Development of Innovation Acceptance Model for Wearable Computing: A Study of Users' Technology Acceptance in Malaysia

A Thesis Submitted for the Degree of Doctor of Philosophy

By

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Dec 2020

ABSTRACT

Wearable computing is becoming a phenomenon of emerging innovation which once started from the early era of personal computers. Since then, it has grown to sophisticated wearable smart devices which has promising prospects in this information age and is expected to become mainstream after the phenomena of the mass market adoption of smartphone usage, especially in Malaysia. However, in terms of users' acceptance, wearable computing is still at its infancy stage. This research study examines the development of a conceptual framework to understand the influencing factors for users' acceptance of wearable computing by utilising the integration of Technology Acceptance Model (TAM), the Diffusion of Innovation Theory (DOI) and related factors on mobility and pervasive computing. This research evaluates wearable computing from the potential users' perspective about technological innovation acceptance. It is a challenging field to predict the factors that may drive potential users to accept this new emerging technology, thus expanding innovation diffusion.

Data of 272 respondents were collected in the Malaysian region by employing the quantitative approach of a survey-based questionnaire as the dominant method and was analysed using IBM SPSS software (V.20). A qualitative approach was also conducted to support those quantitative findings. Empirical findings from regression analysis revealed the strongest and unique contribution of predicted factors were perceived usefulness; mobility linked with observability; perceived enjoyment linked factor with personalisation and facilitating conditions that may significantly influence the potential users to accept wearable computing. Conversely, perceived ease of use was not significantly influencing the users' acceptance of wearable computing. The total variance explained by the model factor is 61 percent (R square=61%) of users' acceptance of wearable computing. The findings and the development of this framework will give more insight and contribute to the body of knowledge in understanding the innovation of wearable computing, thus improving innovation diffusion.

ACKNOWLEDGEMENT

In the name of Allah, the Almighty, the Most Gracious and Merciful.

Firstly, I would like to express my sincere gratitude to my Principal supervisor Dr. Rebecca De Coster, for providing me with a great opportunity, guidance, patience and valuable advice, and my second supervisor Dr. Alireza Mousavi towards completing this research study. I am so grateful for the inspiration given, and this research process has contributed significantly to my intellectual growth.

I wish to take this opportunity to express my appreciation to my beloved parents, family, friends, and research colleagues for their support, strength, help, and encouragement. Not to forget, a special thanks to all staff and colleagues at Brunel University London and all the respondents for their time to participate in this study as well as the interviewees to share their opinions on the findings.

Lastly, my special thanks go to everyone involved for their kind assistance and support in completing this research study. I wish this study would be beneficial to all.

DEDICATION

I dedicate this valuable thesis to my beloved family and children for their patience, encouragement and support; they inspire me to accomplish my goal in completing this research journey.

Syakirah binti Mohamad Taib

December 2020

LIST OF PUBLICATIONS

Journal:

Taib, S. M., De Coster, R. and Nyamu, J. (2016) ‘An Empirical Study on the Innovation Acceptance of Wearable Mobile Computing : Pervasive Computing Perspective’, *International Journal of Chaotic Computing*, 4(2), pp. 96–102.

Conference and Doctoral Seminars:

Taib, S. M., De Coster, R. and Sabri, E. T. (2017) ‘Market Adoption Study for Wearable Mobile Computing’, in *3rd International Colloquium of Design, Branding and Marketing (ICDBM) 5-6 April 2017, Bournemouth, UK*.

Taib, S. M., De Coster, R. and Nyamu, J. (2016) ‘Innovation Diffusion of Wearable Mobile Computing : Pervasive Computing Perspective’, in *International Conference on Information Society (i-Society 2016), Technical Co-sponsored by IEEE UK/RI Computer Chapter*. Dublin, Ireland, pp. 97–101.

Taib, S. M., De Coster, R. and Nyamu, J. (2016) ‘Wearable Mobile Computing Applications: Pervasive Computing Perspective’, in *Computer Science Doctoral Consortium, 21-22 April 2016, Brunel University London, UK*.

Taib, S. M. (2015) ‘A Study on the Innovation Adoption of Mobile Computing and Wearable Technology in a Developing Country’, in *Research Student Poster Conference,2015, Brunel University London, UK*.

Taib, S. M., De Coster, R. and Nyamu, J. (2015) ‘Users’ Behavioural Intentions to Adopt a Wearable Technology in Malaysia’, in *2015 British Academy of Management Conference, University of Portsmouth, UK*.

Co-author for the innovation study:

De Coster, R. and Taib, S. M. (2017) ‘Collaborative Innovation Approaches for the Commercialisation of University Engineering Projects’, *Journal of Small Business and Entrepreneurship*. *Waiting for acceptance.*

Nyamu, J., Coster, R. De and Taib, S. M. (2015) ‘A framework for collaborative innovation to facilitate e-health systems adoption’, *International Journal of e-Healthcare Information Systems (IJe-HIS)*, 2(2).

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BAM	British Academy Management
DOI	Diffusion of Innovation
FC	Facilitating Conditions
IT	Information Technology
MA	Mobile Application
MCMC	Malaysian Communications and Multimedia Commission
MOB	Mobility
MYR	Malaysian Ringgit
OBS	Observability
PE	Perceived Enjoyment
PEU	Perceived Ease of Use
PN	Personalisation
PU	Perceived Usefulness
SI	Social Influence
SPSS	IBM SPSS
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology
WC	Wearable Computing
WT	Wearable Technology

DECLARATION

I declare that the presented work is original and of my works otherwise stated or duly acknowledged as reference work.

Syakirah Binti Mohamad Taib,

23 December 2020

CHAPTER 1

1 INTRODUCTION

1.1 Research background

The global market of the emerging wearable technology will become mainstream (Do, Martini and Choo, 2016). Moreover, some researchers believe that wearable computing will enhance people’s quality of life and affect every aspect of their lives (Billinghurst and Starner, 1999; Mann, 1998; Kipkebut and Busienei, 2014). However, there are limited studies to investigate the perceived value of wearable computing (Karahanoglu and Erbug, 2012) and how this value impacts consumers’ adoption and usage decisions; thus, it is essential to examine the users’ acceptance to adopt wearable computing.

The term “wearable computing” refers to electronic technologies or computers that are comfortably worn on the human body using integration, particularly into items of clothing and accessories. By its definition, wearable computing is attached to where its wearer goes (Billinghurst and Starner, 1999). It can perform many possible computing tasks similar to mobile phones and laptop computers, for example, sensing, communications, navigation, decision-making or actuation (Jhajharia et al. 2014; Milano and Ugur 2012; Sydiinheimo et al. 1999; Dunne 2004). In this philosophy, the main idea is that the user wears a computing system that forms an interface between them in the ubiquitous environment.

Wearable computing technology in this research study is an innovative concept that utilises mobile technologies like a smartphone for accessing mobile services and mobile commerce (Yang, 2005), mobile entertainment (Wong and Hiew, 2005) and the Internet of Things (Wei, 2014). In this study, wearable computing refers to electronic technologies worn on the human body (Anumba and Wang, 2012) as unobtrusive apparel, such as a smartwatch, that continuously provides an interface to many computing tasks with the mobile smartphone acting as a hub (Wei, 2014).

The transition time from widespread penetration of smartphone to wearable computing has been enabled by the developments in mobile and wireless communication technologies, such as WAP2, Bluetooth, and 3G mobile phones and computing devices, suggesting the possibility of fundamentally new types of computing services (Lyytinen and Yoo, 2001).

The telecommunications industry is known for its fast technological progress (Boor, Oliveira and Veloso, 2014) and technological innovation has created a new generation of small, powerful, mobile computing devices for accessing information anytime, anywhere. Research in microelectronics, wireless communications, and human-computer interaction, particularly in augmented reality applications, has improved the system (Ashok and Agrawal, 2003). Starner (2001) stated that user's preference is an important factor for acceptance and perception of design affects the acceptance of wearable technology (Karahanoglu and Erbug, 2012). Recently, a growing interest in a research study on wearable computing for example, in the context of Bangladesh, has been conducted to understand and increase self-awareness of drivers' wellbeing. The research employed a quantitative approach by using a low-cost wearable heartbeat sensor on 88 drivers to monitor their Heart Rate Variability (HRV) by collecting their heart rate data according to road conditions (Rony and Ahmed, 2019). Furthermore, according to a study conducted by (Dehghani, Abubakar and Pashna, 2018) based on semi-structured interviews with ten start-up managers in Wearable Technology 2017 conference, they indicated that wearables fit into four sectors which are health and fitness, lifestyle, productivity, organization and enterprise. They suggest that these four stages need to be considered by start-ups for successful market readiness, including "the time of entry and overcoming market entry barriers, product attributes, product development process, and commercialisation".

A study on human factors of wearable computing devices (WCD) acceptance was conducted to identify physical attributes. It includes a range of acceptable form factors such as the weight, volume and placement of WCD at different body areas for user's movement and posture through an empirical and quantitative approach. The findings may be expected as practical parameters for WCD design in improving user acceptance (Park *et al.*, 2019). A systematic review of literature on the recent trends of wearable computing revealed that research in both commercial and academic areas are still lacking. Though the emergence of this innovation shows a growth of with more than 300% of published papers of wearable technology, the majority of research is conducted in universities in the USA, Japan, and China respectively (Amorim, Oliveira and Silva, 2020).

Moreover, a study conducted by Kim and Shin (2015) identified the key psychological determinants of smartwatch adoption in South Korea by employing the extended Technology Acceptance Model (TAM). The results may not be generalisable to more diverse populations as the study is still preliminary. The Technology Acceptance Model (TAM) is widely cited to explain potential users' intentions with regards to the acceptance of particular technologies (Davis, 1989). However, TAM has been criticised not to fit the new context, specifically in wearable technologies. A study of smartwatch adoption in Malaysia using TAM was found to be unreplicable as perceived ease of use is not directly significant, but indirectly related to attitude while perceived usefulness is not a significant predictor (Chuah et al., 2016). Mobile technology has been widely accepted; however, the study on users' acceptance of wearable computing is still limited. This phenomenon drives this research to examine the potential user to accept wearable computing by integrating TAM and diffusion theory with the related factor to fit the wearable computing context.

Additionally, the wearable technology market was expected to grow from US$750 million in 2012 to US$5.8 billion in 2018, reported by Transparency Market Research (2013) in “Wearable Technology Market—Global Scenario, Trends, Industry Analysis, Size, Share and Forecast, 2012–2018”. This trend reveals a growing interest in wearable computing. Figure 1.1 shows the wearable computing attributes which comprise of hands-free, always-on, environmentally aware, must be connected to (wifi, 3G/4G, Bluetooth or Near

Field Communication (NFC) and attention-getting with development platform. Wearable computing devices attached to the user may augment reality, for example, computer-generated images or audio, to provide context-sensitivity (Billinghurst and Starner, 1999).

Figure 1.1: The attribute of wearable computing technology

Source: KPCB cited in (Kipkebut and Busienei, 2014)

1.2 Malaysia ICT overview

Malaysia is also not excluded from facing telecommunication evolution. Malaysian Communications and Multimedia Commission (2012) reported that the government had supported the Information and communications technology (ICT) development in allocating a rebate of MYR200 for a young person aged between 21 to 30 with monthly income below than MYR3000 to get the opportunity to migrate from old second generation mobile phones to a basic 3G smartphone which aimed to bridge the digital divide. The Prime Minister announced the allocation for young people as they constituted 22% of the population in Malaysia. Malaysia is moving forward in improving its communications infrastructure where broadband connectivity has now reached 63.5% of households with more than 17.5 million users, as revealed by Malaysian Communications and Multimedia Commission (MCMC) (2012). In 2007, Malaysia's government had launched the e-government program known as eKL, which aimed to incorporate the delivery of efficient services across agencies for the benefit of citizens and businesses within the Klang Valley area (Althunibat, Azan and Ashaari, 2011). The mobile landscape in Malaysia, especially the smartphone trend is gradually diffused.

In 1985, Telekom Malaysia has introduced the first cellular network. In 1989, Celcom had introduced the ART 900 (Automatic Radio Telecommunication 900) which is based on British ETACS technology (Extended Total Access Communications System). The GPRS entry enables instant access of WAP, HTML or even i-mode sites using mobile phones, PDAs or Notebooks. GPRS has enabled information to become accessible anytime, anywhere and from any place. In 1995, 3G was made available in Malaysia. In 2007, both Maxis and Celcom offered connectivity in major cities around Malaysia (Osman *et al.*, 2012).

Malaysians might be interested in mobile services including email access; wireless gaming; downloading music; information services; directory services; banking or other investment related activities; location-based services; video-conferencing and video streaming (Goi, 2008). The smartphone adoption among Malaysians has been increasing from the statistical report of Malaysian Communication and Multimedia Commission (MCMC), which presented that there were a total of 44,929,000 3G subscribers in the year 2014 in MCMC Statistic (2015) (Lazim and Sasitharan, 2015).

The Malaysian government has highly supported the development of information technology (IT) and e-commerce by providing a comprehensive regulatory framework of cyber laws and intellectual property laws (Mozie, Mustapha and Ghazali, 2012). The Malaysian government has set a goal to reach 50% penetration of Internet services in 2013 and to push toward 75% penetration by 2015. Young mobile phone users within a particular age group may get a subsidy to purchase an entry-level smartphone with income-based smartphone subsidies for Malaysians that earn less than MYR3,000 per month (approximately U.S. $934) (Ahanonu *et al.*, 2013).

The growing diffusion of mobile phone usage has been developing; however, concerning the literature, the study on users' acceptance of wearable technology is still at an early stage. Malaysia represents an appropriate research study since smartwatch diffusion is still extremely low (Chuah *et al.*, 2016). Therefore, this research will fill the gap to understand the users' acceptance of wearable computing.

1.3 Research motivation

The Southeast Asian region reflects a diverse mix of economies and cultures with varying mobile technology usage (Ahanonu et al., 2013) and has been widely adopted. Malaysia is reported to have the second highest mobile penetration in Southeast Asia after Singapore, and m-Commerce may have a bright future in Malaysia (Goi, 2008). Malaysian Communications and Multimedia Commission (MCMC) (2012) also reported that the government had supported the ICT development in facing telecommunication evolution. It reveals that 85% of Malaysians own mobile phones (Osman *et al.*, 2012).

The growing diffusion of mobile phone usage has been developing; however, the extant literature on the study of users' acceptance of wearable technology is still at an early stage. IDC (2016) had expected the wearable devices to reach 101.9 million units by the end of 2016 and 213.6 million units to be shipped in 2020. A research study revealed smartwatch acceptance is still low in the Malaysian context (Chuah *et al.*, 2016). This phenomenon drives this research to empirically examine the potential user in accepting wearable computing in the Malaysian context, as Malaysia is moving towards the development of digital economy, shown through the promotion of mobile payment services and the emergence of smartwatch. Since there is limited research carried in understanding the factors that may significantly influence users' acceptance of wearable computing in the Malaysian context, this study aims to fill the knowledge gap. Therefore, the conceptual framework of Innovation Acceptance Model of Wearable Computing has been designed based on the integration factors from the Technology Acceptance Model (TAM), the Diffusion of Innovation Theory (DOI) and related factors on mobility and pervasive computing technology to deepen understanding. This has also predicted factors that may have a positive effect on the acceptance at its early stage of emergence.

The findings from this study would give insightful knowledge and contribute to supporting the decision making for the IT industry and the service providers as an alternative comprehensive tool.

Wearable computing may become an interesting field of research in the implementation of pervasive and ubiquitous computing. Eventually, humans and computing will work together to achieve innovative ways of improving daily life, thus stirring the widespread of mobile applications and devices to be used anywhere and everywhere. The research concerning the acceptability of wearable technology is very limited. Gribel, Regier and Stengel (2016) in their study, found psychographic factors from a qualitative perspective on social and psychological contexts lead to either acceptance or resistance of wearable computing in the European market. However, the results were not generalisable due to the theoretical sample. Moreover, Kim and Shin (2015) in their study have identified the key psychological determinants of smartwatch adoption in South Korea by the extended Technology Acceptance Model (TAM) and the results also found greater theoretical contribution with its integration of affective, rational, and usability factors in a single research model. The findings also may not be generalisable to more diverse populations as the studies are still preliminary. Additionally, a study on smartwatch acceptance in the Malaysian context using TAM cannot be replicated as perceived ease of use is not directly significant, but indirectly related to attitude while perceived usefulness was not a significant predictor (Chuah et al., 2016).

The argument on employing TAM to explain the intention of potential users regarding the acceptance of particular technologies (Davis, 1989) is widely cited. TAM still has been criticised for being less informative in a particular context, and it needs to be reviewed to fit the innovation context, explicitly in wearable computing technologies. For that reason, a new conceptual framework of the Innovation Acceptance Model of Wearable computing has been designed to fill the research gap.

The well-established and relevant theories, models and factors for the users' acceptance have been reviewed, contributing to the innovation adoption research in the information technology (IT) field. Such theories include: Theory of Reasoned Action (TRA) by Ajzen and Fishbein (1980) and Diffusion of Innovation (DOI) theory (Rogers, 2003). Furthermore, technology acceptance theories like Technology Acceptance Model (TAM) by (Davis, 1989); Theory of Planned Behaviour (TPB) by Ajzen (1991) and Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh *et al.* (2003). DOI is extensively used in the studies that performed organisational analysis while TAM, TRA, TPB is utilised mainly for individual level analysis (Hameed, Counsell and Swift, 2012). Hence, TAM is still considered relevant to technological innovation factors. After considering other theories related to innovation, DOI was chosen due to its solid theoretical foundation and remained a popular model for investigating the adoption of innovation. It has received substantial criticism for its application on the organisational level. Rogers (2003) proposed five attributes of innovation that play a key role in an individual's innovation adoption attitudes. Several studies had employed DOI model particularly in ubiquitous environments, (Sydiinheimo *et al.*, 1999; Zeal and Smith, 2010; Kim, 2012) as many devices are introduced to the market to access information. The five attributes in DOI were viewed to determine the rate of innovation adoption.

Wearable computing is one of the new technologies that is likely to grow and become part of users' lives generally in the future. While some users may have positive attitudes towards this innovation, some may reject wearable computing due to different reasons. Consequently, understanding the users' intentions to accept the innovation may be challenging and has been growing attention recently. Therefore, this research attempts to develop and examine the conceptual framework in predicting the influencing factors of users' acceptance for wearable computing through a mixed methods approach. This research is expected to contribute to the body of knowledge on wearable computing acceptance and how potential users perceived this new emerging technology for improving daily life.

1.4 Research aim, objectives and questions

Research Aim:

To develop a conceptual framework and examine the factors on the innovation diffusion and users' acceptance of wearable computing in Malaysia.

Research Objectives:

This research aim can be achieved by performing these objectives:

1. To investigate the pervasive computing-based applications and how technology acceptance has been understood in the past that may drive the acceptance of Wearable Computing.

2. To develop a conceptual framework and empirically identify the influencing factors for users' acceptance of Wearable Computing in the Malaysian context.

3. To investigate social influence and mobile application experience that may influence wearable computing acceptance.

4. To support the development of the conceptual framework which may influence the deployment of wearable computing by conducting interviews.

Research questions

This research has formulated a research question to achieve the research aim. The main research question is to identify the predicted factors that may influence users' acceptance of wearable computing in Malaysia. Therefore, the following research questions were identified as follows:

1. What are the pervasive computing-based mobile applications and how has technology acceptance been understood in the past that may drive the acceptance of wearable computing?

2. What are the factors that may influence users' acceptance of wearable computing in Malaysia?

3. To what extent do the social influence and mobile application influence wearable computing acceptance in Malaysia?

1.5 Thesis structure

Chapter one introduces the background of the research, the research motivation, aims and objectives, research contribution and the thesis structure.

Chapter two reviews the extant literature in the field of the pervasive computing, mobile computing, wearable computing, and the technological innovation acceptance model. as well as innovation diffusion model.

Chapter three presents the understanding of research methodologies that underpins the study in developing the conceptual framework, the different research paradigms, questionnaire design, sampling, pilot study, research design, ethical procedure and the research findings' validation.

Chapter four presents the development of the conceptual framework from the extracted factors of the related literature in pervasive computing, mobile technology and wearable computing, technology acceptance theories as well as the innovation diffusion model. Furthermore, related hypotheses are formulated.

Chapter five presents the survey outcome characteristics: including the sample profile, the demographic characteristics including effect of gender, age, prior experience and computing knowledge on the model factors. Moreover, the effect of users' acceptance of wearable computing based on demographics characteristic has been presented using analysis of variance (ANOVA) and T-Test.

Chapter six presents the research model testing comprising of data screening, reliability and validity test and test of normality. Furthermore, the related tests are conducted, such as correlation, factor analysis and regression analysis to achieve the research objectives. The qualitative interviews were also presented for results validation.

Chapter seven discusses the empirical findings in the context of the related literature. The main research findings of the study factors were also explained.

Chapter eight presents the thesis conclusion and recommendations by describing the research summary, its contributions to knowledge as well as in academia, managerial implications and key limitations of the work and suggesting areas for future research.

1.6 Chapter summary

In this chapter, the aims and objectives for undertaking this research study were presented. The research background and motivation in doing this study were also introduced. Due to limited research on wearable computing as it is still at an early stage of emerging technological innovation, specifically in the Malaysian context as a developing country, research questions were developed to answer this research study. There were existing frameworks of wearable computing that had been developed in other countries; however, the models are related to different territories with different demographics characteristics, culture and knowledge.

Therefore, to fill the knowledge gap in understanding which factors may influence users' acceptance in the Malaysian context, relevant literature with the established theoretical framework has been employed to develop a conceptual framework in predicting the factors. In the following chapter, the extant literature for this study will be explored and explained further. The theories underpinning the study will be discussed in detail, the choice of the methodology, the development of the conceptual framework may be discussed and presented. Also, the choice of running the robust statistical test using IBM SPSS V.20 including the descriptive analysis and model testing will be justified. The novelty of the research findings may significantly contribute to the body of knowledge in terms of theoretical and managerial implications.

CHAPTER 2

2 LITERATURE REVIEW

In the era of wireless communication and widespread adoption of mobile technology, the extant literature on mobile technology acceptance has been growing - for example in m-commerce, mobile banking, smartphone usage acceptance for healthcare and smartphone adoption. However, research on wearable computing is still at the early stages of emergence, specifically in developing countries. This chapter reviews the literature on the characteristics, evolution and application of pervasive computing, mobile computing as well as the characteristics of wearable computing and its applications. Furthermore, various theories on technology acceptance including Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB), Unified Theory of Acceptance and Use of Technology (UTAUT) and Diffusion of Innovation Theory (IDT) are provided for clearer understanding in this field. This study aims to contribute and add to the existing knowledge on which factors may influence users' acceptance of wearable computing.

2.1 Pervasive Computing

Technological innovation is evolving the way information is communicated due to the advancement in digital technologies. This evolution dates back to the era of the personal computer and is now in the era of pervasive computing. Pervasive computing is one of the necessary elements of wearable computing. Weiser (1991) stated his vision of pervasive computing, *"The most profound technologies are those that disappear. He meant they weave themselves into the fabric of everyday life until they are indistinguishable from it".* Pervasive computing is evolving towards embedding microprocessors in everyday objects for information exchange, enabling communication anytime and anywhere (Bhasker, 2013). The essential centre of pervasive computing is human-centricity, self-sufficient recognition of use necessities and provision of programmed administration (Shuib, Shamshirband and Ismail, 2015).

Weiser (1991) as a chief technologist at PARC, the Xerox Palo Alto Research Center described pervasive or ubiquitous computing as "*invisible, context-aware, an embedded technology that will serve users in seamless and unconscious interaction*". Pervasive computing is where a user can interact with the system by using: laptops; tablets; terminals; mobile phones and smartphones (Choi, Park and Jeong, 2013); a pair of glasses (wearable computing) and wearable fabrics that are sensor-embedded (Oluwagbemi, Misra and Omoregbe, 2014).

The words "pervasive" and "ubiquitous" mean "existing everywhere" with mobility being the basis for the system to be pervasive (Choi, Park and Jeong, 2013). The ubiquitous computing is the concept of the disappearing computer, which is also known as pervasive computing (Satyanarayanan, 2001; Orwat, Graefe and Faulwasser, 2008; Hong, Suh and Kim, 2009; Sriram *et al.*, 2015).

Mobility is considered as an essential part of everyday life, which new technological innovation may need to support for. Pervasive computing may likely be driven by advancement in mobile computing. Wearable computing is comprised of a small device with wrist-mounted systems to a large backpack computer (Billinghurst and Starner, 1999; Abowd, 2016). In most applications, the wearable devices comprise of possibly display connected, wireless communications hardware and some input devices, such as a touchpad. This combination has predominantly improved user performance in applications such as aircraft maintenance, navigational support and vehicle inspection (Billinghurst and Starner, 1999; Jhajharia, Pal and Verma, 2014).

The wireless Internet has improved the spread of smartphones and accelerated the need for pervasive and ubiquitous computing (Choi, Park and Jeong, 2013; Oluwagbemi, Misra and Omoregbe, 2014). According to Lee, Lee and Madria (2008), they described the pervasive data access architecture as shown in Figure 2.1, where a base station serves the mobile device (which supports bidirectional communication) or is covered by a satellite (which only supports unidirectional data transmission). The Internet backbone with high speed is linked to all access points and servers. This architecture of a base station serves as a gateway between mobile clients and remote servers. A wireless cell may be called a simple client or server environment where a base station functions as a local server disseminating information to clients inside the cell. The servers in this architecture are information providers while mobile clients are customers. Without a loss of generality, all updates are performed at the servers.

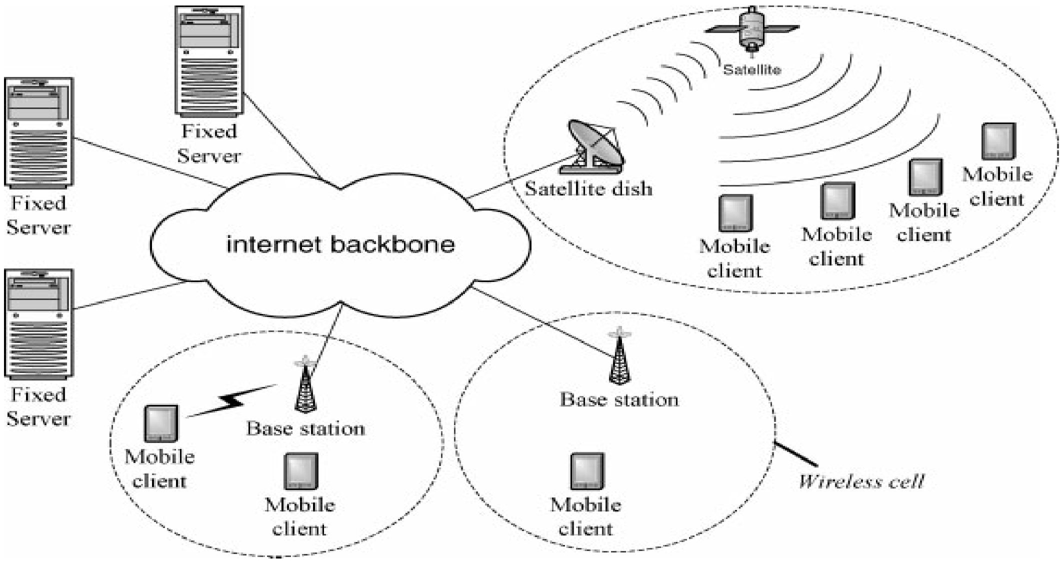


Figure 2.1: Pervasive data access architecture

Source: Lee, Lee and Madria (2008)

2.1.1 Pervasive computing characteristics

Wearable computing has become part of the key objective of pervasive computing, where people will have access to computing anywhere, anytime. Wearable computing may able to support the vision of the pervasive environment by embedding computers in many daily-life components such as clothing, smartwatches, glasses (Karahanoglu and Erbug, 2012), caps, headwear, shoes, and other wearable objects. Wearable computing designed as clothing items might be the new generation of computers (Shim and

Dekleva, 2006). The goal of wearable computing is to be able to be constantly worn with the ability to have an intelligent assistant that augments memory, intellect, communication, and physical abilities (Starner, 2001). The smart interface is the focus of wearable computing. The major challenges in wearable computing relate to power requirements, network resources, privacy concerns and the design of innovative interface (Starner, 2001).

Pervasive computing devices sense and interpret sensory information using intelligence characteristics and are context-aware. Increasing devices support interfaces like natural communication with computing multisensory interaction (Sriram *et al.*, 2015). Context-awareness is defined as a computer or general class of mobile systems that can sense their physical environment and adapt their behaviour accordingly. Context-aware systems are the component of a pervasive computing environment. Context-awareness emerged from pervasive computing research at Xerox PARC in the early 1990s. Context-awareness has three important aspects of context which are: User Context, Physical Context, and Computing Context (Sriram *et al.*, 2015).

Context-awareness refers to the enhancement of a user's interactions by understanding the user with the context and the applications and information being used, typically across a wide set of user goals (Anumba and Wang, 2012). Context-awareness is capturing a broad range of contextual attributes to understand what the user needs and what products or services that they may be interested in, and is part of contextual computing.

A context-aware mobile phone, for example, would use context aspects that would be appropriate when trying to notify the user of incoming calls. Notifications could range from ringing to buzzing or vibrating. The mobile even might suppress notifications of less important calls. Perception or context-awareness is an intrinsic characteristic of intelligent environments. It introduces significant complications: location monitoring, uncertainty modeling, real-time information processing, and merging data from multiple and possibly disagreeing sensors. The information that defines context-awareness must be accurate; otherwise, it can confuse or intrude on the user experience (Saha and Mukherjee, 2003).

Invisibility (Satyanarayanan, 2001; Saha and Mukherjee, 2003) concerns the disappearance of pervasive computing technology from a user's consciousness. Invisibility is the norm in pervasive computing. True invisibility is the challenging component in pervasive computing with minimal user distraction. Concepts like pervasive or ubiquitous computing enabled by the developments in mobile and wireless communication technologies, such as WAP, Bluetooth, and 3G mobile phones and the continued miniaturisation of chips and computing devices, suggest the possibility of radically new types of computing services (Lyytinen and Yoo, 2001).

The technological advances build a pervasive computing environment into four broad areas: devices; network; middleware and applications. Figure 2.2 illustrates the relationships: the networking kernel mediates the pervasive middleware interactions and facilitates users' engagement in the pervasive computing space; and the middleware performs in either client-server or peer-to-peer mode which consists of firmware and software (Saha and Mukherjee, 2003).

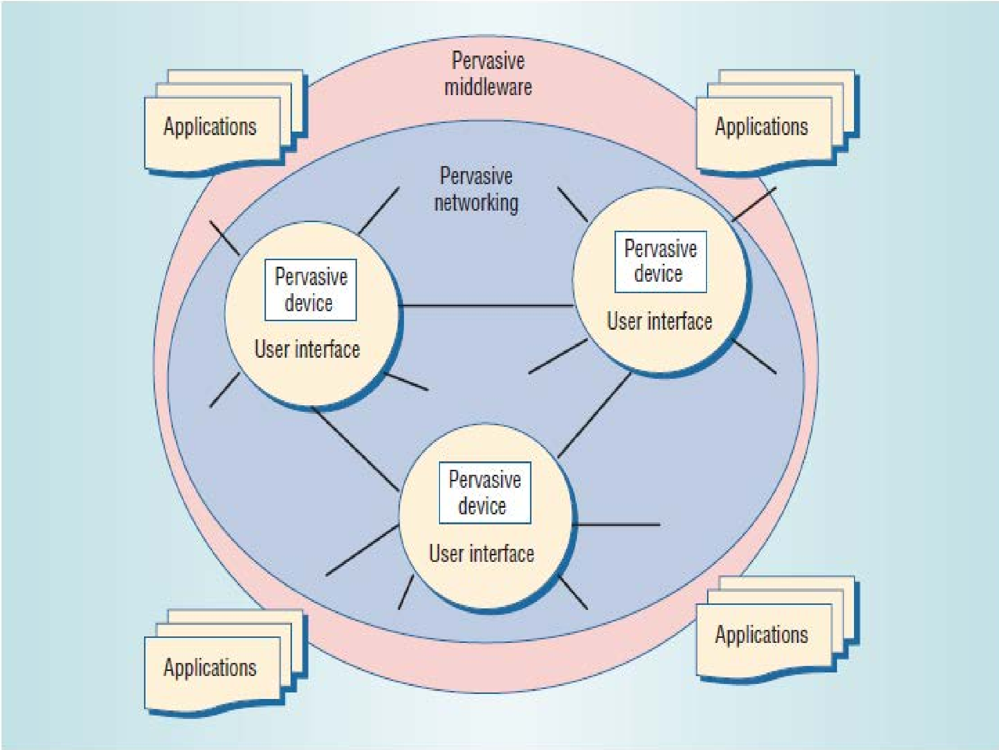


Figure 2.2: Pervasive middleware facilitate interactions with the networking kernel and keeping users engaging in the pervasive computing space

Source: Saha and Mukherjee (2003)

The objective of pervasive middleware is to link the application to available resources efficiently. The pervasive computing application comprises of enabling technologies of a smart device, wireless communications software, embedded processors, wearable computers and handheld smartphones. Figure 2.3 shows the distributed middleware components in the Reference model for pervasive computing middleware and user application. (Raychoudhury *et al.*, 2013)

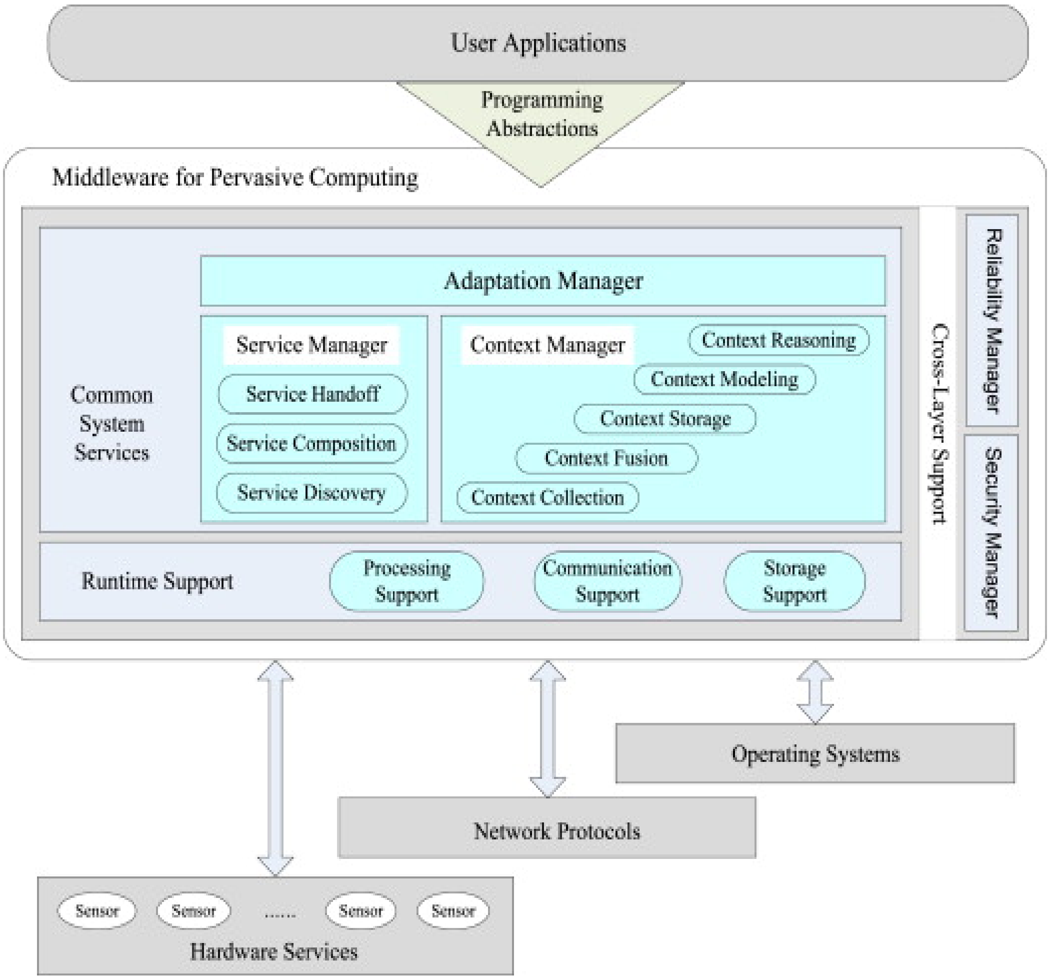


Figure 2.3: Reference model for pervasive computing middleware and user application

Source: Raychoudhury *et al.* (2013)

The pervasive computing architecture consists of devices, networking, middleware and applications. Pervasive computing is the latest computing technology available where communication is taking place all over the place. In this pervasive environment, any device from anywhere can be accessed by the user. Users may be connected or interacted with the system through laptops, tablets, terminals, mobile phones and smartphones (Bhasker, 2013). Table 2.1 shows the pervasive computing architecture with four important areas.

Table 2.1: The Pervasive computing architecture with four important areas

Sources: Satyanarayanan (2001); Lueg (2002); Bhasker (2013)

Devices	• Traditional input device like mouse or keyboards while output devices, such as speakers • Wireless mobile device including pagers, personal digital assistants, cell phones, palmtops • Smart devices such as intelligent appliances, floor tiles embedded sensors and biosensors.
Networking	• The pervasive computing with distributed network linked with other pervasive devices. • Wireless phones, pagers, vending machines, refrigerators and washing machines with chips embedded and connected to a pervasive network. • The pervasive devices interlink through the Local Area Network (LAN) or Metropolitan Area Network (MAN) or Wide Area Network (WAN) for global availability.
Middleware	• The need for a middleware "kernel ” for communication in the pervasive network between end-user and a system, • The web application (Web Page) or set of software in the middle either. • The software executes in client-server mode or peer-to-peer mode
Applications	• Web-based or mobile computing is less environment-centric than Pervasive computing. • Data collected from the pervasive environment will be processed.

Figure 2.4 shows the pervasive computing is a superset of mobile computing. In addition to mobility, pervasive systems necessitate support for “*interoperability, scalability, smartness, and invisibility”,* such that users may seamlessly access computing whenever they need it (Saha and Mukherjee, 2003).

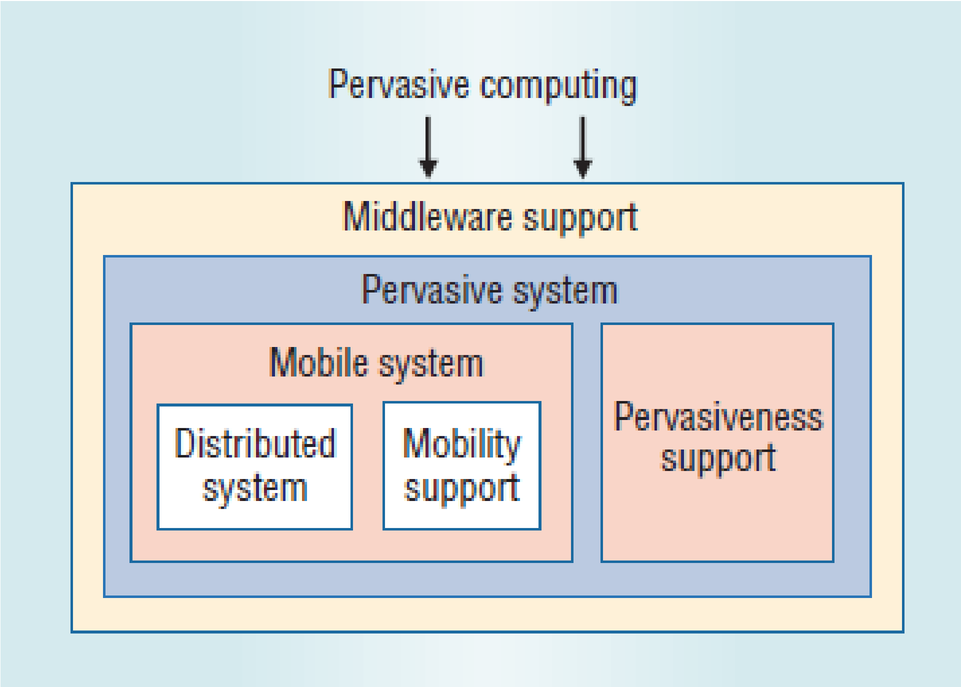


Figure 2.4: Pervasive computing is a superset of mobile computing

Source: Saha and Mukherjee (2003).

The wireless technologies, for instance Bluetooth, IEEE. 802.11, UMTS and satellite, could be integrated into constructing the pervasive data access platform seamlessly. Although the applications are very different, data access through these wireless technologies can capture a basic access point which is the cellular base station or satellite and certain wireless channels.

Lee, Lee, and Madria (2008) stated the need for mobility in mobile computing environments where users are free to move. User mobility promotes location-dependent applications that requests data based on the current positions of users. The development of wearable technology has increased the interest in pervasive computing of which mobility is the main objective (Freitas and Levene, 2006).

2.1.2 Pervasive computing evolution

Pervasive computing began in the mid-1970s when computers were made known to the user. From Weiser’s vision, the intention was to make computing part of a user’s daily life. Although the computer has not fully conveyed the information technology to users, the initial development of the computer has been helping the growth of hardware components and the development of graphical user interfaces (Saha and Mukherjee, 2003). By the late 1970s, the evolution has been progressing from a small computer on the user’s desktop and brought into the era of one-to-one computing, with one person having one personal computer (PC). The following PC revolution, together with the Internet revolution in 1990s, has transformed into the communication industry. In the new millennium, the era of one-to-one computing has created the one-to-many era, with the devices are becoming increasingly mobile (Waldrop, 2003).

Table 2.2 shows a framework for comparing computer generation evolution from Weiser's perspectives. It summarises the evolution of computing generations since the 1930s, associated changes in the human-computer relationship which represent each generation, and the driving applications that have driven wide-scale adoption of the technologies. In the next generations’ devices and applications which do not disappear, however, they are augmented by those of the next generation (Abowd, 2016).

Table 2.2: A framework for comparing computer generations evolution, inspired by Weiser

Source: Abowd (2016)

Generation	Time frame	Human–computer ratio	Canonical device	Application	
				Initial	Follow-on
1	Mid-1930s	Many–1	Mainframe	Scientific calculation	Data processing
2	Late 1960s	1–1	PC	Spreadsheet	Database management, document processing
3	Late 1980s	1–many	Inch/foot/yard	Calendar and contact management, human–human communication	Location-based services, social media, app ecosystem, education
4	Mid-2000s	Many–many	Cloud/crowd/shroud	Personal navigation and entertainment	Health advisors, educational assistants, supply chain logistics

With the connection of wireless and mobility, smaller devices and computing power has led to the ubiquitous computing era, which then evolved to the emergence of wearable computing. Ensemble computing extends the ideas of distributed and ubiquitous. Figure 2.5 shows some of the key waves of computing paradigms from centralised computing, client-server and internet computing to pervasive or ubiquitous computing and the next generation which is known as ensemble computing.

Satyanarayanan (2001) discussed that pervasive computing is facing a major evolutionary step, such as distributed systems and mobile computing. The field of distributed systems is the intersection of personal computers and local area networks. The research that followed from the mid-1970s through the early 1990s involved two or more computers being connected by a network, whether that was mobile or static, wired or wireless, sparse or pervasive. This body of knowledge contributed to the areas of pervasive computing.

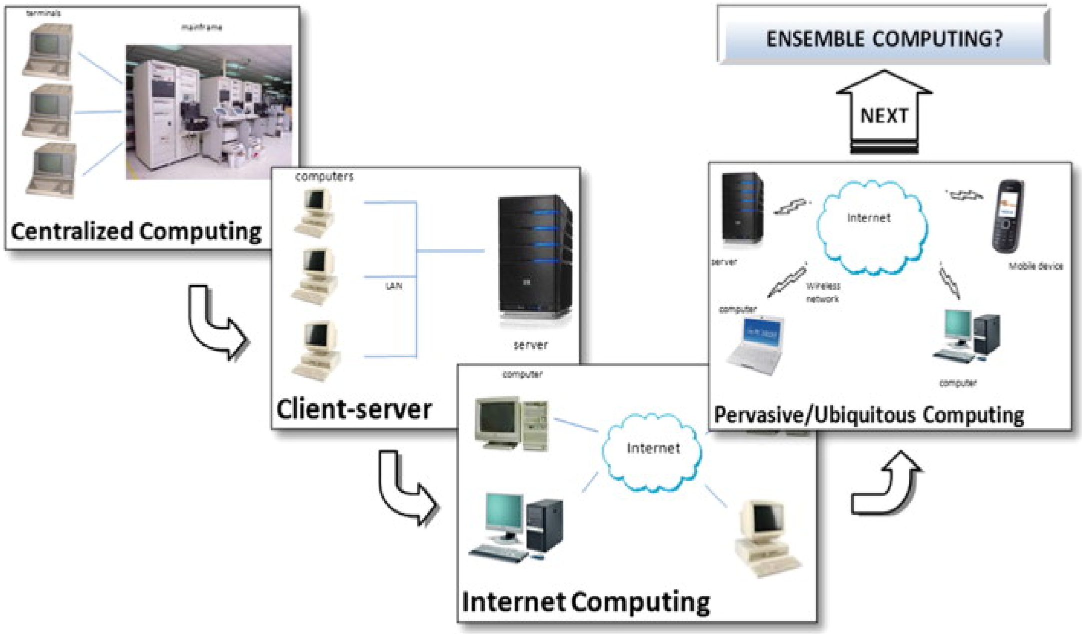


Figure 2.5: Key waves of computing paradigms

Source: Patel, Nordin and Al-Haiqi (2014)

In the early 1990s, researchers built a distributed system with mobile clients when laptop computers and wireless LANs were fully functioned. The constraints of mobility forced the development of specialised techniques such as network quality, limitations on weight and size constraints, concern for battery power consumption (Satyanarayanan, 2001) and many basic principles of distributed system design that continued to apply. The computing technology evolving from the two computers moved towards creating the World Wide Web by connecting a large number of computers together (Perera et al., 2015). Figure 2.6 shows the evolution of distributed computing, mobile computing to the current ubiquitous/pervasive computing.

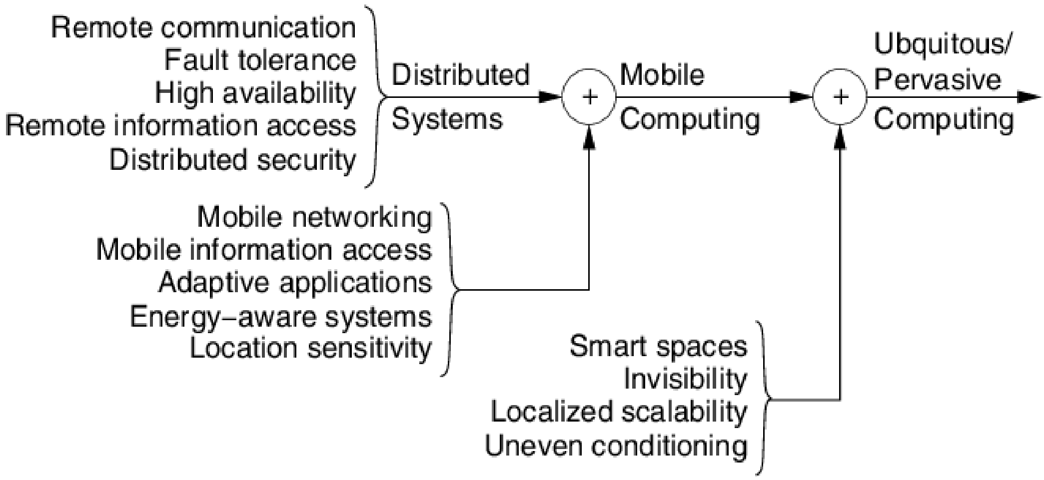


Figure 2.6: Evolution from distributed computing to ubiquitous/pervasive computing

Source : Satyanarayanan (2001); Van Bunningen, Feng and Apers (2005)

In addition, intelligent environments are core characteristics of pervasive computing (Saha and Mukherjee, 2003). Lyytinen and Yoo (2001) have foreseen that mobility will be the most distinctive characteristic of future computing environments, enabling nomadic information creation and sharing. Unlike traditional stationary computing technology that is tied to a physical location, the emerging wireless and handheld computing tools can be taken to and held in different places at ease, while still providing both access and adequate computational services. At the same time, they support all forms of mobility through characteristics such as their size (smaller), shape (more diverse, ergonomic, and stylistic) and functional diversity (from simple mobile phones to portable laptops offering complex virtual reality environments). Pervasive computing is perceived context (Saha and Mukherjee, 2003). The evolution of pervasive computing may support the growing research in mobile computing.

2.1.3 Pervasive applications

Orwat, Graefe, and Faulwasser (2008) stated pervasive computing is associated with the further spreading of mobile or embedded information and communication technologies (ICT) with some degree of intelligence network connectivity and advanced user interfaces. Since pervasive computing is unobtrusive analytically, diagnostically, supportively and has information functions, pervasive computing is predicted to expand in healthcare with automated patient remote monitoring and diagnosis. Moreover, pervasive computing may enhance independent patient self-care. The pervasive system included in Table 2.3.

Table 2.3: Pervasive system application and criteria

Source: Orwat, Graefe and Faulwasser (2008)

Pervasive system criteria	**Pervasive application**
Not attached to a dedicated location	For example, mobile devices (laptops, PDAs, tablet PCs, mobile phones)
Wearable items	Computer-enhanced textiles, accessories or medical devices
Stationary devices	For example, sensors or other ICT embedded in 'everyday objects' or infrastructure, such as buildings, furniture
Intelligence element	It is in the sense of context-awareness or decision support capabilities

Smartphones, e-readers, as well as GPS-enabled cameras and tablets, are already having a transformative effect on the development in the cyber and physical world (Conti *et al.*, 2012). The capabilities of sensing and interacting the physical to adapt to the cyber world of the applications and devices in a pervasive computing system are as shown in Figure 2.7.

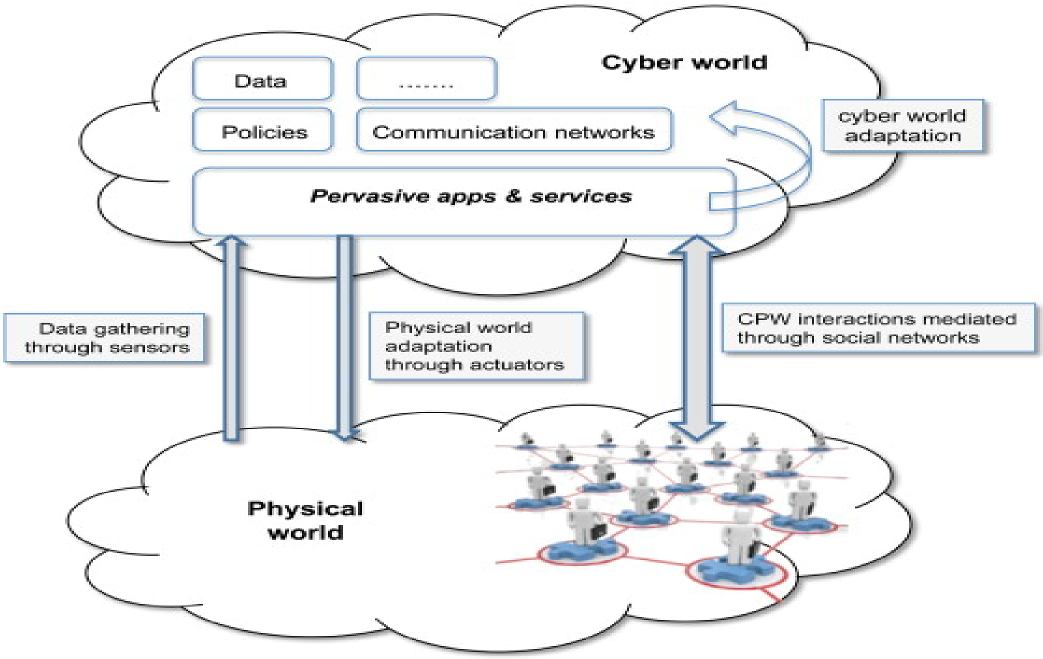


Figure 2.7: Physical and cyber world interactions of pervasive application and services

Source: Conti *et al.* (2012)

Users may access several pervasive devices with computing capabilities in the virtual world linking to the physical world with the users' devices and applications created as shown in Figure 2.8, by translating human relationships into the cyber world in sharing information. Pervasive computing typically may have a range of applications, for instance, in environmental monitoring, healthcare and intelligent transportation systems. Pervasive computing can potentially build an environment like other emerging and prominent technologies (Anumba and Wang, 2012).

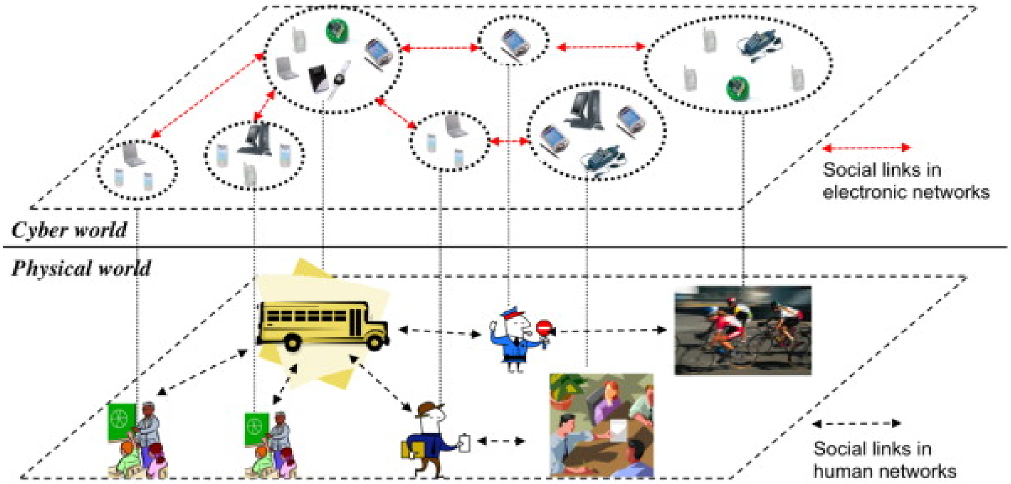


Figure 2.8: User and electronic network relationships

Source: Conti *et al.* (2012)

Elements of pervasive computing that are uncommon previously are now becoming a commercial product (Satyanarayanan, 2001). Pervasive computing is a perceived context in which users may access computing seamlessly and timely. Pervasive computing is the embedded technology that promises many possible solutions to many problems in various fields with the intelligence to sense and interpret, and supports interfaces like usage context and personality (Sriram et al., 2015).

2.1.4 Barriers to pervasive computing deployment

Moran and Nakata (2009) claimed that the 'pervasive-era' of computing would soon become a reality. The rapid advance of wireless and mobile computing technology has brought a lot of research interests in the area of mobile computing, for example, research focused on pervasive data access. Connecting to wireless connections, users can access information at any place, at anytime. However, various constraints such as limited client capability, limited bandwidth, weak connectivity, and client mobility impose many challenging technical issues (Lee, Lee and Madria, 2008). A major technical concern is dealing with the high complexity of development, integration, deployment, and management of pervasive computing systems. Non-technical challenges include: legal; ethical; social; cultural, political; educational; economics as well as organisational issues raised in the pervasive human-centric computing (Pour, 2006). Table 2.4 shows the issue in a pervasive environment.

Table 2.4: Factors concerning the pervasive computing

Source: Bhasker (2013)

Factors	**Issues**
Heterogeneity	This system is open to several vulnerabilities and reputed solutions are not applicable due to the distributed and ad-hoc nature of the pervasive computing environment.
Location Detection	The request for a trusted channel is flowing through the shared, unreliable wireless channel. The number of devices can be a huge amount and it is very hard to detect the physical device with which the user is interacting. There is a need for a secure communication channel, along with device authentication.
Access Control	The freedom of accessing system resources and services where the system is based on the user's role and identity depends on the time, situation and other contextual information. Trust in a pervasive computing environment is needed to ensure users' identity and access privileges are under control.

Anumba and Wang (2012) further stated that the privacy and security issues in pervasive computing are the same as for mobile computing. There is scope to access users' everyday interactions, movements, preferences and attitudes, without user intervention or consent to retrieve and use information from large databases of stored data, as well as to alter the environment via actuating devices. Bhasker (2013) highlighted the concerns about the flexible security policy.

2.1.5 Mobile Computing Innovation

Popular mobile computing technology began in the 1960s and 1970s with digital watches and calculators. Currently, the development of wireless and mobile networks has made mobile commerce (m-Commerce) a growing research interest, and the most widespread mobile computing device is the mobile phone. Rapid advances in mobile technologies have improved mobile banking or mobile commerce, where mobile banking can be considered a key platform for expanding access to banking transactions via mobile or handheld devices and operating wireless communication technologies. Mobile banking with new features (such as ubiquity, flexibility and mobility) are compared to conventional banking channels (Lin, 2011). Shaikh and Karjaluoto (2015) had reviewed the consumer adoption behaviour toward m-banking diffusion pattern with 55 studies that were published between 2010–2012.

Mobile entertainment is also one of mobile technology innovations. It comprises a range of activities including downloading ringtones, logos, music and movies, playing games, instant messaging, accessing location-based entertainment services, and Internet browsing. The youth absorb and incorporate the most changes in mobile communications development. The analysis of a Malaysian survey of 384 respondents between 18 to 25 years old shows greater importance on the perceived benefit of mobile entertainment compared to issues of pricing, product and technological standardisation, peers and community as well as privacy and security (Wong and Hiew, 2005).

Today, the mobile application is a newly emerging mobile technology that has been widely used. Gartner reported worldwide mobile application store revenue to be projected to $15.1 billion by the end of 2014, and forecasted over 185 billion applications to be downloaded from mobile app stores (Wang, Liao and Yang, 2013).

Mobile computing with the 3G of mobile telecommunication networks was being deployed in many global locations. Mobile telephones will no longer be used just for transmitting voice. With 3G, mobile technology will support data transfer across the whole communication marketplace. The utility of mobile communications is rapidly becoming a trend in high penetration of cellular and innovative ways in reaching users (Goi, 2008). For example, the study on factors affecting the mobile banking adoption in Saudi Arabia offering banking services through mobile phones showed the growing interest in mobile computing technology research (Al-Jabri and Sohail, 2012).

Mobile Computing Technology Applications

Information and Communication Technologies (ICT) offer numerous opportunities for the usage of the underlying technology. Initially, the mobile phone was conceived as a basic tool for communication. The mobile phone quickly evolved into a multipurpose platform that is now used for all sorts of services: gaming; texting; broadcasting; map services; music and video.

As mobile phones have evolved from single-purpose communication devices into dynamic tools that support users in a wide variety of tasks, the number of available applications for mobile phones is steadily increasing. Today, 370,000 or more apps are available for the Android platform and 425,000 for Apple’s iPhone with more than 10 billion apps downloaded from the iPhone platform (Böhmer *et al.*, 2011). With the introduction of smartphones and mobile applications, the telecom industry and mobile banking is a particularly attractive sector to be considered when studying service innovation because the adoption of the services in this field has been remarkably rapid and widespread and several important technological innovations in the field of mobile payments. Furthermore, mobile banking has provided unique access to financial services, especially in the developing world (Boor, Oliveira and

Veloso, 2014). It shows that mobile applications usage has been widely adopted.

2.2 Wearable Computing

Wearable computing is defined as "*apparel with unobtrusively built-in electronic functions*, *intelligent assistance that augments memory, intellect, creativity, communication and physical senses"* (Virkki and Aggarwal, 2014). Wearable computing is designed primarily to be worn or attached to the body, or used as body extensions. Also, wearable computing is expected to be *'worn for an extended period, with the user experience significantly enhanced as a result',* which can be considered as computers mounted on the body to perform specific tasks (Kuru and Erbuğ, 2013). Wearable computing technology in this research study is an innovative concept that utilises mobile technologies such as a smartphone for accessing mobile services and mobile commerce (Yang, 2005) and the Internet of Things (Wei, 2014). The differences between traditional desktop systems and pervasive or ubiquitous computing models, wearable computing is seamlessly integrated into daily life, improving all daily activities (Gribel, Regier and Stengel, 2016).

The emergence of wearable computing will become a challenge in information technology research. The perceived value of this technological innovation may not be fully understood until it is accepted and adopted by potential users which is the main focus of this research. Wearable computing enhances personal computing with continuously worn, smart assistants that may augment memory and physical abilities (Starner, 2001). Table 2.5 shows various definitions from research about wearable computing.

Table 2.5: Wearable computing definitions

Definition	Research firm
"Products that [are] worn on the user's body for an extended period significantly enhancing the user's experience from the product worn. Furthermore, the product must contain advanced circuitry, wireless connectivity, and at least a minimal level of independent processing capability".	IHS
"Wearable is defined as miniature electronic devices that are worn somewhere on a user's body and enable users to integrate computing experiences more tightly into everyday life."	Forbes
"Wearable computers and their interfaces are designed to be worn on the body to enable mobility, such as a wrist-mounted screen or a head-mounted display, as well as a hands-free or eyes-free activities. Traditional uses are for mobile industrial inspection, maintenance and the military; including display peripherals, computer-ready clothing, and smart fabrics".	Gartner

Wearable computing for this study refers to electronic technologies embedded or worn on the human body (Anumba and Wang, 2012) as unobtrusive apparel, such as a smartwatch that continuously provides an interface to many computing tasks with the mobile smartphone acting as a hub (Wei, 2014). There are some other applications of wearable computing for instance, for healthcare monitoring, fitness and wellness, infotainment as well as for military and industrial purposes.

Wearable computing should be sufficiently small and lightweight which can be considered as a part of the human body, so that they are less of a burden on the wearer. Although the early innovations of this technology are bulky and heavy, developers are continuously redesigning wearable computing to assemble the form of usual clothing and accessories used by people, making them as unobtrusive as possible.

Figure 2.9 shows the evolution of Steve Mann's WearComp wearable computer from backpack based systems in the early 1980s to his current systems.

Figure 2.9: Evolution of Steve Mann's WearComp wearable computer from backpack based systems to current covert systems

Source: Buenaflor and Kim (2013)

Wearable computing will become the market mainstream. However, given that the first wearable computers were made in the 1960s, it took a significant time to reach this stage in wearable computing (Starner, 2002).

2.2.1 Wearable computing characteristics

Wearable computing is an electronic device that can be worn or attached to the body, allowing the user to access information anytime and anywhere. In this research context, wearable computing refers to electronic technologies embedded or worn on the human body that continuously provides an interface to many computing tasks with the mobile smartphones acting as a hub, as shown in Figure 2.10. The devices transmit data to wireless sensor network nodes equipped with communication interfaces which do not need complex cable connections. Wearable devices have a central processing unit (CPU). The first ten years of wearable technology were concerned with research about the engineering of wearable sensors and systems. However, future wearables are focused on wearable technology applications that are directed to an improvement in the quality of life and the value of life (Lee *et al.*, 2016).

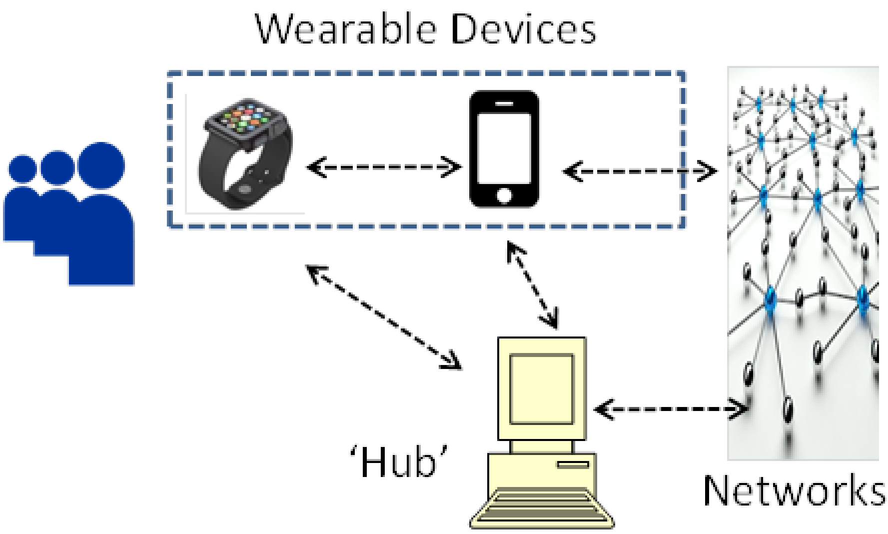


Figure 2.10: Interaction between wearable devices for wearable computing

Source: redrawn from (De Coster and Taib, 2017)

Wearable computing is defined by Mann (1998) as a new form of interaction between human and computer through three operational modes: constancy where the computer runs continuously to interact with the user; augmentation where the computer senses the user while the user is doing something else; and mediation where a computer may serve as an intermediary when the user is interacting with untrusted systems. Wearable computing creates a new human-machine synergy enabled by six attributes: unrestrictive to the users; not monopolising of the user's attention; observable and controllable by the user at any time; attentive to the environmental awareness and communicative to others (Deng and Christodoulidou, 2015).

The user's environment is made to be aware of when a computer is worn. Context-sensitive applications could be developed to accomplish the response between humans, computers, and the environment. An early example of this technology was the Touring Machine, developed by Steve Feiner of Columbia University. A GPS (global positioning system) receiver and a head-orientation sensor was used to track the wearer as he walked around and to look at various buildings on campus (Billinghurst and Starner, 1999).

Figure 2.11: Wearable barcode scanner

Source: Billinghurst and Starner (1999)

Figure 2.11 displays the early invented wearable computing - namely a ring-mounted barcode scanner. It has a range of 26 inches and a wireless LAN. The prototypes were delivered to UPS for user testing. Each unit was used for 40,000 plus hours to scan 400 to 500 parcels an hour. The work conditions proved far more rugged than anticipated (Billinghurst and Starner, 1999).

2.2.2 Wearable computing applications

There are many applications that have emerged for wearable computing. For example, recent smartwatches deploy modern mobile infrastructures where Bluetooth links to a user's mobile phone with mobile apps broadly connect to cloud services. A lot of wearable computing devices are emerging in the market including Apple iWatch, iRing; Sony Smart Band; Google Glass; Bluetooth Ring and smart contact lenses for medical purposes (Jhajharia, Pal and Verma, 2014). Another application as shown in Figure 2.12, is the Mercedes-Benz pebble smartwatch. The idea is that drivers may use the styled smartwatch to check on their vehicle's location, door lock status and even fuel level. The watch can alert its wearer of incoming calls, texts and emails, and is able to warn the driver of real-time hazards when behind the wheel (Jhajharia, Pal and Verma, 2014)

Figure 2.12: Mercedes-Benz pebble smartwatch

(http://www.digitalspy.co.uk/) cited in (Jhajharia, Pal and Verma, 2014)

Table 2.6 shows various wearable computing applications used in the following practices: healthcare and medical, fitness and wellness, infotainment, and the military.

Table 2.6: Wearable computing applications

Source : Jhajharia, Pal and Verma (2014)

Application	Product categories	
Healthcare And Medical	Blood pressure Monitors ContinuousGlucose Monitoring Defibrillators Drug Delivery Product ECG Monitoring Hearing Aids	Insulin pumps Smart Glasses Patches PERS Pulse Oximetry
Fitness and Wellness	Activity Monitors Emotional Measurement Fitness &Heart rate Monitors Food Pods & Pedometers Heads-up Displays	Sleep Sensors Smart Glasses Smart Clothing Smart Watches Other, Audio Ear buds
Infotainment	Bluetooth Headsets Head–up Displays Imaging Products Smart Glasses Smart Watches	
Military	Hand-Worn Terminals Head-up Display Smart Clothing	
Industrial	Hand-Worn Terminals Head-up Display Smart Clothing Smart Glasses	

Figure 2.13 shows the several systems that can be involved in the smartwatch data collection scenario: wearables, smartphones, computers and servers/cloud services.

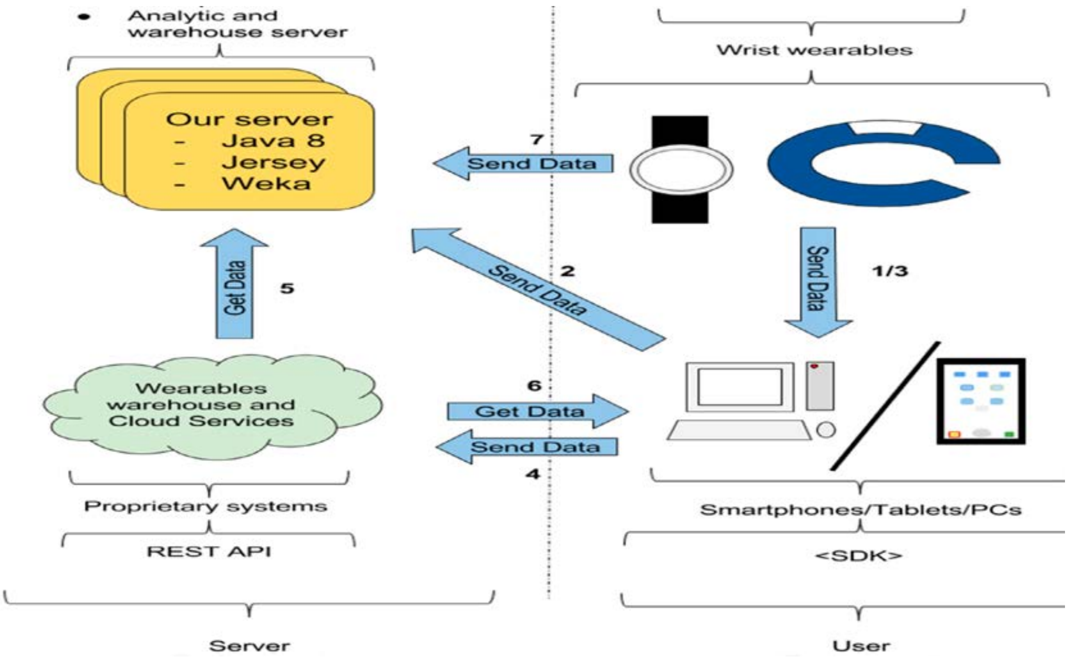


Figure 2.13: Systems involved in the smartwatch data collection scenario

Source : de Arriba-Pérez, Caeiro-Rodríguez and Santos-Gago (2016)

Two types of systems are proprietary and third-party. Proprietary systems can be found as wearable device apps for smartphones, computers and cloud services. These systems are provided by wearable vendors to collect users' data to perform analytics and to provide analytic results to users and authorised third parties. Programs for computers can be developed and maintained by external entities to provide specific functionalities. Each one of these components is intended for external entities to provide specific functionalities (de Arriba-Pérez, Caeiro-Rodríguez and Santos-Gago, 2016).

The general architecture of wearable computing is shown in Figure 2.14 which consists of power supply, display, application processor/embedded controller, sensing and wireless connection. Many smartwatches depend on a mobile phone for operation, for example the Apple Watch, Android Wear watches and Pebble watches (Lyons, 2016). Figure 2.15 shows a typical smartwatch system. LEDs, buzzers, and vibrating motors help to implement alerts and feedback from the device to the user, it is connected to a mobile phone and needs to alert the user when a message arrives. It is important to understand users' perception of the smartwatch in order to spread adoption; the smartwatch is a continuous innovative product of the smartphone (Jeong, Byun and Jeong, 2016)

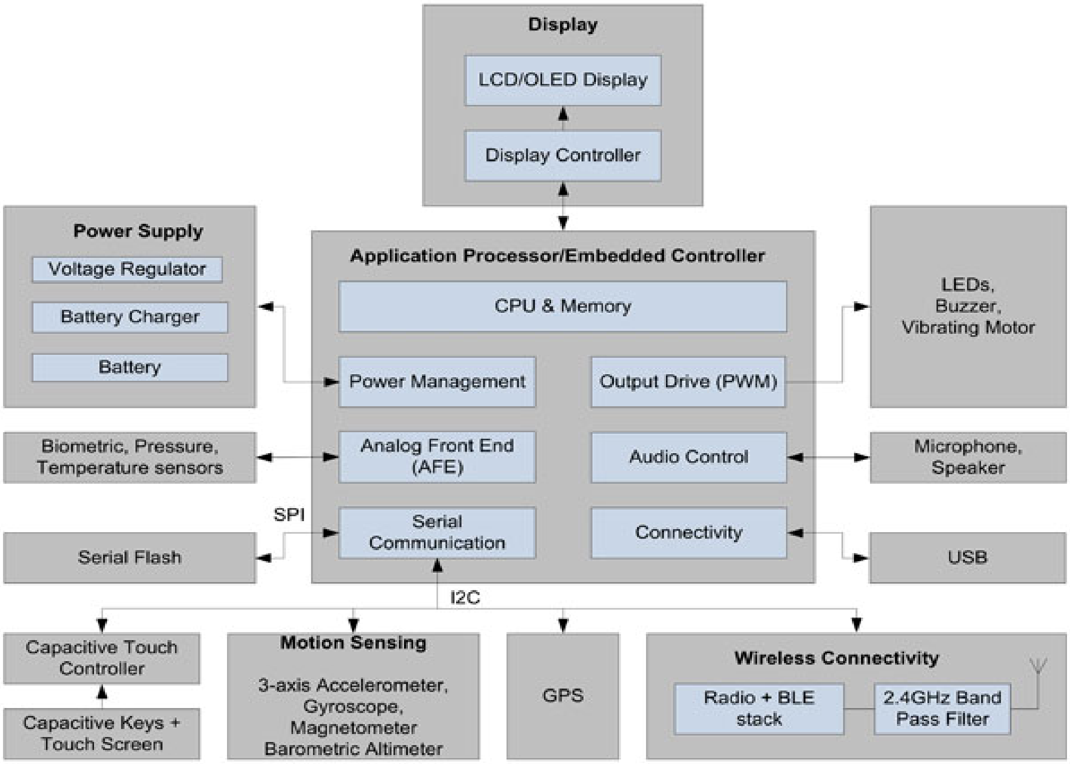


Figure 2.14: General architecture of wearable computing

Source: Ramasamy, Gowda and Noopuran (2014)

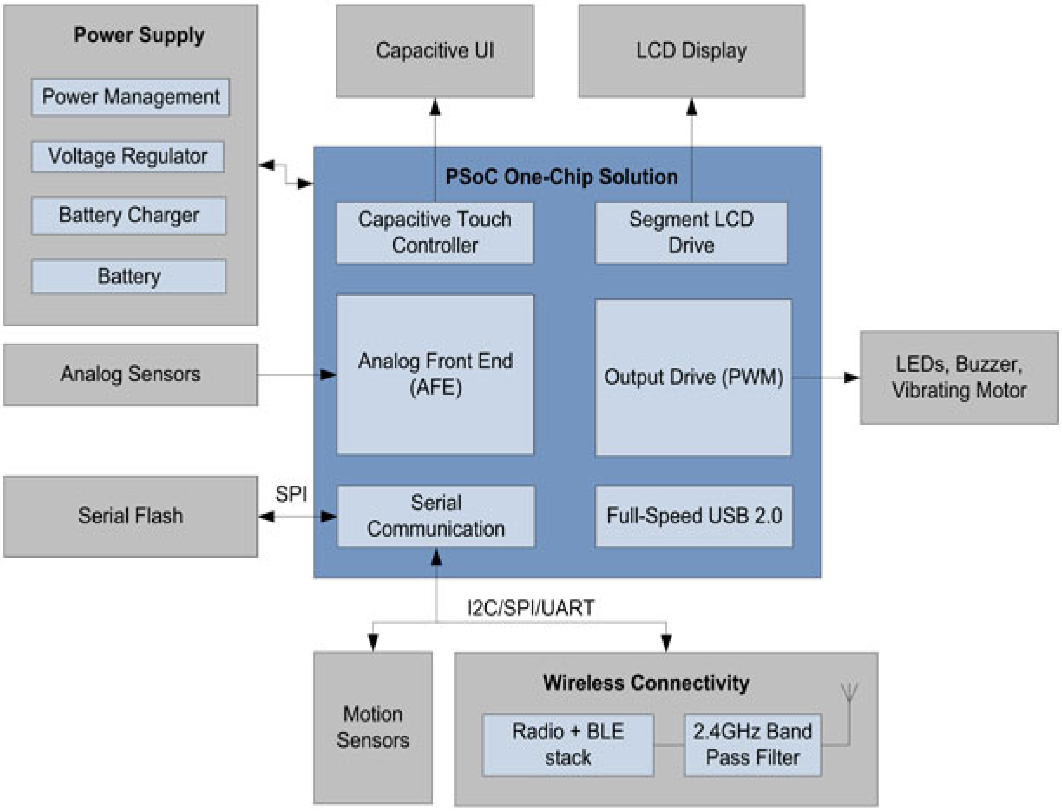


Figure 2.15: Typical smartwatch system

Source: Ramasamy, Gowda and Noopuran (2014)

Figure 2.16: Unobtrusive wearable devices for various physiological measurement developed by different groups

Source: Zheng *et al.*, 2014

Figure 2.16 shows the wearable computing application in various physiological measurement, type of wearable devices such as watch-type BP device, PPG sensors mounted on eyeglasses, motion assessment with sensors mounted on shoes, wireless ECG necklace for ambulatory cardiac monitoring (courtesy of IMEC, Netherlands), h-Shirt for BP and cardiac measurements, ear-worn activity recognition sensor, glove-type pulse oximeter, strain sensors mounted on stocking for motion monitoring, and ring-type device for pulse rate and

SpO2 measurement. Many of them already have a variety of applications in healthcare, as well as wellness and fitness training (Zheng *et al.*, 2014).

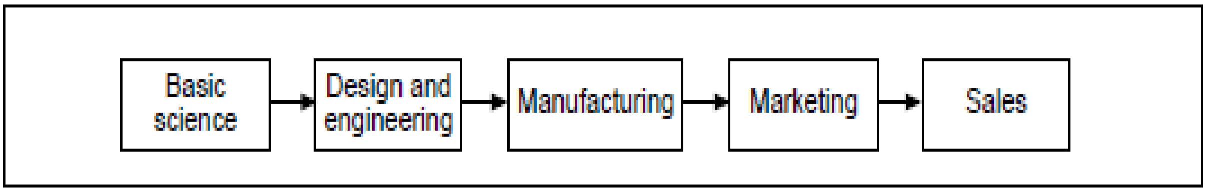
Since wearable computing may become mainstream in daily human lives, the understanding of technological innovation acceptance for the potential user of this advanced wearable computing paradigm shall be considered. For instance, some smartwatches might be independent, but most of the applications are still linked to the mobile smartphone for communication. A proof-concept study to investigate a smartwatch's ability in the future for health monitoring systems and applications validates the smartwatches' ability to track human posture, thus enabling future development in more complex environments (Mortazavi *et al.*, 2015). A study was conducted to understand the potential users' perceptions of smartwatches with five smartwatch attributes: brand, price, standalone communication, display shape, and display size. It exhibited that display shape and standalone communication become a critical factor influencing respondents' smartwatch choices compared to brand and price for users (Jung, Kim and Choi, 2016).

2.3 Technology Acceptance and Innovation

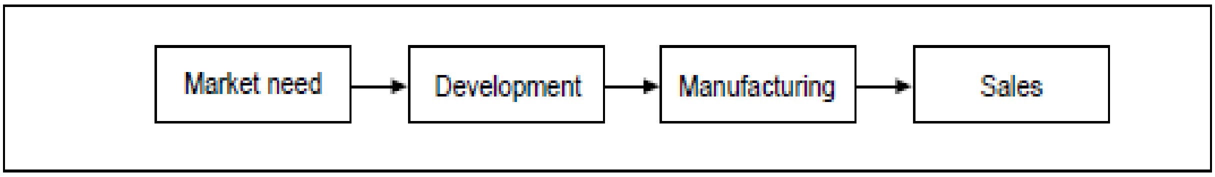
Innovation is defined by Rogers (2003) as an idea, practice or object that is perceived as newness by an individual or another unit of adoption. Newness in innovation could be expressed as knowledge, persuasion or decision to adopt. Researchers have put on efforts to increase the understanding of the innovation adoption process over the past two decades. As wearable computing is considered as technological innovation, theories based on technological innovation have been applied empirically in examining the factors influencing users' acceptance of wearable computing. Examining the processes of users' acceptance is vital to successful acceptance and adoption.

Rothwell (1994) in his article has shown the developments towards the fifth-generation (5G) innovation process in Figure 2.17 and Figure 2.18. The first generation is a technology push concept which more research and development (R&D) produced "*more successful new products out*." With the emergence of the second generation of “market-pull” (sometimes referred to as the “need-pull”) model, the market was the key idea for directing R&D and the marketplace (Rothwell, 1994). Most western companies, up to the mid-1980s, agreed that the third-generation innovation model was recognised as the best practice. The fourth generation is the integrated innovation process as practised in Nissan. The process 5G is essentially a development of the 4G process in which the technology itself changes. In summary, the key aspects of the process are integration, flexibility, networking and parallel information processing (Rothwell, 1994).

Technology Push (First Generation)



Market Pull (Second Generation)



The “Coupling” Model of Innovation (Third Generation)

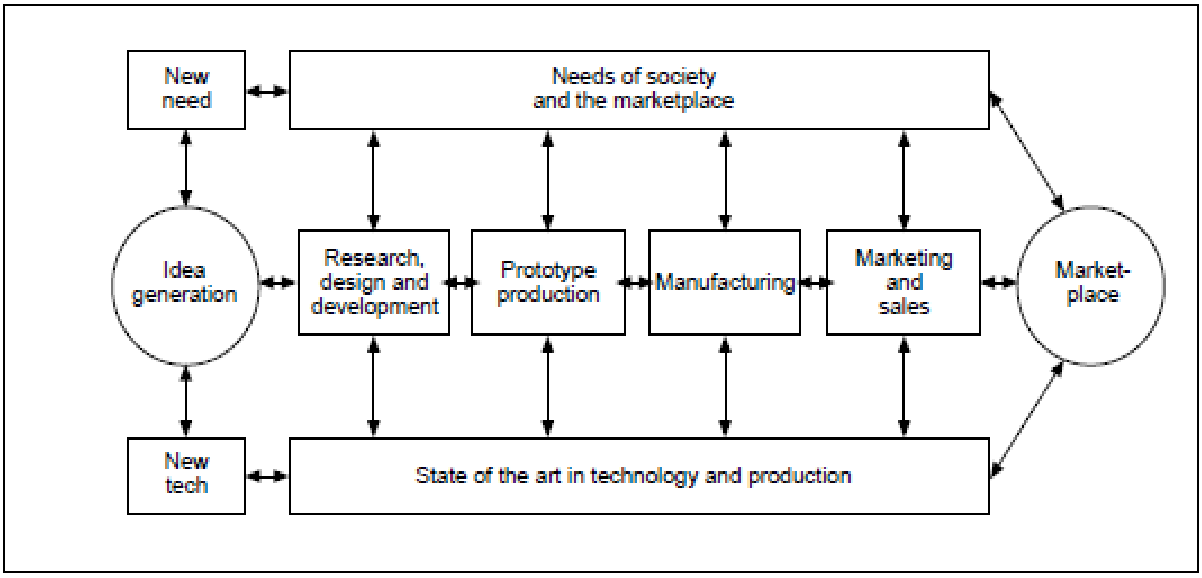


Figure 2.17: The developments towards the Fifth-generation (5G) innovation process

Source: Rothwell (1994)

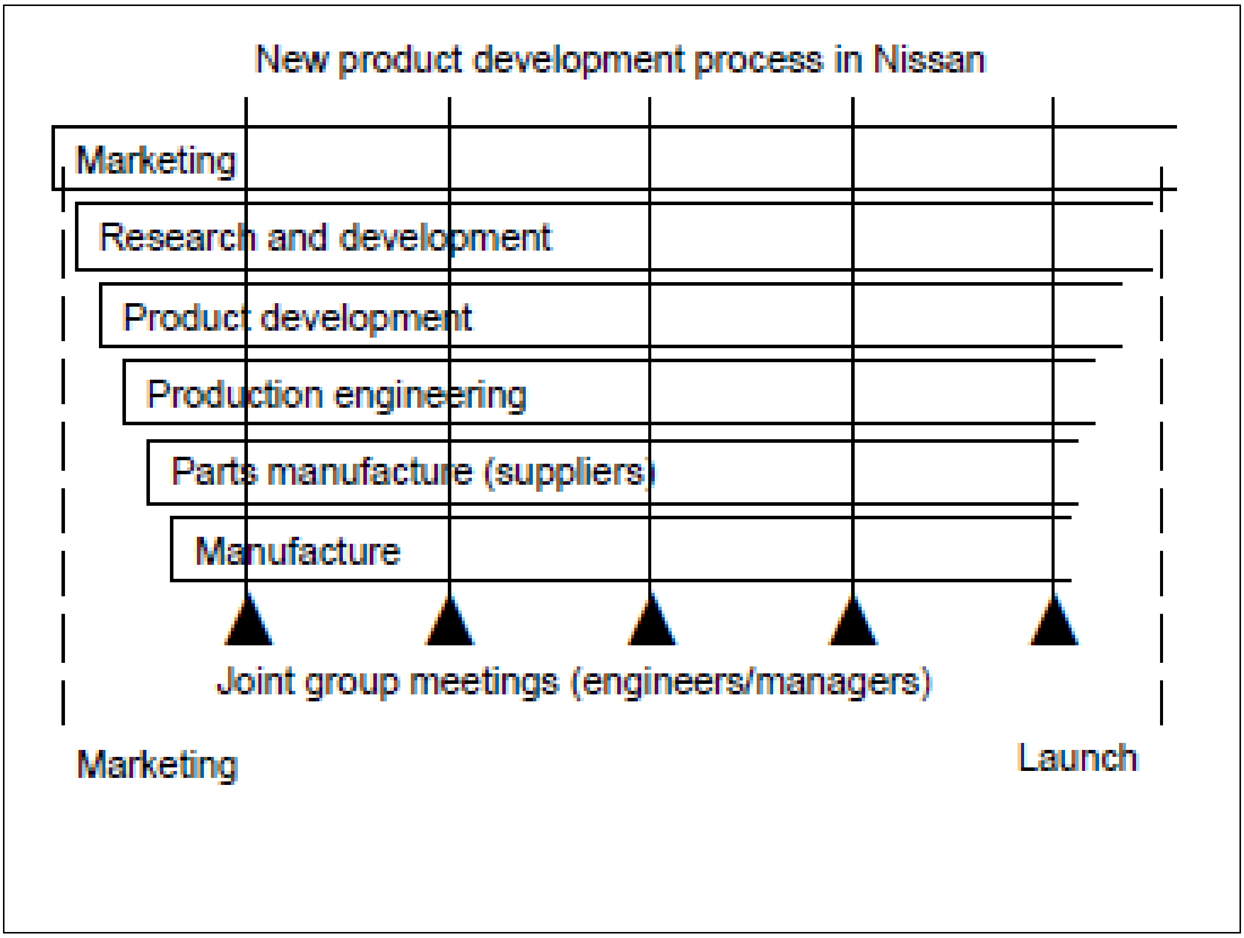


Figure 2.18: Example of the Integrated (Fourth Generation) Innovation Process

Source: Rothwell (1994)

Moreover, 5G represents a more comprehensive process of the *"electronification"* of innovation across the whole innovation system. Electronic development tools (a more parallel development process) are becoming a feature of product development increasingly, not only in manufacturing (hardware) but also in software (Rothwell, 1994).

From the extant literature, amongst all the innovation adoption theories: Diffusion of Innovation (DOI) theory, Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) have been widely used in IT innovation adoption studies. DOI was more extensively used in the studies that performed organisational analysis and TAM, TRA, TPB were utilised mainly for individual level analysis (Hameed, Counsell and Swift, 2012).

The relevant theories, models and factors for the users' acceptance have been reviewed in contributing to the innovation adoption. Based on the extant literature search, this study reviewed the innovation acceptance theories, a model which has been well established in understanding innovation acceptance of information technology (IT) by many researchers. Theories include : Theory of Reasoned Action (TRA) from Ajzen and Fishbein (1980) and Diffusion of Innovation (DOI) theory (Rogers, 2003). Furthermore, technology acceptance theories like Technology Acceptance Model (TAM) by (Davis, 1989), Theory of Planned Behaviour (TPB) by Ajzen (1991) and Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh *et al.* (2003) have been proposed.

2.2.1 Diffusion of Innovations Theory

Rogers (2003) defined diffusion as a process of innovation communicated through certain channels over a period of time among the members of a social system. Rogers used the adoption in the context of the decision to accept and use innovation. Diffusion of Innovation (DOI) was initially formulated to consider the analysis of individual level adoption behaviour, but recent work has been applied to studies assessing organisational level adoption. Rogers defined some attributes of innovation that were perceived as supporting the diffusion of technological innovation and proposed five attributes of innovation which play a key role in an individual's attitudes towards innovation adoption.

Several studies in innovation diffusion research based on the Diffusion of Innovation Theory (DOI) by Rogers' model have been applied to implement new emerging technologies particularly in ubiquitous environments (Sydiinheimo *et al.*, 1999; Zeal and Smith, 2010; Kim, 2012) as many devices are introduced to the market to access information. For this reason, it is needed to study the intentions of use based on the Diffusion of Innovation Theory.

Previous innovation diffusion studies have suggested that innovation attributes affect an individual's attitude of the innovation prior to adoption and may consequently influence the speed of adoptions. These DOI factors include relative advantage, compatibility, complexity, trialability and observability (Rogers, 1995). Yongwon, Sungjoon, Hyunsik and Bong Gyou (2010) urged that DOI factors can be applied for smartphone adoption in healthcare services while a study from Al-Gahtani (2003) revealed that complexity has a significant negative relationship with computer adoption.

Technological innovation may be adopted and diffused with these five attributes of relative advantage, compatibility, complexity, trialability and observability of the innovation. The literature revealed that DOI has a solid theoretical foundation that remains a popular model for investigating the adoption of innovation in organisations; however, it has received substantial criticism in its application at an organisational level. The five attributes in DOI are viewed to determine the rate of innovation adoption; these attributes are shown in Table 2.7. These are the five attributes of innovation that may lead to the adoption rate as perceived by the user. The rate of adoption is the speed at how innovation is adopted by the social system. Moreover, the type of decision process may also impact the rate of adoption (Rogers, 2003).

Table 2.7: The five attributes in DOI

Source: Rogers (2003)

Attribute	**Description**
Relative advantage	The degree of innovation is perceived as being better than the practice it supersedes.
Compatibility	The degree of innovation is perceived consistent with the existing values, past experiences and need of potential adopters.
Complexity	Innovation is perceived as relative difficulty in using and understanding the new technology innovation.
Trialability	The degree an innovation may be experimented with on a limited basis before making an adoption or rejection.
Observability	The degree of making visible results of innovation to others.

Additionally, the five adopter categories in DOI is divided into Innovators, Early Adopters, Early Majority, Later Majority and Laggards as shown in Figure 2.19. According to Rogers (2003), Innovators (Venturesome) are very eager to try new ideas. The Innovator shall be able to cope with the high degree of uncertainty about innovation at the time that the Innovator adopts. The Innovator should also be willing to accept when one of the new ideas he or she adopts proves unsuccessful. Early Adopters are part of the local social systems; additionally, the Innovators are cosmopolites while the Early Adopters are localities. This adopter category has opinion leadership in most social systems. Potential adopters may look at the Early Adopters for advice and information about the innovation. The Early Adopter is known as "the individual to check with" before using a new idea or decision. Early Majority (Deliberate) adopt new ideas just before the average member of a social system. The Early Majority frequently interact with their peers but seldom hold leadership positions. Their innovation-decision period is relatively longer compared to the Innovator and the Early Adopter. The Late Majority may adopt new ideas when the average member of a social system has been involved. Adoption may be both an economic necessity and the answer to increase network pressures. Laggards (Traditional) are the last in a social system to adopt an innovation. They possess almost no opinion leadership and isolates in social networks. The person may interact with those who also have relatively traditional values.

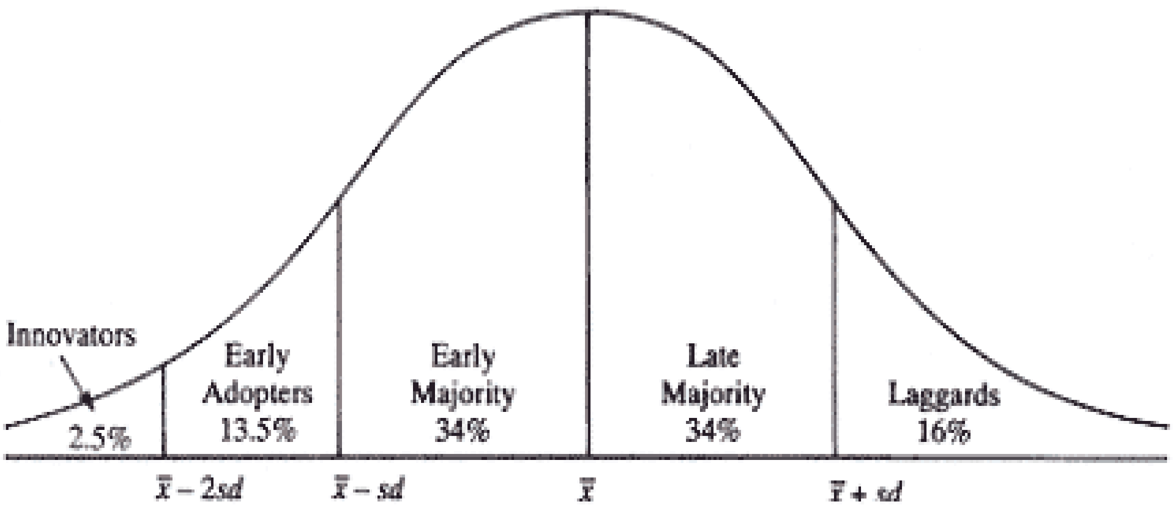


Figure 2.19: Adopter categorisation by Innovativeness

Source: Rogers (2003)

The innovation-decision process is the process in which an individual passes the knowledge of an innovation to form an attitude towards the innovation, deciding whether to adopt or to reject. For the implementing stage, the new idea is to confirm this decision. Table 2.8 illustrates the stages, and the definition involves innovation decision process: knowledge, persuasion, decision, implementation and confirmation. The decision process is based on the characteristics of the decision-making unit with socio-economics characteristics, personality variables and communication behaviour.

Table 2.8: Innovation-decision proses definition

Source: Rogers (2003)

Stage	Definition
Knowledge	The individual is exposed to innovation and understands the functions.
Persuasion	The individual has a form of interest in seeking innovation.
Decision	The individual engages and decides whether to adopt or reject the innovation.
Implementation	The individual adopts the innovation.
Confirmation	The individual seeks the reinforcement of the decision made; however, the previous decision made may be reversed if exposed to a conflicting message on the innovation idea.

The process consists of a series of choices and actions over time through which an individual or system evaluates a new idea and decides whether or not to incorporate the innovation into continuing practice as shown in Figure 2.20.

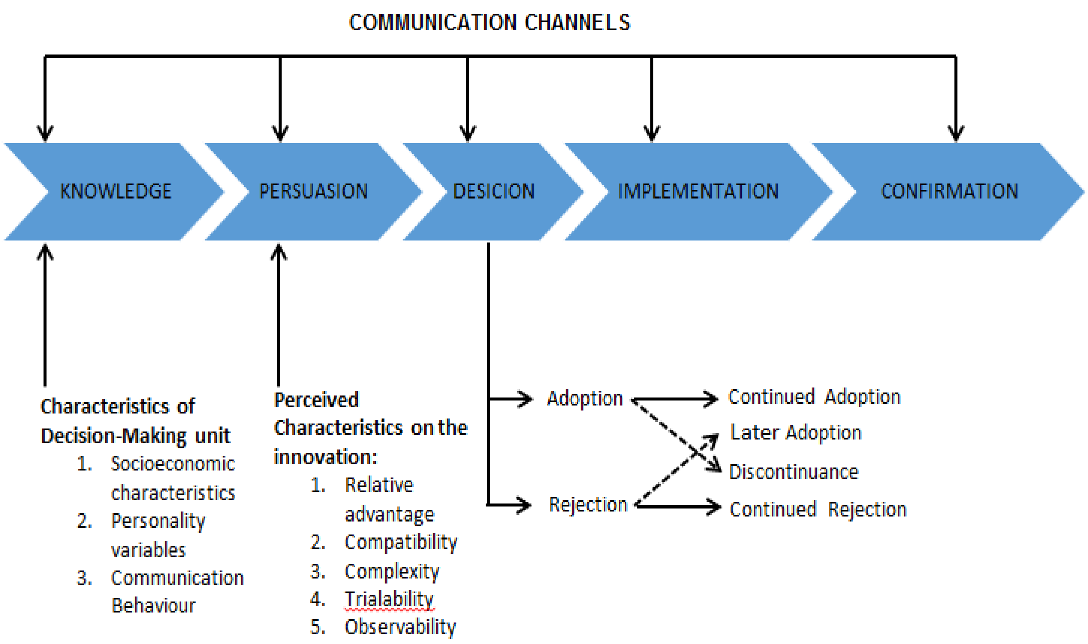


Figure 2.20: The Innovation-decision Process Model

Redrawn from Rogers (2003)

2.2.2 Technology Acceptance Model (TAM)

Theory of Reasoned Action (TRA) developed by Ajzen and Fishbein (1980) is one of the first theories to explain users' acceptance behaviour. TRA is a social psychology model based on behavioural beliefs and subjective norms in predicting behavioural intention and actual behaviour as shown in Figure 2.21. TRA postulates that user's behaviour may influence the actual use of a specific technology usage intention depending on the user's attitude and subjective norms of using the technology (Ajzen and Fishbein, 1980; Röcker, 2010; Hameed, Counsell and Swift, 2012).

TRA has been applied in a variety of research settings from predicting the intention in psychological services and the Information system (IS) field. The model can predict behavioural intention to use a certain technology agreed by many researchers (Nor and Pearson, 2008). Theory of Reasoned Action (TRA) theorises that Behavioural Intention (BI) is an individual's evaluation of a particular behaviour. Behavioural Intention (BI) is an individual's readiness to act and is an antecedent to actual behaviour (Mital *et al.*, 2017). Subjective norm refers to *"the person's perception that certain people who are important to him might think he either should or should not perform the behaviour*" (Ajzen and Fishbein, 1980; Zeal and Smith, 2010).

Technology Acceptance Model (TAM) was introduced by Davis (1989), which is the extension of the Theory of Reasoned Action (TRA) in the specific context of organisational Information Technology acceptance and adoption. TAM hypothesises the outcome is dependent upon the individual's perception of perceived usefulness (PU) and perceived ease of use (PEU). Perceived usefulness (PU) is known as "*the extent to which an individual perceives a positive impact of using a particular system would improve the user job performance."* Perceived ease of use (PEU) is "*the degree to which an individual perceives that using a particular system would be effortless"* (Davis, 1989).

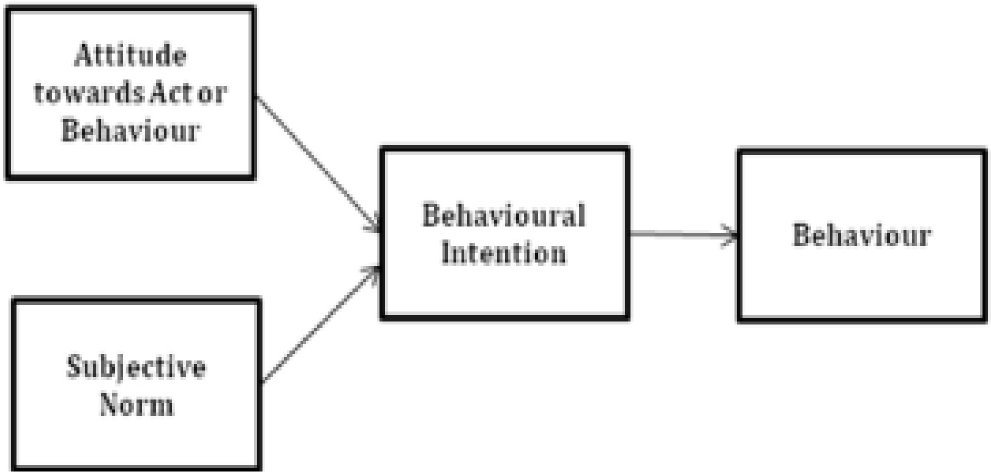


Figure 2.21: Theory of Reasoned Action (TRA)

Source: Ajzen and Fishbein (1980)

Various models have been developed to investigate the determinants of Information Technology (IT) acceptance and adoption in a different country. The past study had integrated components from several models and theories which are TAM and DOI, to explain the drivers of smartphone acceptance among healthcare professionals in the United States (US) and Taiwan (Chen, Park and Putzer, 2010).

TAM's reliability and measurement validity have been demonstrated in various research models by different criteria such as user types, technology types and organisational types. TAM has been applied to explain IT acceptance. Previous studies suggest that TAM is capable of providing an adequate explanation and prediction of user acceptance of IT (Chen, Park and Putzer, 2010). Unlike TRA, TAM does not include a subjective norm component as a determinant of intentions. The attitude constructs found in TRA have been excluded in the TAM. TAM has explained the adoption of many technological innovations. Usage in psychological and behavioural contexts has been studied in the context of Theory of Reasoned Action (TRA) (Mital *et al.*, 2017).

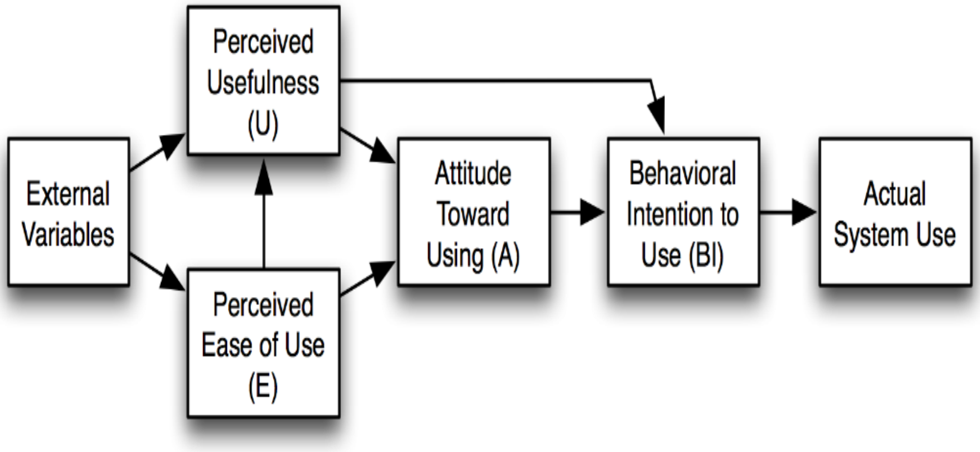


Figure 2.22: TAM Model

Source: Davis (1989)

Figure 2.22 shows the TAM model which is believed to be more accurate and parsimonious when it is used to predict technology adoption. However, the parsimony of TAM often results in the model being less informative in understanding user behaviour. Due to this limitation, researchers have attempted to extend the TAM framework by encompassing various constructs such as gender, culture, trust, experience, social influence, and self-efficacy (Chen, Park and Putzer, 2010). In Table 2.9, it demonstrates the use of different integration of innovation adoption theories and frameworks for the individual level adoption studies reviewed by Hameed, Counsell and Swift (2012).

Table 2.9: Integration of innovation adoption models in the reviewed studies (individual level)

Source: Hameed, Counsell and Swift (2012)

Theories/models	**No. of studies**
TAM + TRA	12
TAM + TPB	8
TAM + DOI	3
TAM + TRA + TPB	4
TAM + TRA + DOI	1
TAM + TRA + TPB + DOI	–

Researchers have been developing several theories and theoretical models to explain the adopter's attitude, innovation adoption behaviour and various determinants in different contexts of IT adoption (Hameed, Counsell and Swift, 2012). The technology acceptance model (TAM) was developed to improve user acceptance processes by providing new theoretical insights into the successful design and implementation of information systems. TAM could provide the theoretical basis for a practical methodology in user acceptance testing that enables system designers to evaluate and propose new systems before their implementation (Davis, 1985). PU shows a stronger relationship with user acceptance of technology than PEOU. TAM steadily explains the variance (typically about 40%) in usage intentions and behaviour (Venkatesh and Davis, 2000).

Venkatesh and Davis (2000) have developed another extension model of TAM which is known as TAM2 as shown in Figure 2.23. TAM2 comprises social influence which is also known as the subjective norm, voluntariness and image, and the cognitive instrumental which are: job relevance, output quality, result demonstrability, and perceived ease of use as determinants of perceived usefulness and usage intentions. TAM2 explained between 37% and 52% of the variance in usage intentions.

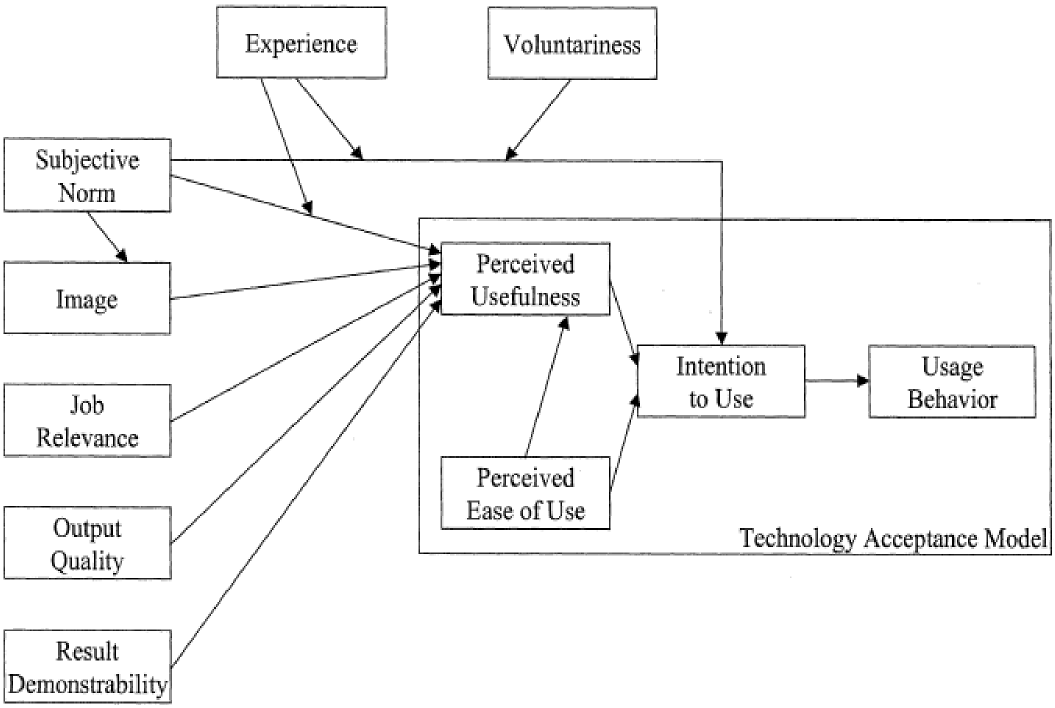


Figure 2.23: Proposed TAM2 with the Extension of the Technology Acceptance Model

Source: Venkatesh and Davis (2000)

TAM2 was tested with the data collected from four different systems at four organisations with a sample of 156 respondents employing an approach where two of these organisations where longitudinally studied and usage of the systems were voluntary, and the remaining two systems were to be used mandatorily. The extended model was strongly supported for all four organisations with 40%–60% of the variance explained in usefulness perceptions, and 34%–52% of the variance explained in usage intentions. The extended TAM2 with social influence, cognitive instrumental and perceived ease of use significantly influenced user acceptance. These findings contribute to the foundation for future research in understanding user adoption behaviour;

however, the sample sizes were less than 50, which may reduce the power of significance tests (Venkatesh and Davis, 2000)

Kim and Shin (2015) have developed a user experience model as shown in Figure 2.24 to identify the psychological determinants for the acceptance of smartwatches in South Korea with the extended TAM. The study found the contribution of the integration of the affective and rational components with the usability of TAM factors; the result was likely to have greater explanatory power and positively influence a user's intentions to use the smartwatch (Kim and Shin, 2015).

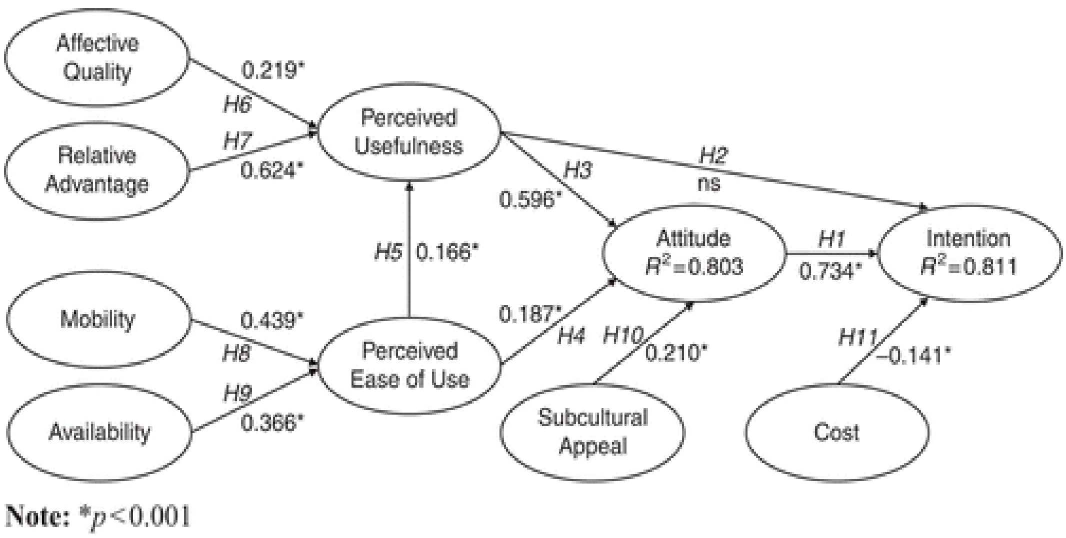


Figure 2.24: User Experience Model with extended TAM

Source: Kim and Shin (2015)

2.3.3 Theory of Planned Behaviour

Various contexts of innovation acceptance research have used TAM and are empirically supported (Kuo, Liu and Ma, 2013). The development of the adoption of large data studies produced initial evidence that earlier technology acceptance and diffusion research, and the integration of TAM and DOI can provide underpinning research on employees' adoption of large data-related activities (Soon, Lee and Boursier, 2016). Due to rapid growth in mobile data services, a study had been conducted to empirically assess the factors that drive consumers' acceptance of mobile data services. The research model was based on the decomposed theory of planned behaviour and incorporated factors that represent personal needs and motivations in using mobile data services (Hong *et al.*, 2008).

Another theory of innovation acceptance that is widely used in technology acceptance research is the Theory of Planned Behaviour (TPB). The Theory of Planned Behaviour (TPB) as shown in Figure 2.25 is also derived from TRA. Ajzen (1991) extended TRA by adding a new component 'Perceived Behavioural Control' (PBC) in TPB, as a variable that affects the intention towards the behaviour.

PBC affects behaviour directly or indirectly through behavioural intention. TPB added belief (perceived behavioural control) to explain behavioural intention. The independent determinants of intention in TPB includes attitude toward the behaviour, subjective norm and perceived behavioural control. Perceived behavioural control reflects the individual's beliefs of his or her ability to perform the behaviour, which is affected by external resources and internal perceptions (Ajzen, 1991). The theory has been used in a wide variety of settings, including IT acceptance research (Nor and Pearson, 2008). The theory of planned behaviour was made necessary by the original model's limitations in dealing with behaviours over which people have incomplete control.

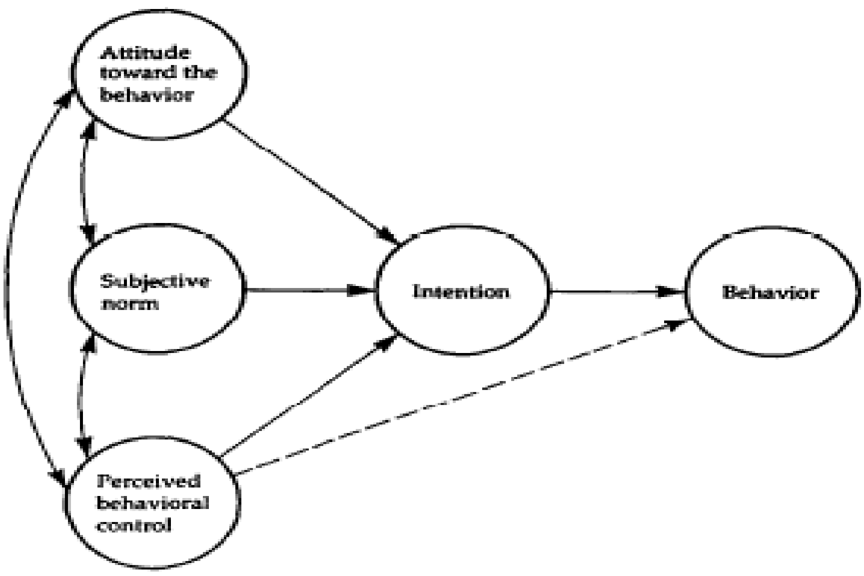


Figure 2.25: Theory of Planned Behaviour (TPB)

Source: Ajzen (1991)

2.3.4 Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT is another technological innovation theory developed to explain intentions to use IS and usage behaviour. The four key constructs in UTAUT are: performance expectancy; effort expectancy; social influence and facilitating conditions that are direct determinants of usage intention and behaviour. The moderating effect is gender, age, experience and voluntariness of use that are predicted to moderate the impact of the key constructs on usage intention and behaviour (Venkatesh *et al.*, 2003). The UTAUT model as shown in Figure 2.26 was developed through a review and the consolidation of the constructs of eight models from earlier research in IS usage behaviour, comprising of TRA; TAM; Motivational Model; Theory of Planned Behaviour; a combined theory of Planned Behaviour with TAM; model of PC Utilisation; Innovation Diffusion Theory and Social Cognitive Theory. Subsequent validation of UTAUT in a longitudinal study found 70% of the variance to be explained by usage intention (Venkatesh *et al.*, 2003).

Besides, TAM and TAM2, have explained only 40% of a system's use. It can be concluded that TAM is a useful model but has to be integrated into a broader one to enhance predictive power. In conclusion, the unified Theory of Acceptance and Use of Technology model (UTAUT) was developed recently (Venkatesh et al., 2003) based on a review of relevant user acceptance literature of eight models including TRA, TPB, TAM, Motivational Model (MM) and Innovation Diffusion Theory (IDT). UTAUT is more comprehensive to understand technology success and the drivers of acceptance (Lu, Yao and Yu, 2005).

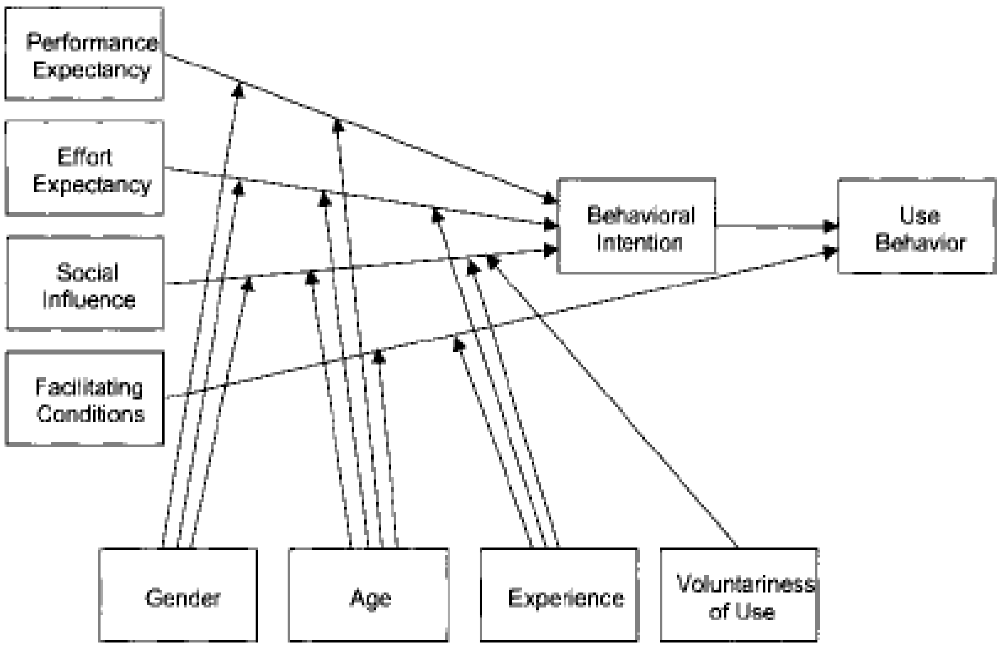


Figure 2.26: Unified Theory of Acceptance and Use of Technology (UTAUT)

Source: Venkatesh *et al*. (2003)

UTAUT is suitable for analysing users' acceptance of any information technology. The model has been applied to many topics, including mobile Internet, mobile communication and mobile banking. In addition, Wu, Wu and Chang (2016) researched consumer perceptions toward acceptance of the smartwatch using an integrated model of IDT, TAM, UTAUT with perceived enjoyment as the determinant of the model developed. Another study was conducted by surveying different groups of Malaysian community acceptance of the m-government service with a structured questionnaire to collect data from 566 respondents. Results of the study proved that the proposed model was comprehensive to study the integrated constructs from the technology TAM, TRA, UTAUT and trust models (Althunibat, Azan and Ashaari, 2011).

Furthermore, in a study conducted by Rauschnabel and Ro (2016) on the new stream of wearable technology devices known as Microsoft Hololens and Google Glass (Project Aura), the authors reviewed the prior technology acceptance research and proposed an exploratory model of smart glasses adoption. It was also known as Augmented Reality Smart Glasses that influence media usage. Practically, TAM2 and UTAUT incorporate 'image' as a factor describing the degree *to which the use of a particular technology enhances the user's status among other people in the same social system*. TAM uses the term 'perceived usefulness' while UTAUT uses 'performance expectancy.' Another similarity is the ease of use which is referred to as 'effort expectancy.' UTAUT also integrates social influences (norms, image) and facilitating conditions. According to UTAUT, facilitating conditions should be directly related to the actual behaviour of adopters and not to behavioural intentions. The empirical study has revealed the importance of various drivers such as functional benefits, ease of use, individual difference variables, brand attitudes and social norms as shown in Figure 2.27, to which the model was developed with significant predictors. The potential adopters of this new technology would be Innovators and Early Adopters (Rauschnabel and Ro, 2016). This study contributed to the understanding of the wearable computing acceptance.

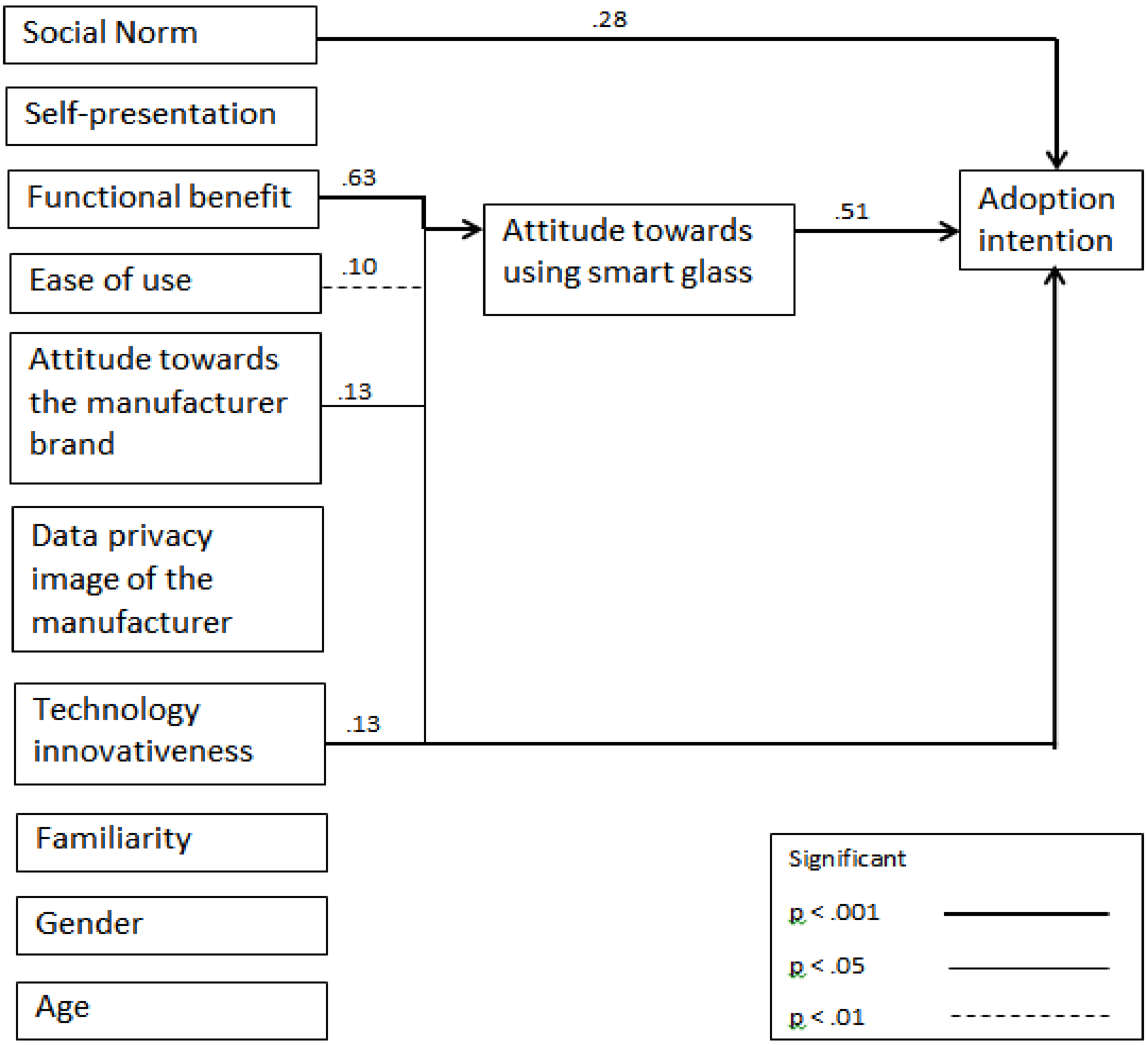


Figure 2.27: The model developed for augmented reality smart glasses: an investigation of technology acceptance drivers

Source: Redrawn from Rauschnabel and Ro (2016)

The extant literature on the pervasive computing, mobile technology and wearable computing, as well as the understanding of various technological and innovation theories are only suitable for particular countries with certain cultural and socio-economic characteristics. These studies cannot be generalised to contexts such as Malaysia, a developing country with high penetration of mobile technology, thus showing the limitation in the current research on the adoption of wearable computing. This merits a study in understanding users' acceptance

2.4 Chapter summary

This chapter has presented the literature review on pervasive computing with characteristics, evolution processes, thus explaining the application of pervasive computing, and some development process barriers. The literature is extended to mobile computing development in ICT and wearable computing. Also, the literature on the main theory of technology innovation acceptances and adoption, such as the Technology Acceptance Model (TAM), Diffusion of Innovation theory (DOI) with other theories such as the Theory of Reason Action (TRA), TPB and UTAUT have been reviewed extensively to extract the model factors.

The rate of adoption of mobile phone usage in Malaysia is promising in supporting the widespread research of wearable computing innovation acceptance; however, the study on the users' acceptance of wearable computing is still at an early stage. Wearable computing is expected to become mainstream after the phenomena of the mass market adoption of smartphone usage. The Malaysian government had also supported the ICT development in facing telecommunication evolution, and m-Commerce may have a bright future in Malaysia. Limited empirical studies have been carried out in understanding the factors that may significantly influence users' acceptance in the Malaysian context. The existing frameworks in innovation acceptance studies may not be applicable to fit the Malaysian market context. Therefore, this research intends to fill the existing knowledge gap by developing a new comprehensive model with an acceptable explanatory power in explaining the innovation acceptance factors of wearable computing. The lines of enquiry for the primary research have been laid up to identify '*What are the pervasive computing-based mobile applications and how has technology acceptance been understood in the past that may drive the acceptance of wearable computing?'; 'What are the factors that may influence users' acceptance of wearable computing in Malaysia?';* and *'To what extent do the social influence* *and mobile application influence wearable computing acceptance in Malaysia?'.* Findings from this study are expected to aid businesses, policymakers and IT providers as an alternative tool for aiding in decision making in the technological innovation industry.

The next chapter will emphasise the methodology in chapter 3, explaining how the research will be conducted accordingly, while chapter 4 will present the development of the conceptual framework based on the literature reviewed and discussed. The model factors or construct measures and the related hypotheses will be presented for this research study.

CHAPTER 3

3 RESEARCH METHODOLOGY

This chapter discusses the methodology, and the way research is studied and designed. For a particular method and technique used in collecting and analysing the data, the valuable insight of the research questions and objectives will be justified.

A successful research study needs a detailed research plan and a well-organised set of research activities as well as good management of time and budget. Therefore, the research approach employed for this research will be discussed in detail. It covers the research paradigm; qualitative and quantitative and mixed methods research approaches within the technological innovation acceptance; the research design embraced in this study; sampling method; questionnaire design; as well as the timeline for data collection and ethical consideration. Besides, the pilot study is explained, further with qualitative interviews for supporting the findings.

3.1 Research Paradigms

Mackenzie and Knipe, (2006) urged that the prior plan to select which research paradigm at the initial research process, the choices concerning methodology, method and research design should be justified. According to them, "*methodology is the overall approach to research process associated with the paradigm or theoretical framework underpinned* while the *method refers to systematic procedures or tools used for data collection and analysis".*

Collis and Hussey, (2009 *p.55)* state that a research paradigm *is "a philosophical framework that guides how scientific research should be conducted. Philosophy is the 'use of reason and argument in seeking truth and knowledge, especially of ultimate reality or of general causes and principle".* Also*,* according to Saunders, Lewis and Thornhill, (2012 *p.140),* research paradigms is *"a way of examining social phenomena from which a particular* *understanding of these phenomena can be gained, and explanations attempted".*

Wahyuni, (2012) emphasises that when undertaking a social study in understanding social phenomena, it is vital to specify the research paradigm at the beginning as it addresses the philosophical dimensions of fundamental assumptions and beliefs of the world. While Creswell (2013) uses 'worldview' as a term instead of paradigm while others call epistemologies and ontologies, he highlights four widely discussed worldviews or paradigms in the literature: post-positivism or positivist, constructivism or interpretivism, transformative and pragmatism.

Saunders et al. (2012) identify positivism and interpretivism as the two research paradigms that a researcher can select to guide particular research.

3.1.1 Positivism versus Interpretivism

The positivist observes and measures the objective reality that exists carefully, and aims to test variables comprising of hypotheses and a research question. The scientific research method and approach for positivists begin with the theory, data collecting and testing whether the theory is supported, typically seen as quantitative research (Creswell, 2013). According to Orlikowski and Baroudi (1991), positivism involves drawing inferences about a phenomenon from a population sample, quantifying measures of variables and hypotheses testing. Positivism is a belief that reality is independent and the aim is the theories developed by empirical research such as observation and experiment. Theories provide the basis of explanation, permit the anticipation of phenomena, predict the occurrence and thus, allow to be controlled; since it assumes that social phenomena can be measured, positivism is related to quantitative methods of analysis (Collis and Hussey, 2009). Creswell (2013) claims that positivism studies mainly use structured quantitative approaches such as questionnaire and experiments.

Interpretivism is a belief that social reality is subjective because of shaping perceptions. The researcher interacts with what is being researched because it is not possible to separate what exists in the social world from what is in the researcher’s mind. Interpretivist adopts a range of methods to describe, translate and the findings are not derived from quantitative data. According to Collis and Hussey (2009), interpretivism studies develop theories to understand phenomena. Positivism research uses a deductive approach that involves developing a conceptual structure that is investigated empirically. A deductive approach is mainly used in quantitative research. On the other hand, interpretivism research uses an inductive approach to develop a theory from an observation. The interpretivism approach is mainly used in qualitative research (Saunders et al., 2012).

3.1.2 Deductive versus Inductive

Deductive approach is scientific research that involves the development of a theory that is subjected to rigorous testing through a series of propositions. It explains the causal relationship between concepts and variables, and that concept should be operationalised to enable measuring the facts quantitatively. Moreover, the deductive approach should be able to generalise. Thus, the sample should be sufficient and carefully selected (Saunders, Lewis and Thornhill, 2012).

An inductive approach is to make a cause-effect link between variables without an understanding of the way how human interpreted the social world. This approach concerns the context of events that would take place. Usually, the small sample size might be appropriate compared to deductive approach; this type of research is more likely to use qualitative data and various methods to collect the data to understand the phenomena (Saunders, Lewis and Thornhill, 2012).

Therefore, this current research employed the positivism paradigm because the researcher wanted to get the respondents’ opinions on the users’ acceptance of wearable computing and to generalise the results to the wider population. For a positivist paradigm, a conceptual framework was developed from existing literature; then, hypotheses were formulated and tested. The questionnaire used to gather information from a data sample of 272 respondents and the hypotheses developed were tested using IBM SPSS version 20.

Quantitative, Qualitative and Mixed Methods

As quantitative research is associated with positivism with highly predetermined and structured data collections techniques, and is usually associated with the deductive approach testing the theory, it may also be possible to incorporate an inductive approach to developing a theory (Saunders, Lewis and Thornhill, 2012, p.162). A quantitative approach normally gathers both numeric information (instruments) as well as text information (interviews) so that the final database represents both quantitative and qualitative information (Mackenzie and Knipe, 2006; Creswell, 2013). Table 3.1 shows the research design for qualitative, quantitative and mixed methods.

Quantitative approach seeks to know the relationships among the variables while quantitative hypotheses are predictions made about the outcome of the relationship among the variable. The quantitative approach method is rigorous to test the theory and the cause-and-effect logic measure of variables. Quantitative studies attempt to verify theories, so demographic variables (e.g., age, income, education level) typically are considered as mediating or moderation factors instead of the independent variable (Creswell, 2013).

The qualitative approach is where the researcher seeks the broader question for exploration of the central phenomenon or concept of study. The intention is to explore the complex set of factors surrounding the central phenomenon. Using an open-ended question without reference to literature or theory is otherwise indicated by qualitative strategy (Creswell, 2013). For example, a survey of 45 personal interviews was conducted to study the privacy of wearable applications. The results indicate that the majority of people would be content to use wearable computing, but the application is more favourable in the UK than in Finland (Virkki and Aggarwal, 2014).

Table 3.1: Research design
Source: Saunders, Lewis and Thornhill (2012)

Research design	**Quantitative**	**Qualitative**	**Mixed Methods**
Philosophy	Positivism	Interpretivism	Pragmatism
Approach	Deductive approach	Inductive approach	May use deductive or inductive or combining both approaches
Characteristics	Examines the relationship between variables, often uses probability sampling techniques to generalise, the researcher is independent	Study participants, meaning and relationships to develop a conceptual framework. Likely using non-probability sampling, the researcher is dependent on the participants and rapport as well as sensitivity to gain data.	Both quantitative and qualitative are combined.
Strategies	It is usually associated with experiment and survey research strategies. For survey research, normally a set of questionnaires or structured interviews or observations are conducted.	Variety of strategies: action research, case study research, ethnography, Grounded Theory and narrative research, can be used in multiple methods research design.	Principal research strategies are concurrent triangulation design, concurrent embedded design, sequential explanatory design, sequential explanatory design and sequential, multiphase design.

Mixed methods research paradigm emerged from the 1990s onwards, establishing itself alongside ‘‘three methodological or research paradigm worlds with quantitative, qualitative, and mixed methods research’’. Some researchers may use mixed methods to improve data accuracy, whereas others use mixed methods to produce a complete picture. Mixed methods are used for avoiding biases intrinsic to single-method approaches. Mixed methods have been used in developing the analysis and building on initial findings using different kinds of data or methods, and as an aid for sampling; for example, questionnaires were used to screen potential participants for inclusion in an interview program (Denscombe, 2008). Strong mixed methods should have a qualitative question, as well as a hypothesis for a quantitative and mixed methods question.

Furthermore, quantitative and qualitative research methods can be integrated into one study. Johnson et al. (2007) broadly define the mixed method as “a type of research in which a researcher integrates aspects of qualitative and quantitative research methods for the broad purposes and depth of understanding”. Mixed methods research can either be purely mixed where both quantitative and qualitative methods have equal input to the research or having a dominant quantitative approach (QUAN →qual research) or having a dominant qualitative approach (QUAL → quan research) (Johnson et al., 2007). Thus, this research study employs mixed methods. The aim of this research is to examine the predicted factors of users’ acceptance of wearable computing by testing the hypotheses formulated; therefore, the appropriate approach is quantitative is dominant with a follow up qualitative semi-structured interview (QUAN →qual research) to support or add value to the findings.

3.1.3 Cross-sectional versus Longitudinal research

Cross-sectional research often employs survey strategies in seeking to describe the phenomena, or to explain how the factors are related to a study of a particular phenomenon at a particular time. It may also use qualitative or multiple research strategies (Saunders, Lewis and Thornhill, 2012).

According to Collis and Hussey, (2009), this research is designed to obtain the data in different contexts but over the same period of time. It is conducted due to the issue of time constraint or limited resources. Cross-sectional surveys have several advantages. Surveys are flexible, suitable for many different areas of human behaviour and conditions, with many populations; thus, reflected a snapshot of results studied.

In addition, the longitudinal research is to study a group of subjects or variable over a long period of time, to examine the change of phenomenon. This methodology is expensive and time consuming for research students. For longitudinal research, data are collected for at least at two points in time to allow the researcher to detect changes over time while a cross-sectional study occurs at one point in time. Hence, a cross-sectional sample survey field study is employed in this research as data were collected at a single point in time.

3.2 Research approach in Technological Innovation Acceptance

Choosing the right method is essential in conducting research in technological adoption and acceptance. In the study investigated users' adoption behaviour toward m-banking had identified interesting insights into the diffusion pattern of m-banking with 55 studies utilising quantitative approaches. It was also known as the most popular method. Findings reported used a quantitative (survey) method for data collection and only five percent employed qualitative methods such as interviews (Shaikh and Karjaluoto, 2015),

In view of innovative technologies, almost empirical studies on technology acceptance depend on quantitative methodologies. Academic research in the area of ubiquitous and wearable computing acceptance is still relatively scarce. The study on the factors influencing smartphone ownership among Malaysians, the researchers distributed questionnaire to collect data with a sample size of 500 (Lazim and Sasitharan, 2015). The research on the decision-making process to adopt m-commerce surveyed 866 Singaporean students using a quantitative approach (Yang, 2005). In order to address the problems faced by the elderly in using wearable devices, a preliminary analysis by conducting an interview method was used in the quantitative analysis (Sin *et al.*, 2014). The other study explored factors that influence user intention to accept smartwatch, where the questionnaire data collection was utilised (Wu, Wu and Chang, 2016).

Furthermore, in studying users' behaviours involving wearable computing, a questionnaire has to be designed to measure user salient perceptions of the pervasive device (Moran, Nishida and Nakata, 2013). The questionnaire regarding two systems that are widely used in the laboratory, electronic mail and the XEDIT file editor was distributed for the study (Davis, 1985). Also, data were collected through an Internet survey for smartwatches and glasses research (Liu and Guo, 2016). A survey research method was adopted to explore and describe what was observed (Soon, Lee and Boursier, 2016). The study to investigate smartphone adoption by employing questionnaire (Chen, Park and Putzer, 2010).

In spite of the survey-based questionnaire, in understanding mobile services, focus groups also may be employed. For example, findings regarding the usage of mobile devices and services, both quantitative and qualitative data were collected from two focus group. The focus groups used a semi-structured method, and the conversations were recorded with the consent of the participants, transcribed, and used alongside notes for manual coding (Rahmati and Zhong, 2013). Another study to understand the perceived qualities of smart wearables was conducted in a usability laboratory with dome cameras were used to record the actions and comments of the participants (Karahanoglu and Erbug, 2012). Therefore, may find relevant research approach to answer the research question.

3.3 Research approaches employed in this study

This research aims to develop a framework to identify the predicted factors that may positively influence users' acceptance of wearable computing in the Malaysian context, thus, the appropriate research plan and appropriate method are essential to ensure the research study's reliability and validity.

There was a variety of selection of suitable research approaches and methodologies developed in the field of information technology and social science, such as survey methods and case studies. After considering the two research paradigms aforementioned, the positivism paradigm was adopted for this research with the mixed methods approach where the quantitative approach was dominant (QUAN → qual) and was followed by a qualitative semi-structured interview as collateral to support the main research findings.

Based on literature in technology acceptance, which was presented in Chapter 2, the rationale for choosing the positivism and quantitative deductive approach are based on three main principles which are first, researcher assumed that there are underlying laws and principles which govern how things work in the world. The researcher plays a main role in discovering these laws and principles primarily by distancing herself from respondents. Secondly, once the laws and principles have been discovered, the next step is to document and describe the facts. Finally, for data analysis, well-established and justified statistical techniques were used. According to Creswell (2013), the scientific research method and approach for positivists begin with the theory, collecting data and testing whether the theory is supported, and is typically seen as quantitative research. Furthermore, Orlikowski and Baroudi (1991) urged that positivism involves drawing inferences about a phenomenon from a population sample, quantifying measures of variables and hypotheses testing. Based on the aforementioned arguments, to answer the research questions of which factors may positively influence wearable acceptance in the Malaysian context, the appropriate mixed methods approach with (QUAN → qual) approach was employed as the researcher wanted to examine the formulated hypotheses and empirically tested using IBM SPSS V.20, and followed by the semi-structured interview as collateral to support the quantitative findings.

Moreover, other researchers also used positivist approach regarding technology acceptance conducted in this area previously (Davis, 1985; Yang, 2005; Liu and Guo, 2016; Wu, Wu and Chang, 2016), the existing literature in the technology acceptance was used as a guide to support this research. The choice made for the whole research plan was based on the aim of identifying the factors for wearable computing acceptance by testing the formulated hypotheses related to the proposed conceptual framework empirically.

This research employed a self-administered questionnaire survey-based approach. The respondents were selected from university students and employed professionals as the potential adopters; they were recruited from two clusters known as cluster 2 for the central and cluster 3 for Malaysia's southern region by utilising clustering sampling. The rationale for choosing this probabilistic sampling was based on geographical areas with natural occurring group characteristics with prior experience in mobile technology and internet knowledge. Choosing the right technique might improve the findings. Cluster sampling is a sampling technique for collecting the sample in a large geographical area, while the sampling frame is not available (Awang, 2012).

The data collection was conducted from December 2015 to February 2016, after research approval from Brunel University Research Ethics committee had been granted. This research employed a survey strategy using self-administered questionnaire technique of five-point Likert scales to indicate the extent of agreement where 1 is strongly disagree to 5 is strongly agree – this was adapted from literature. To further understand the results from the model testing, the qualitative interviews were carried out with six respondents who are highly experienced professionals with many years of experience in ICT, particularly in the mobile technology computing field to give a comment on the results in supporting the main research findings

3.4 Research design

The success of research depends on the organisation of research activities, selecting the right data collection technique and data analyses technique so that the researcher can achieve the research aim. Research design is a link between the existing theory, argument and the empirical data collected. Figure

3.1 illustrates the three steps of research design were undertaken in this research.

At this first stage, an extensive literature review was conducted in the area of pervasive and mobile computing, wearable computing and technology acceptance and innovation adoption theories. Secondly, the proposed framework was developed, and the hypotheses were formulated by extracting the most cited factors from the well-established technology acceptance theories, such as TAM and DOI. The preliminary framework was presented at the BAM conference in order get feedback from knowledgeable academics who are actively researching in the area of technology acceptance and adoption models.

At stage two, a questionnaire was developed by extracting the questions from previous literature in the field of pervasive and mobile computing, as well as wearable computing. These questions were adapted and adjusted to match the wearable computing context. After the questionnaire was developed, it was refined by the supervisor and the PhD student. The ethical approval was granted prior to conduct a pilot study. The pilot study was conducted in the southern region, named as cluster 3 with a convenience sample of university students. Next, the results were processed by using the SPSS V20, and the scale reliability was assessed, and the questionnaire was refined based on the pilot study.

After that, the field study was conducted in Malaysia by administrating a self-administer questionnaire, which was distributed during December 2015-February 2016. Then, the data were analysed using IBM SPSS with descriptive analysis and model testing; the model then was revised based on the regression analysis and factor analysis. These results were presented at the i-society conference in Dublin. These results will be described and presented in detail in Chapter 6.

At stage three, interviews were carried out with six respondents who are highly experienced professionally with years of experience in mobile computing, as well as in the wearable area to support the results of this study.

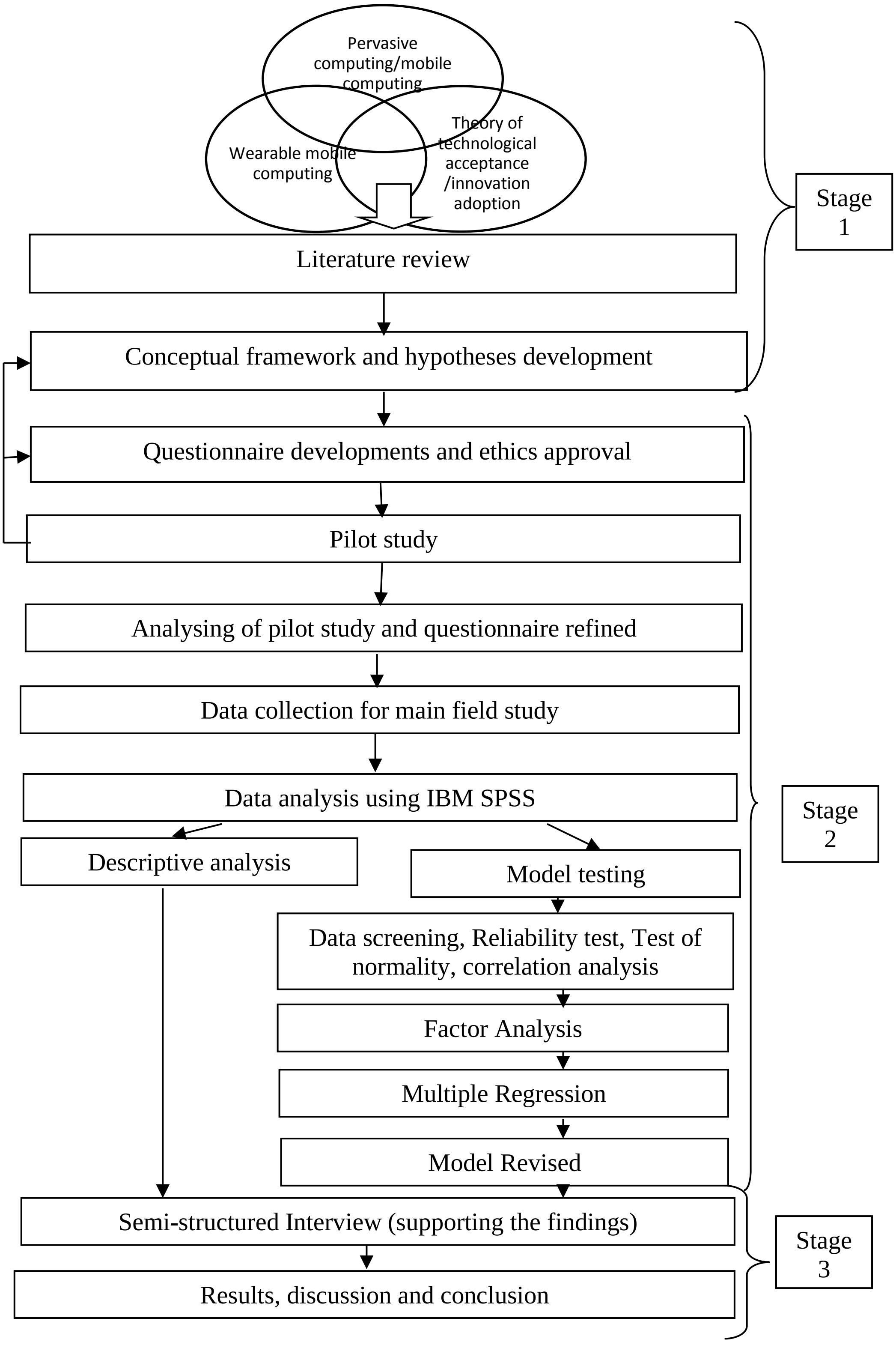


Figure 3.1: Research design employed in this study

Figure 3.1 shows the research design employed in this study to achieve the research objectives with three stages started from conducting the literature review until results, discussion and conclusion.

3.5 Survey deployment and sampling

In this study, the survey questionnaire was developed and adapted from the past study in pervasive computing, mobile computing, technological acceptance and adoption theory. A questionnaire was prepared with a cover page which stated the main objective of the study conducted. Respondents were informed that their participation is voluntary, anonymous and confidential for this study. The self-administered questionnaire was divided into six sections: section A was for demographic profile of the respondent; section B was for mobile application experience; section C was on users' attitude towards wearable computing; section D was about technology acceptance; section E was on users' preference towards the wearable computing, and the last section F was for users' service preferences. The last part was open-ended and asked for the user's overall comment on wearable computing. The questionnaire used a five-point Likert scale ranging from '1 =strongly disagree to 5 = strongly agree'. A questionnaire is provided at Appendix A for reference. The definition about wearable computing was given in the cover page for users to familiarise with the topic that had been surveyed; The wearable computing that is being envisaged in this research was mentioned in the front page of the questionnaire - it refers to electronic technologies or computing technology embedded or worn on the human body as apparel or accessories such as a smartwatch, smart glasses or jewellery. Moreover, the researcher's email address was also provided if any of the respondents had any comments or wanted to seek clarification. The respondents are university students and professionals with prior experience and computing knowledge.

The objective of sample selection was to attain a sufficient sample in terms of different perspectives on wearable computing with different levels of personal user experience and different computing knowledge experience on mobile computing technology.

Malaysia encompasses six main regions: Northern Region; Central Region; Southern Region; East Coast; Sabah and Sarawak. Cluster sampling is ideal when it is impractical to compile a list of the elements composing the population. For conducting cluster sampling, the researcher identified the region as a cluster. The Northern Region was named as Cluster 1; the Central Region was named as Cluster 2; the Southern Region was named as Cluster 3; the East Coast was named as Cluster 4; then, Sabah was named as cluster 5 and Cluster 6 is Sarawak. Cluster sampling is a sampling technique for collecting the sample in a large geographical area, while the sampling frame is not available (Awang, 2012). For this research, two Clusters were selected based on simple random sampling (SRS) which were cluster 2 and cluster 3, then sampled the element in the cluster (Creswell, 2013). From the cluster selected, the sample were the respondents of university students and professionals. According to Pallant (2013), the sample size calculation is N> 50 + (8 x m), where m=number of an independent variable (model factors). For this study, model factors of seven have been chosen. Stratified sampling is about dividing the target population into strata where the sample is drawn for each strata, but this procedure is likely to take longer as it involves more cost. Instead of choosing all stratum, the only selected cluster was chosen.

Therefore, N> 50 + (8 x 7) = N> 106 respondents; so, data of 272 participants were managed to be collected from Central and Southern Region with a confident interval of 95%. The sample size of 272 respondents is sufficient with 33.5% male, and 66.5% of female. The age group of 18-25 contributed the most with 60.7%, and the age group 45-54 that contributed the least of 3.3% and sufficient for further analysis.

3.6 Questionnaire design

A questionnaire was designed based on extant literature and conceptual research framework developed by determining which variables were related to wearable computing. Use of questionnaire was preferred to other data collection methods such as interviews and case studies (Saunders, Lewis and Thornhill, 2012).

The questionnaire is usually associated with a deductive research approach, a popular and common strategy in business and management research. Hence, it was used for exploratory and descriptive research. Standardised data from a sizeable population is collected economically. By using an existing instrument from the past research, it was essential to check the validity of the questionnaire which are content validity, predictive validity and construct validity, as well as the reliability of the questionnaire. When the item is modified or combined, the original validity may not hold; therefore, the reestablishment of the validity should be checked (Creswell, 2013).

In this study, a questionnaire was developed and adapted from the past study in pervasive computing, mobile computing and technology adoption theory. A questionnaire was prepared with a cover page that stated the main objective of the study conducted. Respondents were informed that their participation was voluntary, anonymous and confidential for this study. The questionnaire was divided into six sections: section A was for demographic profile of respondent, section B was for mobile application experience, section C was on users' attitude towards wearable computing, section D was about technology acceptance, section E was on users' preference towards the wearable computing and last section F was for users' service preferences. The last part was open-ended and asked about the user's overall comment on wearable computing. The questionnaire used a five-point Likert scale ranging from '1 =strongly disagree to 5 = strongly agree'. A questionnaire is provided at Appendix A for reference. Table 3.2 below shows the development of the questionnaire. The development of the questionnaire was then tested for reliability by using Cronbach alpha and factor analysis for construct validity.

Table 3.2: Questionnaire development

Factor	Questions	Source
Behavioural Intention (BI)	Assuming I have access to wearable computing, I intend to use it.	(Lu, Yao and Yu, 2005)(Luarn and Lin, 2005)(Wu, Wu and Chang, 2016)
	Assuming I have access to wearable computing, I intend to use it frequently.	(Gu, Lee and Suh, 2009)(Althunibat, Azan and Ashaari, 2011)
	I intend to use wearable computing frequently to access mobile services.	(Gu, Lee and Suh, 2009)(Yang, 2012)(Althunibat, Azan and Ashaari, 2011)
	I intend to use wearable computing in the future.	(Gu, Lee and Suh, 2009)(Yang, 2012)
	My general opinion of wearable computing is favourable.	(Yang, 2005)
Social Influence (SI)	People who can influence my behaviour would think that I should use wearable computing.	(Lu, Yao and Yu, 2005)(Venkatesh *et al.*, 2003)
	People who are important to me would think that I should use wearable computing.	(Hong *et al.*, 2008)(Venkatesh *et al.*, 2003)
	People whose opinions I value would prefer that I use wearable computing.	(Hong *et al.*, 2008)
	People around me who use wearable computing have more prestige than those who do not.	(Lu, Yao and Yu, 2005)
	Using wearable computing is considered a status symbol among my friends.	(Lu, Yao and Yu, 2005)
Mobile Application (MA)	Searching for specific information on the Internet	(Chen *et al.*, 2011)
	Sending or receiving e-mails	(Chen *et al.*, 2011)
	Using Internet search engines (e.g. yahoo, google, etc.)	(Chen *et al.*, 2011)
	Sharing digital files or personal information online with friends, family and others	(Chen *et al.*, 2011)
	Chatting with others on the Internet	(Chen et al., 2011)
	Managing personal appointments and meetings through the Internet	(Chen et al., 2011)
	Performing routine banking services (pay bills, check account, etc.)	(Chen et al., 2011)
	Listening to music from the Internet, including downloaded MP3	(Chen *et al.*, 2011)

Perceived Usefulness (PU)	Using wearable computing services would help me to accomplish things more quickly.	(Davis, 1989)(Gu, Lee and Suh, 2009)(Althunibat, Azan and Ashaari, 2011)
	Using wearable computing would make my life easier.	(Althunibat, Azan and Ashaari, 2011)(Davis, 1989)
	I find wearable computing would be useful in my life.	(Althunibat, Azan and Ashaari, 2011)(Lu, Yao and Yu, 2005)
	Using wearable computing would increase my productivity.	(Althunibat, Azan and Ashaari, 2011)(Davis, 1989)
	Using wearable computing would help me perform many things more conveniently.	(Davis, 1989)(Hong, Suh and Kim, 2009)
	Considering all tasks, the use of wearable computing could assist my life.	(Lu, Yao and Yu, 2005)(Davis, 1989)
Perceived Ease of Use (PEU)	Learning to use wearable computing services would be easy for me.	(Althunibat, Azan and Ashaari, 2011)(Davis, 1989)(Thakur and Srivastava, 2016)
	Wearable computing services would be understandable to use.	(Althunibat, Azan and Ashaari, 2011)(Davis, 1989)(Thakur and Srivastava, 2016)
	It would be easy for me to get the services I need from wearable computing.	(Althunibat, Azan and Ashaari, 2011)(Davis, 1989)
	I expect that my interaction with wearable computing would be clear.	(Davis, 1989)(Thakur and Srivastava, 2016)
	I think learning to use wearable computing is easy.	(Davis, 1989)(Thakur and Srivastava, 2016)(Gu, Lee and Suh, 2009)
	Overall, I find wearable computing is easy to use.	(Davis, 1989)(Gu, Lee and Suh, 2009)
Observability (OBS)	Wearable computing can be accessed anytime.	(Al-Jabri and Sohail, 2012)
	Wearable computing has no matter for me.	(Al-Jabri and Sohail, 2012)
	Wearable computing can be accessed anywhere.	(Al-Jabri and Sohail, 2012)
	I can see the effect of a transaction immediately.	(Al-Jabri and Sohail, 2012)
Mobility (MOB)	I expect that I would be able to use wearable computing at anytime and anywhere.	(Hong *et al.*, 2008)
	I find wearable computing would be easily accessible.	(Hong *et al.*, 2008)

	I expect that wearable computing would be available for use whenever I need it.	(Hong *et al.*, 2008)
	In general, I expect that I would have control over using wearable computing anytime.	(Hong *et al.*, 2008)
Perceived Enjoyment (PE)	Using wearable computing would be enjoyable.	(Hong *et al.*, 2008)
	Using wearable computing would be pleasurable.	(Hong *et al.*, 2008)
	I expect that using wearable computing would be interesting.	(Hong *et al.*, 2008)
	The actual process of wearable computing would be pleasant.	(Yang, 2012)
Facilitating Conditions (FC)	I am given the necessary assistance to use wearable computing.	(P. E. Pedersen, 2005) (Thakur and Srivastava, 2016)
	I have the necessary knowledge to use wearable computing.	(Thakur and Srivastava, 2016) (Gu, Wei and Xu, 2016)
	I have access to the software, hardware and network services required to use wearable computing.	(P. E. Pedersen, 2005) (Thakur and Srivastava, 2016)
	My service provider facilitates the use of wearable computing.	(P. E. Pedersen, 2005)
	I have the person available for assistance with wearable computing.	(Thakur and Srivastava, 2016) (Gu, Wei and Xu, 2016)
Personalisation (PN)	How important is the ability to personalise a wearable computing?	(Kim and Mirusmonov, 2012)

3.7 Timeline for data collection

The data collection was conducted from December 2015 to February 2016, after research ethics approval from Brunel University Research Ethics committee was granted. This research employed a quantitative approach, cross-sectional survey-based self-administered questionnaire with five-point Likert scales that indicate the extent of agreement where 1 =strongly disagree to 5=strongly agree. This was adapted from literature.

3.8 Ethical consideration

Research ethics are the standards of behaviour that guide the conduct about the rights of those who become the subject of work or are affected by it. The appropriateness or acceptability of a researchers' conduct may be influenced by the broader social norm of behaviour (Saunders, Lewis and Thornhill, 2012).

To ensure research is ethically conducted, before the questionnaire was distributed to the intended sample, ethical approval was applied to the Brunel University Research Ethics committee. All the related documents including the survey questionnaire, the cover letter clarifying the purpose of the research and participant consent form were sent for approval. Also, all the participants involved in the study were informed about the confidentiality and anonymity of the data collected. After the research ethics was granted by the Brunel University Ethics committee, the questionnaire was distributed to the respondents.

For result validation, second ethical approval was applied to Brunel University Research Ethics committee to conduct a validation interview with the highly experienced professionals in the related organisation. Prior consent from the organisation was obtained before the interview was conducted (see APPENDIX C).

3.9 Pilot study

Prior to conducting the main field research study, it is essential to run a pilot test in order to check the questionnaire and refine before distributing to the respondents. The pilot study involved a more practical number of the sample in comparison to the sample size of the population. Moreover, it was conducted to test the reliability and validity of the questionnaire. At this phase of conducting a survey, the questionnaire was administered by a convenience sample of Malaysian university students consisting of 60 respondents.

At the earlier stages of the study, the preliminary proposed framework was developed based on extant literature by integrating factors from several models and theories which are highly relevant frameworks to guide in developing the wearable computing conceptual framework. This research adopts Theory of Technology Acceptance Model (TAM) introduced by Davis (1989). Compatibility, complexity, and observability were selected from the Diffusion of Innovation Theory (DOI) (Rogers, 1995). Specifically, this research added mobility, personalisation, facilitating conditions and perceived enjoyment as determinants of key constructs, while social influence and application space were added as the external variables that affect the factors chosen.

The preliminary conceptual framework is shown in Figure 3.2. The conceptual paper had been presented in the British Academy of Management (BAM) conference to gain feedback on the framework (Taib, De Coster and Nyamu, 2015). The feedback obtained from the conference was to check any redundancy factors. After conducting the pilot test, the outcome found two factors needed to be dropped, which were compatibility and complexity due to it having the same meaning as the factor Perceived ease of use in TAM. During the pilot test, the reliability of the questionnaire was checked, and the questionnaire had been refined by doing content validity which was checked by an expert, as well as PhD students in the mobile technology field for main field study.

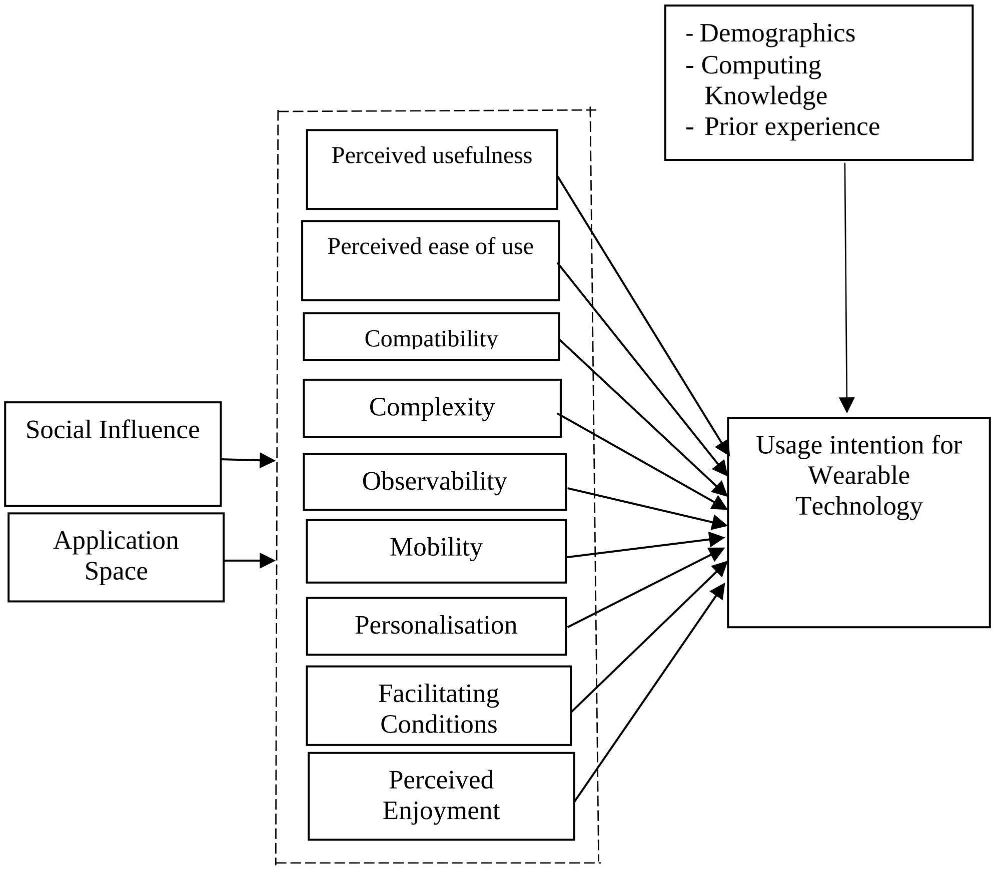


Figure 3.2: Preliminary conceptual framework

3.9.1 Sample profile for pilot study

Table 3.3 and Table 3.4 show the sample profile and the reliability test for the pilot study. The pilot study was conducted to refine the questionnaire, thus avoiding any possible problems that may arise during the main field research for data collection. The sample profile consists of 60 Malaysian university students.

Table 3.3: Sample Profile for a pilot study

Characteristics		Frequency	Percent (%)
Gender	Male	26	43.3
	Female	34	56.7
Age Group	18-26	52	53.3
	27-35	18	30.0
	36-44	8	13.3
	45-54	2	3.3
Purpose of using a smartphone	Business	1	1.7
	Personal	52	86.7
	Study	6	10.0

3.9.2 Reliability and Validity Test

Reliability refers to measuring the consistency of the scales (Pallant, 2013; Heale and Twycross, 2015). The two common scales of reliability are test-retest reliability and internal consistency. The test-rest reliability is used to access the same people at two different occasions; higher test-retest indicates a reliable scale. The internal consistency is also known as Cronbach alpha coefficient, which is the degree to which measured items of the scales have same the underlying construct. According to Pallant (2013), ideally, the values ranging from 0 to 1, shows greater reliability. Cronbach alpha coefficient should be above 0.70.

Reliability testing was conducted for the pilot study to check the internal consistency of the constructs measured with the Cronbach alpha above .70 (Pallant, 2013).

Table 3.4: Reliability test for a pilot study

Factors	Cronbach Alpha N=60
Behavioral intention (BI)	0.900
Social influence (SI)	0.826
Perceived usefulness (PU)	0.913
Perceived ease of use (PEU)	0.887
Compatibility (COP)	0.818
Complexity (COM)	0.704
Observability (OBS)	0.820
Mobility (MOB)	0.878
Facilitating conditions (FC)	0.809
Perceived enjoyment (PE)	0.906

Validity expresses the degree to which items measure what it purports to measure. Several types of validity include face validity, construct validity, content validity and criterion validity (which could be concurrent and predictive validity). Content validity refers to the adequacy which a measure or scale sampled is from the intended universe. Criterion validity concerns the relationship between score and specified measurable criterion. The construct validity concerns about the underlying theoretical construct. The construct validity explores its relationship with another construct. If this other construct is related, this validity is known as convergent validity, whereas if it is unrelated, it is known discriminant validity. For the pilot study, content validity was done to validate the scale measurement against the conceptual by sending it to professionals in the mobile computing field.

3.10 Qualitative semi-structured interviews

To strengthen and support the findings of the research framework developed in this research, a semi-structured interview will be conducted with senior executives from industry were conducted. The interview questions were developed with the predicted factors found in the revised model and to support the relationships of the model. There were six participants with the knowledge in the mobile technologies area who were happy to voluntarily take part in the interviews from July-August 2017.

In view of this persistent research gap, there is a need for a supplementary explorative function to attain more background knowledge about the study topic. Consequently, a semi-structured interview appears to be appropriate for this study (Gribel, Regier and Stengel, 2016). Prior to conduct the interview, second ethical approval from Brunel Research ethics committee was granted. The participant consent form and participant information sheet about the interview purpose were emailed to all the participants in assuring that all the information given will be treated anonymous and confidential (see Appendix B). Moreover, in qualitative research, the sample is usually derived purposefully rather than randomly, focussing primarily on the information-richness of each case. The analysis of the interviews' data will be discussed in Chapter 6.

3.11 Chapter summary

In this chapter, the focus is to discuss the methodology of the research design with different research paradigms; thus, the positivism paradigm has been employed in this research study. The choice of the research approach and methods are vital in helping the researcher to identify the findings in research questions, in terms of study design, sample choice and size, questionnaire design and the related analysis required. Additionally, the ethical approval by Brunel research committee was granted prior to carry out this research.

The next chapter will present the development of the conceptual framework of the model factors and the hypotheses formulated in understanding users' acceptance of wearable computing.

CHAPTER 4

4 CONCEPTUAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

4.1 Introduction

From the extant literature on wearable computing technology, pervasive and mobile computing factors, in addition to adoption and technological innovation acceptance, theories have been explored in developing the conceptual framework for this study. The gaps in this research are to identify the significant factors which may affect the users' acceptance of wearable computing. As the smartwatch is widely perceived as the next-generation wearable device, understanding users' perceptions and acceptance with their relationships towards technology acceptance will increase adoption of this emerging technology, thus, give insights for future researchers and practitioners in the related industry.

Shaikh and Karjaluoto (2015) examined the literature on mobile banking or m-banking acceptance and adoption. They identified from 55 studies which were published from January 2005-March 2014. They found that 23% to 42% research studies utilised the Technology Acceptance Model (TAM) developed by (Davis, 1989) as their theoretical framework underpinning their study, while Diffusion of Innovation theory (DOI) from Rogers (1995) was the second preferable theory for the research and is the third being UTAUT.

Furthermore, Hameed, Counsell and Swift (2012) in their study to develop a model for IT adoption in organisations and user acceptance of IT have reviewed the literature since 1981, from 151 published IS journals on empirical research studies. They found out among all the innovation adoption theories Diffusion of Innovation (DOI) theory, Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) have been extensively used in IT innovation adoption studies. The results suggest that DOI was more broadly used in the studies that performed organisational analysis while TAM, TRA, TPB were utilised mainly for individual level analysis.

Nor and Pearson (2008) also agreed that DOI, TRA, TPB and TAM in predicting information systems innovation adoption were widely used. However, they decided to extend the Decomposed Theory of Planned Behaviour (DTPB) to understand the individual's intention to adopt Internet banking. Also, TAM, the Self-Efficacy Theory and the DOI have been integrated to elucidate the smartphone acceptance among healthcare professionals in the United States (US) and Taiwan (Chen, Park and Putzer, 2010). Moreover, numerous frameworks and predictive models in the literature including the Perceptions of System Attributes-Behavioural Intention (PSA-BI) model (Moran, Nishida and Nakata, 2013) was designed to predict user behaviours in ubiquitously monitored environments. To add TPB, TAM and the use of DTPB were able to explain mobile data service acceptance (Hong *et al.*, 2008; Faziharudean and Li-Ly, 2011).

In wearable computing research, Wu, Wu and Chang (2016) explored the intentions of using a smartwatch from the consumer perspective, combining innovation diffusion theory (IDT), the technology acceptance model (TAM), UTAUT and perceived enjoyment. Furthermore, the findings from 562 Korean participants on the intention to use a smartwatch, also utilised TAM as the framework which extended the model by integrating perceived enjoyment and perceived self-expressiveness (Choi and Kim, 2016). The study has extended the TAM attitude and subjective norm from the TPB onto the research of wearable fitness technologies (WFT) on users' perceptions of the impact of WFT devices on their health and fitness behaviour (Lunney, Cunningham and Eastin, 2016). Kim and Shin (2015) in their paper identified the key psychological determinants of smartwatch adoption, and has integrated the affective and rational factors with TAM. TAM is consistently used to explore technological innovation acceptance because it considers why and how people accept and use particular technological innovation, while DOI examines the factors that support the popularisation and subsequent diffusion of a given innovation across a social system, and finally, the UTAUT focuses on the individual (Canhoto and Arp, 2016). Thus, in developing the framework for exploring users' acceptance of wearable computing, the relevant theories and factors have been carefully considered in this study.

4.2 Factors developed for conceptual framework

The development of this conceptual framework for this research was extracted from TAM, DOI and related factors on mobile and pervasive computing. TAM was chosen as the fundamental basis as TAM has become an established, robust and dominant model for predicting user acceptance in IT innovation. TAM can also explain typically about 40% of the variance in usage intentions and behaviour (Venkatesh and Davis, 2000). Furthermore, TAM has been widely used to provide satisfactory predictors of user acceptance of IT. However, researchers have attempted to extend the TAM framework by integrating it with other models or various constructs such as gender, culture, trust, experience, social influence, and self-efficacy (Chen, Park and Putzer, 2010). Other factors like economic, demographic factors and external variables (Venkatesh and Davis, 2000) was claimed to be insufficient in explaining users' attitudes and behavioural intentions in adoptions.

For instance, in the study of the m-government service acceptance in Malaysia, the constructs from the TAM, TRA, UTAUT were integrated. The adoption of different types of technologies was argued to not be sufficient in explaining the outcome with the used of generic models of TAM solely (Althunibat, Azan and Ashaari, 2011). Therefore, since the objective of this research study is to investigate and deepen understanding of the influencing predicting factors that may affect the user acceptance of wearable computing, integration of relevant technology acceptance theory, innovation adoption theory and relevant specific mobile technology factor have been sensibly measured.

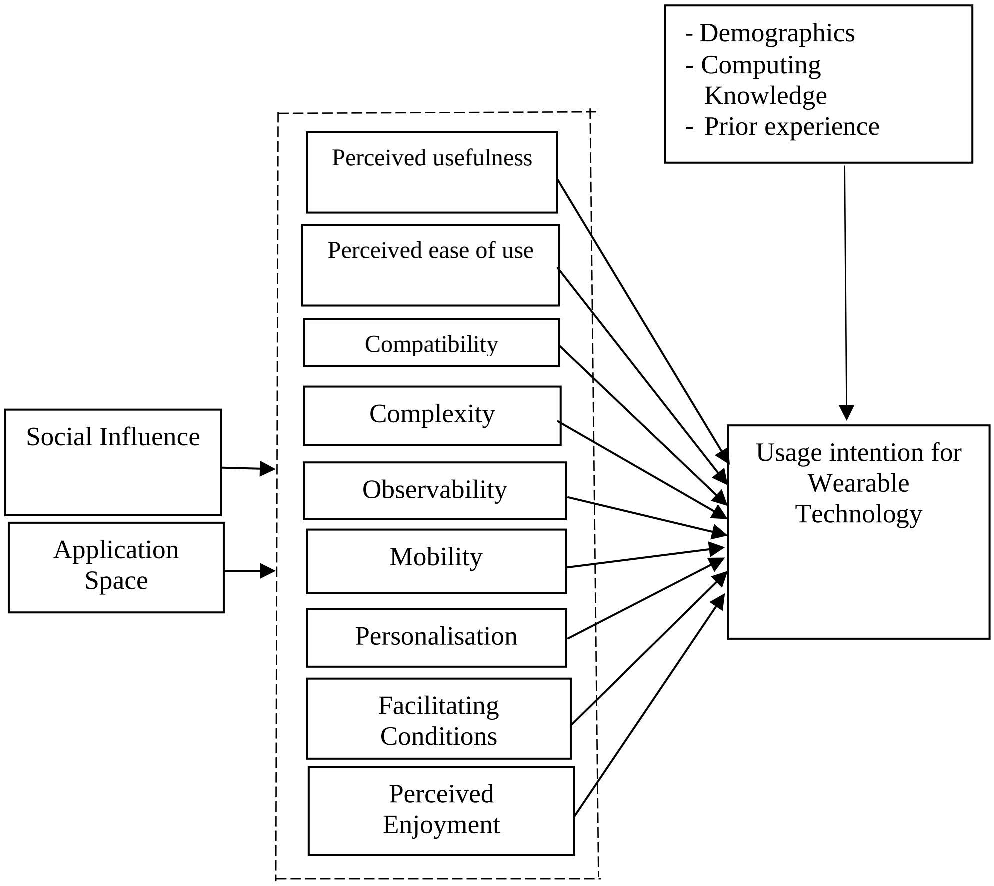


Figure 4.1: Preliminary conceptual framework

The preliminary framework as shown in Figure 4.1 was developed before the pilot study was conducted. For this study, the factors from the TAM is incorporated with factors from DOI, and mobile and pervasive computing factors as the key fundamental framework that underpins the study. The factors from the TAM introduced by Davis (1989) are perceived usefulness (PU) and perceived ease of use (PEU), compatibility, complexity and observability were selected from DOI (Rogers, 2003). Moreover, other selected factors for this research are mobility (MOB), personalisation (PN), facilitating conditions (FC) and perceived enjoyment (PE) as integrated factors, while social influence (SI) and mobile application (MA) as the precursor, which may affect the factors predicted.

This preliminary framework had been presented in British Academy Management conference (Taib, De Coster and Nyamu, 2015) and the feedback from the conference, together with pilot study, resulted in the refinement of the proposed conceptual framework as shown in Figure 4.2. Two factors which are compatibility and complexity had been removed from the framework after the pilot study due to the redundancy of complexity and compatibility. They were said to have the same meaning as perceived ease of use, as gathered from the comments from the panel to check the redundancy of factors. This framework may predict the acceptance of wearable computing for future products development and enhance the research area of wearable technology holistically.

The main contribution in this study is the integration of the established models (TAM and DOI) with related proposed factors from mobile technology factor, pervasive/ubiquitous factors to evaluate potential user usage acceptance, thus promising the diffusion of innovation. The development of the constructs (factors) for this research was selected from extant and related literature which were adapted to the context of wearable computing.

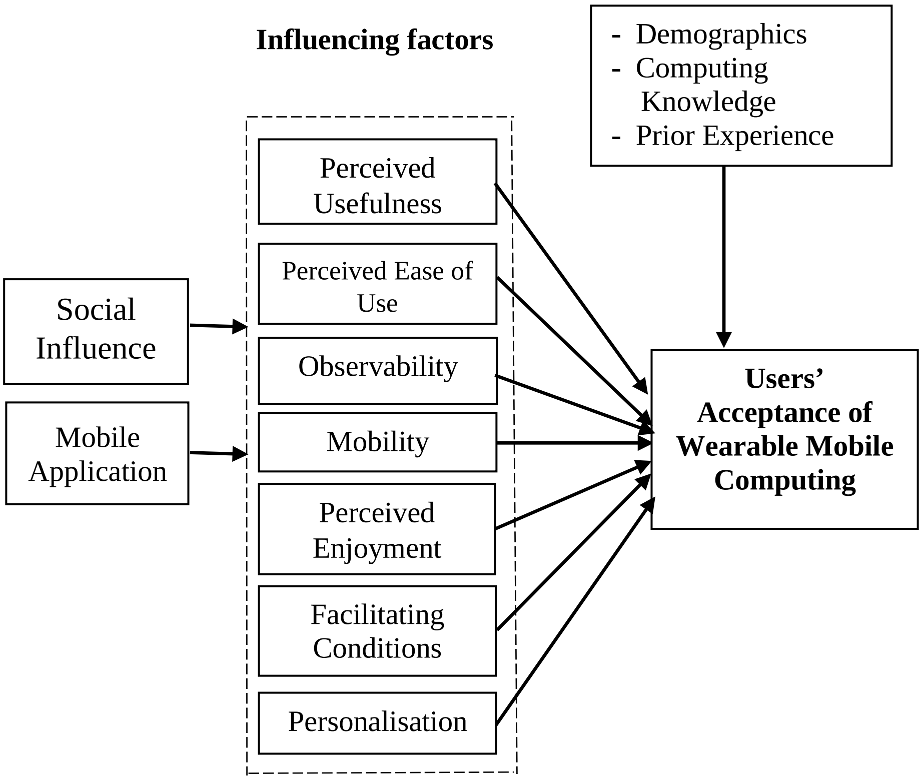


Figure 4.2: A proposed conceptual framework

The proposed framework illustrated in Figure 4.2 has been refined after conducting the pilot study. The framework was organised into three sections. The left section presents the precursor (in preliminary was application space), which was changed to mobile application and social influence. The precursors may influence the factors in the second section and the last section further influence the outcome of the dependent variable (usage intention for wearable technology). It had been changed to the specific term of users' acceptance of wearable mobile computing for the specific measure in the questionnaire of main field data collection.

Therefore, the proposed framework is divided into three main sections, social influence (SI) and mobile application (MA) as a precursor which will influence the key predicted factors of acceptance of wearable computing. The model factor is perceived usefulness (PU); perceived ease of use (PEU); observability (OBS); mobility (MOB); perceived enjoyment (PE); facilitating conditions (FC) and personalisation (PN). The influencing factors of wearable computing thus may significantly influence the dependent variable outcome of users' acceptance of wearable computing. Furthermore, the demographic characteristics, computing knowledge and prior experience are included to deepen the exploration of the outcome. The concept was chosen to operationalise the framework based on the factors used by the previous research in mobile and wearable computing. The selection is based on the wearable context which integrates with existing established innovation acceptance models.

4.2.1 Factors developed sources

The factors related to this study were selected, adapted and developed from extant literature in mobile computing, pervasive computing as well as wearable computing. The definition of the selected factors is demonstrated in Table 4.1, while the source of the factors chosen has been clarified in Table 4.2.

Table 4.1: Factors definition for the conceptual framework

Factors	Definition
Perceived Usefulness	Perceived usefulness is the extent to which an individual believes that using a specific system would improve his or her job performance.
Perceived Ease of Use	Perceived ease of use is the degree to which an individual may believe that using a particular system would be free of effort.
Observability	Observability is the degree of making visible the results of innovation.
Mobility	Mobility is the factor for mobile computing to provide a pervasive and ubiquitous connection that encourages users' behavioural intention to use the services.
Personalisation	Personalisation is the ability to customise wearable technology services to fit the user's preferences.
Facilitating Conditions	Facilitating Conditions is defined as the degree to which an individual believes that the conditions exist, which gives them control (or choice) over whether they perform a behaviour.
Perceived Enjoyment	Perceived enjoyment is defined as interesting, fun, enjoyable, and entertaining to adopt wearable computing technology.
Social Influence	Social influence is defined as the user's perception that most people who are important to him may think that he should or should not perform the behaviour.
Mobile Application	Mobile application usage with a program designed that runs on a mobile device (smartphone, tablet) operated by the mobile operating system owner, like the Apple App Store, Google Play, to access the mobile services.

To develop the conceptual framework, the related factors which are significantly used in the users' acceptance study of technological innovation and mobile technology, as well as wearable computing adoption in a different country, were identified from extant literature of TAM, DOI and pervasive computing.

Table 4.2: Conceptual framework factors sources

Factors	Theories/ Factor/source adapted
Perceived Usefulness, Perceived Ease of Use	From Technology Acceptance Model (TAM) (Davis, 1989; Venkatesh and Davis, 2000; Wong and Hiew, 2005; Yang, 2005; Luarn and Lin, 2005; Wakefield and Whitten, 2006; Kim, Chan and Gupta, 2007; Hong *et al.*, 2008; Choi, Kim and Kim, 2011; Daud *et al.*, 2011; Faziharudean and Li-Ly, 2011; Hameed, Counsell and Swift, 2012; Park and Kim, 2014; Sabir, Shahnawaz and Batool, 2014; Shaikh and Karjaluoto, 2015; Kim and Shin, 2015; Lunney, Cunningham and Eastin, 2016; Wu, Wu and Chang, 2016; Jeong, Byun and Jeong, 2016)
Observability	Diffusion of Innovation Theory (DOI) (Al-Gahtani, 2003; Rogers, 2003; Chen, Park and Putzer, 2010; Al-Jabri and Sohail, 2012; Hameed, Counsell and Swift, 2012; Wu, Wu and Chang, 2016)
Mobility	(Hong *et al.*, 2008; Faziharudean and Li-Ly, 2011; Karahanoglu and Erbug, 2012; Kim and Mirusmonov, 2012; Park and Kim, 2014; Kim and Shin, 2015)
Personalisation	(Saeed, 2011; Ho, 2012; Kim and Mirusmonov, 2012)(Ho, 2012)
Facilitating Conditions	(P. Pedersen, 2005; Nor and Pearson, 2008; Gu, Lee and Suh, 2009; Saeed, 2011; Al-Jabri and Sohail, 2012; Yu, 2012; Moran, Nishida and Nakata, 2013; Dehghani, 2016; Gu, Wei and Xu, 2016)
Perceived Enjoyment	(Choi, Kim and Kim, 2011; Faziharudean and Li-Ly, 2011; Kim, 2012; Tojib and Tsarenko, 2012; Yang, 2012; Moorty, Sann and Ling, 2014; Choi and Kim, 2016; Wu, Wu and Chang, 2016; Alzahrani *et al.*, 2017)
Social Influence	(Hong *et al.*, 2008; Faziharudean and Li-Ly, 2011; Yu, 2012; Moorty, Sann and Ling, 2014; Wu, Wu and Chang, 2016)
Mobile Application	(Chen *et al.*, 2011; Wang, Liao and Yang, 2013; Lazim and Sasitharan, 2015)

Demographic and Users' characteristics

Demographic factors may play a significant role in diffusion decisions. A survey conducted in Malaysia reveals that both demographic and psychographic variables affect the adoption of innovations such as in m-banking, the demographic characteristics like age, gender, personal income, and education (Shaikh and Karjaluoto, 2015). In the study of technology adoption, in UTAUT, there are four key moderating variables: experience, voluntariness, gender, and age (Venkatesh *et al.*, 2003; Weng, 2016). Technology self-efficacy, technology innovativeness and experience using technology for the individual level were expected to be significant moderating variables of mobile shopping adoption (Yang, 2012). Gender and age were used as the moderating factors in categorising the samples and identifying the characteristics among different groups in the smartwatch acceptance study (Wu, Wu and Chang, 2016). This research employed age group, gender, computing knowledge and prior experience to identify the effect on users' acceptance of different demographics and characteristics.

Users' Acceptance of Wearable Computing (Behavioural Intention)

Behavioural intention is a meaningful predictor of actual behaviour, and this construct possesses various determinants in different cases. TAM has connected perceived usefulness and attitude to behavioural intention (Davis, 1989; Wu, Wu and Chang, 2016).

The research model adopts TAM as a belief influences users' behavioural intention in using mobile banking when they perceive it to be useful and helpful for efficiency (Gu, Lee and Suh, 2009). The behavioural intention (BI) is used in TAM to predict and explain human behaviour in the various area (Wu and Wang, 2005). Prior studies found that the TAM seemed to have greater outcomes compared to TPB in explaining behavioural intention to use an IS

(Luarn and Lin, 2005). A research study explored the users' intentions of using a smartwatch by combining IDT, TAM, and UTAUT (Wu, Wu and Chang, 2016). For this research study, BI is measured for understanding users' acceptance of wearable computing as the outcome.

4.3 Hypotheses development

In quantitative research, usually in a survey study, the researcher may use quantitative research questions and hypotheses or objective as the focus of the study. According to Creswell (2013), the hypothesis is the prediction that the researcher makes about the expected outcomes of the relationship among variable. The numeric estimates population values based on data collected from the samples. Testing of hypothesis employs statistical procedure in which the researcher draws an inference about the population from a study sample as well as stating the direction of the study. The rigorous form of quantitative research follows from a test as a theory.

From the literature in Chapter 2, the emergence of wearable computing is still at an early stage, and there is limited research done to understand users' acceptance of wearable computing. A research gap was identified from the wearable computing literature, especially in the developing countries. It was found that some scholars had suggested different hypotheses based on the different model to study the acceptance of wearable computing that might not be the same condition in the population of a developing country.

Thus, in this research, the main focus is to explore the factors developed and tested to predict the significant effect on the outcome of the study. Moreover, researchers highlighted that wearable computing is growing research and limited empirical studies on users' perception towards acceptance of innovation in the mobile technology era. The emergence of wearable computing and a widespread of smartwatches as a popular wearable computing (Cecchinato, Cox and Bird, 2015; Kim and Shin, 2015; Choi and Kim, 2016; Chuah *et al.*, 2016; Dehghani, 2016; Pizza *et al.*, 2016; Taib, De

Coster and Nyamu, 2016a) will contribute the insights for future acceptance as well as product development in wearable technological innovation.

4.3.1 Social Influence

Social influence refers to "*the perceived social pressure to perform or not to perform the behaviour*" (Ajzen, 1991). Social influence was represented as a subjective norm in TRA and TAM2, while in UTAUT social influence is known as "*the degree to which an individual perceives that important others believe he or she should use the new system*" (Venkatesh *et al.*, 2003).

Gao, Li and Luo (2008) found that social influence positively influences adoption in healthcare wearable device. Moreover, social influence refers to the perceived pressure from the people who might think it is important. Research in social psychology concerning this concept and social influence is incorporated in the theory of planned behaviour as an independent predictor of behavioural intention.

To be recognised in a group, the user should act in ways of the group norms. Social influence is an essential antecedent of user behaviour in information technology. Social influence was found to influence users to continually use mobile data services (Hong *et al.*, 2008). Social influence also was found to have a significant positive impact on the prediction of consumers' usage intention for mobile data services in Malaysia (Faziharudean and Li-Ly, 2011). In the study of Generation Y in Malaysia to adopt m-commerce, it showed social influence has a positive effect on Behaviour Intention to adopt m-commerce (Moorty, Sann and Ling, 2014). Moreover, social influence had directly influenced the user's intention to use a wearable device, which were smart bands (Weng, 2016).

In TRA and TPB, social influence was tested as subjective norms on behavioural intention (Bhatti, 2007). In this study, social influence is predicted as a precursor that may influence the model factors, hence contributing to users' acceptance of wearable computing. The hypotheses formulated on social influence are demonstrated in Figure 4.3.

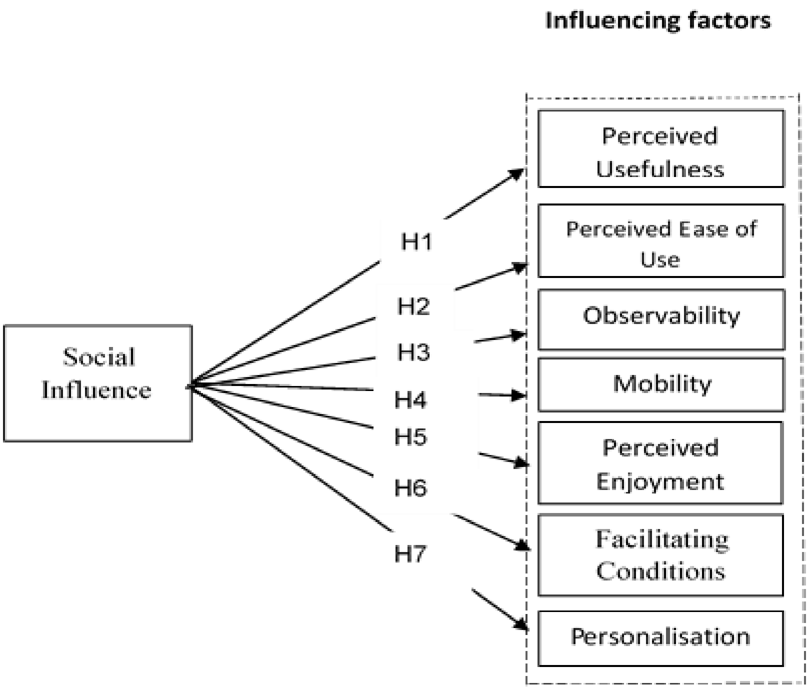


Figure 4.3: Hypotheses developed related to Social Influence

Therefore, it is hypothesised that:

H1: Social Influence has a positive effect on Perceived Usefulness

H2: Social Influence has a positive effect on Perceived Ease of Use

H3: Social Influence has a positive effect on Observability

H4: Social Influence has a positive effect on Mobility

H5: Social Influence has a positive effect on Facilitating Conditions

H6: Social Influence has a positive effect on Perceived Enjoyment

H7: Social Influence has a positive effect on Personalisation

4.3.2 Mobile Application

A mobile application (or Mobile Apps) is known as a software application that runs on a mobile device (smartphone, tablet, iPod) and has an operating system that supports standalone software. The application is available in distribution platforms, which are operated by the owner of the mobile operating system, for instance, the Apple App Store, Google Play, Windows Phone Store and BlackBerry App. Mobile Apps may be downloaded by users from the Mobile Apps store or preloaded onto the mobile device (Wang, Liao and Yang, 2013). The mobile application distribution is where an application is developed for the market and purchased by users for mobile devices (Holzer and Ondrus, 2011).

Accordingly, Apps may become a revenue source in the mobile communication sector and has received growing interest. It is important to understand the users' perception of Apps usage and the profit from Apps (Wang, Liao and Yang, 2013). The most common usage of the smartphone is still related to its core functionalities which are to make phone calls and SMS. Interestingly, 40% of the respondents have reported that they use a smartphone for instant messaging daily (Osman *et al.*, 2012). In addition, entertainment is one type of smartphone usage with music playing, movies, and games. There were four applications which received high respond rates: Facebook; download; e-mail and YouTube. From that study, the significant increase in smartphone demand among Malaysian consumers was due to smartphones' multipurpose features and applications that make life easier (Lazim and Sasitharan, 2015).

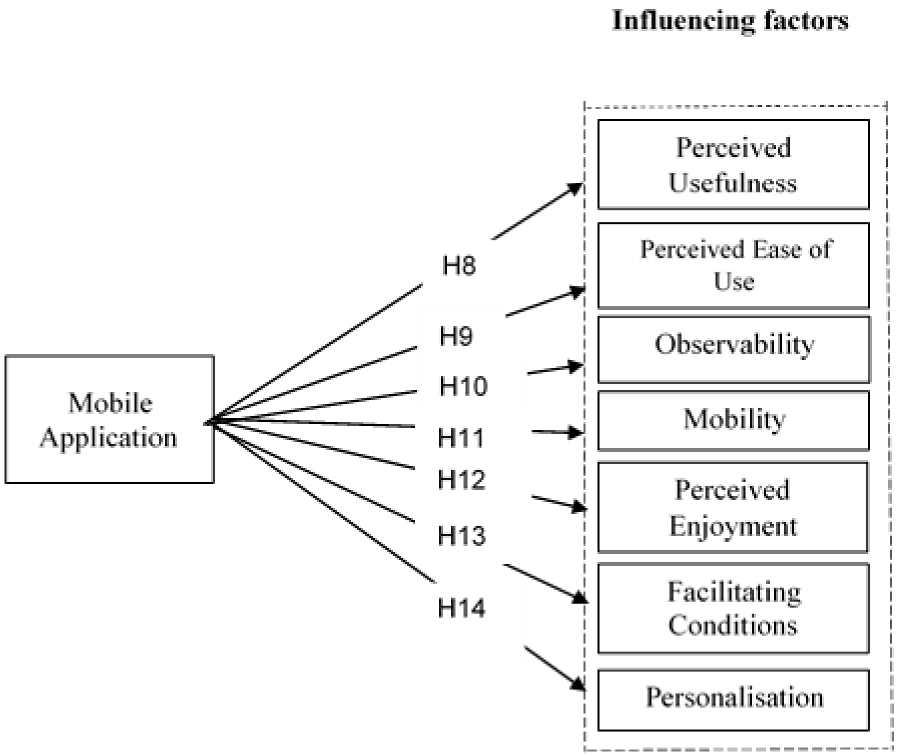


Figure 4.4: Hypotheses developed related to Mobile Application

Having fitness apps in smartwatches make users feel it is worth spending and it has become a major influencing factor for users to adopt smartwatches, thus boosting the motivation to buy smartwatches (Adapa, 2016). The survey results on m-commerce of 44 mobile applications were employed in online Chinese consumers, which they perceived as convenient and "always-on". (Chen *et al.*, 2011). Mobile applications are essential like a calculator, an alarm clock for a daily basis for work-related or personal purposes (Cheng *et al.*, 2015). Since the mobile application has become a convincing factor, it was chosen as a precursor in influencing the model factor in users' acceptance of wearable computing for this study. Figure 4.4 shows the hypotheses developed related to the Mobile Application.

Therefore, it is hypothesised that:

H8: Mobile Application has a positive effect on Perceived Usefulness

H9: Mobile Application has a positive effect on Perceived Ease of Use

H10: Mobile Application has a positive effect on Observability

H11: Mobile Application has a positive effect on Mobility

H12: Mobile Application has a positive effect on Facilitating Conditions

H13: Mobile Application has a positive effect on Perceived Enjoyment

H14: Mobile Application has a positive effect on Personalisation

4.3.3 Perceived Usefulness

The factors in the conceptual framework proposed by Davis (1989) might be the most popular theories to examine user acceptance and behaviour of new computer technologies. Davis (1989) defined perceived usefulness as *"the extent to which an individual believes that using a specific system would improve his or her job performance",* while perceived ease of use is *"the degree for an individual to believe that using a particular system would be free of effort".*

Empirical results on the study of smartwatch adoption exhibited perceived usefulness as important factors (Chuah *et al.*, 2016). A study from wearable computing adoption in the European market consisting of expert interviews revealed that the strongest factor in users' acceptance is perceived usefulness (Gribel, Regier and Stengel, 2016). Research on the Wearable fitness technologies (WFT) acceptance that attempted to extend the TAM also found PU has a positive relation. Moreover, perceived usefulness has a significant effect on the user's attitude in mobile banking in Malaysia (Daud *et al.*, 2011). In particular, TAM has theoretical models which have been broadly utilised in understanding user acceptance of ICT that postulates perceived usefulness (PU) as the key psychological determinants of intention to use the technology.

Therefore, it is hypothesised that:

> H15: Perceived usefulness has a positive effect on users' acceptance to adopt wearable computing

4.3.4 Perceived Ease of Use

According to TAM, the perceived ease of use (PEU) is defined as '*the degree to which a person believes where using a particular system would be free of an effort'.* Perceived ease of use is used in the study of smartwatch acceptance (Jeong, Byun and Jeong, 2016); however, perceived ease of use has no significant impact on attitude toward using the smartwatch in the study conducted by Wu, Wu and Chang (2016). When users find a particular technology easy to learn and operate, users may likely be more confident in using it and thus more likely to accept it (Buenaflor and Kim, 2013). Research to investigate user mobile commerce acceptance found Perceived ease does not directly influence behavioural intention to use but indirectly through PU (Wu and Wang, 2005). Past research provide evidence on the significant effect of perceived ease of use on the intention to use in technology.

Therefore, it is hypothesised that:

> H16: Perceived ease of use has a positive effect on users' acceptance to adopt wearable computing

4.3.5 Observability

Observability of innovation describes "*the extent to which an innovation is visible to the members of a social system, and the benefits can be easily observed and communicated*" (Rogers, 2003). Observability is also defined as the ability to access the services at any time from anywhere without any delay;

the effect of transactions are seen immediately, thus conveying benefits to others, so the observability has a positive effect on adoption (Al-Jabri and Sohail, 2012).

Result demonstrability is a relatively less examined construct in technological innovation. In the TAM2, the result demonstrability is defined as the tangibility of the results of using the innovation, including their observability. A user might be expected to form more positive perceptions of a system if the positive results are observed (Venkatesh and Davis, 2000). The study on smartwatch acceptance postulated that higher result demonstrability might motivate the willingness to accept the innovation (Wu, Wu and Chang, 2016). Therefore, it is hypothesised that:

> H17: Observability has a positive effect on users' acceptance to adopt wearable computing

4.3.6 Mobility

Mobility is an important factor for mobile computing to be able to provide a pervasive and ubiquitous connection to motivate consumers' behavioural intention to use the services. The study examined perceived mobility as a determinant for mobile cloud services as a factor of any wireless or ubiquitous network service. Perceived mobility refers to *"the degree to which users are aware of the mobility value of mobile services via a user's device"* (Park and Kim, 2014). In the study of mobile data services, the uniqueness of mobility access to mobile data services anywhere, anytime was considered as a determinant. This implies that the extent to which mobile data services can maintain instant connectivity on the road is an important consideration for users. Previous technology innovation adoption of software packages such as Microsoft Word, Windows operating system, Excel), training systems, do not address the notion of mobility. (Hong *et al.*, 2008)

A past research study conducted in Malaysia on mobile data services from Faziharudean and Li-Ly (2011) found that mobility is the key determinant to enable users to access these services anytime and anywhere. Lyytinen and Yoo (2001) also urged mobility will be the most distinctive characteristic of future computing environments, enabling nomadic information creation and sharing. Another study of mobile data services employed perceived mobility as being able to provide pervasive and timely connections (Hong *et al.*, 2008).

Mobility is evolving from portability to seamlessly wearable technology, enhancing the ubiquity of personal communication. MOB's "anywhere" characteristic of mobile technology refers to user's belief that they can be in different locations while using their devices. Mobility has been included in the smartwatch adoption model (Kim and Shin, 2015). Mobility in the ubiquitous environment will lead users to adopt mobile devices with ubiquitous computing capacity (Kim, 2012).

Park and Kim(2014) urged and examined perceived mobility as a determinant of perceived usefulness of mobile cloud services, and they claimed mobility (portability) is the main factor of any wireless or ubiquitous network service. Therefore, it is hypothesised that:

> H18: Mobility has a positive effect on users' acceptance to adopt wearable computing

4.3.7 Facilitating Conditions

Wong and Hiew (2005) suggested that the adoption of mobile entertainment in Malaysia is driven by the attributes of mobile services which include: Ubiquity, personalisation, localisation, timeliness, network stability and mobility.

In UTAUT, facilitating conditions is the "*degree to which an individual believes that an organisational and technical infrastructure may exist to support the use of the system*" (Venkatesh *et al.*, 2003). FC also is defined as the degree to which an individual believes the conditions may give them control or choice to perform a behaviour (Moran et al. 2013; Saeed, 2011). For example, using the wearable monitoring device, then the facilitating conditions would be related to whether or not a person can remove it (Moran et al., 2013).

An individual may seek assistance when interacting with a new system, that is a challenging experience and the support, such as tutorials to seek expert assistance must be provided; so, the more confident the support system is, the more likely users are in adopting the service (Saeed, 2011). Facilitating conditions can also contribute towards convenience because the user knows that support is available and will likely adopt wearable computing. Facilitating conditions is similar to perceived behavioural control in the Theory of Planned Behaviour (TPB) model. Some scholars proved that facilitating conditions would have a positive impact on the trust of e-commerce and mobile commerce (Gu, Wei and Xu, 2016).

Therefore, it is hypothesised that:

> H19: Facilitating conditions has a positive effect on users' acceptance to adopt wearable computing

4.3.8 Perceived Enjoyment

Users' perceived enjoyment to adopt wearable computing is interesting, fun, enjoyable, and entertaining. Perceived enjoyment is defined as ‘'*the extent to which the activity of using that specific system is perceived enjoyable in its own right, and apart from any performance consequences resulting from system use*" (Davis, Bagozzi and Warshaw, 1992; Alzahrani *et al.*, 2017). According to Yang (2005) and Faziharudean and Li-Ly (2011), fun is an important factor in determining technology adoption. Perceived enjoyment was the strongest determinant in creating the beliefs of the extended TPB with the idea that if there is a greater the level of experience, there is a greater level of perceived enjoyment influencing higher mobile shopping adoption (Yang 2005).

Hong *et al.* (2008) in their study found that perceived enjoyment influence the usage of mobile data services as innovative technology. Choi and Kim (2016) found post enjoyment to significantly influence post-adoption behaviour for mobile data service. Users are likely to adopt the technology and others personally enjoy on its own right (Kim, Chan and Gupta, 2007; Kim, 2012).

Perceived enjoyment was significantly found to influence a user to adopt a smartwatch that interacted with attitude to influence behavioural intention (Wu, Wu and Chang, 2016).

Therefore, it is hypothesised that:

> H20: Perceived enjoyment has a positive effect on users' acceptance to adopt wearable computing

4.3.9 Personalisation

The personalisation of mobile devices has made it easier for the user to fill in their preferences, so it is an important feature of ubiquitous computing (Kim, 2012). The on-body technologies offer more intimate interactions than other products and therefore may be more personal, enjoyable and expressive (Kuru and Erbuğ, 2013).

Research on using mobile services revealed that mobile personalisation provided an important factor and the effectiveness of location personalisation. Personalisation is the process of generating and presenting individuals with the right content and format (e.g. correct time and location) (Ho, 2012).

An individual's ability to personalise the service according to his or her preferences and the ability of the system to uniquely identify the individual constitute an important perspective related to uniqueness (Saeed, 2011). For this study, personalisation is the ability to customise wearable computing services to fit the user's preferences.

Personalisation is considered to be a vital factor in the success of mobile devices and services. The personalisation services on mobile devices deal with very dynamic user experiences because a mobile user is moving around. The idea of the personalisation of mobile devices is to make it easier for the user to fill in their preferences, and to make the perception of the mobile device utility richer (Kim and Mirusmonov, 2012).

Therefore, it is hypothesised that:

> H21: Personalisation has a positive effect on users' acceptance to adopt wearable computing

Hypotheses relating to influencing factor: PU, PEU, OBS, MOB, PE, FC and PN have a positive effect on users' acceptance to adopt wearable computing are summarised and is shown in Figure 4.5.

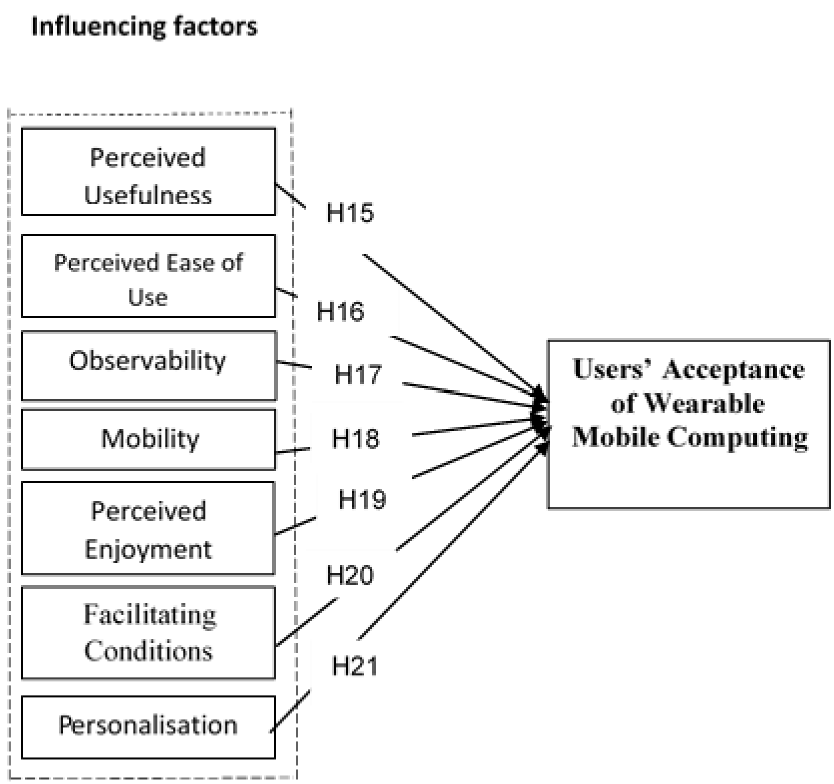


Figure 4.5: Hypotheses related to influencing factors

4.4 Chapter summary

In summary, the Innovation Acceptance Model for Wearable Computing was developed from the established model of the technology acceptance models, innovation adoption and related factor from mobile technology and pervasive computing literature. The uniqueness of this proposed conceptual framework underpinning this study is that it comprises of three sections which include: SI and MA as the precursors; the predicted model factors are PU, PEU, OBS, MOB, FC, PE and PN influencing users' innovation acceptance; and the outcome of users' acceptance of wearable computing. This proposed framework is a comprehensive innovation acceptance model operationalised based on the integration of the existing TAM model, DOI and the factors in pervasive computing, mobile technologies and wearable computing study in the Malaysian context. Furthermore, the demographic characteristics in terms of age group and gender, computing knowledge and prior experience are included to better explain the unique characteristics of the outcome. Moreover, in this chapter, all hypotheses were formulated accordingly and will be tested empirically in Chapter 6 to examine the significant factors for this study. In the next Chapter, the descriptive and inferential analyses will be conducted systematically to test the model developed.

CHAPTER 5

5 SURVEY CHARACTERISTICS

5.1 Introduction

In this research chapter, the cross-sectional survey strategy with a self-administered questionnaire technique was conducted in Malaysia. This questionnaire was developed and empirically tested the model factors to deeper understand the factors that may influence potential users to accept consequently adopting wearable computing in Malaysia as a developing country.

The first section is to understand the demographic profile of the respondents, including gender, age, job position, prior experience in mobile technology and computing knowledge. The second section is the main idea of this research to explore potential users' perception of the model factors to accept the technological innovation of wearable computing using the 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) for the items in each construct. The last part is the open-ended questions to understand further how potential users perceive about this emerging technology. Forty (40) items or statements were developed and used to measure the potential users' perception in Malaysia to accept wearable computing in their daily lives.

The questionnaire was distributed from December 2015 until February 2016. The respondents took ten to fifteen minutes approximately to answer the questions.

5.2 Sample profile

An Early Adopter, according to Rogers (2003), has formal education in more years, are literate, has higher social status and has greater knowledge of innovation; he claimed that a few diffusion studies found that age to be related to innovation adoption and they might be younger or older. In this research, the sample of respondents is the potential users for this emerging innovation in wearable computing. Table 5.1 shows that from the sample size consisting of 272 respondents in Malaysia, 33.5% (91) of the respondents are male and 66.5% (181) are female. Most of the respondents' are aged between 18-26 years at 165 respondents (60.7%), followed by 82 respondents (30.1%) between 27-35 years, 16 respondents (5.9%) in the age range of 36-44 years and 9 (3.3%) in the age group 45-54; there were no respondents 55-64 and 65 or over. The majority of respondents are employed or is a professional in an organisation, consisting of 130 (47.8%), followed by students at 140 (51.5%), and there were two ‘other’s (0.7%) retained for data completeness.

From Table 5.2, most of the potential users have prior experience in mobile computing, and used a smartphone for business (21 respondents, 7.7%), personal (211 respondents, 77.6%) and for study (40 respondents, 14.7%). The majority used an Android operating system for their smartphone.

Table 5.1: Sample profile for a research study

Characteristics		**Frequency**	**Percent (%)**
Gender	Male	91	33.5
	Female	181	66.5
Age Groups	18-26	165	60.7
	27-35	82	30.1
	36-44	16	5.9
	45-54	9	3.3
Position	Employed	130	47.8
	Student	140	51.5
	Others	2	0.7

Table 5.2: Sample profile of prior experience in mobile computing

Characteristics		**Frequency**	**Percent (%)**
Purpose of using a smartphone	Business	21	7.7
	Personal	211	77.6
	Study	40	14.7
Smartphone operating system	Android	186	68.4
	iPhone OS	80	29.4
	Blackberry	2	0.7
	Window	2	0.7
	Others	2	0.7

As shown in Table 5.3, the respondent was asked about their lifestyle, particularly their time spent on the Internet to deepen understanding on their computing knowledge. Since the respondents are Malaysian, the monthly expenditure was asked in MYR (Malaysian Ringgit) for them to answer the questions easily. For this purpose, MYR 5.5= GBP 1 (usual average currency conversion). For monthly spending on entertainment, the highest spending was less than MYR 50 (approximately GBP 10) with 127 (46.7%) respondents. Furthermore, the monthly spending on mobile services, again, less than MYR 50 (approximately GBP 10) constituted the majority of respondents with 139 (51.1%) while the least was six respondents who spent more than MYR 300 (approximately GBP 50). The monthly spending on online shopping with less than MYR 50 (approximately GBP 10) constituted the majority of respondents of 143 (52.6%). The respondents also were asked about their willingness to buy wearable computing technology; the majority of respondents of 114 (41.9%) willing to spend MYR 50 (approximately GBP 10) to get that device. Table 5.4 shows the mobile application usage of potential respondents. The mobile application question was selected from the past research study by Chen et al. (2011). The survey results found that Chinese users prefer using mobile phone applications for information searching, and they ranked the top score of usage: searching for specific information on the Internet, sending or receiving e-mails and using Internet search engines. The researcher chose eight items to represent the mobile application usage after refining from a pilot study with the most frequently used.

Table 5.3: Sample profile of computing knowledge

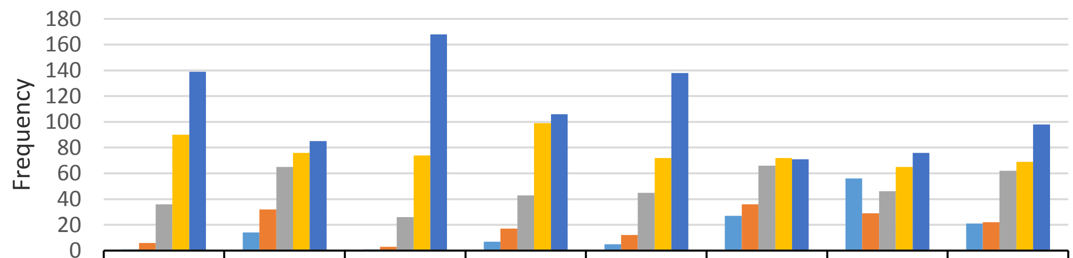
Characteristics		Frequency	Percent (%)
Monthly spend (MYR) on entertainment	<50	127	46.7
	51-100	59	21.7
	101-200	59	21.7
	201-300	19	7.0
	>300	8	2.9
Monthly spend (MYR) on mobile services	<50	139	51.1
	51-100	67	24.6
	101-200	49	18.0
	201-300	11	4.0
	>300	6	2.2
Monthly spend (MYR) on shopping on the internet	<50	143	52.6
	51-100	63	23.2
	101-200	36	13.2
	201-300	14	5.1
	>300	16	5.9
Willingness to buy wearable computing (MYR)	<100	114	41.9
	51-100	49	18.0
	101-500	47	17.3
	501-1000	27	9.9
	1001-2000	17	6.3
	>2000	18	6.6

**For this purpose, MYR 5.5= GBP 1 (usual average of currency conversion).*

Table 5.4: Mobile Application usage

Mobile Application (1=rarely to 5=frequently)	1		to		5
Searching for specific information on the Internet	1	6	36	90	139
Sending or receiving e-mails	14	32	65	76	85
Using Internet search engines (e.g., Yahoo, Google, etc.)	1	3	26	74	168
Sharing digital files or personal information online with friends, family and others	7	17	43	99	106
Chatting with others on the Internet	5	12	45	72	138
Managing personal appointments and meetings through the Internet	27	36	66	72	71
Performing routine banking services (pay bills, check account, etc.)	56	29	46	65	76
Listening to music from the Internet, including downloaded MP3	21	22	62	69	98

Mobile applications are urged to be beneficial for daily work or study, personal purposes or business. Cheng *et al.* (2015) in their study found that attitude, subjective norm, and perceived behavioural control have positively influenced the usage of mobile applications. The reason behind asking about the mobile applications is to understand this precursor that may drive the user to have a positive relationship with the model factors. Clearly, from Figure 5.1, almost all applications were frequently used by the potential user of wearable computing. The highest frequently used was 168 respondents using internet search engines, for example, Google, Yahoo followed by 139 respondents searching for specific information on the Internet and the least was managing personal appointments or meetings using the Internet.



	Searching for specific information on the Internet	Sending or receiving e-mails	Using Internet search engines (e.g. yahoo, google, etc.)	Sharing digital files or personal information online with friends, family and others	Chatting with others on the Internet	Managing personal appointmen ts and meetings through Internet	Performing routine banking services (pay bills, check account, etc.)	Listening to music from the Internet, including downloaded MP3
1	1	14	1	7	5	27	56	21
2	6	32	3	17	12	36	29	22
3	36	65	26	43	45	66	46	62
4	90	76	74	99	72	72	65	69
5	139	85	168	106	138	71	76	98

Figure 5.1: Current mobile application usage

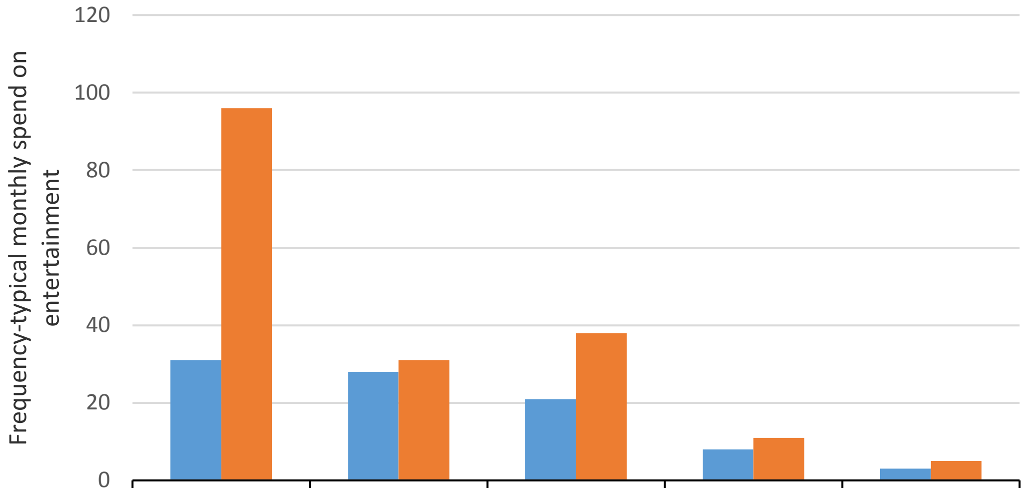
5.3 Lifestyle spending on entertainment, mobile services and shopping on the internet

Malaysia is an upper-middle income country. Malaysia today has a diversified economy to increase the quality of human capital of high-income economies. The survey report from MCMC revealed that the percentage of Internet users in 2016 was 76.9%, meaning that almost 24.5 million Internet users rose from 24.1 million in 2015. The report showed the lifestyle of Internet users in Malaysia use the Internet for their activities. Among the most popular activities was accessing the Internet by using a smartphone, with 89.4% of users making Malaysia a mobile-oriented society (Malaysian Communications and Multimedia Commission, 2017). Higher smartphone adoption amongst Internet users encouraging the digital economy. Due to that reason, this research is seeking the potential users of wearable computing technology on their typical monthly spend for entertainment (e.g., TV subscription), for mobile services and online shopping. The data was segmented based on gender, age group and the position.

5.3.1 Typical monthly spend on entertainment

Based on gender

Figure 5.2 shows typical monthly spending in MYR on entertainment (e.g., TV subscription) based on gender. For this purpose, MYR 5.5 = GBP 1 (usual average of currency conversion). After this, all the spending will be stated in MYR. The majority of users' spending on the entertainment below MYR 50 is the female category with 96 respondents, while the least was male of 3 respondents spending less than MYR 300.



	<50	51-100	101-200	201-300	>300
Male	31	28	21	8	3
Female	96	31	38	11	5

Figure 5.2 Typical monthly spend on entertainment based on gender

Based on the age group

As shown in Figure 5.3, the typical monthly spending (MYR) on entertainment based on age groups shows that the younger ages of 18-26 with 109 respondents spend less than MYR 50 and 38 respondents spend MYR 51-100. However, the age group of 45-54 years and over was found to spend less on entertainment.

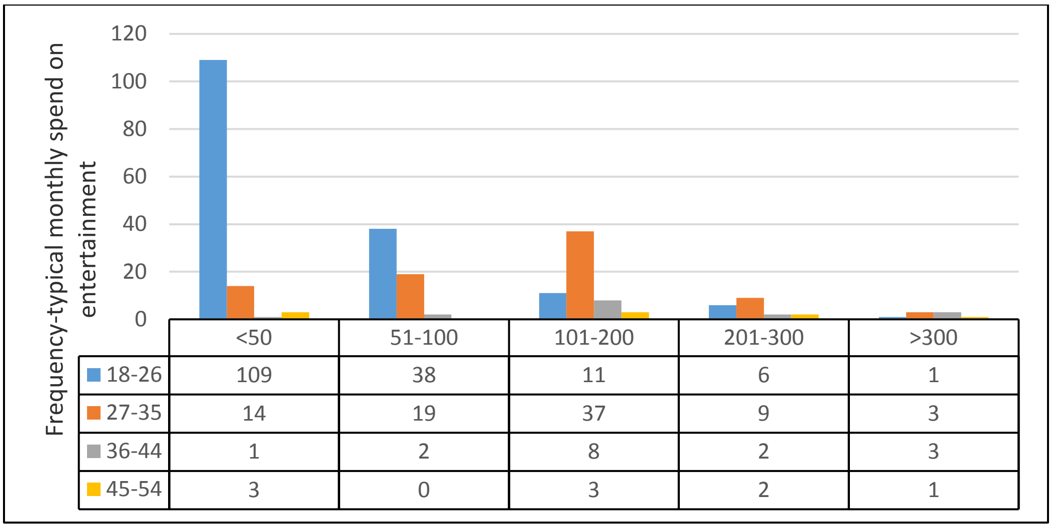


Figure 5.3 Typical monthly spend on entertainment based on the age group

Based on the position

The bar graph in Figure 5.4 shows that 100 students were spending more on entertainment which is less than MYR 50, while 51 employed personnel or professionals were spending between MYR 101-200 on entertainment.

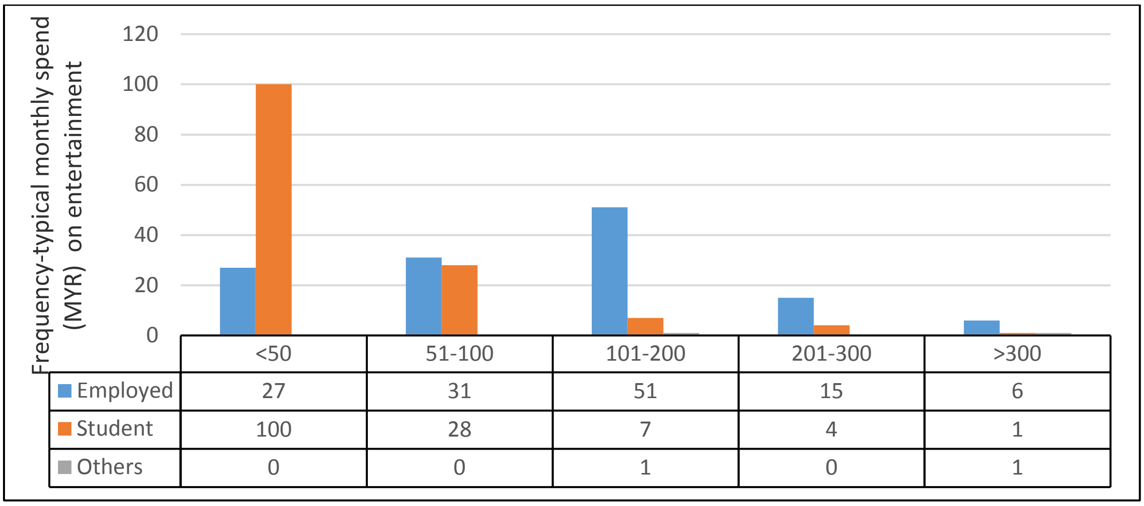


Figure 5.4: Typical monthly spend on entertainment based on the position

5.3.2 Typical monthly spend on mobile services

Based on gender

By looking at Figure 5.4, typical monthly spending (MYR) on mobile services based on gender, female respondents constitute the majority compared to male respondents. More female users were spending below MYR 50 with the frequency of 99, while both genders do not spend above MYR 300. Usually, users may prefer reasonable mobile services with high performance to do their tasks.

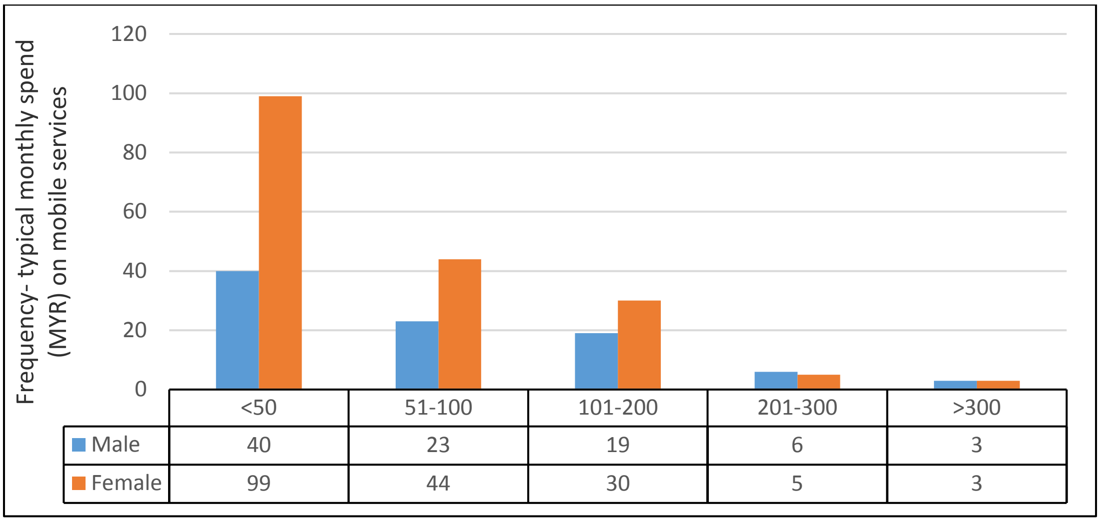
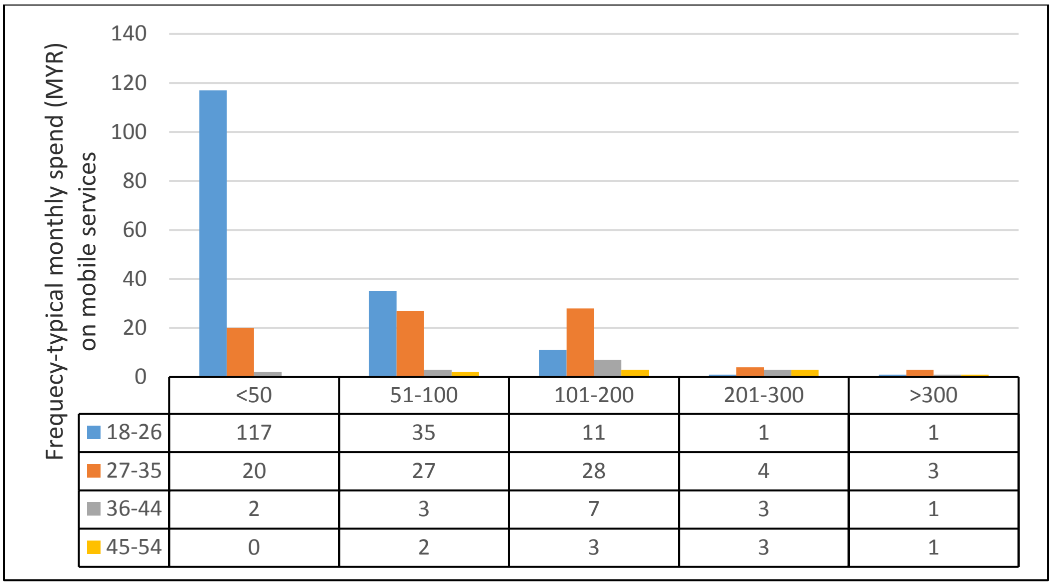


Figure 5.5: Typical monthly spend on mobile services based on gender

Based on the age group

It can be seen from Figure 5.6 that the age group of 18-26 spend less than MYR 50 at 117 respondents, which is the majority of the group, while a small portion of all the age groups spend above MYR 300 for mobile services. Younger age might be a category of users who interested in mobile service at less cost.

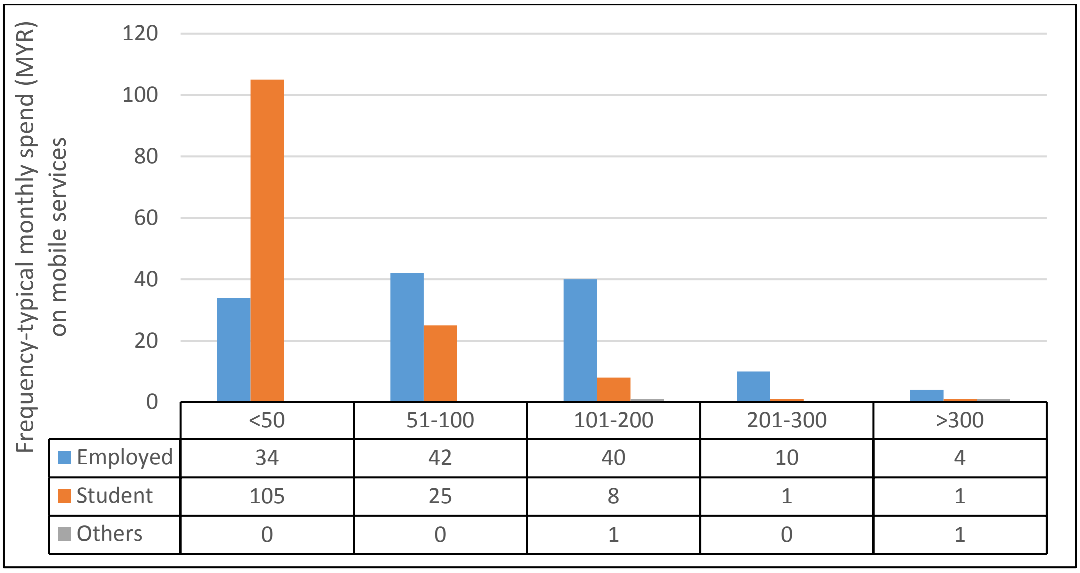


	<50	51-100	101-200	201-300	>300
18-26	117	35	11	1	1
27-35	20	27	28	4	3
36-44	2	3	7	3	1
45-54	0	2	3	3	1

Figure 5.6: Typical monthly spend on mobile services based on the age group

Based on the position

It can be seen from Figure 5.7 that 105 students have been spending less than MYR 50, which is the majority of the group, while professional personnel spend between MYR 51-100 and MYR 101-200 for mobile services more than the students. Employed personnel might spend more due to their work and getting income.



	<50	51-100	101-200	201-300	>300
Employed	34	42	40	10	4
Student	105	25	8	1	1
Others	0	0	1	0	1

Figure 5.7: Typical monthly spend on mobile services based on the position

5.3.3 Typical monthly spend on online shopping

Based on gender

It can be seen from Figure 5.8 that 97 female respondents have been spending less than MYR 50 compared to the male respondents at 46. The female respondents also spend more than males for monthly online shopping. It is reasonably common to see females do online shopping.

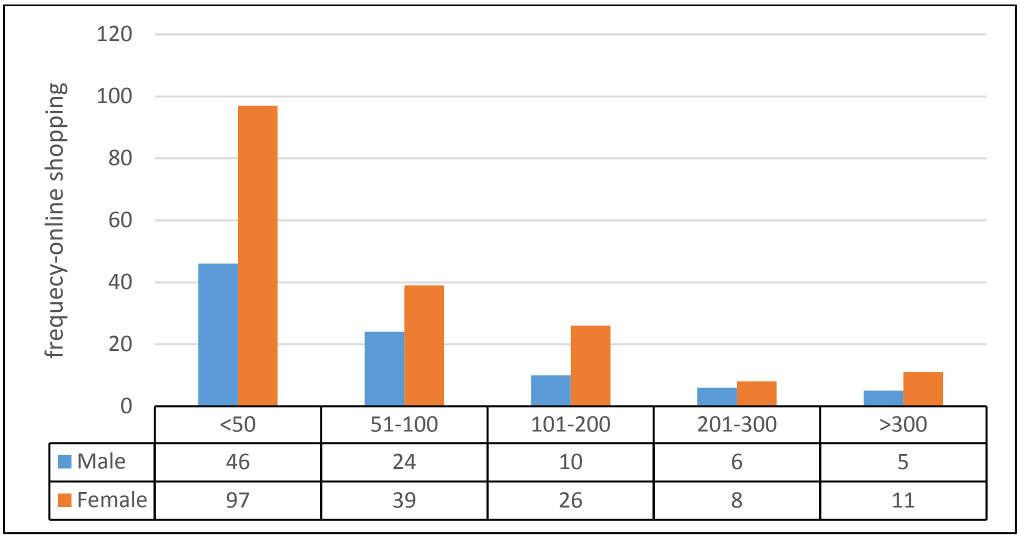
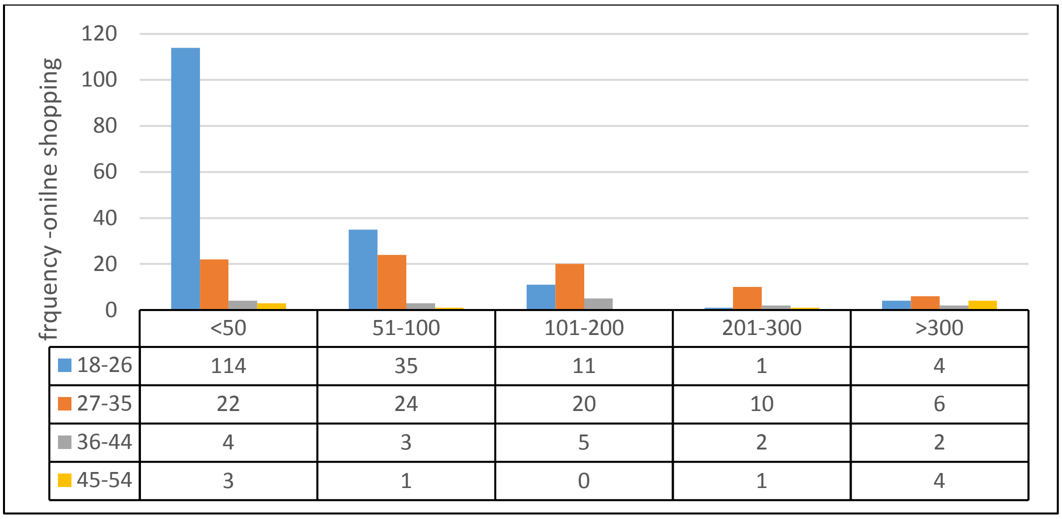


Figure 5.8: Typical monthly spend on online shopping based on gender

Based on the age group

It could be seen from Figure 5.9 that the younger age group of respondents 18-26 spend less than MYR 50 compared to respondents aged 36 and above, and those aged 27-35 spend about MYR 101-200 more for monthly online shopping. It is reasonably common to see young people do online shopping.

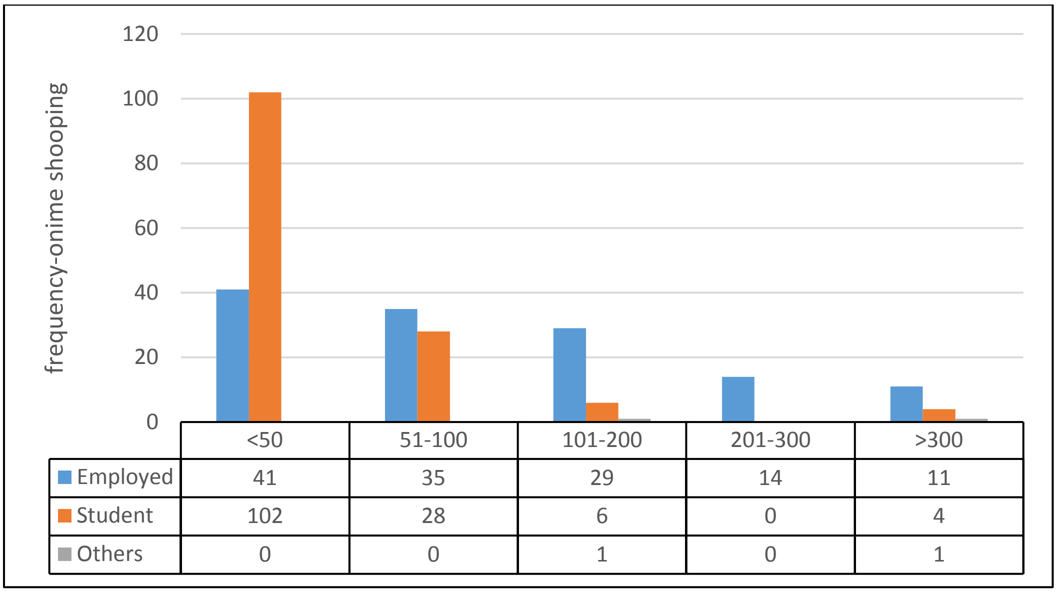


	<50	51-100	101-200	201-300	>300
18-26	114	35	11	1	4
27-35	22	24	20	10	6
36-44	4	3	5	2	2
45-54	3	1	0	1	4

Figure 5.9: Typical monthly spend on online shopping based on age group

Based on the position

It can be seen from Figure 5.10, 102 students have been spending less than MYR 50 compared to those employed with 41 respondents. Employed respondents showed spending above MYR 51, and did more monthly online shopping.



	<50	51-100	101-200	201-300	>300
Employed	41	35	29	14	11
Student	102	28	6	0	4
Others	0	0	1	0	1

Figure 5.10: Typical monthly spend on online shopping based on the position

5.4 Prior mobile experience

This section is to understand the potential users to accept wearable computing based on their prior experience and computing knowledge in Malaysia. A descriptive analysis utilising IBM SPSS V.20 was segmented by users' purpose in using a smartphone based on gender, age group and position. Prior experience in mobile usage will lead to the intention to accept the innovation mainly wearable computing. Based on the interview results from the past study, prior experience with wearable technology with the degree of personal innovativeness may influence users about the perceived risk and usefulness of such technologies (Gribel, Regier and Stengel, 2016). Hong *et al.* (2008) found that the control variables included in his study model of mobile data experience may positively affect users' attitude in continuing to use entertainment services. Furthermore, users were asked about their willingness to buy this emerging innovation to see their response to accept wearable computing.

5.4.1 Purpose of using a mobile smartphone

Figure 5.11 describes the general purpose of using the smartphone, where the vast majority of respondents use it for personal purposes of 77.6%, the least is 7.7% for study purposes.

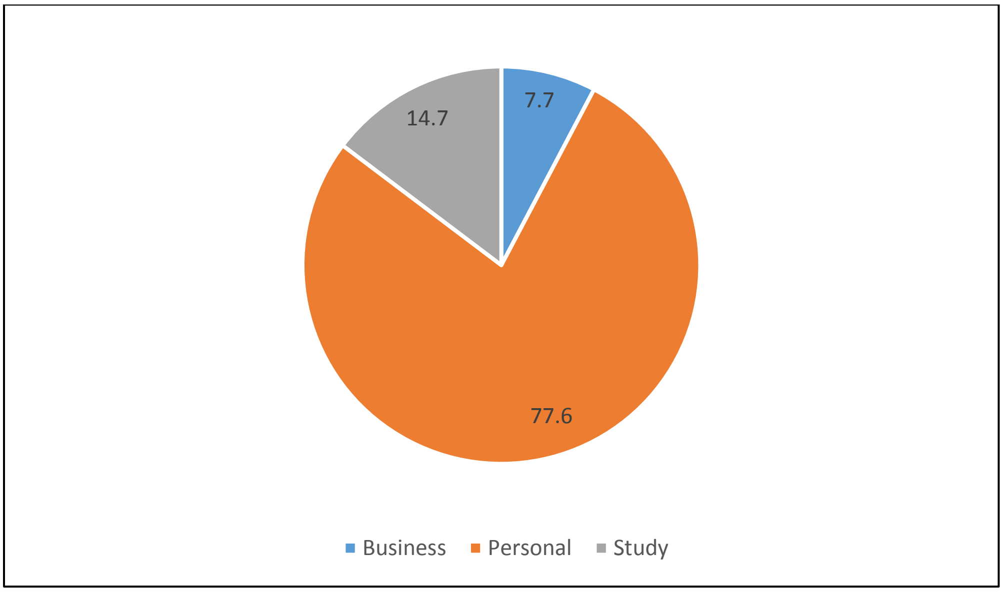
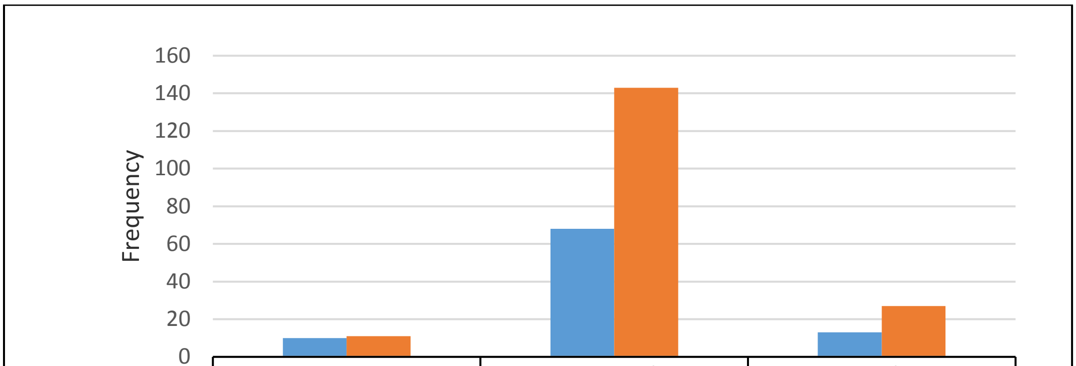


Figure 5.11: Purpose of using a mobile smartphone

5.4.2 Purpose of using a smartphone based on gender

Figure 5.12 demonstrates that both females (143) and males (68) use a smartphone for personal purposes. Female users use their smartphone for personal purposes and study purposes more than male users.

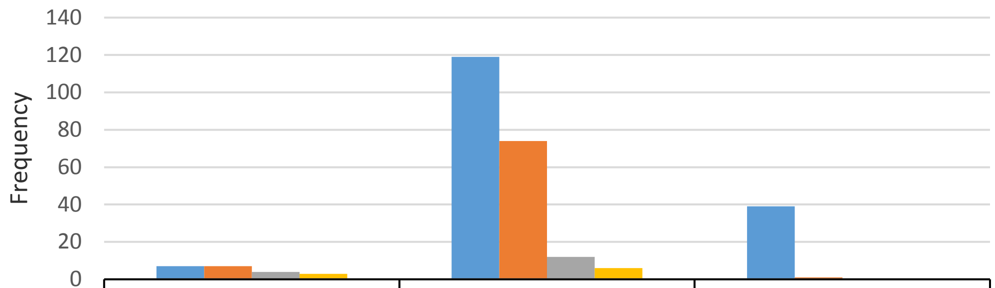


	Business	Personal	Study
Male	10	68	13
Female	11	143	27

Figure 5.12: Purpose of using a mobile smartphone based on gender

5.4.3 Purpose of using a smartphone based on the age group

As shown in Figure 5.13, the age group of 18-26 of 119 respondents and the age group 27-35 of 74 respondents contribute the highest personal usage respectively, compared to aged 45-54. Those aged 18-26 were using their smartphones for study and more for personal purposes.



	Business	Personal	Study
18-26	7	119	39
27-35	7	74	1
36-44	4	12	0
45-54	3	6	0

Figure 5.13: Purpose of using a mobile smartphone based on the age group

5.4.4 Purpose of using a smartphone based on the position

Figure 5.14 illustrates 114 employed professionals and 97 students use a smartphone for personal purposes. Only two respondents (categorised as others) use a smartphone for business, while 40 students use it for study purposes.

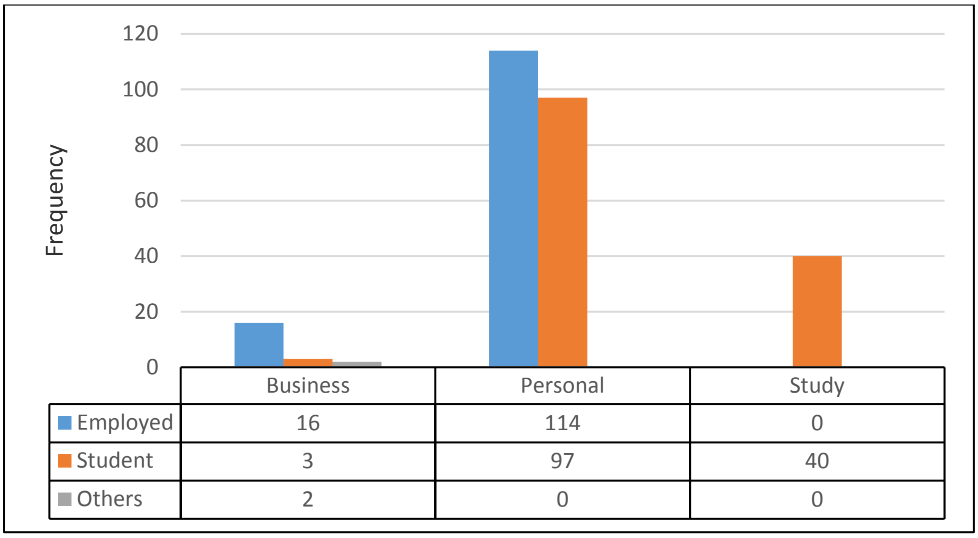
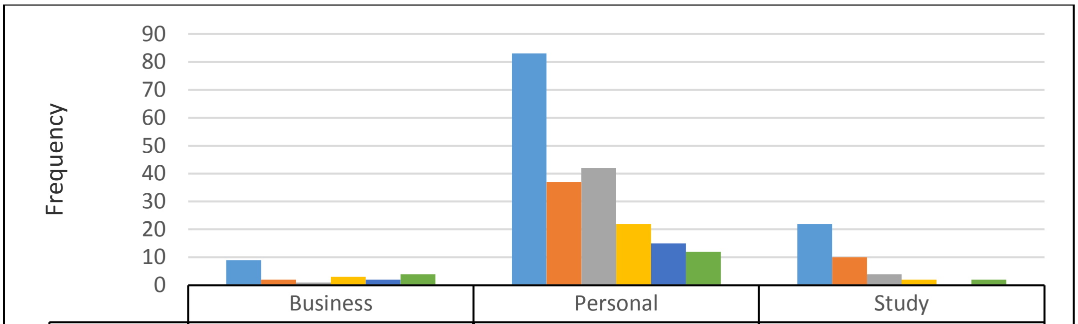


Figure 5.14: Purpose of using a mobile smartphone based on the position

5.4.5 Purpose of using a smartphone and willingness to buy wearable computing

As shown in Figure 5.15, the purpose of using a mobile smartphone and the willingness to buy wearable computing (e.g., smartwatch, fitness tracker) relationship was explored. The result showed that respondents were willing to spend less than MYR 100 to buy wearable computing for personal purposes. The majority of respondents were willing to spend less than MYR 100 to have the wearable compared to business or study purposes. However, 12 respondents were willing to spend above MYR 2000 to get wearable computing for personal purposes.



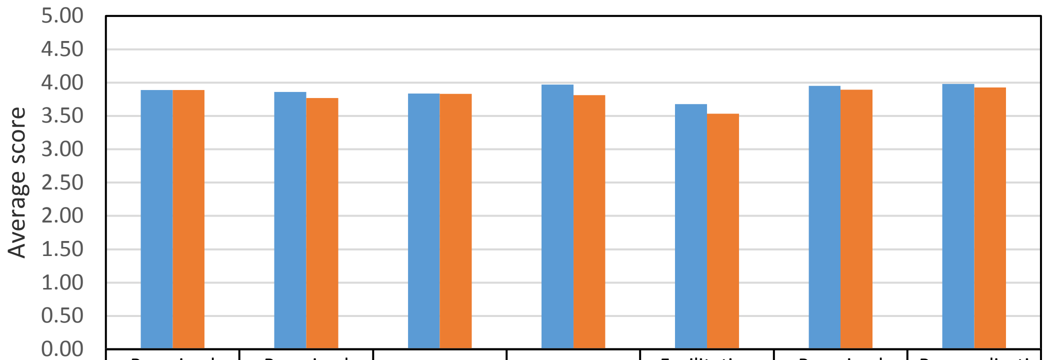
	Business	Personal	Study
<100	9	83	22
51-100	2	37	10
101-500	1	42	4
501-1000	3	22	2
1001-2000	2	15	0
>2000	4	12	2

Figure 5.15: Purpose of using a mobile smartphone and their willingness to buy wearable computing

5.5 Model factors effect

5.5.1 Model factor effect based on gender

The model factors in this research are Perceived usefulness (PU), Perceived ease of use (PEU), Observability (OBS), Mobility (MOB), Facilitating conditions (FC), Perceived Enjoyment (PE) and Personalisation (PN). Figure 5.16 demonstrates the model factors' differences based on gender. It shows that males have a higher mean score than females for personalisation (PN), followed by mobility (MOB), perceived enjoyment (PE), but they are very similar. Though both genders have a slight difference mean score in facilitating conditions (FC).

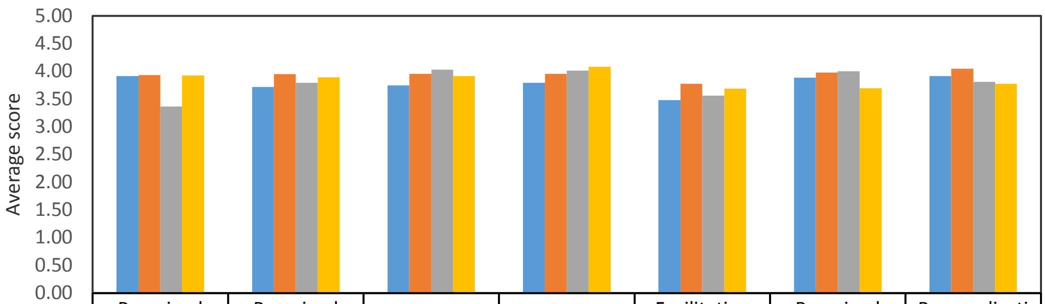


	Perceived usefulness	Perceived ease of use	Observability	Mobility	Facilitating conditions	Perceived enjoyment	Personalisati on
Male	3.89	3.86	3.84	3.97	3.68	3.95	3.98
Female	3.89	3.77	3.83	3.81	3.53	3.90	3.93

Figure 5.16: Model factors differences based on gender

5.5.2 Model factor effect based on the age group

As demonstrated in Figure 5.17, can be seen that all the model factors based on age group has higher mean score, however, the age group of 36-44 has the highest mean score for observability (OBS), followed by mobility (MB) and perceived enjoyment (PE), which showed that middle-aged respondents have positive acceptance towards the innovation of wearable computing. Overall, all age groups have a positive mean score across all the model factors.

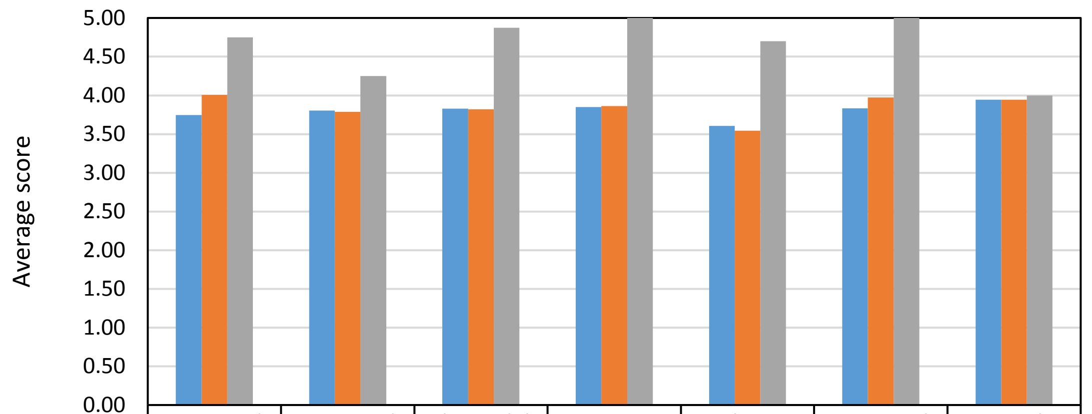


	Perceived usefulness	Perceived ease of use	Observability	Mobility	Facilitating conditions	Perceived enjoyment	Personalisati on
18-26	3.91	3.72	3.75	3.79	3.48	3.89	3.92
27-35	3.93	3.95	3.96	3.95	3.77	3.98	4.05
36-44	3.36	3.79	4.03	4.02	3.56	4.00	3.81
45-54	3.93	3.89	3.92	4.08	3.69	3.69	3.78

Figure 5.17: Model factors differences based on the age group

5.5.3 Model factor effect based on position

Figure 5.18 shows the model factors differences based on position; only two groups will be analysed (employed and student); the group consisting of others was retained for data completeness. Both groups, which are employed professionals and students, have higher mean score across all the model factors. Again, personalisation (PN), mobility (MOB) and observability (OBS) factors were the highest among all the factors for professionals; on the other hand, perceived usefulness (PU) was found to be the highest mean score from students.

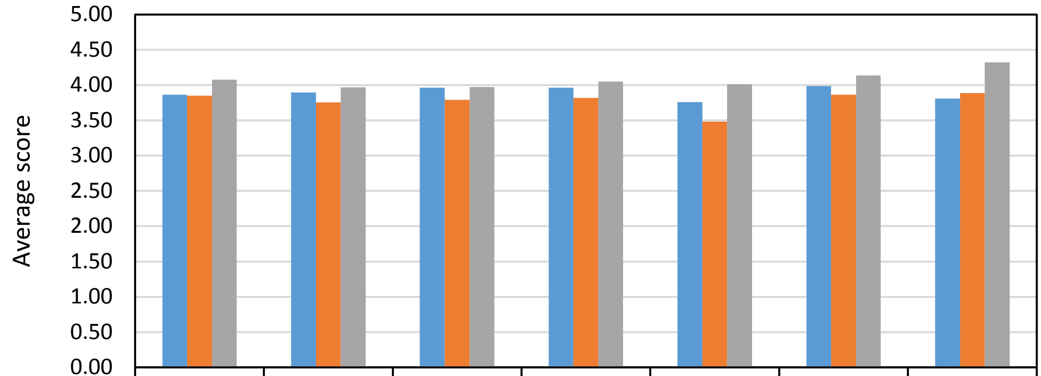


	Perceived usefulness	Perceived ease of use	Observability	Mobility	Facilitating conditions	Perceived enjoyment	Personalisation
Employed	3.74	3.80	3.83	3.85	3.60	3.83	3.95
Student	4.01	3.79	3.82	3.86	3.54	3.97	3.94
Others	4.75	4.25	4.88	5.00	4.70	5.00	4.00

Figure 5.18: Model factors differences based on the position

5.5.4 Model factor effect based on the purpose of using a smartphone

Figure 5.19 illustrates the model factors differences based on the purpose of using a smartphone, the rationale to analyse these groups were to understand the effects of the purpose of using a smartphone on the model factors. Overall, the purpose of using a smartphone showed almost higher mean score for all the model factors, again, personalisation (PN) showed the highest for the study purpose group, followed by perceived enjoyment (PE). Perceived usefulness (PU) is the highest mean score from students.

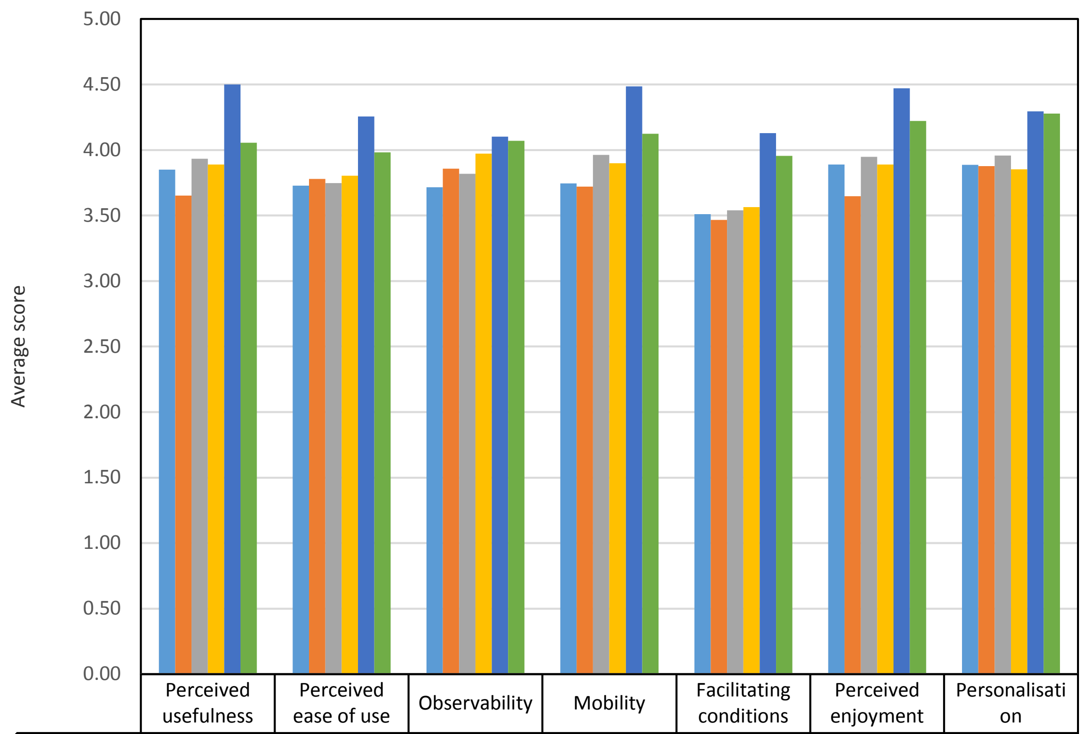


	Perceived usefulness	Perceived ease of use	Observability	Mobility	Facilitating conditions	Perceived enjoyment	Personalisation
Business	3.87	3.90	3.96	3.96	3.76	3.99	3.81
Personal	3.85	3.76	3.79	3.82	3.48	3.86	3.89
Study	4.08	3.97	3.98	4.05	4.02	4.14	4.33

Figure 5.19: Model factors differences based on the purpose of using a smartphone

5.5.5 Model factor effect on willingness to buy wearable computing

Figure 5.20 illustrates the model factors differences based on willingness to buy wearable computing; the motivation is to analyse how these groups perceive the model factors. Overall, all groups showed almost higher mean score for all the model factors, the group that spends MYR 1000-2000 showed the highest mean score of perceived usefulness (PU) of mean score 4.50.



	Perceived usefulness	Perceived ease of use	Observability	Mobility	Facilitating conditions	Perceived enjoyment	Personalisation
<100	3.85	3.73	3.71	3.75	3.51	3.89	3.89
51-100	3.65	3.78	3.86	3.72	3.47	3.65	3.88
101-500	3.93	3.75	3.82	3.96	3.54	3.95	3.96
501-1000	3.89	3.80	3.97	3.90	3.56	3.89	3.85
1001-2000	4.50	4.25	4.10	4.49	4.13	4.47	4.29
>2000	4.06	3.98	4.07	4.13	3.96	4.22	4.28

Figure 5.20: Model factors differences based on Willingness to Buy Wearable Computing

5.6 Effect of demographic characteristic on users' acceptance of wearable mobile computing (Behavioural Intention)

5.6.1 Based on gender and the age group

As shown in Figure 5.21, it indicates the potential users' acceptance or behavioural intention towards wearable computing based on gender towards the age groups. It can be seen that females of the ages 45-54 years have the highest means score compared to the male; this showed that female at the professional level were willing to accept the innovation of this emerging technology. The male group aged between 18 to 44 years has the highest level of acceptance compared to the female group.

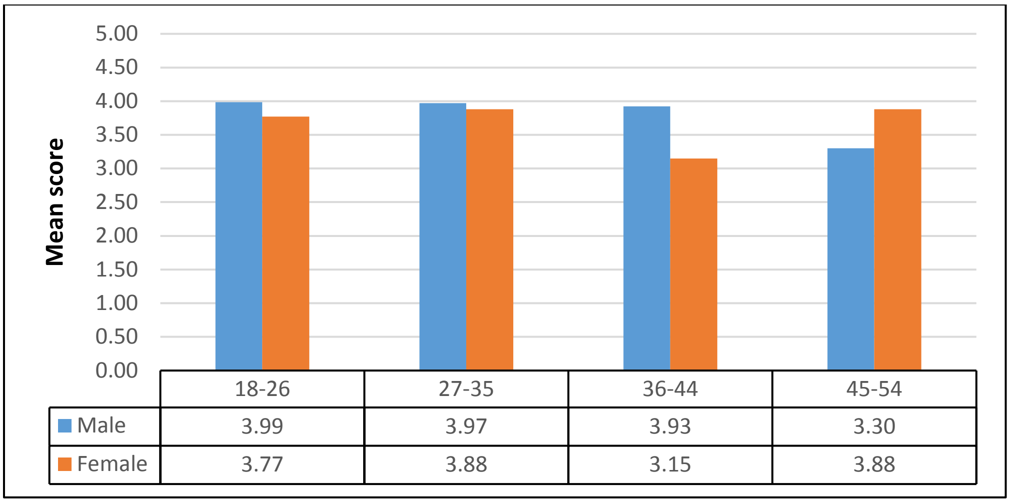


Figure 5.21: Behavioural intention differences based on gender and age

5.6.2 Based on the purpose of using a smartphone

As shown in Figure 5.22 indicates the potential users' acceptance of behavioural intention towards wearable computing based on the purpose of using a smartphone, it can be seen study purpose has the highest score compared to business and personal.

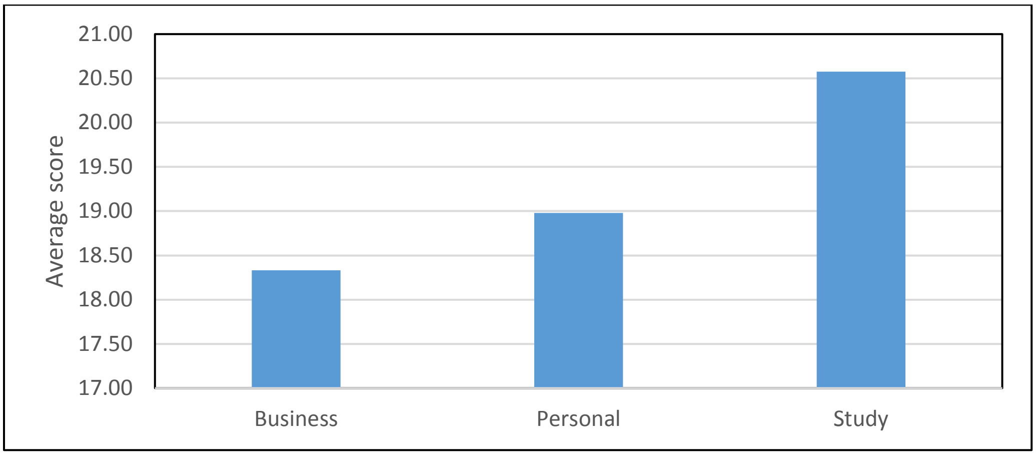


Figure 5.22: Behavioural intention differences based on the purpose of using a smartphone

5.6.3 Based on willingness to buy wearable computing

As shown in Figure 5.23, it indicates the potential users' acceptance of behavioural intention towards wearable computing based on willingness to buy wearable computing. It can be seen the respondents willing to spend MYR 1000-2000 on it has the highest score, showing that users are positive toward buying the wearable computing technology.

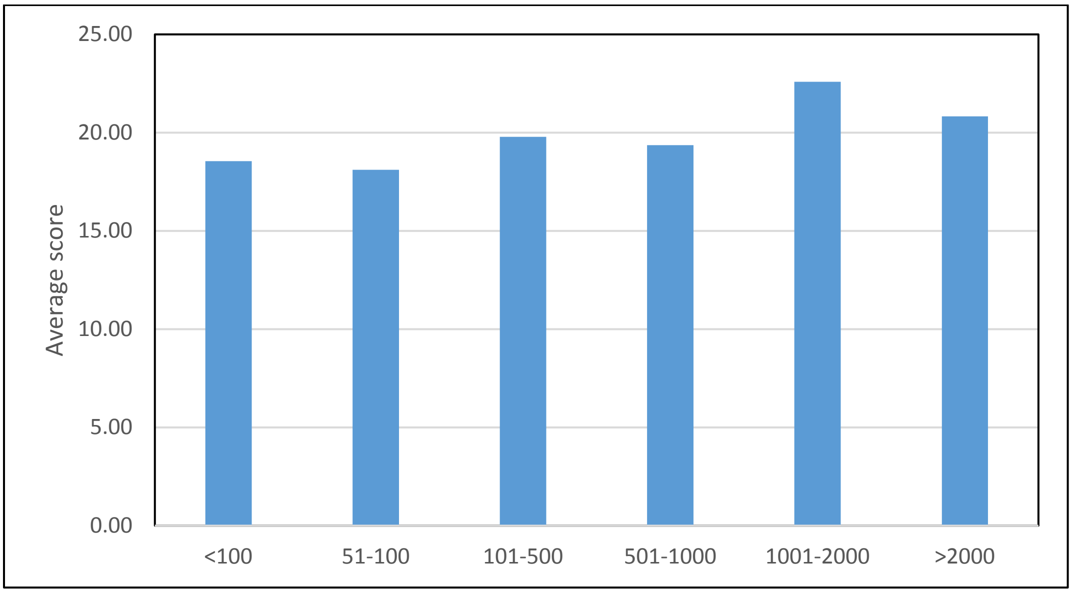


Figure 5.23: Behavioural intention based on willingness to buy wearable computing

5.7 Analysis of t-test and variance (ANOVA) on users' acceptance of wearable computing

5.7.1 Analysis of T-test on the gender effect

Researchers may want to see the differences between groups of people rather than relationships between variables (Field, 2009). An independent sample t-test can be used to compare the mean score for two different groups of participants (Pallant, 2010). In a study of the human participant, it is useful to collect a number of respondents' gender and age information. Prior to conducting this test, any assumption shall not be violated. As shown in Table 5.5, an independent t-test was conducted to compare the gender (male and female) effect on users' acceptance of wearable computing. The results indicated there was no significant difference in score for males and females (M=19.73, SD=4.07) and females (M=18.88, SD=3.85; t(270)= 1.67, p = .097). The magnitude means revealed that gender is not affected by the behavioural intention of users.

Table 5.5: T-test for gender effect on users' acceptance of wearable computing

Gender	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Male	91	19.7253	4.07449	1.667	270	.097
Female	181	18.8840	3.85037			

5.7.2 Analysis of variance (ANOVA)

Effect on the age group

A one-way ANOVA between groups was conducted to explore the impact of age groups on the users' acceptance of wearable computing. Respondents were divided into age groups. Table 5.6 shows that there was no statistical significant difference, p = .28, F(3, 268) = 1.28, p = .281. Tukey Post-hoc test was not conducted due to no significant difference.

Table 5.6: One way ANOVA test for the effect of the age group on the users' acceptance of wearable computing

BI	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	59.423	3	19.808	1.280	.281
Within Groups	4146.132	268	15.471		
Total	4205.555	271			

Effect on the purpose of using a smartphone

A one-way ANOVA was conducted to explore the impact of the purpose of using a smartphone on the users' acceptance of wearable computing.

Respondents were divided into three groups of business, personal and study purposes. Table 5.7 shows that there was a statistically significant difference, p = .038, F (2, 269) = 3.32, p = 0.38; then, Tukey Post-hoc test was conducted to determine the difference of group. In Table 5.8, the difference was found between personal (M=18.98, SD= 4.23) and study (M=20.58, SD=3.94).

Table 5.7: One way ANOVA test for the effect of the position on the users' acceptance of wearable computing

BI	Sum of Squares	df	Mean Square	F	Sig.
Between Groups Within Groups Total	101.189 4104.366 4205.555	2 269 271	50.595 15.258	3.316	.038

Table 5.8: Tukey post-hoct comparison test for the position

(I) What is your main purpose of using mobile smartphone?	(J) What is your main purpose in using mobile smartphone?	Mean Difference (I-J)	Sig.
Business	Personal	-.64771	.749
	Study	-2.24167	.086
Personal	Business	.64771	.749
	Study	-1.59396*	.049
Study	Business	2.24167	.086
	Personal	1.59396*	.049

**. The mean difference is significant at the 0.05 level*

Effect on willingness to buy wearable computing

ANOVA was conducted to explore between groups on the impact of willingness to buy wearable computing on the users' acceptance of wearable computing (BI). Respondents were divided into six groups of less 100, 51-100, 101-500, 501-1000 and above 2000 in MYR.

Table 5.9 shows there was a statistical significant difference, p = .000, F (5, 266) =5.102, p = 0.000. A Tukey Post-hoc test was conducted to determine the difference of groups, and in Table 5.10, it illustrates the difference was found between less 100 (M=18.54, SD= 4.15) and 51-100 (M=18.10, SD=3.40) and 1000-2000 (M=22.59, SD=2.69).

Table 5.9: One way ANOVA test for the effect of willingness to buy wearable computing on the users' acceptance of wearable computing (BI)

BI	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	367.998	5	73.600	5.102	.000
Within Groups	3837.557	266	14.427		
Total	4205.555	271			

Table 5.10: Tukey post-hoct comparison test for willingness to buy wearable computing

(I) How much are you willing to spend (RM) to buy wearable mobile computing	(J) How much are you willing to spend (RM) to buy wearable mobile computing	Mean Difference (I-J)	Sig.
	51-100	.44182	.984
	101-500	-1.24337	.412
<100	501-1000	-.82651	.912
	1001-2000	-4.04438*	.001
	>2000	-2.28947	.168
	<100	-.44182	.984
	101-500	-1.68519	.254
51-100	501-1000	-1.26833	.731
	1001-2000	-4.48619*	.001
	>2000	-2.73129	.099
	<100	1.24337	.412
	51-100	1.68519	.254
101-500	501-1000	.41686	.998
	1001-2000	-2.80100	.099
	>2000	-1.04610	.920
	<100	.82651	.912
	51-100	1.26833	.731
501-1000	101-500	-.41686	.998
	1001-2000	-3.21786	.072
	>2000	-1.46296	.803
	<100	4.04438*	.001
	51-100	4.48619*	.001
1001-2000	101-500	2.80100	.099
	501-1000	3.21786	.072
	>2000	1.75490	.747
	<100	2.28947	.168
	51-100	2.73129	.099
>2000	101-500	1.04610	.920
	501-1000	1.46296	.803
	1001-2000	-1.75490	.747

*. The mean difference is significant at the 0.05 level.

After conducting the t-test and the one-way ANOVA test, Table 5.11 summarises the statistically significant differences in terms of the purpose of using a smartphone and willingness to buy wearable computing. Nevertheless, there were no statistically significant differences in terms of gender and age.

Table 5.11: T-test and ANOVA test significance differences summary

Test	**Grouping criteria**	**Significant (p <.05)**	**Significant difference**
T-test	Gender	.097	No significant was found
ANOVA	Age	.281	No significant was found
ANOVA	Purpose of using Smartphone	.038	A significant difference between personal and study
ANOVA	Willingness to buy Wearable Mobile Computing	.000	A significant difference between <100, 501-1000 and 1001-2000

5.8 Chapter summary

This chapter explored the respondents' profiles regarding their gender, age group, prior experience and computing knowledge. Data was examined using a descriptive SPSS V.20 analysis with cross-tabulation for understanding users' characteristics in the Malaysian context. The key findings for the Malaysian market's unique characteristics were that the respondents showed positive results, regardless of gender and age, as well as their utilisation of mobile applications for daily activities, their spending lifestyle on mobile service and online shopping. Besides, the effects of gender, age group, prior experience and computing knowledge for users' acceptance or behavioural intention to adopt wearable computing have been tested by employing t-tests and one-way ANOVA tests. The results revealed there was a significant difference in terms of the purpose of using a smartphone and a willingness to buy wearable computing. There was no statistically significant differences in terms of gender and the age group. This new data will advance the technology provider considering that age and gender will have no effect on wearable acceptance; however, despite that, users may have a positive intention to buy the wearable computing devices. Besides, the means score for model factors differences based on the age group, gender, position and purpose of using a smartphone were supported. The next chapter will further explain the model testing on the different hypotheses within the conceptual model.

CHAPTER 6

6 RESEARCH MODEL TESTING

6.1 Introduction

Chapter 5 has presented a descriptive analysis of the data collected from the main field research study; in this chapter, a rigorous analysis of the main field results were discussed empirically by conducting reasonable tests including reliability tests, correlations, factor analysis and multiple regression tests in further understanding the framework developed in explaining users' acceptance of wearable computing. IBM SPSS (V.20) was utilised in data analysis. According to Pallant (2013), multiple regression can be utilised to explore the relationship between one continuous dependent variable and some independent variables or predictors. Furthermore, multiple regression is based on correlation and allows more advanced exploration of the interrelationship among a set of variables. How well a set of variables can predict a particular dependent by conducting the multiple regression test. To check the number of assumptions prior to conducting multiple regression, the researcher must ensure the relevant sample size, multicollinearity, normality, linearity, homoscedasticity, independence of residuals and outliers.

6.2 Data screening

The dataset needs to be checked prior to any analysis done to avoid any error or mistake which may result in data distortion. In the survey research, problems with missing data occurred when the respondents were unable to fully answer questions or perhaps they missed some questions in the questionnaire, thus affecting the research findings. For checking all the variables, the *Descriptive statistics* were run or using Explore procedure for the continuous variables with the reasonable means score was carried out; for the categorical variables, Frequencies procedure can be helpful, where the frequency of the minimum and maximum values according to codebook is checked (Pallant, 2013). The data screening was conducted in this research prior to performing further analysis and no missing data found.

6.3 Reliability Test

Table 6.1 shows the reliability test for this data analysis. According to Pallant (2010), reliability refers to the degree to which the items of the scale are correlated when measuring the same constructs. Cronbach alpha is considered the most commonly used, easy to calculate, and most well-known among academic researchers for testing data reliability (Tabachnick and Fidell, 2007). The questionnaire was tested with Cronbach alpha measurements. Cronbach's alpha coefficients are beyond the suggested value of 0.70 (Pallant, 2010).

Table 6.1: Reliability Test analysis

Factors	Cronbach Alpha N=272
Behavioral intention (BI)	0.93
Social influence (SI)	0.89
Mobile application (MA)	0.76
Perceived usefulness (PU)	0.94
Perceived ease of use (PEU)	0.93
Observability (OBS)	0.88
Mobility (MOB)	0.92
Facilitating condition (FC)	0.93
Perceived enjoyment (PE)	0.93

The reliability was tested for the developed questionnaire using IBM SPSS version 2.0 to check the scale's internal consistency. The Cronbach alpha coefficient should be above 0.70 (Pallant, 2013) and all the factors chosen above the suggested value, which has good internal consistency and acceptable for further statistical analysis. Personalisation was measured by understanding the importance of it with the Likert scale of less important to important. Construct validity test is run by using Factor Analysis, which will be explained in the next section.

6.4 Test of Normality

Table 6.2 demonstrates the distribution of scores on factors based on Skewness and Kurtosis values. Normality is defined by the assumption that the shape of the data distribution is an asymmetrical and bell-shaped curve (Hair et al., 2010; Pallant, 2010). According to Pallant (2010, p.59), skewness is an indication of the "*symmetry of the distribution,"* while, Kurtosis provides information on the "*peakedness"* or flatness of the distribution compared to the normal distribution. The perfectly normal distribution is where the value of skewness and kurtosis is zero, which is unusual in social science (Pallant, 2013). Furthermore, Tabachnick and Fidell (2013) stated with a large sample size, skewness will not make any major difference in the analysis; moreover, with a large sample size of over 200, this risk is reduced for an underestimate of the variance. In this research, the data from the sample of 272 was collected, which was acceptable for analysis regardless of non-normality, but from the results shown, the skewness and kurtosis are acceptable with the tolerable range is +/- 1 (Tabachnick and Fidell, 2013).

Table 6.2: Distribution of scores on factors based on Skewness and Kurtosis values

Factors	Skewness	Kurtosis
BI	-.348	-.342
SI	-.415	.462
MA	-.395	-.197
PU	-.698	.396
PEU	-.247	-.142
OBS	-.437	.119
MOB	-.444	-.240
FC	-.304	-.334
PE	-.290	-.467
PN	-.541	.373

After the test of normality had been done, the parametric test will be conducted. The parametric statistics can be used with the Likert data, even with small sample sizes or unequal variances, and with non-normal distributions, (Norman, 2010). In the medical education literature, there is a controversy regarding whether ordinal data may be converted to numbers, so it was treated as interval data. Educators and researchers also created several Likert-type items, then it was grouped into a ‘‘survey scale,’’ and a total score or mean score for the scale items were calculated. The parametric tests can be used to analyse Likert scale responses. The data follows a classic normal distribution and (Sullivan and Artino, 2013). According to Pallant 2013, skewness and kurtosis with normal distribution allowing for a parametric test such as a t-test, ANOVA, correlation, factor analysis and regression which require continuous interval data. Therefore, from the above skewness and kurtosis, they are acceptable with the tolerable range is +/- 1 (Tabachnick and Fidell, 2013) thus, parametric tests may be conducted.

6.5 Outlier

The essential procedure to check the outliers as the multiple regression analysis is sensitive to the data obtained. Extreme data scores shall be checked at the initial data screening process. Scholars suggest either removing all the extreme outliers or changing the value to a less extreme score avoiding the distortion. In the Descriptive programme in SPSS, the 5% *Trimmed Mean* is similar to the mean; so, the data could be retained. In this research, the 5% *Trimmed Mean* was in the range. Thus, all the data was retained for further analysis. Also, from the standardised residual plot, the outliers can be detected through multiple regression programmes. The values with a standardised residual of more than +3.3 or less than -3.3 are considered as outliers; however, if only a few outliers are identified with a large sample size, no action should be taken (Pallant, 2013; Tabachnick and Fidell, 2013). In the study, a scatterplot with a standard residual showed data in a range of +3.3 and -3.3.; thus, further analysis may be conducted.

6.6 Multicollinearity

Multicollinearity refers to the relationship between the independent variables. Multicollinearity happens due to a highly correlated independent variable (r = .9 or above). Singularity is where an independent variable is a combination of another independent variable. Thus, it is imperative to check correlations among variables as the contribution to a good model in the multiple regression will be affected. Table 6.3 shows the correlation matrix is less than 0.9, confirming no multicollinearity (Pallant, 2013)

Multicollinearity is the condition where two or more explanatory variables in a research overlap. As a result of the overlap, the analysis does not explain explanatory variables differently from others. Multicollinearity could also be explained as the presence of a high degree of correlation among different independent variables. The symptoms of multicollinearity include wide changes in parameter estimates because of small changes in data. In other words, coefficients have high standard errors and significance levels (Pallant, 2010).

Collinearity diagnostics also can be checked through multiple regression procedures with tolerance and VIF values. Tolerance is the indicator of how much the variability of the independent variable may not be explained by another independent variable in the model; the value shall be above .10. On the other side, VIF (variance inflation factor) is the inverse of tolerance, and a VIF less than 10 is acceptable (Pallant, 2013).

6.7 Correlation analysis

Results from Correlation Analysis are shown in Table 6.3. A Pearson product-moment correlation coefficient (r) was run to determine the relationship between the independent constructs and the dependent variables.

Correlation is used to describe the strength and direction of the relationship between two variables. The correlation of Pearson, r is ranging from -1 and +1. The strength of the correlation relationship ranging from r=.01 to 0.29 (small), r= 0.30 to 0.49 (medium) and r= 0.50 to 1.0 (large) (Pallant, 2013).

Table 6.3: Pearson's Correlation matrix

	BI	SI	MA	PU	PEU	OBS	MOB	FC	PE	PN
BI	1									
SI	.596**	1								
MA	.558**	.480**	1							
PU	.733**	.616**	.505**	1						
PEU	.636**	.502**	.475**	.645**	1					
OBS	.574**	.470**	.430**	.591**	.670**	1				
MOB	.686**	.492**	.457**	.654**	.739**	.750**	1			
FC	.602**	.597**	.448**	.624**	.675**	.657**	.686**	1		
PE	.670**	.465**	.419**	.675**	.670**	.634**	.707**	.682**	1	
PN	.512**	.432**	.360**	.592**	.582**	.430**	.556**	.585**	.569**	1

*** Correlation is significant at the 0.01 level (2-tailed)*

Again, as can be seen in Table 6.3, the positive relationship of the factors are revealed; the Pearson r, the correlation of dependent construct which is Behavioral intention (BI), also known as users' acceptance of wearable computing between independent constructs (SI, MA, PU, PEU, OBS, MOB, FC, PE and PN) has a positive correlation.

6.8 Factor analysis

Factor analysis (FA) is known as the data reduction technique. A large set of variables may be reduced or summarised using a smaller set of factors or components (Pallant, 2013). Thus, factor analysis demonstrates the set of variables are ‘clumped’ or grouped together, so FA is used in the development and evaluation of tests and scales for much research with a large number of an individual items in a questionnaire. Employing the FA can refine and reduce the items with a coherent, reasonable and manageable small number of the subscale. FA is conducted prior to run multiple regression tests of multivariate analysis of variance and for construct validity testing (Pallant, 2013; Tabachnick and Fidell, 2013). The Exploratory Factor analysis (EFA) is one of the multivariate statistical correlation analyses that could be used to examine the validity of variable items (Ong and Fadilah Puteh, 2017)

FA can be done either exploratory or confirmatory. For the initial stage to explore interrelationship among a set of variables, the researcher may use exploratory FA while confirmatory FA is more complex to confirm specific hypotheses or theories. Information about the number of possible factors in the model may be decided by the researcher (Hair et al., 2010).

Furthermore, principal components analysis (PCA) and FA is a technique used interchangeably by researchers even though they differ in some way, but both attempt to produce the linear combination of the original variable. In PCA analysis, all the original variables form a smaller set of linear combinations and all the variance are used. On the other hand, FA is estimated using a mathematical model with the shared variance being taken for analysis (Tabachnick and Fidell, 2013). Thus, for this research, FA with principal components was chosen; so, an extraction with Varimax rotation was run on 35 items to examine the construct validity.

To run the factor analysis test, a sample of 150 cases is sufficient or with five cases per item. The sample size in this research is 272, which is suitable for the FA test. Moreover, the Kaiser- Meyer-Olkin (KMO) test and Bartlett’s test of sphericity can help for accessing the suitability to run FA as both measures the sampling adequacy (Pallant, 2013).

KMO that is greater than 0.6 suggests that the relationship between items is statistically significant and is suitable for factor analysis, while Bartlett’s test of sphericity must be significant ($p<.05$), since the correlation among the items is higher than 0.3, it is suitable for factor analysis. In this research, as presented in Table 6.4, the Kaiser- Meyer-Olkin (KMO) value of 0.925 and the significance of Bartlett’s is significant ($p = 0.001$), hence confirming the suitability of factor analysis for the data set.

Table 6.4: Initial assumption of factor analysis (KMO and Bartlett's Test)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.952
Bartlett's Test of Sphericity	Approx. Chi-Square	8920.562
	df	595
	Sig.	.000

Table 6.5: Eigenvalues and variance extracted by each component

Total Variance Explained

Component	Initial Eigenvalues			Loadings			Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	18.323	52.352	52.352	18.323	52.352	52.352	5.657	16.163	16.163
2	2.409	6.883	59.236	2.409	6.883	59.236	5.118	14.623	30.786
3	1.733	4.952	64.188	1.733	4.952	64.188	5.102	14.578	45.364
4	1.400	4.001	68.188	1.400	4.001	68.188	4.950	14.143	59.507
5	1.248	3.565	71.754	1.248	3.565	71.754	4.286	12.247	71.754
6	.975	2.786	74.539						
7	.792	2.263	76.803						
8	.714	2.039	78.841						
9	.636	1.816	80.657						
10	.566	1.616	82.273						
11	.501	1.433	83.706						
12	.458	1.309	85.015						
13	.444	1.269	86.284						
14	.425	1.214	87.498						
15	.372	1.064	88.562						
16	.343	.981	89.543						
17	.323	.924	90.467						
18	.303	.866	91.333						
19	.281	.803	92.136						
20	.273	.780	92.917						
21	.255	.728	93.645						
22	.234	.669	94.314						
23	.225	.643	94.957						
24	.220	.628	95.585						
25	.197	.563	96.148						
26	.173	.495	96.643						
27	.158	.452	97.095						
28	.156	.447	97.541						
29	.155	.442	97.984						
30	.143	.410	98.393						
31	.137	.391	98.784						
32	.123	.350	99.135						
33	.118	.337	99.472						
34	.098	.280	99.752						
35	.087	.248	100.000						

Extraction Method: Principal Component Analysis.

Table 6.6: Rotated matrix (factor loading)

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	5
PU2	.771				
PU3	.759				
PU5	.757				
PU1	.748				
PU6	.696				
PU4	.685				
FC4		.685			
FC2		.672			
FC5		.671			
FC1		.669			
FC3		.668			
PE1	.463	.597			
PE3	.495	.578			
PE4	.429	.568			
PE2	.512	.564			
PN1		.419	.414		
PEU2			.780		
PEU5			.740		
PEU1			.722		
PEU6			.689		
PEU3			.675		
PEU4			.663		
OBS3				.793	
OBS1				.721	
OBS4				.708	
OBS2				.621	
MOB2				.604	
MOB1				.598	
MOB3			.460	.578	
MOB4				.550	
SI5					.769
SI2					.763
SI4					.743
SI1					.731
SI3					.716
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 8 iterations.					

Table 6.5 shows the total variance explained by each element. The number of factors that contributed to Eigenvalue>1 were significant and thus remained, while factors with Eigenvalue<1 were ignored (quest et al., 2010; Tabachnick and Fidell, 2007). Out of 35 components, five components have Eigenvalue>1, as stated in column 2 of Total Variance. These five components explained a total variance of 71.754%. Table 6.6 illustrates the rotated component matrix with five factors showing the factor loading coefficient above .30.

6.9 Regression and hypotheses testing

6.9.1 Multiples Regression Analysis (Stage 1)

Multiple regression analysis is utilised to examine the relationship between a single dependent variable and some independent variables or predictors. Furthermore, multiple regression also can explain how well a set of variables may be able to predict the dependent variable. This research employs standard multiple regression with all the predictors entering simultaneously (Pallant, 2013). In stage 1, the precursor: Social influence and mobile application were tested towards the model factors as shown in Figure 6.1 and Figure 6.2.

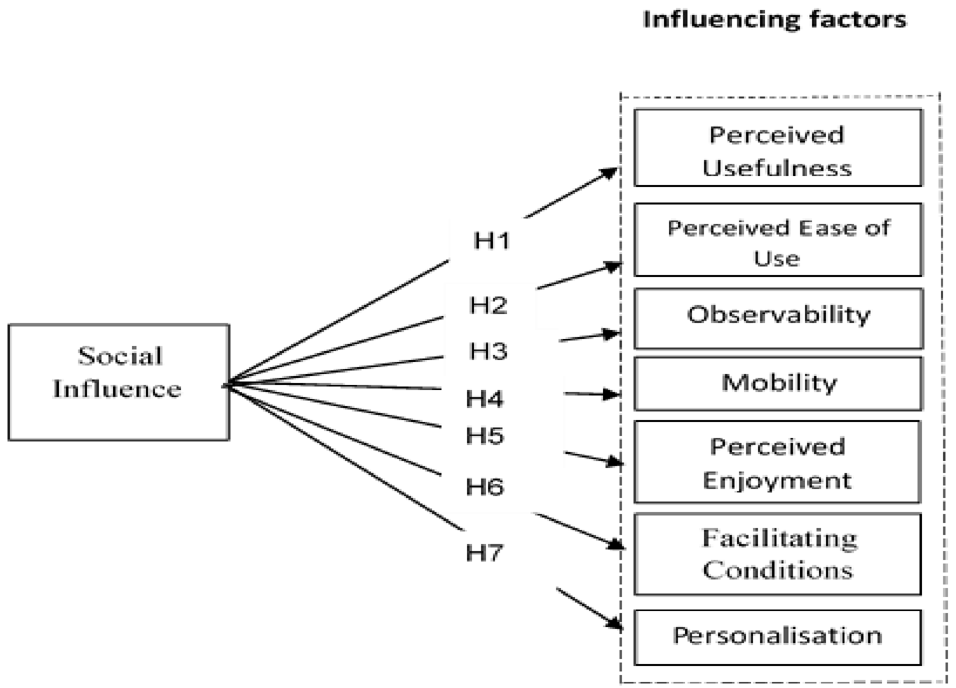


Figure 6.1: Model 1 regression analysis of Social Influence on model factor

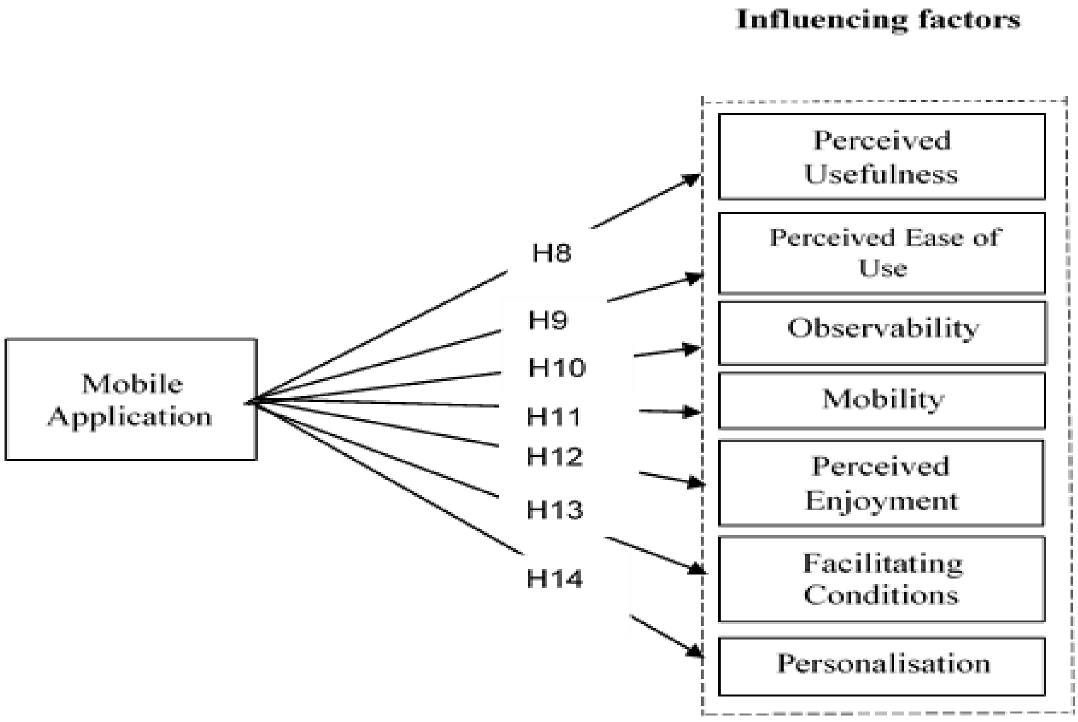


Figure 6.2: Model 1 regression analysis of Mobile Application on model factor

Influence of Social Influence and Mobile Application on Perceived Usefulness

The results from Table 6.7 shows that SI (beta=.485, p<.000) and MA (beta=.272, p<.000) have a significant relationship with PU, thus supporting the hypotheses H1 and H8, respectively. VIF values indicate there is no sign of multicollinearity, as (VIF<10).

Table 6.7: Regression analysis on Perceived Usefulness

Model		Unstandardized Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	6.471	1.329		4.870	.000	3.855	9.087		
	SI	.554	.060	.485	9.290	.000	.436	.671	.769	1.300
	MA	.242	.047	.272	5.202	.000	.151	.334	.769	1.300

Dependent Variable: PU

Influence of Social Influence and Mobile Application on Perceived Ease of Use (PEU)

The results from Table 6.8 shows that SI (beta=.356, p<.000) and MA (beta=.304, p<.000) have a significant relationship with PEU, thus supporting the hypotheses H2 and H9, respectively. VIF values indicate there is no sign of multicollinearity, as (VIF<10).

Table 6.8: Regression analysis on Perceived Ease of Use

Model		Unstandardized Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	9.736	1.244		7.828	.000	7.287	12.184		
	SI	.348	.056	.356	6.230	.000	.238	.457	.769	1.300
	MA	.231	.044	.304	5.310	.000	.146	.317	.769	1.300

Dependent Variable: PEU

Influence of Social Influence and Mobile Application on Observability (OBS)

The results from Table 6.9 shows that SI (beta=.342, p<.000) and MA (beta=.266, p<.000) have a significant relationship with OBS, thus supporting the hypotheses H3 and H10. VIF values indicate there is no sign of multicollinearity, as (VIF<10).

Table 6.9: Regression analysis on Observability

Model		Unstandardized Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	6.361	.969		6.567	.000	4.454	8.268		
	SI	.251	.043	.342	5.781	.000	.166	.337	.769	1.300
	MA	.152	.034	.266	4.487	.000	.085	.219	.769	1.300

a. Dependent Variable: OBS

Influence of Social Influence and Mobile Application on Mobility (MOB)

The results from Table 6.10 shows that SI (beta=.355, p<.000) and MA (beta=.287, p<.000) have a significant relationship with MOB, thus supporting the hypotheses H4 and H11. VIF values indicate there is no sign of multicollinearity, as (VIF<10).

Table 6.10: Regression analysis on Mobility

Model		Unstandardized Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	5.756	.968		5.948	.000	3.851	7.662		
	SI	.266	.043	.355	6.124	.000	.180	.351	.769	1.300
	MA	.168	.034	.287	4.955	.000	.101	.235	.769	1.300

a. Dependent Variable: MOB

Influence of Social Influence and Mobile Application on Perceived Enjoyment (PE)

The results from Table 6.10 shows that SI (beta=.343, p<.000) and MA (beta=.254, p<.000) have a significant relationship with PE, thus supporting the hypotheses H5 and H12. VIF values indicate there is no sign of multicollinearity, as (VIF<10).

Table 6.11: Regression analysis on Perceived Enjoyment

Model		Unstandardized Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	7.038	.958		7.347	.000	5.152	8.924		
	SI	.247	.043	.343	5.756	.000	.163	.332	.769	1.300
	MA	.143	.034	.254	4.268	.000	.077	.209	.769	1.300

a. Dependent Variable: PE

Influence of Social Influence and Mobile Application on Facilitating Conditions (FC)

The results from Table 6.12 shows that SI (beta=.496, p<.000) and MA (beta=.210, p<.000) have a significant relationship with FC, thus supporting the hypotheses H6 and H13. VIF values indicate there is no sign of multicollinearity, as (VIF<10).

Table 6.12: Regression analysis on Facilitating Conditions

Model		Unstandardized Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	4.244	1.229		3.453	.001	1.824	6.664		
	SI	.504	.055	.496	9.137	.000	.395	.612	.769	1.300
	MA	.167	.043	.210	3.876	.000	.082	.252	.769	1.300

a. Dependent Variable: FC

Influence of Social Influence and Mobile Application on Personalisation (PN)

The results from Table 6.13 shows that SI (beta=.336, p<.000) and MA (beta=.199, p<.001) have a significant relationship with PN, thus supporting the hypotheses H6 and H13. VIF values indicate there is no sign of multicollinearity, as (VIF<10).

Table 6.13: Regression analysis on Personalisation

Model		Unstandardized Coefficients		Standardised Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.888	.269		7.019	.000	1.358	2.418		
	SI	.066	.012	.336	5.468	.000	.042	.090	.769	1.300
	MA	.030	.009	.199	3.231	.001	.012	.049	.769	1.300

a. Dependent Variable: PN

6.9.2 Multiples Regression Analysis (Stage 2)

In this part, the multiple regression analysis was conducted to predict model factors which influence the outcome or criterion variable as shown in Figure 6.3. The findings revealed that Perceived Usefulness (PU), Observability (OBS) linked with Mobility (MOB); Perceived Enjoyment (PE) linked with Facilitating Conditions; and Personalisation (PN) has a positive effect towards users' acceptance of wearable computing, while Perceived Ease of Use (PEU) has no significant effect.

The R square value shows how well the variance in the dependent variable is explained by the model (Pallant, 2010). The R square result in Table 6.14 indicates that the model explains 61 percent (61%) of the variance in the users' acceptance of wearable computing. The adjusted R square is used to estimate the true population. The R square explains to what extent the variance of one variable explains the variance of the second variable. The value of R square ranged from 0 to 1 and it is commonly stated as percent from 0% to 100%. R square of 100% means the dependent variable is well explained by the independent variable.

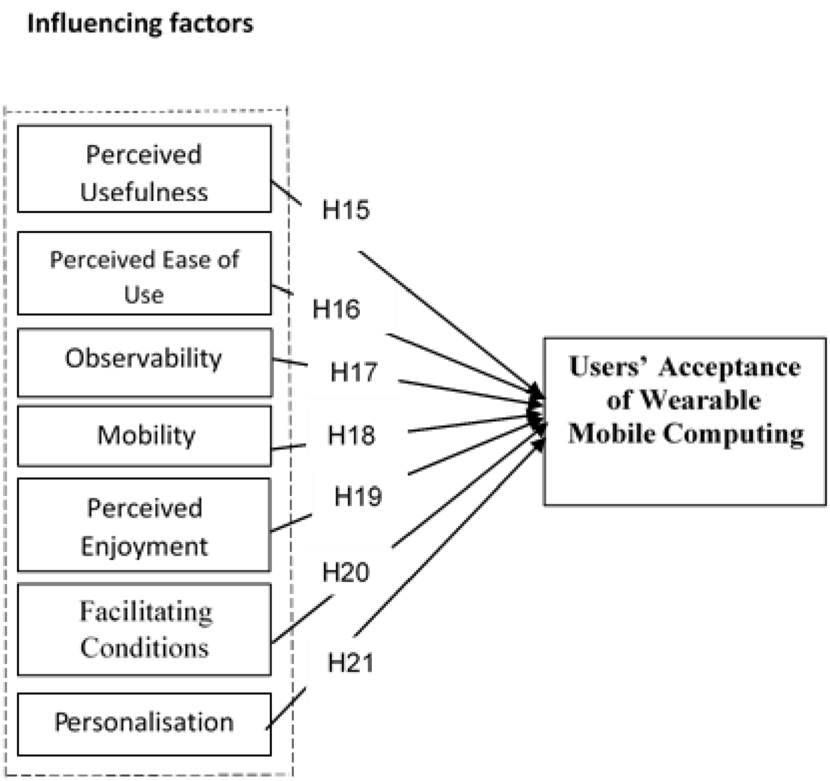


Figure 6.3: Multiple regression analysis on Users' acceptance of wearable computing

Table 6.14: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.785[a]	.616	.610	2.46086

a. Predictors: (Constant), FCPEPN, PU, PEU, OBSMOB

b. Dependent Variable: BI

Table 6.15: Multiple regression analysis

Model		Unstandardized Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.882	.885		2.127	.034		
	PU	.343	.046	.425	7.482	.000	.446	2.240
	PEU	.089	.060	.095	1.499	.135	.362	2.762
	OBSMOB	.122	.045	.184	2.715	.007	.314	3.186
	FCPEPN	.093	.037	.174	2.479	.014	.293	3.407

The result of the multiple regression analyses presented PU (beta = .425, p< .000), while OBS was found to link with MOB (beta = .184, p< .007), FC linked with PE and PN (beta = .174, p < .014), and PEU (beta = .095, p< .135) which does not support the hypothesis. The model explained 61% of the variance in users’ acceptance of wearable computing. PU contributes to the greatest, reflecting that the TAM model is still relevant in technological innovation adoption. This result has been presented in an i-Society conference at Dublin (Taib, De Coster and Nyamu, 2016b) and was published in International Journal of Chaotic Computing (Taib, De Coster and Nyamu, 2016a). The factors were found to have linked OSB with MOB (OBSMOB) and FC linked with PE and PN (FCPEPN), after conducting the factor analysis prior to run the multiple regression. The users might see them as the same attribute;

but eventually, they are different underlying constructs; further research may be conducted in the future.

From Figure 6.4, the Normal Probability Plot (P-P) of the Regression Standard Residual and Scatterplot shows the outliers, normality, linearity, homoscedasticity. Normality is where the residual should be normally distributed about the predicted dependent score; linearity is the residual which should have a straight line relationship with the predicted dependent variable, and homoscedasticity is the variance of the residual about predicted dependent variables, which should be the same for all predicted scores (Pallant, 2013).

An outlier can be detected from the scatterplot of standard residual more than 3.3 or less than -3.3 (Pallant, 2013; Tabachnick and Fidell, 2013). Therefore, the regression result obtained in this study has no violation and meet the regression assumption.

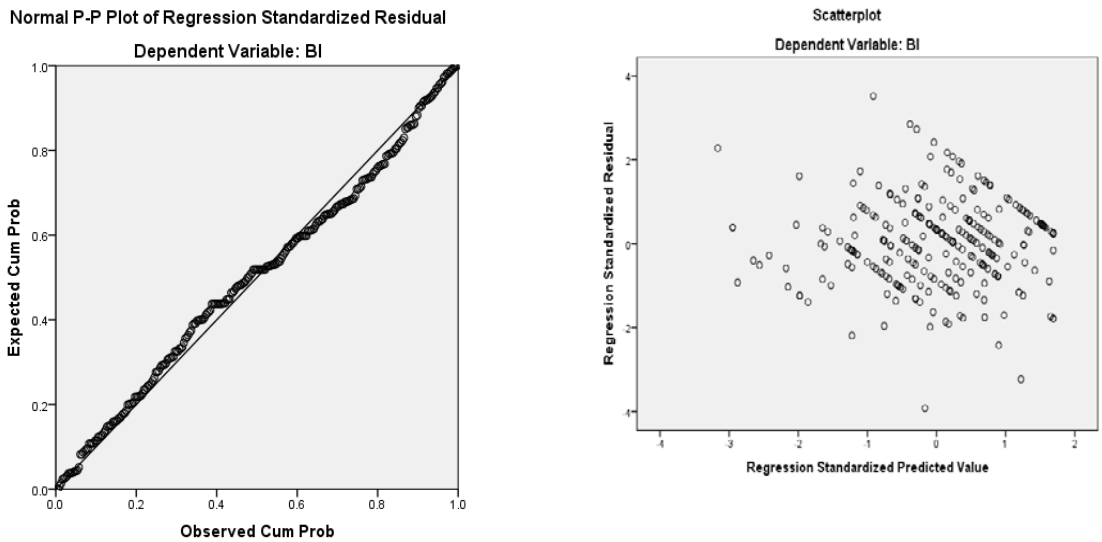


Figure 6.4: Normal probability plot (P-P) of the regression standard residual and scatterplot

6.10 Summary of the hypotheses testing

The summary of the hypotheses testing can be seen in Table 6.16; all results are supported; only PEU was found to be not supported.

Table 6.16: Summary of the hypotheses testing

Hypotheses	Independent variable	Dependent Variable	Beta	Sig. (p)	Results
H1	Social Influence	Perceived Usefulness	.485	.000	Supported
H2	Social Influence	Perceived Ease of Use	.356	.000	Supported
H3	Social Influence	Observability	.342	.000	Supported
H4	Social Influence	Mobility	.355	.000	Supported
H5	Social Influence	Perceived Enjoyment	.343	.000	Supported
H6	Social Influence	Facilitating Conditions	.496	.000	Supported
H7	Social Influence	Personalisation	.336	.000	Supported
H8	Mobile Application	Perceived Usefulness	.272	.000	Supported
H9	Mobile Application	Perceived Ease of Use	.304	.000	Supported
H10	Mobile Application	Observability	.266	.000	Supported
H11	Mobile Application	Mobility	.287	.000	Supported
H12	Mobile Application	Perceived Enjoyment	.254	.000	Supported
H13	Mobile Application	Facilitating Conditions	.210	.000	Supported
H14	Mobile Application	Personalisation	.199	.001	Supported
H15	Perceived Usefulness	Users' acceptance of wearable mobile computing	.425	.000	Supported

H16	Perceived Ease of Use	Users' acceptance of wearable mobile computing	.095	.0135	Not supported
H17	Observability	Users' acceptance of wearable mobile computing	.184	.007	Supported
H18	Mobility	Users' acceptance of wearable mobile computing			
H19	Perceived Enjoyment	Users' acceptance of wearable mobile computing	.174	.014	Supported
H20	Facilitating Conditions	Users' acceptance of wearable mobile computing			
H21	Personalisation	Users' acceptance of wearable mobile computing			

The revised model is presented in Figure 6.5 which has become four independent model factors (PU, PEU, OBSMOB and FCPEPN) which may influence users' acceptance of wearable computing. The precursor SI and MA have a positive effect on all model factors.

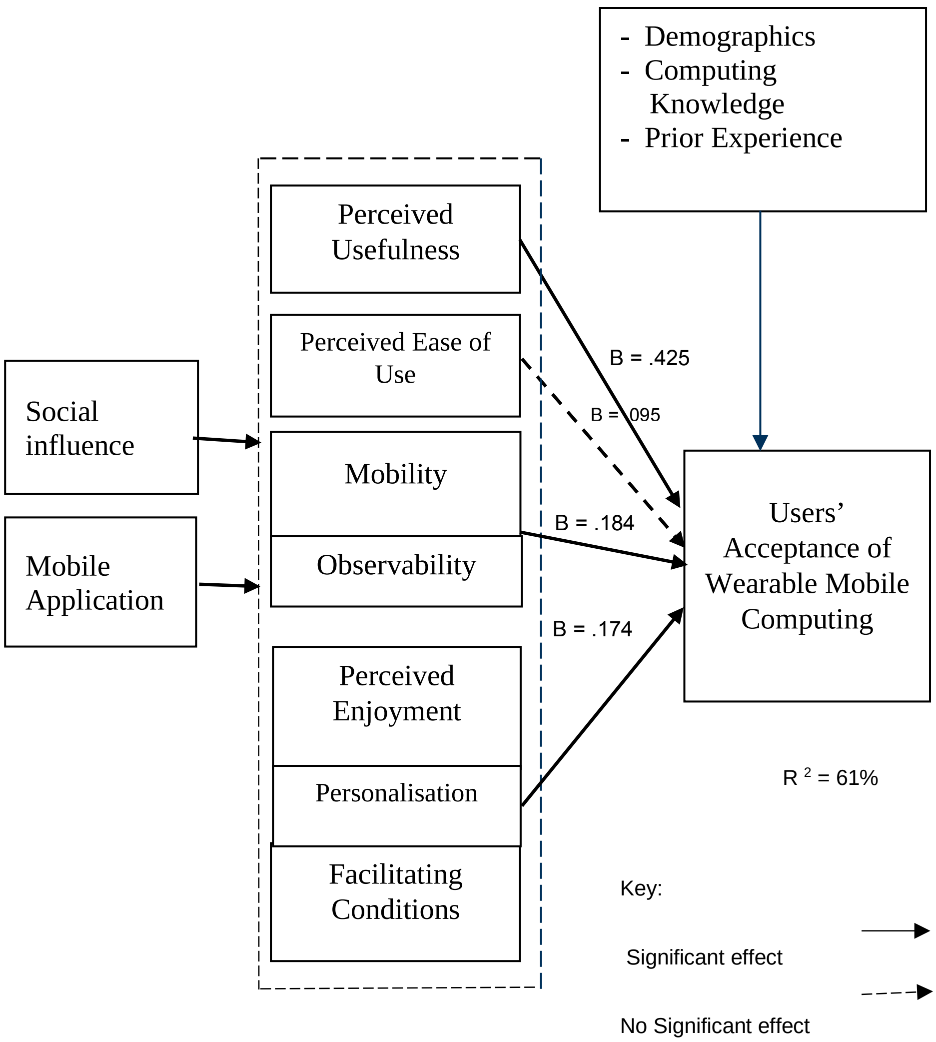


Figure 6.5: Revised model based on regression results

6.11 Qualitative interview to support the Revised Research Model

The purpose of conducting the interview was to support the findings in the revised conceptual model developed from the quantitative study, as shown in Figure 6.5, to add the value or as collateral for the findings. The semi-structured interview (see Appendix B) was conducted by a pre-arranged telephone call. Prior to conduct the interview, the cover letter, participant consent form and information sheet about the study were emailed to get the consent from the participants. The consent forms gained its ethics approval from Brunel University London.

The interview took place from July until August 2017 and was treated voluntarily, anonymous and confidential. The interviews were carried out with six participants from the ICT field who were chosen based on being highly experienced managers and IT professionals. The duration of interviews was approximately between 30 and 40 minutes with a follow-up call for further clarification.

The following Table 6.17 shows the profile of the participants. It can be seen that all participants are highly experienced in their field of mobile technology and information technology, with 8 to 25 years of working experience.

The interview-based approach was employed in accordance with Johnson, Onwuegbuzie and Turner, 2007 to validate a quantitative model, who stated '*Quantitative dominant mixed methods research is the type of mixed research in which one relies on a quantitative, postpositivist view of the research process while recognising the value of qualitative data may add value to the most research projects',* and it was symbolised as (QUAN+qual) research.

Creswell (2013) mentioned that the '*explanatory sequential mixed method is one in which the researcher first conducts the quantitative research, analyses the results and the builds on the results to explain them in more detail with qualitative research.'* It is considered explanatory due to the initial quantitative data that is explained further with quanlitative data; though, it was known as sequential due to the initial stage being quantitative phase then followed by the qualitative phase.

Table 6.17: Interviewee profile

Participant	Job role	Years of experience
P1	Senior Manager in the mobile company	20
P2	IT Officer in the government sector	13
P3	Consultant in telemedicine	15
P4	IT Consultant	25
P5	Web Developer	8
P6	Cloud Product Architect in a mobile company	17

A mixed methods research design is useful when '*the quantitative or qualitative approach by itself is inadequate to understand a research problem and the strength of both approaches can provide the best understanding.'* Creswell, (2013) added that the research findings might be generalised to a population, as well as develop a detailed view of a phenomenon or concept. The survey can be conducted to '*a large number of individuals and then follow up with few participants to obtain their specific views and voices about the topic.'*

In this research, the data were analysed using thematic analysis. According to Braun and Clarke (2006), '*Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data.'* The interview data was recorded as note-taking due to no audio recording being allowed for privacy purposes; then, the interview transcripts were typed accordingly. There are six phases of analysis of the data: familiarising with data, generating initial codes, searching for themes, reviewing themes, defining and naming, and finally producing the report. The objective of thematic analysis is to identify themes which there are the patterns in the data that are significant or interesting; these themes were used to address the research question (Maguire and Delahunt, 2017).

The top-down or theoretical thematic analysis is done to address the specific research question (Maguire and Delahunt, 2017); for this research, the analysis was driven by the research question. Coding was performed manually in this research. To code manually, notes can be taken from the texts while analysing, by using highlighters or coloured pens to indicate potential patterns and using ‘post-it’ notes to identify segments of data. It involves sorting the different codes into potential themes and collating all the relevant coded data extracts within the identified themes. During this stage, codes were examined and fitted together into a theme. Codes related to themes were underlined. Themes had been devised from the literature and the revised model. In organising a theme, the researcher may use a table, mind-maps or they may write the name codes on a separate piece of paper (Braun and Clarke, 2006). Below shows Table 6.18 for data analysis using thematic code with the devised theme from the literature, as well as the revised model.

Table 6.18: Theme and code for analysis

Theme	P	Code/ Quote
Social Influence	P1	In a society with widespread smartphone and users' interaction among them to share the information on wearable in social media, as well the social status would benefit accepting wearable computing.
	P2	Having someone that always tells you about how good the wearable technology to him/her and suggests you have it is one of the factors that can attract you to have it too. I can say, social influence is the main reason why someone can accept the use of wearable technology.
	P3	Like my field in healthcare, most of the users tend to make the decisions on the devices based on others' suggestions since the device is new for them.
	P4	Sharing and peer pressure in a social group are among the reasons why one's going for a wearable. In a group of cyclists, people start sharing what they find useful in tracking their activities, and they will compare features among them and decide which wearable is the most suitable for their activities.

	P5	Social status can also spread innovation. When a potential user shares any information about the new things, like wearing the smartwatch, their friends tend to know the benefit of it, thus encouraging the intention to have it as well.
	P6	Social influence is an essential factor as people might be influenced when seeing others have new tech.
Mobile Application	P1	As we know, nowadays mobile apps are common and easy to be downloaded, the app's developer created more apps to make the user more convenient in accessing their tasks.
	P2	Yes, there is a positive relationship between them. Currently, many applications can be downloaded into your smartphone, which links to wearable technology. This application makes it easy for you to monitor all the data from wearable technology and smartphone provides an intelligent way to process the data and present it in a very useful way.
	P3	Yes, mobile apps help me a lot in managing my daily tasks, so it is possible to influence potential users attracted to accept wearable computing.
	P4	Yes, an eco-system (platform), which includes mobile application, is definitely a plus. Users can customise their watch faces (smartwatches), seamless sync of gathered data like GPS location and fitness data into a mobile application for further analysis
	P5	Yes, it may be the factor due to the development of the vast apps like mobile banking apps, email, and gaming.
	P6	Mobile apps are growing nowadays; I also download mobile apps that can ease my tasks. I think this is an important point for wearable.
Perceived Usefulness	P1	I agree that usefulness influences acceptance in any innovation; there must be advantages of having the new technology, especially wearable.
	P2	When people think about the technology that is useful to them, they tend to find more information about it and look for a reasonable price to buy it. For me, as a first-time user of any new wearable device, I would prefer to buy an acceptable quality for cheap/acceptable price. If only I feel it's good and useful enough for me, then only I will spend some money to buy a good quality one. This is the main idea of having an innovation due to its usefulness and increase work performance.
	P3	The reason why any technology is developed is to benefit daily users' tasks and to promote a convenient lifestyle.

	P4	Yes, there is a positive relationship between them, one of the deciding factors for most users is the functions of the devices and if the device works for them. For example, for health-conscious, users will find fitness tracker useful for them, and they will buy wearable that is tailored to fitness.
	P5	This new technology is an attached computer which may have numerous benefits with the ability to provide greater accuracy and usability.
	P6	Yes, usefulness might be the critical factor for wearable computing, but I do think security also may be considered in using the devices or gadgets
Perceived Ease of Use	P1	I think any enabling technology should be easy to use; then users will try to keep on using it in the future; however it could not be the significant factor as the current users are majority technological savvy; they might think wearable is easy to use due to the advancement of the smartphone usage.
	P2	Ease of use is not an indication of how useful the technology to them. Everyone can use it, but what is it for? If it helps you to achieve particular objective, then it is good. But if it is just because of how easy to use it make you accept that technology, it is not quite important. If the price is reasonable, maybe you can buy it for exploration or trying new technology. But not for me.
	P3	Since many potential users have a smartphone, wearing a smartwatch for health monitoring would not be a big issue, I guess.
	P4	Ease of use is definitely one of the main deciding factors, so I'm a bit disagree as it is 'not significant.' There are few examples of the early generation of wearables where users found that some of the devices are hard to operate or navigate and abandoned them and start to find other alternatives that are user-friendly and easy to use.
	P5	I think many users know how to operate wearable computing since they are smartphone users. They can easily employ wearable devices to perform any task.
	P6	Less effort and think the gadgets will do analytics thinking maybe one of the factors.
Mobility linked with Observability	P1	From my point of view, mobility is the key factor for mobile technology; the same goes for wearable as it is connected to a smartphone. However, the linked with observability may due to users want to see the effect of having it anywhere.

	P2	What I can understand about mobility is the easiness of bringing that technology anywhere, everywhere. While for observatory means that people observe someone who uses the wearable and try to figure out the easiness and usefulness of the wearable technology. I am not sure about the link between mobility and observatory. But what I can say, if it is mobile technology, people can easily see and curious about it. It is like free marketing. People will observe this new mobile technology and guess about what it is used for. They can find out by asking directly or search through google. When people wear wearable technology being observed, then more people curious and interested in it. Wearable computing could be a good idea, having it in the workplace as it is mobile, the result is visible to people in promoting remote communication, for example, having a virtual live meeting
	P3	Mobility is to access the function at anytime and anywhere, but when it linked factor, the user prefers an innovation that offers observable results. Individuals can see the results of the innovation, they are more likely to adopt it. Wearable computing should be ‘mobile’ and have the mobility characteristic at anytime and anywhere; this technological innovation still at an early stage, my company has tried to promote telemedicine awareness.”
	P4	I think there is a positive relationship between mobility and observability on user acceptance. The device should be lightweight for mobility, comfortable, appealing, and durable to the users. Observability is important because information can be easily available/read as and when needed in a single display.
	P5	For example, wearable devices can collect all kind of data in motion with the integration of electronics. Mobility is the main factor for wearable as it attaches to the users’ body, about the linked factor may be users see it as the same meaning or should be observable while mobile.
	P6	As for me, of course, wearable must be accessed anywhere, which is mobility, but the linked with observability might be people expect wearable computing to be seen by others anywhere.

Perceive Enjoyment; Personalisation linked with Facilitating Conditions	P1	For me, when we can personalise any preference in wearable, we tend to enjoy using it, like a smartphone can be personalised according to user preference, surely it is fun to explore the function. While the facilitating conditions are essential to help users to understand the system, therefore encourage acceptance.
	P2	I believe people enjoy to having wearable technology because the design of the technology allows them to choose their preferences. How the application should look like known as personalisation and the design that facilitate them to access certain information to achieve their objective smoothly. For example, a fitness detection that you wear to detect a pulse, deep sleep, blood pressure, number of steps, people are happy to know their health condition that is very personal to them. This information facilitates them to decide what they should do next whether to be more active to achieve an ideal body weight or to go to the clinic to get treated with whatever condition that seems very alarming like high blood pressure.
	P3	I enjoy it when I got an opportunity to learn new technological innovation, currently am doing research on telemedicine, exploring wearable which benefits the healthcare and it is fun too. Wearable able to be personalised with right facilitating conditions could have a promising future.
	P4	The relationship is defined by the type of applications in wearable mobile computing. For example, for health monitoring (e.g., fitness tracker), enjoyment and personalisation are not necessary to have positive relationships because the users need basic information. However, in wearable such as smartwatches, enjoyment and personalisation are the main deciding factors. For all types of wearables, a platform (eco-system) plays an important role in users' acceptance.
	P5	I think these factors are significant when users enjoy and have fun using any system; they will love to have it, like the smartphone. Users now rely on mobile applications available on mobile smartphones to do daily tasks. The relationship is linked due to users expect they can get support from the provider in facilitating the difficulty faced and able to personalise depending on their preference, thus creating excitement.

		Like an Apple watch, the promising benefit for personal use or monitoring of health, it's quite fun.
	P6	Some prefer to have it for fun and the ability to personalise users' needs. The linked between these factors fun while can be personalised, and the system provides facilitating conditions for users. I think these factors are positive to give the user flexibility to use wearable computing as they intended.

P* is a participant

Perceived usefulness

The result from the interview showed that all participants' perceived usefulness has a positive effect on users' acceptance of wearable computing aligns with the findings from the quantitative study. Furthermore, it was recognised that perceived usefulness was the greatest contribution to technological innovation, acceptance of innovation, and from the participant perspective, they said:

P1 *"I do agree on usefulness influences acceptance in any innovation; there must be an advantage of having the new technology, especially wearable."*

P2 *"When people think about the technology that is useful to them, they tend to find more information about it and look for a reasonable price to buy it. For me, as a first-time user of any new wearable device, I would prefer to buy an acceptable quality at a cheap/acceptable price. If only I feel it's good and useful enough for me, then only I will spend some money to buy a good quality one. There is the main idea of having an innovation due to its usefulness and increase work performance".*

P3 *"This is why any technology is developed to benefit daily user tasks and to promote a convenient lifestyle."*

P4 *"Yes, there is a positive relationship between them, one of the deciding factors for most users is the device function, and if the device works for them. For example, health-conscious, users will find fitness tracker useful for them, and they will buy wearable that is tailored to fitness".*

P5 *"This new technology is an attached computer which may have numerous benefits with the ability to provide greater accuracy and usability."*

P6 *"Yes, usefulness might be the critical factor for wearable computing, but I do think security also may be considered in using the devices or gadgets."*

Perceived ease of use

The results obtained from the survey questionnaire showed that perceived ease of use has no positive influence on users' acceptance of wearable computing. It was discussed that many users already knew how to operate mobile devices, and users perceive that wearable computing is as easy as they have experience in mobile smartphones. Thus, ease of use may not be the influencing factor in adoption. The participants commented as follow:

P1 *"I think any enabling technology should be easy to use, then the user will try to keep using it in the future, however, it could not be the significant factor as current users are majority are technological savvy; they perceive wearable is easy to use due to the advancement of the smartphone."*

P2 *"Ease of use, not an indication of how useful the technology is to them. Everyone can use it, but what is it for? If it helps you to achieve a particular objective, it is good. But if it is just because of how easy to use to make you accept that technology, it is not quite important. If the price is reasonable, maybe you can buy it for exploration or trying new technology. But not for me".*

P3 *"Since almost many potential users have a smartphone, wearing a smartwatch for health monitoring would not be a big issue, I guess."*

From the interview, only participant 4 (P4) responded not to agree that ease of use was found not a significant factor; he commented as follow:

P4 *"The ease of use is one of the main deciding factors, so I'm a bit disagree as it was found ''not significant.' There are few examples of the early generation of wearables where the users found that some of the devices are hard to operate or navigate and abandoned them and start to find other alternatives which are user-friendly and easy to use".*

P5 *"I think many users know how to operate wearable computing since they are smartphone users. They can easily employ wearable devices to perform a task".*

P6 *"Less effort and thinking on gadgets to do analytics thinking maybe one of the factors."*

Mobility and Observability

Questions were asked about the positive relationship between Mobility (as associated with Observability) on Users' Acceptance of Wearable Mobile Computing. In general, the participants commented that users tend to see it as one factor, as wearable computing should display good results when using it in daily life, as well as it being able to support mobility, which is the key idea of a pervasive system, from the participants' point of view:

P1 *"From my point of view, mobility is the key factor for mobile technology; the same goes for wearable as it connected to a smartphone. However, the linked with observability, possibly due to users want to see the effect of having it anywhere".*

P2 *"What I can understand about mobility is the easiness to bring the technology anywhere, everywhere. While for observatory means that people observe someone who uses the wearable and try to figure out the easiness and usefulness of the wearable technology. I am not sure about the link between mobility and observatory. But what I can say, if it is mobile technology, people can easily see and curious about it. It is like free marketing. People will observe this new mobile technology and guessing about what it is used for. They can find out by asking directly or search through google. When a lot of people use wearable technology being observed, then more people curious and interested in it".*

"Wearable computing could be a good idea of having it in the workplace as it is mobile, the result is visible to people in promoting remote communication, for example, having a virtual live meeting

P3 *Mobility is to access the function at anytime and anywhere is essential for adopting the innovation, but when it linked factor, the user prefers a change that offers observable results. The more individuals can see the results of technological innovation, the more likely they are to adopt it".*

"Wearable computing should be 'mobile' to have the mobility characteristic at anytime and anywhere, this technological innovation still at an early stage, my company has tried to promote telemedicine awareness."

P4 *I think there is a positive relationship between mobility and observability to user acceptance. Mobile means the device should be comfortable, appealing, and durable to the users. Observability is important because information can be easily available/read as and when needed in a single display".*

P5 *"For example, wearable devices can collect all kinds of data in motion with the integration of electronics. Mobility is the main factor for wearable as it attaches to the users' body, about the linked factor may be users see it as the same meaning or should be observable while mobile".*

P6 *"As for me, of course, wearable must be accessed anywhere, which is mobility, but the linked with observability might be people want the wearable computing to be seen to others anywhere."*

Perceived Enjoyment, Personalisation and Facilitating Conditions

All participants were asked about the positive relationship between Perceived Enjoyment (as associated with Personalisation and Facilitating Conditions) on Users' Acceptance of Wearable Mobile Computing. From the discussion, the majority of the participants agreed on the positive effect on users' acceptance, the participants' opinions as follows:

P1 *"For me, when we can personalise any preference, we tend to enjoy using it, like a smartphone can be personalised according to user preference, surely it is fun to explore the function. While the facilitating conditions are essential to help users to understand the system, therefore would encourage acceptance".*

P2 *"I believe people enjoy to use wearable technology because the design of the technology allows them to choose their preferences of how the application should look like or known as personalisation and the design that facilitate them to access certain information to achieve their objective smoothly. For example, a fitness detection that you wear to detect a pulse, deep sleep, blood pressure, number of steps, people happy to know their health condition that very personal to them. This information facilitates them to decide what they should do next whether to be more active to achieve an ideal body weight or to go the clinic to get treated with whatever condition that seems very alarming like high blood pressure."*

P3 *"I enjoyed it when I got an opportunity to learn new technological innovation, currently am researching telemedicine, exploring wearable which benefits for the healthcare is fun too. Wearable able to be personalised with right facilitating conditions could have a promising future."*

P4 *"The relationship is defined by the type of applications in wearable mobile computing. For example, for health monitoring (e.g., fitness tracker), enjoyment and personalisation are not necessary to have positive relationships because the users need basic information. However, in wearable such as smartwatches, enjoyment and personalisation are the main deciding factors. For all types of wearables, a platform (eco-system) plays an important role in users' acceptance."*

P5 *"I think these factors are significant when users enjoy and have fun using any system; they will love to have it, like the smartphone. Users now rely on mobile applications available on mobile smartphones to do daily tasks. The relationship is linked possibly due to users expect they can get support from the provider in facilitating the difficulty faced and able to personalise depending on their preference, thus creating excitement.*
Like an Apple watch, the promising benefit for personal use or monitoring of health, it's quite fun".

P6 *"Some prefer to have it for fun and the ability to personalise users' needs. The linked between these factors fun while can be personalised, and the system provides facilitating conditions for users. I think these factors are positive to give the user flexibility to use wearable computing as they intended".*

The purpose of conducting the qualitative semi-structure interview was to verify and support the revised model developed based on a survey-based questionnaire deployment. The interviewees were recruited to participate based on being highly experienced in the IT field. The findings from the interviews supported the revised model and verified the influencing factors in having a positive effect on users' acceptance of wearable computing. To conclude, all participants have a positive opinion and agree on the overall conceptual framework, and no major concern was found pertaining to the model.

6.12 Chapter summary

This chapter presented the model testing using SPSS V.20 with multiple regression statistical analysis to answer the research questions. Semi-structured interviews were conducted to support the main field study as a collateral and verified the respondents' perception in the survey-based questionnaire. The findings from the follow-up interviews revealed that the revised framework factors were acceptable for users' acceptance of wearable computing. Empirical tests were applied, including reliability test, correlation test, factor analysis test, and regression test, to examine the proposed model factors and hypotheses were formulated.

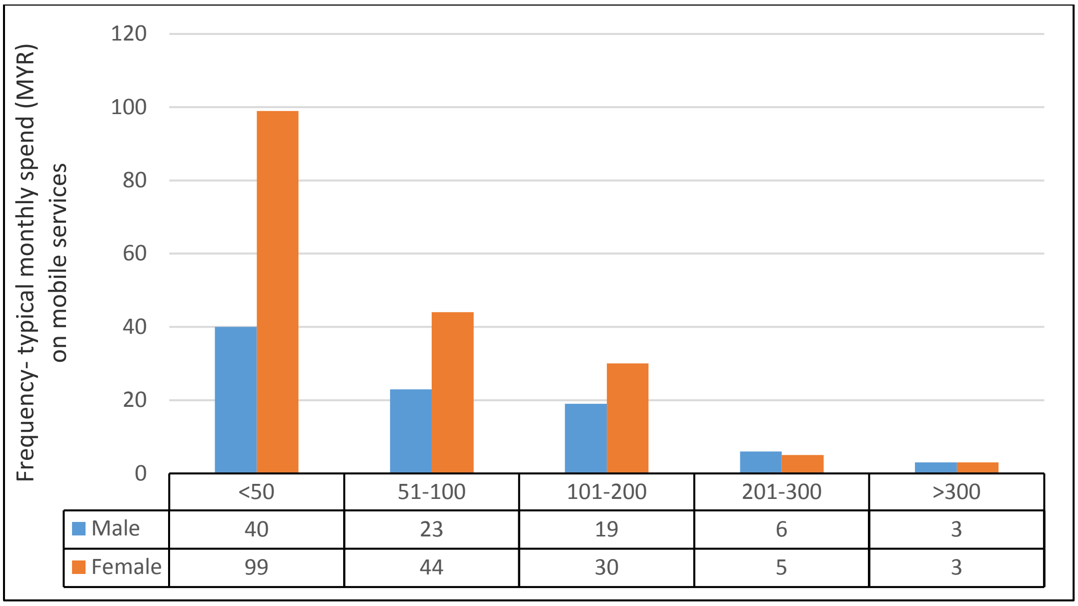
The key findings of this study indicate the important contribution of the factors chosen in developing the framework with the integration of TAM, DOI and related pervasive factors. It also revealed the result of the multiple regression analyses presented all hypotheses were supported except for PEU. PU (beta = .425, p< .000), while OBS was found to link with MOB (beta = .184, p< .007); FC linked with PE and PN (beta = .174, p < .014), and PEU (beta = .095, p< .135) did not support the hypothesis. The explanatory power was R^2=61% in explaining users' acceptance of wearable computing, while TAM typically explains 40% of the variance on its original context. The new knowledge emerged from this study shows the model explained 61% where PU contributed to the highest predicted factors. This new data will advance the knowledge in considering the factors: usefulness is the most important factor followed by OBS, MOB, FC, PE and PN for wearable acceptance, while perceived ease of use was found not influencing the acceptance. The findings from the interviews supported the revised model and verified the influencing factors in having a positive effect on users' acceptance of wearable computing. In the next chapter, the comprehensive discussion on findings will be elaborated to further understand users' acceptance of wearable computing in the Malaysian context, thus, increasing adoption.

CHAPTER 7

7 DISCUSSION

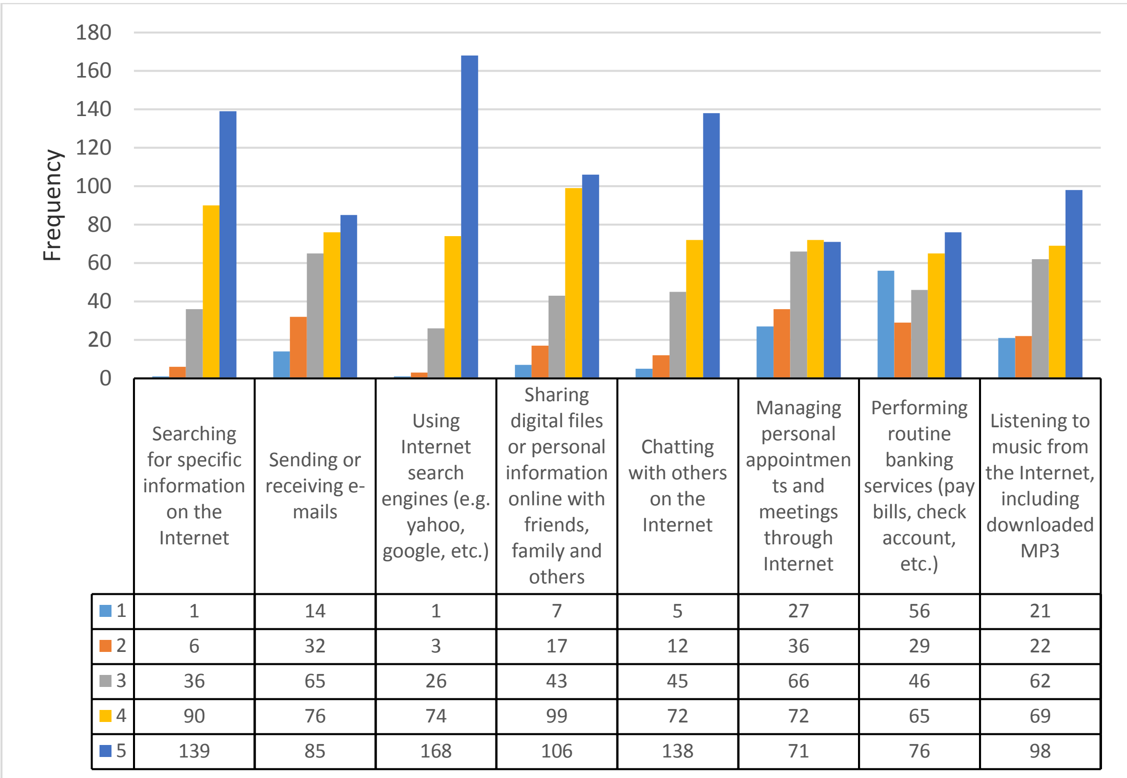
7.1 Social influence and mobile application

This research attempts to develop the Innovation Acceptance Model for Wearable Computing by integrating the precursors: social influence (SI) and mobile application (MA) with the model factors which are PU, PEU, OBS, MOB, PE, FC and PN which may influence users' acceptance of wearable computing in the Malaysian context. The factors are extracted from the Technology Acceptance Model (TAM), the Diffusion of Innovation Theory (DOI) and related factors on mobility and pervasive computing technology. The uniqueness of this framework where SI and MA as the precursors demonstrate significant positive effects on all model factors. To further understand on users' characteristic, as shown in Figure 7.1, female respondents have more interests in monthly spending on mobile services; typically, they are willing to spend and utilise the mobile application services, as well as online shopping and TV subscriptions. Figure 7.2 shows mobile applications usage among users and reveals that sending an email and performing online banking, reflecting that the users have prior experience in mobile computing technology. Since the mobile application has substantially changed the mobile technology landscape over the past years, mobile development platforms have become more integrated. The current mobile application evolutions show that the game has changed dramatically for developers (Holzer and Ondrus, 2011). These findings demonstrated that the pervasive application has been growing for deployment in users' daily activities.



	<50	51-100	101-200	201-300	>300
Male	40	23	19	6	3
Female	99	44	30	5	3

Figure 7.1: Typical monthly spend on mobile service based on gender



	Searching for specific information on the Internet	Sending or receiving e-mails	Using Internet search engines (e.g. yahoo, google, etc.)	Sharing digital files or personal information online with friends, family and others	Chatting with others on the Internet	Managing personal appointmen ts and meetings through Internet	Performing routine banking services (pay bills, check account, etc.)	Listening to music from the Internet, including downloaded MP3
1	1	14	1	7	5	27	56	21
2	6	32	3	17	12	36	29	22
3	36	65	26	43	45	66	46	62
4	90	76	74	99	72	72	65	69
5	139	85	168	106	138	71	76	98

Figure 7.2: Mobile application usage frequency

A mobile application may offer context-aware functionalities. In order to perform the desired tasks, the application must have location data, user preferences, activity prediction, user schedules and information retrieved. This phenomenon shows the complexity of collecting and processing information increased over time. The amount of information collected may aid decision-making (Perera *et al.*, 2015). User experience in using mobile services may motivate them to accept wearable computing.

The lifestyle of users for online shopping and mobile service subscription encourages the mobility of anytime and anywhere activity. As society and organisations become dynamic, individuals' information services have to be suited accordingly (Lyytinen and Yoo, 2002). Mobility is a core factor of any wireless or pervasive network service. Perceived mobility refers to "*the degree to which users are aware of the mobility value of mobile services and systems capability in accessing information in the wireless environment via a user's mobile device*" (Park and Kim, 2014). Mobility is predicted to be a significant role in enhancing users' acceptance of wearable computing as users have been utilising the mobile application and expect to access information in the wireless environment. In addition, in this study, the regression result for mobility shows *beta= .184* where factors of mobility linked with observability (OBSMOB) has significantly influenced wearable computing acceptance.

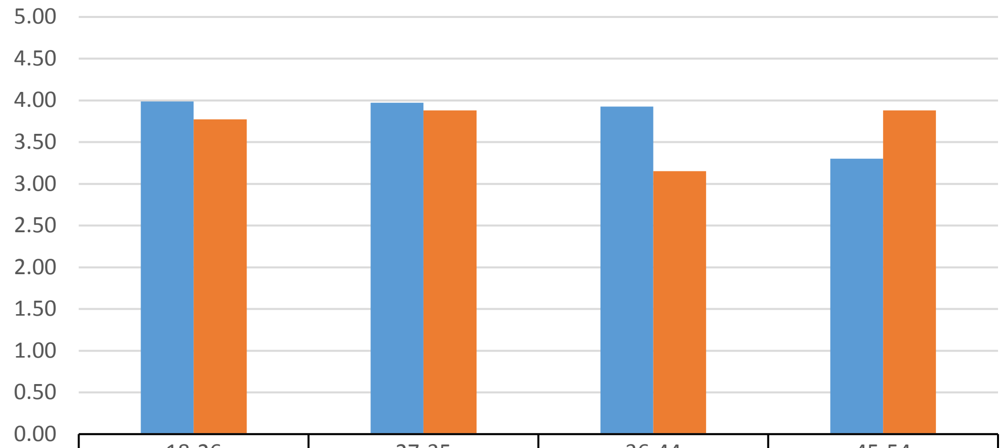
Additionally, from regression analysis revealed that social influence (SI) has significantly influenced the model factors. Similarly, Gao, Li and Luo, (2008) in their study investigated the factors associated with consumer's intention to adopt wearable technology in healthcare; SI was found as the most significant predictors. There were two groups of fitness and medical wearable devices consumers, it showed fitness users care more about social influence. They urged that the younger and the healthy users likely to have more interests to purchase fitness wearable devices and care more about their social networks. Moreover, similar result of SI on behavioural intention is significant in using smart bands, other factors were usefulness and compatibility (Weng, 2016). Another study to identify the predicted factor of actual use of online game playing amongst Malaysian found social influence as significant factor

(Alzahrani *et al.*, 2017). The two precursors: SI and MA in this current study reveal significant effect on the model factors which may motivate users to accept wearable computing.

7.2 The factors affecting users' acceptance of wearable computing

The main objective of this research is to develop and examine the influencing factors of the Innovation Acceptance Model of wearable computing. Findings from the multiple regression analyses presented PU (beta= .425, p< .000) supported the hypothesis formulated and being the greatest contribution of 42.5% of users' acceptance, while OBS was found linked with MOB (beta = .184, p< .007), which also supported the formulated hypothesis. Moreover, FC linked with PE and PN (beta = .174, p < .014) also supported the hypothesis being examined, and PEU (beta = .095, p< .135) did not support the hypothesis and thus did not significantly influence users' acceptance. The model explained 61% of the variance (R square =61%) in users' acceptance of wearable computing. The adjusted R square is used to estimate the true population. The R square explains to what extent the variance of one variable explains the variance of the second variable. The value of R square ranges from 0 to 1 and it is commonly stated as a percentage from 0% to 100%. R square of 100% means the dependent variable is well explained by the independent variable.

The effect on the demographic characteristics, prior experience and computing knowledge were tested on the dependent variable which is behavioural intention (users' acceptance of wearable computing). The analysis of T-test conducted for gender and ANOVA test for the age group found that was no significant effect on behavioural intention. These findings may add to the valuable insights in aiding the business decision making on gender and the age group for the Malaysian context. It offers as an alternative tools for decision making in understandings users' characteristics.



	18-26	27-35	36-44	45-54
Male	3.99	3.97	3.93	3.30
Female	3.77	3.88	3.15	3.88

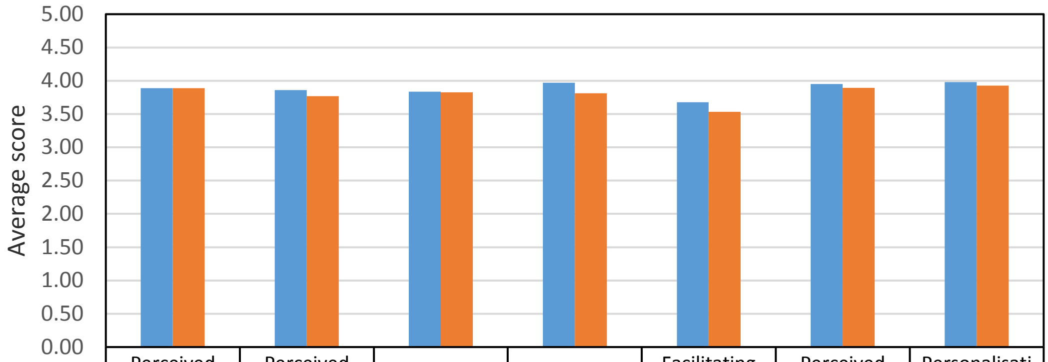
Figure 7.3: Behavioural Intention (users' acceptance) based on gender and the age group

The dependent variable (users' acceptance of wearable computing) based on the age groups and gender as shown in Figure 7.3 highlights the highest average score is for the two age groups of 18-26 and 27-35. These findings show that the younger age group shows positive intention on wearable computing. This finding parallels with the research conducted to study mobile phone use amongst students in a university in Malaysia concerning psychological health which revealed usage acceptance by Malaysian students (Zulkefly and Baharudin, 2009). Also, a previous study found that the majority of smartphone users are teenagers and younger adults (Osman *et al.*, 2012; Mayudia *et al.*, 2013). The results on the behavioural intention also reflect males aged 36 and above also have the intention to adopt wearable innovation. Findings also demonstrate in contrast that females at an older age show that they are more likely to adopt this emerging technology compared to males.

As shown in Figure 7.4, the model factors based on gender shows that both gender and the age group revealed a positive intention to accept the technological innovation of wearable computing with higher mean scores.

However, findings from other research revealed that young people who were not using mobile communication services might not be happy about maintaining social relationships (Hong *et al.*, 2008). Another study on the behavioural intention of mobile phones in rural China found that younger males with lower education and factory workers were early adopters of mobile phone (Wei and Zhang, 2008). It may be that young users are willing to accept innovation due to peer influence in general, as some of the younger generations believe their status will increase if they are seen using the innovative mobile phone (Shuib, Shamshirband and Ismail, 2015; Canhoto and Arp, 2016). A study by Mayudia *et al.* (2013) found that Malaysian undergraduates value their smartphone as it is associated with their image this reflecting to social influence factor. This finding shows the growth of smartphone consumption and its popularity among young people. In another study, the demographic characteristics where age and gender were taken into consideration in the acceptability of wearable computers (Buenaflor and Kim, 2013).

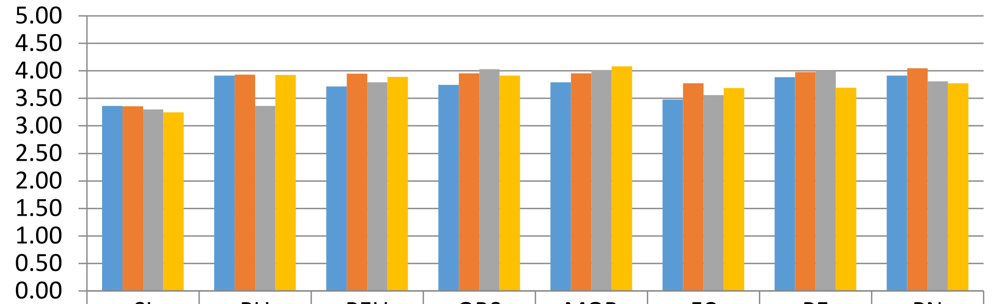
The model factor score differences based on gender as shown in Figure 7.4 revealed that MOB, PN and PE have contributed to the highest average scores for both male and female, following the PU, PEU (the two TAM factors), OBS and FC.



	Perceived usefulness	Perceived ease of use	Observability	Mobility	Facilitating conditions	Perceived enjoyment	Personalisation
Male	3.89	3.86	3.84	3.97	3.68	3.95	3.98
Female	3.89	3.77	3.83	3.81	3.53	3.90	3.93

Figure 7.4: Factor score based on gender

Figure 7.5 shows the mean scores of the model factors have a positive effect based on the age groups. It can be seen that all model factors have higher mean scores across all the factor for users' acceptance of wearable computing.



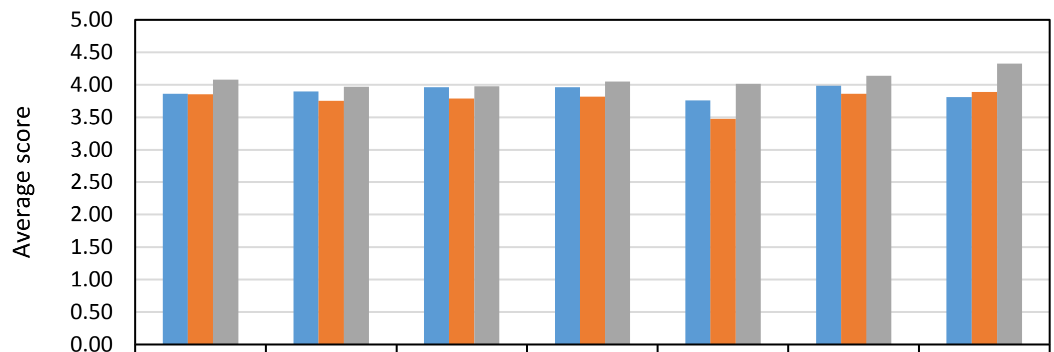
	SI	PU	PEU	OBS	MOB	FC	PE	PN
18-26	3.36	3.91	3.72	3.75	3.79	3.48	3.89	3.92
27-35	3.36	3.93	3.95	3.96	3.95	3.77	3.98	4.05
36-44	3.30	3.36	3.79	4.03	4.02	3.56	4.00	3.81
45-54	3.24	3.93	3.89	3.92	4.08	3.69	3.69	3.78

Figure 7.5: Factors score based on the age group

These findings may likely reflect the chosen samples are educated with computing knowledge and prior mobile experience. The factors score difference based on age groups in Figure 7.5 also shows that MOB, PE and PN contribute to the highest average score followed by PU. The age group of 36-44 reported the highest average scores for OBS, MOB and PE, this finding might reflect the midcareer age users who are more likely to accept innovation. Additionally, the distinctiveness of this framework for intergrating mobility (MOB) as the predictor, shows associated with observabilty (OBS) and significantly influence the outcome, similarly, perceived mobility influenced user acceptance of mobile cloud services and mobility has significant on PU (Park and Kim, 2014). Rogers argued that a technological innovation that was not observable may have a relatively slower rate of adoption as perceived by members of a social system. Observability was found significant on the computer adoption and use (Al-Gahtani, 2003); similar in current research, OBS was also found to be significant factor. These findings reflect that users are likely to adopt wearable computing when the benefit of the innovation is visible and has mobility characteristic.

A study conducted by Wu, Wu and Chang (2016) found that age is an important factor as users under 34 years of age show a strong demand for smartwatches. Perceived enjoyment was found to be significant only for people aged between 35 and 54 as it was similar to this current study where perceived enjoyment revealed higher mean scores for all age groups. Wu, Wu and Chang (2016) urged that this condition may likely be because the potential users usually have a higher social position, better employment, and higher-income. However, they found ease of use and gender was found not significant, this finding in line with current study which found PEU was not significant predictor. Moreover, results from a smartwatch study showed enjoyment is a significant predictor on attitude (Choi and Kim, 2016).

The model factors based on the age and gender for the purpose of using a smartphone revealed higher average mean scores, supporting that users are willing to adopt this technological innovation. As seen from Figure 7.6, using a smartphone for study purposes indicated the higher mean score across the model factors.



	Perceived usefulness	Perceived ease of use	Observability	Mobility	Facilitating conditions	Perceived enjoyment	Personalisation
Business	3.87	3.90	3.96	3.96	3.76	3.99	3.81
Personal	3.85	3.76	3.79	3.82	3.48	3.86	3.89
Study	4.08	3.97	3.98	4.05	4.02	4.14	4.33

Figure 7.6: Factor score based on the purpose of using a smartphone

Also, Figure 7.6 shows personalisation contributed to a higher mean in the model factor based on the purpose of using a smartphone. Personalisation is a context-aware computing. Thus, it is a challenge to apply the ideas of personalisation to real humans (Smith, 2007). The challenges in wearable devices include miniaturisation, intelligence, networking, digitalisation and standardisation, security, unobtrusiveness, personalisation, energy efficiency, and robustness (Zheng *et al.*, 2014). Since personalisation means integration of information onto a single device, systems and services should provide visibility controls for different types of information (Lyytinen and Yoo, 2001). A survey of 266 questionnaire on initial trust in wearable commerce revealed that five proposed factors (privacy concern, trust propensity, performance expectancy, facilitating conditions and hedonic motivation) all have significant effects (Gu, Wei and Xu, 2016), in line with the current study, from the regression analysis conducted, personalisation (PN) is seen to be linked with FC and PE, as one of the important factors in technology acceptance for wearable computing, (FCPEPN) with beta= .174 (β=.174; $p<.014$). In summary, all the hypotheses have been examined to achieve the research objectives.

7.3 TAM contribution on users' acceptance of wearable computing

The main contribution of this study is the integration of the TAM model with DOI factors, mobility and pervasive factors were added to demonstrate the significant predictors of users' intentions and acceptance to adopt wearable technology in the Malaysian context.

TAM is known as the established model in IS research. However, some of the TAM factors are not applicable for particular technology developments, for example, in smartwatch acceptance (Krey *et al.*, 2016; Wu, Wu and Chang, 2016). Similar to this study, regression analysis found that PEU is not a predictor of users' acceptance of wearable computing, which aligns with the study by Wu, Wu and Chang (2016) who found PEU as not significant. In contrast, Kim and Shin (2015) found that PU was not a significant predictor of intention to adopt the smartwatches. However, in this study, PU was found to be the highest contributor in predicting the users' acceptance with beta=.425, PEU demonstrates potential users might expect wearable computing to be easy to use, which is likely due to users using the smartphones with computing knowledge and prior mobile experiences. Hence, the existing theories and models, such as the Technology Acceptance Model (TAM), need to be extended to fit the new context of wearable computing technologies perspective.

UTAUT and TAM integration has potential in theoretical contributions. The model factors were predicted in examining how potential users perceived to adopt the new emerging technology for better lives. In this study, R square=61%, explaining the total variance of 61% for users' acceptance of wearable computing in the Malaysian context. Factors were selected by integrating with TAM, DOI and together with pervasive and mobile computing factors by considering the fact of wearable computing characteristics. A study in a mobile banking acceptance context added perceived credibility, perceived self-efficacy' and perceived financial cost into the model, and found the R-square was 82% for the extended TAM (Luarn and Lin, 2005). Chuah *et al.*, (2016) revealed the result of 85.8% of the variance in user intention toward mobile cloud computing is explainable by the combination extended TAM with attitude, satisfaction, and service and system. TAM still plays an important key role in understanding technological innovation, as PU contributed to the highest predicted factor, while PEU was found not significantly influence users' acceptance of wearable computing in the Malaysian context. This reflects users are still looking for the benefit of innovation, the usefulness of wearable computing in helping and increasing their productivity in daily activities. From the interview conducted to support the revised framework, majority of the interviewees also agreed that usefulness is significant factor for users to accept innovation.

7.4 Chapter summary

In this chapter, the research data were analysed based on the results in chapter 5 and 6. The precursor: MA and SI were found to positively influence the model factor of users' acceptance of wearable computing. The model factors also show that PU has the highest contribution and positively influence the outcome (BI). OBS is linked to MOB (OSBMOB) and PE linked with FC and PN (PEPNFC). Users perceived OBS to be linked with MOB; PE linked with FC and PN as one attribute; nevertheless, there were different attributes and theories. Future research shall be extended to further understanding the underlying constructs for users' acceptance of wearable computing.

The key findings for this integrated model have explained the total variance of 61% (R=61%) on users' acceptance of wearable computing, while TAM classically explains 40% of the variance for its original research context. TAM still plays an important key role in understanding technological innovation as PU has contributed to the highest predicted factor, while PEU was found not significantly influence users' acceptance of wearable computing. The unique integration of this model with TAM and DOI for the Malaysian context revealed the unique characteristic of Malaysia's social culture and lifestyle with all higher mean scores of all model factors. Demographic characteristics for gender and the age group have no impact on accepting innovation or BI. The similarities and differences of the findings from this research and previous studies have also been presented. Respondents show the intention to buy the wearables. Since this emerging technology is expected to become mainstream, mobile applications development may encourage widespread wearable computing adoption. The next chapter will conclude this research by highlighting the contribution to academic and practical implications, limitations, and recommendations for future studies.

CHAPTER 8

8 CONCLUSIONS AND RECOMMENDATION

8.1 Introduction

This research aims to develop and examine the conceptual framework of users’ acceptance of wearable computing technology in the Malaysian context as a developing country for potential users. It has contributed to the body of knowledge about wearable computing acceptance. Extant literature was conducted to achieve the research aim. The main literature areas were reviewed: pervasive computing, mobile computing and wearable computing with also reviewing of technological innovation and adoption literature.

Data was collected by using a survey-based questionnaire with quantitative deductive approach, while the qualitative semi-structured interviews were carried out to support the results found in a quantitative study. Empirical tests were conducted to achieve the aim and objectives.

8.2 Summary of research findings

The regression analysis of the survey based on the framework deployed, the results indicated that the users are positive towards wearable computing acceptance. The precursors of SI and MA play a significant role in influencing the predicted model factors towards wearable acceptance.

The age group and gender have no direct effect on behavioural intention (BI) or user's acceptance; this might be due to the potential users being literate with prior experience in mobile usage and computing knowledge. The purpose of using mobile computing (personal, business and study) may influence the acceptance of wearable computing. There was a significant difference of the results in the willingness to buy wearable computing with a certain affordable budget on the BI.

Furthermore, the results from regression analyses presented that social influence (SI) has a strong positive influence on PU (48.5%), PEU (35.6%),

OBS (34.2%), MOB (35.5%) PE (34.3%), FC (49.6%) and lastly, PN (33.6%). Additionally, mobile application (MA) as the precursor selected for the model has a strong positive influence on PU (27.2%), PEU (30.4%), OBS (26.6%), MOB (28.7%) PE (25.4%), FC (21.0%) and lastly, PN (19.9%).

Also, the findings revealed that the strongest predicted factor on the dependent variable (users' acceptance of wearable computing) was Perceived Usefulness (PU) with beta= .425 ($\beta=.425$; $p<.000$), the linked factors comprise of Mobility (MOB) with Observability (OBS) (OBSMOB) with beta= .184 ($\beta=.184$; $p<.007$). Another linked factor is comprised of Perceived Enjoyment (PE) with Personalisation (PN) and Facilitating Conditions (FC) (FCPEPN) with beta= .174 ($\beta=.174$; $p<.014$). It demonstrated that predicted factors influenced potential users to adopt the wearable computing with 61% (R square) of variance explained in BI. TAM has explained the variance typically of 40% in its context. However, in this study, PEU was not supported for users' acceptance of wearable computing. To summarise, this study has presented a comprehensive proposed conceptual framework, the uniqueness of this framework is the integration of TAM, DOI and related pervasive and mobile computing factors that underpin the study, all the hypotheses formulated has been supported except for PEU. The results may offer an alternative tool in predicting wearable computing acceptance of the distinctive characteristics of Malaysian context, regardless of the age groups and gender.

8.3 Research contribution to knowledge

1. This study is novel and empirically conducted on the innovation acceptance of wearable computing technology for the Malaysian context. It contributed to the body of knowledge about wearable computing acceptance and how potential users perceived the new emerging technology for the benefit of their daily life. To add, this study is a limited empirical study on innovation acceptance in developing countries, especially Malaysia.

2. This study has shed light and added valuable insights to the existing literature of the TAM and DOI, by identifying predicted factors from the conceptual framework developed to comprehend which factors will positively influence the users' behaviour intention to adopt the wearable computing technology.

3. This research has developed the innovation acceptance framework that attempts to explain the integration of TAM, DOI and other related mobile technology factors and pervasive factors to empirically test which factors may have the greatest contribution on the acceptance of wearable computing at its early stage of emergence.

4. This study has contributed to knowledge through publications in the journal and proceedings, as well as in seminars. The publications are available for reference in future research.

5. This study has developed an integrated Innovation Acceptance Model for Wearable Computing, which may aid the ICT industry, policymakers and designers in the wearable technology landscape to gain more insights for improvement.

6. To strengthen the results, this study has employed mixed methods by employing survey-based quantitative approach and a qualitative semi-structured interview with the professionals in the Information and Telecommunication organisation and government sector to understand innovation acceptance of this enabling technology for the Malaysian context.

7. This study has developed an integrated model based on TAM and DOI and other related factors which may be considered as a valuable contribution in academia by evaluating the established TAM model. TAM still plays an important role in predicting the advancement of innovation in wearable technology, as well as pervasive computing technology. Though few current studies found out one of TAM factors -

perceived ease of use (PEU) - was not supported which the current study has replicated.

8.4 Theoretical contribution

The findings provide several implications for academicians concerning innovation acceptance of wearable computing in developing countries

Firstly, the results of this study have been published in the *International Journal of Chaotic Computing*, 4(2), pp. 96–102, which can be accessed online.

Secondly, the study of this research provided empirical evidence on users' acceptance of innovation by examining the model factors.

Thirdly, regarding the existing literature on wearable computing adoption, this research highlighted the importance of selecting suitable factors from many established theoretical models for hypothesis testing.

Fourthly, the results of this research may contribute to a lack of empirical studies on wearable computing areas in developing countries as wearable computing become mainstream in the future.

Lastly, this study has explanatory power, R square = 61% which is acceptable in IS research.

8.5 Managerial implications

This study provides meaningful findings on how users' perceived innovation adoption on emerging technology. A survey based on the framework could be deployed and the results may be used for the developers or designers of wearable computing technology to gain insights in designing the wearable computing devices that meet users' preference. The findings may help to understand PU as the greatest contributing factor in explaining users' acceptance. Results on the gender and the age group has no significant effect towards BI or users' acceptance of this innovation as users are exposed to mobile usage experience or technological savvy in ICT. This may offer a useful tool for technology providers in promoting current wearable computing in boosting digital economy. Users may have positive intentions to utilise a smartwatch in daily activities, for example in mobile payment using mobile apps. Also, the researcher may suggest in motivating users to accept technological innovation; it is essential to ensure the system developed should be useful, pervasive in supporting mobility and observability factors, perceived preference with enjoyment, have facilitating conditions available and able to be personalised in wearable computing applications. The qualitative interview results also have supported the revised model; all the interviewees agreed that the model factors extracted were able to predict the potential users. The policymakers may decide on how to set the procedures in encouraging the wearable deployment by considering the factors of innovation acceptance.

8.6 Achieving the research objectives

This study aims to examine the users' innovation acceptance of wearable computing technology in a developing country. It uniquely contributes to the body of knowledge about wearable computing acceptance. This research aim can be achieved by performing these objectives:

1. To investigate the pervasive computing-based applications and how technology acceptance has been understood in the past that may drive the acceptance of Wearable Computing.

2. To develop a conceptual framework and empirically identify the influencing factors for users' acceptance of wearable computing in the Malaysian context.

3. To investigate the social influence and mobile application experience that may influence wearable computing acceptance.

4. To support the value of the development of the conceptual framework which may influence the deployment of wearable computing by conducting interviews.

To achieve these objectives, three approaches were used. Firstly, extant literature related to wearable computing, pervasive computing and mobile computing, as well as technology adoption and acceptance theories were reviewed. Secondly, the field research was conducted with the survey questionnaire. The field data were analysed using IBM SPSS V.20.

To achieve the first objective, an extensive study of the extant literature was carried out on pervasive computing, wearable computing, mobile computing and relevant theories of technology innovation acceptance as presented in chapter 2.

The second objective and third objective were achieved by identifying the key factors that influence users' acceptance from extant literature as presented in chapters 2, 3, 4, 5 and 6.

To achieve the fourth objective, interviews were carried out by professionals in ICT areas as presented in Chapter 6.

8.7 Answering the research questions

The following research questions were addressed in understanding the predicted factor to influence users' acceptance of wearable computing positively.

Research question 1: What are the pervasive-based mobile applications and how technology acceptance has been understood in the past that may drive the acceptance of wearable computing?

For identifying the pervasive-based mobile applications, the comprehensive background study on pervasive computing applications, mobile computing technological innovation and wearable computing application and characteristics with various technological acceptance model and innovation acceptance model has been carried out in Chapter 2. The empirical results were shown in the descriptive analysis and inferential analysis in Chapters 5 and 6.

Research question 2: What are the factors that may influence users' acceptance of wearable computing in Malaysia?

A field study was carried out for data collection. The raw data was analysed using IBM SPSS ver.20. The results are presented in chapter 5, 6 and 7.

Research question 3: To what extent do the social influence and mobile application influence wearable computing acceptance in Malaysia?

A field study was carried out by distributing the self-administered questionnaire to the respondents with an acceptable sampling size. The influencing factors were then examined statistically and analysed using IBM SPSS (V.20). The results are presented in chapter 5, 6 and 7.

A field study was carried out and analysed, the finding from the quantitative approach was then supported as collateral by interviewing the professionals and experts in the area of mobile computing and ICT to find out the trend of the Malaysian perception on wearable computing acceptance and diffusion. The results are presented in chapter 5, 6 and 7.

8.8 Research limitation and recommendation for future research

In this research, a series of research processes and procedures have been taken into consideration to ensure the novelty, starting from the philosophical assumptions with relevant literature until the development of the research framework. The relevant research design and methods have been employed in analysing the data with robust statistical techniques to deepen understanding the users' acceptance of wearable computing. In spite of conducting robust analysis, the study still has a limitation to consider.

The researcher may want to generalise the findings to a population as well as explaining the phenomena of the research taken. However, this research was conducted in Malaysia with the sampling from a certain region; so, the findings might not be applicable to another developing country. Yet choosing the right methodology of quantitative and deductive approach has been carefully designed with follow up qualitative interviews to allow research to have innovative work in answering the research questions, a decision on selecting the right method might be influenced by the research issue or personal experience of the researcher (Creswell, 2013). Thus, the researcher chose the mixed methods approach which may have implications in the study limitations.

This study employed a cross-sectional survey design as the researcher had time constraints with limited resources. This research measures the potential users to adopt wearable computing; the longitudinal approach may be employed to test the pre-adopter and post adopter to understand the behavioural acceptance further.

Furthermore, the researcher opted for a probabilistic sampling method for a robust analysis with cluster sampling to represent the population. Even though the sampling was done accordingly, to generalise the findings to another developing country might be a concern due to different demographics and technological experience.

Finally, the framework developed has contributed 61% of variance explained; other reasonable factors from pervasive and wearable computing aspect might be added to possibly explain the higher variance of integration with other established models in technological innovation.

8.9 Chapter summary

Despite the limitations encountered in this research, substantial contributions have been made in examining users' acceptance of wearable computing, thus contributing to the body of knowledge. The study has shown the conceptual model developed to understand users' acceptance of new emerging innovation which is expected to become a phenomenon in the future. The findings in this study will shed light on the implementation of wearable computing atmosphere and will be beneficial to technological adoption.

To conclude, this research study managed to achieve its aim and objectives which were hypothesised at the earlier stages of the literature study. The findings may give insights into the diffusion of technological innovation.

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10 APPENDICES

APPENDIX A: SURVEY QUESTIONNAIRE

Brunel University London

Consumer Acceptance of Wearable Mobile Computing

This study is designed to evaluate and identify users' behavioural intention to adopt wearable mobile computing, one of the new emerging technologies that are expected to grow extensively, and its applications have promising prospects in the digital age. The term 'wearable technology', 'wearable devices' and 'wearable computing' is an innovative concept of new technology refers to "electronic technologies or computing technology embedded and worn on the human body as apparel or accessories" such as smartwatch, smart glasses and jewellery continuously provide an interface to do many computing tasks like mobile smartphones can do.

This survey is part of the PhD thesis at Brunel University London. The questionnaire is designed to understand the factors affecting users' intention to use and adopt the innovative concept of wearable computing in daily life. Your participation is voluntary, anonymous and confidential for the purpose of this study. This survey will take 10-15 minutes of your valuable time. Your kind contribution is appreciated towards the success of this research.

If you have any concerns, please do not hesitate to contact the following email address: mepgssm3@brunel.ac.uk.

Mohamad Taib, S.

Brunel University London

Consumer Acceptance of Wearable Mobile Computing

Section A: User Demographics Profile

i. Please indicate your gender? (Kindly tick √ on the grey area)

	Male		**Female**

ii. Please indicate your age?

18-26	27-35	36-44	45-54	55-64	65 or over

iii. What is your current position? (Please choose one only)

	Employed		**Student**		**Others**

iv. What is your main purpose of using mobile smartphone? (Please choose one only)

	Business		**Personal**		**Study**

v. Which operating system does your smartphone use?

Android	iPhone OS	Blackberry	Window	Others

vi. Please show your typical monthly spend (RM) on entertainment (eg: TV subscription)?

<50	51-100	101-200	201-300	>300

vii. Please show your typical monthly spend (RM) on mobile services (eg: mobile subscription)?

<50	51-100	101-200	201-300	>300

viii. Please show your typical monthly spend (RM) when shopping on the internet?

<50	51-100	101-200	201-300	>300

ix. How much are you willing to spend (RM) to buy wearable mobile computing (eg: smartwatch, fitness tracker)?

<100	51-100	101-500	501-1000	1001-2000	>2000

Section B: Mobile application

Please indicate your current mobile smartphone usage:

Mobile application		1 = Rarely 5 = Frequently				
		1	**2**	**3**	**4**	**5**
a.	Searching for specific information on the Internet					
b.	Sending or receiving e-mails					
c.	Using Internet search engines (e.g. yahoo, google, etc.)					
d.	Sharing digital files or personal information online with friends, family and others					
e.	Chatting with others on the Internet					
f.	Managing personal appointments and meetings through Internet					
g.	Performing routine banking services (pay bills, check account, etc.)					
h.	Listening to music from the Internet, including downloaded MP3					

Section C: Consumer Attitude towards wearable mobile computing

This section is to understand your opinion and intention about using/wearing wearable computing. Please indicate/rate on a five point scales the extent to which you strongly disagree or strongly agree with the following statements. **1 = Strongly Disagree to 5 = Strongly Agree**

Q1	Statement	1 = Strongly Disagree 5=Strongly Agree				
Behavioural intention (BI)		**1**	**2**	**3**	**4**	**5**
a.	Assuming I have access to wearable computing, I intend to use it.					
b.	Assuming I have access to wearable computing, I intend to use it frequently.					
c.	I intent to use wearable computing frequently to access mobile services.					
d.	I intend to use wearable computing in the future.					
e.	My general opinion of wearable computing is favourable.					

Q2	Statement	1 = Strongly Disagree 5=Strongly Agree				
Social influence (SI)		**1**	**2**	**3**	**4**	**5**
a.	People who can influence my behaviour would think that I should use wearable computing.					
b.	People who are important to me would think that I should use wearable computing.					
c.	People whose opinions I value would prefer that I use wearable computing.					
d.	People around me who use wearable computing have more prestige than those who do not.					
e.	Using wearable computing is considered a status symbol among my friends.					

Section D: User Technology Acceptance

This section is to understand your attitude towards new emerging and innovation of technology.

Q3	Statement	1 = Strongly Disagree 5=Strongly Agree				
Perceived usefulness (PU)		**1**	**2**	**3**	**4**	**5**
a.	Using wearable computing services would help me to accomplish things more quickly.					
b.	Using wearable computing would make my life easier.					
c.	I find wearable computing would be useful in my life.					
d.	Using wearable computing would increase my productivity.					
e.	Using wearable computing would help me perform many things more conveniently.					
f.	Considering all tasks, the use of wearable computing could assist my life.					

Q4	Statement	1 = Strongly Disagree				5=Strongly Agree
Perceived ease of use (PEOU)		**1**	**2**	**3**	**4**	**5**
a.	Learning to use wearable computing services would be easy for me.					
b.	Wearable computing services would be understandable to use.					
c.	It would be easy for me to get the services I need from wearable computing.					
d.	I expect that my interaction with wearable computing would be clear.					
e.	I think learning to use wearable computing is easy.					
f.	Overall, I find wearable computing is easy to use.					

Section E: User Preference

This section is to understand your expectation towards wearing wearable computing.

Q5	Statement	1 = Strongly Disagree				5=Strongly Agree
Observability		**1**	**2**	**3**	**4**	**5**
a.	Wearable computing can be accessed anytime.					
b.	Wearable computing has no matter for me.					
c.	Wearable computing can be accessed anywhere.					
d.	I can see the effect of a transaction immediately.					

Q6	Statement	1 = Strongly Disagree				5=Strongly Agree
Mobility		**1**	**2**	**3**	**4**	**5**
a.	I expect that I would be able to use wearable computing at anytime and anywhere.					
b.	I find wearable computing would be easily accessible.					
c.	I expect that wearable computing would be available for use whenever I need it.					
d.	In general, I expect that I would have control over using wearable computing anytime.					

Section F: Consumer Service Perceptions

This section is to understand your perception about the support service of wearing wearable computing.

Q7	Statement	1 = Strongly Disagree 5=Strongly Agree				
Facilitating condition (FC)		**1**	**2**	**3**	**4**	**5**
a.	I am given the necessary assistance to use wearable computing.					
b.	I have the necessary knowledge to use wearable computing.					
c.	I have access to the software, hardware and network services required to use wearable computing.					
d.	My service provider facilitates the use of wearable computing.					
e.	I have the person available for assistance with wearable computing.					

Q8	Statement	1 = Strongly Disagree 5=Strongly Agree				
Perceived enjoyment (PE)		**1**	**2**	**3**	**4**	**5**
a.	Using wearable computing would be enjoyable.					
b.	Using wearable computing would be pleasurable.					
c.	I expect that using wearable computing would be interesting.					
d.	The actual process of wearable computing would be pleasant.					

Q9	Statement	1 = Less Important 5=Important				
Personalisation		**1**	**2**	**3**	**4**	**5**
a.	How important is the ability to personalise wearable computing.					

Please comment on your future expectations for wearable computing:

____

____

Please make any other comments about wearable mobile computing:

____

____

“Thank you for your support in this research”

APPENDIX B: INTERVIEW FOR RESEARCH FINDINGS VALIDATION

Dear Sir / Madam,

This interview is part of my PhD research at Brunel University London. It is designed to understand the factors influencing users' acceptance of wearable mobile computing in developing countries.

The interview is designed to take approximately 30 minutes of your valuable time. Your participation is voluntary and all the information provided will be confidential and only be used for this research.

If you have any concerns, please do not hesitate to contact me.

Thank you.

Mohamad Taib, S.

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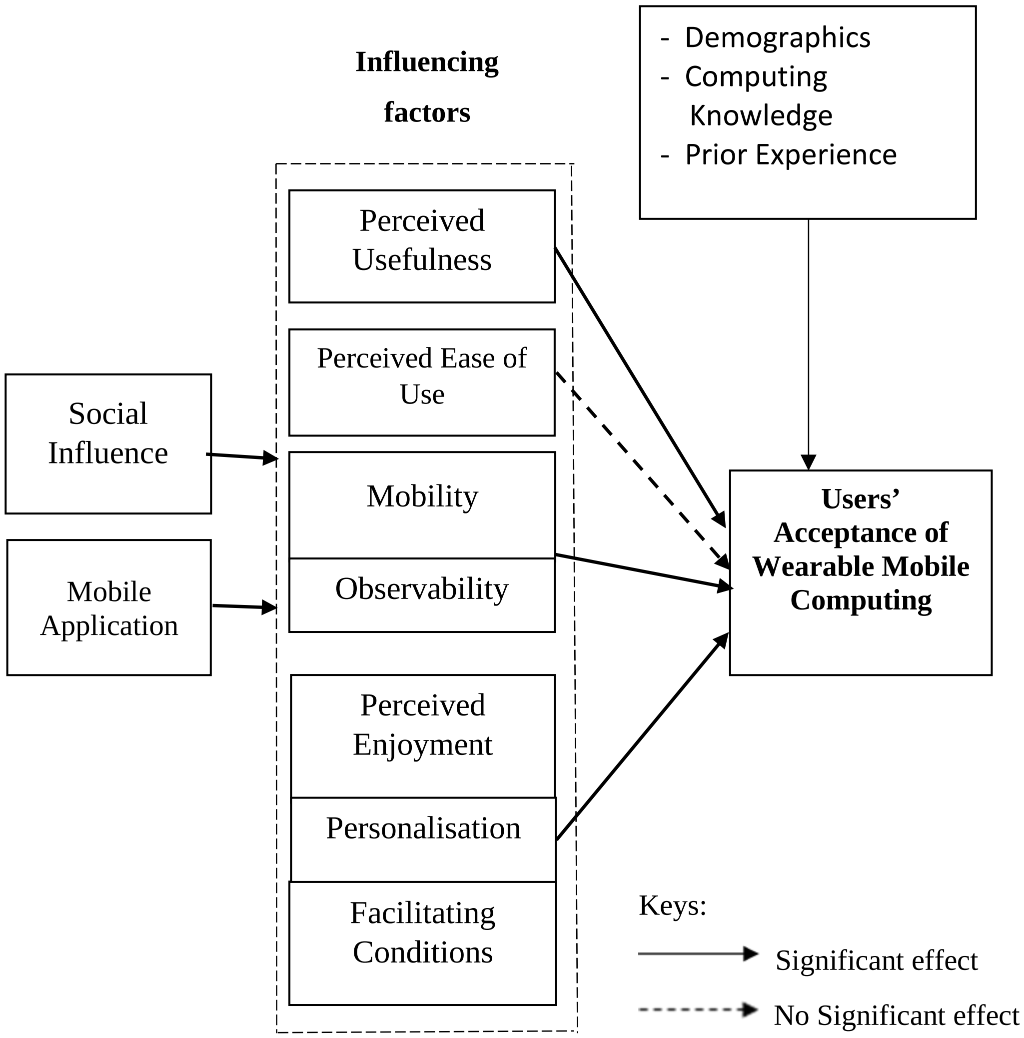
Proposed framework



Job role: ______________________ Working experience: ___________

1. What are the key contextual factors that may affect Wearable Technology implementation in Malaysia?

____

____

2. What is your opinion about the positive relationship between Perceived Usefulness (PU) and Users' Acceptance of Wearable Mobile Computing?

____

____

3. What is your opinion about the positive relationship between Mobility (MOB) linked factor with Observability (OBS) and Users' Acceptance of Wearable Mobile Computing?

____

____

4. What is your opinion about the positive relationship between Perceived Enjoyment (PE) linked factor with Personalisation (PN) and Facilitating Condition (FC) and Users' Acceptance of Wearable Mobile Computing?

____

____

5. What is your opinion about the not significant relationship between Perceived Ease of Use (PEU) and Users' Acceptance of Wearable Mobile Computing?

____

____

6. What is your opinion on the following, there is a positive relationship between Social Influence and Users' Acceptance of Wearable Mobile Computing?

____

____

7. What is your opinion on the following, there is a positive relationship between Mobile Application and Users' Acceptance of Wearable Mobile Computing?

8. What are your comments about this model framework developed on the acceptance of Wearable Mobile Computing?

9. What are the strategic plans or programmes towards encouraging the Wearable Technology implementation in Malaysia?

10. Please comment on likely future trends of Wearable Technology in Malaysia.

APPENDIX C: ETHICS APPROVAL FROM BRUNEL UNIVERSITY LONDON

Brunel University London

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07 September 2015

STATEMENT OF ETHICS APPROVAL

Proposer: Syakirah Binti Mohamad Taib

Dear Syakirah,

Project Title: **Consumer Acceptance of Wearable Mobile Computing**

Under delegated authority from the College Research Ethics Committee, I have considered the application recently submitted by you. I am satisfied that there is no objection on ethical grounds to the proposed study.

Approval is given on the understanding that you will adhere to the terms agreed with participants and to inform me of any change of plans in relation to the information provided in the application form.

In addition, please provide notification to the College Research Office when the study is complete, if it fails to start or is abandoned.

Yours sincerely,

John Park
College Research Manager
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Brunel University London
College of Engineering, Design and Physical Sciences

College of Engineering, Design and Physical Sciences Research Ethics Committee
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6 July 2017

LETTER OF APPROVAL

Applicant: Mrs Syakirah Mohamad Taib

Project Title: Consumer Acceptance of Wearable Mobile Computing (an extension of the previous approved project)

Reference: 6635-LR-Jul/2017- 7718-2

Dear Mrs Syakirah Mohamad Taib

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- Approval to proceed with the study is granted subject to receipt by the Committee of satisfactory responses to any conditions that may appear above, in addition to any subsequent changes to the protocol.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

Professor Hua Zhao

Chair

College of Engineering, Design and Physical Sciences Research Ethics Committee
Brunel University London

APPENDIX D: RESEARCH DATA

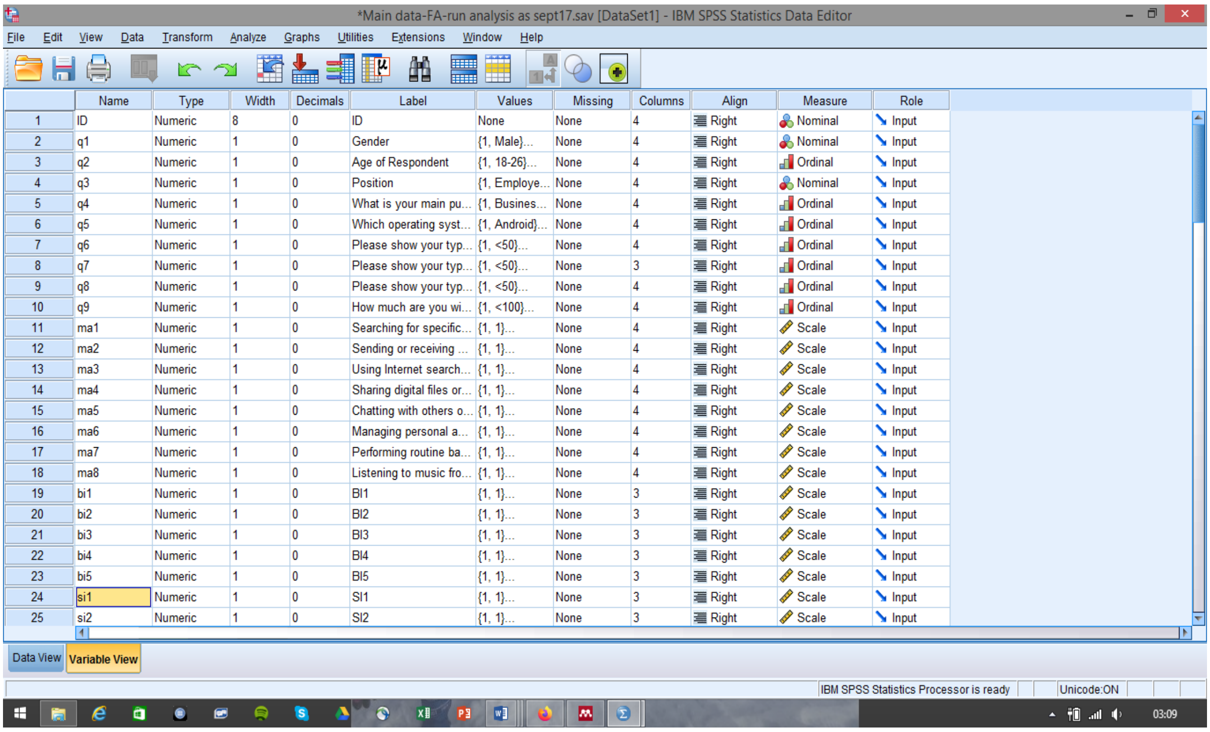

Figure A1: Example of variable view

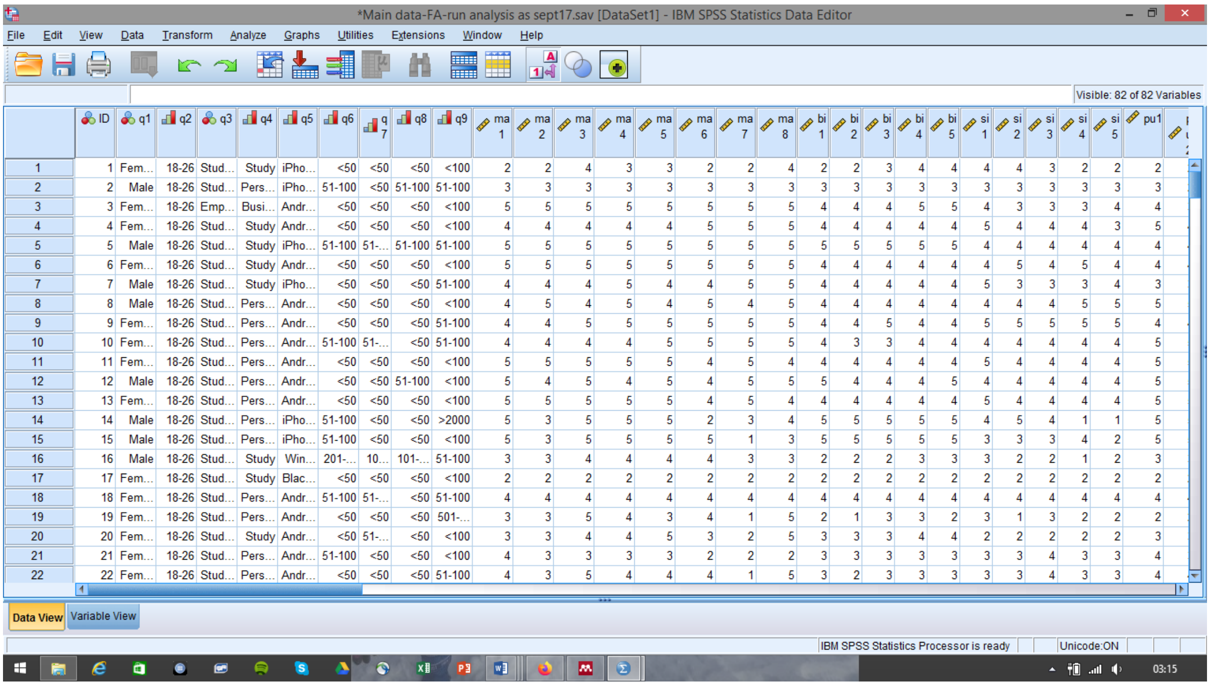

Figure A: Example of Data Editor Window (sample of research data)

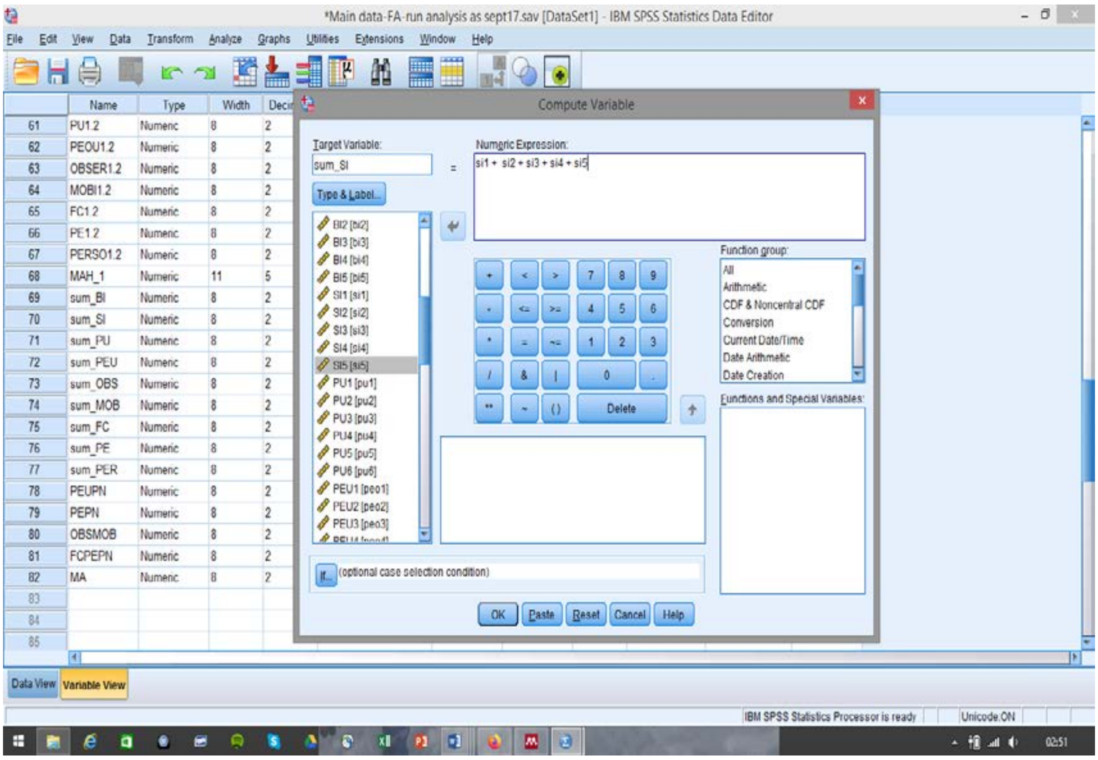

Figure 1: Example of adding the total score for the scale (sum_SI)

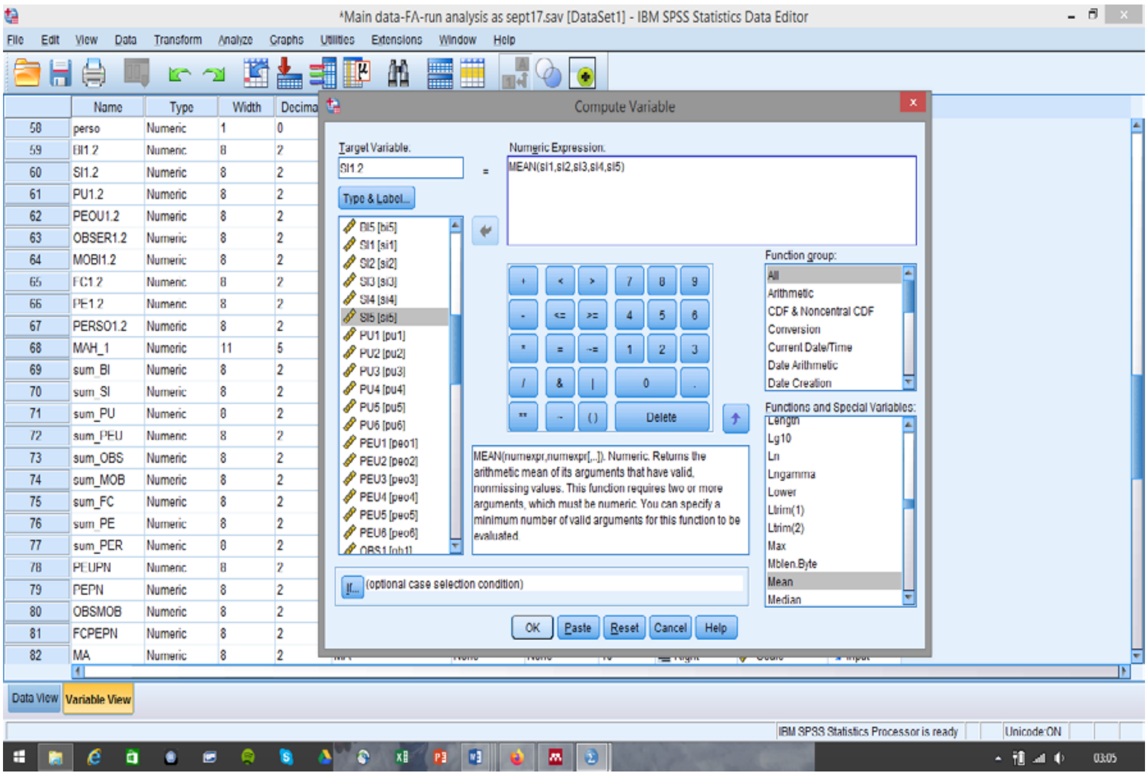

Figure 2: Example of finding Mean score for the scale (SI1.2)

Interview Transcript

Interview Transcript with Participant 1 (P1)

Job role: Senior Manager in mobile company Experience: 20 years

Researcher:	Thank you for your time to share your opinion on my research topic about users' acceptance of wearable computing in Malaysia.
Researcher :	What are the key contextual factors that may affect Wearable Technology implementation in Malaysia?
P1 :	As for me, in the mobile technology field, I am concern about the benefit of the system that may affect the implementation.
Researcher :	What is your opinion about the positive relationship between Perceived Usefulness (PU) and Users' Acceptance of Wearable Mobile Computing?
P1 :	I do agree on usefulness influences acceptance in any innovation; there must be advantages of having the new technology, especially wearable.
Researcher :	What is your opinion about the positive relationship between Mobility (MOB) linked factor with Observability (OBS) and Users' Acceptance of Wearable Mobile Computing?
P1 :	From my point of view, mobility is the key factor for mobile technology; the same goes for wearable as it is connected to a smartphone. However, it linked with observability, could be due to users want to see the effect of having it anywhere.
Researcher :	What is your opinion about the positive relationship between Perceived Enjoyment (PE) linked factor with Personalisation (PN) and Facilitating Condition (FC) and Users' Acceptance of Wearable Mobile Computing?
P1 :	For me, when we can personalise any preference in wearable, we tent to enjoy, like a smartphone can be personalised according to user preference, surely it is fun to explore the function. Whilst the facilitating conditions are essential to help users to understand the system, therefore would encourage acceptance.
Researcher :	What is your opinion about the not significant relationship between Perceived Ease of Use (PEU) and Users' Acceptance of Wearable Mobile Computing?
P1 :	I think any enabling technology should be easy to use; then the user will try to keep using it in the future; however, it could not be the significant factor as current users are majority are technological savvy; they might think wearable is easy to use due to the advancement of a smartphone.
Researcher :	What is your opinion on the following, there is a positive relationship between Social Influence and Users' Acceptance of Wearable Mobile Computing?
P1 :	A society with widespread smartphone and users' interaction among them to sharing the information on wearable in social media as well, social status would benefit to accept wearable computing.

Researcher :	What is your opinion on the following, there is a positive relationship between Mobile Application and Users' Acceptance of Wearable Mobile Computing?
P1 :	As we know, nowadays, mobile apps are common and easy to be downloaded; the app's developer created more apps to make the user more convenient in accessing their tasks.
Researcher :	What are your comments about this model framework developed on the acceptance of Wearable Mobile Computing?
P1 :	Overall the framework is reasonable.
Researcher :	What are the strategic plans or programmes towards encouraging the Wearable Technology implementation in Malaysia?
P1 :	I think through promotion, awareness from the industry involves in telecommunication, the government is also not exceptional to support any innovation which can benefit the country.
Researcher :	Please comment on likely future trends of Wearable Technology in Malaysia.
P1 :	Malaysian may be likely to adopt the wearable, especially the smartwatch; the function is similar to smartphones; to add, it can be worn instead of carrying, which is more convenient.

Interview Transcript with Participant 2 (P2)

Job role: IT Officer in government sector Experience: 13 years

Researcher :	Thank you for being able to share your opinion on my research topic about users' acceptance of wearable computing in Malaysia.
Researcher :	What are the key contextual factors that may affect Wearable Technology implementation in Malaysia?
P2 :	I think people who live in the cities are exposed to any new technologies which include Wearable technology. In a city, internet connection coverage is good, so people have a lot of choices to use any wearable technology if it is useful enough. The use of wearable technology in rural areas is limited as the internet connection coverage is limited, and without a stable internet connection, the technology can't reach its full potential.
Researcher :	What is your opinion about the positive relationship between Perceived Usefulness (PU) and Users' Acceptance of Wearable Mobile Computing?
P2 :	When people think of the technology that is useful to them, they tend to find more information about it and look for a reasonable price to buy it. As for me, as a first-time user of any new wearable device, I would prefer to buy an acceptable quality at a cheap/acceptable price. If only I feel it's good and

	useful enough for me, then only I will spend some money to buy a good quality one. There is the main idea of having an innovation due to its usefulness and increase work performance.
Researcher :	What is your opinion about the positive relationship between Mobility (MOB) linked factor with Observability (OBS) and Users' Acceptance of Wearable Mobile Computing?
P2 :	What I can understand about mobility is the easiness of bringing technology anywhere, everywhere. While for observatory means that people observe someone who uses the wearable and try to figure out the easiness and usefulness of the wearable technology. I am not sure about the link between mobility and observatory. But what I can say, if it is mobile technology, people can easily see and curious about it. It is like free marketing. People will observe this new mobile technology and guessing about what it is used for. They can find out by asking directly or search through google. When a lot of people use wearable technology being observed, then more people curious and interested in it. Wearable computing could be a good idea of having it in the workplace as it is mobile, the result is visible to people in promoting remote communication, for example, having a virtual live meeting
Researcher :	What is your opinion about the positive relationship between Perceived Enjoyment (PE) linked factor with Personalisation (PN) and Facilitating Condition (FC) and Users' Acceptance of Wearable Mobile Computing?
P2 :	I believe people enjoy having a wearable technology because the design of the technology allows them to choose their preferences of how the application should look like or known as personalisation and the design that facilitate them to access certain information to achieve their objective smoothly. For example, a fitness detection that you wear to detect a pulse, deep sleep, blood pressure, number of steps, people happy to know their health condition that very personal to them. This information facilitates them to decide what they should do next, whether to be more active to achieve an ideal body weight or to go the clinic to get treated with whatever condition that seems very alarming, like high blood pressure.
Researcher :	What is your opinion about the not significant relationship between Perceived Ease of Use (PEU) and Users' Acceptance of Wearable Mobile Computing?
P2 :	Ease of use, not an indication of how useful the technology is to them. Everyone can use it, but what is it for? If it helps you to achieve a particular objective is good. But if it is just because of how easy to use to make you accept that technology, it is not quite important. If the price is reasonable, maybe you can buy it for exploration or trying new technology. But not for me.

Researcher :	What is your opinion on the following, there is a positive relationship between Social Influence and Users' Acceptance of Wearable Mobile Computing?
P2 :	Having someone that always tells you about how good the wearable technology to him/her and suggests you have it is one of the factors that can attract you to have it too. I can say, social influence is the main reason why someone can accept the use of wearable technology.
Researcher :	What is your opinion on the following, there is a positive relationship between Mobile Application and Users' Acceptance of Wearable Mobile Computing?
P2 :	Yes, there is a positive relationship between them. Currently, many applications can be downloaded into your smartphone, which links to wearable technology. This application makes it easy for you to monitor all the data from wearable technology, and the smartphone provides an intelligent way to process the data and present it in a very useful way.
Researcher :	What are your comments about this model framework developed on the acceptance of Wearable Mobile Computing?
P2 :	First, this framework model helps us to understand more about Malaysian's acceptance of wearable technology. For any stakeholders who plan to introduce an invention of wearable technology for Malaysians, this framework provides a guideline on what Malaysian will look for if any new wearable device penetrating to Malaysia market. The inventor can strategise on how this invention can be accepted by Malaysian and further boost their profit, perhaps.
Researcher :	What are the strategic plans or programmes towards encouraging the Wearable Technology implementation in Malaysia?
P2 :	I think the government may have an important role in this specific plan as a government can control the media. With a TV programme, the government can provide an informative talk about wearable technology that exists in Malaysia. The government may also work with private companies to research what kind of wearable technology is likely to be accepted by Malaysians, and it opens to opportunities for new inventions that are based on wearable technology.
Researcher :	Please comment on likely future trends of Wearable Technology in Malaysia.
P2 :	Although Malaysian is slow in adopting wearable technologies in their life, we also can't deny that the use of wearable technologies keep growing in Malaysia. People get a lot of information through social media and any news about new technology that appears in the market and may spread rapidly and easily. As compared to the early years, technology acceptance much more difficult, but nowadays, with better income and educations, people can be educated easily on how useful the new technology is in their life.

Interview Transcript with Participant 3 (P3)

Job role: Consultant in Telemedicine Experience: 15 years

Researcher :	Thank you for being able to share your opinion on my research topic about users' acceptance of wearable computing in Malaysia.
Researcher :	What are the key contextual factors that may affect Wearable Technology implementation in Malaysia?
P3 :	The mobility of the device like a health monitoring system.
Researcher :	What is your opinion about the positive relationship between Perceived Usefulness (PU) and Users' Acceptance of Wearable Mobile Computing?
P3 :	This is why any technology is developed to benefit the user's daily tasks and to promote a convenient lifestyle.
Researcher :	What is your opinion about the positive relationship between Mobility (MOB) linked factor with Observability (OBS) and Users' Acceptance of Wearable Mobile Computing?
P3 :	Mobility is to access the function at anytime and anywhere is essential for adopting the innovation, but when it linked factor, I can say the user prefers an innovation that offers observable results. The more individuals can see the results of technological innovation, the more likely they are to adopt it. Wearable computing should be 'mobile,' to have the mobility characteristic at anytime and anywhere, this technological innovation still at an early stage, my company has tried to promote telemedicine awareness."
Researcher :	What is your opinion about the positive relationship between Perceived Enjoyment (PE) linked factor with Personalisation (PN) and Facilitating Condition (FC) and Users' Acceptance of Wearable Mobile Computing?
P3 :	I enjoyed it when I got an opportunity to learn new technological innovation, currently am doing research on telemedicine, exploring wearable which benefits the healthcare is fun too. Wearable able to be personalised with right facilitating conditions could have a promising future.
Researcher :	What is your opinion about the not significant relationship between Perceived Ease of Use (PEU) and Users' Acceptance of Wearable Mobile Computing?
P3 :	Since almost many potential users have the smartphone, wearing a smartwatch for health monitoring would not be a big issue, I guess.
Researcher :	What is your opinion on the following, there is a positive relationship between Social Influence and Users' Acceptance of Wearable Mobile Computing?
P3 :	Like in my field of healthcare, most users tend to make the decisions to know the devices based on others' suggestions since the device is new for them.

Researcher :	What is your opinion on the following, there is a positive relationship between Mobile Application and Users' Acceptance of Wearable Mobile Computing?
P3 :	Yes, mobile apps help me a lot in managing my daily tasks, so it is possible to influence potential users attracted to accept wearable computing.
Researcher :	What are your comments about this model framework developed on the acceptance of Wearable Mobile Computing?
P3 :	As I can see, the predicted factors are in the wearable computing context.
Researcher :	What are the strategic plans or programmes towards encouraging the Wearable Technology implementation in Malaysia?
P3 :	Spreading the information on the innovation and awareness about wearable devices through any social platform.
Researcher :	Please comment on likely future trends of Wearable Technology in Malaysia.
P3 :	Malaysian like to explore and are excited about new technology, but when it comes to cost, they tend to think whether to spend on that, like my telemedicine programme to monitor the health condition, requires a longer time to influence user acceptance as money is concerned.

Interview Transcript with Participant 4 (P4)

Job role: IT Consultant Experience: 25 years

Researcher :	Thank you for being able to share your opinion on my research topic about users' acceptance of wearable computing in Malaysia.
Researcher :	What are the key contextual factors that may affect Wearable Technology implementation in Malaysia?
P4 :	Age, family economy, educational background, technology background, location, interest, peer influence.
Researcher :	What is your opinion about the positive relationship between Perceived Usefulness (PU) and Users' Acceptance of Wearable Mobile Computing?
P4 :	Yes, there is a positive relationship between them, one of the deciding factors for most users is the primary device function and if the device works for them. For example, for health-conscious, users will find fitness tracker useful for them, and they will buy wearable that is tailored to fitness.
Researcher :	What is your opinion about the positive relationship between Mobility (MOB) linked factor with Observability (OBS) and Users' Acceptance of Wearable Mobile Computing?
P4 :	I think there is a positive relationship between mobility and observability to user acceptance. Being mobile means the device should be lightweight, comfortable, appealing, and durable to the users. Observability is important because information can be easily available/read as and when needed in a single display.
Researcher :	What is your opinion about the positive relationship between Perceived Enjoyment (PE) linked factor with Personalisation (PN) and Facilitating Condition (FC) and Users' Acceptance of Wearable Mobile Computing?
P4 :	The relationship is defined by the type of applications in wearable mobile computing. For example, for health monitoring (e.g., fitness tracker), enjoyment and personalisation are not necessary to have positive relationships because the users need basic information. However, in wearable such as smartwatches, enjoyment and personalisation are the main deciding factors. For all types of wearables, a platform (eco-system) plays an important role in users' acceptance.
Researcher :	What is your opinion about the not significant relationship between Perceived Ease of Use (PEU) and Users' Acceptance of Wearable Mobile Computing?
P4 :	The ease of use is definitely one of the main deciding factors, so I'm a bit disagree with it being a 'not significant.' There are few examples of the early generation of wearables where the users found that some of the devices are hard to operate or navigate and abandoned them and start to find other alternatives that are user-friendly and easy to use.

Researcher :	What is your opinion on the following, there is a positive relationship between Social Influence and Users' Acceptance of Wearable Mobile Computing?
P4 :	Sharing and peer pressure in a social group are among the reasons why one's going for a wearable. In a group of cyclists, people start sharing what they find useful in tracking their activities, and they will compare features among them and decide which wearable is the most suitable for their activities.
Researcher :	What is your opinion on the following, there is a positive relationship between Mobile Application and Users' Acceptance of Wearable Mobile Computing?
P4 :	Yes, an eco-system (platform), which includes a mobile application, is definitely a plus. Users can customise their watch faces (smartwatches), seamless sync of gathered data like GPS location and fitness data into a mobile application for further analysis.
Researcher :	What are your comments about this model framework developed on the acceptance of Wearable Mobile Computing?
P4 :	Generally, the framework provides an overall understanding of the factors that influence the acceptance of wearable mobile computing.
Researcher :	What are the strategic plans or programmes towards encouraging the Wearable Technology implementation in Malaysia?
P4 :	To create exposure and awareness of wearable technology by engaging the public in most major events. Government and private sectors alike have been promoting youth, sports, fitness, and health-conscious related programs all year long, and at these events, the parties that are interested in wearable technology should get involved.
Researcher :	Please comment on likely future trends of Wearable Technology in Malaysia.
P4 :	Malaysians generally can easily adapt to the latest technology, and for wearable, the take-up rate for devices such as the fitness tracker and smartwatch will be higher in the future. A device such as the virtual reality headset is pretty popular, especially among the millennial, mostly for gaming. Those who are well educated, health-conscious, and having a good economy will surely have no second thought in adapting the smartwatch and fitness tracker. However, for those who're not, the availability of cheap alternatives from China manufacturers helps a lot in gaining their interest.

Interview Transcript with Participant 5 (P5)

Job role: Web Developer Experience: 8 years

Researcher :	Thank you for being able to share your opinion on my research topic about users' acceptance of wearable computing in Malaysia.
Researcher :	What are the key contextual factors that may affect Wearable Technology implementation in Malaysia?
P5 :	The simple function makes things easier, using wearable for business as well as for fun.
Researcher :	What is your opinion about the positive relationship between Perceived Usefulness (PU) and Users' Acceptance of Wearable Mobile Computing?
P5 :	This new technology is attached to the computer will have numerous benefits, the ability to provide greater accuracy and usability.
Researcher :	What is your opinion about the positive relationship between Mobility (MOB) linked factor with Observability (OBS) and Users' Acceptance of Wearable Mobile Computing?
P5 :	For example, wearable devices can collect all kinds of data in motion with the integration of electronics. Mobility is the main factor for wearable as it attaches to the users' body, about the linked factor may be users see it as the same meaning or should be observable while mobile.
Researcher :	What is your opinion about the positive relationship between Perceived Enjoyment (PE) linked factor with Personalisation (PN) and Facilitating Condition (FC) and Users' Acceptance of Wearable Mobile Computing?
P5 :	I think these factors are significant when users enjoy and have fun using any system; they will love to have it, like the smartphone. Users now rely on the mobile application available in the mobile smartphone to do daily tasks. The relationship is linked could be due to users expect they can get support from a provider in facilitating the difficulty faced and able to personalise depending on their preference, thus creating excitement. Like an Apple watch, the promising benefit for personal use or monitoring of health, it's quite fun.
Researcher :	What is your opinion about the not significant relationship between Perceived Ease of Use (PEU) and Users' Acceptance of Wearable Mobile Computing?
P5 :	I think many users know how to operate wearable computing since they are the smartphone users. They prefer the convenience of wearable devices to perform the task.
Researcher :	What is your opinion on the following, there is a positive relationship between Social Influence and Users' Acceptance of Wearable Mobile Computing?
P5 :	Social status can also spread innovation. When a potential user shares any information about the new things, like wearing

	the smartwatch, their friends tend to know the benefit of it, thus encouraging the intention to have it as well.
Researcher :	What is your opinion on the following, there is a positive relationship between Mobile Application and Users' Acceptance of Wearable Mobile Computing?
P5 :	Yes, it may be the factor due to the development of the vast app like mobile banking apps, email, and gaming.
Researcher :	What are your comments about this model framework developed on the acceptance of Wearable Mobile Computing?
P5 :	For me, this framework is beneficial for the Apps developer or any developer of wearable computing to consider in designing wearable from the users' perspective.
Researcher :	What are the strategic plans or programmes towards encouraging the Wearable Technology implementation in Malaysia?
P5 :	Maybe through campaign and technology awareness to society.
Researcher :	Please comment on likely future trends of Wearable Technology in Malaysia.
P5 :	It may be possible for Malaysians to adopt smartwatch if it beneficial at an affordable price.

Interview Transcript with Participant 6 (P6)

Job role: Cloud Product Architect in a Mobile Company Experience: 17 years

Researcher :	Thank you for being able to share your opinion on my research topic about users' acceptance of wearable computing in Malaysia.
Researcher :	What are the key contextual factors that may affect Wearable Technology implementation in Malaysia?
P6 :	I think usefulness when the new gadget may improve the Malaysian lifestyle, e.g., smartwatch for them to monitor their fitness, sleep time, etc.
Researcher :	What is your opinion about the positive relationship between Perceived Usefulness (PU) and Users' Acceptance of Wearable Mobile Computing?
P6 :	Yes, usefulness might be the critical factor for wearable computing, but I do think security also may be considered in using the devices or gadgets
Researcher :	What is your opinion about the positive relationship between Mobility (MOB) linked factor with Observability (OBS) and Users' Acceptance of Wearable Mobile Computing?
P6 :	As for me, of course, wearable must be accessed anywhere, which is mobility, but the linked with observability might be people see it the wearable computing must be seen to others anywhere.
Researcher :	What is your opinion about the positive relationship between Perceived Enjoyment (PE) linked factor with Personalisation (PN) and Facilitating Condition (FC) and Users' Acceptance of Wearable Mobile Computing?
P6 :	Some prefer to have it for fun and the ability to personalise users' needs. The linked between these factors as users see them as the same factor as it is fun, it can be personalised, and the system provides facilitating conditions for users. I think these factors are positive to give the user flexibility to use wearable computing as they intended.
Researcher :	What is your opinion about the not significant relationship between Perceived Ease of Use (PEU) and Users' Acceptance of Wearable Mobile Computing?
P6 :	Less effort to operate the gadgets may motivate to continually use the system.
Researcher :	What is your opinion on the following, there is a positive relationship between Social Influence and Users' Acceptance of Wearable Mobile Computing?
P6 :	Social influence is one of the main factors as people might be influenced when seeing others have a new tech.
Researcher :	What is your opinion on the following, there is a positive relationship between Mobile Application and Users' Acceptance of Wearable Mobile Computing?
P6 :	Mobile apps are growing nowadays; I also download mobile apps that can ease my tasks. I think this is an important point for wearable as well.

Researcher :	What are your comments about this model framework developed on the acceptance of Wearable Mobile Computing?
P6 :	As the framework may help the development and deployment of wearable computing, this framework is seen as reasonable for users to accept innovation in wearable.
Researcher :	What are the strategic plans or programmes towards encouraging the Wearable Technology implementation in Malaysia?
P6 :	Social Media and lifestyle promotions could be the programmes to influence users.
Researcher :	Please comment on likely future trends of Wearable Technology in Malaysia.
P6 :	Based on current culture the trends would be favourable for youngsters in their social life