social inclusion into well-being (Castells, 2001; Andrade and Doolin, 2016). On one hand, ICT use facilitates participation in communities with valued relationships and collective social capital, which ultimately increases social inclusion (Broadbent and Papadopoulos, 2013; Hill et al., 2015). On the other hand, ICTs have been found to be a resource of five valuable capabilities that contribute to social involvement in the case of newly resettled refugees (Andrade and Doolin, 2016). These individuals' well-being in the new communities increased with the aid of these capabilities offered by ICTs: i.e. participating in an information society; communicating effectively; understanding a new society; being socially connected; and expressing a cultural identity (Andrade and Doolin, 2016).

Based on the previous empirical evidence it is proposed that:

H1.2: Social inclusion positively influences the users' (a) perceived ease of use of, (b) perceived usefulness of, and (c) continuance intention of using the Internet.

3.2.2.2 Self-Determination Theory and Basic Psychological Needs

According to the Self-Determination Theory (SDT), when faced with new skills and ideas, people have innate needs to feel effective, agentic and being connected, which derive from the three basic psychological needs for competence (NC), autonomy (NA), and relatedness (NR) (Ryan and Deci, 2000c; Ryan and Deci, 2000b). These three psychological needs are the basis of maintaining an individual's intrinsic motivation and self-determining extrinsic motivation (Ryan and Deci, 2000b). Specifically, interpersonal activities can catalyse people's need for competence and fulfilling this need enhances their intrinsic motivation (Ryan and Deci, 2000b; Gagné and Deci, 2005). Intrinsic motivations could be diminished by external factors such as rewards, threats, deadlines, and competition pressure, which hinder the individuals' experienced autonomy (Ryan and Deci, 2000b; Gagné and Deci, 2005). The environmental and social contextual conditions that support or control the needs for autonomy and competence could facilitate or undermine intrinsic motivation and social functioning (Ryan and Deci, 2000c; Ryan and Deci, 2000b). Satisfying the need for relatedness is the main motivation driving people to perform activities which, per se, are less enjoyable or not of interest, but valued by people connected to them (Roca and Gagné, 2008).

Studies based on SDT have reported close relationships between Internet use, needs satisfaction, and psychological states. Need fulfilment can indirectly lead to excessive Internet use, which is fully mediated by psychological distress (Wong et al., 2014). Psychological distress, such as social anxiety, has direct influences on excessive Internet use as well (Casale and Fioravanti, 2015). For males, this influence can be partially mediated by the satisfaction of the need for self-presentation, which can be met through social networking service use (Casale and Fioravanti, 2015). In addition, the basic psychological need satisfaction perceived online and in daily life both significantly predicts Internet use behaviour and the emotional effect among elementary school children (Shen et al., 2013). Participants who fulfilled their psychological needs online tend to spend more time on and more frequently use the Internet, and they will also experience more positive outcomes (Shen et al., 2013). In the context of e-learning system use, users can be intrinsically motivated by fulfilling the three psychological needs, which in turn affects their well-being and emotional responses (Ryan and Deci, 2000b; Ryan and Deci, 2000a; Gagné and Deci, 2005; Roca and Gagné, 2008). The need for autonomy is one of the salient needs that could be satisfied to a significantly larger extent by technology use, especially in successful cases of technology adoption (Partala, 2011; Partala and Saari, 2015). Previous work which incorporated the SDT with technology acceptance theories supported a number of significant relationships between the three psychological needs and technology acceptance constructs (Table 3). More specifically, although PEOU has been found to be positively affected by the three psychological needs, their influences on PU and intentions are relatively ambiguous. The majority of the empirical studies suggest that the three needs have significant positive influences on PU and BI. Still, the needs for competence and autonomy were not found to significantly relate to PU in three of the studies (Roca and Gagné, 2008; Sørebø et al., 2009; Nikou and Economides, 2017). Notably, these studies were conducted in different contexts, with models featuring additional determinants, such as intrinsic motivation (Sørebø et al., 2009), perceived enjoyment (Lee et al., 2015), perceived playfulness (Roca and Gagné, 2008), etc.

Based on the findings of prior literature, this study hypothesises that the three dimensions of psychological needs act as motivations for continuing Internet use as outlined below:

H1.3: The users' need for competence positively affects their (a) perceived ease of use of, (b) perceived usefulness of, and (c) continuance intention of using the Internet.

H1.4: The users' need for autonomy positively affects their (a) perceived ease of use of, (b) perceived usefulness of, and (c) continuance intention of using the Internet.

H1.5: The users' need for relatedness positively influences their (a) perceived ease of use of, (b) perceived usefulness of, and (c) continuance intention of using the Internet.

Table 3 Relationships between Psychological Needs and Technology Acceptance Variables

Psychological needs and Definitions	Dependent variable	Effect	Supportive evidence
Need for competence The human intention to effectively interact with the environment in order to experience the feeling of competence when performing an activity (Deci and Ryan, 2000; Roca and Gagné, 2008; Van den Broeck et al., 2010; Lee et al., 2015).	PU	Positive	(Roca and Gagné, 2008; Lee et al., 2015)
	PEOU	Positive*	(Nikou and Economides, 2017)
	BI	Positive***	(Hew and Kadir, 2016)
	PU	Not supported	(Sørebø et al., 2009; Nikou and Economides, 2017)
	BI	Not supported	(Huang et al., 2016)
Need for autonomy An individual's innate desire to experience psychological freedom and the sense of choice in activity engagement (Deci and Ryan, 2000; Van den Broeck et al., 2010).	PU	Positive	(Roca and Gagné, 2008; Sørebø et al., 2009; Lee et al., 2015; Nikou and Economides, 2017)
	PEOU	Positive	(Roca and Gagné, 2008; Nikou and Economides, 2017)
	BI	Positive	(Hew and Kadir, 2016; Huang et al., 2016)
Need for relatedness The feeling of being connected to, being loved and supported by others, and belonging to social communities (Roca and Gagné, 2008; Van den Broeck et al., 2010; Lee et al., 2015).	PU	Positive***	(Lee et al., 2015; Nikou and Economides, 2017)
	PEOU	Positive**	(Nikou and Economides, 2017)
	Attitude	Positive***	(Hew and Kadir, 2016)
	BI	Positive*	(Huang et al., 2016)
	PU	Not supported	(Roca and Gagné, 2008; Sørebø et al., 2009)
	BI	Not supported	(Hew and Kadir, 2016)

*Significant at p: * = < .05; ** = < .01; *** = < .001*

3.2.2.3 Well-Being, Perceived Value, and Social Inclusion

An individual's degree of well-being can be affected by social inclusion and the satisfaction of basic psychological needs (Deci and Ryan, 2000; Ryan and Deci, 2000c; Tay and Diener, 2011; Broadbent and Papadopoulos, 2013; Andrade and Doolin, 2016; Dennis et al., 2016). The positive influences of social inclusion and need fulfilment on well-being can be enhanced by technology use (Gagné and Deci, 2005; Roca and Gagné, 2008; Andrade and Doolin, 2016). Accordingly, this study defines well-being as the degree of need satisfaction and life quality enhancement by using the Internet. Empirical studies have explored the role of well-being in technology acceptance. For instance, in studying the mobile money service agents' technology readiness and acceptance, subjective well-being has been found to be a positive outcome of mobile money service use, which was directly affected by PU and PEOU (Rahman et al., 2017). Well-being can act as both a driver and an outcome of social networking service (SNS) use (Munzel et al., 2018). Subjective well-being can only increase the highly extraverted individuals' time spent on SNS when they are unhappy, which consequently improves their general well-being (Munzel et al., 2018). In addition, well-being can also be measured from the perspective of psychological flourishing (psychological wealth, positive emotions, and life satisfaction) and mental health ("*the lack of depressive symptoms*") (Partala and Saari, 2015). Regarding the users' most influential experiences of successful and unsuccessful technology adoptions, psychological flourishing well-being has been found to be largely dependent on the fulfilment of needs and concordance of value (Partala and Saari, 2015).

H1.6: Users' continuance intention to use the Internet has a positive impact on their well-being.

Perceived value has been incorporated as one of the outcomes of technology use. For instance, Turel et al. (2007) decomposed users' overall perceived value to a multi-dimensional determinant of short messaging service acceptance. Their study demonstrated that the hedonic and monetary values significantly influence behavioural intention, that performance value was a potential moderator on use intentions and that the social value did not show a significant impact on use intentions (Turel et al., 2007). On the other hand, perceived performance value, which describes the perceived benefits and profits offered by the IS/IT, has been found to be an antecedent of acceptance of hotel front office systems (Kim et al., 2008). (Wang, 2014) investigated utilitarian and monetary aspects of perceived value, which illustrated the user's "*overall assessment of the utility*" regarding the mobile government system. Results indicated that mobility, security, and PU were antecedents of the overall perceived value, while technology satisfaction, trust in technology, trust in the agent, and trust in government were the consequences (Wang, 2014). Users' perceived benefits, i.e. perceived usefulness, perceived enjoyment, and social image, and perceived sacrifice, i.e. perceived risk, were all found to have a positive effect on their overall assessment of the perceived value of media tablet adoption (Yu et al., 2015a). Taking into account that this study aims to examine the emotional and psychological factors related to the adoption of a pervasive technological paradigm, i.e. the Internet, the users' perceived value is investigated from a comprehensive perspective. As such, perceived value is defined as the justification of the experience of using the Internet in individuals' daily life, regardless of whether this is for work or for personal purposes (Okada, 2005).

Based on the above it is proposed that:

H1.7: Users' continuance intention to use the Internet has a positive impact on their perceived value.

3.2.2.4 Emotional Responses to Internet Use

An emotional response is defined as a set of emotional reactions elicited during IT/IS use or by use experiences, such as happiness, anger, anxiety, and excitement (Westbrook and Oliver, 1991; Beaudry and Pinsonneault, 2010). Prior studies provide evidence that users' emotions critically affect beliefs, intentions, and behaviours in technology acceptance and adoption contexts (Beaudry and Pinsonneault, 2010; Kim and Lennon, 2013; Chang et al., 2014). For instance, positive emotions such as happiness and excitement were found to positively relate to information technology use, either directly or indirectly (Beaudry and Pinsonneault, 2010). However, negative emotions, e.g. anger and anxiety, also have an indirect positive influence on technology use. These positive and indirect relationships via seeking social support imply that seeking social support may counter the original negative influences of anger and anxiety (Beaudry and Pinsonneault, 2010). On the other hand, external stimulation, such as adoption and the use of certain technologies, can also trigger and influence users' emotional responses (Chang et al., 2014; Partala and Kujala, 2015; Partala and Saari, 2015). For instance, individuals reported significantly different levels of positive and negative emotions in successful and unsuccessful cases of technology adoption (Partala and Saari, 2015).

This study adopts (Beaudry and Pinsonneault, 2010) classification of the emotional responses, specifically toward information technologies. Their framework has been developed by combining two appraisals of technology assessment which determine users' emotional reactions toward a new IT (Beaudry and Pinsonneault, 2005; Beaudry and Pinsonneault, 2010). The primary appraisal is whether a user perceives a new technology as constituting an opportunity or a threat, which is in line with the individual's goal achievement (Bagozzi, 1992; Beaudry and Pinsonneault, 2010). Fundamentally, the goal or outcome of an individual can be either achieved or not, which in turn triggers pleasant or unpleasant feelings toward events in both planned and unplanned cases (Bagozzi, 1992). This primary appraisal determines the users' emotional reactions as positive (they perceive the technology as an opportunity, they achieve the goal) or negative (they perceive the technology as a threat, and do not achieve the goal). Notably, individuals can experience both positive and negative emotions, triggered by the same external stimulation, thus the levels of these two dimensions of emotions can be measured separately (Russell and Carroll, 1999; Chang et al., 2014; Partala and Kujala, 2015). The emotions aroused by the adoption of a given IT may vary among individuals depending on their unique psychological evaluations (Beaudry and Pinsonneault, 2010).

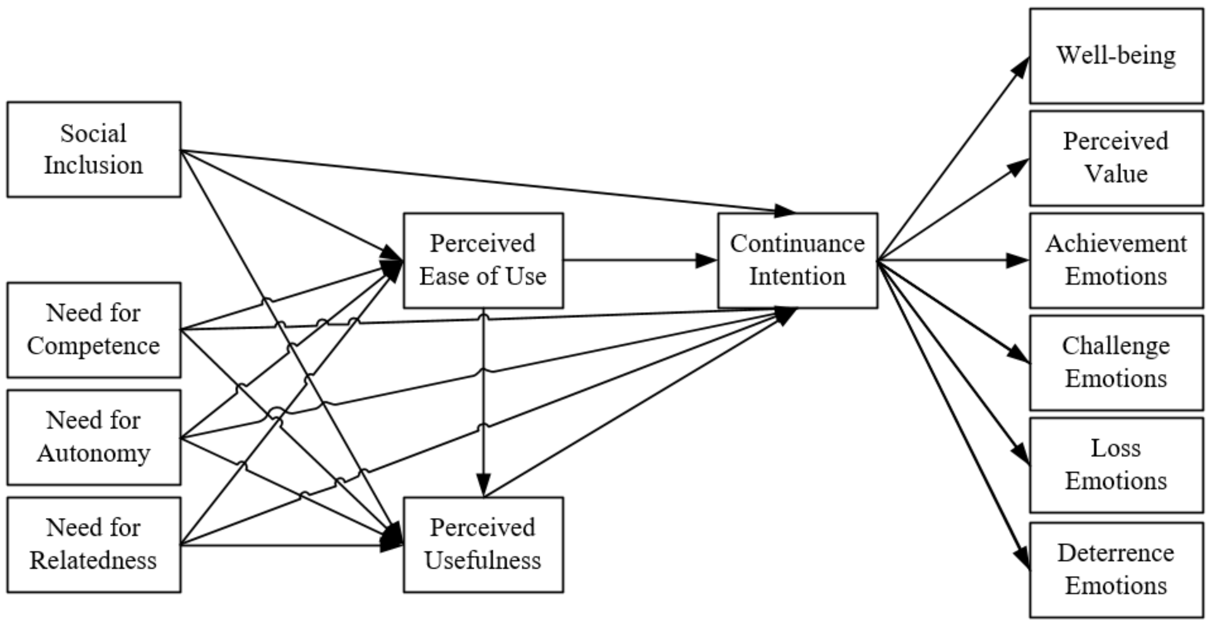
The second appraisal refers to the degree of users' perceived control over the achievement of the expected outcome of accepting a technology (Lazarus and Folkman, 1984; Beaudry and Pinsonneault, 2010). This dimension further classified the emotions triggered by an IT event into four categories, i.e. achievement, challenge, loss, and deterrence emotions. The achievement and challenge emotions are experienced when the users perceived an IT as an opportunity that would generate positive outcomes, such as happiness and excitement (Beaudry and Pinsonneault, 2010). The achievement emotions refer to the users' pleasant feeling when they are able to achieve their goal by using the IT with very little effort (Beaudry and Pinsonneault, 2010; Lee et al., 2012). Challenge emotions could enhance users' positive attitudes toward the technology and help them achieve their goals (Beaudry and Pinsonneault, 2005; Lee et al., 2012). A new IT which is perceived as a threat would be likely to trigger loss or deterrence emotions (Beaudry and Pinsonneault, 2010). When individuals lack control over their expected outcomes of the new technology, they are likely to experience loss emotions such as anger, disappointment and frustration (Beaudry and Pinsonneault, 2010). Finally, when users have some control over their expected outcomes, their emotional reactions fall into the deterrence aspect, represented by anxiety, fear, worry, distress, etc. (Beaudry and Pinsonneault, 2010).

Accordingly, the above-mentioned four distinct classes of users' emotional responses are hypothesised to be influenced by Internet use.

H1.8: An individuals' continuance intention to use the Internet has a positive impact on their (a) achievement and (b) challenge emotions, and has a negative impact on their (c) loss and (d) deterrence emotions.

Based on the above hypotheses, Figure 14 presents the emotional-TAM model (E-TAM) which depicts the main effects. A number of moderating effects were also tested as discussed below.

Figure 14 Research Framework of Study 1: E-TAM



3.2.3 Moderators

The mechanism of psychological factors affecting technology acceptance and use is complex and varies among individuals. Personal attributes may play a role in influencing the hypothesised relationships (H1.1-H1.8). This section reviews three categories of individual differences which potentially moderate the main relationships hypothesised above (Figure 14). Nine moderators will be tested in the following sections with the aim of exploring and examining potential effects.

3.2.3.1 Internet Use Behaviour and Expertise

The success of ICT implementation is not only determined by the initial adoption decision, but is also influenced by long-term use and continuance intention, which is shaped by users' experience and knowledge gained over time (Venkatesh, 2000; Venkatesh and Bala, 2008). Initial judgement anchors perceived ease of use in the pre-adoption stage (Venkatesh, 2000; Venkatesh and Bala, 2008). However, this judgement would be adjusted after the users gained experience by using the target system (Venkatesh, 2000; Venkatesh and Bala, 2008). Therefore, the influences of PU and PEOU on intention would be moderated by the level of use behaviour and expertise. In the Action Identification Theory of human behaviour, high-level action identity refers to the individuals' goals and plans toward a certain action, while low-level action identity describes their means to achieve these goals and plans (Vallacher and Kaufman, 1996; Venkatesh and Bala, 2008). In the context of acceptance, PU and PEOU represent high-level and low-level action identities respectively (Venkatesh and Bala, 2008). By using technology, users are forming assessments of goal achieving possibilities based on the knowledge and experience gained from low-level actions (Venkatesh and Davis, 2000; Davis and Venkatesh, 2004; Venkatesh and Bala, 2008). Consequently, the role of PEOU switches from forming BI in the early stage of technology adoption to mainly influencing PU in a later stage (Venkatesh and Bala, 2008). Empirical evidence has suggested that experienced individuals' attitude toward websites were more affected by perceived usefulness, whereas the less-experienced users focused more on perceived ease of use (Castañeda et al., 2007). In the case of Internet use, individuals may have an initial judgement based on their perception of the easiness of use in the early stage of acceptance. With Internet use experience gained at a later stage, their perception of ease-of-use will affect their continuance intention indirectly through perceived usefulness.

The users' beliefs and reactions toward using the Internet will be influenced by Internet experience as well. Firstly, societal factors have complex and contingent effects on technology acceptance, which may alter users' intention in the early stage of technology use (Venkatesh and Davis, 2000; Venkatesh et al., 2003). The influences of societal factors on users' intention and perceived usefulness would attenuate with users' increased experience (Venkatesh and Davis, 2000). Additionally, users' psychological states, such as satisfaction of the three SDT-based needs, can form intrinsic motivations for technology acceptance and use. Intrinsic motivations would be diminished by introducing extrinsic motivations or by controlling external conditions (Davis et al., 1992; Ryan and Deci, 2000b; Gagné and Deci, 2005). For experienced users, extrinsic motivations could play a relatively higher role when it comes to determining the individuals' intention on technology use (Venkatesh and Bala, 2008). As such the influential effects of psychological need fulfilment may diminish with increased Internet experience. In terms of outcomes, prior experience with an IS/IT would enable people to clearly and confidently evaluate the value of a new IS/IT (Kim, 2008; Yu et al., 2015a). Experience has been shown to significantly increase the positive effect of perceived usefulness on users' perceived value of the media tablet (Yu et al., 2015a). Experienced Internet users are more capable of effectively taking advantage of Internet services with less effort devoted to it (Nysveen and Pedersen, 2004). Therefore, similarly to the perceived value, the other positive outcomes such as well-being, achievement emotions, and challenge emotions may increase among experienced Internet users.

Following the above, Internet use behaviour and expertise are expected to be significant moderators. Specifically, a high degree of Internet use behaviour and expertise strengthens the relationship between PEOU and PU and the influence of PU on CI, and dampens the influence of PEOU on CI. A high level of Internet use behaviour and expertise influences the psychological antecedents as well, strengthening the positive outcomes of Internet use, and dampening the negative ones.

3.2.3.2 Demographic Characteristics: Age and Gender

Age moderates most of the key relationships of technology acceptance theories such as the UTAUT, TPB, and Innovation Diffusion Theory (IDT) (moderates the effects of relative advantage and image on adoption and use) (Morris and Venkatesh, 2000; Venkatesh et al., 2003; Venkatesh et al., 2012b). Gender also has strong impacts on individuals' beliefs and behaviours, moderating the influences of PEOU, PU, and social influences on behavioural intention (Venkatesh and Morris, 2000; Venkatesh et al., 2003). The relationship between perceived ease of use and intention has been found to be stronger for female and older users, whereas the influence of perceived usefulness on intention was stronger for men and younger users (Venkatesh et al., 2003). PU is more important than PEOU in determining Internet continuance use intention for young and male users (Venkatesh and Morris, 2000; Venkatesh et al., 2003).

This study proposes a further exploration of the role of age and gender in moderating the effects of social and psychological factors on ICT use. The relationship between social influence and behavioural intention is stronger for women and older workers, though only for the less-experienced workers under mandatory conditions (Venkatesh et al., 2003). Female users are more affected by social factors since they may adopt and use a technology with the aim of being more socially included (Venkatesh and Morris, 2000; Gefen and Ridings, 2005; Hwang, 2010). Accordingly, social inclusion has stronger effects on Internet acceptance and use among women. Older age has been shown to significantly strengthen the direct negative impact of social exclusion on well-being (Dennis et al., 2016). However, this study did not support the moderating effect of age on the indirect relationship between social exclusion and well-being via technology use (Dennis et al., 2016). Given that the moderation effects by demographic characteristics on the relationships between psychological factors and technology use have not yet been comprehensively tested, this study proposes to examine the influences of age and gender on the E-TAM framework. Following the above, the influences of psychological antecedents and outcomes on Internet acceptance are expected to be weaker for individuals who are younger in age or who are male.

3.2.3.3 Personality Traits

Personality refers to the pattern of one's behaviour and the unique facets and traits that define the essence of human beings (Devaraj et al., 2008; Venkatesh et al., 2012a). Personality traits determine an individual's thoughts and actions reacting to different situations (Terzis et al., 2012). The motivational mechanism that underlies human behaviour is manifested via satisfaction of the psychological needs and interacts with their personality development and well-being (Deci and Ryan, 2000; Ryan and Deci, 2000c; Van den Broeck et al., 2010). Personality traits have been found to affect the users' emotional and psychological conditions, which consequently shape their experience of and behaviours in consumption and technology use, (e.g. (Desmet and Hekkert, 2007; Munzel et al., 2018). In technology acceptance studies, a number of variables representing personality traits have been introduced. For instance, personal innovativeness, (e.g. (Koenigstorfer and Groeppel-Klein, 2012; Venkatesh et al., 2012a; Wu and Ke, 2015), individual playfulness, (e.g. (Terzis et al., 2012; Wu and Ke, 2015), and the Big-5 personality traits, (e.g. (Devaraj et al., 2008; Sykes et al., 2011; Terzis et al., 2012).

This study adopted the Big-5 Personality Traits Model (Big-5), which is parsimonious, but sufficiently comprehensive. The model comprises five facets of human personality, namely extraversion, agreeableness, conscientiousness, neuroticism, imagination/openness (Costa and MacCrae, 1992; Donnellan et al., 2006). Table 4 summarises the empirically supported influential and moderating effects of the five facets of Big-5 personality on technology acceptance models. The majority of current IS/IT empirical studies have simply hypothesised that the traits influence some or all of the core technology acceptance constructs. Results and directions of effects vary among the studies, depending on their research contexts and research objects. These personality traits performed even better than technology acceptance constructs, i.e. performance expectancy, effort expectancy, social influence, and facilitating conditions (Chong et al., 2015). On the other hand, the work of (Devaraj et al., 2008) introduced the five personality traits as both influencing and moderating variables. Their findings supported the idea that a high degree of extraversion, agreeableness, and conscientiousness strengthens the positive influences of subjective norm and perceived usefulness on behavioural intention (Devaraj et al., 2008).

Table 4 Relationships between Big-5 Personality Traits and Technology Acceptance Variables

Personality traits and Definitions	**Relationship**	**Path**	**Results**	**Supportive evidence**
Extraversion (E)	Moderation	SN → BI	P*	(Devaraj et al., 2008)
The tendency to actively engage in social activities; comprises facets of friendliness, gregariousness, assertiveness, activity level, excitement	Correlation	E → PU	P*	(Svendsen et al., 2013)
		E → USE	P***	(Venkatesh et al., 2012a)
		E →	P*	(Terzis et al., 2012)

seeking, and cheerfulness (Barrick and Mount, 1991; Costa and MacCrae, 1992; Donnellan et al., 2006; Venkatesh et al., 2012a).		Perceived importance		
Agreeableness (A) The degree of compassionate interpersonal orientation; comprises facets of trust, morality, altruism, cooperation, modesty, and sympathy (Donnellan et al., 2006; Devaraj et al., 2008).	Moderation	SN → BI	P*	(Devaraj et al., 2008)
	Correlation	A → PU	P/N	(Devaraj et al., 2008; Terzis et al., 2012)
		A → PEOU	P**	(Terzis et al., 2012; Özbek et al., 2014)
		A → SN	P***	(Terzis et al., 2012)
Conscientiousness (C) The degree of organization, persistence, and being goal-oriented; comprises facets of self-efficacy, orderliness, dutifulness, achievement striving, self-discipline, and cautiousness (Barrick and Mount, 1991; Costa and MacCrae, 1992; Donnellan et al., 2006; Devaraj et al., 2008).	Moderation	SN → BI	P*	(Devaraj et al., 2008)
		PU → BI	P*	(Devaraj et al., 2008)
	Correlation	C → PEOU	P*	(Terzis et al., 2012)
		C → USE	P	(Sykes et al., 2011; Venkatesh et al., 2012a)
Neuroticism (N) The degree of emotional instability and experiencing constant negative feelings; comprises facets of anxiety, anger, depression, self-consciousness, immoderation, and vulnerability (Donnellan et al., 2006; Devaraj et al., 2008; Venkatesh et al., 2012a).	Correlation	N → PU	P/N	(Devaraj et al., 2008; Terzis et al., 2012)
		N → USE	P**	(Sykes et al., 2011)
		N → Goal expectancy	P*	(Terzis et al., 2012; Özbek et al., 2014)
Imagination/Openness (I) The degree of flexibility of thought and openness to new ideas; comprises facets of imagination, artistic interest, emotionality, adventurousness, intellect, and liberalism (Donnellan et al., 2006; Devaraj et al., 2008; Venkatesh et al., 2012a).	Correlation	I → PEOU	P	(Svendsen et al., 2013; Özbek et al., 2014)
		I → USE	P/N	(Sykes et al., 2011; Venkatesh et al., 2012a)
		I → Perceived importance	P**	(Terzis et al., 2012)

*Notes: SN = Social Influence/Subjective Norm; P = positive effect; N = negative effect; Significant at p: * = < .05; ** = < .01; *** = < .001*

3.3 Study 2: Spillover from the Internet to the IoT

3.3.1 Research Objectives and Study Design

The Internet of Things (IoT) refers to a dynamic network infrastructure that is composed by numerous uniquely addressed *"things"* which are smart objects able to interact with other objects and people and react to the physical environment (Guillemin and Friess, 2009; Atzori et al., 2010; Lu et al., 2018). IoT enhances the connection between any people and any thing at any time and any place (Guillemin and Friess, 2009). The ubiquitous nature of IoT means that services are integrated to the surrounding environments and equipped with sensors and communication components that enable the automatic adaptation to the users' requirements (Atzori et al., 2010; Dlodlo et al., 2012; Lu et al., 2018). For instance, considering a smart home context, IoT can create a private space for users by automating security monitoring, making adjustments to the environment and controlling household appliances (Dlodlo et al., 2012; Stojkoska and Trivodaliev, 2017; Lu et al., 2018). Such connectivity can extend the scope of existing interactions between users and Internet-based applications and services (Atzori et al., 2010; Falcone and Sapienza, 2018; Lu et al., 2018). Given that IoT extends users experiences with the Internet beyond those typical interactions undertaken using consumer electronics devices such as computers, mobile phones and televisions, there is a growing need to study how predispositions based on existing interactions can affect the attitudes related to IoT.

Previous studies have sufficiently explored and tested the antecedents of IoT acceptance abstracted from information system management (MIS) theories. More specifically, studies incorporated and tested the effects of many MIS constructs, such as perceived usefulness (Bao et al., 2014; Gao and Bai, 2014; Liew et al., 2017; Mital et al., 2017), perceived ease of use (Bao et al., 2014; Gao and Bai, 2014; Balaji and Roy, 2016; Liew et al., 2017; Mital et al., 2017), social influences (Leong et al., 2017; Caputo et al., 2018; Pal et al., 2018), personal innovativeness (Karahoca et al., 2017; Caputo et al., 2018; Martínez-Caro et al., 2018), technological characteristics (Park et al., 2017; Shin, 2017), demographic characteristics (Jang and Yu, 2017), etc., which all significantly influence the user's attitudes toward IoT acceptance. Although testing the determinants of technology acceptance is of interest and can provide valuable insights, empirical studies tend to be narrow in that they typically test the ecological validity of existing factors in a different context. They seldom though examine the impact that relevant technologies can have, assuming that acceptance can be confined within technological silos.

Given the above, study 2 of this thesis proposes exploring IoT acceptance from a different approach. This study starts with the premise that the IoT, as a technological platform that can underpin a wide range of new applications, has evolved from an existing technological platform that the users are familiar with, i.e. the Internet. Access to the Internet has in the past two decades has been made possible using devices such as desktop computers and then mobile devices. Interacting with the Internet can result in a number of outcomes, e.g. spark emotional reactions (Beaudry and Pinsonneault, 2010), have an impact on well-being (Munzel et al., 2018; Lu et al., 2019) and on the perceived values of gets from using a technology (Wang, 2014; Yu et al., 2015a). These can potentially spill over into the individuals' predispositions toward IoT use. As such, study 2 proposes to examine whether the Internet's acceptance can have a spill-over effect on the acceptance of IoT. If that was found to be the case, then technology acceptance could be conceptualised as interconnected acceptance events as opposed to isolated and separated ones. To this end, this study incorporates psychological and emotional factors of user experiences with the Internet to test how these would affect IoT acceptance.

3.3.2 Hypotheses Development and Research Framework

3.3.2.1 Spillover Effects

As introduced in section 2.4.5, spillover is a mechanism that links various areas of one's everyday life. Previous studies examined the spillover effects of the skills, value, behaviour and affect from one life domain to another. However, none of the existing studies investigated the role of an information system and/or technology (IS/IT) in resulting in spillover effects. It has been suggested that the spillover effect from one technological platform to its extensions, e.g. from the Internet to the IoT, is meaningful research area (Ratnadeep Suri and Sawhney, 2008). Given the above, this study aims to explore and test the potential spillover effects of affect and value from Internet domain into the IoT domain. By which this study proposes that the affect generated in Internet use, i.e. emotions and well-being, and the users' perceived value of the Internet would spill over into the users' intention of IoT use. The following sections proceed to introduce the development of hypotheses.

3.3.2.2 Spillover of Emotions

The emotional spillover effect has been demonstrated as a mechanism of message processing (Yegiyan, 2015). The individuals' memory accuracy for neutral objects can be improved, if the object was previously paired with arousing objects (Yegiyan, 2015). Specifically, the stimulus of arousing experience will be carried over to affect the individuals' emotional responses to the subsequent stimulus (Yegiyan, 2015). Continually monitoring and constraining the spillover of emotions is a ubiquitous function of the human brain and is fundamental to emotion regulation and adaptation (Lapate et al., 2017). On the one hand, the emotions provoked in the originating context may directly spillover into the receiving context (Lapate et al., 2017). For instance, individuals may experience higher degrees of psychological arousal and emotional positivity and negativity in the processing of advertisements following watching arousing movie clips (Yegiyan, 2015). On the other hand, the individuals' emotions can also spill over into their attitude and behaviour. For instance, (Hoffmann and Ketteler, 2015) suggested that the shareowner customers trading a company's stock that see gains are likely to experience more positive emotions, which in turn lead to increasing their preference to the company and engagement in positive word-of-mouth. The losses in stock trading would cause negative emotions, as well as lower degrees of satisfaction and behavioural loyalty toward the company (Hoffmann and Ketteler, 2015). (Salmela-Aro et al., 2017) reported that the contextual school-related mental health problems can predict excessive Internet use among adolescents, and latterly spill over into their general affect, such as depressive symptoms. Negative emotions, e.g. anger, can spill over from previous contexts to affect one's judgements and decisions in unrelated contexts (Motro et al., 2016). Specifically, the employees' anger unrelated to their task at hand can spill over into the workplace and reduce their cooperation activity with partners (Motro et al., 2016).

Given the above, this study proposes that the users' emotional responses generated in using the Internet may spillover into their acceptance of IoT. Aiming to comprehensively explore the potential spillover of various user emotions, this study adopted the emotional responses of

IS/IT use classified by (Beaudry and Pinsonneault, 2010). This classification combined two appraisals and defined four types of emotions. The primary appraisal is that the new technology acceptance would constitute an opportunity or a threat for the users (Beaudry and Pinsonneault, 2005; Beaudry and Pinsonneault, 2010). This primary appraisal determines the users' emotional reactions as positive or negative (Beaudry and Pinsonneault, 2010; Lu et al., 2019). For instance, enjoyment, as a positive emotion, is usually experienced when users believe that the new technology would bring about better performance. The second appraisal refers to the degree of users’ perceived control over expected outcomes of using a technology (Beaudry and Pinsonneault, 2010). These two appraisals classified users emotions into four types, i.e. achievement, challenge, loss and deterrence emotions (Beaudry and Pinsonneault, 2010). Accordingly, in the context of technology acceptance, these four types of emotions are typically represented by satisfaction and enjoyment, excitement and flow, frustration and dissatisfaction, and anxiety and fear respectively. The achievement and challenge emotions are experienced when users believe that using the new technology would generate positive outcomes, while the loss and deterrence emotions would be caused by perceived negative consequences (Beaudry and Pinsonneault, 2010).

Perceived control over the expected consequences of using the IS/IT plays a critical role in such a classification. Perceived control is defined as the perceptions of ability to manage the constraints on behaviour, which is similar to the perceived behaviour control, self-efficacy, compatibility, and facilitating conditions (Taylor and Todd, 1995; Venkatesh et al., 2003; Lowry et al., 2013). (Leong et al., 2017; Liew et al., 2017; Mital et al., 2017; Pal et al., 2018) found that perceived control did not directly predict the intention of IoT adoption, whereas (Gao and Bai, 2014; Chong et al., 2015; Park et al., 2017; Martínez-Caro et al., 2018) confirmed that perceived control positively affects the intention and beliefs of IoT acceptance. Perceived behaviour control is strongly correlated with the ease of use (Agarwal and Karahanna, 2000; Lowry et al., 2013). When users perceive themselves as having control over an easy-to-use system, their psychological feelings and enhances the intention of performing the behaviour (Lowry et al., 2013). When individuals believe that they have little control over the behaviour, due to the lack of imperative opportunity or capacity, they are unlikely to perform the behaviour even though they have strong intentions (Liew et al., 2017). Feeling a lack of control would cause negative consequences, such as low competence, psychological strain, and depression (Lowry et al., 2013).

Given the above, this study expects that the spillover effects of emotions from Internet use to IoT use would be largely dependent on the perceived control. That is, the challenge and deterrence emotions, which are more likely to be aroused when the users feel having control over the expected outcomes (Beaudry and Pinsonneault, 2010), will positively influence the IoT behavioural intention. Whereas the achievement and loss emotions, which are caused by a lack of perceived control (Beaudry and Pinsonneault, 2010), have negative effects on IoT behavioural intention.

H2.1: The users' (a) challenge emotions and (b) deterrence emotions generated via Internet use are positively correlated with IoT behavioural intention, and their (c) achievement emotions and (d) loss emotions are negatively correlated with IoT behavioural intention.

3.3.2.3 Well-being

Well-being is the degree of users' needs fulfilment and quality of life enhancement by using technological platforms, namely the Internet and IoT. It has been found that the work-related well-being can spill over into other life domains and predicts the general and context-free well-being in the long-term (Hakanen and Schaufeli, 2012; Donoso et al., 2015). However, the relationship between technology use and the individual's well-being is arguable. On the one hand, past studies suggested that the individuals' engagement in technology use and related activities blurs the boundary of work and life, which negatively affects their well-being in aspects of decreasing life satisfaction and arouses negative affect (Chesley, 2005; Berkowsky, 2013). On the other hand, technology use has been found facilitating the individual's work-family role balancing and thereby enhances their well-being (Gözü et al., 2015). More specifically, the users' attitude toward personal web use weakened the negative effect of work-family conflict on their well-being, and such attitude also strengthened the positive effect of work-family facilitation on well-being (Gözü et al., 2015). These findings indicated that technology use facilitates the flexibility and autonomy in dealing with work-family conflicts, which consequently contributes to managing the work-family spillover and further enhancing the well-being (Gözü et al., 2015).

Beyond the previous research on work and life relationship influenced by technology use, using the Internet per se can be beneficial to the users' emotions and well-being (Lu et al., 2019). Also, IoT-based services, especially smart healthcare, would largely benefit users' well-being (Marikyan et al., 2018; Martínez-Caro et al., 2018). A high degree of satisfaction of using IoT technologies enhances the users' quality of life and needs fulfilment (Martínez-Caro et al., 2018), which is corresponding to the concept of well-being. In the context of social networking service, it was empirically confirmed that subjective well-being drove the general use, and the use had a positive impact on users' well-being (Munzel et al., 2018). Following the above, this study proposes that well-being, as an outcome of Internet use, may spill over into IoT use and act as an outcome as well. As such, this study hypothesises the following.

H2.2a: The well-being experienced when using the Internet has a positive effect on users' behavioural intention of using the IoT.

H2.2b: The behavioural intention of using the IoT has a positive effect on the users' well-being experienced in using the IoT.

3.3.2.4 Spillover of Perceived Value

Perceived value has roots in behavioural decision theory and social psychology, which describes a cognitive trade-off between the effort required to be devoted (e.g. PEOU) and the quality of the expected outcomes (e.g. PU) (Davis, 1989; Kim et al., 2007). As such, perceived value can be defined as the users' cognitive overall assessment of using a technological product or service, regardless for work or personal purposes (Zeithaml, 1988; Okada, 2005; Kim et al., 2007). Perceived functional, economic, emotional, and social values of a product spill over into the consumers' loyalty and behavioural intentions toward the service provider, and vice versa (Arne et al., 2017). Also, the quality and perceived value of one service partner can spill over onto the consumers' evaluations and reuse intention of a service partnership (Bourdeau et al., 2007). Similarly, consumers expect the value of a new service alliance would be in accordance with its parent brands, due to the spillover effects of perceived value (Bleijerveld et al., 2015). Perceived value has been found to positively influence the attitude toward and the intention of using IoT-based smart home services (Kim et al., 2017).

As a representation of the overall evaluation of the performance of technological services, users' perceived value of an IS/IT is determined by the perceived benefits and sacrifice (Kim et al., 2017; Shin, 2017). Perceived benefits can influence user response to technology use (Beaudry and Pinsonneault, 2005; Kim and Kankanhalli, 2009). The users are unlikely to adopt a technology, if they do not perceive the use as beneficial. IoT benefits users in terms of improving the quality of life in a wide range of aspects, e.g. entertainment, social networking, healthcare, transportation, etc. (Hsu and Lin, 2016; Lu et al., 2018). Perceived benefits have been found to positively influence users' intention of IoT acceptance (Hsu and Lin, 2016). In the context of IoT e-retail industry, the organisational assets and service processes constitute the hard and soft infrastructure (Yu et al., 2015b). However, hard and soft infrastructures do not directly determine consumer experience (Yu et al., 2015b). Whereas the perceived benefits provided by these infrastructures, i.e. the flexibility of adapting the product according to customer requirements, enhances consumer satisfaction. Besides, as the number of IoT users increases, network externalities, can further enhance the perceived value and benefits provided by IoT service (Katz and Shapiro, 1985; Hsu and Lin, 2016; Hsu and Yeh, 2017). With the proliferation of IoT, perceived benefits may gain importance in enhancing acceptance and use.

On the other hand, potential users may be sceptical about the caveats and threats regarding using IoT services (Caputo et al., 2018; Lu et al., 2018). Perceived sacrifices, which include monetary costs (Pal et al., 2018), privacy risks (Hsu and Lin, 2016; Caputo et al., 2018), and the difficulties in use (Kim et al., 2017), negatively affect the intention of IoT adoption. However, privacy concerns have a smaller effect on continuance intention of use compared to the perceived benefits provided by IoT services (Hsu and Lin, 2016). IoT users withstand privacy risk and tend to share their information (Weber, 2010; Caputo et al., 2018). This may be due to the very nature of IoT services and may also reflect Internet use trends, especially when it comes to young people (Scuotto et al., 2017; Caputo et al., 2018). Also, the uncertainties and lack of information related to IoT do not arouse users' deterrence emotions such as fear, but stimulate frequency of use (Hirunyawipada and Paswan, 2006; Caputo et al., 2018). The trade-off between privacy risk and perceived benefits also suggest that users are more willing to adopt and use IoT services if they are compatible with their values and beliefs (Hsu and Lin, 2016).

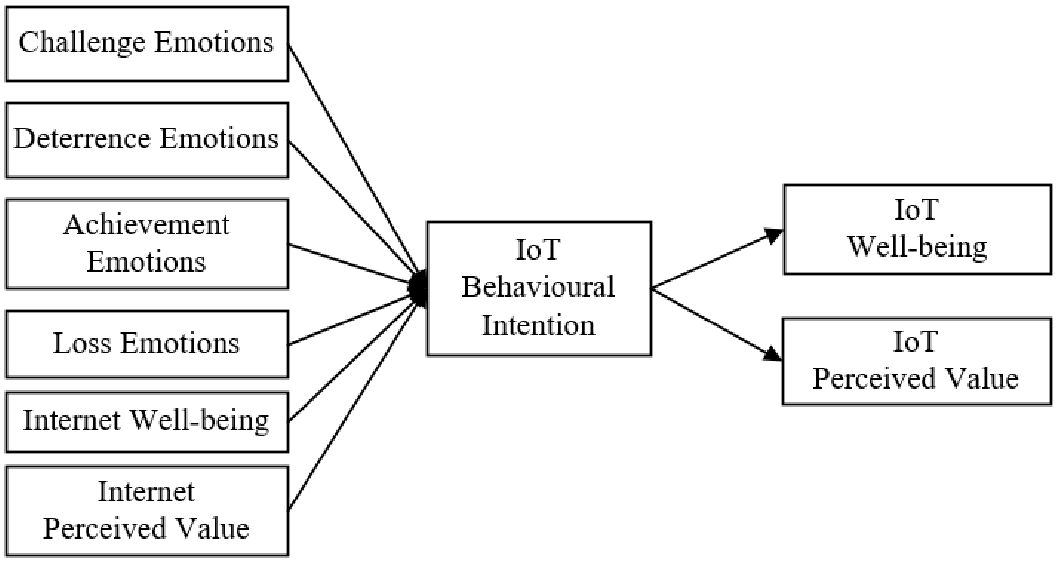
Overall, perceived value, which reflects users' beliefs in the utility and effectiveness of the technology, is hypothesised to be spilt over into IoT adoption intention.

H2.3a: The perceived value of the Internet has a positive effect on the users' behavioural intention of using the IoT.

H2.3b: The behavioural intention of using the IoT has a positive effect on the users' perceived value of the IoT.

Based on the hypotheses presented above, this study put forward the research framework (Figure 15).

Figure 15: Research Framework of Study 2: Spillover Effects



3.4 Study 3: User Adoption of the IoT

3.4.1 Research Objectives and Study Design

Studies of the IoT from the user perspective largely focus on exploring and examining potential factors influencing users' acceptance of IoT applications and services. The majority of the current studies were conducted within a specified research context or targeting a specific IoT service, e.g. smart home (Bao et al., 2014; Kim et al., 2017; Park et al., 2017), smart healthcare (Karahoca et al., 2017; Martínez-Caro et al., 2018; Pal et al., 2018), and the smart city (Leong et al., 2017). Moreover, as presented in Table 2, previous studies usually construct their research framework on the basis of technology acceptance theories such as the Technology Acceptance Model (TAM) (Davis et al., 1989), the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), the Theory of Planned Behaviour (Ajzen, 1991), etc. Among them, the most commonly used dependent variable is the behavioural intention, which is an indication of the individual's readiness to perform a given behaviour (Davis et al., 1989; Tscherning, 2012). Also, evidence supported the claim that the two fundamental constructs of TAM, i.e. perceived usefulness and perceived ease of use, significantly and positively determine the users' intention of using IoT applications and services (Bao et al., 2014; Gao and Bai, 2014; Jang and Yu, 2017; Liew et al., 2017; Mital et al., 2017; Park et al., 2017).

Given that previous studies have sufficiently explored the acceptance of many IoT applications and services, a comprehensive view of users' attitude toward the IoT platform may offer further insights. Also, incorporating and testing factors from technology adoption theory, e.g. Innovation Diffusion Theory (IDT) (Rogers, 1962), will potentially contribute to facilitating understandings of IoT acceptance and adoption. Drawing on the above, this study examines the effects of six perceived characteristics of innovation adapted from TAM and IDT on adoption intention of the IoT platform. To better understand the users' beliefs and attitudes toward adopting the IoT, two potential outcomes are also incorporated and tested, i.e. well-being and perceived value. The next section proceeds to elaborate on the development of the hypotheses and the construction of the research model.

3.4.2 Hypothesis Development and Research Framework

3.4.2.1 IoT Acceptance and Adoption

IDT is one of the most influential theories in understanding technological evolution. IDT suggested that individuals have different degrees of willingness to adopt an innovation and such a willingness is influenced by the individuals' perceived characteristics of the target innovation (Tornatzky and Klein, 1982; Rogers, 1995). IDT explored and developed a comprehensive set of attributes of innovation that significantly determine the adoption (Rogers, 1962). This set of attributes has been further revised to six perceived characteristics of innovating, i.e. relative advantage, complexity, compatibility, result demonstrability, visibility, and trialability (Rogers, 1983; Moore and Benbasat, 1991).

First of all, relative advantage is a leading factor that determines the users' intention of adoption (Abu-Khadra and Ziadat, 2012), referring to *"the degree to which an innovation is perceived as being better than the idea it supersedes"* (Rogers, 1983). The *"advantage"* is often expressed in terms of economic profitability, social prestige, convenience, and satisfaction (Rogers, 1983; Karahoca et al., 2017). However, whether an innovation is objectively advantageous has limited influence on the users' adoption; instead, the individual's perception of the advantages determines the rate of adoption (Rogers, 1983). Perceived usefulness directly describes the perceived utilitarian value and functionalities of new technology, which is defined as the degree to which an individual believes that using the technology might enhance their performance in completing tasks (Davis, 1989; Davis et al., 1989). This study employed perceived usefulness in testing IoT adoption intention.

An empirical study on the acceptance of IoT healthcare products reported that perceived advantage has positive effects on the users' perceived usefulness, perceived ease of use, and behavioural intention (Karahoca et al., 2017). Perceived usefulness was also reported as having positive effects on the users' attitude (Karahoca et al., 2017; Park et al., 2017), behavioural intention (Bao et al., 2014; Gao and Bai, 2014; Liew et al., 2017; Mital et al., 2017; Park et al., 2017), reuse intention (Jang and Yu, 2017), and satisfaction (Martínez-Caro et al., 2018) of using the IoT. With the aim of investigating the users' intention toward adopting the IoT, this study hypothesises that

H3.1a: Perceived usefulness is positively correlated with users' behavioural intention of using the IoT.

Complexity refers to *"the degree to which an innovation is perceived as relatively difficult to understand and use"* (Rogers, 1983), while perceived ease of use is defined as the degree to which an innovation is perceived to be easy to learn and use (Moore and Benbasat, 1991). These two constructs have a resemblance in concept (Moore and Benbasat, 1996; Venkatesh et al., 2003). Fundamentally, an innovation that is perceived to be less complicated is more likely to be accepted and adopted (Davis et al., 1989; Rogers, 1995). The effect of perceived ease of use on IoT acceptance and adoption is arguable. The majority of studies have reported positive effects of perceived ease of use on users' attitudes toward IoT (e.g. Gao and Bai, 2014; Liew et al., 2017; Mital et al., 2017; Park et al., 2017). However, the study of (Bao et al., 2014) did not show a significant effect and (Karahoca et al., 2017) reported a negative effect of perceived ease of use on users' intention to adopt IoT. This study proposes to examine the role of perceived ease of use and proposes a positive effect.

H3.1b: Perceived ease of use is positively correlated with users' behavioural intention of using the IoT.

The third perceived characteristic of innovation, compatibility, refers to *"the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters"* (Rogers, 1983). A high degree of compatibility implies that an innovation is less uncertain to its' potential adopters (Rogers, 1983). Ensuring the compatibility between IoT products is critical since IoT-based services are enabled by connecting many smart objects into the network (Shin et al., 2018). For instance, smart home services usually require connection and communication between various home appliances (Shin et al., 2018). Previous studies reported that compatibility is one of the most influential characteristics on IoT acceptance and adoption, e.g. (Bao et al., 2014; Karahoca et al., 2017; Park et al., 2017; Hubert et al., 2018; Shin et al., 2018), etc.

H3.1c: Compatibility is positively correlated with users' behavioural intention of using the IoT.

Observability in IDT has been separated into result demonstrability and visibility (Moore and Benbasat, 1991). Result demonstrability refers to the degree to which the results of using an innovation are visible and communicable to the others (Rogers, 1983; Moore and Benbasat, 1991; Moore and Benbasat, 1996). It also describes the tangibility of the results of using the innovation (Moore and Benbasat, 1991). Even an effective IS/IT could fail to gain acceptance and adoption if the users cannot attribute their performance to using it (Rogers, 1983; Venkatesh and Davis, 2000). The study of (Hubert et al., 2018) indicated that the effects of result demonstrability were positive on perceived ease of use, negative on perceived usefulness, and not significant for behavioural intention of adopting the smart home system. This study proposes to test the effect of result demonstrability on IoT adoption decisions.

H3.1d: Result demonstrability is positively correlated with users' behavioural intention of using the IoT.

Visibility describes the degree to which an IS/IT is apparent to the sense of sight (Rogers, 1983; Moore and Benbasat, 1991; Moore and Benbasat, 1996), and does not necessarily require communication between potential users. Visibility was suggested to be influential in persuading potential users to try the innovation (Agarwal and Prasad, 1997). The finding of (Chuah et al., 2016) suggested that visibility positively affects the intention of adopting a smartwatch. However, the study by (Hubert et al., 2018) reported a non-significant effect of visibility on smart home adoption. Many IoT products, such as wearable devices for smart healthcare, smart transportation services, and smart security products that are distributed in public spaces, are noticeable for the potential users (Lu et al., 2018). However, IoT products distributed in private spaces may not be visible to others. This study expects that visibility will be an influential factor in enhancing adoption of the IoT paradigm.

H3.1e: Visibility is positively correlated with users' behavioural intention of using the IoT.

Lastly, trialability is defined as *"the degree to which an innovation may be experimented with on a limited basis"* (Rogers, 1983), which describes the possibility of trying out or using an innovation before adoption (Moore and Benbasat, 1991; Moore and Benbasat, 1996). A high degree of trialability of innovation can decrease the perceived uncertainty for the potential adopters, which further enhances the adoption and use (Rogers, 1983; Dutta and Omolayole, 2016). Although very few studies have examined the effects of trialability, it is an important component in the process of technology adoption (Mohamad Hsbollah et al., 2009; Karahoca et al., 2017).

H3.1f: Trialability is positively correlated with users' behavioural intention of using the IoT.

3.4.2.2 Internet of Things and Well-being

Well-being refers to the users' need fulfilment and quality of life enhancement by using the IoT. IoT will bring about many benefits in the users' daily life, such as improving convenience and promoting well-being (Marikyan et al., 2018; Wang et al., 2018). Also, improving the users' psychological well-being is a long-term objective of smart technologies (Marikyan et al., 2018). Among the wide range of IoT-based services, IoT healthcare would largely benefit the users and enhance their well-being by monitoring health remotely, thus reducing pointless hospitalisation and lessening expenses in human services (Mital et al., 2017; Martínez-Caro et al., 2018; Papa et al., 2018). Smart buildings and smart cities that have massively distributed IoT-enabled sensors can monitor the surrounding environment. thus creating a better living condition for the citizens, ideally benefiting their health and well-being (Spaceti, 2017). Broadly speaking, IoT services and products will positively influence the users' well-being.

H3.2: Using the IoT is positively correlated with users' degree of well-being.

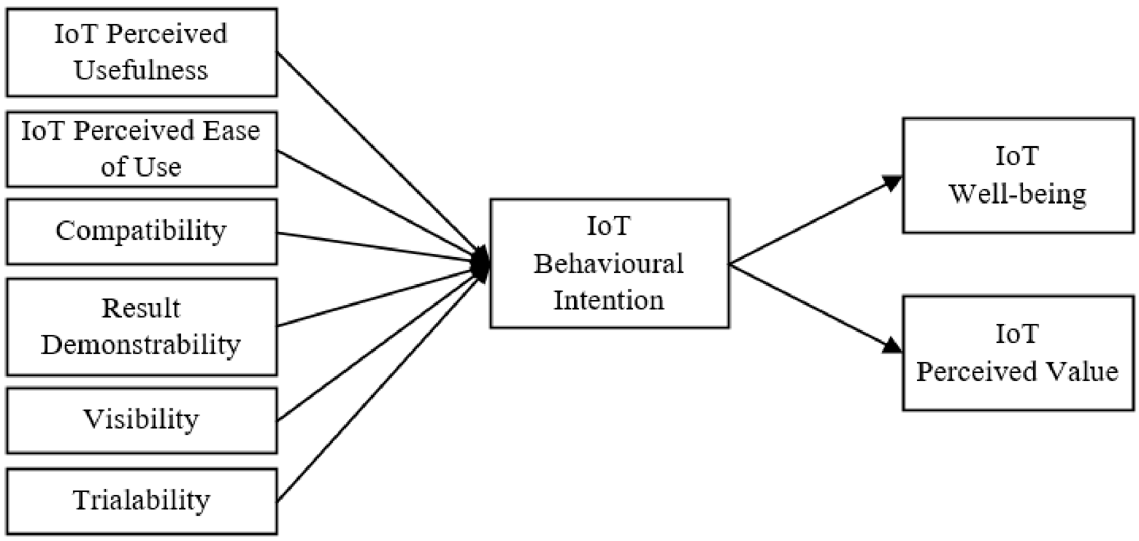
3.4.2.3 Internet of Things and Perceived Value

Perceived value refers to the users' cognitive overall assessment of using the IoT (Zeithaml, 1988; Okada, 2005; Kim et al., 2007). (Shin, 2017) studied the value of IoT from the utilitarian and hedonic points of view, suggesting that the perceived value positively influenced the quality of overall experience of IoT use. Taking into account that the IoT is delivered in the form of a service, the quality of experience critically determines the success of IoT implementation (Shin, 2017). The perceived value of IoT increased the users' continuance intention of smart devices that interact with public services (El-Haddadeh et al., 2018). The study of (Kim et al., 2017) viewed perceived value as an evaluation regarding the benefits and sacrifices, positively influencing the user's intention of accepting smart home services. (Jayashankar et al., 2018) suggested that perceived value positively affected the adoption intention of smart agriculture technology. Existing studies have examined perceived value as antecedents of IoT acceptance and use because perceived value, especially the instrumental value, was viewed as closely related to the perceived usefulness in TAM (El-Haddadeh et al., 2018). Given that this study regards perceived value as a construct reflecting the perceived importance and overall evaluation of using the IoT in people's daily life, it proposes to examine the perceived value as an outcome of IoT use.

H3.3: Using the IoT is positively correlated with users' perceived value.

Based on the hypotheses presented above, the research framework was put forward as follows (Figure 16).

Figure 16 Research Framework of Study 3: IoT Adoption



Chapter 4. Methodology

The previous chapter reviewed the MIS theories and the status of IoT studies, and a number of hypotheses were established. This chapter further explains how they will be tested. Beginning with the philosophical foundations of survey-based studies, the following sections proceed to introduce the methodology adopted, the strategy of sampling and data collection, the questionnaire design, and the process of the data analysis.

4.1 Research Philosophy

The philosophical paradigm refers to a system of beliefs that guide scientific research (Wynn Jr and Williams, 2008). Researchers take actions following a particular philosophical paradigm to generate and interpret knowledge claims about facts (Wynn Jr and Williams, 2008). The mainstream MIS studies were dominated by positivist and interpretivist paradigms (Wynn Jr and Williams, 2008; Tsang, 2014). Scientific research involves two approaches, namely the subjective and objective approaches (Holden and Lynch, 2004). Positivism falls into the objectivist paradigm while interpretivism falls into subjectivism (Holden and Lynch, 2004). Fundamentally, positivism focuses on testing, confirmation and falsification of hypotheses concerning an objective reality and apprehended reality (Wynn Jr and Williams, 2008). Interpretivism concerns the subjective understanding of a given phenomenon in a specific and unique context (Wynn Jr and Williams, 2008). Both of them are viewed as successful in generating rigorous and usable MIS theories (Weber, 2004). Table 5 presents a comparison of positivism and interpretivism in terms of ontology, epistemology, and the processes of conducting research.

Philosophical paradigms can be differentiated in terms of ontology and epistemology. More specifically, ontology refers to the nature of reality and being, while epistemology refers to the “evidentiary assessment and justification of knowledge claims” (Orlikowski and Baroudi, 1991; Wynn Jr and Williams, 2008). As far as ontology is concerned, the positivists believe that reality and the individual (i.e. the researcher) are separated and are independent. That is, positivistic ontology is dualistic in nature (Weber, 2004). On the other hand, interpretivists believe that the individual interacts with the reality and the understanding of the phenomena is bound to the individual's previous experiences (Weber, 2004). As the life-world consists of both subjective and objective characteristics, interpretivistic ontology is objective in terms of reflecting intersubjective reality (Weber, 2004). With regard to epistemology, positivists believe that human experience reflects objective and independent reality and such a reality lays the foundation for knowledge (Weber, 2004). Interpretivists intentionally constitute knowledge that possibly reflects the world and such knowledge is built within their life-world framework and their particular goals for the work (Weber, 2004).

The philosophical paradigm of this thesis will be based on positivism. Fundamentally, positivism assumes an objective reality and treats *"the constant conjunction of events as an indicator of a causal relationship"* (Tsang, 2014). Positivism has been viewed as a standard of scientific MIS research (Orlikowski and Baroudi, 1991; Siponen and Tsohou, 2018). Also, scientific MIS studies must be generalisable, focus on stable independent variables, have ontological assumptions, and use quantitative research methods (Siponen and Tsohou, 2018). (Siponen and Tsohou, 2018) summarised the features of positivist MIS research. For instance, the majority of it investigates the a priori relationships within phenomena, it has formal propositions, uses quantifiable measures for the dependent and independent variables, collects and analyses objective data, tests hypotheses that are generalisable across settings, etc. (Orlikowski and Baroudi, 1991; Siponen and Tsohou, 2018).

The methodology adopted by a scientific study should be consequential to the philosophical stance of the researcher and to the target phenomena to be investigated (Holden and Lynch, 2004). A positivistic study adopts a hypothetico-deductive approach with the aim of investigating relationships among empirically measurable constructs and the findings usually have predictive power (Tsang, 2014). Quantitative data analysis is a typical research method based on positivism, which requires data collection from questionnaire surveys, experiments, or archival data (Tsang, 2014). The reliability of results largely depend on the sample size (Tsang, 2014). This thesis proceeded with a positivism-based methodology following the above, using questionnaire-based data collection and statistical analysis based hypothesis testing.

Table 5 Comparison of Positivism and Interpretivism

	Positivism	**Interpretivism**
Ontology	Person (researcher) and reality are separate.	Person (researcher) and reality are inseparable (life-world).
Epistemology	Objective reality exists beyond the human mind.	Knowledge of the world is intentionally constituted through a person's lived experience.
Research Object	Research object has inherent qualities that exist independently of the researcher.	Research object is interpreted in light of the meaning structure of a person's lived experience.
Reductionism	Problems as a whole are better understood if they are reduced into the simplest possible elements.	Problems as a whole are better understood if the totality of the situation is looked at.
Research Design	Static design: categories isolated before the study.	Emerging design: categories identified during the research process.
Methodology	Primarily quantitative methods, e.g. surveys, experiments, content analysis.	Primarily qualitative methods, e.g. ethnographies based on hermeneutics, dialectics, phenomenology.
Sampling	Generalisability to the target population.	Small samples investigated in depth or over time.
Validity	Certainty: data truly measure reality.	Defensible knowledge claims.
Reliability	Replicability: research results can be reproduced.	Interpretive awareness: researchers recognise and address the implications of their subjectivity.
Value	Researcher assumed to be unbiased (value-free).	Researcher's biases part of the study (value-laden).
Generalisation	Aimed at generalising about regularities in human and social behaviour; leads to prediction, explanation and understanding.	Everything is contextual; theories developed for understanding.
Findings	Findings assumed true until falsified.	Findings "created" by the researcher based on this understanding.

Adapted from (Holden and Lynch, 2004; Weber, 2004; Wynn Jr and Williams, 2008; Haddadi et al., 2017)

4.2 Sampling and Data Collection

The aim of a survey is to gather unknown information from every unit in a population (Fricker Jr, 2016). Given that it is usually impossible or impractical to survey an entire population, a sample is required for surveys (Fricker Jr, 2016). Sampling is a process of selecting a subset of a group or population to become the foundation of a survey (Fricker Jr, 2016). There are two broad categories of sampling that are widely employed, namely, probability sampling and non-probability sampling (Taherdoost, 2016).

Probability sampling means that all of the respondents of the sample are selected using a probabilistic mechanism, by which each unit of the population has an equal probability of being selected (Saunders et al., 2009; Fricker Jr, 2016; Taherdoost, 2016). Typical probability sampling techniques are simple random sampling, systematic sampling, stratified random sampling, cluster sampling, etc. (Fricker Jr, 2016; Taherdoost, 2016). Non-probability samples can also be called convenience samples, and are usually selected when the probability of each unit from a population cannot be determined (Fricker Jr, 2016). Non-probability sampling is mostly employed in case study research and qualitative research (Taherdoost, 2016). That is, non-probability sampling can be used in examining real-life phenomena instead of making statistical inferences to a larger population (Taherdoost, 2016). Non-probability sampling techniques consist of convenience sampling, snowball sampling, quota sampling, and purposive or judgmental sampling (Taherdoost, 2016). Table 6 introduces the advantages and disadvantages of the eight probability and non-probability sampling techniques.

Table 6 Commonly Used Sampling Techniques

Sampling Technique	Advantages	Disadvantages
	Probability Sampling	
Simple Random Sampling: Every unit of the population has an equal probability of selection.	Easily understood; Results projectable	Difficult to construct a sampling frame; Expensive; Lower precision; No assurance of representativeness
Systematic Sampling: Every nth case after a random start is selected.	Can increase representativeness; Easier to implement than simple random sampling; Sampling frame not always necessary	Can decrease representativeness
Stratified Random Sampling: Dividing the population into subgroups which are then separately sampled.	Includes all important sub-population; Precision	Difficult to select relevant stratification variables; Not feasible to stratify on many variables; Expensive
Cluster Sampling: A natural sampling unit is a group or cluster of individual units.	Easy to implement; Cost-effective	Imprecise; Difficult to compute an interpret results
	Non-probability Sampling	
Convenience Sampling: Selecting participants because they are often readily and easily available.	Least expensive; Least time-consuming; Most convenient	Selection bias; Sample not representative; Not recommended by descriptive or casual research
Snowball Sampling: Using a few cases to encourage other cases to participate in the study, thereby increasing sample size. Mostly applied in a small population that is difficult to access.	Can estimate rare characteristics	Time-consuming
Quota Sampling: Specify quotas for the desired number of respondents with certain characteristics.	Sample can be controlled for certain characteristics	Selection bias; No assurance
Purposive/Judgmental Sampling: A type of convenience sampling in which the researcher selects the sample based on his or her judgement.	Low-cost; Convenient; Not time-consuming; Ideal for exploratory research design	Does not allow generalization, subjective

Adapted from (Fricker Jr, 2016; Taherdoost, 2016)

The target population of the three empirical studies of this research is current Internet users and potential IoT users. It is impracticable and impossible to collect data from the entire population. As such, a sample is required for the purpose of collecting data for hypothesis testing and examining phenomena. Given that the probability of selection for each unit of the population cannot be determined and the choice of participation is left up to the potential respondents (Saunders et al., 2009; Fricker Jr, 2016), a non-probability sampling technique is preferred for this research. Among the afore-mentioned sampling techniques, a convenience sampling technique is used for this research since convenience sampling is less time-consuming and is useful for collecting non-inferential data (Fricker Jr, 2016; Taherdoost, 2016). As such, the data required for the three empirical studies were collected from a consumer panel using an online-distributed questionnaire.

The sample size of a survey can influence the results of statistical tests. At any given alpha level, a large sample size usually offers greater power for statistical analysis. However, a very large sample size can also make the test overly sensitive (Hair Jr et al., 2014). According to (Bartlett et al., 2001), for surveys designed to achieve alpha levels of at least 0.05, aimed at collecting continuous data, and a targeted population size over 4000, the minimum sample size is 119. For studies using covariance based structural equation modelling (SEM) as the analysis method and with models containing more than seven constructs, the suggested sample size is over 500 (Hair Jr et al., 2014). The sample size of this thesis is 615 that offers sufficient power for the hypothesis tests.

Following the above, a questionnaire-based online survey was carried out to collect data for the three studies. Ethical approval was obtained in accordance with the established procedures of Newcastle University prior to the study taking place. This research was properly conducted following the Code of Good Practice in Research (Newcastle University, 2011). An introduction to the survey was presented on the first page of the questionnaire, introducing the objective of the study and providing instructions to the respondents, a declaration about data use and contact information about the researcher. An independent market research company organised the respondent recruitment, consisting of Internet users in the United States. Respondents were given the URL of the online survey and were asked to complete it. The authors did not have direct access to the respondents, which preserved their anonymity. 670 full questionnaires were initially received.

Prior to the main survey, a pilot study was carried out with 10 participants. Based on the evaluation of this pilot study and the average completion time of the main study (23.3 minutes), collected questionnaires that had been completed in less than five minutes were excluded from the dataset. Additionally, this study removed questionnaires completed by selecting the same answer for most of the scaled measurement items, including the 11 reversed ones. By applying the above-stated criteria in the data screening process, 615 completed questionnaires were entered into the analysis.

As the participants' profile (Table 7) illustrates, the participants of this research are the general population and have a reasonable distribution of demographic characteristics. This thesis targets general Internet users and potential IoT users. Therefore, the participants should have relatively sufficient experience and expertise on the Internet. The questionnaire investigated the experience of Internet use and self-reported Internet expertise, as shown in Table 9. Among the 615 respondents, 71.2% of them use the Internet for more than 3 hours on a daily basis. More than half of the respondents believe that they are heavy users of the Internet and spend more time than others. Also, more than 60% of the participants consider themselves to be relatively informed and knowledgeable about the Internet. Given that the IoT is evolving from the Internet and will serve as a more advanced platform, this group of experienced Internet users are also potential IoT users. Data collected from this group of respondents satisfied the requirement of this thesis.

Table 7 Demographic Profile of Respondents

Demographic characteristic	Type	Frequency (n=615)	Percentage (%)
Gender	Male	266	43.3%
	Female	349	56.7%
Age	20-29	69	11.2%
	30-39	127	20.7%
	40-49	114	18.5%
	50-59	139	22.6%
	60 or over	166	27.0%
Current employment status	Full-time employed	258	42.0%
	Part-time employed	64	10.4%
	Out of work (looking for work)	26	4.2%
	Out of work (not looking for work)	6	1.0%
	Homemaker	77	12.5%
	Student	16	2.6%
	Retired	125	20.3%
	Unable to work	43	7.0%
Ethnicity	African American	65	10.6%
	Native American	6	1.0%
	USA White	452	73.5%
	Asian American	28	4.6%
	Hispanic American	37	6.0%
	Multiracial	8	1.3%
	Other White Background	15	2.4%
	Other	4	0.7%
Education attainment	Some high school or less	12	2.0%
	High school graduate or equivalent	118	19.2%
	Vocational/technical school	54	8.8%
	Some college, but no degree	157	25.5%
	College graduate	156	25.4%
	Some graduate school	22	3.6%
	Graduate degree	78	12.7%
	Professional degree	18	2.9%
Residence area	Urbanized area	256	41.6%
	Urban cluster	231	37.6%
	Rural area	128	20.8%
Household income	$0- $24,999	114	18.5%
	$25,000-$49,999	161	26.2%
	$50,000-$74,999	138	22.4%
	$75,000-$99,999	95	15.4%
	More than $100,000	107	17.4%

4.3 Measurement Items

The full questionnaire consists of 118 questions in total. Specifically, there were 81 items measuring 22 main constructs, 3 items measuring unrelated variables, 29 items measuring 9 moderating variables, and 5 additional questions about demographic characteristics. The measure items of the main variables were adapted from previously validated measurements in the literature. The majority of the items were measured by a 7-point Likert scale, i.e. Strongly disagree; Disagree; Somewhat disagree; Neither agree nor disagree; Somewhat agree; Agree; Strongly agree, except special statement marked by ** in Table 9. The following sections present details of the measuring items of each study.

4.3.1 Study 1

Table 8 presents the 47 measure items of the 13 variables in study 1. Items for the TAM variables, i.e. PEOU, PU, and CI, were adapted from (Fishbein and Ajzen, 1975; Davis, 1989; Venkatesh, 2000). Social inclusion items were adopted from (Richardson and Le Grand, 2002), while items for the psychological needs for competence, autonomy, and relatedness were adapted from the Work-related Basic Need Satisfaction scale (Van den Broeck et al., 2010). Items measuring the well-being and perceived value were adapted for the Internet users in the post-adoption context from (El Hedhli et al., 2013) and (Okada, 2005) respectively. Lastly, this survey included ten potential emotional responses toward Internet use (Beaudry and Pinsonneault, 2010).

Study 1 also included 9 moderating variables (see Table 9). First of all, this survey measured both the subjective and objective dimensions of Internet use. Respondents were asked about the time spent on the Internet on a daily basis, and the degree to which they perceive themselves as heavy users (Dishaw and Strong, 1999; Mathwick and Rigdon, 2004). Subjective Internet expertise was also measured with 7-point Likert scale, describing the degree to which participants perceived themselves to be an expert on and to be knowledgeable and informed about the Internet (Oliver and Bearden, 1985; Dishaw and Strong, 1999). As far as personality characteristics are concerned, this survey investigated the respondents' age groups and gender. Moreover, (Credé et al., 2012) reviewed eight measures of the Big-5 personalities and suggested that "*even slightly longer measures can substantially increase the* *validity of research findings*". Taking into account the length, scale validity, and reliability of the questionnaire, this survey adopted the 20-item Mini International Personality Item Pool by (Donnellan et al., 2006).

Table 8 Study 1: Measure Items of Constructs

Construct	Item	Label	Source
Social Inclusion	How do you feel about your affordability of food?	SI1	(Richardson and Le Grand, 2002)
	How do you feel about your access to affordable accommodation?	SI2	
	How do you feel about your ability to obtain credit?	SI3	
	How do you feel about your access to public services.	SI4	
	How do you feel about your access to health care?	SI5	
	How do you feel about your affordability of transportation costs?	SI6	
Need for Competence	Using the Internet makes me feel competent.	NC1	(Van den Broeck et al., 2010)
	Using the Internet makes me feel that I can be good at the things that I do.	NC2	
	Using the Internet makes me feel that I could even accomplish the most difficult objectives.	NC3	
Need for Autonomy	Using the Internet helps me be myself.	NA1	(Van den Broeck et al., 2010)
	Using the Internet makes me feel that I don't have to follow other people's commands.	NA2	
	Using the Internet gives me the opportunity to do things differently.	NA3	
	Using the Internet gives me the opportunity to do things the way I really want.	NA4	
Need for Relatedness	Using the Internet makes me feel connected with other people.	NR1	(Van den Broeck et al., 2010)
	Using the Internet makes me feel part of a group.	NR2	
	Using the Internet helps me to mix with other people.	NR3	
	Using the Internet gives me the opportunity to talk with people about things that really matter to me.	NR4	
Internet Perceived Ease of Use	Using the Internet is clear and easy to understand.	I-PEOU1	(Venkatesh, 2000)
	Using the Internet does not require a lot of my effort.	I-PEOU2	
	I find the Internet to be easy to use.	I-PEOU3	
	I find it easy to get the Internet to do what I want it to do.	I-PEOU4	
Internet Perceived Usefulness	Using the Internet improves my performance in my personal and work-related tasks.	I-PU1	(Venkatesh, 2000)
	Using the Internet in my personal and work-related	I-PU2	

	tasks increases my productivity.		
	Using the Internet enhances my effectiveness in my personal and work-related tasks.	I-PU3	
	I find the Internet to be useful in my personal and work-related tasks.	I-PU4	
Internet Continuance Intention	I intend to continue using the Internet in the future.	I-CI1	(Venkatesh, 2000)
	I will always try to use the Internet in my daily life.	I-CI2	
	I plan to continue to use the Internet frequently.	I-CI3	
Internet Well-Being	The Internet satisfies my overall needs.	I-WB1	(El Hedhli et al., 2013)
	The Internet plays a very important role in my social well-being.	I-WB2	
	The Internet plays a very important role in my leisure well-being.	I-WB3	
	The Internet plays an important role in enhancing the quality of my life in my community.	I-WB4	
Internet Perceived Value	Overall, what is the value of the Internet in your life?	I-PV1	(Okada, 2005)
	How well-off are you with the Internet in your life?	I-PV2	
	How would you feel if you did not have access to the Internet?	I-PV3	
Achievement Emotions	Satisfaction	AE1	(Beaudry and Pinsonneault, 2010)
	Pleasure	AE2	
	Enjoyment	AE3	
Challenge Emotions	Arousal	CE1	(Beaudry and Pinsonneault, 2010)
	Playfulness	CE2	
	Flow	CE3	
Loss Emotions	Disappointment	LE1	(Beaudry and Pinsonneault, 2010)
	Frustration	LE2	
	Disgust	LE3	
Deterrence Emotions	Fear	DE1	(Beaudry and Pinsonneault, 2010)
	Worry	DE2	
	Distress	DE3	

Table 9 Study 1: Measure Items of Moderators

Moderators	Measure Item	Mean	S.D.
Internet Use Behaviour (Dishaw and Strong, 1999; Mathwick and Rigdon, 2004)	How much time do you typically spend using the Internet on a daily basis? (0 - Up to 1 hour; 1 hour - up to 3 hours; 3 hours - up to 5 hours; 5 hours - up to 7 hours; 7 hours or more)**	3.32	1.174
	Compared with most users, I think I spend more time on the Internet.	4.49	1.753
	Outside of the time I spend with e-mail, I consider myself to be a "heavy user" of the Internet.	4.42	1.863
	In a typical week, I visit dozens of websites.	4.89	1.811
Internet Expertise (Oliver and Bearden, 1985)	Considering your knowledge on the Internet, how do you rate yourself in terms of your expertise? (Novice - Expert)**	4.85	1.392
	To what extent do you consider yourself informed about the Internet? (Not at all informed - Highly informed)**	4.89	1.415
	Would you consider yourself knowledgeable about the Internet? (Know nothing at all - Know a great deal)**	4.98	1.386
Age	Five Groups**: 20 – 29; 30 – 39; 40 -49; 50 – 59; Over 60	3.33	1.361
Gender	Male or Female**	1.57	0.496
Big-5 Extraversion (Donnellan et al., 2006)	I am the life of the party.	3.54	1.782
	I don't talk a lot. *	3.80	1.785
	I talk to a lot of different people at parties.	4.18	1.812
	I keep myself in the background. *	3.68	1.666
Big-5 Agreeableness (Donnellan et al., 2006)	I sympathise with others' feelings.	5.57	1.235
	I am not interested in other people's problems. *	4.58	1.665
	I feel others' emotions.	5.05	1.336
	I am not really interested in others. *	4.90	1.654
Big-5 Conscientiousness (Donnellan et al., 2006)	I get chores done right away.	5.21	1.397
	I often forget to put things back in their proper place. *	4.93	1.820
	I like order.	5.53	1.260
	I make a mess of things. *	5.26	1.709
Big-5 Neuroticism (Donnellan et al., 2006)	I have frequent mood swings.	3.50	1.802
	I am relaxed most of the time. *	3.12	1.503
	I get upset easily.	3.47	1.756
	I seldom feel blue. *	3.68	1.757
Big-5 Imagination (Donnellan et al., 2006)	I have a vivid imagination.	4.98	1.453
	I am not interested in abstract ideas. *	4.32	1.635
	I have difficulty understanding abstract ideas. *	4.67	1.655
	I do not have a good imagination. *	5.06	1.701

*Notes: S.D. = Standard Deviation. * = Reverse items. Most items measured by 7-point Likert scale except special statement marked by **.*

4.3.2 Study 2

Study 2 consists of 29 measure items of the 9 variables. Table 10 presents the measurement items, means, standard deviation (S.D.), and factor loadings. Well-being was measured by items from (El Hedhli et al., 2013), while items for the perceived value were adapted from (Okada, 2005). These two constructs were measured twice by adapting the items to the Internet and the IoT contexts respectively. Items for behavioural intention were adapted from (Venkatesh, 2000). Lastly, ten emotional reactions toward using the Internet, which fall into four categories, were selected from the original article about the emotion classifying framework (Beaudry and Pinsonneault, 2010).

Table 10 Study 2: Measure Items of Constructs

Construct	Item	Label	Source
Achievement Emotions	Satisfaction	AE1	(Beaudry and Pinsonneault, 2010)
	Pleasure	AE2	
	Enjoyment	AE3	
Challenge Emotions	Arousal	CE1	(Beaudry and Pinsonneault, 2010)
	Playfulness	CE2	
	Flow	CE3	
Loss Emotions	Disappointment	LE1	(Beaudry and Pinsonneault, 2010)
	Frustration	LE2	
	Disgust	LE3	
Deterrence Emotions	Fear	DE1	(Beaudry and Pinsonneault, 2010)
	Worry	DE2	
	Distress	DE3	
Internet Well-being	The Internet satisfies my overall needs.	I-WB1	(El Hedhli et al., 2013)
	The Internet plays a very important role in my social well-being.	I-WB2	
	The Internet plays a very important role in my leisure well-being.	I-WB3	
	The Internet plays an important role in enhancing the quality of my life in my community.	I-WB4	
Internet Perceived Value	Overall, what is the value of the Internet in your life?	I-PV1	(Okada, 2005)
	How well-off are you with the Internet in your life?	I-PV2	
	How would you feel if you did not have access to the Internet?	I-PV3	
IoT Behavioural Intention	I intend to use the IoT in the future.	IoT-BI1	(Venkatesh, 2000)
	I will try to use the IoT in my daily life.	IoT-BI2	
	I will plan to use the IoT frequently.	IoT-BI3	

IoT Well-being	The IoT satisfies my overall needs.	IoT-WB1	(El Hedhli et al., 2013)
	The IoT will play a very important role in my social well-being.	IoT-WB2	
	The IoT plays a very important role in my leisure well-being.	IoT-WB3	
	The IoT will play an important role in enhancing the quality of my life in my community.	IoT-WB4	
IoT Perceived Value	Overall, what would be the value of the IoT for you personally?	IoT-PV1	(Okada, 2005)
	How well-off would you be with the IoT?	IoT-PV2	
	How happy would you be with the IoT?	IoT-PV3	

4.3.3 Study 3

The theoretical framework of study 3 consists of 34 measure items of the 9 constructs. This model included three variables adapted from TAM, four constructs selected from the perceived characteristics of innovation, and two potential outcomes of IoT use (Table 10). Measurement of the perceived usefulness, perceived ease of use, and behavioural intention of using the IoT were adapted from (Venkatesh, 2000). The measure items of perceived characteristics of innovation, i.e. compatibility, result demonstrability, visibility, and trialability, were adapted from the study of (Moore and Benbasat, 1991). Similar to the previous studies, items about well-being and perceived value were adapted from the studies of (El Hedhli et al., 2013) and (Okada, 2005) respectively.

Table 11 Study 3: Measure Items of Constructs

Construct	Item	Label	Source
IoT Perceived Usefulness	Using the IoT improves my performance in my personal and work-related tasks.	IoT-PU1	(Venkatesh, 2000)
	Using the IoT in my personal and work-related tasks increases my productivity.	IoT-PU2	
	Using the IoT enhances my effectiveness in my personal and work-related tasks.	IoT-PU3	
	I find the IoT to be useful in my personal and work-related tasks.	IoT-PU4	
IoT Perceived Ease of Use	The IoT is clear and easy to understand.	IoT-PEOU1	(Venkatesh, 2000)
	Using the IoT does not require a lot of my effort.	IoT-PEOU2	
	I find the IoT to be easy to use.	IoT-PEOU3	
	I find it easy to get the IoT to do what I want it to do.	IoT-PEOU4	

Compatibility	The IoT will be compatible with all aspects of personal and work-related tasks.	CPT1	(Moore and Benbasat, 1991)
	The IoT will be completely compatible with my current situation.	CPT2	
	The IoT will fit well with the way I like to accomplish my tasks.	CPT3	
	The IoT will fit into my work style.	CPT4	
Result Demonstrability	I would have no difficulty telling others about the results of using IoT products.	RD1	(Moore and Benbasat, 1991)
	I believe I could communicate to others the consequences of using IoT products.	RD2	
	The results of using the IoT products are apparent to me.	RD3	
	I would have difficulty explaining why using the IoT products may or may not be beneficial.	RD4	
Visibility	I have seen what others do using IoT products.	VIS1	(Moore and Benbasat, 1991)
	In my community, one sees the others using IoT products.	VIS2	
	The use of IoT products is not very visible among my friends.*	VIS3	
	It is easy for me to observe others using IoT products.	VIS4	
Trialability	I've had a great deal of opportunity to try various IoT products.	TR1	(Moore and Benbasat, 1991)
	The IoT products were available to me to adequately test run various applications.	TR2	
	Before deciding whether to use any IoT products, I was able to properly try them out.	TR3	
	I was permitted to use IoT products on a trial basis long enough to see what it could do.	TR4	
IoT Behavioural Intention	I intend to use the IoT in the future.	IoT-BI1	(Venkatesh, 2000)
	I will try to use the IoT in my daily life.	IoT-BI2	
	I will plan to use the IoT frequently.	IoT-BI3	
IoT Well-being	The IoT will satisfy my overall needs.	IoT-WB1	(El Hedhli et al., 2013)
	The IoT will play a very important role in my social well-being.	IoT-WB2	
	The IoT will play a very important role in my social well-being.	IoT-WB3	
	The IoT will play an important role in enhancing the quality of my life in my community.	IoT-WB4	
IoT Perceived Value	Overall, what would be the value of the IoT for you personally?	IoT-PV1	(Okada, 2005)
	How well-off would you be with the IoT?	IoT-PV2	
	How happy would you be with the IoT?	IoT-PV3	

*Notes: * = Reverse item.*

4.4 Data Analysis Approach

Multivariate analysis is widely used in addressing practical and theoretical research questions (Hair Jr et al., 2014). A number of widely used multivariate techniques, such as multiple regression, factor analysis, multivariate analysis of variance, and discriminant analysis, expanded the explanatory ability of surveys (Hair Jr et al., 2014). However, these techniques have a common limitation in statistical efficiency in that they can examine only one relationship at a time and the relationship between only one independent variable and many dependent variables (Hair Jr et al., 2014). Structural equation modelling offers a number of advantages when compared with techniques such as those mentioned above in terms of (a) making it possible to examine a series of dependence relationships simultaneously; (b) it being particularly useful in testing dependence relationships of multiple equations; and (c) allowing for assessing measurement properties and testing theoretical relationships. This study employed structural equation modelling as the data analysis technique and followed the process suggested by (Hair Jr et al., 2014) and by (Gaskin, 2016). SPSS v.23 and SPSS Amos v.24 were used for the statistical analysis of the main hypotheses and moderation effects.

The following section presents the strategy of data analysis of the three studies. Each of the studies was analysed separately using individual models. This research adopted three steps in the analysis, i.e. reliability and validity tests using confirmatory factor analysis, collinearity and common method bias tests, and hypothesis tests using structural equation modelling (Hair Jr et al., 2014). Following the multi-group analysis approach of moderation effect analysis involved in study 1, partial metric invariance was tested to ensure the factor loading equivalence of the two clusters of each moderator. The first section presents details of the reliability and validity tests, and includes the results of confirmatory factor analysis and the correlations between the constructs of each model. Given that common method bias can be a potential issue for empirical studies using the same method to measure variables (Podsakoff et al., 2003; Richardson et al., 2009), section 4.4.2 further estimates the common method variances. The last section presents details about the hypothesis test and the partial metric invariance test for moderation effect analysis.

4.4.1 Reliability and Validity Analysis

Reliability refers to the consistency between a variable and what it intended to measure, while validity describes the degree to which the measurements can correctly represent the concept of study (Hair Jr et al., 2014). Put differently, reliability describes how a variable is measured whereas validity concerns how well the concept is defined by the measurements. The construct reliability must be satisfied before assessing validity (Hair Jr et al., 2014). As such this research tested construct reliability, construct validity, and convergent validity by CFA. Three CFA models were established separately.

In CFA analysis, the researchers should report at least one incremental index, one absolute index, the Chi-square value, and the associated degrees of freedom with aim of providing adequate evidence of model fit (Hair Jr et al., 2014). This study reported the comparative fit index (CFI) as an incremental index and root mean square error of approximation (RMSEA) as an absolute index. The criterion of CFA models depends on the sample size (N) and the number of observed variables (m). The suggested criteria are CFI > 0.92 and RMSEA < 0.07 for study 1 (N>250, 12<m<30) and CFI > 0.95 and RMSEA < 0.07 for study 2 and 3 (N>250, m<12) (Hair Jr et al., 2014). The three CFA models all achieved satisfactory model fit indices (see Table 12-14).

Table 12-14 also reported the factor loadings of each item and construct reliability (C.R.), average variance extracted (AVE) and Cronbach's α of the variables. First of all, (Hair Jr et al., 2014) suggested that factor loadings greater than 0.3 are considered as having practical significance when the N > 350. To satisfy the criteria of construct reliability and validity, the standardized loading should be greater than 0.5 and ideally higher than 0.7 (Hair Jr et al., 2014). The measured variables should also satisfy the criteria of C.R. > 0.7, AVE > 0.5 and Cronbach's α > 0.7. Given the above, some items were removed from the CFA model since they (a) fail to load with the expected factor, (b) have factor loading lower than 0.5, or (c) cause high cross-loadings. To this end, 10 items were removed from study 1, 4 items were removed from study 2, and 6 items were removed from study 3.

Table 12 Study 1: Confirmatory Factor Analysis

Construct	C.R.	AVE	Cronbach's α	Item	Loading
Social Inclusion	0.884	0.607	0.898	SI1	0.807
				SI2	0.867
				SI3	0.660
				SI4	Removed
				SI5	0.705
				SI6	0.836
Need for Competence	0.915	0.783	0.913	NC1	0.866
				NC2	0.917
				NC3	0.870
Need for Autonomy	0.890	0.802	0.889	NA1	Removed
				NA2	Removed
				NA3	0.869
				NA4	0.921
Need for Relatedness	0.927	0.809	0.921	NR1	Removed
				NR2	0.876
				NR3	0.936
				NR4	0.885
Internet Perceived Ease of Use	0.927	0.761	0.925	I-PEOU1	0.821
				I-PEOU2	0.840
				I-PEOU3	0.932
				I-PEOU4	0.892
Internet Perceived Usefulness	0.938	0.834	0.936	I-PU1	0.880
				I-PU2	0.935
				I-PU3	0.924
				I-PU4	Removed
Internet Continuance Intention	0.868	0.767	0.868	I-CI1	0.877
				I-CI2	Removed
				I-CI3	0.875
Internet Well-Being	0.857	0.749	0.783	I-WB1	Removed
				I-WB2	0.875
				I-WB3	Removed
				I-WB4	0.856
Internet Perceived Value	0.829	0.621	0.806	I-PV1	0.906
				I-PV2	0.749
				I-PV3	0.694
Achievement Emotions	0.899	0.748	0.890	AE1	0.895
				AE2	0.847
				AE3	0.851
Challenge Emotions	0.765	0.619	0.761	CE1	Removed
				CE2	0.778
				CE3	0.796
Loss Emotions	0.892	0.805	0.890	LE1	0.922

				LE2	0.872
				LE3	Removed
Deterrence Emotions	0.941	0.842	0.940	DE1	0.895
				DE2	0.941
				DE3	0.916

Notes: Method: M.L.; Model fit: χ2 (551) = 1200.367, CMIN/DF = 2.179, GFI = 0.904, CFI= 0.967, RMSEA= 0.044.

Table 13 Study 2: Confirmatory Factor Analysis

Construct	**C.R.**	**AVE**	**Cronbach's α**	**Item**	**Mean (S.D.)**	**Loading**
Achievement Emotions	0.900	0.749	0.899	AE1	5.69 (1.103)	0.879
				AE2	5.54 (1.199)	0.861
				AE3	5.69 (1.142)	0.856
Challenge Emotions	0.790	0.560	0.773	CE1	3.46 (1.854)	0.639
				CE2	4.54 (1.591)	0.843
				CE3	4.86 (1.390)	0.750
Loss Emotions	0.892	0.806	0.890	LE1	2.96 (1.588)	0.928
				LE2	3.19 (1.706)	0.867
				LE3	Removed	Removed
Deterrence Emotions	0.942	0.844	0.941	DE1	2.64 (1.598)	0.895
				DE2	2.74 (1.608)	0.941
				DE3	2.63 (1.621)	0.918
Internet Well-being	0.872	0.695	0.868	I-WB1	Removed	Removed
				I-WB2	4.72 (1.723)	0.857
				I-WB3	5.31 (1.414)	0.791
				I-WB4	4.69 (1.647)	0.851
Internet Perceived Value	0.828	0.619	0.805	I-PV1	5.71 (1.157)	0.886
				I-PV2	5.38 (1.287)	0.761
				I-PV3	5.47 (1.497)	0.700
IoT Behavioural Intention	0.964	0.900	0.964	IoT-BI1	4.48 (1.591)	0.923
				IoT-BI2	4.48 (1.599)	0.961
				IoT-BI3	4.42 (1.616)	0.961
IoT Well-being	0.956	0.878	0.956	IoT-WB1	Removed	Removed
				IoT-WB2	4.19 (1.726)	0.938
				IoT-WB3	4.40 (1.699)	0.940
				IoT-WB4	4.30 (1.711)	0.933
IoT Perceived Value	0.906	0.828	0.903	IoT-PV1	Removed	Removed
				IoT-PV2	4.45 (1.531)	0.879
				IoT-PV3	4.49 (1.657)	0.940

Notes: Method: M.L.; Model fit: χ2 (240) = 699.285, CMIN/DF = 2.914, GFI = 0.917, CFI= 0.969, RMSEA= 0.056.

Table 14 Study 3: Confirmatory Factor Analysis

	C.R.	AVE	Cronbach's α	Item	Loading
IoT Perceived Usefulness	0.958	0.884	0.958	IoT-PU1	Removed
				IoT-PU2	0.930
				IoT-PU3	0.955
				IoT-PU4	0.936
IoT Perceived Ease of Use	0.926	0.759	0.923	IoT-PEOU1	0.893
				IoT-PEOU2	0.733
				IoT-PEOU3	0.925
				IoT-PEOU4	0.918
Compatibility	0.959	0.853	0.958	CPT1	0.923
				CPT2	0.933
				CPT3	0.950
				CPT4	0.888
Result Demonstrability	0.914	0.781	0.914	RD1	0.847
				RD2	0.907
				RD3	0.896
				RD4	Removed
Visibility	0.894	0.808	0.894	VIS1	0.882
				VIS2	0.916
				VIS3	Removed
				VIS4	Removed
Trialability	0.937	0.832	0.937	TR1	Removed
				TR2	0.911
				TR3	0.916
				TR4	0.909
IoT Behavioural Intention	0.942	0.890	0.942	IoT-BI1	0.940
				IoT-BI2	0.947
				IoT-BI3	Removed
IoT Well-Being	0.962	0.863	0.961	IoT-WB1	0.915
				IoT-WB2	0.929
				IoT-WB3	0.946
				IoT-WB4	0.926
IoT Perceived Value	0.938	0.835	0.938	IoT-PV1	0.934
				IoT-PV2	0.880
				IoT-PV3	0.927

Notes: Method: M.L.; Model fit: $\chi 2(314) = 952.391$, CMIN/DF = 3.033, GFI = 0.902, CFI= 0.972, RMSEA= 0.058.

Convergent validity tests were carried out based on the three CFA models, as presented in Table 15-17. Figures in the diagonal of each table represent the square root of the AVE and those below the diagonal represent the correlations between the constructs. The square root of the AVE is greater than the correlations between the constructs, suggesting that there was no convergent validity issue with the three research models (Hair Jr et al., 2014). Given the above, the three studies of this thesis successfully established the reliability and validity of the constructs.

Table 15 Study 1: Convergent Validity Test

	SI	NC	NA	NR	I-PEOU	I-PU	I-CI	I-WB	I-PV	AE	CE	LE	DE
SI	**0.779**												
NC	0.284	**0.884**											
NA	0.291	0.852	**0.895**										
NR	0.199	0.693	0.623	**0.900**									
I-PEOU	0.344	0.571	0.568	0.461	**0.872**								
I-PU	0.295	0.674	0.589	0.606	0.672	**0.913**							
I-CI	0.334	0.527	0.537	0.394	0.761	0.590	**0.876**						
I-WB	0.199	0.667	0.592	0.813	0.508	0.645	0.411	**0.866**					
I-PV	0.324	0.662	0.655	0.581	0.689	0.665	0.735	0.674	**0.788**				
AE	0.414	0.662	0.639	0.552	0.699	0.591	0.688	0.602	0.757	**0.864**			
CE	0.231	0.659	0.661	0.683	0.464	0.574	0.341	0.703	0.570	0.633	**0.787**		
LE	-0.221	-0.158	-0.142	-0.062	-0.348	-0.156	-0.347	-0.093	-0.277	-0.336	0.061	**0.897**	
DE	-0.204	-0.076	-0.077	0.037	-0.262	-0.086	-0.327	0.012	-0.213	-0.293	0.123	0.840	**0.918**

Table 16 Study 2: Convergent Validity Test

	AE	CE	LE	DE	I-PV	I-WB	IoT-BI	IoT-PV	IoT-WB
AE	**0.866**								
CE	0.579	**0.748**							
LE	-0.320	0.142	**0.898**						
DE	-0.282	0.195	0.840	**0.919**					
I-PV	0.672	0.685	-0.126	-0.025	**0.834**				
I-WB	0.761	0.538	-0.272	-0.210	0.737	**0.786**			
IoT-BI	0.430	0.532	-0.038	0.052	0.607	0.507	**0.949**		
IoT-PV	0.478	0.609	-0.034	0.075	0.749	0.532	0.839	**0.937**	
IoT-WB	0.455	0.558	-0.065	0.039	0.650	0.588	0.829	0.888	**0.910**

Table 17 Study 3: Convergent Validity Test

	IoT-PU	IoT-PEOU	CPT	RD	VIS	TR	IoT-BI	IoT-WB	IoT-PV
IoT-PU	**0.940**								
IoT-PEOU	0.833	**0.871**							
CPT	0.855	0.754	**0.924**						
RD	0.751	0.787	0.786	**0.884**					
VIS	0.656	0.630	0.695	0.745	**0.899**				
TR	0.596	0.591	0.654	0.695	0.836	**0.912**			
IoT-BI	0.910	0.831	0.858	0.742	0.686	0.609	**0.944**		
IoT-WB	0.825	0.750	0.914	0.768	0.726	0.689	0.849	**0.929**	
IoT-PV	0.794	0.742	0.888	0.784	0.718	0.693	0.824	0.908	**0.914**

4.4.2 Collinearity and Common Method Bias Tests

Collinearity is a predictor-predictor phenomenon that occurs in multiple regression models. It exists when two or more predictors measure the same underlying construct (Kock, 2015). A full collinearity test should be conducted by calculating the variance inflation factor (VIF) based on multiple regression analysis (Kock and Lynn, 2012; Kock, 2015). In the context of co-variance-based SEM, VIF lower than 5 is the recommended threshold (Kline, 1998; Kock and Lynn, 2012) while VIF lower than or equal to 3.3 indicates that the research model is free of collinearity issues (Kock, 2015). Regression analysis of each dependent variable was run separately according to the composites of their predictors. Results showed that the VIFs ranged from 1.074 to 3.192 for study 1, from 1.546 to 2.659 for study 2, and from 2.674 to 4.707 for study 3. All of the VIFs were lower than the recommended threshold of 5, indicating that collinearity is not an issue in the three studies of this thesis.

Common method bias (CMB), or common method variance, refers to the spurious variance that is attributed to the measurement method rather than to the constructs themselves (Podsakoff et al., 2003). CMB can be viewed as a “systematic error variance” shared among the variables being measured with a common scaling approach or from a single data source (Richardson et al., 2009; Fuller et al., 2016). A great deal of evidence indicates that CMB can (a) influence construct validity and reliability, (b) inflate or deflate the correlations between latent constructs, and (c) bias the true relationships between substantial variables (Williams and Anderson, 1994; MacKenzie and Podsakoff, 2012; Fuller et al., 2016). However, on the other hand, researchers have also suggested that the common method variance at a typical level of multiple-item measures is not a threat to the validity of research findings (Fuller et al., 2016).

CMB arises from a number of sources, such as common scale formats, common rater effects, item characteristic effects, intermixing of items (MacKenzie and Podsakoff, 2012). CMB is more likely to occur in surveys using similar content in the items and a response format that asks a group of respondents with similar characteristics in similar settings (MacKenzie and Podsakoff, 2012). The questionnaire of this research used a common scale format, i.e. the 7-point Likert scale, which may heighten the perceived similarity of the items and may cause the participants to be less attentive when answering questions (Podsakoff et al., 2003; MacKenzie and Podsakoff, 2012). A common scale format is widely used in empirical studies in the business field since it requires less cognitive effort for the respondents in completing the questionnaire (Podsakoff et al., 2003). However, the consistency in the scale may also result in falsely observed covariations among the constructs (Podsakoff et al., 2003; Fuller et al., 2016).

In addition to the common scale format, the length of the questionnaire is another potential source of CMB (Podsakoff et al., 2003; MacKenzie and Podsakoff, 2012). (Podsakoff et al., 2003) suggested that although short questionnaires can reduce the bias caused by the respondents' fatigue and carelessness, it may enhance other forms of bias such as the risk that the respondents' may artificially maintain the consistency of their answers by accessing previous items or their short-term memory. On the other hand, very lengthy questionnaires that require more cognitive effort to complete may result in *"poorer comprehension, less thorough retrieval, less careful judgment and mapping of judgments on to response categories, and/or stylistic responding"* (MacKenzie and Podsakoff, 2012). Given that this research used one relatively long questionnaire in the data collection of the three empirical studies, it is necessary to test for potential CMB.

There are many widely-applied techniques for CMB tests, e.g. Harman's single factor test (Podsakoff et al., 2003), full collinearity test (Kock and Lynn, 2012; Kock, 2015), CFA marker technique (Williams et al., 2010), and the common latent variable technique (Lindell and Whitney, 2001; Podsakoff et al., 2003). Among these techniques, Harman's single factor test has been the most commonly used one in the past few years due to its simplicity (Fuller et al., 2016). However, it solely examines how much common method variance may exist in one single dimension, which has critical limitations in terms of accuracy, sensitiveness, and effectiveness (Podsakoff et al., 2003; Fuller et al., 2016). (Podsakoff et al., 2003) noted that, in Harman's single factor test, CMB would be regarded as a problem only if the method variance completely accounted for the covariances among the items.

This research adopted the common latent variable technique, or the marker variable approach, to estimate the size of method variance in each of the studies. This technique was applied to the three CFA models and included three steps (a) partialling out an unrelated variable as a surrogate/marker variable for common method variances, (b) loading all of the items on both their theoretical constructs and the marker variable that has its own measure items, and (c) constraining the parameters between research items and the marker variables to be equal (Podsakoff and Organ, 1986; Lindell and Whitney, 2001; Podsakoff et al., 2003). The marker variable in the case of this thesis is Job Satisfaction, which is theoretically unrelated to all of the constructs. Job Satisfaction was measured in the same approach with other constructs, i.e. the 7-point Likert scale, and included three items adapted from (Brayfield and Rothe, 1951), i.e. "I feel fairly satisfied with my present job", "most days I am enthusiastic about my work" and "I find real enjoyment in my work". The parameters between research items and Job Satisfaction represented the amounts of method variance in the three studies, i.e. 13.4%, 11.2% and 33.0% respectively. These results suggest that the common method variances of each research model did not account for the majority of the variances. Therefore, this thesis is free of CMB issues.

Taking into account the above, this research adopted a full collinearity test and an estimation of the CMV using the marker variable approach. Statistical results indicated that collinearity is not problematic in this thesis and the research findings are not affected by CMB. The next section proceeds to test the main hypotheses and moderation effects, as proposed in Chapter 3.

4.4.3 Hypothesis Test and Moderation Analysis

Structural equation modelling (SEM) was employed to test the hypotheses about the main effects. First of all, three SEM models were successfully established, by which the model fit criteria, i.e. 2 < CMIN/DF < 5, CFI > 0.9, RMSEA < 0.08 (Hooper et al., 2008; Hair Jr et al., 2014), were satisfied. The R^2, direct effects, indirect effects, and total effects also suggested that the three SEM models explained a sufficient amount of variance (details presented in chapter 5). Given that study 1 proposed nine factors as potential moderating factors and the SEM model has been established, this study proceeded to explore the moderation effects. There are nine moderators explored in study 1. The measuring items and their mean value and standard deviation were presented in Table 9. A multi-group analysis approach following Hair Jr et al. (2014) was applied to the SEM-based research model. The two-step cluster function in SPSS was used to classify the samples into two groups, representing low and high levels for each moderating index (except for gender, which was classified into two groups). The number of samples and percentage of each cluster are presented in Table 18.

A partial metric invariance test was required to ensure the factor loading equivalence of the two clusters of each moderator. Each pair of datasets was assigned to the research model of study 1 and then the unconstrained model, measurement weights model, and structural weights models were generated. This analysis achieved the equivalence of factor loadings by comparing the unconstrained model and measurement weights model (model comparison non-significant, p>0.05). Path relations variance was also ensured by the significant difference between the measurement weights model and the structural weights model reported in the model comparison (model comparison significant, p<0.05). Therefore, this study continues to examine moderation effects.

Table 18 Study 1: Partial Metric Invariance Test

Moderator	**Group cluster (N/%)**	**Model**	**CMIN**	**DF**	**CMIN/ DF**	**CFI**	**RMSEA**	**Model comparison**	**ΔDF**	**ΔCMIN**	**P**	**Sig.**
Internet use behaviour	Low (184/29.9%) High (431/70.1%)	Unconstrained model	3321.874	1204	2.759	0.883	0.054					
		Measurement weights model	3354.480	1226	2.736	0.882	0.053	Compare with unconstrained model	22	32.606	0.068	ns
		Structural weights model	3434.888	1249	2.750	0.879	0.053	Compare with measurement weights model	23	80.408	0.000	***
Internet Expertise	Low (369/60.0%) High (246/40.0%)	Unconstrained model	3299.494	1204	2.740	0.880	0.053					
		Measurement weights model	3330.951	1226	2.717	0.879	0.053	Compare with unconstrained model	22	31.457	0.087	ns
		Structural weights model	3435.569	1249	2.751	0.875	0.053	Compare with measurement weights model	23	104.619	0.000	***
Age	Low (196/31.9%) High (419/68.1%)	Unconstrained model	3336.021	1204	2.771	0.892	0.054					
		Measurement weights model	3360.921	1228	2.737	0.892	0.053	Compare with unconstrained model	24	24.900	0.411	ns
		Structural weights model	3429.111	1249	2.745	0.890	0.053	Compare with measurement weights model	21	68.190	0.000	***
Gender	Male (266/43.3%) Female (349/56.7%)	Unconstrained model	3357.381	1204	2.789	0.891	0.054					
		Measurement weights model	3385.516	1226	2.761	0.891	0.054	Compare with unconstrained model	22	28.134	0.171	ns
		Structural weights model	3436.506	1249	2.751	0.890	0.053	Compare with measurement weights model	23	50.990	0.001	***
Big-5 - Extraversion	Low (268/43.6%) High (347/56.4%)	Unconstrained model	3254.022	1204	2.703	0.891	0.053					
		Measurement weights model	3278.748	1226	2.674	0.891	0.052	Compare with unconstrained model	22	24.726	0.310	ns
		Structural weights model	3319.813	1249	2.658	0.890	0.052	Compare with measurement weights model	23	41.065	0.012	***
Big-5 - Agreeableness	Low (382/62.1%) High (233/37.9%)	Unconstrained model	3349.190	1204	2.782	0.889	0.054					
		Measurement weights model	3380.236	1228	2.753	0.889	0.053	Compare with unconstrained model	24	31.047	0.152	ns
		Structural weights model	3443.359	1249	2.757	0.887	0.054	Compare with measurement weights model	21	63.123	0.000	***
Big-5 - Conscientiousness	Low (337/54.8%) High (278/45.2%)	Unconstrained model	3121.483	1204	2.593	0.900	0.051					
		Measurement weights model	3150.588	1225	2.572	0.899	0.051	Compare with unconstrained model	21	29.105	0.111	ns
		Structural weights model	3282.181	1249	2.628	0.894	0.052	Compare with measurement weights model	24	131.593	0.000	***
Big-5 - Neuroticism	Low (243/39.5%) High (372/60.5%)	Unconstrained model	3263.652	1204	2.711	0.895	0.053					
		Measurement weights model	3296.489	1226	2.689	0.894	0.052	Compare with unconstrained model	22	32.837	0.064	ns
		Structural weights model	3376.058	1249	2.703	0.891	0.053	Compare with measurement weights model	23	79.569	0.000	***
Big-5 - Imagination	Low (405/65.9%) High (210/34.1%)	Unconstrained model	3369.868	1204	2.799	0.888	0.054					
		Measurement weights model	3403.649	1227	2.774	0.888	0.054	Compare with unconstrained model	23	33.781	0.068	ns
		Structural weights model	3472.698	1249	2.780	0.885	0.054	Compare with measurement weights model	22	69.049	0.000	***

*Notes: Significant at p: ns ≥ .05; * < .05; ** < .01; *** < .00*

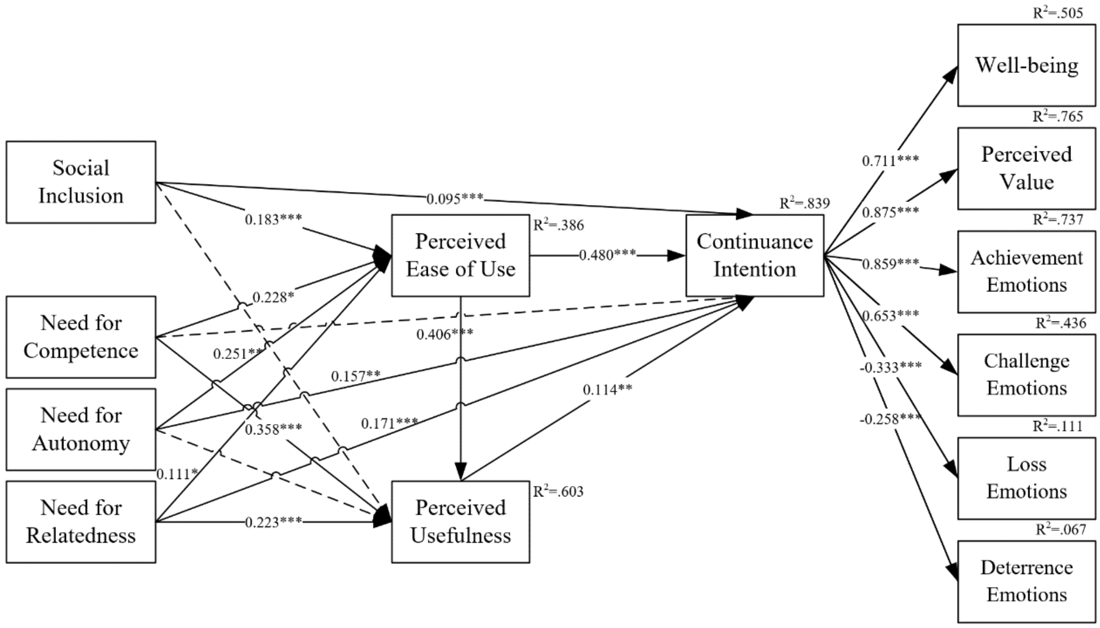
Chapter 5. Results and Findings

5.1 Study 1: Emotional Antecedents and Outcomes of Internet Use

5.1.1 Path Analysis and the Structural Model

The E-TAM framework of study 1 satisfied the model fit criteria (Table 19 and Figure 17). The R^2, direct effects, indirect effects, and total effects suggested that the research model explained a sufficient amount of variance (Table 20). The majority of the hypotheses were accepted except for H1.2b, H1.3c, and H1.4b. More specifically, all TAM effects (H1.1) were statistically supported. Perceived Ease of Use showed significant and strong relationships with Continuance Intentions (H1.1a) and Perceived Usefulness (H1.1c). The relationship between Perceived Usefulness and Continuance Intentions (H1.1b) was significant, but weaker than that between Perceived Ease of Use and Continuance Intentions. The proposed antecedents, i.e. Social Inclusion, Need for Competence, Autonomy and Relatedness, were positively and significantly related to users' perceptions of and Continuance Intention of using the Internet (H1.2-H1.5 partially supported). Among the relationships between the four antecedents and Perceived Usefulness, the Need for Competence was the strongest, whereas Social Inclusion and the Need for Autonomy were not significant. The needs for Competence and Autonomy were significantly related to Perceived Ease of Use. When it came to Continuance Intention, Social Inclusion and the Needs for Autonomy and Relatedness showed significant relationships. Lastly, the statistical analysis supported the significance of the six-proposed psychological and emotional outcomes of using the Internet (H1.6-H1.8 all significant at the <0.01 level). The Continuance Intention of Internet use was positively related to Well-being, Perceived Value, Achievement Emotions, and Challenge Emotions. The relationship of Continuance Intentions with negative emotions, i.e. Loss Emotions and Deterrence Emotions, was negative with the path coefficients much smaller than positive outcomes.

Figure 17 Study 1: Path Significances and Estimates



*Notes: Significant at p: ns = > .05; * = < .05; ** = < .01; *** = < .001*

Table 19 Study 1: Structural Equation Model and Hypotheses Test (H1.1-H1.8)

Hypotheses	**Path**			**Coef. (t-test)**
H1.1a	Perceived Ease of Use	→	Continuance Intention	0.480 (12.052***)
H1.1b	Perceived Usefulness	→	Continuance Intention	0.114 (2.836**)
H1.1c	Perceived Ease of Use	→	Perceived Usefulness	0.406 (10.376***)
H1.2a	Social Inclusion	→	Perceived Ease of Use	0.183 (4.842***)
H1.2b	Social Inclusion	→	Perceived Usefulness	0.038 (1.166ns)
H1.2c	Social Inclusion	→	Continuance Intention	0.095 (3.607***)
H1.3a	Need for Competence	→	Perceived Ease of Use	0.228 (2.543*)
H1.3b	Need for Competence	→	Perceived Usefulness	0.358 (4.720***)
H1.3c	Need for Competence	→	Continuance Intention	0.121 (1.914ns)
H1.4a	Need for Autonomy	→	Perceived Ease of Use	0.251 (3.026**)
H1.4b	Need for Autonomy	→	Perceived Usefulness	-0.096 (-1.374ns)
H1.4c	Need for Autonomy	→	Continuance Intention	0.157 (2.764**)
H1.5a	Need for Relatedness	→	Perceived Ease of Use	0.111 (2.167*)
H1.5b	Need for Relatedness	→	Perceived Usefulness	0.223 (5.132***)
H1.5c	Need for Relatedness	→	Continuance Intention	0.171 (4.704***)
H1.6	Continuance Intention	→	Well-being	0.711 (14.730***)
H1.7	Continuance Intention	→	Perceived Value	0.875 (15.278***)
H1.8a	Continuance Intention	→	Achievement Emotions	0.859 (19.242***)
H1.8b	Continuance Intention	→	Challenge Emotions	0.653 (11.286***)
H1.8c	Continuance Intention	→	Loss Emotions	-0.333 (-7.101***)
H1.8d	Continuance Intention	→	Deterrence Emotions	-0.258 (-5.979***)

Notes: Method: M.L.; Model fit: $\chi 2$ (602) = 2530.516, CMIN/DF = 4.204, CFI= 0.901, RMSEA= 0.072.
*Significant at p: ns = > .05; * = < .05; ** = < .01; *** = < .001*

Table 20 Study 1: R^2 and Effect Size

Dependent Variable	R^2	Independent Variable	Direct Effect	Indirect Effect	Total Effect
Perceived Ease of Use	0.386	Social Inclusion	0.183		0.183
		Need for Competence	0.228		0.228
		Need for Autonomy	0.251		0.251
		Need for Relatedness	0.111		0.111
Perceived Usefulness	0.603	Social Inclusion	0.038	0.074	0.112
		Need for Competence	0.358	0.093	0.450
		Need for Autonomy	-0.096	0.102	0.006
		Need for Relatedness	0.223	0.045	0.268
		Perceived Ease of Use	0.406		0.406
Continuance Intention	0.839	Social Inclusion	0.095	0.101	0.195
		Need for Competence	0.121	0.161	0.282
		Need for Autonomy	0.157	0.121	0.278
		Need for Relatedness	0.171	0.084	0.255
		Perceived Ease of Use	0.480	0.046	0.526
		Perceived Usefulness	0.114		0.114
Well-Being	0.505	Social Inclusion		0.139	0.139
		Need for Competence		0.200	0.200
		Need for Autonomy		0.198	0.198
		Need for Relatedness		0.181	0.181
		Perceived Ease of Use		0.374	0.374
		Perceived Usefulness		0.081	0.081
		Continuance Intention	0.711		0.711
Perceived Value	0.765	Social Inclusion		0.171	0.171
		Need for Competence		0.246	0.246
		Need for Autonomy		0.244	0.244
		Need for Relatedness		0.223	0.223
		Perceived Ease of Use		0.460	0.460
		Perceived Usefulness		0.099	0.099
		Continuance Intention	0.875		0.875
Achievement Emotion	0.737	Social Inclusion		0.168	0.168
		Need for Competence		0.242	0.242
		Need for Autonomy		0.239	0.239
		Need for Relatedness		0.219	0.219
		Perceived Ease of Use		0.452	0.452
		Perceived Usefulness		0.097	0.097
		Continuance Intention	0.859		0.859
Challenge Emotion	0.426	Social Inclusion		0.127	0.127
		Need for Competence		0.184	0.184
		Need for Autonomy		0.182	0.182
		Need for Relatedness		0.167	0.167
		Perceived Ease of Use		0.344	0.344

		Perceived Usefulness		0.074	0.074
		Continuance Intention	0.653		0.653
Loss Emotion	0.111	Social Inclusion		-0.065	-0.065
		Need for Competence		-0.094	-0.094
		Need for Autonomy		-0.093	-0.093
		Need for Relatedness		-0.085	-0.085
		Perceived Ease of Use		-0.176	-0.176
		Perceived Usefulness		-0.038	-0.038
		Continuance Intention	-0.333		-0.333
Deterrence Emotion	0.067	Social Inclusion		-0.050	-0.050
		Need for Competence		-0.073	-0.073
		Need for Autonomy		-0.072	-0.072
		Need for Relatedness		-0.066	-0.066
		Perceived Ease of Use		-0.136	-0.136
		Perceived Usefulness		-0.029	-0.029
		Continuance Intention	-0.258		-0.258

5.1.2 Moderation Effects

Following the analysis of the main effects (H1.1-H1.8), this study proceeded to explore the moderation effects. A full metric or partial metric invariance was established for each pair of the clusters. Table 21 provides a summary of the significant moderations identified in the data analysis and Table 22-24 presents detailed statistical results of the path estimates. Among the nine moderators, Internet Expertise is the most influential, affecting nine out of 21 paths of the E-TAM model, whereas Extraversion moderated only the relationship between Continuance Intention and Challenge Emotion. As can be seen from Table 21, moderating effects were more frequently present on the outcomes side of the model, especially when it came to the influences of Continuance Intention on Well-Being and the four types of emotions.

The directions of the moderation effects were broadly consistent with Internet Use Behaviour and Internet expertise. Specifically, increases in Internet Use Behaviour and Internet Expertise significantly strengthened the influences of Perceived Ease of Use on Perceived Usefulness, and Continuance Intention on Well-Being and Challenge Emotions, whereas they dampened the effects of Social Inclusion on Perceived Ease of Use and the Need for Competence on Perceived Usefulness. Also, although the relationship between the Need for Autonomy and Perceived Usefulness was not found to be significant in the path analysis, this effect was found to be significant for users with less Internet Expertise. Internet Expertise negatively moderated three more outcomes (i.e. Achievement, Loss, and Deterrence Emotions) of using the Internet than Internet Use Behaviour did.

When it came to age, statistical results indicated that among high-age users (≥40 years old, 68.1%), Perceived Ease of Use was less important in influencing Perceived Usefulness and Continuance Intention. The positive effect of the Need for Competence on Perceived Usefulness was only significant among senior users, whereas the Need for Relatedness showed a stronger impact on Perceived Usefulness for participants who are younger in age (≤39 years old, 31.9%). When using the Internet, females were likely to experience higher degrees of Well-Being, Perceived Value, and Challenge Emotions but a slightly lower level of Achievement Emotions than males.

Lastly, the majority of the moderation effects of the Big-5 variables were found to be significant on the outcome side of the E-TAM (Table 24). The highly agreeable, conscientious, imaginative, or less neurotic users were more likely to have negative emotional reactions when using the Internet. Internet users who are highly extroverted and conscientious tend to experience more challenge emotions, whereas the more conscientious ones might experience fewer achievement emotions. Well-being was enhanced by using the Internet for low-conscientiousness or high-neuroticism individuals, though they might believe the Internet was less valuable.

Table 21 Study 1: Summary of Significant Moderation Effects

Path			IU	IE	Age	Gender	E	A	C	N	I
Perceived Ease of Use	→	Continuance Intention			N*				N**		
Perceived Usefulness	→	Continuance Intention									
Perceived Ease of Use	→	Perceived Usefulness	P***	P**	N***						
Social Inclusion	→	Perceived Ease of Use	N*	N***				N*			
Social Inclusion	→	Perceived Usefulness									
Social Inclusion	→	Continuance Intention	N**					N**			
Need for Competence	→	Perceived Ease of Use									
Need for Competence	→	Perceived Usefulness	N*	N***	P***			N*			
Need for Competence	→	Continuance Intention									
Need for Autonomy	→	Perceived Ease of Use									
Need for Autonomy	→	Perceived Usefulness		N*				N**			
Need for Autonomy	→	Continuance Intention									
Need for Relatedness	→	Perceived Ease of Use									N*
Need for Relatedness	→	Perceived Usefulness			N*					P**	
Need for Relatedness	→	Continuance Intention									
Continuance Intention	→	Well-being	P***	P**		P**			N***	P**	
Continuance Intention	→	Perceived Value				P***		P***	P***	N***	
Continuance Intention	→	Achievement Emotions		N**		N*			N**		
Continuance Intention	→	Challenge Emotions	P**	P**		P**	P*		P***		
Continuance Intention	→	Loss Emotions		N*	P**			P***	P***	N***	P**
Continuance Intention	→	Deterrence Emotions		N**				P*	P**	N***	P**

*Notes: P = positive effect; N = negative effect; Significant at p: * = < .05; ** = < .01; *** = < .001; Internet Use Behaviour (IU); Internet Expertise (IE); Extraversion (E); Agreeableness (A); Conscientiousness (C); Neuroticism (N); Imagination (I)*

Table 22 Study 1: Moderation Analysis of Internet Use Behaviour and Internet Expertise

Path		Internet Use Behaviour			Internet Expertise		
		Low Coef.(t-test)	High Coef.(t-test)	Moderation	Low Coef.(t-test)	High Coef.(t-test)	Moderation
Perceived Ease of Use	→ Continuance Intention	0.443 (6.851***)	0.561 (9.869***)	ns	0.511 (10.329***)	0.493 (6.841***)	ns
Perceived Usefulness	→ Continuance Intention	0.165 (2.131*)	0.042 (0.790ns)	ns	0.039 (0.720ns)	0.239 (3.444***)	ns
Perceived Ease of Use	→ Perceived Usefulness	0.217 (3.050**)	0.514 (10.582***)	P***	0.351 (6.751***)	0.456 (7.162***)	P**
Social Inclusion	→ Perceived Ease of Use	0.277 (3.987***)	0.149 (3.044**)	N*	0.262 (5.216***)	0.045 (0.660ns)	N***
Social Inclusion	→ Perceived Usefulness	0.091 (1.451ns)	0.021 (0.515ns)	ns	0.021 (0.467ns)	0.098 (1.781ns)	ns
Social Inclusion	→ Continuance Intention	0.214 (3.923***)	0.063 (1.815ns)	N**	0.125 (3.304***)	0.101 (2.116*)	ns
Need for Competence	→ Perceived Ease of Use	0.476 (2.265*)	0.180 (1.955ns)	ns	0.268 (1.999*)	0.176 (1.579ns)	ns
Need for Competence	→ Perceived Usefulness	0.686 (3.585***)	0.244 (3.188**)	N*	0.612 (4.947***)	0.109 (1.225ns)	N***
Need for Competence	→ Continuance Intention	-0.018 (-0.104ns)	0.159 (2.386*)	ns	0.223 (2.070*)	0.028 (0.360ns)	ns
Need for Autonomy	→ Perceived Ease of Use	-0.067 (-0.356ns)	0.319 (3.497***)	ns	0.128 (1.078ns)	0.323 (2.742**)	ns
Need for Autonomy	→ Perceived Usefulness	-0.267 (-1.610ns)	-0.104 (-1.355ns)	ns	-0.286 (-2.651**)	0.050 (0.518ns)	N*
Need for Autonomy	→ Continuance Intention	0.273 (1.894ns)	0.107 (1.621ns)	ns	0.099 (1.109ns)	0.161 (1.924ns)	ns
Need for Relatedness	→ Perceived Ease of Use	0.076 (0.863ns)	0.045 (0.712ns)	ns	0.091 (1.377ns)	0.007 (0.081ns)	ns
Need for Relatedness	→ Perceived Usefulness	0.178 (2.352*)	0.243 (4.561***)	ns	0.148 (2.530*)	0.249 (3.599***)	ns
Need for Relatedness	→ Continuance Intention	0.073 (1.122ns)	0.201 (4.211***)	ns	0.128 (2.690**)	0.194 (3.077**)	ns
Continuance Intention	→ Well-being	0.520 (5.064***)	0.675 (11.523***)	P***	0.591 (10.163***)	0.640 (7.949***)	P**
Continuance Intention	→ Perceived Value	0.893 (11.380***)	0.814 (12.023***)	ns	0.877 (13.766***)	0.707 (8.469***)	ns
Continuance Intention	→ Achievement Emotions	0.853 (13.282***)	0.829 (14.864***)	ns	0.841 (16.515***)	0.812 (10.622***)	N**
Continuance Intention	→ Challenge Emotions	0.459 (5.227***)	0.602 (8.097***)	P**	0.542 (7.858***)	0.557 (6.334***)	P**
Continuance Intention	→ Loss Emotions	-0.501 (-6.430***)	-0.333 (-6.124***)	ns	-0.421 (-7.482***)	-0.328 (-4.577***)	N*
Continuance Intention	→ Deterrence Emotions	-0.437 (-5.706***)	-0.299 (-5.752***)	ns	-0.343 (-6.201***)	-0.330 (-4.762***)	N**

*Notes: P = positive effect; N = negative effect; Significant at p: ns = > .05; * = < .05; ** = < .01; *** = < .001*

Table 23 Study 1: Moderation Analysis of Demographic Characteristics

Path		Age			Gender		
		Low Coef.(t-test)	High Coef.(t-test)	Moderation	Male Coef.(t-test)	Female Coef.(t-test)	Moderation
Perceived Ease of Use	→ Continuance Intention	0.619 (6.845***)	0.465 (10.175***)	N*	0.508 (8.710***)	0.443 (8.567***)	ns
Perceived Usefulness	→ Continuance Intention	0.046 (0.533ns)	0.126 (2.579*)	ns	0.152 (2.561*)	0.092 (1.700ns)	ns
Perceived Ease of Use	→ Perceived Usefulness	0.666 (9.459***)	0.344 (7.455***)	N***	0.354 (5.692***)	0.425 (8.412***)	ns
Social Inclusion	→ Perceived Ease of Use	0.141 (1.991*)	0.197 (4.229***)	ns	0.226 (3.906***)	0.150 (2.904**)	ns
Social Inclusion	→ Perceived Usefulness	0.066 (1.207ns)	0.061 (1.514ns)	ns	0.099 (1.869ns)	0.016 (0.370ns)	ns
Social Inclusion	→ Continuance Intention	0.062 (1.438ns)	0.093 (2.774**)	ns	0.114 (2.643**)	0.073 (2.155*)	ns
Need for Competence	→ Perceived Ease of Use	0.240 (1.437ns)	0.241 (2.244*)	ns	0.174 (1.632ns)	0.336 (2.328*)	ns
Need for Competence	→ Perceived Usefulness	-0.120 (-0.943ns)	0.468 (5.047***)	P***	0.415 (4.368***)	0.294 (2.491*)	ns
Need for Competence	→ Continuance Intention	0.115 (1.155ns)	0.121 (1.487ns)	ns	0.049 (0.604ns)	0.214 (2.208*)	ns
Need for Autonomy	→ Perceived Ease of Use	0.337 (2.604**)	0.195 (1.889ns)	ns	0.369 (3.394***)	0.105 (0.825ns)	ns
Need for Autonomy	→ Perceived Usefulness	-0.033 (-0.325ns)	-0.129 (-1.465ns)	ns	-0.089 (-0.904ns)	-0.086 (-0.839ns)	ns
Need for Autonomy	→ Continuance Intention	0.121 (1.540ns)	0.160 (2.163*)	ns	0.147 (1.838ns)	0.128 (1.550ns)	ns
Need for Relatedness	→ Perceived Ease of Use	0.138 (1.369ns)	0.095 (1.578ns)	ns	0.058 (0.873ns)	0.130 (1.670ns)	ns
Need for Relatedness	→ Perceived Usefulness	0.411 (5.310***)	0.175 (3.439***)	N*	0.176 (2.977**)	0.272 (4.322***)	ns
Need for Relatedness	→ Continuance Intention	0.141 (1.967*)	0.178 (4.092***)	ns	0.144 (2.957**)	0.191 (3.595***)	ns
Continuance Intention	→ Well-being	0.826 (11.676***)	0.650 (11.676***)	ns	0.671 (10.517***)	0.742 (11.993***)	P**
Continuance Intention	→ Perceived Value	0.858 (11.615***)	0.882 (14.010***)	ns	0.856 (12.592***)	0.897 (13.243***)	P***
Continuance Intention	→ Achievement Emotions	0.894 (14.261***)	0.832 (16.026***)	ns	0.869 (15.336***)	0.843 (14.584***)	N*
Continuance Intention	→ Challenge Emotions	0.701 (8.744***)	0.615 (9.471***)	ns	0.636 (8.705***)	0.682 (9.669***)	P**
Continuance Intention	→ Loss Emotions	-0.145 (-1.901ns)	-0.468 (-8.084***)	P**	-0.403 (-6.047***)	-0.279 (-4.626***)	ns
Continuance Intention	→ Deterrence Emotions	-0.189 (-2.541*)	-0.343 (-6.569***)	ns	-0.283 (-4.432***)	-0.244 (-4.255***)	ns

*Notes: P = positive effect; N = negative effect; Significant at p: ns = > .05; * = < .05; ** = < .01; *** = < .001*

Table 24 Study 1: Moderation Analysis of Big-5 Personality Traits

Path		Extraversion			Agreeableness		
		Low Coef.(t-test)	High Coef.(t-test)	Moderation	Low Coef.(t-test)	High Coef.(t-test)	Moderation
Perceived Ease of Use	→ Continuance Intention	0.506 (8.651***)	0.500 (9.246***)	ns	0.481 (9.725***)	0.412 (6.856***)	ns
Perceived Usefulness	→ Continuance Intention	0.128 (2.102*)	0.090 (1.684ns)	ns	0.101 (2.000*)	0.142 (2.138*)	ns
Perceived Ease of Use	→ Perceived Usefulness	0.360 (5.931***)	0.483 (9.149***)	ns	0.439 (8.579***)	0.309 (5.141***)	ns
Social Inclusion	→ Perceived Ease of Use	0.227 (3.981***)	0.128 (2.417*)	ns	0.209 (4.365***)	0.080 (1.221ns)	N*
Social Inclusion	→ Perceived Usefulness	0.054 (1.035ns)	0.022 (0.500ns)	ns	0.076 (1.798ns)	0.001 (0.012ns)	ns
Social Inclusion	→ Continuance Intention	0.096 (2.204*)	0.101 (2.928**)	ns	0.146 (4.519***)	0.006 (0.133ns)	N**
Need for Competence	→ Perceived Ease of Use	0.166 (1.383ns)	0.387 (2.880**)	ns	0.249 (1.858ns)	0.276 (2.004*)	ns
Need for Competence	→ Perceived Usefulness	0.329 (3.092**)	0.400 (3.524***)	ns	0.501 (4.245***)	0.215 (1.901ns)	N*
Need for Competence	→ Continuance Intention	0.094 (1.022ns)	0.115 (1.261ns)	ns	0.154 (1.655ns)	0.145 (1.464ns)	ns
Need for Autonomy	→ Perceived Ease of Use	0.295 (2.530*)	0.131 (1.115ns)	ns	0.235 (2.087*)	0.167 (1.188ns)	ns
Need for Autonomy	→ Perceived Usefulness	-0.059 (-0.572ns)	-0.124 (-1.278ns)	ns	-0.287 (-2.891**)	0.162 (1.421ns)	N**
Need for Autonomy	→ Continuance Intention	0.196 (2.251*)	0.127 (1.672ns)	ns	0.126 (1.656ns)	0.157 (1.575ns)	ns
Need for Relatedness	→ Perceived Ease of Use	0.121 (1.776ns)	0.070 (0.876ns)	ns	0.113 (1.560ns)	0.072 (0.865ns)	ns
Need for Relatedness	→ Perceived Usefulness	0.252 (4.156***)	0.112 (1.714ns)	ns	0.194 (3.092**)	0.215 (3.196**)	ns
Need for Relatedness	→ Continuance Intention	0.084 (1.599ns)	0.227 (4.343***)	ns	0.157 (3.331***)	0.233 (3.808***)	ns
Continuance Intention	→ Well-being	0.623 (9.397***)	0.701 (11.236***)	ns	0.750 (13.073***)	0.694 (9.526***)	ns
Continuance Intention	→ Perceived Value	0.853 (12.679***)	0.888 (12.849***)	ns	0.878 (13.339***)	0.902 (11.760***)	P***
Continuance Intention	→ Achievement Emotions	0.805 (14.060***)	0.884 (15.688***)	ns	0.864 (15.892***)	0.805 (11.838***)	ns
Continuance Intention	→ Challenge Emotions	0.530 (6.982***)	0.668 (8.753***)	P*	0.695 (10.908***)	0.675 (8.128***)	ns
Continuance Intention	→ Loss Emotions	-0.387 (-5.759***)	-0.360 (-6.009***)	ns	-0.190 (-3.373***)	-0.456 (-6.295***)	P***
Continuance Intention	→ Deterrence Emotions	-0.327 (-5.045***)	-0.302 (-5.349***)	ns	-0.141 (-2.609**)	-0.329 (-4.649***)	P*

Path	Conscientiousness			Neuroticism		
	Low Coef.(t-test)	High Coef.(t-test)	Moderation	Low Coef.(t-test)	High Coef.(t-test)	Moderation
Perceived Ease of Use → Continuance Intention	0.448 (7.931***)	0.347 (6.274***)	N**	0.470 (7.941***)	0.468 (9.255***)	ns
Perceived Usefulness → Continuance Intention	0.174 (3.115**)	0.122 (1.967*)	ns	0.113 (1.791ns)	0.121 (2.356*)	ns
Perceived Ease of Use → Perceived Usefulness	0.489 (8.529***)	0.357 (6.771***)	ns	0.395 (6.637***)	0.395 (7.591***)	ns
Social Inclusion → Perceived Ease of Use	0.113 (2.315*)	0.130 (2.161*)	ns	0.159 (2.671**)	0.128 (2.527*)	ns
Social Inclusion → Perceived Usefulness	0.039 (0.910ns)	0.063 (1.314ns)	ns	0.054 (1.083ns)	0.042 (0.971ns)	ns
Social Inclusion → Continuance Intention	0.083 (2.537*)	0.092 (2.183*)	ns	0.140 (3.454***)	0.062 (1.768ns)	ns
Need for Competence → Perceived Ease of Use	0.185 (1.646ns)	0.311 (2.118*)	ns	0.292 (1.757ns)	0.223 (2.074*)	ns
Need for Competence → Perceived Usefulness	0.311 (3.202**)	0.384 (3.261**)	ns	0.532 (3.788***)	0.247 (2.698**)	ns
Need for Competence → Continuance Intention	0.049 (0.640ns)	0.238 (2.212*)	ns	0.204 (1.715ns)	0.102 (1.361ns)	ns
Need for Autonomy → Perceived Ease of Use	0.340 (3.044**)	0.059 (0.466ns)	ns	0.146 (0.965ns)	0.334 (3.386***)	ns
Need for Autonomy → Perceived Usefulness	-0.100 (-1.016ns)	-0.087 (-0.859ns)	ns	-0.124 (-0.989ns)	-0.107 (-1.255ns)	ns
Need for Autonomy → Continuance Intention	0.202 (2.637**)	0.093 (1.051ns)	ns	0.071 (0.706ns)	0.205 (2.944**)	ns
Need for Relatedness → Perceived Ease of Use	0.196 (2.948**)	0.095 (1.130ns)	ns	0.154 (1.832ns)	0.086 (1.311ns)	ns
Need for Relatedness → Perceived Usefulness	0.202 (3.468***)	0.224 (3.352***)	ns	0.063 (0.894ns)	0.353 (6.244***)	P**
Need for Relatedness → Continuance Intention	0.157 (3.391***)	0.276 (4.444***)	ns	0.185 (3.286**)	0.149 (3.064**)	ns
Continuance Intention → Well-being	0.812 (13.351***)	0.738 (10.456***)	N***	0.725 (10.293***)	0.733 (12.689***)	P**
Continuance Intention → Perceived Value	0.875 (13.140***)	0.880 (11.000***)	P***	0.920 (11.963***)	0.859 (13.544***)	N***
Continuance Intention → Achievement Emotions	0.869 (15.522***)	0.802 (11.472***)	N**	0.859 (12.985***)	0.855 (16.389***)	ns
Continuance Intention → Challenge Emotions	0.722 (11.114***)	0.729 (9.134***)	P***	0.641 (7.914***)	0.697 (10.826***)	ns
Continuance Intention → Loss Emotions	-0.135 (-2.236*)	-0.451 (-6.501***)	P***	-0.534 (-7.130***)	-0.203 (-3.529***)	N***
Continuance Intention → Deterrence Emotions	-0.081 (-1.401ns)	-0.318 (-4.775***)	P**	-0.443 (-6.460***)	-0.140 (-2.545*)	N***

Path		Imagination		
		Low Coef.(t-test)	High Coef.(t-test)	Moderation
Perceived Ease of Use	→ Continuance Intention	0.438 (9.151***)	0.522 (7.817***)	ns
Perceived Usefulness	→ Continuance Intention	0.133 (2.768**)	0.047 (0.679ns)	ns
Perceived Ease of Use	→ Perceived Usefulness	0.428 (8.740***)	0.314 (4.665***)	ns
Social Inclusion	→ Perceived Ease of Use	0.214 (4.608***)	0.121 (1.811ns)	ns
Social Inclusion	→ Perceived Usefulness	0.054 (1.331ns)	-0.001 (-0.023ns)	ns
Social Inclusion	→ Continuance Intention	0.106 (3.270**)	0.072 (1.576ns)	ns
Need for Competence	→ Perceived Ease of Use	0.266 (2.398*)	0.100 (0.618ns)	ns
Need for Competence	→ Perceived Usefulness	0.299 (3.125**)	0.469 (3.530***)	ns
Need for Competence	→ Continuance Intention	0.077 (1.004ns)	0.285 (2.446*)	ns
Need for Autonomy	→ Perceived Ease of Use	0.119 (1.173ns)	0.446 (2.877**)	ns
Need for Autonomy	→ Perceived Usefulness	-0.038 (-0.441ns)	-0.186 (-1.415ns)	ns
Need for Autonomy	→ Continuance Intention	0.209 (3.045**)	-0.015 (-0.134ns)	ns
Need for Relatedness	→ Perceived Ease of Use	0.204 (3.223**)	0.014 (0.158ns)	N*
Need for Relatedness	→ Perceived Usefulness	0.183 (3.353***)	0.295 (3.915***)	ns
Need for Relatedness	→ Continuance Intention	0.193 (4.358***)	0.236 (3.572***)	ns
Continuance Intention	→ Well-being	0.764 (13.252***)	0.663 (8.616***)	ns
Continuance Intention	→ Perceived Value	0.891 (13.557***)	0.829 (10.466***)	ns
Continuance Intention	→ Achievement Emotions	0.840 (15.479***)	0.847 (12.189***)	ns
Continuance Intention	→ Challenge Emotions	0.671 (10.410***)	0.671 (7.868***)	ns
Continuance Intention	→ Loss Emotions	-0.182 (-3.293***)	-0.484 (-6.024***)	P**
Continuance Intention	→ Deterrence Emotions	-0.113 (-2.122*)	-0.371 (-5.121***)	P**

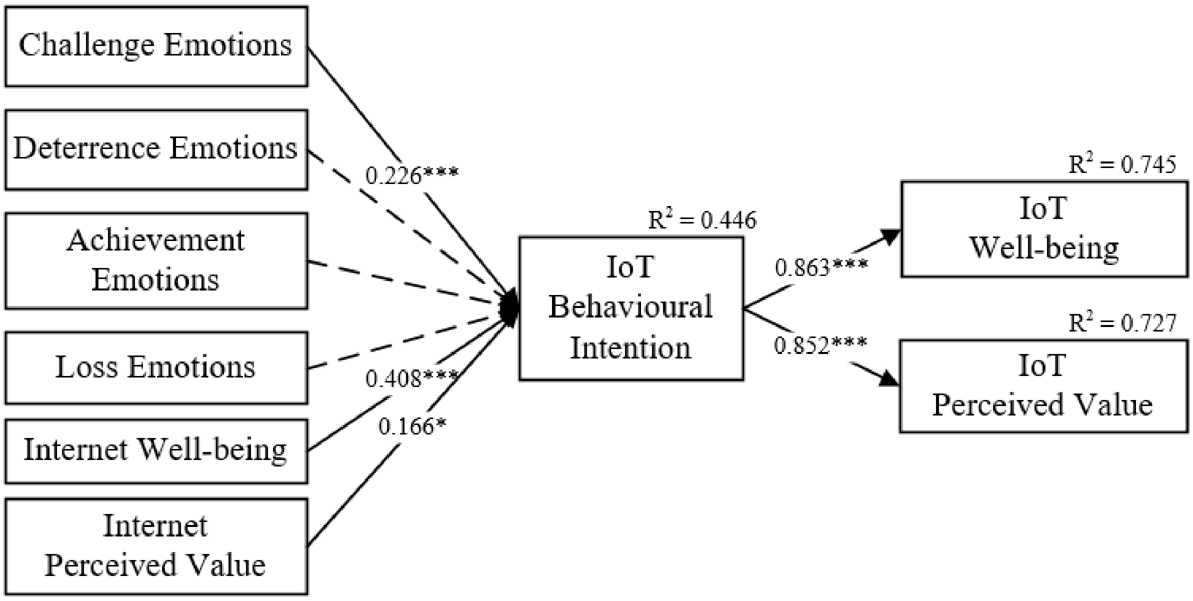
*Notes: P = positive effect; N = negative effect; Significant at p: ns = > .05; * = < .05; ** = < .01; *** = < .001*

5.2 Study 2: Spillover from the Internet to the IoT

The structural equation model of study 2 was established. Specifically, the model fit indices, i.e. CMIN/DF = 4.131, CFI = 0.946, and RMSEA = 0.071, suggested a satisfactory fitness of the research model (Hair Jr et al., 2014). Table 25 and Figure 18 present the statistical results of the hypothesised paths. Five out of the eight hypotheses were accepted, i.e. H2.1a, H2.2a, H2.2b, H2.3a, and H2.3b. Three out of six psychological outcomes of Internet use were found to be significant determinants of Behavioural Intention of using the IoT. Among the four categories of the emotional responses to Internet use, only the Challenge Emotion (e.g. enjoyment, playfulness, flow, etc.) significantly influences the Behavioural Intention of using the IoT. The direct effect size is coef. = 0.226 at the significance level of 0.001. Additionally, the mean values of the items of the four constructs of user emotions showed that the negative emotions, i.e. Loss and Deterrence Emotions, were much lower than the positive emotions. Moreover, the Well-Being experienced when using the Internet has the strongest effect (coef. = 0.408; $p<0.001$) on the Behavioural Intention. The Perceived Value of using the Internet showed a significant positive influence, with smaller path estimates (coef. = 0.166; $p<0.05$). Furthermore, using the IoT is expected to arouse two positive psychological outcomes as well. The users' Behavioural Intention significantly and strongly enhances their Well-Being (coef. = 0.863; $p<0.001$) and Perceived Value (coef. = 0.852; $p<0.001$) of IoT use.

The R^2 and the direct effects, indirect effects, and total effects of the three dependent variables indicated a satisfied practical significance of this research model (Table 26). The R^2 of behavioural intention was 44.6%, suggesting a moderate explanatory power of the six psychological outcomes of using the Internet in explaining variances of the behavioural intention toward using the IoT (Hair Jr et al., 2014). The effects of behavioural intention on IoT well-being and IoT perceived value were positive, substantial, and significant. Large amounts of variances of the estimated well-being and overall value of using the IoT were explained, 74.5% and 72.7% respectively.

Figure 18 Study 2: Path Significances and Estimates



*Notes: Significant at p: ns = > .05; * = < .05; ** = < .01; *** = < .001*

Table 25 Study 2: Structural Equation Model and Hypothesis Test (H2.1-H2.5)

Hypotheses	Path			Coef. (t-test)
H2.1a	Challenge Emotions	→	Behavioural Intention	0.226 (3.464***)
H2.1b	Deterrence Emotions	→	Behavioural Intention	0.117 (1.570ns)
H2.1c	Achievement Emotions	→	Behavioural Intention	-0.083 (-1.197ns)
H2.1d	Loss Emotions	→	Behavioural Intention	-0.101 (-1.324ns)
H2.2a	Internet Well-Being	→	Behavioural Intention	0.408 (5.613***)
H2.3a	Internet Perceived Value	→	Behavioural Intention	0.166 (2.297*)
H2.2b	Behavioural Intention	→	IoT Well-Being	0.863 (29.352***)
H2.3b	Behavioural Intention	→	IoT Perceived Value	0.852 (24.638***)

Notes: Method: M.L.; Model fit: $\chi2$ (252) = 1040.926, CMIN/DF = 4.131, CFI= 0.946, RMSEA= 0.071
*Significant at p: ns ≥ .05; * < .05; ** < .01; *** < .001*

Table 26: Study 2: R^2 and Effect Size

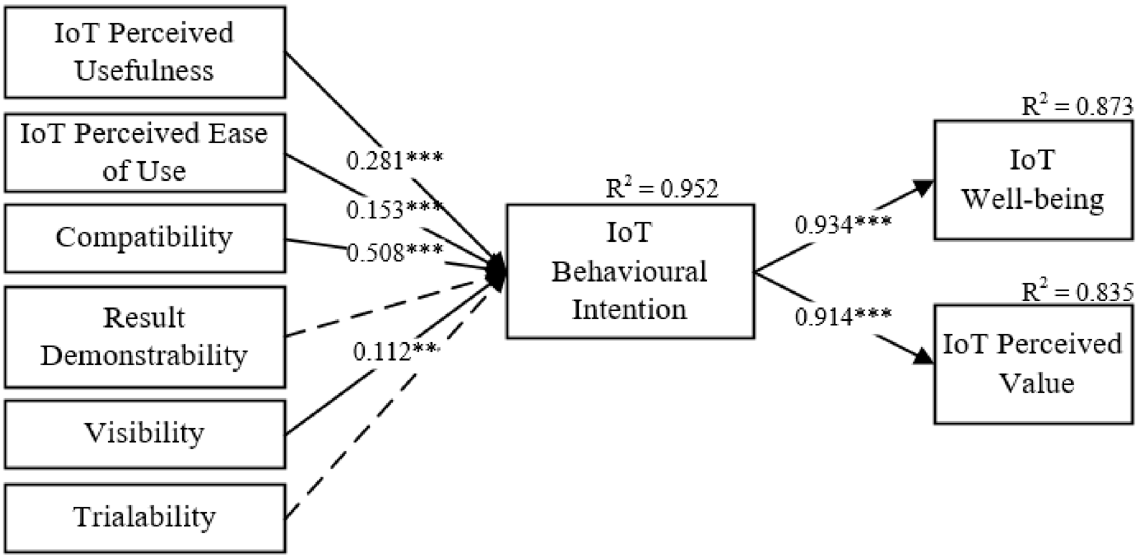
Dependent Variable	R^2	Independent Variable	Direct Effect	Indirect Effect	Total Effect
IoT Behavioural Intention	0.446	Challenge Emotions	0.226		0.226
		Deterrence Emotions	0.117		0.117
		Achievement Emotions	-0.083		-0.083
		Loss Emotions	-0.101		-0.101
		Internet Well-Being	0.408		0.408
		Internet Perceived Value	0.166		0.166
IoT Well-Being	0.745	Challenge Emotions		0.195	0.195
		Deterrence Emotions		0.101	0.101
		Achievement Emotions		-0.072	-0.072
		Loss Emotions		-0.087	-0.087
		Internet Well-Being		0.352	0.352
		Internet Perceived Value		0.143	0.143
		Behavioural Intention	0.863		0.863
IoT Perceived Value	0.727	Challenge Emotions		0.192	0.192
		Deterrence Emotions		0.100	0.100
		Achievement Emotions		-0.071	-0.071
		Loss Emotions		-0.086	-0.086
		Internet Well-Being		0.348	0.348
		Internet Perceived Value		0.142	0.142
		Behavioural Intention	0.852		0.852

5.3 Study 3: User Adoption of the IoT

Statistical results indicated an adequate level of fitness of the structural equation model of study 3, i.e. CMIN/DF = 4.094, CFI= 0.955, RMSEA= 0.071. According to the model fit criteria suggested by (Hooper et al., 2008; Hair Jr et al., 2014), i.e. 2<CMIN/DF<5, CFI>0.9, RMSEA<0.08, the research model of this study was successfully established. Table 27 and Figure 19 present the statistical results of the path analysis. Six out of the eight hypotheses were accepted, i.e. H3.1a, H3.1b, H3.1c, H3.1e, H3.2 and H3.3. Specifically, among the six perceived characteristics of the IoT, Perceived Usefulness (coef. = 0.281; p<0.001), Perceived Ease of Use (coef. = 0.153; p<0.001), Compatibility (coef. = 0.508; p<0.001), and Visibility (coef. = 0.112; p<0.01) showed significant and positive effects on the Behavioural Intention of IoT use. Also, Well-Being (coef. = 0.934; p<0.001) and Perceived Value (coef. = 0.914; p<0.001) were found to be significantly related to Behavioural Intention.

Table 28 presents the R^2 and the direct effects, indirect effects, and total effects of the three dependent variables, indicating a satisfied practical significance of the research model. The R^2 of IoT Behavioural Intention is 0.952, which suggests that the six perceived characteristics sufficiently and largely explained the variances in the users' intention of accepting the IoT (Moore, 2010). This research model also explained a substantial amount of the effects on Well-Being (R^2=0.873) and Perceived Value (R^2=0.835). Notably, Compatibility is the most powerful IoT characteristic and it represented the largest amount of the direct effect on Behavioural Intention (Table 28).

Figure 19 Study 2: Path Significances and Estimates



*Notes: Significant at p: ns = > .05; * = < .05; ** = < .01; *** = < .001*

Table 27 Study 3: Structural Equation Model and Hypothesis Test (H3.1-H3.3)

Hypotheses	Path			Coef. (t-test)
H3.1a	IoT Perceived Usefulness	→	IoT Behavioural Intention	0.281 (6.801***)
H3.1b	IoT Perceived Ease of Use	→	IoT Behavioural Intention	0.153 (4.458***)
H3.1c	Compatibility	→	IoT Behavioural Intention	0.508 (13.261***)
H3.1d	Result Demonstrability	→	IoT Behavioural Intention	-0.022 (-0.632ns)
H3.1e	Visibility	→	IoT Behavioural Intention	0.112 (3.056**)
H3.1f	Trialability	→	IoT Behavioural Intention	0.029 (0.916ns)
H3.2	IoT Behavioural Intention	→	IoT Well-Being	0.934 (30.906***)
H3.3	IoT Behavioural Intention	→	IoT Perceived Value	0.914 (30.267***)

Notes: Method: M.L.; Model fit: $\chi 2$ (327) = 1338.596 , CMIN/DF = 4.094, CFI= 0.955, RMSEA= 0.071
*Significant at p: ns = > .05; * = < .05; ** = < .01; *** = < .001.*

Table 28 Study 3: R^2 and Effect Size

Dependent Variable	R^2	Independent Variable	Direct Effect	Indirect Effect	Total Effect
IoT Behavioural Intention	0.952	IoT Perceived Usefulness	0.281		0.281
		IoT Perceived Ease of Use	0.153		0.153
		Compatibility	0.508		0.508
		Result Demonstrability	-0.022		-0.022
		Visibility	0.112		0.112
		Trialability	0.029		0.029
IoT Well-Being	0.873	IoT Perceived Usefulness		0.262	0.262
		IoT Perceived Ease of Use		0.143	0.143
		Compatibility		0.475	0.475
		Result Demonstrability		-0.021	-0.021
		Visibility		0.105	0.105
		Trialability		0.028	0.028
		IoT Behavioural Intention	0.934		0.934
IoT Perceived Value	0.835	IoT Perceived Usefulness		0.256	0.256
		IoT Perceived Ease of Use		0.139	0.139
		Compatibility		0.464	0.464
		Result Demonstrability		-0.020	-0.020
		Visibility		0.103	0.103
		Trialability		0.027	0.027
		IoT Behavioural Intention	0.914		0.914

Chapter 6. Discussion

This thesis has tackled the main research objective as presented in the first chapter, namely, to understand the users' interactions with technology platforms by exploring and testing the factors influencing their acceptance and use of the Internet and IoT. In doing so, three empirical studies were conducted. As Figure 1 illustrates, the first and third study focused on the acceptance, adoption and use of the Internet and IoT respectively, whereas the second study investigated the users' interactions with these two technology platforms and examined the influences of the Internet on the IoT. The following sub-sections present discussions on the results and findings of the three studies respectively.

6.1 Study 1: Emotional Antecedents and Outcomes of Internet Use

6.1.1 Technology Acceptance

This study has extended TAM using a number of psychological antecedents and outcomes, following the overarching model shown in section 3.2 (Davis et al., 1989; Bagozzi et al., 1992; Taylor and Todd, 1995; Venkatesh et al., 2003). As the majority of the hypotheses (H1.1-H1.8) were accepted, this study further corroborated the robustness, flexibility for extensions, and explanatory power of TAM (Davis, 1989; Mathieson, 1991; Venkatesh et al., 2003). Path analysis results suggested that PEOU had a stronger influence than PU on CI. This research did not support previous literature which suggested that PEOU is less influential than PU when it comes to affecting technology acceptance, e.g. (Davis et al., 1989; Chau, 1996; Chau and Hu, 2001). One possible interpretation may be that the users' increasing familiarity with the Internet may alter their expectations on new ICTs (Mathieson, 1991). PU was significantly and strongly affected by PEOU, and this relationship was strengthened by high levels of Internet use behaviour and expertise. These findings supported the ideas that the role of PEOU may switch from forming intentions to mainly influencing PU in a later stage of technology adoption (Venkatesh and Bala, 2008). In the cases of accepting new technology, user background knowledge has been found to positively affect their perceived usefulness (Kardooni et al., 2016), and insufficient subjective knowledge could be a barrier (Liu et al., 2018). The effects of PEOU on both PU and CI were dampened for high-age users. This is in contrast to previous literature reporting that PEOU was more influential among older users (Venkatesh and Morris, 2000; Venkatesh et al., 2003). This may be explained by the fact that Internet users falling into such groups may have 15-20 years of experience with the technology and services, compared to those surveyed in the past.

6.1.2 Social Inclusion and Satisfaction of Needs

This study has provided evidence for the relationships between social inclusion and technology acceptance (i.e. PEOU and CI), which is broadly consistent with previous findings (Park, 2010; Smith and Sivo, 2012; Choi and Chung, 2013; Park et al., 2013). The statistical results suggested that social inclusion had a smaller influence on continuance intention of the Internet among the proficient users, which is in line with the viewpoint of (Venkatesh and Davis, 2000; Venkatesh et al., 2003). For the less experienced users, being socially included could strengthen their beliefs in the easiness of using the Internet and drive their intention to continue using it. This finding also corroborates the standpoint that new forms of technological breakthrough possibly create new forms of digital/social exclusion (Selwyn, 2002; Hill et al., 2015; Andrade and Doolin, 2016). Lack of digital knowledge and skills consequently causes people to be excluded from participating in society or networks of information (Hill et al., 2015; Andrade and Doolin, 2016).

Two of the main effects between psychological need satisfaction and TAM were not supported, namely, Need for Competence → Continuance Intention and Need for Autonomy → Perceived Usefulness. The overall effects of the need for competence on TAM were in line with previous results (Roca and Gagné, 2008; Lee et al., 2015; Huang et al., 2016). The influence of the need for autonomy on PEOU and CI partially supported the studies of (Roca and Gagné, 2008; Hew and Kadir, 2016; Huang et al., 2016; Nikou and Economides, 2017). Statistical results reported significant relationships between the need for relatedness and TAM, which were broadly consistent with (Lee et al., 2015; Huang et al., 2016; Nikou and Economides, 2017). The effects of the needs for autonomy and relatedness on ones' continuance intention were significant, which partially corroborated the viewpoint that the psychological need fulfilment perceived online enhances Internet use (Shen et al., 2013). Moderation tests suggested that the need for competence had a stronger effect on PU for the less experienced users. The relationship between the need for autonomy and PU was only significant among the less Internet-knowledgeable individuals. These findings suggested that the determining role of psychological needs satisfied by technology use would be attenuated with increased experience (Ryan and Deci, 2000b; Gagné and Deci, 2005; Venkatesh and Bala, 2008). Additionally, the increase of age strengthened the effects of the need for competence but dampened the influence of the need for relatedness on PU. Fulfilling the need for relatedness enhances young people's belief in the usefulness of the Internet, whereas satisfying the need for competence boosts the older or novice users' acceptance.

6.1.3 Intention and Psychological Outcomes

This study has investigated six psychological outcomes of using the Internet. Path coefficients indicated that the intention to continue using the Internet positively affected the positive outcomes, i.e. well-being, perceived value, and positive emotions. The negative coefficients between intention and negative emotions offered additional evidence that the outcome of using the Internet is, overall, beneficial. The results presented a strong relationship between continuance intention and well-being, which is consistent with (Partala and Saari, 2015; Rahman et al., 2017; Munzel et al., 2018). This finding could be partially attributed to the viewpoint that using the Internet can strengthen the effect of social inclusion on well-being (Castells, 2001; Andrade and Doolin, 2016). The correlation between the continuance intention of Internet use and perceived value was significant and strong, which confirmed the finding of (Kim et al., 2008; Partala and Saari, 2015).

This study categorised users' emotional reactions into four dimensions according to (Beaudry and Pinsonneault, 2010). The two positive emotions, i.e. achievement and challenge, were strongly affected by continuance intention. The negative emotions, i.e. loss and deterrence, had comparatively weaker relationships with the users' intention. These findings agreed with previous studies suggesting that users could experience both positive and negative emotions triggered by the same technology (Beaudry and Pinsonneault, 2010; Chang et al., 2014; Partala and Kujala, 2015; Partala and Saari, 2015).

The moderation test results provided strong evidence for the significance of the influence of Big-5 personality traits on consumers' psychological states when using the Internet (Desmet and Hekkert, 2007; Munzel et al., 2018). The Internet caused stronger negative emotions among the more agreeable, conscientious, imaginative, or less neurotic users, though the Internet may possess value for them. Also, neurotic or less conscientious users experienced a higher level of well-being. These findings could possibly be attributed to the emotional value of the Internet. Using the Internet may help neurotic people achieve a higher level of well-being and reduce negative emotions. The more agreeable, conscientious, or imaginative Internet users may seek excitement and playfulness rather than emotional relief.

Interestingly, the moderating effects on the two categories of positive emotions were in opposite directions. For the proficient, female, or more conscientious users, the Internet was more likely to arouse challenge emotions but less likely to evoke achievement emotions. This could be because using a new IS/IT evokes positive emotions when the users regard it as an effective approach to achieving their goals or tasks (Beaudry and Pinsonneault, 2010). In this case, the new technology would arouse achievement emotions for users who are able to achieve the expected outcomes or evoke challenge emotions for those who have full control over the benefits (Beaudry and Pinsonneault, 2010; Lee et al., 2012). Therefore, proficient or more conscientious individuals who perceived themselves as having more control over their use of Internet technologies experienced more challenge emotions (Beaudry and Pinsonneault, 2005; Beaudry and Pinsonneault, 2010).

6.2 Study 2: Spillover from the Internet to the IoT

This study aimed to explore the potential factors influencing user acceptance of IoT. A research framework was put forward hypothesising that the users' affect and value generated in using the Internet could influence the users' predispositions toward using the IoT. The findings supported the spillover effects from the Internet to IoT and the determinants showed moderate explanatory power in explaining variances in the behavioural intention of IoT use. Three out of the six outcomes of Internet use significantly drove users' IoT intention. Intentions were significantly linked to two expected outcomes, i.e. the perceived value and well-being. These results suggest that the affect experienced in the originating domain can influence the users' self-efficacy, motivations and experiences in the receiving domain

(Edwards and Rothbard, 2000; Judge et al., 2000; Hanson et al., 2006; Eby et al., 2010; Pierce et al., 2016).

The four types of emotions generated in Internet use performed differently in influencing the behavioural intention of IoT acceptance. Only challenge emotions significantly affected the behavioural intention of IoT, which suggests that the users' emotions such as playfulness and flow experienced in Internet use can enhance IoT acceptance. The significant effect of emotional response toward the Internet on the behavioural intention of IoT confirmed that the individuals' emotions provoked by the Internet as experienced by users can spill over into the receiving context (Yegiyan, 2015; Lapate et al., 2017). This finding also partially supported the viewpoint that the spillover effects of emotions can further influence the user's attitude and behaviour (Edwards and Rothbard, 2000; Hanson et al., 2006; Hoffmann and Ketteler, 2015; Pierce et al., 2016).

Challenge and achievement emotions can be categorised as positive emotions. Experiencing positive emotions indicates that users could benefit from using the Internet. Although challenge emotions were found to significantly influence IoT acceptance, the same did not apply for achievement emotions. A potential explanation could be that challenge emotions were different from achievement emotions in terms of the willingness to devote effort to achieve the expected consequences of technology use (Beaudry and Pinsonneault, 2010). Specifically, achievement emotions indicate that the users believe that the outcomes of using an IS/IT are favourable, high in certainty, and involve very little effort (Beaudry and Pinsonneault, 2010), whereas challenge emotions imply that the users are willing to devote some effort to securing potential benefits (Beaudry and Pinsonneault, 2005). Challenge emotions significantly spill over into IoT acceptance, implying that the users are willing to explore the IoT applications and desire to pursue the benefits even though this requires investing some effort. Accordingly, the results of this study are in correspondence with the studies of (Gao and Bai, 2014; Chong et al., 2015; Park et al., 2017; Martínez-Caro et al., 2018) which suggested perceived control significantly influences user beliefs and intentions of IoT acceptance, but the findings contradict to the results of (Leong et al., 2017; Liew et al., 2017; Mital et al., 2017; Pal et al., 2018), who reported non-significant effects of the perceived control. Previous studies indicated that achievement emotions (e.g. perceived enjoyment) would be more influential at the post-adoption stage (Agarwal and Karahanna, 2000; Venkatesh and Bala, 2008). As such, the effects of achievement emotions would be increasingly important with the gaining of user experiences on the IoT.

On the other hand, negative emotions, i.e. loss and deterrence emotions, did not show significant influence on IoT acceptance. This finding contradicts the argument that negative emotions from the previous context can affect the individuals' judgement and decisions in other contexts, even in unrelated domains (Motro et al., 2016). It also differs from the findings of (Pal et al., 2018), who reported significant relationships between deterrence emotions (e.g. technology anxiety) and behavioural intention of IoT use. It is worth noting that the differences between the mean values of the four categories of emotions suggest that the degrees of negative emotions experienced in using the Internet are much lower than the positive emotions (see Table 13). Also, negative emotions were only evoked when the users were unsatisfied with the performance of the technology. Given the above, one potential explanation for these non-significant effects is that the Internet has become more general in recent years and the performance of Internet-based services and applications is relatively satisfying.

This study defined well-being as the degree of need satisfaction and quality of life enhanced by using the Internet and/or IoT. The significant effect of Internet well-being on IoT behavioural intention confirmed that well-being can be transferred indirectly from one life domain to another via influencing one's behaviour (Edwards and Rothbard, 2000; Hanson et al., 2006). On the other hand, some have argued that IS/IT use blurs the boundary of work and life, consequently bringing about negative spillover effects on the user's well-being (Chesley, 2005; Berkowsky, 2013). However, the positive effect IoT acceptance on IoT well-being implied that technology use is, overall, considered beneficial to individuals' general affect, such as well-being (Martínez-Caro et al., 2018; Munzel et al., 2018; Lu et al., 2019). One potential reason is that technology use alleviates the individual's role conflict between different life domains by enhancing their flexibility and autonomy in dealing with work-family conflicts (Gözü et al., 2015).

Statistical results showed that the perceived value of the Internet significantly influences IoT acceptance. Perceived value, as a cognitive trade-off between the perceived benefits and sacrifices, enhances the users' beliefs and attitudes towards IoT (Kim and Kankanhalli, 2009; Hsu and Lin, 2016; Kim et al., 2017). This significant spillover effect partially supports the viewpoint that the perceived value of a product/service can spill over into the consumer's behavioural intention (Arne et al., 2017) and evaluations of relevant products/services (Bourdeau et al., 2007; Bleijerveld et al., 2015). What is more, potential users may believe that IoT can bring value to their daily life. According to the network externalities (Katz and Shapiro, 1985; Hsu and Lin, 2016; Hsu and Yeh, 2017), users believe that the perceived value will gain importance with the proliferation of the IoT. Despite the fact that users may be sceptical about the potential privacy and security risks of the IoT (Lu et al., 2018), these findings imply that users may be willing to withstand the risks considering the potential benefits and convenience brought by the IoT (Weber, 2010; Hsu and Lin, 2016; Scuotto et al., 2017; Caputo et al., 2018).

6.3 Study 3: User Adoption of the IoT

The findings indicated that the six determinants adapted from TAM and IDT sufficiently explained variances in users' behavioural intention of using the IoT. Specifically, perceived usefulness, perceived ease of use, compatibility and visibility had significant positive effects on the users' intention of using the IoT, whereas demonstrability and trialability did not show significant influence on IoT adoption decisions.

Perceived usefulness is one of the leading factors determining user acceptance and adoption (Abu-Khadra and Ziadat, 2012). The positive effect of perceived usefulness on behavioural intention suggested that the instrumental value and the functionality of the IoT that can enhance the users' performance in completing certain tasks is critical to the potential users. Perceived ease of use had a significant but relatively small influence on the users' adoption decisions on IoT. This finding is in correspondence with the results of (Gao and Bai, 2014; Liew et al., 2017; Mital et al., 2017; Park et al., 2017) but in contrast with (Bao et al., 2014). This finding also supported the argument proposed in study 1, indicating that PEOU is less influential than PU at the early stage of implementation of the IoT platform. Given the fact that the less complicated technology is usually more attractive to the users (Davis et al., 1989; Rogers, 1995), perceived ease of use may gain importance once users have hands-on experience with IoT applications and services.

Compatibility is the most influential factor driving IoT adoption, indicating that the consistency between the IoT services and their current situation is one of the users' concerns (Moore and Benbasat, 1991). These results confirmed the findings of (Bao et al., 2014; Karahoca et al., 2017; Park et al., 2017; Shin, 2017; Hubert et al., 2018; Wang et al., 2018). Then, this result confirmed the finding of (Karahoca et al., 2017). Visibility significantly affects one's intention to adopt the IoT as well, supporting the viewpoint that the smart devices which are apparent to the users' sense of sight will encourage them to adopt (Agarwal and Prasad, 1997; Chuah et al., 2016). On the other hand, statistical results suggested that result demonstrability and trialability do not have any influence on the users' intention. One potential explanation is that the uncertainty of using IoT products is not the users' main concern, thus the tangibility of the results of use and opportunities to try the products before adoption would not affect their intention (Dutta and Omolayole, 2016).

The strong positive effects of intention of IoT use on the expected outcomes suggest that the potential users believe that the IoT has value in their daily life and they expect the IoT to benefit their well-being. These findings confirmed that using the IoT is believed to be of importance to the users' daily life (Shin, 2017; El-Haddadeh et al., 2018) and would benefit them in terms of enhancing their well-being (Mital et al., 2017; Spaceti, 2017; Marikyan et al., 2018; Martínez-Caro et al., 2018; Papa et al., 2018).

Chapter 7. Conclusions, Contributions, and Implications

This chapter concludes this thesis. Section 7.1 summarises the conclusions and contributions of the three studies and the thesis. Section 7.2 proceeds to present the theoretical and practical implications of this thesis. Lastly, section 7.3 discusses the limitations of the three studies and provides suggestions for future research.

7.1 Conclusions and Contributions

7.1.1 Main Conclusion

This research focused on understanding the users' interaction with the two technological platforms in different phases. It considered and examined the influence of relevant technologies by conducting three studies in the research context of the evolution from the Internet to the IoT. Three empirical studies were designed and conducted, targeting the three research aims as proposed in Chapter 1.

Research aim 1: to explore and test the antecedents and outcomes of using technology platforms from the psychological and emotional perspectives.

This research aim was addressed in the three empirical studies by incorporating and testing a number of psychological factors, e.g. basic psychological needs, social inclusion, well-being, and emotional responses. First of all, social inclusion and the three basic psychological needs derived from the Self-Determination Theory, i.e. the needs for competence, autonomy, and relatedness, were supported as determinants of users' attitudes towards and beliefs about the Internet. Then, well-being was confirmed as an outcome of technology platform use and can be transferred from the Internet domain to the IoT domain. Furthermore, four types of the users' emotions, i.e. achievement, challenge, loss, and deterrence emotions, regarding information systems and technologies all showed significant correlations with Internet acceptance and use. That is, using the Internet arouses the users' positive achievement and challenge emotions and alleviates their negative loss and deterrence emotions. Beyond that, challenge emotions generated in Internet use, e.g. excitement, playfulness and flow, can spill over into IoT acceptance.

Research aim 2: to examine the spillover effects of outcomes of Internet acceptance and use on IoT acceptance.

The evolution from the Internet to the IoT provides a context for studying the influence of relevant technologies on the users' attitudes. As such, study 2 tackled research aim 2 by putting forward a research framework that was constructed on the basis of the spillover effect between the two technological platforms. That is, the users' emotional response, well-being, and perceived value of using the Internet can be transferred from the Internet domain to the IoT domain. The results of study 2 showed that challenge emotions, well-being, and perceived value significantly determine users' intention of IoT acceptance and use, supporting the spillover effects from the Internet domain to the IoT domain.

Research aim 3: to test the effects of innovation characteristics on user adoption of the IoT platform.

Study 3 addressed this aim by testing the effects of innovation characteristics drawn from TAM and IDT. The findings suggested that four out of the six characteristics, i.e. perceived usefulness, perceived ease of use, compatibility, and visibility, significantly and positively influence users' adoption decisions on the IoT.

By tackling the three research aims, this research contributes to the existing body of knowledge about technology acceptance, adoption and use in four areas. First of all, this research provided valuable insights into the MIS theories in terms of extending the commonly used intention-based causal chain by incorporating the users' motivations of technology acceptance and potential outcomes of technology use. A second contribution was made by exploring the effects of a number of psychological and emotional factors on technology acceptance and adoption. Furthermore, given that previous studies have sufficiently investigated the influences of system and design characteristics, this research incorporated and tested the effects of individual characteristics. Lastly, a fourth contribution is made by introducing and testing spillover effects in technology acceptance contexts, facilitating the understanding of the influence of relevant technologies.

7.1.2 Study 1

Study 1 extended the commonly adopted causal chain of technology acceptance theories by employing the Internet users' psychological states and emotional responses as antecedents of behavioural intention and outcomes of use behaviour. In this way, a comprehensive research framework, i.e. the emotional-TAM (E-TAM), was successfully constructed and empirically validated. Three types of personal attributes, i.e. Internet use behaviour and expertise, demographic characteristics, and personality traits, were incorporated as moderators and their effects were tested on the main relationships of E-TAM.

The main effects of this study (a) corroborated the robustness, flexibility for extensions, and explanatory power of TAM; (b) suggested that psychological factors play critical roles in driving the users' motivations for technology acceptance; (c) supported the idea that the impact of using the Internet on the public is overall beneficial in terms of enhancing the users' degree of well-being, obtaining value in their everyday life, arousing positive emotions, and alleviating negative emotions. Furthermore, the moderation effects suggested that the users' background knowledge significantly influences their perceived usefulness of new technology (Kardooni et al., 2016). That is, sufficient knowledge of technologies strengthens the individuals' intention to accept new IS/IT, whereas lack of expertise could be a barrier (Liu et al., 2018). Less-experienced and/or older individuals are more likely to use the Internet with the aim of fulfilling their need for competence, whereas the younger ones mainly use the Internet for satisfying their need for relatedness.

This study contributes to facilitating the understanding of how psychological and social factors influence users' beliefs about information technologies. The novice users believe that the use of the Internet constitutes threats but can be an effective approach to gaining competence and autonomy. Still, the perceived limitations in IS/IT knowledge and experience are a barrier which hinders them from benefitting from technology acceptance and use (Kardooni et al., 2016; Liu et al., 2018). It admits the possibility that technological breakthroughs may exacerbate or create new forms of social exclusion, especially for the individuals lacking digital knowledge and skills (Selwyn, 2002; Hill et al., 2015; Andrade and Doolin, 2016). However, social support can mitigate the negative effect of the novices' emotional barriers toward using a new IS/IT and encourage them to accept new ICTs (Venkatesh et al., 2003; Beaudry and Pinsonneault, 2010), thus alleviating the potential digital exclusion brought about by the diffusion of novel technological breakthroughs (Shirazi et al., 2009; Tapia et al., 2011; Hill et al., 2015; Andrade and Doolin, 2016).

7.1.3 Study 2

Study 2 viewed user acceptance of a new technology platform as interconnected acceptance events instead of separated ones. It started with the premise that the IoT is evolving from the Internet (Atzori et al., 2010; Evans, 2012; Shin, 2017; Falcone and Sapienza, 2018), serving as the basis for examining how the users' predispositions based on an existing technological platform can affect their attitudes toward its subsequent version. A research framework was put forward by hypothesising the spillover effects of psychological outcomes of Internet use on IoT acceptance. Findings suggested that the users' emotions, psychological states, and values can be transferred from the Internet domain to the IoT. Similar to the Internet, the IoT can also bring about beneficial outcomes for the users, such as enhancing their degree of well-being.

Study 2 made significant contributions to the growing body of IoT related literature. Firstly, it confirmed that technology acceptance in one setting can spill over into another, suggesting that acceptance of technology should not be considered in isolation but that existing and emerging technology platforms may overlap (Sood and Tellis, 2005). Secondly, it examined the potential outcomes brought about by a more pervasive and ubiquitous platform.

7.1.4 Study 3

Study 3 considered IoT adoption as a critical part of the innovation diffusion process, and it thus examined the effects of characteristics of innovation on the users' adoption decisions. The successful establishment of the research model indicated that the perceived characteristics of innovation sufficiently explained variances in users' behavioural intention of adopting the IoT. Statistical results suggested that the compatibility between IoT applications and the users' current situations and target tasks is the main concern. Also, the instrumental value and the visibility of IoT devices play important roles in encouraging the users to adopt the IoT.

This study contributed to providing further insights into the existing body of knowledge of IoT-related literature by elaborating the effects of the attributes of innovation on the users' intention of adoption and examining the acceptance and adoption of the IoT platform instead of one specific service.

7.2 Practical Implications

This research provides practical implications for companies and practitioners aiming at developing and providing IoT-based products and services. First of all, this research summarised the definitions, characteristics, and applications and services of the IoT, depicting a future scenario of the users' everyday life enabled by IoT devices. Fundamentally, the IoT platform and technologies could enhance the *"smartness"* of future services, leveraging data automatically collected by the context-aware objects (Dlodlo et al., 2012; Winter, 2014; Baldini et al., 2016). For instance, in a future smart home context, the smart objects will be able to cooperate and communicate with the physical environment to automatically execute tasks that meet personal needs (Bassi and Horn, 2008; Atzori et al., 2010; O'Leary, 2013; Gretzel et al., 2015). This concept of smartness implied many business opportunities for service and product innovations for companies and developers.

The users' psychological feelings have significant effects on their intention and future behaviour and such effects vary depending on the users' characteristics. For instance, younger Internet users are concerned about their need for relatedness, while older users mainly use the Internet with the aim of gaining competence. This research suggests that practitioners should take note of the target consumers' psychological attributes, personal preferences, and emotional responses when developing new technological products and services and designing marketing strategies. Similarly, as the potential IoT users are affected by the outcomes of Internet use, practitioners should also be aware of the target users' previous experience of relevant technologies.

Thirdly, this thesis implies that the potential users have a relatively high expectation about the instrumental value of, and psychological benefits brought about by, using the IoT. Furthermore, though the Internet has overall beneficial impacts on the users, diffusion of new technological products can still possibly create new forms of social exclusion, especially for those who lack relevant skills and experiences of use. As such, the practitioners should also be aware of the functionalities and ease of use of IoT products and ensure the compatibility between various technological products and the current technological platform.

Lastly, the effect of technologies on the users' different life domains is gaining importance. Some argue that the use of information technologies blurs the boundary between work and life and brings about negative effects on users' well-being, whereas the users expect the IoT to enhance their well-being. As such, practitioners should take both the instrumental value and emotional value into consideration when developing IoT products.

7.3 Limitations and Future Research Avenues

This section summarises six main limitations concerning this research and, accordingly, provides suggestions for future studies. First of all, these three cross-sectional studies have limitations in elaborating (a) how the big changes can be brought by technological paradigms can to the public and (b) how they can transform individuals' psychological states and emotional reactions at different stages of diffusion. Also, as far as the users' experiences and expertise was concerned, a longitudinal study may provide further insights into the understanding of (a) the effects of relevant experience and knowledge in affecting the acceptance of novel technological concepts, and (b) the roles of the participants' experience of a specific technology and their actual behaviour of use. Given that, a longitudinal study focusing on a detailed examination of the role of technology experience and expertise on affecting the users' attitudes and beliefs toward relevant technological platforms could be an important research area.

Then, the data for three of the studies was collected once, using a relatively long questionnaire. Also, given that an application or product that perfectly depicts the futuristic scenario of IoT has not yet been developed, this research recruited Internet users as questionnaire respondents and provided a brief description of IoT prior to the questions. Although these three studies were free of common method bias, this survey strategy may have affected the quality of the data.

Thirdly, these three studies posited direct effects of the psychological factors and innovation characteristics on TAM-based constructs, i.e. the users' attitudes and intentions. Further tests and validations such as the interactions and crossover effects between the independent variables are required. Similarly, the multi-group approach of moderating effects test adopted in study 1 did not evaluate the interactions between moderators. In the future, further investigation into the interactions, e.g. experience*age*extraversion, as well as their combined effects on technology acceptance could be taken into consideration.

The fourth limitation concerns the generalisability of the research frameworks. Specifically, these three studies statistically tested the research models using data collected from consumers in the U.S. Although these models performed well in elaborating the factors influencing user acceptance of the Internet and the IoT, the compatibility of these research models should be examined in other contexts, such as users in societies with different cultural backgrounds. This provides another potential research avenue, that is, to examine and validate the research models in other settings.

Given that the first study incorporated and tested three categories of psychological factors as outcomes of Internet use, the second study tests only the effects of these outcomes on IoT acceptance. Another meaningful research area is the direct spillover of psychological states from the Internet context into the IoT context, e.g. the spillover of Internet emotions into IoT emotions.

Lastly, a number of factors that potentially influence user acceptance and use of the Internet and IoT should be explored and examined in the future. For instance, in addition to the typical characteristics of innovation investigated by the third study, the unique characteristic of the IoT such as the ubiquitous distribution of sensors and the users’ concerns about privacy invasion could be investigated in the future. Also, psychological factors concerning IoT use and the personal attributes of IoT users should be investigated.

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