The Adoption of Mobile Health Systems in Hospitals: An Empirical Cross-City Study in China

Submitted by Binheng Duan to the University of Exeter

as a thesis for the degree of

Doctor of Philosophy in Management Studies

In March 2018

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: …………………………………………………………..

Abstract

Purpose – The aim of this thesis is to develop a model that can predict the hospitals that are likely to adopt Mobile Health Systems (MHS) and the factors influencing their adoption. This study will reveal the reasons why certain factors are more influential than others as well as the reasons behind MHS adoption.

Design/methodology/approach – Data was collected in three phases. In phase one, direct interviews with senior hospital managers were conducted in two cities. The objective of this phase was to develop a model of MHS adoption. In phase two, data was collected in 87 hospitals to identify the factors influencing MHS adoption. In phase three, six in-depth interviews were conducted to unravel the reasons behind MHS adoption in hospitals.

Findings – The result shows that perceived ease of use, system reliability, system security and privacy of patients, IT infrastructure, hospital level, top management support, government policy and regulation and external pressure are all significant factors in an adoption decision whereas compatibility, perceived usefulness and hospital (organisation) readiness were found to be insignificant.

Research limitations – Further research is needed to verify our findings by surveying other hospitals across the country.

Practical implications – The model developed can be used by MHS suppliers to develop strategies that target potential adopters, as well as to increase the adoption rate in hospitals. The suppliers could also amend their strategies by fully understanding the reasons behind each factor that facilitates or hinders the adoption of MHS. The government could use the result to develop policy and promote the use of MHS.

Originality/value – The study contributes to the continuing research in innovation adoption and diffusion in the healthcare context in the emerging markets. This thesis is the first MHS adoption research conducted at an organisational level among Chinese mainland public hospitals. It also contributes to the research literature by combining both qualitative and quantitative data to explore determinants of MHS adoption.

Keywords – IT, Mobile Health System, Innovation, Adoption, Public Hospitals, China.

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Academic Thesis: Declaration of Authorship

I, Binheng Duan

declare that this thesis and the work presented in it is my own and has been generated by me as the result of my own original research.

The Adoption of Mobile Health System in Hospitals:

An Empirical Cross-City Study in China

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission.

Signed: ………………………………………………………………………

Date: 16/March/2018

ABBREVIATIONS

IS - Information System

IT - Information Technology

ICT - Information Communication Technology

MHS - Mobile Healthcare System

HIT - Hospital Information Technology

HIS - Hospital Information System

TOE - Technology-Organisation-Environment

PEoU - Perceived Ease of Use

OR - Organisation Readiness (Hospital Readiness)

CM - Compatibility

HL - Hospital Level

PU - Perceived Usefulness

GPR - Government Policy and Regulation

SR - System Reliability

EP - External Pressure

SSPP - System Security and Privacy of Patients

ITI - IT Infrastructure

TMS - Top management support

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Chapter 1 Introduction

1.1 Introduction

Chaudhry *et al.* (2006) argued that health information technology (HIT) is considered critical in transforming the healthcare industry by experts because it is the key to improving the quality and efficiency of the healthcare service as well as to making it more effective and secure (Shekelle *et al.* 2006). Research has shown that there are many significant quality-related benefits (Overhage *et al.*, 1997; Dexter *et al.*, 2004; Kucher *et al.*, 2005; Abookire *et al.*, 2000; Cannon and Allen, 2000) and efficiency-related benefits (Tierney *et al.*, 1993; Chen *et al.*, 2003; Bates *et al.*, 1999; Shojania *et al.*, 1998; Wong *et al.*, 2003) for healthcare organisations to implement health information technology (Chaudhry *et al.,* 2006). Healthcare organisations are somewhat complex and under pressure to adopt and implement innovations and technologies to become more efficient (Sligo *et al.,* 2017). It is argued that HIT could potentially improve the '*quality, efficiency, outcomes, patient safety'* as well as reduce the cost of healthcare (Ahlan and Ahmad, 2014, pp1287).

Due to the nature of healthcare, the consequences of errors could be fatal. The stakes and the uncertainty level are both really high since human lives are at risk (Zhou & Piramuthu, 2010). Compared with other industries, the healthcare industry is often argued to be conventional, and not too keen on adopting innovations (Wu *et al.* 2007), and the technologies it does adopt tend to be more pragmatic (Chau and Hu, 2002b) than in other fields.

Due to the different cultural and social structures in different countries, the factors affecting the adoption of technology in hospitals tend to differ from country to country. Unfortunately, IT (information technology) in healthcare is not properly utilised, nor is it widely available; this problem is especially serious in developing countries (Ahlan and Ahmad, 2015).

Hospitals in China are public sector organisations; however, they differ from both private and common public organisations. Public hospitals in China are expected to have profitability like any other private organisations while receiving differentiated appropriation (special funding for general and special use) from the government, (Barber *et al.* 2013).

Typically, the current hospital IT system is often a system that only provides access to patients' information and clinical results. It is usually based on desktop computers via wired Internet and Intranet. Such systems are difficult to apply new modifications to and can hardly meet the constantly changing business environment (Heslop *et al.,* 2010).

The adoption of wireless Internet via mobile technology which includes the use of all types of mobile devices, such as smartphones and tablets, is becoming an '*unavoidable organisational trend*' (Lu *et al.,* 2005, pp262). Two of the most significant characteristics brought about by mobile technology are mobility and reachability, where mobility means that Internet access goes wherever the users are, and reachability implies that people are connected and can be reached at any time (Aronson *et al.,* 2005).

Mobile health technologies are providing the basis for a radical transformation of the '*practice and reach of medical research and care*', through the gradual miniaturisation of mobile devices which have become increasingly powerful (Steinhubl *et al.,* 2015, pp1). Mobile Health Systems are already having a strong impact on the services which healthcare organisations provide. (Silva *et al.,* 2015).

1.2 Definitions

1.2.1 Health Information Technology

Information technology is defined as the '*use of computers and telecommunications equipment (with their associated microelectronics) to send, receive, store and manipulate data. The data may be textual, numerical, audio or video, or any combination of these'* (Law and Rennie, 2015). Health Information technology is the IT used and applied to the healthcare industry. It is suggested that Health IT could potentially start a significant change in healthcare delivery, which would make health care more efficient, effective and more secure (Shekelle *et al.* 2006).

1.2.2 Health Information System

A Health Information System is defined as the health service technologies and applications which are digitised in order to provide communication and processes for health care (Haux, 2006), while Information Technology is dealing with the technologies involved within the system.

1.2.3 Innovation

A recognised definition of 'innovation' is as follows, '*An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption'* (Rogers, 1983, pp11) and there are three types which are incremental, synthetic or discontinuous innovation.

1.2.4 Innovation Adoption and Diffusion

Adoption is referred to as '*a decision to make full use of an innovation as the best course of action available'* (Rogers, 1983, p21) or the decision of an individual or organisation making use of an innovation (Frambach and Schillewaert, 2002).

1.2.5 Mobile Health Systems (MHS)

M-Health is defined as "*the use of mobile devices – such as mobile phones, patient monitoring devices, personal digital assistants (PDAs) and wireless devices – for medical and public health practice*" (WHO, 2016, pp. 27), while an app (application) is a '*specialised software program that can run on platforms, such as smartphones, tablets, computers or other types of electronic devices*' (Weinstein *et al.,* 2014, pp185). This thesis is focusing on the mobile health systems, which consists of different varieties of applications that are set up to run on mobile devices such as smartphones and tablets, and grant medical professionals access on mobile devices to data that are stored on workstations and enable them to deliver medical services wirelessly.

1.3 Background for Innovation Adoption and Diffusion

Innovation adoption and diffusion has been studied quite heavily in the past and is a relatively mature area (Ramdani, 2008), starting back in the late 1980s and early 1990s (Davis, 1989; Rogers, 1983; Fishbein and Ajzen, 1975; Grover and Goslar, 1993) and continuing to the present (Ramdani, 2009; Kijsanayotin *et al.,* 2009; Dwivedi, *et al.* 2016; Sezgin and Özkan-Yıldırım, 2016; Liang *et al.,* 2017).

The rapid and large-scale growth of information technology has deeply impacted businesses and economies around the world (Seyal and Rahman, 2003). In the past two to three decades, many theoretical and empirical studies have been done on the topic of information technology innovations' adoption and diffusion (Jeyaraj *et al.,* 2006).

In terms of theories, technology and innovation adoption research has put many theories to the test and many new theories have been developed. These include TRA (Theory of Reasoned Action, Fishbein and Ajzen, 1975), IDT/DOI (Innovation Diffusion Theory or Diffusion of Innovation Theory, Rogers, 1983), TAM (Technology Acceptance Model, Davis, 1989), TPB (Theory of Planned Behaviour, Ajzen, 1991), TAM 2 (Venkatesh and Davis, 2000), UTAUT (Unified Theory of Acceptance and Use of Technology, Venkatesh *et al.*, 2003), TAM 3 (Venkatesh and Bala, 2008) and UTAUT 2, Venkatesh *et al.* 2012).

Among the adoption studies, both qualitative and quantitative methods have been used many times; these includes case studies (Cao *et al.,* 2014), ground theory (Liang *et al.,* 2017), field studies (Taylor and Todd, 1995b) and field surveys (Ramdani, 2009).

Most of the theories and models developed were tested and validated. Each has its own strengths and weaknesses. However, due to the highly differentiated technologies, '*there is not necessarily a single adoption model'* that suits all technologies (Ramdani, 2009, pp20).

In the past decades, technology has possessed a more important position than ever in both organisational and individual lives. The studies of innovation adoption were mostly at the individual level, albeit many of the studies (Hu *et al.* 1999; Hung *et al.,* 2012; Phichitchaisopa and Naenna, 2013) were done within an organisational context (Lucas *et al.* 2007).

Mobile technology and applications are changing the healthcare industry; how health information is accessed, transferred and managed has been changed because, with MHS, data can be accessed anywhere; even when the users are not in hospitals, data can be transferred and managed at any time. M-Health services with these applications provide healthcare service to almost anywhere at any time. Normal geographical, time and organisational barriers (Silva *et al.,* 2015) no longer apply, and the price of such technology is affordable: '*m-Health services and applications already have a very important and determinant role in restructuring the old healthcare services and systems that are still based on the physical relationship between patient and physician.* (Silva *et al.,* 2015, pp270). The applications that mobile health provides already have a strong influence on all healthcare services.

1.4 Research Rationale

The adoption of the digital innovation in hospitals has been slow; this is due to the relatively conventional attitude towards new technology within the hospitals (Hikmet and Chen, 2003; Wu *et al.* 2007) as well as the lack of government regulations. However, the situation is changing drastically as modern IT is a significant tool which is reforming the industry (Lee and Shim, 2007; Wu et al. 2007). The General Assembly of the United Natiions (UN) has set the 2030 agenda (UN, 2015a) with a goal to enable all human beings to live healthy lives at all ages as well as to "*achieve universal health coverage*" (pp. 16). However, according to a report from the World Health Organisation (WHO) without the support of e-health, universal health coverage can never be achieved (WHO, 2016). There were 5.1 billion individual mobile subscribers in the world in 2017 (Statista, 2017), and the challenge in healthcare delivery could be solved by using mobile tools to provide healthcare services.

Due to the different social structures of hospitals in mainland China, research studies targeting the hospitals' adoption decisions there are almost non-existent. China, as the second largest economy according to its Gross Domestic Product (GDP) has very little research to date in the area of innovation adoption in healthcare; no-one has looked into MHS adoption in mainland hospitals in China, let alone carried out a cross-city study. As an economically fast-growing developing country with the GDP growth never having dropped to under 6.5% in the past two decades and with its GDP having peaked at 14.2% in 2007 (Worldbank, 2017), with a population of more than 1.3 billion, China has a completely different context compared with Western countries. There are the political differences, i.e. it is a communist country; there are the cultural differences, such as the bureaucracy and the much relied-upon Guanxi (Connections) in Chinese culture; there are differences in the forms of industry in the healthcare sector and especially the differences in hospital structures where the hospitals in China are regarded as part of the public service sector whereas, in fact, they have to make a profit like private hospitals do. A quarter of the entire population of China are aged 60 and over (UN, 2015b) which makes China the country with the largest population of older citizens; the trend of ageing is still growing and is expected to increase by 71% by 2030 (UN, 2015b). Medical inequality is also a serious issue for policymakers; according to a government report, people in urban area possess more than double the number of medical beds than people in rural areas per every 1,000 of the population (China statistical yearbook, 2016), not to mention the fact that the best quality medical personnel are centralised in big cities. There are more than 1.3 billion mobile subscribers in China (International Telecommunications Union (ITU), 2016); given the large number of mobile subscribers, MHS could be the answer that “*can reach across geographic and socioeconomic boundaries and potentially increase access to care and improve health outcomes*” (Ni *et al.*, 2014), especially with the upcoming 5G network that is expected to be *‘characterised by massive capacity and connectivity, seamless heterogeneity, high flexibility, and adaptability’* (Rimal *et al.*, 2017, pp192); it will also be ‘*highly integrative and convergent with a focus on increasing integration of cellular and wireless local area network (WLAN) technologies’* (Rimal *et al.*, 2017, pp192). The uniqueness of public hospitals in China, the lack of any research studies in such a context and also the newly emerging opportunities all provide this research with a unique and significant perspective.

1.4.1 Gap

From reviewing the existing literature that has looked at innovation adoption in healthcare, although the topic of innovation adoption has been looked into heavily, most research to date focuses on the software or the specific technology adoptions, such as EHR (electronic health record) (Gan, 2015, Hassol *et al.* 2004), CDSS (Clinical Decision Support System) (Buenestado *et al.* 2013), PACS (Picture Archiving and Communications System) (Duyck *et al.* 2008). The studies of MHS adoption are very limited, although existing mobile health adoption research projects are looking into the adoption of either patient- or professional-oriented mobile health applications at the individual level (Wu *et al.,* 2011; Deng *et al.,* 2014; Sun *et al.,* 2013; Dwivedi *et al.,* 2016) rather than at the organisational level. Moreover, there is no existing study that is concentrating on MHS adoption in Chinese mainland public hospitals, and this leaves a huge gap in academic studies aiming at the adoption of mobile health technology as a system in Chinese mainland hospitals.

1.4.2 Contributions

The researchers using quantitative method alone (Chau and Tam, 1997; Thiesse *et al.*, 2011; Lin and Lin, 2008; Oliveira *et al.* 2014) can merely speculate rather than explain the reasons why the factors are significant or insignificant in adoption studies. This research will not only look into the influential factors of innovation adoption, it will study the reasons behind those factors and the adoption of MHS, and is looking to contribute in the qualitative study and combined methods by doing in-depth interviews based on the quantitative research result. This will address the current criticisms addresses the current criticisms of adoption research that argues that the research and the adoption models (TAM, IDT, etc.) were designed to look into the factors affecting the adoption decision, not the reasons behind the adoption. Moreover, the practical value of this study is not only to help the MHS vendors to know what factors are influencing the adoption decision of the hospitals; by doing the qualitative research, this study sheds light on why some hospitals adopt MHS while others do not. It would increase significantly the opportunities for developing more useful and bespoke technologies by fully understanding the reasons for the adoption. Therefore, this thesis will contribute to the theoretical academic field by continuing the research stream on adoption studies, setting the research theme in a context that has never been studied before (MHS adoption in Chinese mainland public hospitals), combining the qualitative and quantitative approach, and hence addressing the problem of the traditional adoption study of not being able to look behind the curtain of the adoptions, as well as contributing to the practical world by helping vendors to not only know the factors that are significant, but also why those factors are important; and thus providing a much deeper understanding of the adoption.

1.5 Aim

This thesis is aiming to fill the gaps mentioned above, which include most of the adoption studies in healthcare were specific software adoption rather than a system; the study of MHS is very limited; the existing MHS adoption research is all at an individual level and is either patient- or healthcare professional-oriented, instead of seeing MHS as a system at the organisational level, and there is no research that has been done within the context of public hospitals in mainland China.

1.6 Objectives

The objects of this study are:

Firstly, to develop a theoretical framework in order to examine the adoption of MHS. The factors that impact the adoption of MHS in Chinese hospitals would then be identified so that the hospitals which are more likely to adopt MHS can be predicted. The study then aims to find out why some hospitals adopt MHS while others do not?

1.7 Research Questions

To achieve these objectives, this study aims to answer the following questions:

1. What theory and framework should be used in order to study hospitals' adoption of MHS in China?
2. What determines the adoption of MHS by hospitals?
3. Why do some hospitals adopt MHS while others do not?

1.8 Thesis Overview

Chapter one will give a brief idea of this whole thesis. This chapter will start by introducing the major definitions, followed by a brief background of the IT adoption study. It will then discuss the research rationale and research questions. The structure of this thesis will also be set out.

Chapter two will explain the background and context of the study. It will start by introducing the background of the mobile health system and the healthcare in China; it will then explain the uniqueness of the hospitals in China. The government orientation with its medical reforms and hospital classifications will also be discussed. The benefits and barriers to any innovation adoption will be mentioned in this chapter as well.

Chapter three will review the research literature. It will first introduce and explain the adoption and its process, and also the types of innovation and adopters. It will then explain the most used and most validated theories, and the models and frameworks in innovation adoption and diffusion. The summary of the past studies of each theory will be provided, as well as the studies in the healthcare context. This chapter will provide a view of the research in the field of innovation adoption.

Chapter four will detail how the conceptual framework used in this thesis is developed and what theory the framework is based on. The choice of constructs will be explained; the refinement of the framework will also be discussed based on the pilot study result, which will lead to the research hypotheses.

Chapter five will illustrate the method used for this research. It will explain how each of the phases of the research is designed and how the data are collected in every phase; how the instruments are chosen and how the questionnaire is designed; what sampling methods are used, how the fieldwork is carried out for every phase, how the data from the phase two main survey are analysed with the measurements for the constructs; how the validity and reliability of the model are tested; how data from the qualitative study in phase three is analysed as well as the trustworthiness of the qualitative study; all these will be answered in this chapter.

Chapter six will consider the findings and discussion. This chapter will focus on the findings from the phase one pilot study, the phase two empirical survey result, i.e. the influential factors and the factors that are not significant in adoption decision-making. The results of the tests of model robustness will also be presented. Then, the findings from the phase three qualitative study will be looked at closely after the quantitative result, as the 'why's are being unveiled by analysing the in-depth interviews' result.

Chapter seven will provide the conclusion, acknowledge the limitations of the research and consider what future research is needed. This chapter will conclude the whole study by discussing the findings and its contribution to academia. This chapter will then address the limitations and make suggestions for future research. This chapter will be the final chapter of this thesis.

1.9 Summary

Healthcare industry is being changed by mobile technology and applications because not only are the quality, efficiency, effectiveness and security of medical services all being improved by technologies, but also the barriers such as geography, time and organisation are all being broken down by the use of MHS. China has been facing the problems of ageing and of medical inequality for some time and the country has more than 1.3 billion mobile subscribers (ITU, 2016), MHS could be the technology the country has been longing for in order to solve its healthcare problems. In previous research, most of the adoption studies in the healthcare context have been focusing on the adoption of a particular software or a specific technology; MHS adoption studies are very limited and the current studies are concentrating on individual adoption, with very little research being done in the public hospitals in mainland China. In this chapter, the introduction is followed by the definitions of the major terms used in the study. The background to innovation adoption, which has led to gaps in the research literature and the rationale behind this research, has already been mentioned. The research questions were then listed and these will be answered by this thesis. Finally, the framework of the thesis is listed chapter by chapter providing a clear outline of the research.

Chapter 2 Research Background

2.1 Introduction

This chapter provides the wider context of this study. A discussion of MHS and its current situation including recent developments will be introduced first, followed by the characteristics of the public hospitals in China, the current government orientation in regard to the technology and healthcare industry as well as the benefits and barriers to innovation adoption.

The information processing method of modern times and the latest ICT (Information and Communication Technology) have both impacted human society deeply; health care is a part of life that cannot easily be escaped (Haux, 2006). With the adoption of information technologies, the adopters are provided with new ways to solve the problems as well as to reach out for new opportunities (Hameed *et al.* 2012). The healthcare service information systems emerged because of the extensive use, development and employment of a variety of information communication technologies and electronics, such as computers, in the healthcare sector and in medical industries (Reichertz 2006; Sezgin *et al.,* 2014). Due to the increasing adoption and implementation of the HIS (Health Information System) in many different sectors and fields of the healthcare industry, the increasing development of health information technologies, systems and applications have come under the spotlight and have been given significant and concentrated attention (Sezgin *et al.,* 2014).

2.2 Mobile Health Systems (MHS)

Chassin and Galvin (1998) stated that managing information is fundamental to the delivery of healthcare. Hospitals are heavily relying on ICT to improve the service quality, the medical and data security and the productivity of professionals in the healthcare services (Silva, *et al.,* 2015). HIT (Health Information Technologies) plays a crucial role in the transformation of the healthcare industry as eagerly anticipated by healthcare professionals, government and consumers (Chaudhry *et al.,* 2006).

The concept of e-health has emerged yet it had a slow start in the 1990s due to the hospitals and healthcare industry not prioritising the use of ICT. It had a rapid increase in usage between 1999 and 2002, which was partially caused by the same rapid evolution of ICT infrastructures and patient data access methods (Silva, *et al.,* 2015). M-Health has emerged early with PDAs (personal digital assistants) but has only fully awoken in the past few years with the boom in the use of smartphones where the chip inside a single smartphone is much more powerful than an entire computer from decades ago.

The applications of mobile health are the fundamentals of the system, as they provide software infrastructure for MHS. Weinstein *et al.* (2014) mentioned that the accessories of mobile health such as bespoke sensors and devices that work with multiple mobile health apps are also booming rapidly not only by number, but by innovative features as well. Moreover, the integration of telemedicine and mobile health is also emerging due to the significant size and mobility advantage of mobile devices.

Silva *et al.* (2015) proposed that healthcare can be delivered anytime and anywhere overcoming '*geographical, temporal, and even organisational barriers*' (pp265) with an affordable cost of mobile health. The transformation of the ways that health information is accessed, delivered and managed (Bahga and Madisetti, 2013) is ongoing because of the emerging boom in growth of mobile technologies, and thus mobile health technologies and relevant applications. Furthermore, the fast development and adoption of cloud computing could bring a range of advantages to the healthcare industry. The transformation to the cloud is inevitable and it is already happening (Bahga and Madisetti, 2013). Due to the different demands, requirements and capabilities of different hospitals, a mobile health system varies from hospital to hospital. The functions of MHS might include, but are not limited to, what is shown in Table 2.1.

Table 2.1 Mobile Health and ICT Applications, adapted from Labrique et al. (2013)

Applications	**Examples**
Client education and behaviour change communication (BCC) (Labrique et al., 2013)	Short Message Service (SMS); Multimedia Messaging Service (MMS); Internet Based Messaging Service (iMessage, WeChat etc.); Video Call (Facetime etc.) Interactive Voice Response (IVR); Voice communication/Audio clips; Video clips; Images
Sensors and point-of-care diagnostics (Labrique et al., 2013)	Mobile phone camera; Tethered accessory sensors, devices; Built-in accelerometer; Smart Watch with Health Monitor (Apple Watch etc.)
Registries and vital events tracking (Labrique et al., 2013)	Short Message Service (SMS); Internet Based Messaging Service; Voice communication; Digital forms
Data collection and reporting (Labrique et al., 2013)	Short Message Service (SMS) Internet Based Messaging Service; Digital forms; Voice communication
Electronic health records (Hennington and Janz, 2007; Gan, 2015)	Digital forms; Mobile web (4G/3G/WAP/GPRS)
Radio Frequency Identification (RFID) (Chen et al. 2007)	Tethered accessory sensors, devices; Trackers
Future picture archiving and communications system (PACS) (Duyck et al. 2008)	Images; Mobile web (4G/3G/WAP/GPRS); Mobile phone camera
Electronic Logistics (Tung, et al. 2008)	Mobile web (4G/3G/WAP/GPRS); Stored information ‘‘apps’’; Internet Based Messaging Service; Digital forms
Electronic decision support (information, protocols, algorithms, checklists) (Labrique et al., 2013)	Mobile web (4G/3G/WAP/GPRS); Stored information ‘‘apps’’; Interactive Voice Response (IVR)
Provider-to-provider communication (user groups, consultation) (Labrique et al., 2013)	Short Message Service (SMS); Multimedia Messaging Service (MMS); Internet Based Messaging Service; Video Call; Mobile phone camera

Provider work planning and scheduling (Labrique et al., 2013)	Interactive electronic client lists; Short Message Service (SMS) alerts; Mobile Devices App Notification; Mobile phone calendar
Provider training and education (Labrique et al., 2013)	Short Message Service (SMS); Multimedia Messaging Service (MMS); Interactive Voice Response (IVR); Internet Based Messaging Service; Video Call; Voice communication; Audio or video clips, images
Human resource management (Labrique et al., 2013)	Web-based performance dashboards; Global Positioning Service (GPS); Voice communication; Short Message Service (SMS)
Supply chain management (Labrique et al., 2013)	Web-based supply dashboards; Global Positioning Service (GPS); Digital forms; Short Message Service (SMS)
Financial transactions and incentives (Labrique et al., 2013)	Mobile money transfers and banking services; Transfer of airtime minutes
Telemedicine (Hu et al., 2002)	Mobile phone camera; Tethered accessory sensors, devices; Built-in accelerometer; Smart Watch with Health Monitor (Apple Watch etc.) Video Call; Voice communication

To study, predict and most importantly, understand why certain hospitals adopt MHS while others choose not to is not only vital for MHS companies, it provides a reference point and a pathway ahead for future research in this area.

2.3 Public Hospitals in China

Comparing statistics with developed countries like the United States or the United Kingdom, or even the average figure of the entire world, the health expenditure in China comprised a mere 5.548% of total GDP in 2014, while the figures for the UK, the US and the world average counted for 9.115%, 17.141% and 9.891% respectively. However, there was a slow but gradual increase in the percentage over the year from 3.525% in 1995 to 5.548% in 2014 for China. The country with the highest ratio between health expenditure and GPD is the United States, at 17.141% in 2014 (Figure 2.1).

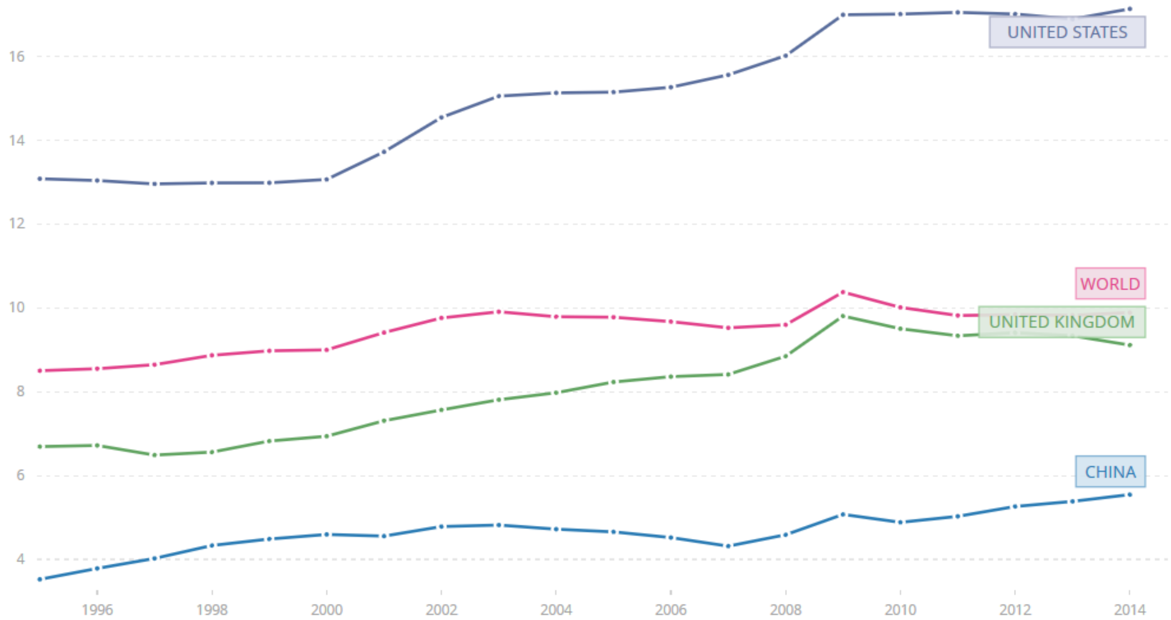

Figure 2.1 Health expenditure, total (% of GDP), Source: Worldbank, 2017

The spending on healthcare in China is much lower compared with the average of the world, but it is increasing and is likely to be reflected by its investment in healthcare technologies. The rapid development of China has also seen an increase in hospital numbers, professionals per capita, as well as the quality of service since China became the second largest economy in the world in 2010 (GDP wise); although China remains a developing country as per capita income, this is still only a fraction of the figure for developed countries. (Worldbank, 2017). The total hospital numbers (Figure 2.2) tripled since 1978 from 9293 to 29140 in 2016 (Figure 2.2); the total licensed doctors and registered nurses increased from 1.17 and 0.47 to 2.31 and 2.54 per 1000 people from 1980 to 2016 respectively (Figure 2.3). (China statistical yearbook, 2017). In comparison with this, in the United Kingdom under the National Health Service (NHS) where the funding is directly from taxation (NHS, 2016), the physicians per 1000 people increased from 1.3 to 2.83 from 1980 to 2016, the number of nurses and midwives decreased from 12.2 in 1997 to 8.42 in 2016 (Worldbank, 2017).

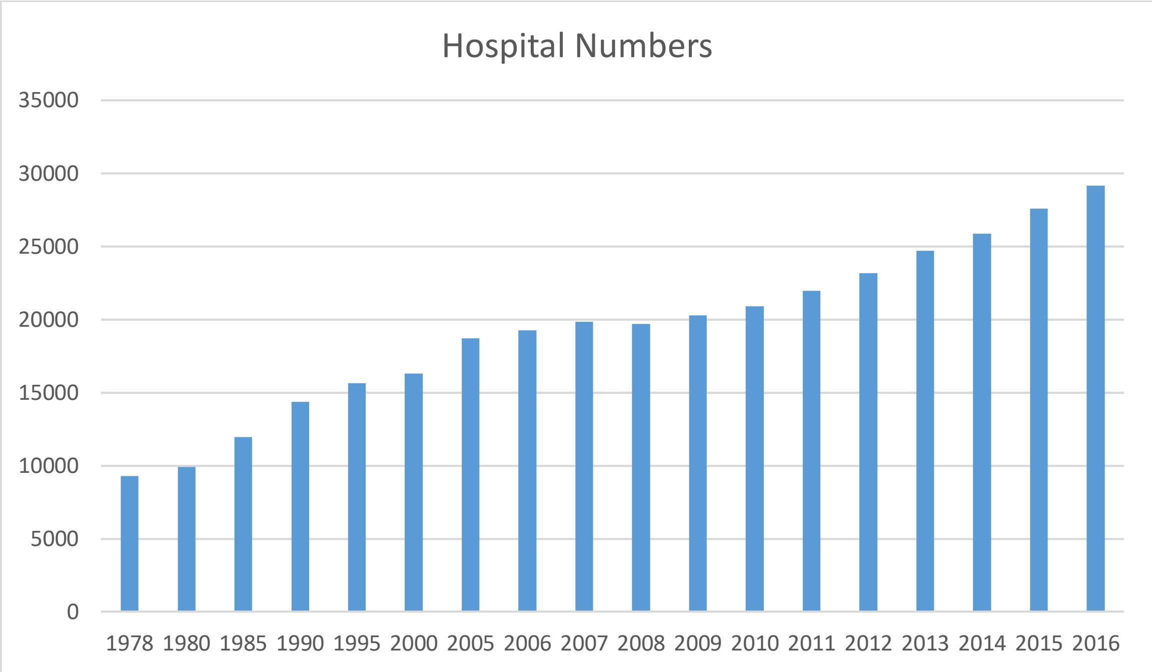

Figure 2.2 Total Hospital Numbers, Source: China Statistics Yearbook of Health and Family Planning, 2017

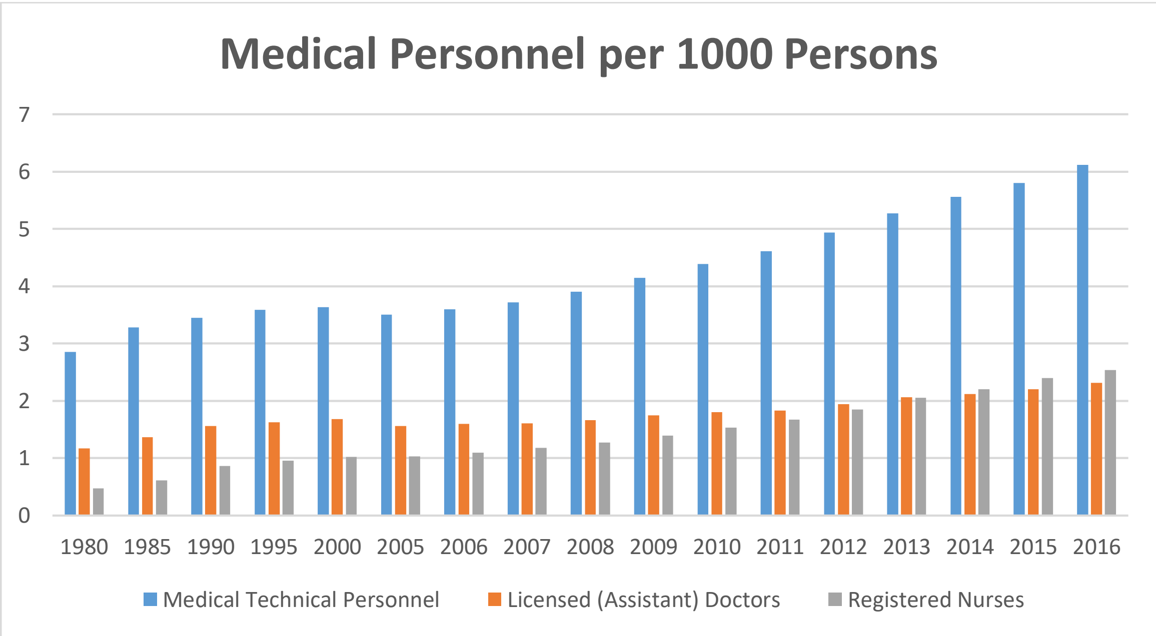

Figure 2.3 Medical Personnel per 1000 Persons, Source: China Statistics Yearbook of Health and Family Planning, 2017

Over the past four decades, the changes and transformations in the hospital and health sector in China have been remarkable (Barber *et al.* 2013). Public hospitals in China have gained the right to retain operating surplus and profits from the turnover of medicine sales and diagnostic tests since the 1980s, which is to offset the government-set compulsory low-fixed prices to benefit people's medical needs on hospitals beds, nursing services, surgeries and other services (Yip *et al.* 2012). Public hospitals gained access to even greater autonomy in 1992, where hospitals were allowed to '*generate and use their resources'* (Barber *et al.* 2013, pp3). Public hospitals continued to generate profit by relying on sales of both medicine and medical services, which totalled more than 90% of the entire revenues, and seems to have had little change over the years (Figure 2.4). Government subsidies for hospitals only account for 10% of the total revenues as of the early 1990s, and decreased to merely 6-7% during 2003 to 2010 (China Health Statistical Yearbook, 2012), and then increased to 9% in 2016 (China Statistics Yearbook of Health and Family Planning, 2017). In order to maintain an affordable health care service for most people, the prices for basic health care were set to below initial cost while the prices for high-tech diagnostic services were set to a relatively high and an above initial cost as well as to permit hospitals to have a 15% profit margin on medicine sales (Yip and Hsiao, 2009).

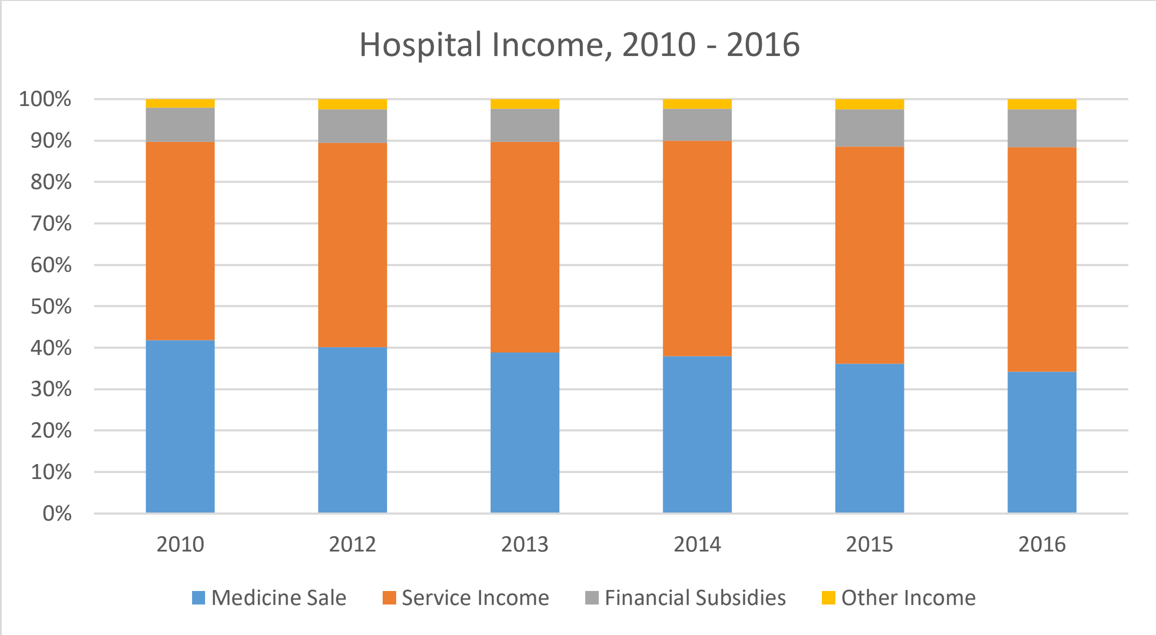

Figure 2.4 Hospital Revenue, Percentage of general public hospital income in China, 2010 - 2016. Source: China Statistics Yearbook of Health and Family Planning, 2017

Due to the autonomy and low government subsidies, although most of the hospitals in China are publicly owned, they have to generate revenue by themselves and rely heavily on the '*business activities*' for their financial survival. Therefore, the health facilities which are technically publicly owned are really *'"private, for-profit" in terms of behaviour.*' (Yip and Hsiao, 2009, pp614).

Such regulations are not without drawbacks. The healthcare providers, who have around 90% of income generated from medical services and medicine sales, are encouraged to profit and receive incentives, and this eventually turned hospitals into profit-seeking entitles (Yip and Hsiao, 2009).

In the UK, the National Health Service was launched in 1948, and it deals with more than 1 million patients every 36 hours. Most of the NHS is free of charge for all UK residents in England (NHS, 2016). The NHS represents one kind of healthcare service – free for all residents and is funded by taxation.

2.4 Government Orientation

An outbreak of the severe acute respiratory syndrome (SARS) in China in 2002 revealed the Chinese health-care system's failure as well as '*some fundamental structural deficiencies*' (Liu, 2004, pp532). The unaffordable medical cost that actually impoverishes residents and the huge medical service inequality between regions, as well as between urban and rural areas, was massively criticised by Chinese residents (Hsiao, 2004). Figure 2.5 illustrates the difference in the number of medical beds per 1000 people between urban and rural areas. It can be clearly seen that in each year from 2010 to 2016, residents in rural areas only had half of the medical beds per 1000 people compared with those living in urban areas (China Statistics Yearbook of Health and Family Planning, 2017). However, compared with the NHS in the United Kingdom and with other European countries, hospitals beds per 1000 people in China was increasing steadily in both rural and urban areas, while beds per 1000 people in European countries which include Germany, Austria, Belgium, Luxembourg, France, Greece, Portugal, Finland, Denmark, Ireland, Spain, Sweden and the UK, suffered a decline from 2004 to 2014 (Ewbank et al, 2017). The number of hospital beds per 1000 people in the UK was 10.7 in 1960, 8.1 in 1980, 4.2 in 2000 and 2.9 in 2011.

Government health expenditure only counted for a mere 30.45% of overall expenditure in 2014, though this almost doubled the figure from 15.47% in 2000. The highest expenditures switched from out-of-pocket expenditure at almost 60% in 2000 to social health expenditure at 41.2% in 2016 (Figure 2.6). The expenditure paid per individual has been decreasing greatly from 59.97% in 2001 to 28.78% in 2016.

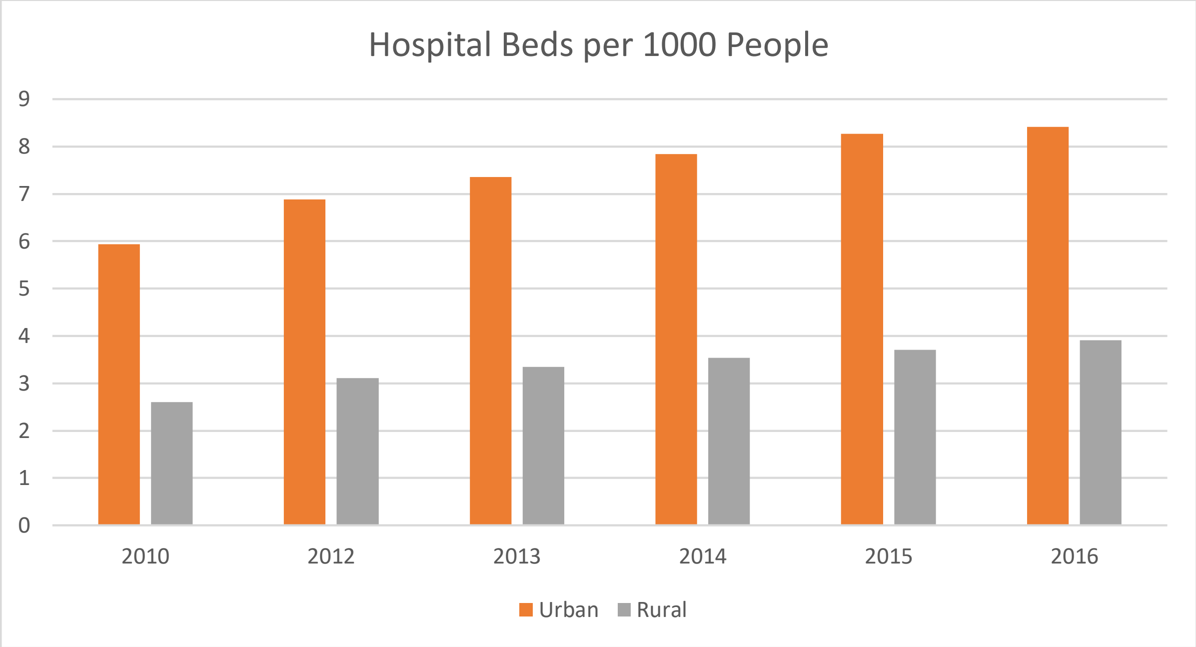

Figure 2.5 Beds per 1000 people, Source: China Statistics Yearbook of Health and Family Planning, 2017

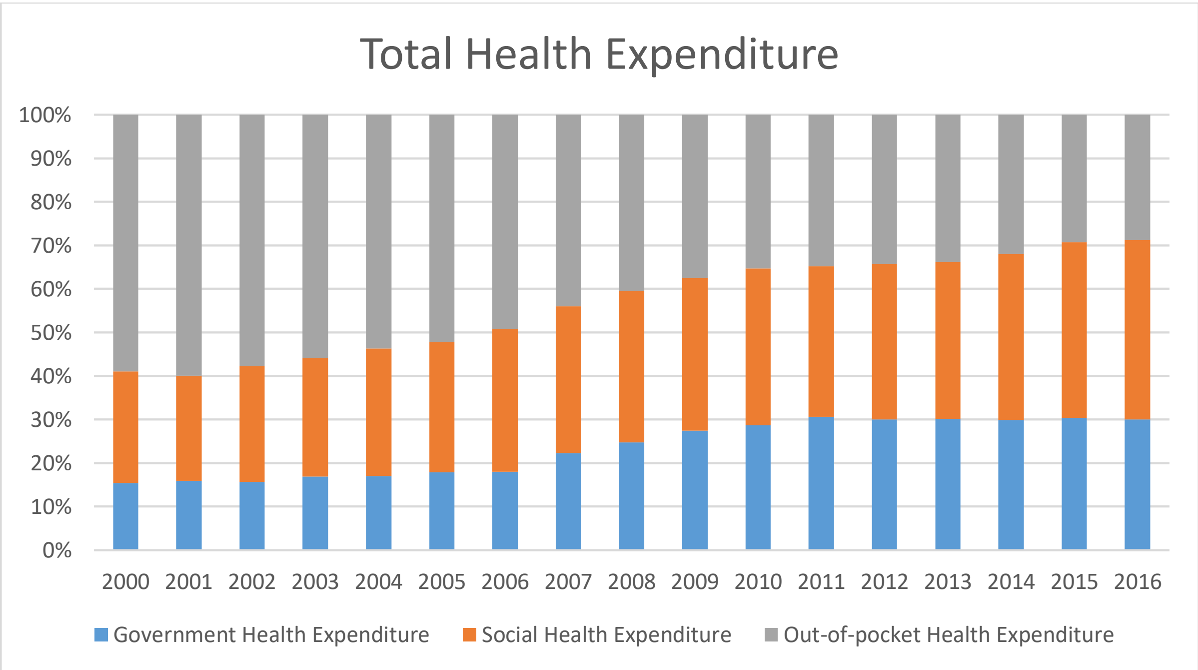

Figure 2.6 Total Health Expenditure, Source: China Statistics Yearbook of Health and Family Planning, 2017

After years of problems and criticisms, a major healthcare reform was introduced in 2009 and is still an ongoing project. The government has announced a major healthcare reformation plan and was planning to spend billions on healthcare investment to provide affordable healthcare for all the people and to eliminate inequality in the healthcare sector by 2020. The reform is seen as the answer to the complaints people have had over time due to the high medical costs, low efficiency, and low coverage; and that high-quality medical resources were centralised in only a few places.

The reforms were focusing on five interdependent areas (Yip *et al.* 2012, Chen, 2009). These were to:

1. Expand the basic healthcare insurance coverage to cover more than 90 percent of the total population;
2. Establish a national basic and essential medicine system to meet the essential needs of everyone by including all the basic medicines in the category that can be reimbursed by health insurance;
3. Improve regional and local healthcare systems, with an emphasis on rural and less-developed regional community hospitals so that basic health care can be reached by everyone;
4. Eliminate the medical resource inequality and make the public healthcare service available to all;
5. Start public hospital reforms (Yip *et al.* 2012, Chen, 2009; Ministry of Health of the People's Republic of China, 2009).

In order to achieve the goals that are set by government, especially to tackle the national coverage and medical resource inequality problems, by adopting MHS in hospitals and by patients, these issues could be addressed given the amount of mobile subscribers, which count for more than 1.3 billion in China, (ITU, 2016).

During the process of reform, government and policy makers gradually released the information regarding how the hospitals should make patients' visits to hospitals easier; it encourages hospitals to consider various options which include, and mainly are, hospital information technology related. The benefits mobile health brings to the table are significant. Mobile appointment systems enable patients to make appointments remotely instead of the traditional ‘going to the hospital in person’ route; telemedicine provides ultimate convenience for patients with disabilities as well as remotely sending better medical resources to rural areas; mobile visual and audio transmission allows experts to attend an emergency surgery without even setting foot in the operation room.

The Chinese Government has been promoting and encouraging the development of information technology since the early 1990s; the Ministry of Science and Technology (MoST) has issued regulations and policies such as the Torch Programme and the 863 Programme which stimulates the development of technology, encourages the research and development of cutting-edge information technologies (Brown *et al.* 2017). With the rapid development of the Internet of Things (IoT) in recent years in China, a concept, WIT120 (Wise Information Technology of 120) has emerged (Guo *et al.,* 2018, National Health and Family Planning Commission, 2014, 2016, 2017; China Mobile Health Conference, 2015) through years of hospital information technology development in order to improve the healthcare reformation; WIT120 consists of three major systems, a wise hospital system, a regional health system and a family care system.

2.4.1 Wise Hospital System

A wise hospital system includes a digital hospital and the improvement of current applications; for example, HIS (Hospital Information System), LIS (Laboratory Information System), PACS (Picture Archiving and Communication

Systems) and professional workstations are all parts of a digital hospital information system. The system is for the collection, storage, management, extraction and information exchange of patients' data. The core functions of the workstation are to collect, store, transmit, manage and utilise patients' medical status and information. A professional workstation retains the data throughout the process of treatment for both inpatients and outpatients.

The improvement of applications includes, but is not limited to, the improvement of image transmission and large file management, which enables remote visiting (preventing visitors from direct contact with patients), telemedicine (quality medical resources can be shared cross-regionally), auto patient alarms, (monitoring a patient's status) clinical decision-making (assisting professionals in analysing medical records) and smart prescriptions (automatic analysis of a patient's allergy and medical history) (China Association for Science and Technology, 2016).

2.4.2 Regional Health System

The regional health system consists of a regional health platform and a public health system. The purpose of the regional health platform is to collect, manage, and transmit the data from and to communities, hospitals, health research facilities, and health monitoring record departments. It uses cutting-edge science and computer technologies to assist medical facilities and relative parties to evaluate and establish a customised plan in order to reduce personal medical costs, as well as establish and manage electronic health records. A public health system contains health monitoring systems and epidemic control systems.

2.4.3 Family Care System

The family care system is aimed at helping disabled or immobilised patients to set up telemedicine, caring for and monitoring patients with chronic disease, disability or contagious disease (National Health and Family Planning Commission, 2014, 2016, 2017; China Mobile Health Conference, 2015).

The ongoing medical reform and the concept of WIT120 have pointed hospitals and healthcare facilities in the direction of digitalisation, wireless cloud-based medical services and mobile health systems.

The Chinese Government has been and is promoting the development and use of information technologies in major industries (Brown *et al.* 2017). With the potential of solving the healthcare issues China has been facing for years, MHS adoption could very well be the next step the Government particularly promotes.

2.5 Hospital Classification

Hospitals are classified into three major tiers, with three sub-tiers within each major tier (Ministry of Health, 2009; Liang *et al.*, 2004).

1. The highest level hospitals are level three hospitals, with their top-tier being 1st class, and these are referred to as level 3A hospitals in this thesis; the second tier in level three is 2nd class, which is referred to as level 3B and the last tier is 3rd class and is regarded as level 3C in this thesis; the same categorisation method applies to level two and level one hospitals.

   The level three hospitals are healthcare facilities which provide medical services to cities, provinces and the nation cross-regionally. Level three hospitals are required to have more than 500 medical beds (Table 2.2); they are the centre of disease prevention and offer the highest standard of medical service with the best techniques; they are also capable of providing a full medical service, as well as teaching and research. The main purposes of the hospitals at this level are to provide specialised medical services in various departments, to take in critical and difficult cases, to accept transfers from level two hospitals, to provide medical training and guidance for lower level hospitals, to provide training for senior-level medical professionals and also to teach and research at the provincial level.

2. Level two hospitals are required to have from 100 to 499 medical beds and they are regional hospitals that provide cross-community medical services. They are the centre of disease prevention and medical service provision in the region. The main functions of level two hospitals include providing guidance for high-risk groups that are being monitored, accepting transfers from level one hospitals, providing certain guides for level one hospitals and doing certain teaching and researching.
3. Level one hospitals are the lowest level community hospitals, which provide medical services, disease prevention, health recovery and care to communities. They are the very basic healthcare facilities. Level one hospitals are mainly to offer prevention of illness to people directly, to care for ordinary patients, to provide the correct preliminary diagnosis to critical patients and to help higher level hospitals make the correct transfer. Level one hospitals should have 20 to 99 hospitals beds.

Level three hospitals are required to have a certain ratio of medical technical personnel and nurses per bed. Only certain professionals with required qualifications and professional titles can be directors of a department in level three hospitals. All the limitations apply to both level two and level one hospitals but with lower requirements (Ministry of Health, 2009; Liang *et al.*, 2004).

Table 2.2 Hospital Levels Comparison, Source: Ministry of Health, (2009); Liang et al., (2004)

	Level 1	**Level 2**	**Level 3**
Medical Beds	20-99	100-499	500+
Medical Technical Personnel (Per Bed)	0.7	0.88	1.03
Nurse (Per Bed)	-	0.4	0.4
Personnel Qualification	Low Requirements	Medium Requirements	High Requirements
Department	Less	Normal	Various
Equipment	Basic	Normal	Rich

2.6 Benefits and Barriers of IT Adoption

There are certain benefits and barriers in adopting IT. In Chinese public hospitals, if the demand is generated internally, the process is often identifying the needs - report to department director - report to IT department or to hospital director directly – hospital director's approval – implementation. However, if the demand is generated externally, i.e. from government orientation, the process would then be the hospital director's request – IT department's evaluation – implementation. In each stage, there are certain barriers stopping a hospital from adopting a certain technology, which will be discussed below.

2.6.1 Benefits of HIT Adoption

Execution is at the root of the difficulties in medical care in modern times. By increasing the use of ICT, healthcare providers could achieve the '*mastery of data and coordination'* (Bates and Gawande, 2003, pp2533) and therefore provide more reliable, efficient and customised services. Information technology can improve medical safety and care significantly by '*structuring actions, catching errors, and bringing evidence-based, patient-centred decision support to the point of care to allow necessary customisation.'* (Bates and Gawande, 2003, pp2533). The need for information technologies in healthcare service is growing also because of the increased needs for health care services due to increasing life expectancy and increases in healthcare costs; healthcare facilities face increasing challenges with rising pressure to deliver high-quality healthcare (Yazici, 2014). The same researcher also mentioned that to increase efficiency and productivity of professional staff, certain health information technologies such as real-time tracking and monitoring of medical equipment could be used.

Buntin *et al.* (2011) argued that the vast majority of studies show that measurable benefits are gained from adopting the health information technologies; they have found that 92 percent of the papers on health information technology agreed on and concluded upon the positive (or mixed-positive) outcomes from adopting health information technologies. The positive outcomes show the benefits emerging on quality, efficiency and provider satisfaction (Figure 2.7). Buntin *et al.* (2011) have studied a total of 154 research papers, 62 percent of which came to the full positive result, which indicates that '*health information technology was associated with improvement in one or more aspects of care, with no aspects worse off*' (pp465); and 92 percent of the studies were either positive or mixed-positive. The improvement has been categorised into eight different areas; these are access to care, preventive care, care process, patient satisfaction, patient safety, provider satisfaction, effectiveness of care and efficiency of care.

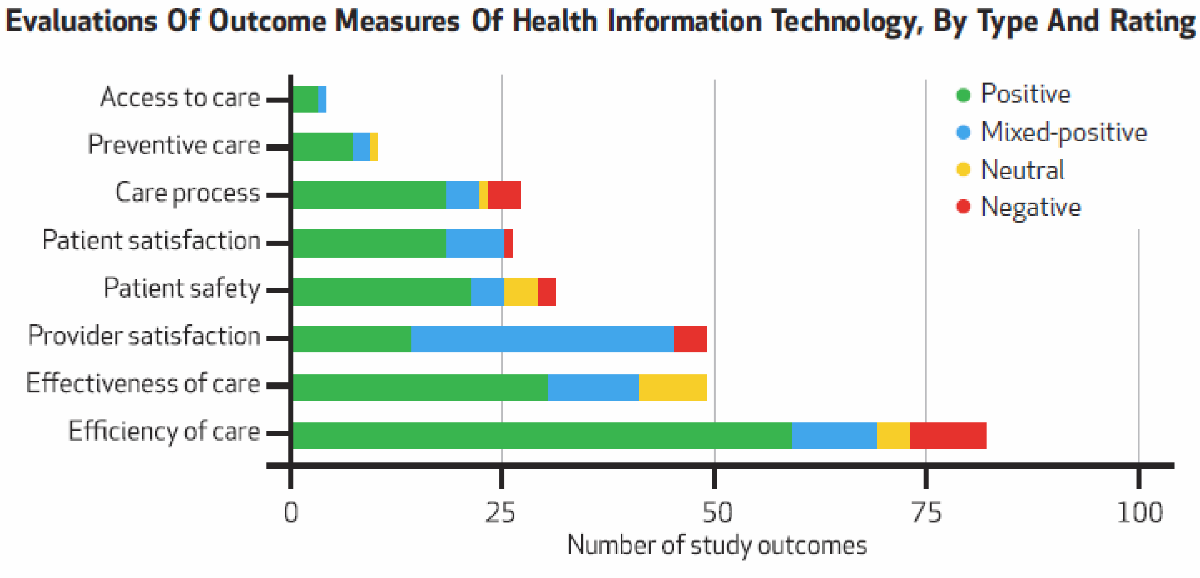

Figure 2.7 HIT Study Outcome, Source: Buntin et al., 2011

2.6.2 Barriers of HIT Adoption

However, adoption of such innovations also faces many barriers. Shekelle *et al.* (2006) argued that the implementation of HIT faces a large number of barriers, which are classified as situational barriers, cognitive and physical barriers, liability barriers and knowledge and attitudinal barriers. Situational barriers include time and financial issues. Cognitive and physical barriers include physical disabilities and insufficient computer skills. Liability barriers include confidentiality and privacy concerns. Knowledge and attitudinal barriers include insufficient research about information technology, insufficient knowledge about the benefits of adopting HIT, reluctance to change, and philosophical hostility against information technology (Johnson, 2001).

The spread of HIT is hindered by the lack of general knowledge regarding finding suitable types and methods of HIT in order to bring benefits and to lower the costs. This is an issue especially for small healthcare hospitals (Shekelle *et al.* 2006). Miller and Sim (2004) identified the barriers as initial high costs, both monetary and time wise, uncertain financial payoffs, insufficient knowledge of technologies and attitude. Hersh (2004) also mentioned several barriers to the adoption of HIT, which are cost, technical difficulties, system interoperability, confidentiality and privacy concerns, and also the lack of trained experts heading up the adoptions. Amongst all the barriers, the financial barrier is identified as the biggest impediment. Many technical issues pose additional threats to a more widespread adoption and diffusion of health IT. System interoperability refers to healthcare information exchange, which suggests that healthcare quality can be improved drastically if healthcare information can be accessed across organisations at anytime from anywhere (Erickson *et al.,* 2002). Confidentiality and privacy concerns suggest that healthcare professionals and hospitals must protect patients' privacy and confidentiality, though privacy issues similarly exist when using the traditional paper records (Hersh, 2004). The resistance from doctors because of the impact on current workflow was found to be the barriers in the adoption of HIT on top of the high initial adoption costs (Poon *et al.,* 2004). Balta-Ozkan et al. (2013) added that, apart from the cost, technical difficulties, system interoperability and confidentiality and privacy concerns which were argued by Hersh (2004), compatibility (fit to current life), administration, reliability and trust are also barriers to the adoption of technology. Kruse et al. (2016) summarised the most frequent barriers in health IT adoption as being initial cost, technical support, technical concerns, resistance to changing work habits, maintenance or ongoing costs, training, privacy concerns, insufficient time and workflow challenges; also, financial incentives and productivity loss are potential barriers albeit not mentioned as frequently.

Apart from the barriers identified by the research above, there are also other barriers to consider in the adoption process; Bates and Gawande (2003) have also identified three barriers, apart from the financial barriers; they argued that the research and development of healthcare information technology applications has largely been funded commercially, which has brought back better profitability instead of better health care. Therefore, the functions of the HIT were aimed more at office-related features rather than at those features which could improve on clinical practice. The second barrier would be the lack of standards, which has led to an insufficient quality of communication between applications even within healthcare organisations and the high cost of the interfaces. Thirdly, there are the cultural barriers, which indicated that for professionals and policymakers, information technologies were not seen as important as they should have been for both research and practice. Table 2.3 provides a summary of the barriers to the health IT adoption.

Table 2.3 Barriers of HIT Adoption

Barriers	**Explanation**	**Study**
Situational Barriers	Time and financial issues	Kruse et al. (2016); Balta-Ozkan et al. (2013); Shekelle *et al.* (2006); Miller and Sim (2004); Hersh (2004); Poon *et al.,* (2004); Bates and Gawande (2003); Johnson (2001)
Cognitive and Physical Barriers	Physical disabilities and insufficient computer skills	Balta-Ozkan et al. (2013); Shekelle *et al.* (2006); Hersh (2004); Hersh (2004); Johnson (2001)
Liability Barriers	Confidentiality and privacy concerns	Kruse et al. (2016); Balta-Ozkan et al. (2013); Shekelle *et al.* (2006); Hersh (2004); Johnson (2001)
Knowledge and Attitudinal Barriers	Lack of knowledge or willingness	Kruse et al. (2016); Balta-Ozkan et al. (2013); Shekelle *et al.* (2006); Miller and Sim (2004); Poon *et al.* (2004); Johnson (2001);
System Interoperability	Information exchange between organisations	Balta-Ozkan et al. (2013); Hersh (2004)
Reliability	System reliability	Balta-Ozkan et al. (2013)
Compatibility	Fit to current life	Balta-Ozkan et al. (2013)
Lack of Standards	Not up-to-date standards	Bates and Gawande (2003);
Cultural Barriers	Culture differences	Bates and Gawande (2003)

2.7 Summary

This chapter has introduced the background to the use of mobile health systems and to its current state; it then gives insight into the contexts of the hospitals in China and explains that they differ from both public and private organisations because of their unique position. The Government initiatives on the adoption of new technologies were discussed; the Chinese Government has launched healthcare reform in order to bring its convenience to people, to address several long-term issues such as medical resource inequalities and medical costs being too high. This chapter has also discussed and summarised several benefits and barriers for this innovation to be adopted by the healthcare industry. Although the benefits are clear, as technologies could bring efficiency, safety and reliability to the table, the barriers to adoption such as situational barriers, cultural barriers and knowledge and attitudinal barriers do exist.

Chapter 3 Information Technology Adoption: A Review of Previous Research

3.1 Introduction

The purpose of this chapter is to review the influential research in the field of innovation, the adoption of information technology adoption and, more specifically, in the context of healthcare, and also to consider the most significant theories and models developed over time.

Beginning with the basics of innovation, technology, adoption and their developments as discussed by the most prominent scholars in the field, this chapter will then review the innovation types and innovation development, followed by the innovation and diffusion discussion, with the diffusion and adoption process and its adoption in the healthcare context. The chapter will then focus on the most significant theories, models and frameworks over time, followed by a closer look at the chosen framework of this thesis, the technology – organisation – environment (TOE) framework.

3.2 Innovation and Technology

Although Dewar and Dutton (1986, pp1422) stated that it might be inappropriate to search for a universal theory of the innovation process due to '*fundamental differences that exist across innovation types'* (Downs and Mohr, 1976), Baregheh *et al.* (2009) offered a multi-disciplinary definition of innovation, which defines innovation as '*the multi-stage process whereby organisations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace.'* (pp1334).

3.2.1 Types of Innovations

There are three types of innovation (or natures of innovation by Baregheh *et al.* (2009)), which creates incremental, synthetic or discontinuous changes (Tushman and Nadler, 1986).

Incremental innovations upgrade existing technologies with new features or new versions; normally these are merely *'minor improvements or simple adjustments in current technology'* (Dewar and Dutton 1986, pp1423). Due to the nature of these innovations, they come with the lowest risk and change for the potential adopters.

Synthetic innovations produce a change in technology, *'where existing ideas or technologies are combined in a novel manner.'* (Baker, 2012, pp232)

Innovations that produce a discontinuous change, which have also been known as radical innovations (Ettlie *et al.* 1984), bring with them significant differences from current technology and they present fundamental changes which produce revolutionary changes in technology (Dewar and Dutton, 1986).

Rogers (2003) shared a similar definition of innovation with Zaltman, *et al.* (1973); he also argued that a technology is a designed instrument which decreases the risk in the cause-effect relationships in order to achieve the targeted outcome. And most technologies have two components, the hardware and the software. Whereas the hardware contains the material or physical tools that represent the technology, it is the software that is needed as the knowledge base to handle the hardware.

3.2.2 Development of Innovation

Technologies are evolving dramatically, organisations have to adapt and adopt in order not to be left behind. Adoption research usually starts directly with the adoption of an innovation, though pre-adoption events and decisions also have impacts on the diffusion process (Rogers, 2003). In order for an innovation to be adopted, there are several stages it has to go through first. One of the most important stages is the innovation-development stage.

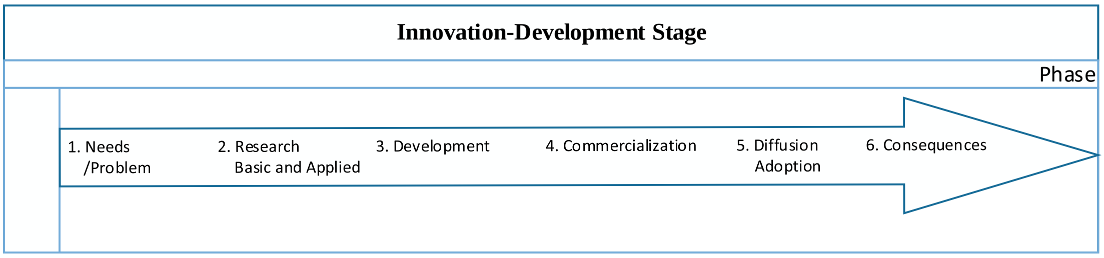

Figure 3.1 Innovation-Development Stage, Source: Rogers, (2003)

Rogers, (2003) developed the six phases of the innovation-development stage (Figure 3.1). It starts by recognising a problem or need that will stimulate research and development (R&D) activities to design an instrument of innovation to solve the problem or need, followed by the basic research and the applied research which leads to the development phase, which is the process of transforming the idea to the form that potential adopters are expecting. A developed product which represents the innovation is then commercialised, and the next step is the diffusion and adoption, which is the particular focus of attention for this thesis. The final stage would be the consequences. In this phase, the original problem or need is either solved by the innovation or not. Moreover, further problems or needs may appear during the entire process.

However, Rogers (2003) mentioned that these six steps do not always present, nor do these always occur, in the same order.

3.3 Adoption and Diffusion of Innovations

Adoption is defined as '*a decision to make full use of an innovation as the best course of action available'* (Rogers, 1983, p21) whereas diffusion is defined as the process where '*an innovation is communicated through certain channels over time among the members of a social system.'* (Rogers, 1983, p5). Rogers (1962) introduced IDT (Innovation Diffusion Theory) which is one of the first and most significant theories to date, especially in organisational adoption studies. Therefore, this this thesis adopts Rogers' definition of adoption.

Because of the newness of the idea contained in diffusion, there is a perceived risk in the diffusion process. However, the perceived risk could be decreased by sufficient information absorption by the potential adopter (Rogers, 2003).

3.3.1 Types of Adopters

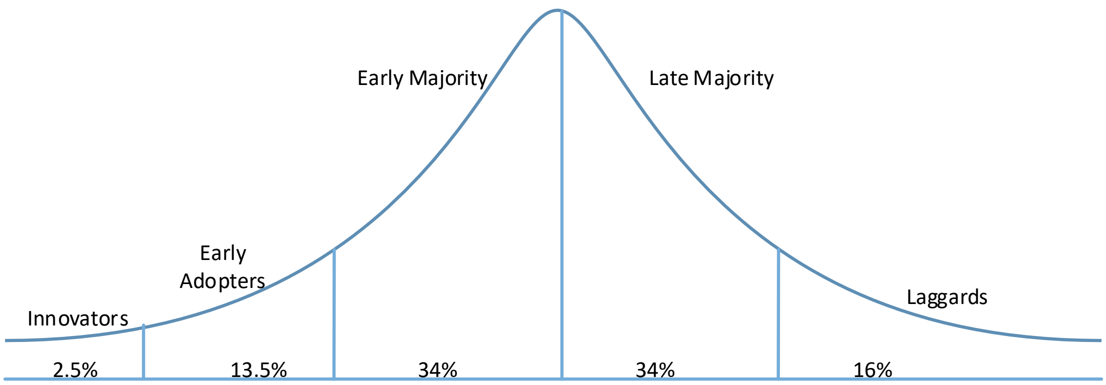

Figure 3.2 Adopter Categorisation on the Basis of Innovativeness, Source: Rogers, (1983)

Adopters are categorised by innovativeness. Innovativeness is defined as '*the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system.'* (Rogers, 1983, p242)

Illustrated in Figure 3.2, based on the innovativeness, the adopters are classed into five categories; these are innovators, early adopters, early majority, late majority and laggards. Figure 3.2 also shows the categories and the approximate percentage of different adopters' distribution (Rogers, 1983). The dominant trait of each categories' adopters is emphasised.

- The innovators are venturesome and are eager to try new ideas, they also tend to have their own social circle.
- Compared to innovators, early adopters are more integrated into the social system, which is defined as *a set of interrelated units that are engaged in joint problem solving to accomplish a common goal* (Rogers, 2003, p24); the people in this category are more likely to have strong leadership qualities, hence the trait of this category is being well respected.
- The early majority are seldom found in leadership positions, however, they hold a significant position in the adoption process, one of interconnection. They tend to think carefully, thus the trait is one of deliberateness.
- Adopters who are in the late majority group are sceptical. They adopt an innovation after the average take-up in a similar social system.
- Laggards are traditional types who tend not to opinions about or show strong leadership. Many members of this group are very isolated in the social system and they tend to interact with people sharing similar traditional values. They are reluctant to change, the innovations they adopted may already be outdated (Rogers, 1983).

3.3.2 Innovation Diffusion and Adoption Process

To diffuse new ideas, there are four main elements included in the process; these are the innovation itself, the particular channels it could be communicated through, the time required for it to be communicated, and the people of a social system amongst whom the innovation is diffused.

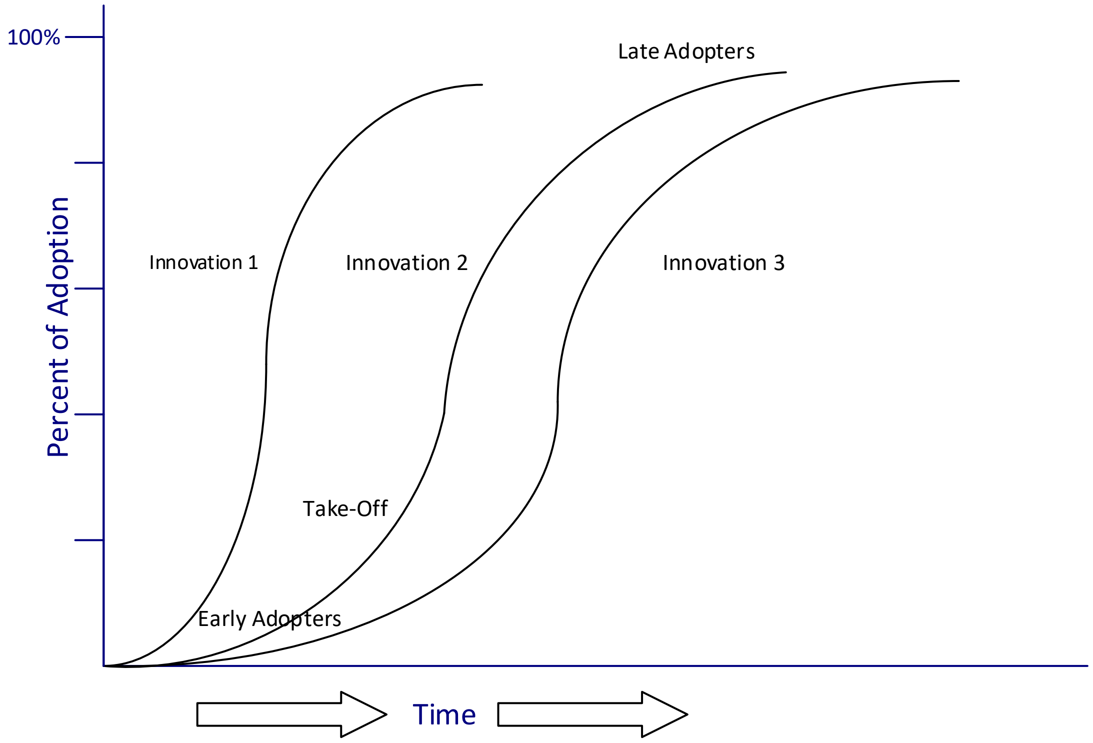

Figure 3.3 The Diffusion process, S-Curve, Source: Rogers, (2003)

The means by which messages are transferring from one to another is the communication channel. The relationship between the transferor and the transferee is the determinant of whether the innovation would be transmitted or not, and the quality of the transfer. Time is a critical factor in the diffusion process (Figure 3.3), as it is involved not only in the innovation decision process, the innovativeness (being an early or late adopter) of the adoption unit, and also in the rate of adoption of an innovation. The last element is a social system (Rogers, 2003).

The innovation decision process is a process whereby a decision-making unit passes from the initial knowledge of an innovation, therefore forming either a positive or negative attitude towards the particular innovation, and turns into the decision phase, to adopt or to reject, to implement the innovation and then proceeds to confirm the decision (Figure 3.4). The decision phase could either lead to adopting or rejecting the innovation.

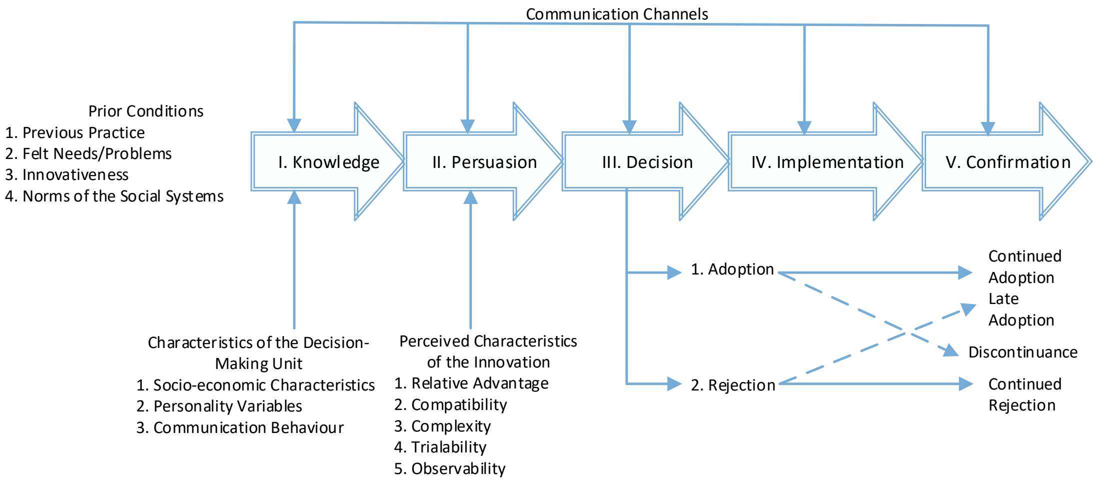

Figure 3.4 Innovation Decision Process, Individual, Source: Rogers, (2003)

The knowledge phase happens when the decision-making unit is aware of the existence of the innovation and obtains a certain understanding of how it works. Persuasion occurs when the decision-making unit gains a positive or negative attitude through knowledge concerning the innovation.

The decision phase is when the decision-making unit engages in activities which result in either the adoption or the rejection of the innovation. The adoption is to decide to use an innovation while rejection is the decision not to. This thesis is based on this very stage and is studying the adoption decision made by hospitals. The process of the adoption decision could logically lead to either decision, adoption or rejection.

Implementation occurs when the decision-making unit actually puts the innovation into practical use. Confirmation is the last step and is when the decision-making unit seeks to fortify the innovation decision the unit has already made. However, the unit may, also, have a change of mind and reverse the previous decision if the unit gains new knowledge about the innovation. (Rogers, 2003).

Frambach and Schillewaert (2002) argued that the innovation adoption process is a sequence of phases that the potential adopter follows before the acceptance of the particular innovation. Since the five stages introduced by Rogers all happen at the individual level of adoption, two key stages are distinguished when considering the process at the organisational level, and these are initiation and implementation (Figure 3.5). The adoption decision is made in between these two stages. In the initiation stage, the organisation is exposed to the existence of the innovation, then takes a view and hence evaluates the innovation. The decision to adopt and make use of the innovation by the organisation is the start of the implementation stage. The adaption and digestion of the innovation within the organisation becomes the priority (Frambach and Schillewaert 2002).

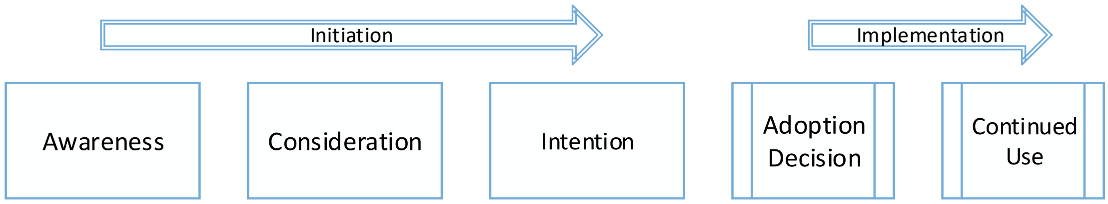

Figure 3.5 Two Stages, Organisational, Source: Frambach and Schillewaert (2002)

3.3.3 Innovation Adoption in Healthcare Systems

Mendonca *et al.* have said that *'Evidence suggests that inadequate access to information and ineffective communication are proximal causes of errors and* *other adverse events in patient care' (*Mendonça *et al.,* 2004, pp631). The consequences that errors bring could be very serious given the nature of healthcare. Ahlan and Ahmad (2014) argued that HIT has the potential to bring better quality and safety to services in the healthcare industry. It has been argued that instead of it being a complicated problem, innovation in healthcare is actually a complex issue because '*simply applying the formula that worked before may not lead to success*' (Plsek, 2003, pp1). Although the innovation adoption has lagged behind in the healthcare industry compared to other industries, it is changing rapidly as the decision-makers and leaders in the healthcare industry realise the significant position HIT could play in order to provide quality medical care and achieve the business targets (Lee and Shim, 2007). The adoption of MHS could eventually eliminate the location, time and other barriers (Silva *et al.*, 2015) that prevent people from receiving quality care (Varshney, 2005). Table 3.1 shows the previous research in this field.

Table 3.1 Significant Research in Healthcare

Technology	Reference
Health Information Technologies (HIT)	Sezgin and Özkan-Yıldırım, (2016)
Mobile Health	Dwivedi, *et al.* (2016)
Electronic Health Record (EHR)	Gan, (2015)
Home Healthcare Robots	Alaiad and Zhou, (2014)
Telehealth	Tsai, (2014)
Mobile Health Service	Deng *et al.,* (2014)
Mobile Health Service	Sun *et al.,* (2013)
HIT	Phichitchaisopa and Naenna, (2013)
Medline system	Hung *et al.,* (2012)
Mobile Healthcare	Wu *et al.,* (2011)
HIT	Kijsanayotin *et al.* (2009)
IS	Ifinedo, (2012)
IT	Kijsanayotin *et al.,* (2009)
Electronic Logistics IS in nurses	Tung, *et al.* (2008)
Future picture archiving and communications system (PACS)	Duyck *et al.* (2008)
Electronic logistics information systems	Tung *et al.* (2008)
Electronic Medical Records (EMR)	Wills *et al.* (2008)
Radio Frequency Identification (RFID) for improving process quality and safety	Chen *et al.* (2007)
ICT	Schaper and Pervan, (2007)
Electronic Medical Records (EMR)	Hennington and Janz, (2007)
Mobile health care systems	Wu *et al.* (2007)
Computerised provider order entry (CPOE)	Paré *et al.* (2006)
Personal digital assistants (PDAs)	Yi *et al.* (2006)
Web-based electronic medical records (EMR)	Liu and Ma (2006); Ma and Liu, (2005)

Among those studies, many have researched general IT/IS adoption (Sezgin *et al.,* 2016; Phichitchaisopa and Naenna, 2013; Kijsanayotin *et al.* 2009; Ifinedo, 2012; Kijsanayotin *et al.,* 2009). As mentioned in the previous chapters, a few studies were focusing on software and specific technologies, such as EHR/EMR (Gan, 2015; Hennington and Janz, 2007; Liu and Ma 2006, Ma and Liu, 2005), electronic logistics (Tung, *et al.* 2008), RFID (Chen *et al.* 2007). Wu *et al.* (2007) studied mobile healthcare systems at an individual level, the research was conducted amongst the users of MHS, such as nurses and medical technicians; Wu *et al.* (2011) conducted mobile healthcare adoption research among healthcare professionals at an individual level as well; the mobile health services adoption research done by Sun *et al.* (2013) concentrated on local residents; Deng *et al.* (2014) studied the mobile health services adoption among the middle-aged and elderly residents and Dwivedi, *et al.* (2016) conducted cross-country m-health adoption amongst patients. All those studies contributed to and extended the mobile health adoption research, but none of the studies was done at the organisational level.

This thesis not only studies the factors that affect the adoption of both hardware (mobile devices, servers etc.) and bespoke applications and software forming a mobile health system in Chinese mainland public hospitals by applying a framework developed and built for this thesis; this study will also shed light on the reasons behind each factor and the reasons behind the adoption.

3.4 Technology Adoption: Theories and Frameworks

Venkatesh *et al.* (2003) outlined a model that brings together the basic elements for an acceptance model, which is the underlying principle of all developed models (Figure 3.6).

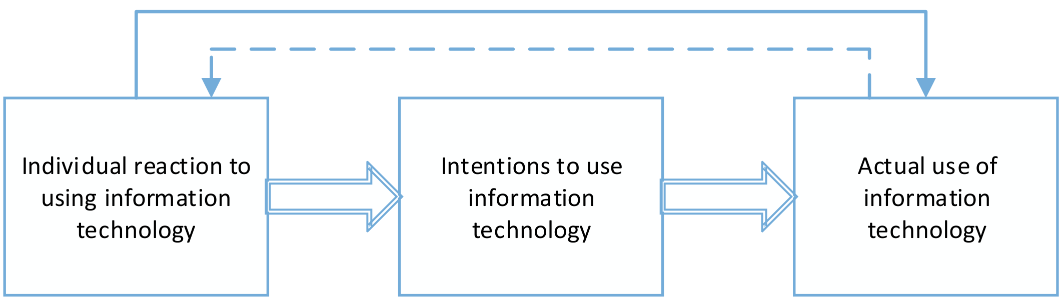

Figure 3.6 Basic Acceptance Model, Source: Venkatesh et al. (2003)

3.4.1 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) (Figure 3.7) was initially invented and developed by Fishbein and Ajzen (1975) to predict behavioural intention. The theory of TRA was drawn from social psychology, as it is '*one of the most fundamental and influential theories of human behaviour*' (Venkatesh *et al.*2003, pp428). After the theory went public, the application of TRA was used widely (Sheppard *et al.* 1988), and was then studied and developed by Davis *et al.* (1989) in individual technology acceptance and it was found that the result was consistent with other studies which had applied TRA in other contexts. However, Davis *et al.* (1989) also noted that because of the nature of TRA, which is a general model, '*it does not specify the beliefs that are operative for a particular behaviour.'* (pp984) Thus the beliefs that are significant for subjects regarding the behaviour must be identified first by any researchers using TRA.

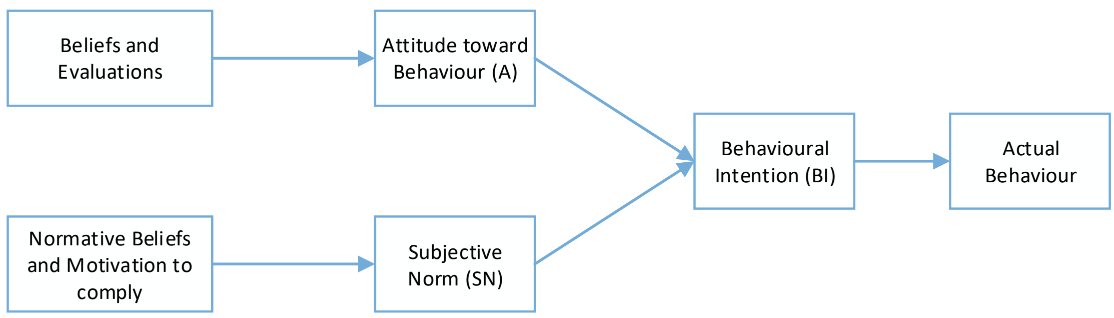

Figure 3.7 Theory of Reasoned Action, Source: Fishbein and Ajzen (1975)

Table 3.2 Constructs

Core Construct	**Definition**
Attitude towards behaviour	"*represents a person's general feeling of favourableness or unfavourableness towards some stimulus object*" (Fishbein and Ajzen, 1975, pp. 216)
Subjective norm	"*the person's perception that most people who are important to him think he should or should not perform the behaviour in question*" (Fishbein and Ajzen, 1975, pp. 302)

Miller (2004) added behavioural intention to the model, which is defined as a function derived from both attitudes toward behaviour and subjective norms toward that behaviour, and this has been recognised in order to predict actual behaviour.

Although TRA was developed as a compelling and coherent model in the attitude and intention field, and the model seems to work well within the constraints defined by Fishbein and Ajzen (Sheppard *et al.* 1988), the restrictions it set prevent the using of the model in many other situations. The model itself focuses on behaviour, control and intention; it would not suit any organisational adoption at hospitals since it studies individual behaviour, nor does it contain any of the three best predictors argued by Jeyaraj *et al.* (2006). Furthermore, appropriate modification on the original model should be developed further (Sheppard *et al.* 1988).

3.4.2 Innovation Diffusion Theory (IDT)

The process for an innovation to be communicated through certain channels among certain members over a certain time is defined as diffusion (Rogers, 2003). As one of the most significant adoption theories, IDT was introduced by Rogers in his book Diffusion of Innovations (1962, 1st Edition; 2003, 5th Edition). Since it was first argued by Rogers in the 1960s, IDT was used to research innovations ranging from agriculture to organisation innovation in the early days (Tornatzky and Klein, 1982).

Rogers (1983) has identified five perceived characteristics of the innovation which are believed to be the critical factors that affect the adoption decision. These are:

- Relative advantage: this is *'the degree to which an innovation is perceived as better than the idea it supersedes'* (pp15). Relative advantage is perceived to be positively related to the rate of adoption by the potential adopters. *Rate of adoption* is defined as the relative speed that members of a social system adopt an innovation.

- Compatibility, which is '*the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters'* (pp15). The compatibility of an innovation is perceived to be positively related to the rate of adoption by the potential adopters. The naming of the innovation and its link to previous ideas are important in order to make an innovation more compatible.
- Complexity, which is the '*degree to which an innovation is perceived as relatively difficult to understand and to use'* (pp15). The complexity of an innovation is perceived to be negatively related to the rate of adoption by the potential adopters.
- Trialability, which is the '*degree to which an innovation may be experimented with on a limited basis'* (pp15). The trialability of an innovation is perceived to be positively related to the rate of adoption by the potential adopters.
- Observability, which is the '*degree to which the results of an innovation are visible to others'* (pp16). The observability of an innovation is perceived to be positively related to the rate of adoption by the potential adopters.

In the field of information technologies and systems, the constructs of innovations argued by Rogers (1962) were extracted and modified by Moore and Benbasat (1991); seven core constructs that could be used to study individual technology acceptance were then refined by them. Venkatesh, *et al. (*2003) have summarised those characteristics. Apart from the original relative advantages, ease of use and compatibility, the added or modified constructs are: image, defined as *'the degree to which use of an innovation is perceived to enhance one's image or status in one's social system'* (Moore and Benbasat, 1991, p.195); visibility, defined as *'the degree to which one can see others using the system in the organisation* (Venkatesh *et al*., 2003, pp431); resulting demonstrability, defined as *'the tangibility of the result of using the innovation, including their observability and communicability'* (Moore and Benbasat, 1991, p. 203) and voluntariness of use, which is defined as *"the degree to which use of an innovation is perceived as being voluntary, or of free will"* (Moore and Benbasat, 1991, p.195).

The characteristics extracted and extended by Moore and Benbasat improve the understanding of the determinants and factors of IT innovation's adoption and diffusion. One of the original constructs, trialability (Rogers, 2003), was deleted but is found to be a significant determinant of ICT adoption (Ramdani, 2009; 2013).

The model was then being continuously tested, developed and being used and integrated with other models and theories by many other scholars in many different fields (Table 3.3).

Table 3.3 IDT and IDT Adaption Application

Adopted Technology	**Studies**
e-appointment service	Zhang et al. (2015)
e-learning systems	Lee, *et al.* (2011)
Vaccine adoption	Agyeman, *et al.* (2009)
Acceptance/adoption of the electronic logistics IS in nurses	Tung, *et al.* (2008)
Innovation Process	Wonglimpiyarat and Yuberk, (2005)
Enterprise resource planning (ERP) Adoption	Bradford and Florin, (2003)
CNCP (Computerized Nursing Care Plan)	Lee, (2004)
TIP (Treatment Improvement Protocols)	Hubbard, *et al.* (2003)
Informatics nurse specialist	Hilz, (1999)
Small firms' IS Evolution	Cragg and King, (1993)

Zhang et al. (2015) studied the e-appointment service adoption among patients using IDT, and argued that the theory '*is useful for conceptualization of technology adoption in the context of e-heath'* (pp4); they also argued that IDT is a prominent theory to study IT adoption and to comprehend how innovations diffuse.

Lee (2004) found out that the Rogers' model *'appropriately described nurses' perceptions toward new technology use in their daily practice.'* (pp237). Zhou *et al.* (2014) used the model to identify the different roles within certain groups in health information and services in order to help the slowest adopters, or 'laggards'. Lee (2000) suggested replacing complexity and observability in IDT with other factors such as image, ease of use, results demonstrability, and visibility, which is similar to the Moore and Benbasat (1991) modification. Cain and Mittman (2002) have applied IDT fully in the health care context and have further expanded the theory to ten critical dynamics, which are: relative advantage, trialability, observability, communications channels, homophilous group, pace of innovation or re-inventions, norms roles and social networks, opinion leaders, compatibility and infrastructure.

The theory of IDT is proven to be a good model to be used in the healthcare context, as the core constructs of the theory are validated (Lee, 2004; Zhang *et al.* 2015). Comparing it with TRA, IDT indeed is more sophisticated and robust as it has more constructs, and many of those constructs are used as core constructs in many later models. However, upon reviewing the literature related to technology adoption, the best organisational predictors are top management support, external pressure and organisation size (Jeyaraj *et al.,* 2006), none of which are included in IDT. IDT provides useful predictors at both individual and organisational level, but the model itself is not enough for an innovation adoption decision study in hospitals.

3.4.3 Technology Acceptance Model (TAM)

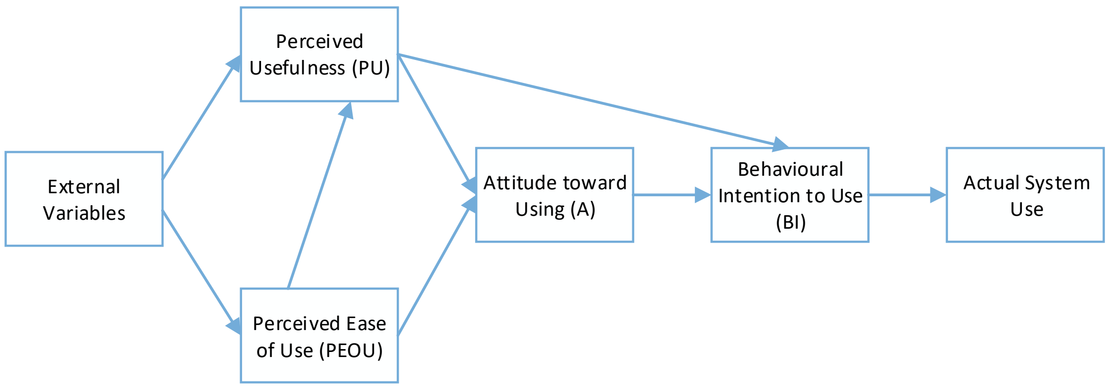

Figure 3.8 Original TAM, Source: Davis et al. (1989)

The Technology Acceptance Model (TAM) was introduced by Davis *et al.* (1989) and is a bespoke model to study adoption in an IT context (Figure 3.8). It is designed for information technology acceptance prediction and usage on the job. It is argued that TAM is one of the most studied and prominent adaption and extension (Irani *et al.*, 2009) of the theory of reasoned action (Fishbein and Ajzen, 1975). It differs from TRA because the final concept of TAM does not include an attitude construct so the intention could be explained better and more succinctly (Venkatesh, *et al.* 2003) in that it posits two particular beliefs or constructs, *perceived usefulness* and *perceived ease of use*. Perceived usefulness (PU) is defined as "*the degree to which a person believes that using a particular system would enhance his or her job performance*" (Davis, 1989, pp. 320) while the perceived ease of use (PEoU) is "*the degree to which a person believes that using a particular system would be free of effort*" (Davis, 1989, pp. 320).

In the final model, Davis *et al.* (1989) realised that there was a weak direct link between attitude and perceived usefulness and a strong link between behavioural intention and perceived usefulness. This could be explained because people intend to use a technology because of its usefulness, regardless of the negative attitude towards the technology. Therefore, attitude was eliminated by Davis *et al.* (1989) in the final conceptualisation.

Karahanna *et al. (*1999) linked TAM with IDT as they argued that among the seven innovation attributes, relative advantage is effectively the perceived usefulness, and complexity is perceived ease of use. They also mentioned that the meta-analysis of Tornatzky and Klein (1982) indicated that only relative advantage, compatibility and complexity in those seven attributes are related consistently to adoption decisions.

Segars and Grover (1993) re-examined the perceived usefulness and perceived ease of use, and they found potentially the third underlying construct, which is 'effectiveness' (Figure 3.9). They developed a model with eight indicators in three structures which was '*derived in an exploratory vein and then validated in a confirmatory analysis'* (pp524).

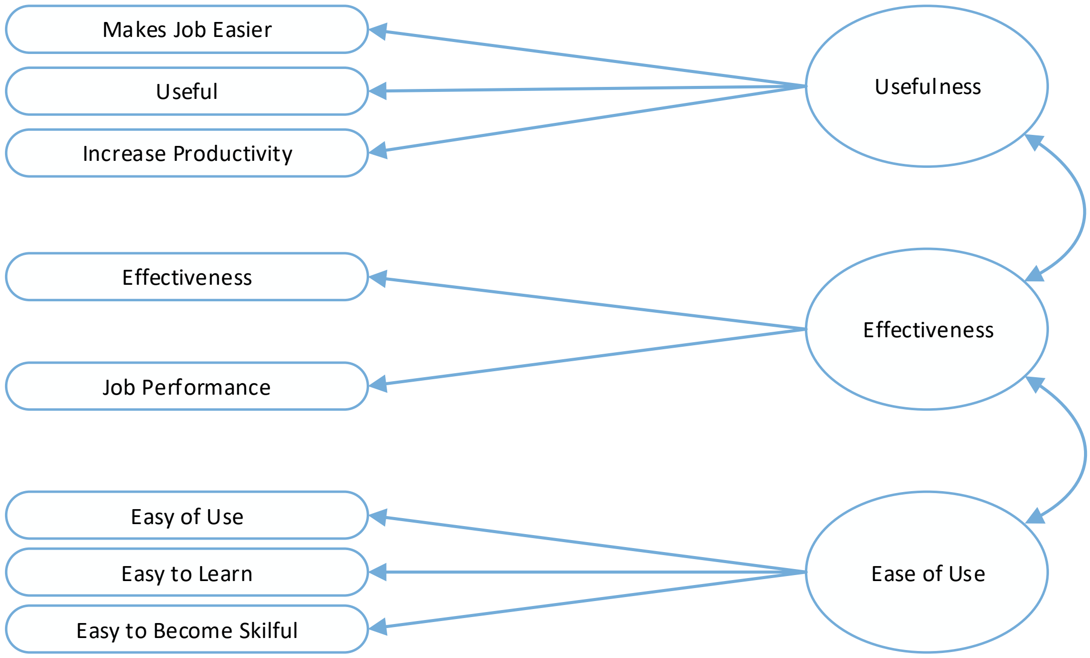

Figure 3.9 Model by Segars and Grover (1993)

In the IT adoption field, researchers have widely used TAM to study different technologies' adoption and *'TAM has arguably become the most influential theory in the IS field'* (Li, 2010, pp3). Table 3.4 shows the influential studies that have applied TAM.

The model has proven to be a helpful theoretical model in understanding and explaining behaviour in IT adoption. The model has also been tested in much empirical research and is proven to yield statistically reliable results (Legris *et al.*2003).

Even though previous research suggests that perceived usefulness is more important than perceived ease of use, IT developers are still focusing on perceived ease of use and overlooking usefulness, and the result could be hazardous. However, Keil (1995) argues that perceived usefulness and perceived ease of use are equally important factors determining the acceptance of IT.

Venkatesh (2000) researched the PEoU specifically because it is *'a key driver of technology acceptance, adoption, and usage behaviour'* (pp351) that could influence the adoption and usage behaviour of IT. PEoU would also affect perceived usefulness because other things being equal, the easier a technology is to use, the more usefulness it will gain (Venkatesh, 2000). He categorised the determinants for PEoU as *anchors* and *adjustments*, where anchors are general beliefs, and adjustments are shaped by direct experiences. Anchors consist of computer self-efficacy, perceptions of external control, computer anxiety and computer playfulness where adjustments have the components of perceived enjoyment and objective usability.

Table 3.4 Influential research applying TAM

Context	**Studies**
3D interior design application	Money *et al.* (2015)
Web 2.0 Applications	Dwivedi *et al.* (2011)
World Wide Web	Lederer *et al.* (2000)
Model testing in 3 countries	Straub *et al.* (1997)
Word processor	Adams *et al.* (1992)
Spreadsheet	Venkatesh and Davis. (1996)
Information technology adoption, Pre- and Post- Adoption	Karahanna *et al.* (1999)
Computerised support systems (CSS) for crisis people (e.g. AIDS/HIV+)	Lu and Gustafson. (1994)
Telemedicine Technology	Hu *et al.* (1999)

The application of TAM has been used quite often in studies on the adoption of technologies in the healthcare context as well (Table 3.5). Holden and Karsh (2010) mentioned that the application of TAM in Health IT started in the late 1990s. They also argued that TAM, as a well-regarded technology acceptance model, has been applied widely outside the healthcare context and '*has lately become an important theoretical tool for health IT research'* (pp169).

Table 3.5 Studies applying TAM in a healthcare context (Derived and Updated based on Holden and Karsh, 2010)

Adopted Technology	**Studies**
Healthcare Technology	Strudwick (2015)
Mobile Healthcare	Wu *et al.,* (2011)
Prototype of spoken dialog technology	Barker *et al.* (2003)
Telemedicine technology	Hu *et al.* (1999); Hu and Chau, (1999); Hu *et al.* (2002)
Radio Frequency Identification (RFID)	Chen *et al.* (2007)
Internet and Internet-based health applications	Chismar and Wiley-Patton. (2002)
Future picture archiving and communications system (PACS)	Duyck *et al.* (2008)
Mobile medical information system	Han *et al.* (2005)
Online disability evaluation system	Horan *et al.* (2004)
Personal digital assistants (PDAs) for healthcare purposes	Liang *et al.* (2003)
Web-based electronic medical records (EMR)	Liu and Ma (2006); Ma and Liu, (2005)
Computerised provider order entry (CPOE)	Paré *et al.* (2006)
Computerised nursing care plans	Rawstorne *et al.* (2000)
Electronic logistics information systems	Tung *et al.* (2008)
Prototype of a portable computerised postural assessment technology	Van Schaik *et al.* (2002)
Mobile healthcare systems (MHS) including mobile Picture Archiving and Communication Systems (PACS) and mobile order systems	Wu *et al.* (2007)
Personal digital assistants (PDAs)	Yi *et al.* (2006)

Despite all the applications of TAM, Hu *et al.* (1999) suggested that, in the health care context, especially where physicians are involved, on average, due to the above-average competence and intellectual capacity, or for someone who has had constant and reliable assistance in technology, TAM may not be an appropriate model. TAM, and in particular the construct of perceived ease of use, '*may weaken as the competency of the users increases'.* (Hu *et al.* 1999, pp106), although there are studies that have found that PEoU is a significant factor even in healthcare adoption studies (Hung *et al.* 2012; Tung *et al.,* 2008; Wu *et al.* 2007).

Meanwhile, TAM is undoubtedly one of the most influential models, and researchers have '*overwhelmingly made use of just one theory; 'TAM', and its associated constructs 'perceived usefulness' and 'perceived ease of use''*

(Williams *et al.*, 2009, pp9). This is indicating that information technology adoption and diffusion research are gradually becoming homogeneous, which would possibly weaken the technology adoption research field.

Kim and Park (2012) developed the health information technology acceptance model by combining TAM with a threat model, the intention of the model is to explain the behaviour of health consumers towards HIT. It consists of five core factors, which are: health status, health belief and concerns, subjective norm, HIT reliability and HIT self-efficacy. The first two factors lead to a perceived threat where consumers may seek HIT to help with their health, which then leads to a perceived usefulness of HIT, where then positive or negative attitudes will be gained which lead to final behaviour. This applies similarly to other factors.

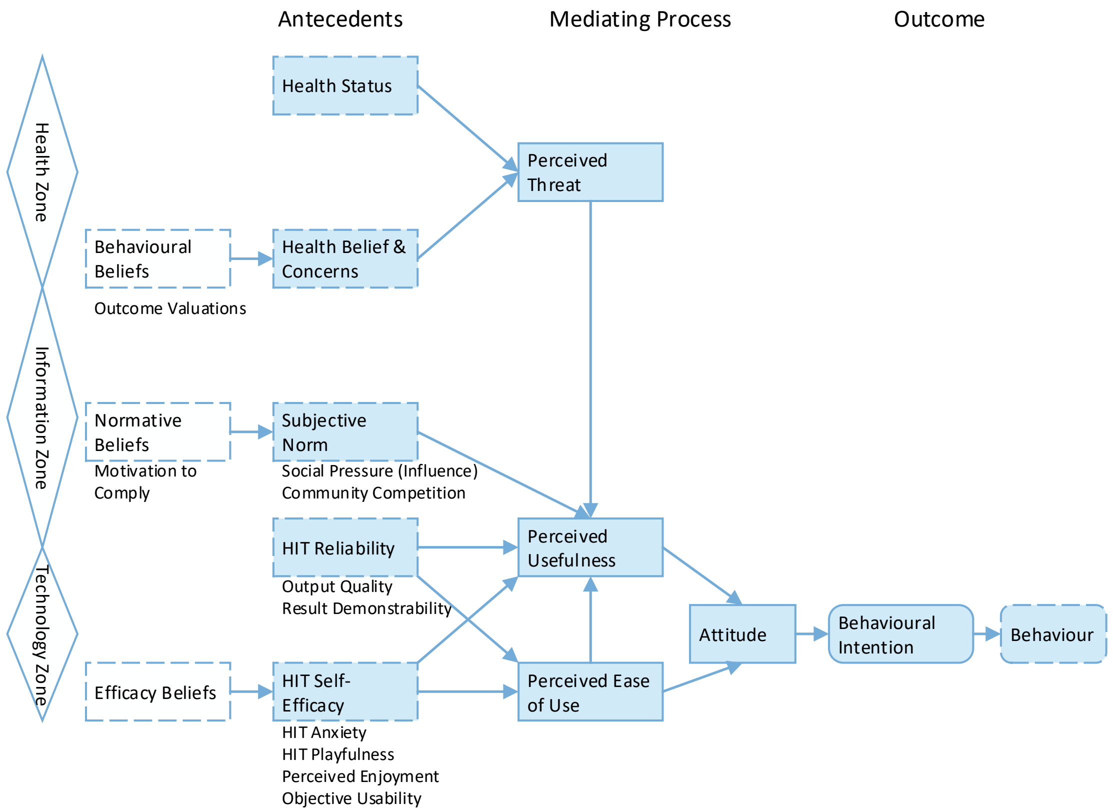

Figure 3.10 The Health Information Technology Acceptance Model (HITAM), Source: Kim and Park (2012)

Kim and Park (2012) argued that many aspects of behaviour regarding the use of HIT would be explained by the Health Technology Acceptance Model (HITAM), and this will be a useful model for the acceptance of internet and smartphone apps in the healthcare context. This model is an extension of TAM. The TAM-based model HITAM added perceived threat, which is patient-oriented, and is unfit for the purpose of this research in many different ways, such as the fact that the model has not been validated by many, as well as the fact that TAM itself is argued to be unhelpful in hospitals' adoption decisions; more importantly, the HITAM is not an organisational level model.

3.4.4 Theory of Planned Behaviour (TPB)

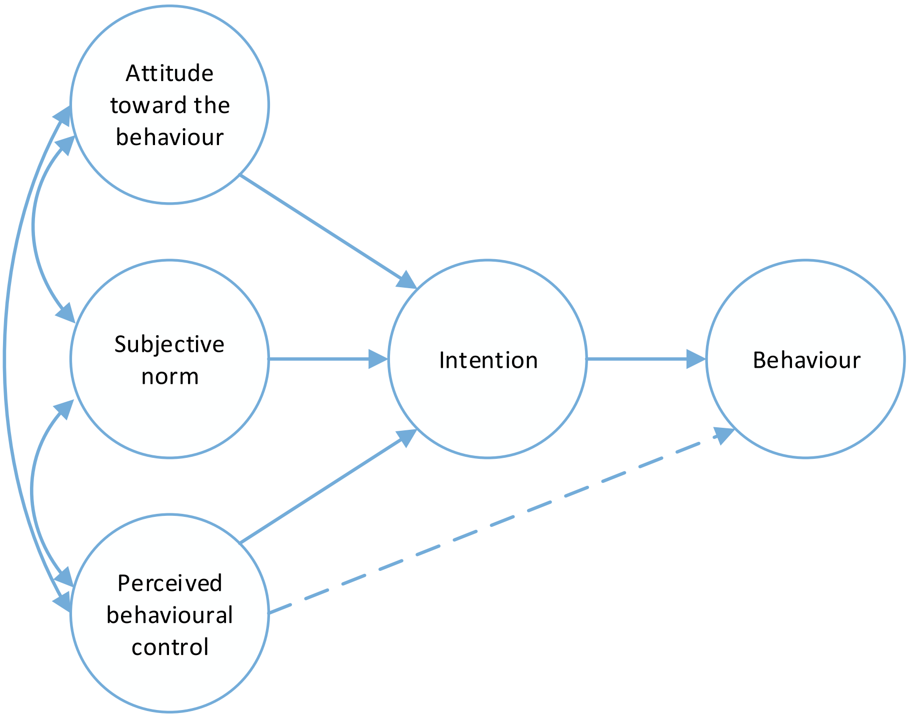

Figure 3.11 Theory of Planned Behaviour, Source: Ajzen, (1991)

Evolving from TRA, the theory of planned behaviour (TRB) was introduced by Ajzen (1991) (Figure 3.11). Comparing it to the original TRA model, Ajzen (1991) has added perceived behavioural control. Since the introduction of TPB, it has '*become one of the most frequently cited and influential models for the* *prediction of human social behaviour.*' (Ajzen, 2011, pp1113). TPB postulates three conceptually independent core factors and the definitions were adapted from the original TRA, which are:

- The attitude toward the behaviour, which '*refers to the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question.*' (Ajzen, 1991, pp188)
- The subjective norm, which '*refers to the perceived social pressure to perform or not to perform the behaviour.'* (Ajzen, 1991, pp188)
- The perceived behavioural control (PBC), which '*refers to the perceived ease or difficulty of performing the behaviour and it is assumed to reflect past experience as well as anticipated impediments and obstacles.'* (Ajzen, 1991, pp188). In the IS context, PBC '*reflects perceptions of internal and external constraints on behaviour'* (Taylor and Todd, 1995b, pp149).

The definition of intention originally referred to the attempt to perform a behaviour rather than to the actual performance of it. However, a strong correlation between the variables of trying to perform and the measures standing for the actual performance is found (Schifter and Ajzen, 1985; Ajzen and Madden, 1986); therefore, the definition of intention is now simply related to the behavioural performance (Ajzen, 1991).

The real difference of TPB from TRA is that, in the prediction of an individual's behaviour TRA wholly depends on genuine voluntary situations, whereas TPB is developed to also consider mandatory ones. The similarity of the two models is that both models posit that individuals are all rational decision-makers (Li, 2010).

TPB was used by many researchers in a wide area to predict behaviours and intentions. It has been applied to understand individual acceptance, usage and adoption of many technologies (Ajzen, 1991).

Taylor and Todd (1995b) argued that behaviour consists of weighted intention and perceived behavioural control, whereas intention has the components of the weighted attitude towards the behaviour, subjective norm and perceived behavioural control.

A related model, the decomposed theory of planned behaviours (DTPB) (Figure 3.12), was introduced by Taylor and Todd (1995b), which is a redesigned TPB for explaining the usage behaviour toward information technology purposes (Lee, *et al.* 2013).

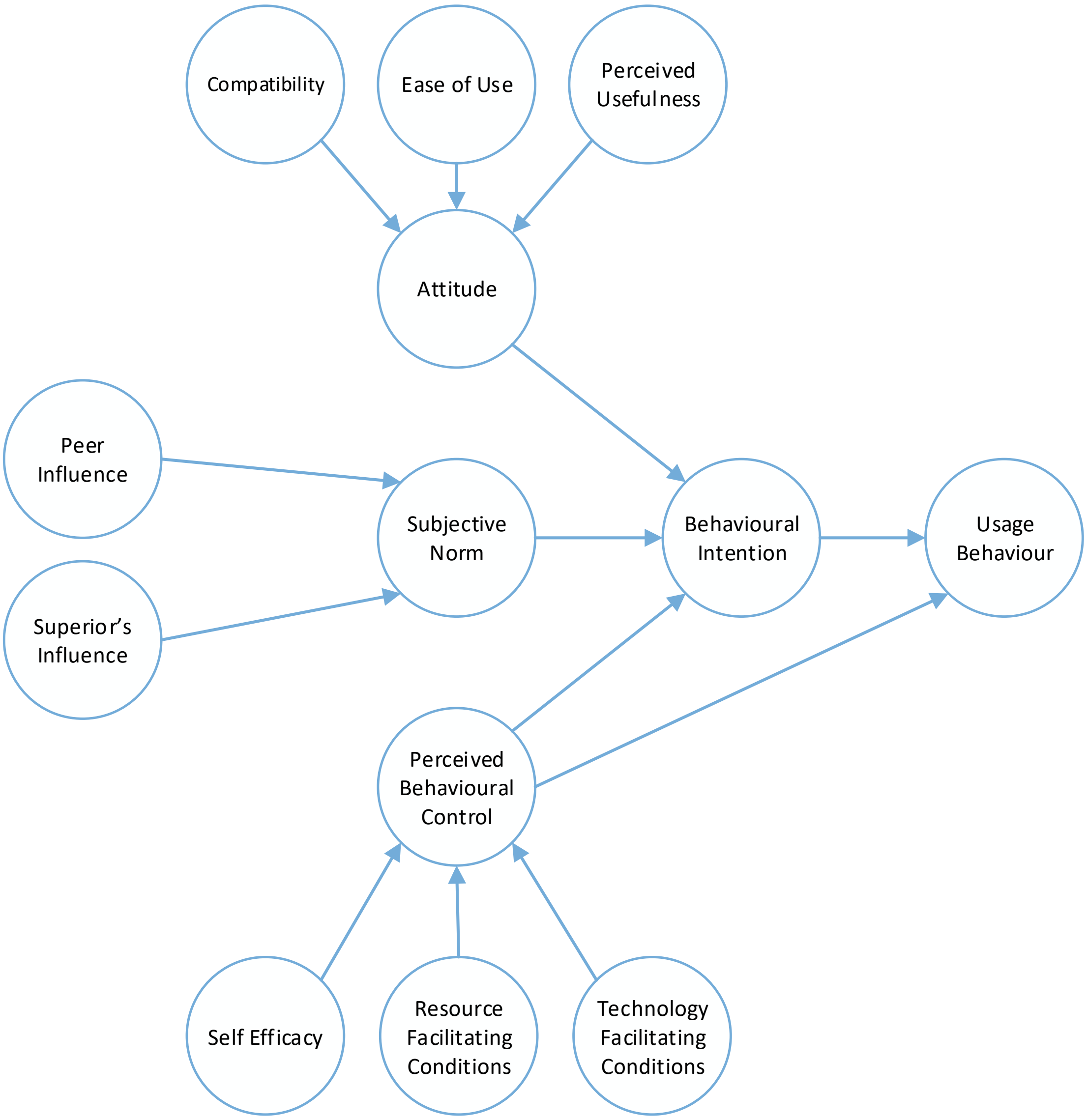

Figure 3.12 Decomposed Theory of Planned Behaviours (DTPB), Source: Taylor and Todd (1995b)

- The attitude toward behaviour has been decomposed to perceived usefulness (Davis, 1989), ease of use (Moore and Benbasat, 1991) and compatibility (Rogers, 2003).
- The subjective norm is divided into two variables, peer influence and superior's influence, where peer influence refers to the attitude and/or the opinions of friends or colleagues towards the adoption of a behaviour, and superior's influence refers to the viewpoints of one's superiors towards the adoption of a behaviour (Lee, *et al.* 2013).

- The perceived behavioural control has been deconstructed to self-efficacy, resource-facilitating conditions and technology-facilitating conditions (Taylor and Todd, 1995b), where self-efficacy refers to an individual's belief that if one is capable of carrying out behaviours necessary to produce specific performance attainments (Bandura, 1997); both resource and technology facilitating conditions reflect *'the availability of resources needed to engage in a behaviour, such as time, money or other specialised resources.'* (Taylor and Todd, 1995b, pp150), but the resource-facilitating conditions, such as time and money, are related to the resource factors, whereas the technology-facilitating conditions are *'technology compatibility issues that may constrain usage'* (Taylor and Todd, 1995b, pp153).

Hung *et al.* (2012) stated that DTPB is a powerful tool to study the IS adoption intention by physicians. They suggested that the IS should be designed in a more user-friendly manner to increase the perceived ease of use and usefulness in order to increase the adoption by physicians. They also found out that subjective norm affects the usage intention, and perceived behavioural control has a significant impact on the intention of use.

Taylor and Todd (1995a) combined TAM and TPB (Figure 3.13) and developed a new model by integrating the predictors from TPB with the perceived usefulness and perceived ease of use from TAM.

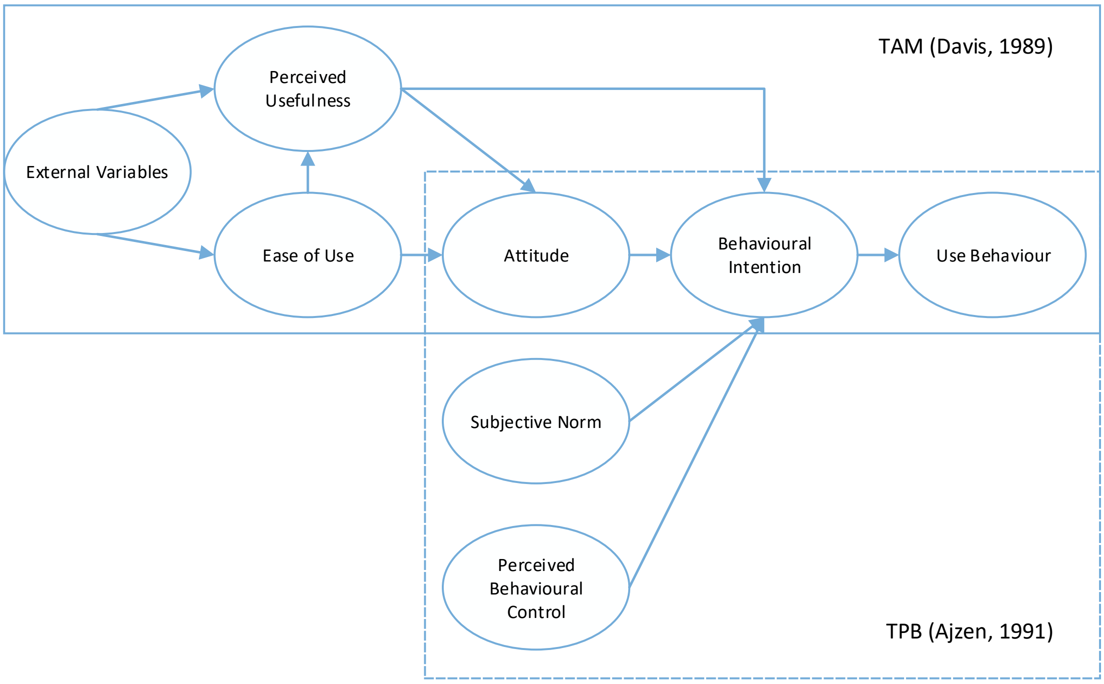

Figure 3.13 Combined-TAM-TPB, Source: Taylor and Todd (1995a)

Because Davis *et al.* (1989) did not include the influence of social factors (subjective norm) or the control factors (perceived behavioural control) on behaviour in TAM, where those factors have actually been found to have a significant impact on IT adoption behaviour (Legris *et al.*, 2003; Taylor and Todd 1995a, 1995b), and so the subjective norm is now one of the key determinants of behaviour intention in information technology (Wu and Wang, 2005).

Those two factors are central determinants in the TPB model (Ajzen, 1991), where social influences (subjective norm) are factors of behavioural intention, and control factors (perceived behavioural control) belong to the determinants of both intention and behaviour. Therefore, subjective norm and perceived behavioural control are added to TAM to provide a more complete test of the important determinants of IT usage. (Taylor and Todd 1995a, 1995b).

TPB, DTPB and Combined-TAM-TPB (C-TAM-TPB) have been applied by many researchers in many different fields, including the healthcare context. Table 3.6 provides the studies that have applied TPB and its adaption.

Table 3.6 Research applied TPB

Model	**Context**	**Studies**
DTPB	University library website	Lee *et al.,* (2013)
TPB	Students' perceptions toward mobile learning in higher education	Cheon, *et al.,* (2012)
TPB	Psychological aspects of outdoor recreation	Ajzen and Driver, (1992)
C-TAM-TPB	IT Usage	Taylor and Todd, (1995a), (1995b)
TPB	Information Technology in Small Business	Harrison and Mykytyn Jr, (1997)
TPB	Predicting Dishonest Actions	Beck and Ajzen, (1991)

The Theory of Predictive Behaviour, as an extension of TRA, has been dominant in health-related behaviour research in the past three decades (Sniehotta *et al.* 2014). The application of TPB in a health-related context is summarised by Godin and Kok (1996). Godin and Kok (1996) categorised the studies to date into addictive behaviour, automobile related behaviour, clinical and screening behaviour, eating behaviour, exercising behaviour, HIV/AIDS related behaviour and oral hygiene behaviour.

Despite the dominant position and influence of the models, the criticism never ceased. Sheeran *et al.* (2013) demonstrated that people's actions are not only guided by *'the conscious, reflective, rule-based system but also by the nonconscious, impulsive, associative system.'* (pp1) The model is criticised due to the nature of it, which focuses on rational reasoning.

The limited predictive validity of TPB has been targeted for criticism the most. '*Reviews show clearly that the majority of variability in observed behaviour is not accounted for by measures of the TPB'* (Sniehotta *et al.* 2014, pp2).

Sniehotta *et al.* (2014) also argued that the main problem of TPB is within the theory's propositions, as some of them are '*patently false'*. For example, the mediation assumptions in TPB is conflicting with the evidence, as '*beliefs are often found to predict behaviour over and above intentions*' (pp3). Moreover, it has been stated that TPB has already lost its usefulness and has become '*an empty gesture to tick the box that science should be theory-based'* (pp4) due to it having failed to develop useful interventions for practitioners and because it did not do well in the experimental test.

In the healthcare context, like TRA, TPB still focuses on individual behaviour and shares almost all the disadvantages when applying the model at the organisational levels, such as not including any of the organisational factors.

3.4.5 TAM 2

From its original model, TAM has evolved over time (Figure 3.14) (Legris *et al.,* 2003).

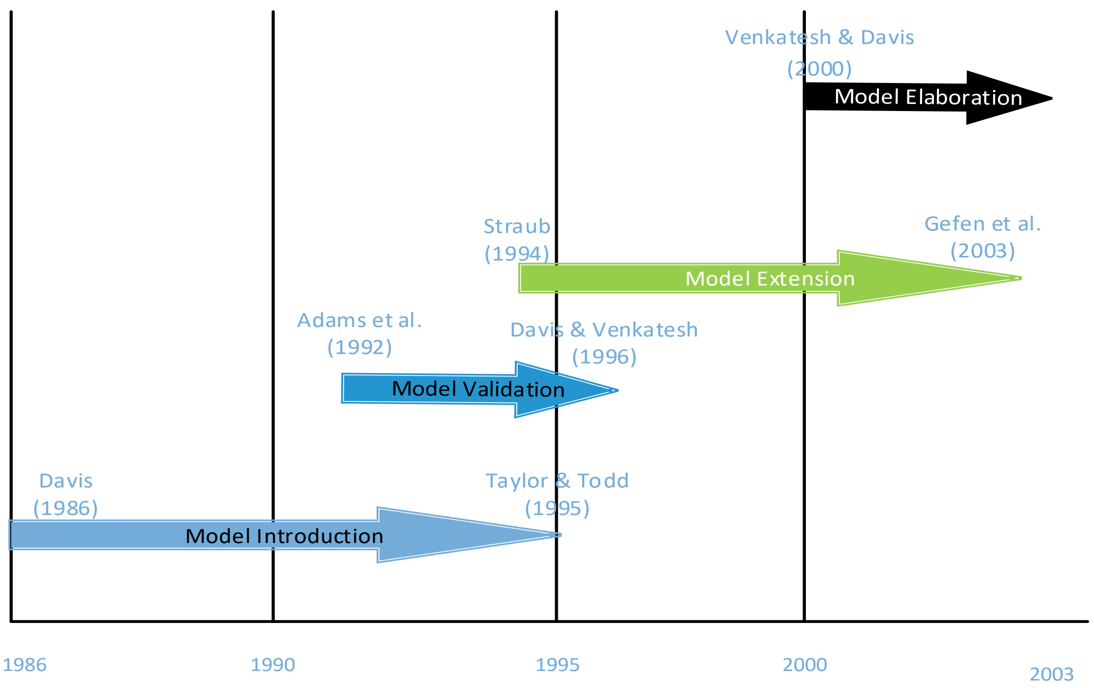

Figure 3.14 Development of TAM, Source: Lee et al. 2003

TAM is extended to TAM 2 by including the subjective norm, which is adapted from TRA as an extra predictor of intention, (Figure 3.15) (Venkatesh and Davis 2000).

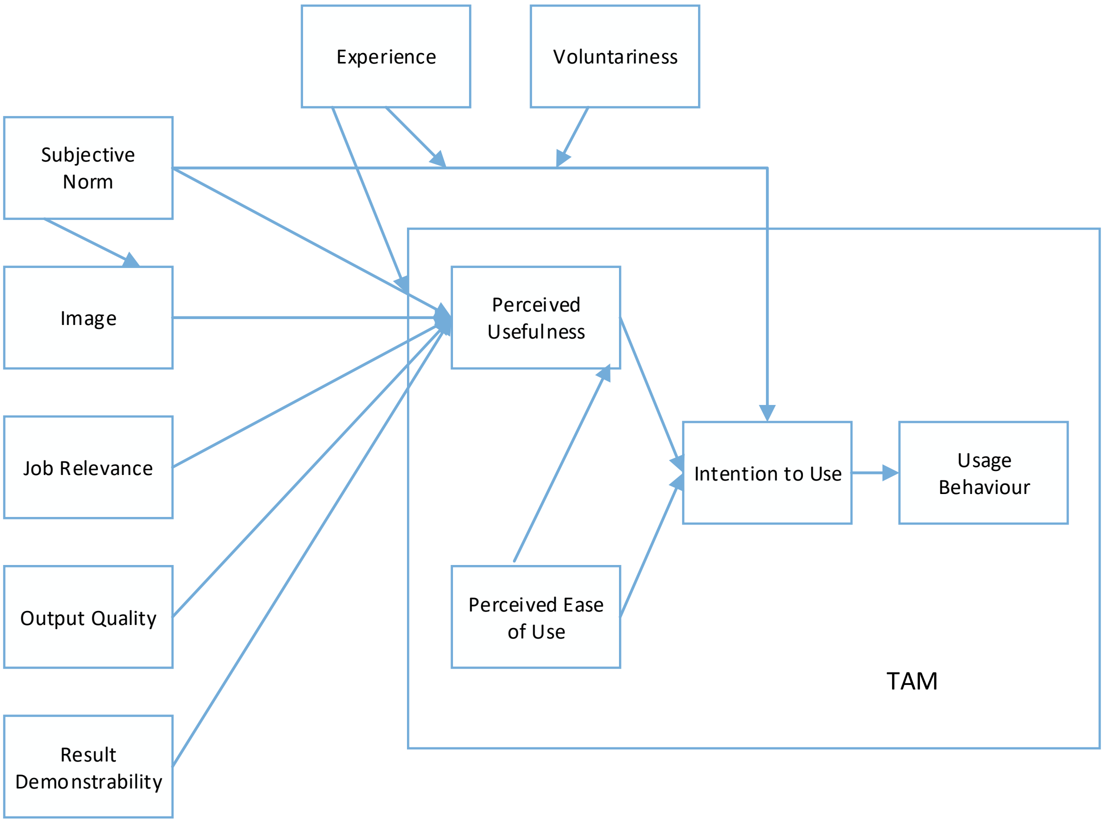

Figure 3.15 TAM 2, Source: Venkatesh and Davis (2000)

The idea of a subjective norm is re-introduced in TAM 2 by Venkatesh and Davis (2000) from the original TRA; they also defined the external variables for perceived usefulness, which has been divided into social influence and cognitive instruments.

Social influence contains three interrelated social forces affecting the adoption decision of an individual. These are subjective norm, voluntariness and image. Voluntariness is *'the degree to which use of the innovation is perceived as being voluntary, or of free will'* (Moore and Benbasat, 1991, pp195), and image is defined as the *'degree to which use of an innovation is perceived to enhance one's status in one's social system'* (Moore and Benbasat, 1991, pp195).

Venkatesh and Davis (2000) then theorised four cognitive instruments to determine perceived usefulness, which are job relevance, output quality, result demonstrability and perceived ease of use. Job relevance is defined as the extent to which an individual perceives that the target system is applicable to his or her job; output quality reflects how well the target system performs the tasks to match the job goals (Venkatesh and Davis, 2000); and result demonstrability is the '*tangibility of the results of using the innovation' (*Moore and Benbasat, 1991, pp203).

However, again, compared to TAM, in the health care context because physicians tend to be pragmatic in IT adoption decisions, this indicates that they care more about perceived usefulness. A physician is likely to accept (or use) a technology when it is considered useful to his or her practice. (Chau and Hu, 2002b). Chismar and Wiley-Patton (2003) mentioned in their findings that, although TAM 2 was able to explain over half of the behavioural intention variance, the results showed an '*insignificant effect for perceived ease of use combined with similar findings from previous TAM studies'*, which is an indicator that the constructs in TAM 2 are '*not applicable in the professional context, specifically, physicians*.' (pp6). Moreover, TAM 2 is designed for individual adoption since the social influence, which includes voluntariness, is affecting the adoption decision of an individual. TAM 2 is not suitable for the purpose of this study.

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

Venkatesh *et al.* (2003) developed the unified theory of acceptance and use of technology (UTAUT) (Figure 3.16) after a thorough review of several models. It is an attempt to produce a unifying model of IT acceptance (Ramdani, 2008).

During their research, they found seven constructs that are significant direct determinants of adoption or intention in individual models. Venkatesh *et al.* (2003) theorised four core constructs as significant direct determinants of acceptance and usage; these are performance expectancy, effort expectancy, social influence and facilitating conditions. However, the attitude toward using technology, self-efficacy and anxiety are stated not to be direct determinants of intention. Venkatesh *et al.* (2003).

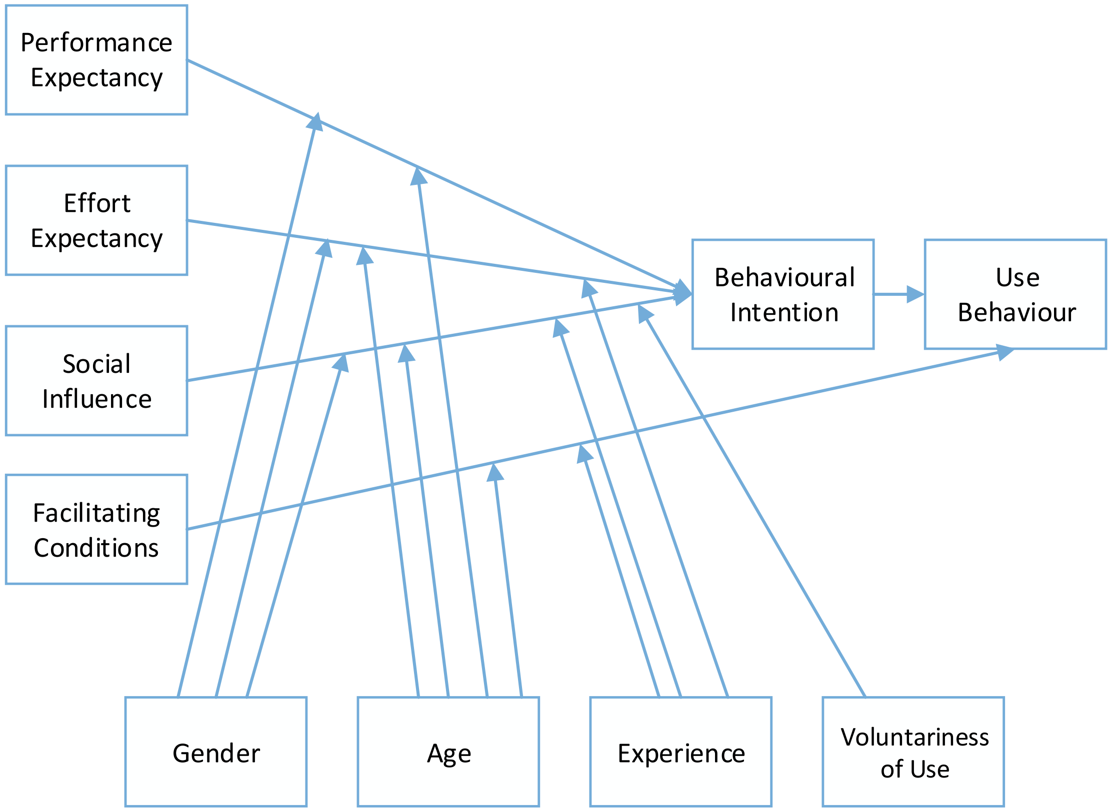

Figure 3.16 UTAUT, Source: Venkatesh et al. (2003)

Performance expectancy is defined as *'The degree to which an individual believes that using the system will help him or her to attain gains in job performance.'* (Venkatesh *et al.* 2003, pp447). It contains five sub-constructs which are: perceived usefulness, extrinsic motivation, job-fit, relative advantage and outcome expectations. Perceived usefulness and relative advantage are constructs from the earlier theories, TAM and IDT; extrinsic motivation is from the Motivational Model (MM) (Davis *et al.,* 1992) and is referred to as '*the performance of an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself*' (pp1112). Job-fit is originally from the Model of PC Utilisation (MPCU) developed by Thompson *et al.* (1991), and is defined as how a system is capable of enhancing an individual's job performance; whereas outcome expectations are related to the consequences of behaviour, this is divided into job-related performance expectations and individual goal-related personal expectations (Compeau and Higgins 1995; Compeau *et al.,*1999).

Effort expectancy is defined as *'the degree of ease associated with the use of the system.'* (Venkatesh *et al.* 2003, pp448), and it consists of three root constructs, which are perceived ease of use, complexity and ease of use, and these are originally from TAM and IDT.

Social influence is '*the degree to which an individual perceives that important others believe he or she should use the new system.'* (Venkatesh *et al.*, 2003, pp451). The root constructs under social influence are subjective norm, social factors and image. Subjective norm is borrowed from TRA; social factors is a term from MPCU and is defined as *"The individual's internalisation of the reference groups' subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations.'* (Triandis, 1980, pp210); while image is a construct from IDT adaption.

Facilitating conditions, defined as '*the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system.'* (Venkatesh *et al.*, 2003, pp451), consists of perceived behavioural control, facilitating conditions and compatibility. Perceived behavioural control is adapted from TPB; facilitating conditions is defined as the objective in the environment, where several observers agree to making an act easy to do (Triandis, 1980; Thompson *et al.* 1991) and is from MPCU; and compatibility originated from IDT.

UTAUT is the most comprehensive model compared with all the models discussed above because of the complexity in the way each core construct is formed; its application in healthcare field is also well known. Kijsanayotin *et al.* (2009) confirmed that UTAUT is a valid model to be used in the context of the health system in developing countries They found out that performance expectancy has the strongest effect in IT adoption. Kijsanayotin *et al.* (2009) also mentioned that the technologies used in community health centres were affected by past IT experience, an individual's intention to use it and the facilitating conditions. By using an extension of UTAUT, Ifinedo (2012) stated that the intention to use IT by healthcare professionals was higher when the implemented IT is perceived as relatively easy to use. Wills *et al.* (2008) suggested that a reduced UTAUT model was able to explain the adoption of EMR (electronic medical records) by healthcare professionals to a reasonable level. Table 3.7 shows the adoption studies that have used UTAUT in the healthcare context.

Table 3.7 UTAUT in the healthcare context

Technology	**Studies**
Electronic medical record (EMR)	Kim *et al.* (2015)
IS adoption	Ifinedo, (2012)
IT adoption in community health centres in Thailand	Kijsanayotin *et al.,* (2009)
EMR Acceptance	Wills *et al.,* (2008)
ICT adoption by Australian occupational therapists	Schaper and Pervan, (2007)
EMR Adoption	Hennington and Janz, (2007)

Although the UTAUT model is a useful tool for technology adoption, and it helps to identify the determinants for adoption, Williams *et al.* (2011) argued that the main downside of the current status of the UTAUT after their systematic review paper, is that the majority of papers used UTAUT as a basis to support an argument, or for criticising it, rather than using the model itself. Also some research only has partial use of the model, i.e. only utilising part of the constructs. Moreover, there is an increasing trend to use UTAUT with external theories or external variables. The model was indeed used by some researchers on innovation adoption in the healthcare context; however, the lack of the best predictors (Jeyaraj *et al.,* 2006) and the overlapping of some root factors make UTAUT not fully fit for the purpose of our research.

3.4.7 TAM 3

Venkatesh and Bala (2008) combined TAM 2 (Venkatesh and Davis, 2000) and the model of perceived ease of use which includes anchor and adjustment, developed by Venkatesh (2000), and the integrated model is named TAM 3 (Figure 3.17). See Table 3.8 for the definition of the determinants of PEOU.

Table 3.8 TAM 3, derived from Venkatesh and Bala (2008)

Determinants		**Definitions**
Anchor	Computer Self-Efficacy	The degree an individual believes he or she is capable of performing a particular task/job using a computer.
	Perception of External Control	"*The degree to which an individual believes that organisational and technical resources exist to support the use of the system (pp279).*"
	Computer Anxiety	The degree of one's apprehension or fear when one is facing the possibility of using a computer.
	Computer Playfulness	"*The degree of cognitive spontaneity in microcomputer interactions (pp279).*"
Adjustment	Perceived Enjoyment	The extent to which *"the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use* (pp279).*"*
	Objective Usability	*A "comparison of systems based on the actual level (rather than perceptions) of effort required to completing specific tasks* (pp279).*"*

TAM 3 (Venkatesh and Bala, 2008) also posits three new relationships, which are PEoU to PU, moderated by experience; computer anxiety to PEoU, moderated by experience; PEoU to behavioural intention, moderated by experience. Venkatesh and Bala (2008) explained that as perceived ease of use is often an initial hurdle for people to use a system, with increased experience within a system, the effect of perceived ease of use will be weaker on perceived usefulness and on behaviour intention; as computer anxiety will be weaker on perceived ease of use.

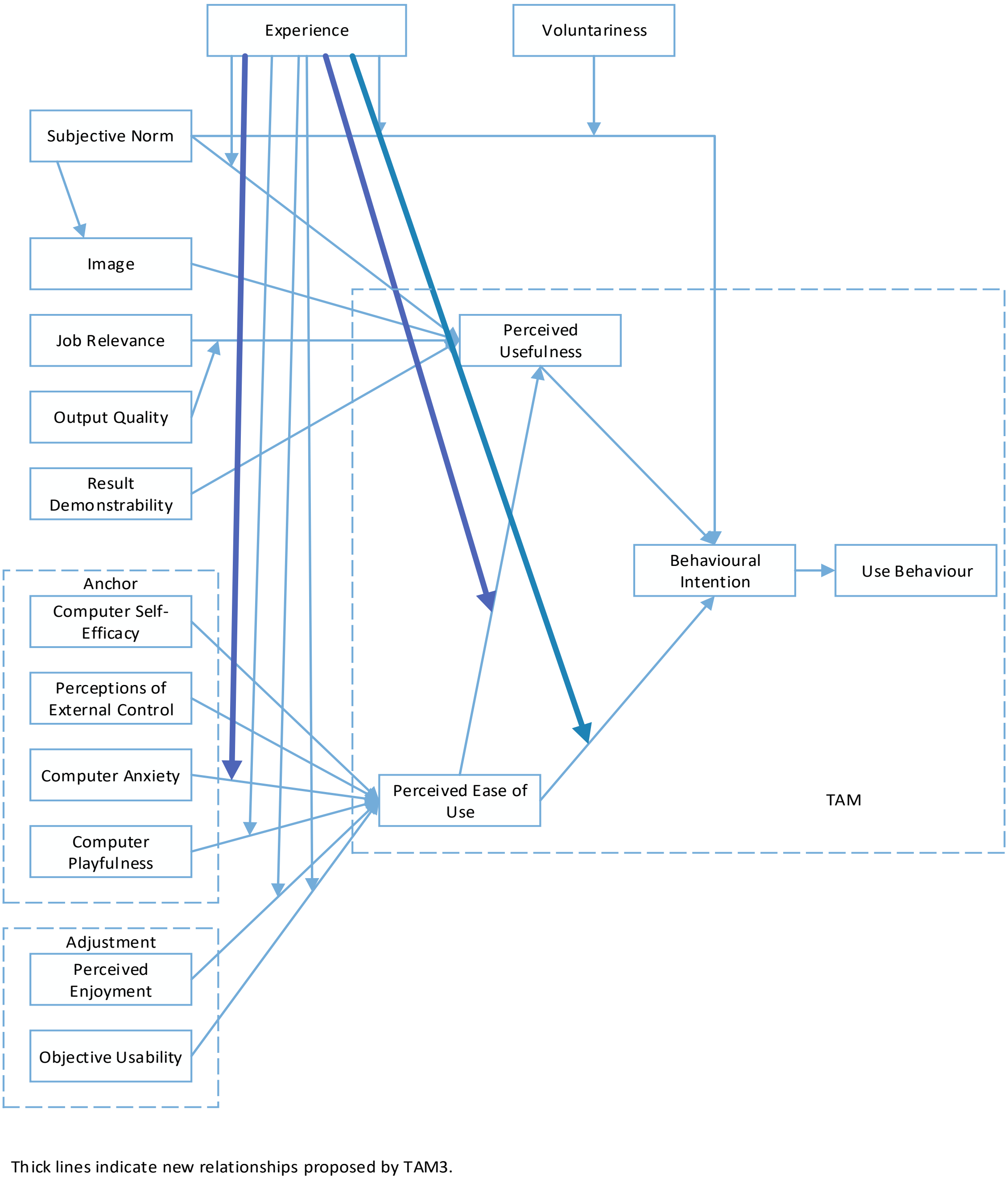

Figure 3.17 TAM 3, Source: Venkatesh and Bala (2008)

Portela *et al.* (2013) applied TAM 3 to study pervasive intelligent decision support system (PIDSS) adoption in intensive care units (ICU). The model and its constructs performed as a helpful tool in order to obtain the output quality of a system and to have a view on job relevance. By using TAM 3 it could be seen that a number of factors could affect the user’s decision on how and when to use a new technology (Portela *et al.,* 2013). Table 3.9 shows the recent studies that applied TAM 3.

Table 3.9 TAM 3 Application

Context	**Studies**
Mobile commerce adoption in Jordan	Faqih and Jaradat, (2015)
Educational context, e-learning system in higher education institutions	Agudo-Peregrina, *et al.*, (2014)
Impact of social network on online purchasing intention.	Pookulangara and Koesler, (2011)

Compared with TAM 2 and TAM1, the anchor and adjustment that TAM 3 added were based at an individual level and this is suspected to have little impact on organisational adoption decisions in Chinese public hospitals. Moreover, as TAM 3 is essentially an adaption of TAM and TAM 2, and the focus point of TAM 3, the perceived ease of use is arguably having little impact on adoption decisions in the healthcare context because of the relatively pragmatic technology preference among professionals due to the fact that they are highly educated and are provided with constant technology assistance (Hu *et al.* 1999), although there are studies that argue the opposite in adoption studies within the healthcare context (Hung *et al.* 2012; Tung *et al.,* 2008; Wu *et al.* 2007).

3.4.8 UTAUT 2

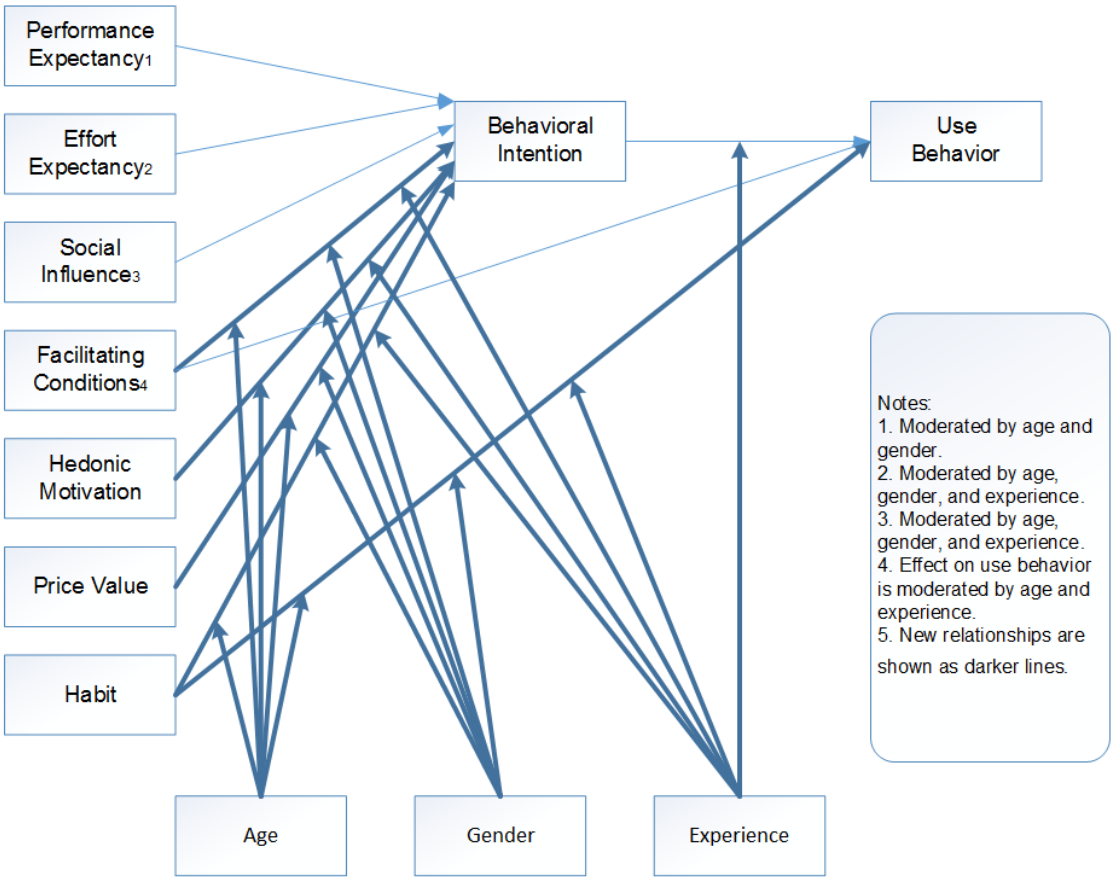

Figure 3.18 UTAUT 2, Source Venkatesh et al. (2012)

Table 3.10 UTAUT 2

Core Constructs	Definition
Hedonic Motivation	*'the fun or pleasure derived from using a technology, and it has been shown to play an important role in determining technology acceptance and use'* (Venkatesh *et al.* 2012, pp161).
Price Value	*'consumers' cognitive tradeoff between the perceived benefits of the applications and the monetary cost for using them'* (Venkatesh *et al.* 2012, pp161).
Habit	The extent to which one would perform certain behaviours automatically because of learning, or habit equal to automaticity (Venkatesh *et al.* 2012).

Venkatesh *et al.* (2012) have redeveloped the original UTAUT argued by Venkatesh *et al.* in 2003. In the newer version of the model (Figure 3.18), three key predictors - hedonic motivation, price value and habit - were added (Table

3.10). And one moderate construct, voluntariness of use, was eliminated. Since the introduction of hedonic motivation, this model is more useful in studying individual adoptions rather than in organisational adoptions.

Raman and Don (2013) have applied UTAUT 2 to predict the adoption of learning management software in teachers. They agreed that the hedonic motivation has a positive influence on adoption while the core construct of habit does not. Slade *et al.* (2013), and Oechslein and Fleischmann (2014) also applied UTAUT 2 in their research; they used it in mobile payments adoption and in social recommendation system respectively and both found the model appropriate.

Developing UTAUT further, the newly added factors of hedonic motivation and habit have little impact on the adoption of innovation in a healthcare context because of the similar reason as to why TAM is not suitable in such a context: the hospital professionals tend to prefer more pragmatic innovations because of their good educational background (Chau and Hu, 2002a, 2002b).

3.4.9 Technology-Organisation-Environment (TOE) Framework

The technology-organisation-environment (TOE) framework established by Tornatzky *et al.* (1990) has been tested and validated by many researchers (Wang, et al., 2016; Vest, 2010; Cao et al., 2014; Venkatesh and Bala, 2012; Ramdani et al., 2009) and is said to be a generic framework of technology adoption (Ramdani *et al.,* 2009) and '*an integrative framework that provides a holistic and guiding theoretical basis'* as the ICT (Information Communication Technology) adoption and diffusion research typically study the variables within technological, organisational and environmental contexts (Ramdani *et al.,* 2013, pp736).

The TOE framework works at the organisational level and it indicates that the firm's adoption decision is influenced by these three elements (Baker, 2012).

The technological context is one which includes all the relevant technologies to the firm, both those that are already in use in the firm and those that are available on the market, but are not in use. Both are important in the adoption process because the former would set a borderline on the scope and pace to indicate how much a firm could undertake in making technological change; while the latter shows a firm all the possibilities when taking on technological evolution and adaption (Baker, 2012).

The organisational context refers to the traits and resources of the firm and consists of '*linking structures between employees, intra-firm communication processes, firm size, and the amount of slack resources.'* (Baker, 2012, pp233). The organisational context would affect the innovation adoption in a number of different ways. Innovation is promoted by the link between the internal subunits mechanism (Galbraith 1973; Tushman and Nadler 1986; Baker, 2012). The top management could encourage innovation by being supportive of innovations that extend the core mission and vision of the firm (Tushman and Nadler 1986; Baker, 2012). Slack and size are all widely researched, '*the factor slack is neither necessary nor sufficient for innovation to occur*' (Tornatzky and Fleischer 1990, pp161) and although there is a higher adoption rate for larger firms, there is criticism that it is actually the more specific underlying factors, such as resource availability, that leads to innovation adoption (Baker, 2012).

The environmental context contains the industry structure and the environment of regulation (Baker, 2012). There are several ways that the industry structure could promote innovation; for example, competition would most likely encourage innovation adoption (Mansfield *et al.* 1977), or the dominant firm in a value chain could influence its partners to adopt an innovation (Kamath and Liker 1994). The support for technology infrastructure impacts innovation adoption as much as government regulation does (Baker, 2012).

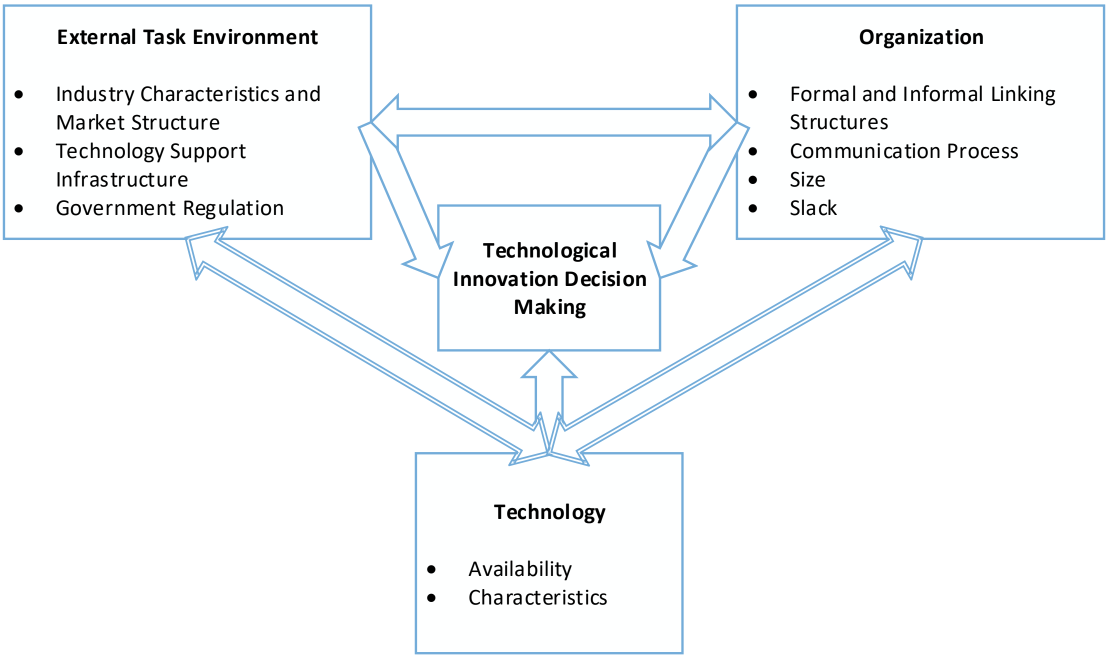

Figure 3.19 TOE, Source: Tornatzky and Fleischer (1990)

These three elements present both opportunities and constraints for technological innovation (Tornatzky and Fleischer 1990).

Different variables are being applied in each of the three contexts in the framework for research in different fields (Table 3.11).

Due to the nature of the TOE model, i.e. a generic model where the predictors could be input and categorised into three different contexts with proper validation, this was the model chosen to be used in this research.

Table 3.11 Studies applying TOE

Author, Year	Context	Technological Context	Organisational Context	Environmental Context
Ramdani *et al.,* (2009)	Enterprise Systems' adoption in SMEs	Relative Advantage; Compatibility; Complexity; Trialability: Observability	Top Management Support; Organisational Readiness; IS Experience; Size	Industry; Market Scope; Competitive Pressure; External ICT Support
Ramdani *et al.,* (2013)	Enterprise Applications' adoption in SMEs	Relative Advantage; Compatibility; Complexity; Trialability: Observability	Top Management Support; Organisational Readiness; ICT Experience; Size	Industry; Market Scope; Competitive Pressure; External ICT Support
Venkatesh and Bala, (2012)	Interorganisational business process standards adoption	Expected benefits; Process compatibility; Standards uncertainty; Technology readiness	Organisational innovativeness	Relational trust
Bernroider and Schmöllerl, (2013)	Decision making Methodologies and IT decision-making satisfaction	IT Support; Framework Support; Method Support	Management Support	Legislative Regulation
Cao *et al.,* (2014)	Adoption of Radio Frequency Identification patient tracking in hospital	Comparative advantages; Compatibility; Security and privacy protection; "Jittering" effects on information accuracy; Mobile component size; Mobile Component battery life	Organisational culture; Organisational Structure; Management support; Financial commitment	Compliance with legislation; Patient's privacy expectation; External pressure
Vest, (2010)	Health information exchange adoption and implementation	Technological readiness; Certified EHR; Point to point connection technologies	Control; Vertical integration; Horizontal integration; Information Needs	Competition; Uncompensated care burden
Wang, *et al.,* (2016)	Mobile reservation systems in hotel	Relative advantage; Complexity; Compatibility	Top management support; Firm size; Technological competence	Competitive pressure; Critical mass; Information intensity

Table 3.12 shows the summary of the models and theories discussed above.

Table 3.12 Summary of the Theories

Theory	**Construct**	**Source**
Theory of Reasoned Action (TRA)	Attitude towards behaviour; Subjective norm	Fishbein and Ajzen (1975)
Innovation Diffusion Theory (IDT)	Relative advantage; Compatibility; Complexity; Trialability; Observability	Rogers (1962)
Technology Acceptance Model (TAM)	Perceived Usefulness; Perceived Ease Of Use	Davis *et al.* (1989)
Theory of Planned Behaviour (TPB)	Attitude towards behaviour; Subjective norm; Perceived behavioural control	Ajzen (1991)
TAM 2	TAM 1 with sub-constructs	Venkatesh and Davis (2000)
Unified Theory of Acceptance and Use of Technology (UTAUT)	Performance expectancy; Effort expectancy; Social influence; Facilitating conditions	Venkatesh *et al.* (2003)
TAM 3	TAM 2 with Anchor and Adjustment	Venkatesh and Bala (2008)
UTAUT 2	Performance expectancy; Effort expectancy; Social influence; Facilitating conditions; Hedonic Motivation; Price Value; Habit	Venkatesh *et al.* (2012)
TOE	Technological Constructs; Organisational Constructs; Environmental Constructs	Tornatzky *et al.* (1990)

Apart from all the criticism about each specific model, Rogers (2003) compiled four major criticisms of diffusion research.

1. The pro-innovation bias, where most diffusion research implied that *'the innovation should be diffused to and adopted by all the members of a social system'* (pp129), and it should be diffused fast; also it should not be either rejected or re-invented.

2. The individual blame bias: the research tends to hold individuals accountable for their problems, instead of the whole system which consists of individuals.
3. The recall problem: the results of the research could be potentially jeopardised if respondents are asked to recall a specific time when the innovations are adopted.
4. The issue of equality: *'as socioeconomic gaps among the members of a social system are often widened as a result of the spread of new ideas.'* (pp129).

Despite most of the models reviewed being prominent and validated by many, few could work at the organisational level as many of the models are aimed specifically at an individual adoption decision. Some of the models set strict restraints (TRA, TPB) and others are criticised for not being suitable for innovation adoption in hospitals (TAMs). The appropriate ones (IDT, UTAUT) are lacking some of the best predictors as argued by Jeyaraj *et al.* (2006). Therefore, the model that would fit the purpose of this research will be developed by extracting the proven to be the most influential and validated factors in the research literature and put them into all three contexts – the technological, organisational and environmental based on the TOE framework.

3.5 Summary

Innovation adoption and diffusion research has been proven to be useful and necessary. In a relatively traditional industry – healthcare – the models, theories and frameworks are especially meaningful in order to study the factors and determinants affecting the adoption decision. Despite all the criticisms regarding the models and research, the models developed are proven to be significant and robust in different contexts, predicting and explaining the adoption in order to help the adoption rate. Previous researchers studied different technologies' adoption in healthcare system using different models and most of the models worked as expected as tools. This chapter reviewed the significant literature and theories in past adoption studies. First it reviewed the innovation types and then moved onto the innovation development stages. The innovation diffusion and adoption process has been discussed as the thesis is based on one of these stages – the decision. Innovation adoption in a healthcare context is then discussed and the prominent studies summarised. The chapter then discussed the theories and models that have been developed in the past for innovation adoption, such as TRA (Fishbein and Ajzen, 1975), IDT (Rogers, 1962, 2003), TAM (Davis *et al.*, 1989), TPB (Ajzen, 1991), UTAUT (Venkatesh *et al.*, 2003) and their adaptions or combinations. Upon reviewing all the theories and models, the models were either focusing at the individual level of adoption (TRA, TPB, TAM 3) or are seen as not suitable to be used in healthcare adoption studies (TAM 2, TAM 3, UTAUT 2) because of the factors included. Most importantly, none of the models includes the best three organisational predictors argued by Jeyaraj *et al.* (2006), which are: top management support, external pressure and organisation size. Therefore, the need to develop a model that fits the purpose of this thesis has emerged.

Chapter 4 Developing a Framework to Study Mobile Health System Adoption in Hospitals

4.1 Introduction

Due to the current criticisms researchers have for the existing dominant models, and also because many of the validated models are for the study of individual adoption which would not be suitable for the purpose of this study, and what is more none of the traditional models has the three best constructs for an organisational adoption, as argued by Jeyaraj *et al.* (2006), a bespoke model for this study needs to be developed. Ramdani and Kawalek (2007) specifically argued that due to the highly differentiated technologies, there is not a single adoption model that fits all purposes.

This chapter first introduces the process of the initial framework development. The choice of the TOE framework is discussed, and from the reviews of the literature, the most validated and significant constructs in adoption study in a healthcare context were chosen and categorised into three TOE categories: technological, organisational and environmental. The draft framework is, therefore, completed. In order to validate the validity of the instruments, as well as to test the initial framework which the researcher has built, before putting that framework into a major survey, a pilot study was conducted. The purpose of the pilot study, apart from validating certain validity, is to add the factors that the researcher might have omitted during the literature review, to eliminate the constructs that have little or no influence as suggested by the experts, and to amend certain constructs based on the views of informants; the detailed pilot study will be discussed in chapters five and six. After the pilot study, the face validity and content validity are proven, the factors, which were initially omitted, are added and certain constructs are adjusted or eliminated following the advice from experts. The framework was then developed and finalised. The chapter then proposes the final hypotheses.

4.2 Dominant Paradigm and Revised Dominant Paradigm

The dominant paradigm for any information technology innovation was argued by Fichman (2004), where Fichman argued that '*organisations with a greater quantity of the "Right Stuff" will exhibit a greater quantity of IT innovation'* (pp316). The quantity of the "right stuff" is defined as '*the extent to which organisations possess certain characteristics - or operate in certain contexts - that increase the need for innovation and/or the ability to innovate successfully*' (pp316). The quantity of innovation is defined as '*the extent to which an organisation adopts innovations often, adopts them early, and/or adopts them thoroughly'* (Fichman, 2004, pp316).

The dominant paradigm indicated that the more significant constructs an organisation possesses, the more likely it is going to adopt a certain innovation. The significant factors are the independent variables, which include size and structure, knowledge and resources, management support, compatibility and competitive environment; the dependent variable is the innovation adoption (Figure 4.1).

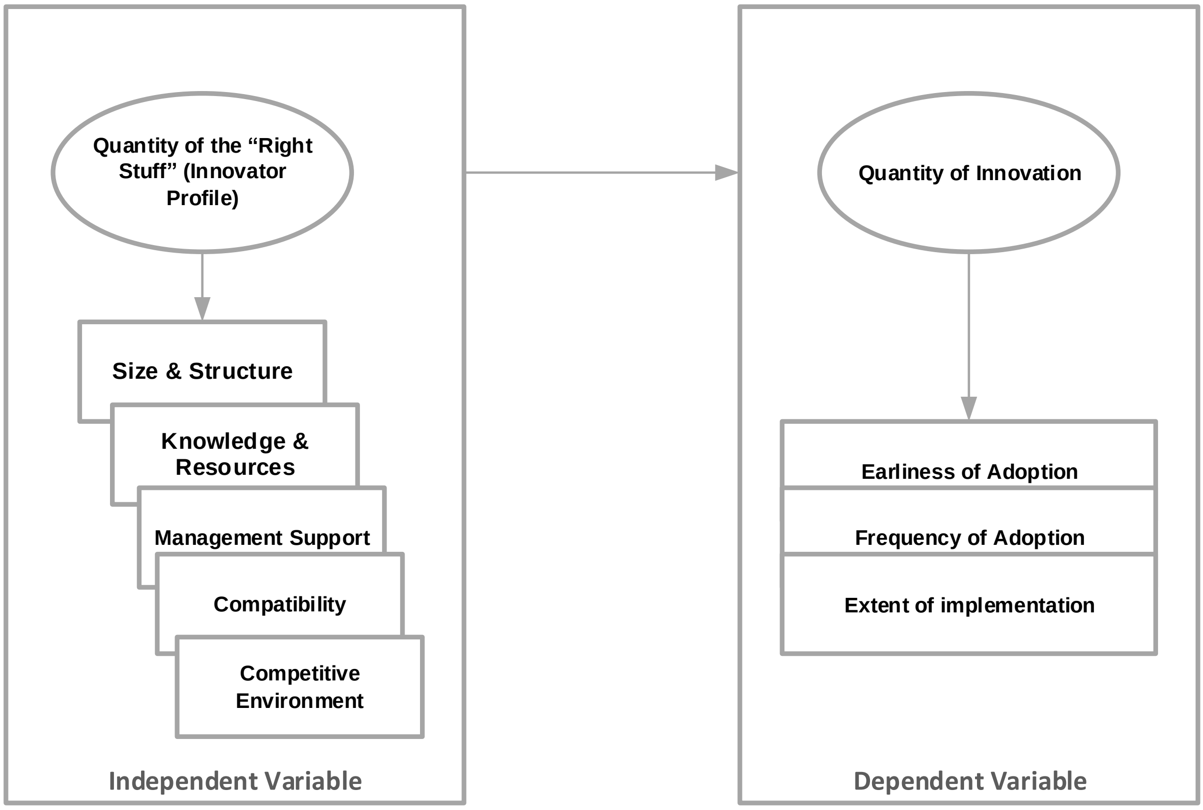

Figure 4.1 Dominant Paradigm, Source: Fichman, (2004)

However, Jeyaraj *et al.* (2006) have argued that there are theoretical biases known in this approach. The biases include pro-innovation bias, rational bias, methodological biases and pro-adopter bias. Pro-innovation bias and methodological bias (recall problem) have been discussed in the previous chapter, while rational bias assumes that adopters always make rational decisions and pro-adopter bias assumes non-adopters are understudied (Roger, 1995; Fichman, 2004; Jeyaraj *et al.,* 2006).

Moreover, the dominant paradigm emerging from Fichman (2004) does not distinguish between an individual adoption and an organisational adoption of IT.

Jeyaraj *et al. (*2006) have then offered the revised version of the dominant paradigm of the adoption IT innovation, which is shown in figure 4.2.

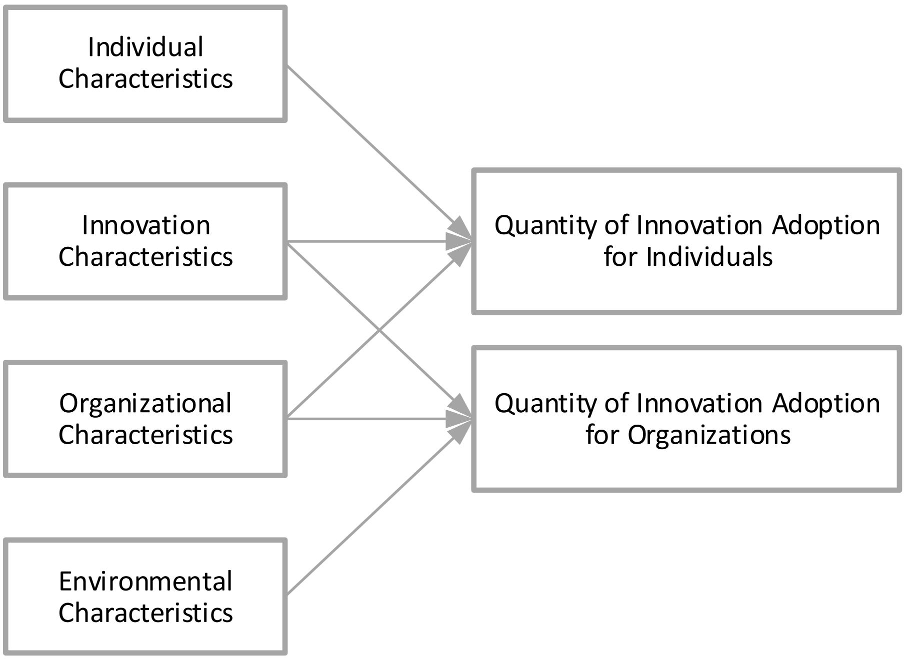

Figure 4.2 Revised Dominant Paradigm, Source: Jeyaraj et al., (2006)

The revised version has distinguished between the individual adoption and organisational adoption. The individual, innovation (technological) and organisational characteristics combined are significant in deciding individual adoptions of IT while the innovation (technological), organisational and environmental characteristics are influential for organisational IT adoption.

4.2.1 Applying the Revised Dominant Paradigm

Jayaraj *et al. (*2006) have indicated that individual characteristics are not included in the organisational adoption of IT. Therefore, applying the revised dominant paradigm in the current research, Figure 4.3 shows the proposed paradigm.

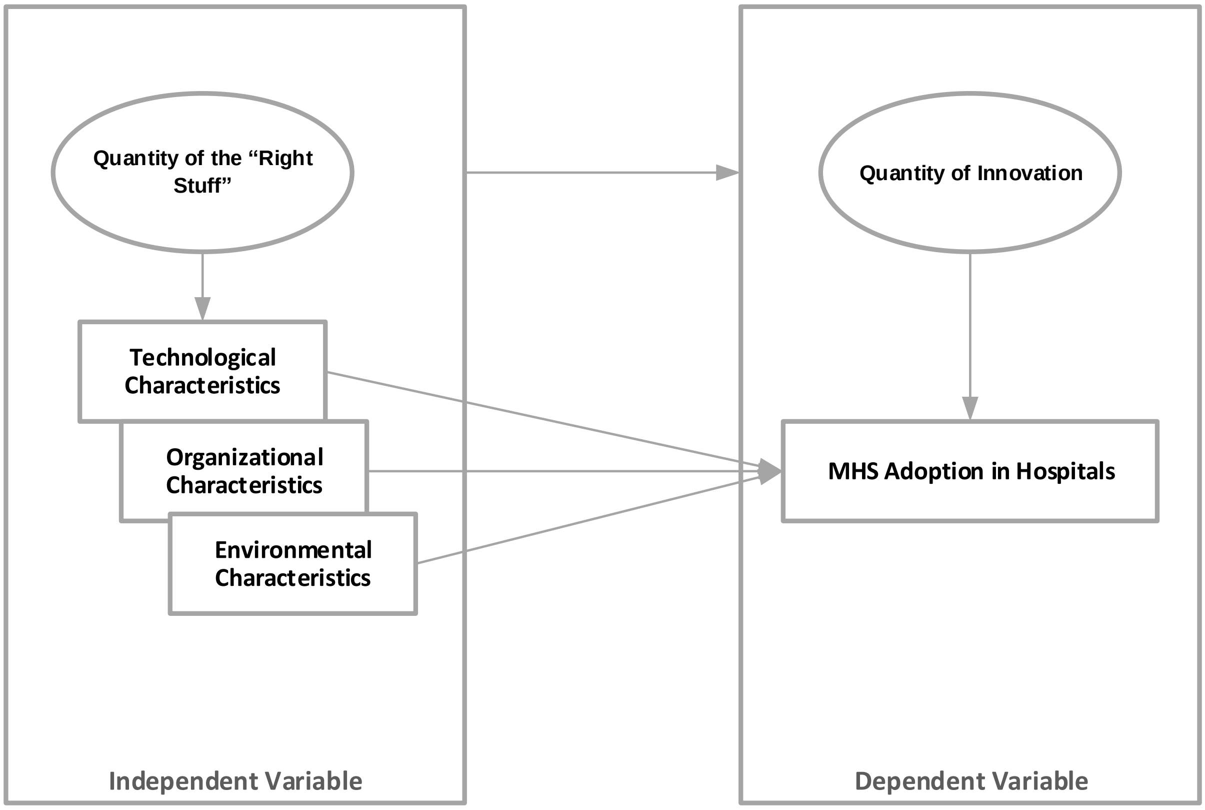

Figure 4.3 Dominant Paradigm, MHS Adoption

4.2.2 Technology – Organisation – Environment (TOE) Framework

To date, there are several models and theories that are used to examine the innovation adoption in a healthcare context, such as TAM (Sezgin and Özkan-Yıldırım, 2016; Buenestado, *et al.* 2013; Hu *et al.*, 1999), TAM/DOI (Tung *et al.,* 2008), UTAUT (Alaiad and Zhou, 2014; Phichitchaisopa and Naenna. 2013; Ifinedo, 2012; Kijsanayotin *et al.* 2009; Schaper and Pervan, 2007), UTAUT 2 (Dwivedi, *et al.* 2016), Task technology fit (TTF) & Social Contagion Theory (Gan, 2015), and TOE (Vest, 2010, Cao *et al.,* 2014).

Although there are many studies done using different theoretical models in adoption in a healthcare context, most of the research focuses on the software within e-health adoptions, such as EHR, CDSS (Clinical Decision Support System), PACS (Picture Archiving and Communications System) and EMR

(Buenestado *et al.* 2013; Hassol *et al.* 2004; Schaper and Pervan, 2007; Duyck *et al.* 2008). The research regarding the adoption of mobile health is limited to an individual adoption (Wu *et al.,* 2011; Deng *et al.,* 2014; Sun *et al.,* 2013; Dwivedi *et al.,* 2016) at either the health professionals' end or the patients' end instead of the adoption of a mobile health system in hospitals at the organisational level.

To examine the mobile health adoption at the organisational level, i.e. the adoption of mobile health in hospitals, a model at organisational level will need to be used.

Baker (2012) argued that TOE works exactly at the organisational level and it indicates that firms' adoption decisions are influenced by three elements; these are the technological element, the organisational element and the environmental element. Jeyaraj *et al.,* (2006) recapped the innovation adoption research and revised the dominant paradigm of IT innovation, which contains four groups – individual characteristics, innovation characteristics, organisational characteristics and environmental characteristics. Where the first three characteristics are for innovation adoption and diffusion for individuals, the last three are indicators for organisations. Jeyaraj *et al.,* (2006) also argued that for organisational IT adoption, the best predictors are top management support, organisation size and external pressure, where the first two factors can be categorised into organisational and the last one belongs to the environmental characteristics in the TOE model.

The TOE framework, which was established by Tornatzky *et al.* (1990) has been tested and validated during years of application. Ramdani *et al.,* (2009) argued that TOE is an IT adoption generic framework, which makes the model versatile and can be used in various adoption studies. Ramdani *et al.* (2013) mentioned that because the variables that adoption research studies generally fall into the category of either the technological, organisational or environmental class, the model, therefore, is an integrative model that offers a complete and guiding theoretical base.

4.3 Preliminary Framework

In order to examine the adoption of MHS in Chinese public hospitals, the model at organisational level will need to be developed. Jeyaraj *et al.,* (2006) argued that for organisational IT adoption, the best predictors are top management support, external pressure and organisation size.

Top management support, external pressure and organisation size are three core constructs in the TOE framework used by Ramdani (2009, 2013), Alam (2009), Thiesse *et al.* (2011), Oliveira *et al.* (2014), Gutierrez *et al.* (2015), Wang *et al.* (2016), Zhu and Kraemer (2005), Zhu, *et al.* (2006a), Zhu, *et al.* (2006b), Chau and Tam (1997), Kuan and Chau (2001) and Lin and Lin (2008). In the revised dominant paradigm which Jeyaraj *et al.* (2006) provided, the innovation characteristics group can be seen effectively as the technological factors in the TOE models, since the independent variables from the innovation characteristics are interchangeable with the factors in the technological context. This study applies the TOE framework and it will be built on all three groups, with constructs extracted from previous prominent research as well as from the result of the pilot study.

Table 4.1 shows the previous studies of IT adoption in the healthcare context.

Table 4.1 Healthcare IT Adoption Studies

Study	**Adoption Theory**	**Technology Adoption (dependent variable)**	**Constructs/Factors (independent variables)**	**Method**	**Data**	**Country/ Region**
Sezgin and Özkan-Yıldırım, (2016)	Integrated Model (TAM, TPB, UTAUT)	Health Information Technologies (HIT)	Behavioral Intention; Perceived Ease-of-Use; Perceived Usefulness; Perceived Behavioral Control; System Factors	Descriptive analysis; Factor analysis; Partial Least Squares (PLS)	2169 participants	Turkey
Dwivedi, *et al.* (2016)	UTAUT 2	Mobile Health	Performance Expectancy; Effort Expectancy; Social Influence; Facilitating Conditions; Hedonic Motivation; Price Value; Habit; Waiting Time; Self-Concept	Confirmatory Factor Analysis; Path Analysis	Three surveys: 387; 359; 375 patients	USA, Canada, and Bangladesh
Gan, (2015)	Task-Technology Fit (TTF) & Social Contagion Theory	Electronic Health Record (EHR)	TTF (Authorisation; Compatibility; Data quality; Ease-of-Use; IS Relationship; Timeliness; Locatability; System Reliability); Social Contagion	PLS; Structural Equation Modeling (SEM)	Survey: 51 students with working experience in healthcare sector	United States
Alaiad and Zhou, (2014)	UTAUT	Home Healthcare Robots	Performance Expectancy; Effort Expectancy; Social Influence; Facilitating Conditions; Trust; Privacy Concerns; Ethical Concerns; Legal Concerns	Power analysis; PLS	14 members of university staff and academics; 65 participants; 108 final responses	United States
Tsai, (2014)	Social Capital Theory; Social Cognitive Theory; TAM	Telehealth	Perceived Ease-of-Use; Perceived Usefulness; System Self-Efficacy; Social Participation; Institutional Trust; Social Trust	SEM	365 patients	Taiwan
Deng *et al.,* (2014)	Integration Of VAB And TPB With Aging Characteristic Constructs	Mobile Health Service	Perceived value; Attitude; Perceived behavior control; Subjective norm; Perceived physical condition; Resistance to change; Technology anxiety; Self-actualisation need	Structural Equation Modeling	424 Residents Older Than 40 Years	Wuhan, China
Sun *et al.,* (2013)	Integrated TPB, UTAUT and PMT	Mobile Health Service	Performance Expectancy (Response Efficacy); Effort Expectancy (Perceived Ease of Use); Social Influence (Subjective Norm); Facilitating Conditions (Response Cost, Self-Efficacy); Threat Appraisals (Perceived Vulnerability, Perceived Severity)	Field Survey ; Partial Least Squares (Pls)	212 Elderly Consumers	Harbin, China
Phichitchaisopa and Naenna, (2013)	UTAUT	HIT	Performance Expectancy; Effort Expectancy; Social Influence; Facilitating Conditions; Provincial Areas	SEM	400 Physicians And Healthcare Staff Members	Thailand
Hung *et al.,* (2012)	Decomposed Theory of Planned Behavior	Medline system	Perceived Usefulness; Perceived Ease-of-Use; Attitude; Interpersonal Influence; Subjective Norm; Personal Innovativeness in IT; Self-Efficacy; Facilitating Conditions; Perceived Behavioral Control; Usage	SEM using PLS	224 Physicians	Taiwan

			Intention)			
Wu *et al.,* (2011)	Integration of TAM and TPB	Mobile Healthcare	Attitude; Perceived Behavioral Control; Subjective Norm; Perceived Usefulness; Perceived Ease Of Use; Personal Innovativeness; Perceived Service Availability	Structural Equation Modelling (PLS)	140 Physicians And Nurses in 80 Hospitals	Taiwan
Kijsanayotin *et al.* (2009)	UTAUT	HIT	Performance Expectancy; Effort Expectancy; Social Influence; Voluntariness; Facilitating Conditions; Experience; IT knowledge	PLS; Path Modeling	1323 Community Health Centers	Thailand
Tung *et al.,* (2008)	TAM/IDT	Electronic Logistics Information System (ELIS)	Compatibility; Perceived Usefulness; Perceived Ease-of-Use; Trust; Perceived Financial Cost; Behavioral Intention	SEM	252 Nurses in 10 Medical centres and hospitals that have used ELIS	Taiwan
Wu *et al.*, (2007)	TAM and IDT	Mobile Healthcare Systems	Compatibility MHS self-efficacy Technical support and training Perceived usefulness Perceived ease of use Behavioral Intention to use	SEM	123 physicians, nurses, and medical technicians	Taiwan
Hu *et al.*, (1999)	TAM	Telemedicine	Perceived usefulness; Perceived ease-of-use	Structural Equation Modeling	408 Physicians	Hong Kong

The significant factors found in an IT adoption study in healthcare, as well as the best predictors argued by Jeyaraj et al. (2006), will be integrated into the model, which are shown in Table 4.2.

Although complexity and ease of use are found to be the least effective independent variables by Jeyaraj *et al.* (2006), the context was broad and not based within the healthcare context. However, the result Chau and Hu (2002b) found amongst the physicians is consistent with the argument of Jeyaraj *et al.* (2006) as physicians tend to be better educated and more pragmatic on innovation adoption. Ease of use, or similar elements, were found insignificant in some research (Chismar and Wiley-Patton. 2003; Alaiad and Zhou, 2014) but many also argue that those similar factors are actually influential (Ramdani *et al.* 2013; Oliveira *et al.* 2014; Gutierrez *et al.* 2015; Wang *et al.* 2016). Furthermore, none of the findings were based on any hospitals' adoption decision, not to mention that the two factors, complexity and ease of use, still have a 40% and 55% chance respectively (two out of five and six out of eleven respectively)

(Jeyaraj *et al.,* 2006); therefore, the perceived ease of use is kept in the pilot study to be tested.

Table 4.2 Significant Constructs

Technological	**Construct**	**Origin**	**Significance**
	Perceived Ease of Use	TAM (Davis *et al.*1989)	Sezgin and Özkan-Yıldırım, (2016); Tsai, (2014); Hung *et al.* (2012); Tung *et al.,* (2008); Wu *et al.* (2007)
	Perceived Behavioural Control	TPB (Taylor and Todd, 1995b)	Sezgin and Özkan-Yıldırım, (2016); Hung *et al.,* (2012); Wu *et al.,* (2011)
	Compatibility	IDT (Rogers, 1983)	Tung *et al.,* (2008); Wu *et al.* (2007)
	Perceived Usefulness	TAM (Davis *et al.*1989)	Tung *et al.,* (2008); Wu *et al.* (2007); Sezgin and Özkan-Yıldırım, (2016)
	Relative Advantage	IDT (Rogers, 1983)	9 out of 13 times RA was found significant (Jeyaraj *et al.*, 2006)
	System Reliability	Task-Technology Fit (Goodhue and Thompson, 1995)	Gan, (2015); Pagani (2006); Goodhue and Thompson, (1995)
Organisational	Top management support	Rai and Howard, (1994)	One of the best three organisational predictors (Jeyaraj *et al.*, 2006)
	Price value	UTAUT 2 (Venkatesh *et al.* 2012)	Tung *et al.,* (2008) (Financial Cost); Dwivedi, *et al.* (2016)
	Facilitating conditions	UTAUT (Venkatesh *et al.*, 2003)	Dwivedi, *et al.* (2016); Alaiad and Zhou, (2014)
	Organisation Size (Hospital Level)	(Grover and Teng, 1992)	One of the best three organisational predictors (Jeyaraj *et al.*, 2006)
Environmental	External Pressure	Iacovou *et al.* (1995)	One of the best three organisational predictors (Jeyaraj *et al.*, 2006)

Due to the high risks which hospitals are involved in, with human lives at stake (Zhou & Piramuthu, 2010), it is argued that hospitals are conventional in IT adoption (Wu *et al.* 2007), and the requirement of system reliability tends to be higher than in other industries. Pagani (2006) argued that reliability and security are some of the most important attributes for the adoption of mobile technology; they have become more important since the traditional adoption models were developed as they are not in the traditional models. System reliability is important because it represents the necessity of a continual service.

In China's specific healthcare background, the construct 'hospital level' is used instead of 'organisation size', as hospital level differences in China indicate the size differences, hardware level differences, varieties of departments, different qualities of directors of each department etc. (Table 2.2, Ministry of Health, 2009). The UTAUT variables - effort expectancy and performance expectancy – were not used because the root constructs such as perceived usefulness, relative advantage, perceived ease of use are preferred.

Due to the nature of the research objects, i.e. Chinese public sector organisations, and the fact that China is a non-democratic country ruled by the Communist Party, the Government plays an extremely important role in public organisations (Guo, 2012, Zhu and Kraemer, 2005). As the hospitals not only have to comply with the legislation, parts of the funding are supported by government subsidies. Xu, *et al. (*2004) argued that government regulations and policies play a far more important role in China than in other developed countries. Dewan and Kraemer (1998) also argued that the appropriate government policies must be met for organisations to adopt new technology. Zhu and Kraemer (2005) also stated that government regulation is more important in developing countries. Therefore, 'government policy and regulation' is added to the environmental characteristics.

Since the study is at an organisational level, the purely individual constructs such as waiting time, self-concept (Dwivedi, *et al.* 2016), personal innovativeness in IT, subjective norm (Hung et al., 2012; Wu et al., 2011) or self-efficacy (Hung *et al.,* 2012) are not included.

The draft conceptual framework is assembled as in Figure 4.4.

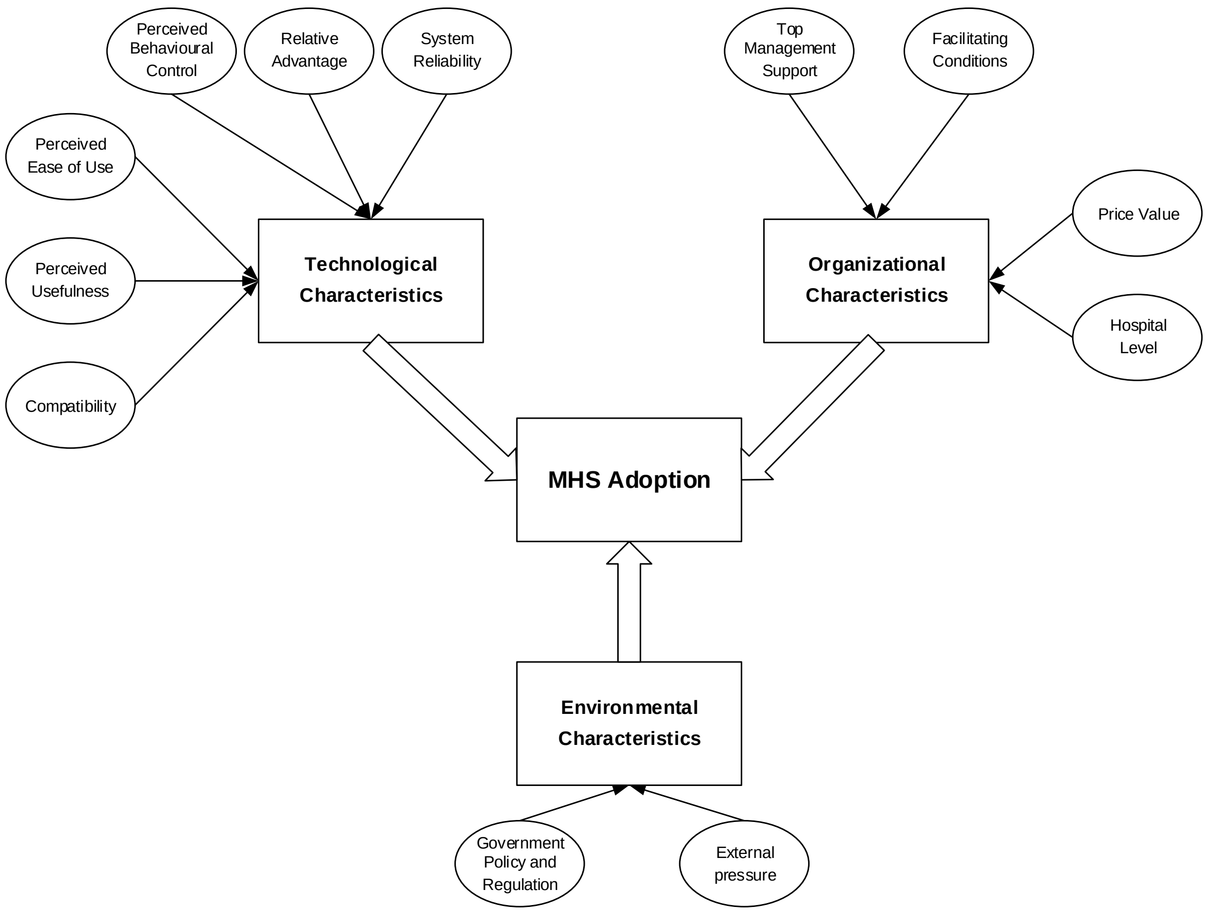

Figure 4.4 Proposed Framework

Table 4.3 shows the initial measurements and the origins of the constructs.

Table 4.3 Initial Measures

		Construct	Measurement	Origin
Dependent variable		Adoption of MHS in Hospitals		
Independent variables	**Technological Characteristics**	Perceived Ease of Use	Multi-items	(Davis *et al.*1989)
		Perceived Behavioural Control		(Taylor and Todd, 1995b)
		Compatibility		(Rogers, 1983)
		Perceived Usefulness		(Davis *et al.*1989)
		Relative Advantage		(Rogers, 1983, p15)
		System Reliability		(Goodhue and Thompson, 1995)
	Organisational Characteristics	Top Management Support	Multi-items	(Rai and Howard, 1994)
		Facilitating Conditions		(Triandis, 1980; Thompson *et al.* 1991)
		Price Value		(Venkatesh *et al.* 2012)
		Hospital Level	1 (A, B, C) Beds 20-99 2 (A, B, C) Beds 100-499 3 (S, A, B, C) Beds 500+	
	Environmental Characteristics	Government Policy and Regulation	Multi-items	(Kuan and Chau, 2001)
		External pressure		(Iacovou *et al.* 1995)

4.4 Reframing the TOE Framework

Based on the pilot study result, which will be discussed in chapter six, following the interviews with eight directors and experts, the initial proposed framework has been reframed for better accuracy and is finalised after being validated. The framework is then ready for the next steps of research, which is phase two, the quantitative survey.

The amendments were made because of the findings of the pilot study. Perceived behavioural control was eliminated; relative advantage is combined with perceived usefulness as informants argued that they share similar meanings; the factor ‘convenience’, which was argued by all the informants, is also merged into perceived usefulness; the factor ‘system security and privacy of patients’ was extended from system security, as this had emerged during the pilot study. The IT infrastructure is added as forming one part of ‘the current state of hospital’ which resulted from the pilot study from the organisational context.

Therefore, the initial technological predictors in the proposed framework based on the literature review were: perceived ease of use, perceived behavioural control, compatibility, perceived usefulness, relative advantage and system reliability whereas the reframed predictors based on phase one of the pilot study findings are: perceived ease of use, perceived usefulness, compatibility, IT infrastructure, system security and privacy of patients, and finally system reliability.

Compared to the originally proposed framework, price value has been taken out; hospital readiness, as an adaption of its original form of ‘organisational readiness’ (Kuan and Chau 2001; Zhu and Kraemer 2005; Zhu, *et al.* 2006b; Alam 2009; Ramdani *et al.* 2009; Thiesse *et al.*2011; Ramdani *et al.* 2013; Oliveira *et al.* 2014), is added as part of ‘the current state of hospital’. The current state of hospital was argued to have significant impact on an adoption decision and it includes IT infrastructure, top management support and organisation readiness during the pilot study. Facilitating conditions has been merged with organisation (hospital) readiness since the definition of organisation readiness, ‘*the availability of the needed organisational resources* *for adoption*' (Iacovou *et al.* 1995, pp.467) includes facilitating conditions. The other part of 'the current state of hospital', IT infrastructure, is added into the technological context. Top management support remains in the context.

Thus, the initial organisational predictors in the proposed framework, based on the literature review, were top management support, price value, hospital level and facilitating conditions whereas the reframed predictors based on the phase one pilot study findings are top management support, hospital level and organisation (hospital) readiness.

In the environmental context, both government policy and regulation and external pressure remain unchanged.

The modified and final version of the conceptual framework is illustrated in Figure 4.5.

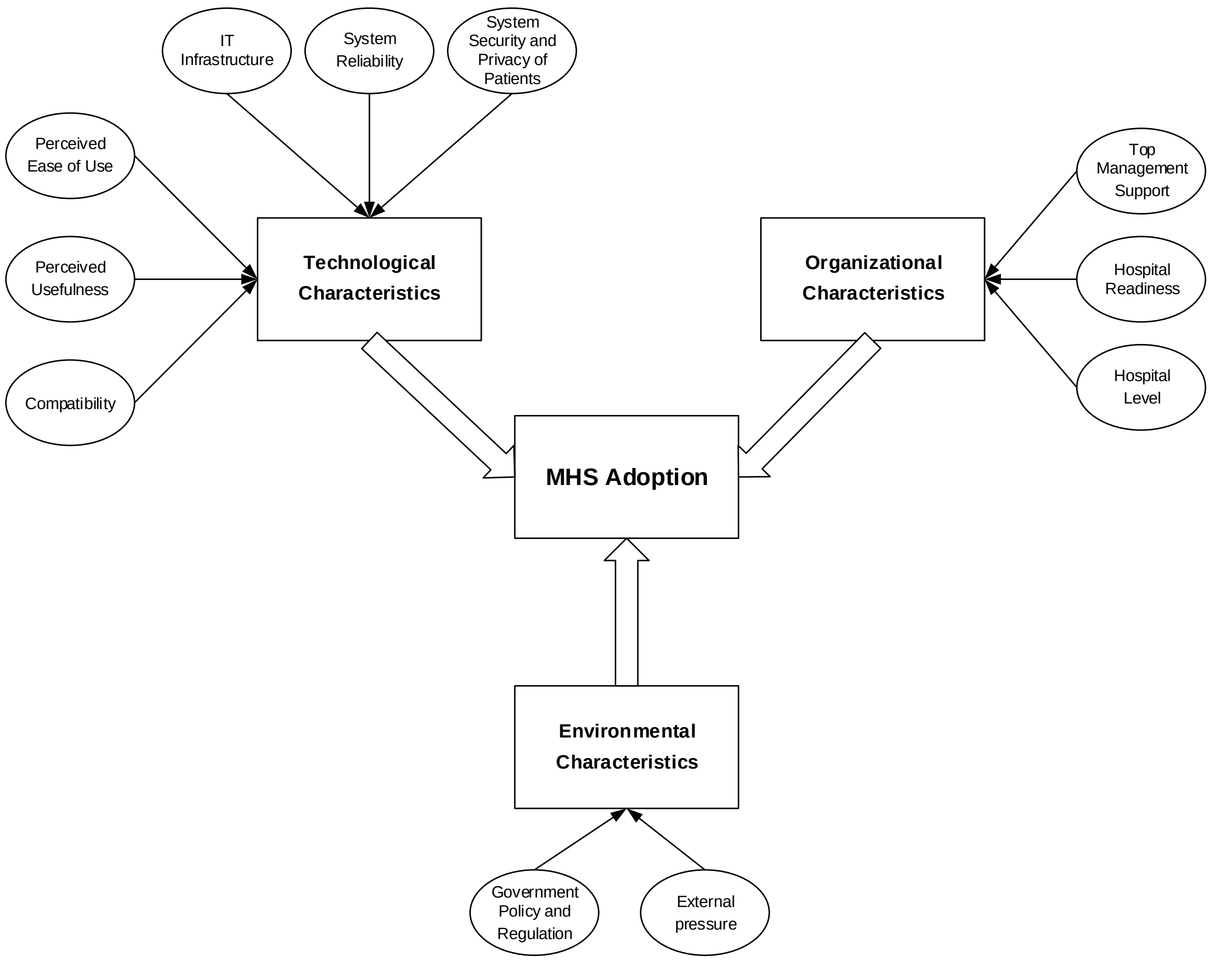

Figure 4.5 Final Framework

4.5 TOE Predictors Validation

The finalised constructs derived from the literature or modified by the pilot study result were all validated by previous TOE studies; some of the original constructs do not bear the same name, but share the same definition of the final predictors in this thesis (Table 4.4); therefore, the construct validity is validated.

Table 4.4 TOE Predictors Validation

Study	Technology Adoption (dependent variable)	Perceived Useful	Perceived Ease of Use	Comp.	Security	IT Infrastructure	Top Management Support	Organ. Read.	Size (Hosp. Lvl.)	Gov. Policy	External Press.
Chau and Tam (1997)	Open Systems	X				X					X
Kuan and Chau (2001)	EDI	X				X		X		X	X
Zhu and Kraemer (2005)	E-Business					X		X	X	X	X
Zhu, *et al.* (2006a)	E-Business	X		X	X	X			X		X
Zhu, *et al.* (2006b)	E-Business					X		X	X	X	X
Lin and Lin (2008)	E-Business	X		X		X		X			X
Alam (2009)	Internet	X		X			X	X			
Ramdani *et al.* (2009)	Enterprise Systems	X	X	X			X	X	X		X
Azadegan and Teich (2010)	E-Procurement	X	X	X		X		X			
Vest (2010)	Health Information Exchange					X				X	
Bose and Luo (2011)	Green IT							X	X	X	X
Thiesse *et al. (*2011)	RFID	X	X	X			X	X	X		
Ramdani *et al.* (2013)	Enterprise Systems	X	X	X			X	X	X		X
Cao *et al.* (2014)	RFID	X		X	X		X	X		X	X
Oliveira *et al.* (2014)	Cloud Computing		X	X	X	X	X	X	X	X	X
Awa and Ojiabo (2015)	ERP	X		X	X	X		X	X		X
Gutierrez *et al.* (2015)	Cloud Computing		X	X		X	X		X		X
Awa and Ojiabo (2016)	Enterprise Resource Planning			X	X	X			X		X
Wang *et al.* (2016)	Mobile Reservation Systems	X	X	X		X	X		X		X
Awa, *et al.* (2017)	IT	X	X	X			X		X		X
Liang *et al.* (2017)	Cloud Computing		X				X	X		X	X

4.6 Hypothesis

Technological characteristics include the relevant technologies to hospitals, the already adopted ones and the ones that are yet to be adopted, and are available on the market.

***H1**. The greater the perceived usefulness of a mobile health system, the higher the possibility for hospitals to adopt it.*

Perceived usefulness is the degree to which a potential adopter believes that using MHS would enhance a hospital's professionals' job performance (adapted from Davis, 1989) and is one of the most studied factors in the adoption research. Keil *et al.* (1995) argued that usefulness is an important factordetermining the acceptance of IT. Hu, *et al. (*1999) suggested that usefulness is significant and has a strong influence on the adoption of the technology by physicians. It is also recognised as an important factor by Wu *et al.,* (2007).

***H2**. The greater the perceived ease of use of Mobile Health, the higher the possibility for hospitals to adopt it.*

Perceived ease of use is defined as the degree to which a potential adopter believes that using MHS would be free of effort (adapted Davis, 1989). Perceived ease of use is found to be an influential factor in the adoption of innovation in the healthcare context; the easier a technology is for professionals to use, the more likely it will be adopted (Tsai, 2014; Sezgin and Özkan-Yıldırım, 2016). It has been found that perceived ease of use is a significant predictor of an adopter's intention to use a particular technology (Dwivedi *et al.,* 2011). Hung *et al.* (2012) suggested that the information system should be designed in a more user-friendly manner to increase the perceived ease of use and usefulness in order to increase the adoption by physicians.

***H3**. The greater the compatibility of a Mobile Health System, the higher the possibility for hospitals to adopt it.*

Compatibility is the degree to which MHS is perceived as consistent with the existing values, past experiences, and needs of a potential adopter (adapted from Rogers, 1983). The compatibility of an innovation is perceived positively related to the rate of adoption by the potential adopters. Wang, *et al. (*2016) found that compatibility is a facilitator in the adoption of innovation. It is also found to be a significant positive factor in an adoption decision (Wang, *et al.,* 2010).

***H4**. The higher the mobile health system reliability, the higher the possibility for hospitals to adopt it.*

Lin and Chen (2012) argued that a company would choose not to adopt due to the increased business risk if there is uncertainty in service availability and reliability, especially if there is unexpected downtime and disruption. They also found that in most cases people would prefer not to use a new technology because of concerns about the stability and reliability of the system. Reliability is also one of the most important factors for adoption in Pagani's findings (2006) because it reflects the ability to provide non-stop services.

***H5**. The higher the mobile health system's security and better protection of privacy for patients, the higher the possibility for hospitals to adopt it.*

It has been suggested that both privacy and security are important and that they have a strong influence (Kim, *et al.,* 2008). To successfully utilise MHS, hospital professionals, MHS suppliers and most importantly, patients, '*must be able to trust the reliability, privacy, and security of their data as well as the devices that collect and share it'* (Steinhubl *et al.,* 2015, pp5). Alaiad and Zhou (2014) indicated that the concern for privacy is raised by customers because customers worry about personal information abuse and it being sold without permission. Cao *et al.* (2014) mentioned that privacy and security of patients' information both need to be protected. During the pilot study in this research, a concern for system security and for privacy were mentioned by several interviewees. One of the directors argued that *"The MHS should not only be secured against cybercrimes, as such would damage patient privacy, the concerns should also be raised because personnel can carry all the information anywhere now even outside the hospital".* And all the other interviewees agreed.

***H6**. The more sophisticated the current Hospital's IT infrastructure, the higher the possibility for hospitals to adopt it.*

IT infrastructure is defined as a technology platform, including computer hardware, software, and networking technologies that are necessary to adequately and appropriately implement IT solutions throughout an organisation (Bhattacherjee and Hikmet, 2008). The first interviewee in the pilot study brought up the factor 'current state of hospital', which consists of IT infrastructure, and the top management team's attitude towards technology and resources available in a hospital. This factor was then agreed by the rest of the interviewees. Hameed *et al.* (2012) argued that organisations have a better chance of adopting IT innovation when the IT infrastructure is well established. They argued that 12 out of 16 studies found IT infrastructure has a significant impact on IT adoption in their review.

Organisational context refers to the traits and resources of the firm. The organisational context would affect the innovation adoption in a few different ways. Top management could be supportive to encourage the use of technology. (Tushman and Nadler 1986; Baker, 2012). Organisation size has been studied and found to be significant many times, although there is a view that it is actually because of the abundant resources larger firms possess, not the size itself. (Baker, 2012).

H7*. The greater the top management support, the higher the possibility for hospitals to adopt it.*

Jeyaraj *et al.,* (2006) argued that for organisational technology adoption, one of the best predictors is top management support. This factor has been tested in many studies and is proven significant (Ramdani *et al.,* 2009; Bernroider and Schmöllerl, 2013; Cao *et al.,* 2014; Wang, *et al.,* 2016). Moreover, all of the interviewees in the pilot study have mentioned that, especially in the Chinese context, top management support is one of if not the most important factor in an adoption decision.

H8*. The greater the organisational readiness, the higher the possibility for hospitals to adopt it.*

Organisational readiness (Iacovou *et al.,* 1995) is defined as the availability of the necessary technological and financial resources for the adoption of MHS. This factor is found in much previous research for organisational technology adoption studies (Hsu *et al.* 2006; Iacovou *et al.* 1995; Chong *et al.* 2009). Hameet *et al.* (2012) confirmed in the meta-analysis test result that organisational readiness is a major factor when determining the adoption of IT. Ramdani *et al. (*2009) suggested that organisations are not able to adopt technology without sufficient resources. A similar factor, that of facilitating conditions, which is defined as the existing organisational and technical resources, is also a well-examined factor in adoption research (Wills *et al.,* 2008; Hennington and Janz, 2007; Kijsanayotin *et al.* 2009; Ifinedo, 2012). Also, the resources of the organisation are important for potential adoption in the healthcare context (Ifinedo, 2012).

H9*. The bigger the size of the hospital (higher hospital Level), the higher the possibility for hospitals to adopt it.*

Jeyaraj *et al.* (2006) identified the firm size as one of the best predictors in the adoption of innovation at the organisational level. Within the Chinese healthcare background, 'hospital level' is used instead of 'organisation size', as hospital level differences indicate many differences including hospital size (Table 2.2). Hospitals in China are classified into several levels from level 1 to level 3A. Level 1 hospitals are mostly community hospitals which are the smallest in size and level 3A hospitals are the current practically top-level hospitals with the best conditions and with the most hospital beds, i.e. the largest hospitals in size. Ramdani *et al. (*2009) suggest that larger firms have greater potential to adopt information systems. The size of an organisation is not only an important factor in deciding the adoption decision, it is also the most influential factor in determining the extent of IS adoption (Thong, 1999).

The environmental context contains both the industry structure and the environment of regulation (Baker, 2012). Competition in industry structure is likely to encourage adoption (Mansfield *et al.* 1977). Government regulations impact the innovation adoption as well (Baker, 2012).

***H10**. Government policy and regulation influences hospitals' decision on the adoption of mobile health.*

Government regulation has been examined as a factor in adoption research. Xu, *et al. (*2004) indicated that government regulation even plays a more important role in the Chinese context than in developed countries like the US. It is also suggested that, for organisations to adopt new technology, the right environmental conditions, which include the appropriate government policies, must be met (Dewan and Kraemer, 1998).

***H11**. The higher the external pressure, the higher the possibility for hospitals to adopt it.*

External pressure is another one of the three best predictors in innovation adoption at the organisational level (Jeyaraj *et al.,* 2006). Luo *et al. (*2014) identified that the competitive environment has a positive correlation with the decision-making in adoption studies in the context of China. Hsu *et al. (*2006) also argue that external pressure is a significant factor. Competition in the same industry of a potential adopter would normally be a positive influence on the adoption of innovations (Gatignon and Robertson, 1989).

4.7 Summary

This chapter discussed the development of the framework used in this research. It started by introducing the dominant paradigm and a revised dominant paradigm for information technology innovation as well as the application of the paradigm in this study. The chapter then discussed the TOE framework followed by the first step of the framework development, where the initial framework was built by extracting the significant constructs from the research literature.

As a result of the pilot study, which will be discussed in chapters five and six, the initial framework is reframed with adjusted, added or eliminated predictors. The chapter then provides the validation of the finalised constructs in a TOE framework, and then the hypotheses are discussed. These hypotheses will then be tested in the main survey.

Chapter 5 Research Method

5.1 Introduction

This chapter details which research methods have been applied to investigate the research questions. The chapter starts with an illustration of the research stages and the three phases. Following a discussion of the research design, it explains the data collection methods for all three phases as well as the research instruments. After the discussion of the unit of analysis, the sampling frame is discussed and then the sampling methods explained for each phase. Afterwards, the chapter moves to fieldwork which includes the phase one pilot-study interviews, the phase two questionnaire-based main survey and the follow-up phase of three in-depth interviews. With the data collected from the fieldwork, data analyses for phase two and three are then discussed with the introduction of the measures, followed by a discussion of the model validity and reliability for the phase two quantitative research and the trustworthiness of the phase three qualitative research. This chapter is then concluded which leads to the results and the findings in chapter six.

5.2 Research Stages

This study was done in three major stages over a period of three years. The first stage can be viewed as the 'set-up' stage. To address the research questions, the researcher has reviewed previous literature published in innovation adoption, information technology, information systems, healthcare, and the Chinese healthcare industry. The literature review has been done throughout the entire process and is not limited to stage one.

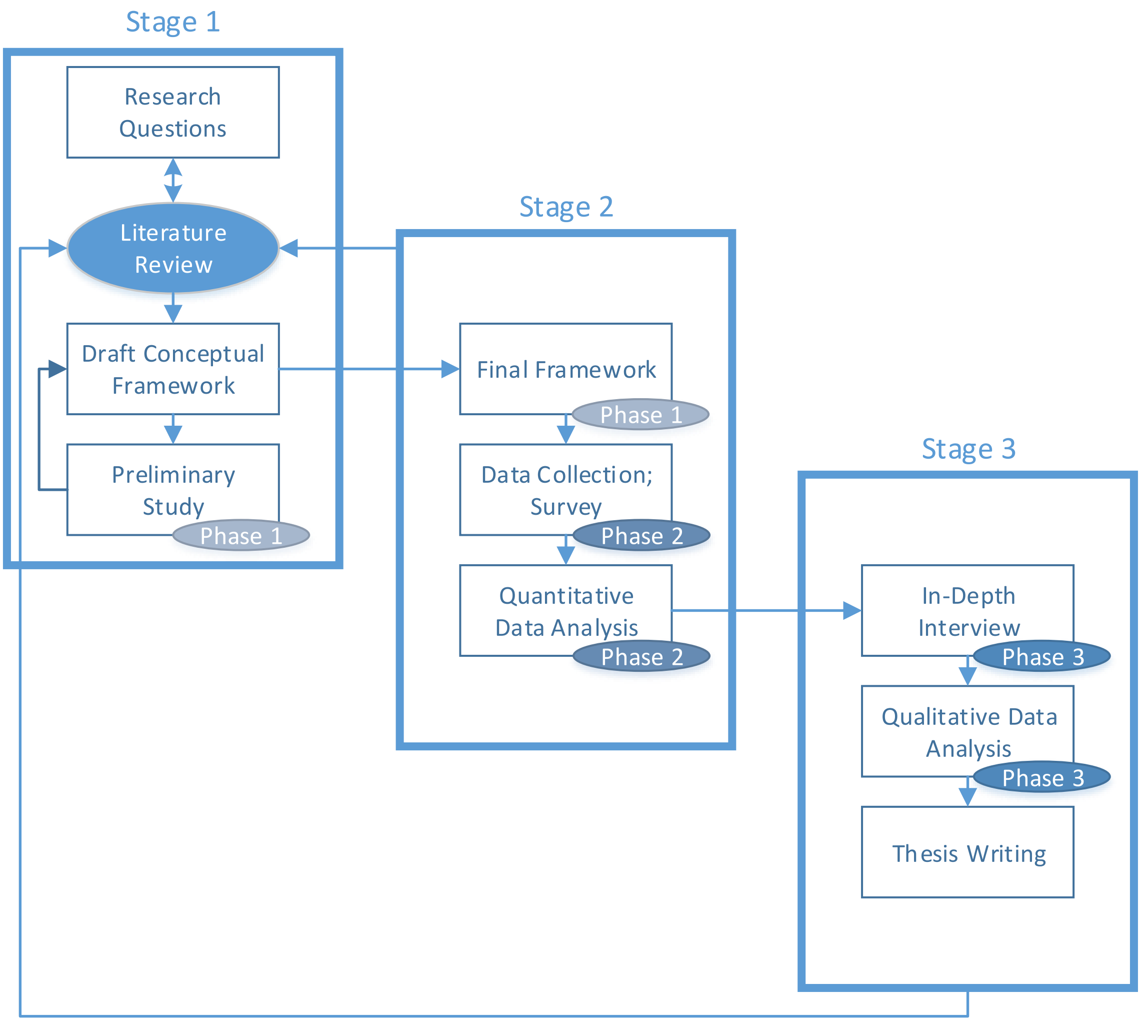

Figure 5.1 Research Stages

After the review of sufficient literature, a draft conceptual framework was built by applying the theory, constructs and measures from reputable journal articles, and this marked the start of phase one. In phase one of the data collection, the pilot study had commenced in order to validate the content of the instrument and to pre-test the framework and hypotheses, then a preliminary empirical study was conducted. The data obtained during the pilot study was then used to refine the conceptual framework, and the framework was then finalised, which marks the start of phase two.

The questionnaire was redesigned with validated content and new and amended constructs, which led to the main quantitative survey of this study, and this is phase two of the research. The survey was done successfully. The data were then inputted into Excel and Statistical Package for the Social Sciences' (SPSS) for logistic regression. The result of the quantitative study marked the end of phase two.

Using the result acquired from phase two, six in-depth interviews were conducted as phase three, in order to reach as deep to the core of the questions as the researcher could. The data were then coded and analysed for explaining the research questions. After all the above work was done, this thesis was then written to inform others (Neuman, 2002).

In short, the major parts of the research followed the steps of topic selection – research question – research design for both quantitative and qualitative aspect – quantitative data collection – quantitative data analysis – quantitative data interpretation - qualitative data collection – qualitative data analysis – qualitative data interpretation. Figure 5.1 shows the three stages and the steps taken in each stage.

5.3 Methodology

This research takes the stance of a pragmatist. Pragmatism provides the epistemological justification and logic for using mixed approaches and methods (Johnson *et al.* 2007; Onwuegbuzie *et al.* 2009). Onwuegbuzie *et al.* (2009) argued that '*the mixed methods research paradigm offers an important approach for generating important research questions and providing warranted answers to those questions*' and depending on the research questions, '*mixed methods research is likely to provide superior research findings and outcomes'* (pp129).

Johnson *et al.* (2007) gave a new definition to the mixed methods research as *'an intellectual and practical synthesis based on qualitative and quantitative research; it is the third methodological or research paradigm (along with qualitative and quantitative research). It recognizes the importance of traditional quantitative and qualitative research but also offers a powerful third paradigm choice that often will provide the most informative, complete, balanced, and useful research results*' (pp129). Therefore, the use of the mixed quantitative and qualitative data is '*not only legitimate, but in some cases necessary'* (Gray, 2013, pp29).

This research has partnered with the philosophy of pragmatism and has followed the logic of mixed methods research as well as relying on the quantitative and qualitative viewpoints, data collection and analyses.

5.3.1 Research Design

Exploration, description, and explanation are three of the most useful and common goals of social research (Babbie, 2012). Exploration study should have some purpose even if no proposition is given (Yin, 1994). Much social research uses an exploration approach to examine new interests or, if the subject of research is new, the three major and typical objectives of doing the exploratory research are to understand the subject better, to test if a more comprehensive research can be undertaken or to prepare for any upcoming study.

To describe a researcher-observed situation or event is the major objective of the description approach (Babbie, 2012). Neuman (2002) argued that description research '*presents a picture of the specific details of a situation, social setting, or relationship*' (pp38). A situation is observed by scientific observation, which is meticulous and intentional. The situation is then scientifically described, which is more rigorous. It is also argued that much qualitative research has primarily taken the form of description study although those studies are rarely stopped at the simple description, and would normally go deeper to try to find out why the situation exists and the implication behind it.

The final goal of social research is to provide explanations for certain objects. Neuman (2002) mentioned that the purpose of explanatory research is to answer 'why'. '*Descriptive studies answer questions of what, where, when, and how; explanatory studies answer questions of why*' (Babbie, 2012, pp92). This thesis has applied all three designs in three phases of studies respectively.

5.3.2 Mixed Methods

To answer the research questions raised by this study, data collection was arranged into three phases: phase one was the pilot study, the main questionnaire quantitative survey was phase two and the final qualitative study was phase three, and each phase served a different purpose. All three phases were administered by the researcher with help from a network of healthcare professionals that the researcher had been in contact with. Therefore, much better access, faster response times and much higher response rates were ensured.

Although Mingers (2001) has argued that the choice of research methods for IT research has been has been under consideration for ages, mixed methods have been used by researchers for several decades (Driscoll *et al.,* 2007). Rocco *et al.* (2003) stated that mixed methods are to combine both the theoretical and the technical aspects of qualitative and quantitative approach to a particular research. This study used mixed research methods for answering the research questions. To be more specific, the pilot study (phase one) and the post-survey in-depth interview (phase three) used the qualitative method while the field survey (phase two) applied the quantitative method. A pragmatic advantage can be acquired, especially when studying more complex research questions, by using both of the research methods. The qualitative method offers a deep understanding of the survey results and quantitative analysis brings a precise assessment of data and is great for hypotheses testing (Driscoll *et al.,* 2007). Each approach has different advantages and disadvantages; for example, the quantitative method emphasises testing and verification while the qualitative method emphasises understanding; the quantitative approach focuses on measured facts while the qualitative approach focuses on understanding from the informant's point of view; the quantitative method tends to be logical and critical while the qualitative method tends to be interpretative and rational; the quantitative method keeps the researcher detached whereas the qualitative method involves the researcher (Neuman, 2002; Ghauri, and Grønhaug, 2005).

Lack of either method would jeopardise the entire research because, without the phase one qualitative research, the constructs and content to be used in the quantitative research cannot be validated; without the phase three qualitative research, the result from the quantitative research would be nothing more than relationships between variables without any real explanations beyond speculation. If the research is done only by the qualitative approach, the research questions cannot be answered because the qualitative approach lacks the ability to test, verify or measure the facts. Only the combination of both methods can bring the most robust result to this research.

Whichever approach is used, the data collection and analysis require numerous research techniques such as surveys and interviews. Both quantitative and qualitative methods '*share core scientific principle'* (Neuman, 2002, pp17). Quantitative techniques can be seen as 'data condensers' where the data are condensed to see the whole picture whereas qualitative methods are 'data enhancers' where the data are enhanced to see the primary aspects of the cases more clearly (Ragin, 2010).

By having both quantitative and qualitative methods, richer, more reliable and more rigorous results are expected to be delivered compared with any single method of data collection (Mingers, 2001; Ghauri and Grønhaug, 2005); as Jick (1979) mentioned, '*weaknesses in each single method will be compensated by the counter-balancing strengths of another'* (pp604). To compensate for the weaknesses of each method, the ideal scenario is to manage a multimethod research that '*draws on the strengths of both the quantitative and qualitative approaches*' (Neuman, 2002, pp17). However, multimethod studies are more difficult to manage due to the fact that conducting a multimethod study generally requires more time, not all researchers are experts in both methods, and also significant complexity is added by mixing both methods (Neuman, 2002).

In terms of the workflow, or sequence of the research, Ghauri and Grønhaug (2005) suggested that firstly, the qualitative approach is more useful in exploratory research, which could lead to developing hypotheses and eventually an explanation study. To test the hypotheses, a quantitative approach is suitable. Both methods or the combination of the two can be used at the final stage. The technique suggested by Ghauri and Grønhaug (2005) belongs to one of the multimethod research designs this study has applied, the sequential design (Mingers and Gill, 1997; Tashakkori and Teddlie, 1998), where the mixed approaches are applied in sequence, as the result from a previous approach is used by the next approach. To be more specific, in this very study, a qualitative research was conducted in order to support the next stage quantitative questionnaire survey, where the analysis result from the quantitative survey is again used for in-depth qualitative interviews for a much better understanding behind the scenes.

The use of the combination of methodologies to study the same phenomenon is defined as triangulation and methodological triangulation is '*the use of a combination of methods such as case studies, interviews and surveys. All methods have their strengths and weaknesses. So not only does the use of multiple methods assist in data triangulation, it helps to balance out any of the potential weaknesses in each data collection method*' (Gray, 2013, pp37). Onwuegbuzie *et al.* (2009) argued that '*objectivity can be approximated by triangulating across these multiple fallible perspectives (i.e. triangulation of method, data and theory*)' (pp121). It has also been argued that the quantitative method makes significant contributions to its qualitative counterpart, and vice-versa. The most attempted used of triangulation is to combine the fieldwork and the survey. The integration of the two has been argued by many to be viable and necessary (Sieber, 1973; Diesing, 1979; Jick, 1979).

5.3.3 Unit of Analysis

The unit of analysis is '*the what or whom being studied'* (Babbie, 2012, pp97), and the most common units of analysis are individuals. Units of analysis can be all sorts of things, such as individuals, groups, organisations, social interactions, social artefacts (Babbie, 2012), institutions, space, culture, society (Morris Rosenberg, 1968), practices, episodes, encounters, roles and social types, social and personal relationships, groups and cliques, settlements and habitats, subcultures and lifestyles (Lofland *et al.,* 2006).

In healthcare innovation adoption studies, the units of analysis are mainly individuals such as healthcare professionals (Hu *et al.* 1999; Chau *et al.* 2001; Chau *et al.* 2002; Yi *et al.* 2006; Bhattacherjee *et al.* 2007; Liang *et al.* 2010; Wu *et al.,* 2011; Moores 2012; Hung *et al.* 2012; Phichitchaisopa and Naenna, 2013), patients (Kim *et al.* 2007; Klein 2007; Akter *et al.* 2010; Tsai, 2014; Dwivedi, *et al.* 2016) and health organisations, i.e. hospitals (Kimberly and Evanisko, 1981; Menachemi *et al.,* 2007; Tung *et al.,* 2008; Kijsanayotin *et al.* 2009; Hung *et al.,* 2010).

This aim of the research is to investigate the factors affecting the MHS's adoption within hospitals, hence the unit of analysis is the hospitals because it is hospitals that are being studied in this thesis, and this is consistent with previous studies mentioned above.

5.3.4 Sampling Frames

Due to the large geographic size of China, the limited resources the researcher had and the data collection method chosen, one province and one autonomous city, which is politically equivalent to the province and some of its surrounding cities, have been deliberately chosen as the sample frame of the study. The two locations are in the northwest and southeast of China geographically.

Table 5.1 Comparison between Shanghai and Gansu, Source: China statistical yearbook, (2017); China Statistics Yearbook of Health and Family Planning, (2017)

Comparison, 2016		
	Shanghai	**Gansu**
GDP (Billion USD)	413.50	107.67
Population	24 million (1.8% of total Chinese population)	26 million (2% of total Chinese population)
Total number of hospitals	349	446
Total hospital beds	17,100	28,700
Utilisation rate of beds	95.7%	82.2%
Total employed medical personnel in hospitals	140,943	83,649
Total in-patients	3,427,403	3,093,150
Treatment provided per physician per day	14.8	6.2
Total out-patients	149,020,321	43,496,190
Medical personnel per 1000 population	7.4	5.2
Doctors per 1000 population	2.7	2.0
Nurses per 1000 population	3.3	1.9

The two chosen locations (Table 5.1) represent the whole population well because economically, Shanghai, the chosen autonomous city, has a GDP of 413.50 billion USD in 2016, which ranked 11th place in China while Gansu, the chosen province as a less developed part of China, has 107.67 billion USD of GDP in 2016, and is ranked as one of the bottom five regions in China; population wise, Shanghai has 24 million people and Gansu has 26 million, each making up around 1.8% to 2% of the total population in China (National Data, 2016); the total number of hospitals in Shanghai in 2016 was 349 (47 level 3, 105 level 2 and 11 level 1, the rest were unclassified); the number was 446 in Gansu (36 level 3, 184 level 2 and 42 level 1, the rest were unclassified); the total number of hospital beds and the beds' utilisation rate are 17,100 and 95.7%, 28,700 and 82.2% respectively in Shanghai and Gansu; the total employed medical personnel in hospitals were 140,943 in Shanghai and 83,649 in Gansu; Shanghai had 3,427,403 and Gansu had 3,093,150 in-patients in 2016 respectively. Patient treatment provided per physician per day in Shanghai was 14.8, while the number was 6.2 in Gansu; total out-patient numbers in 2016 were 149,020,321 and 43,496,190 in Shanghai and Gansu respectively; medical personnel per 1000 population was 7.4 in Shanghai and 5.2 in Gansu, with 2.7 and 2.0 doctors and 3.3 and 1.9 nurses respectively (China Statistics Yearbook of Health and Family Planning, 2017).

Shanghai and its surrounding areas represent one of the best developed locations in China while Gansu is one of the least developed places. It is not physically possible for the researcher to have all the public hospitals in the locations covered in this research. Therefore, choosing a sample of the whole population would be necessary in order to carry out the study.

5.3.5 Fieldwork

The field survey method was used for all three phases of this research; this is in line with most other similar research in the field (Wu *et al.*, 2007; Hung *et al.,* 2012; Cao *et al.*2014; Dwivedi, *et al.* 2016). Data were collected using different methods which include face-to-face interviews, telephone interviews, in-depth interviews and surveys. Ghauri and Grønhaug (2005) mentioned that a mixed strategy method, i.e. quantitative research combined with a qualitative study could provide a very useful and more detailed result. This study uses the combination of both the quantitative method and the qualitative method in order to produce a rigorous result for a deeper understanding of adoption in Chinese hospitals. This research firstly used semi-structured interviews in the pilot study, which is a qualitative approach; the result from the pilot study helped the researcher to set up the quantitative main survey by providing validated and reliable constructs and content; the highly quantitative survey analysis result shows the relationships between independent variables and dependent variables; the in-depth interviews in phase three which applied the qualitative method would help the researcher to answer the 'why' questions.

5.4 Phase One: Pilot Study

5.4.1 Design

The purpose of phase one of this research is to help the researcher understand the MHS in hospitals better, to understand the background of this study better, as well as to prepare for the phase two major quantitative study. Therefore, phase one of this study is exploratory research.

5.4.2 Data Collection

The pilot study phase aimed to validate face validity and content validity, to ensure that there were no significant constructs omitted in the final framework and questionnaire, as well as to correct and eliminate certain constructs by the suggestions of experts. The pilot study used a qualitative research method. The data collection strategy used in this phase was to conduct eight direct face-to-face interviews with directors and experts in three different hospitals in two regions; in each interview a semi-structured interview (Louise Barriball and While, 1994) method was used. The interview was divided into two stages. The first stage involved asking the interviewees questions about innovation and technology adoption in hospitals; and also some background questions (Appendix 1.1), such as what their opinions were, what factors they think would influence the adoption decision, and what the process of the adoption in the hospital was. Stage two was set to ask the interviewees to look at the prepared and translated potential influential predictors together with their definitions and to point out which factors they thought were important for innovation adoption, and to what extent they thought the importance of these factors was and why. Each interview lasted around 30 to 45 minutes.

5.4.3 Sampling

The sampling methods used in the pilot study were purposive sampling and snowball sampling; both belonging to non-probability sampling methods. Purposive sampling is defined as '*a nonrandom sample in which the researcher uses a wide range of methods to locate all possible cases of a highly specific and difficult-to-reach population*. (Neuman, 2002, pp273)' while snowball sampling is defined as 'a *nonprobability sampling method, often employed in field research, whereby each person interviewed may be asked to suggest additional people for interviewing.'* (Babbie, 2012, pp129). Neuman (2002) argued that when doing qualitative research, having a representative sample from a large number of cases may not be required and, instead, nonprobability sampling methods actually often fits the purpose of a study much better.

The reason for using purposive and snowball sampling is that the researcher needed specialised experts who understand innovation adoption, have a deep knowledge in healthcare IT as well as MHS and simultaneously are better placed to be on the management team: a group that is very difficult to reach. Purposive and snowball sampling are the fastest ways to reach all the required experts based on purposive selection and on other experts' recommendations. The initial choice of directors of IT departments ensured the informants have sufficient knowledge in HIT.

5.4.4 Informants

All eight studies were conducted with directors, former directors and one staff in the IT department in three hospitals in two cities, all within the research sample frame. The researcher had initially chosen one informant in each of the two regions (H11 and H31), hence all the interviewees were divided into the two cities mentioned in the sampling frame, Shanghai and Gansu. The rest of the informants that the researcher had chosen were based on the initial recommendation from the initial informants, and the informants recommended to the researcher had then recommended others who had expertise of healthcare IT. Out of the eight informants, one was a staff member in the hospital's IT department, two were the directors of the IT department, one was the former director of the IT department, the remaining four were all directors in various departments in hospitals who possessed the required knowledge based on the recommendations. Seven of the interviewees belonged to the hospital management team and the other was an IT expert. At least two informants were in the same hospital.

Table 5.2 Pilot Study Informants

Hospital Level & Location	Informants	Position
3B Shanghai	H11	Director of IT department
	H12	Staff in IT department
	H13	Director of non-IT department
3A Shanghai	H21	Former director in IT department
	H22	Director of non-IT department
	H23	Director of a sub-department in a non-IT department
3A Gansu	H31	Director of IT department
	H32	Director of non-IT department

5.4.5 Fieldwork

The pilot study included eight semi-structured face-to-face interviews, which allowed the interviewer to try to explain the questions when necessary, to explore the subjects and to observe the interviewees. The goal of the pilot study was to test the framework built out of the literature reviews with all three characteristics, i.e. technological, environmental and organisational characteristics, as well as to test the initial hypotheses. The pilot study was conducted also to help validate the content validity and face validity of the research instruments for the main survey.

Conducting a pilot qualitative study or case study before the main survey is advised by Gable (1994) because it provides great discoverability and representability. Moreover, the pilot study validates the content validity, which is rated as highly recommended by Straub *et al.* (2004) because it is important to validate whether the items are measuring the constructs (Cronbach, 1971). Content validity is a valuable but complex tool to validate the instrumentations and has to be done by doing literature reviews and by verification by experts (Straub *et al.*, 2004).

The researcher travelled to China between September 2015 and December 2015. The initial plan was to finish the pilot study, finish designing the questionnaire and have the phase two survey partially done during the period of three months. However, the pilot study took more than one month which was longer than expected as two of the interviewees were not available until the later dates.

All informants were contacted by the researcher first and had agreed to participate in the pilot study. Before conducting the interviews, certain information, such as which hospital level the informants were working in, had already been acquired by the researcher. All eight interviews were semi-structured interviews which were conducted to gather informants' expert insights on the adoption of MHS, such as the factors that significantly influenced the adoption decision and what the interviewees reckoned that mattered the most when adopting a technology. The interviews also included the current IT service the hospitals provide, the thoughts on all three characteristics in the initial framework as well as the thoughts on the draft framework's predictors. Each interview lasted half an hour to forty-five minutes. All interviews were conducted in the informants' offices in the hospitals.

5.5 Phase Two: Main Quantitative Survey

5.5.1 Design

As stated in the previous chapter, although innovation adoption is, in fact, a heavily researched topic, the existing research has mainly focused on individual adoption in the healthcare context; the research on innovation adoption at an organisational level is very much lacking, especially within a Chinese context. There are very few of these studies in the Chinese healthcare context (Liang *et al*., 2004); the study of MHS adoption in Chinese mainland hospitals has not existed up until this research. Hence, the findings and results from previous studies cannot be expected to apply to the adoption study in this research. Moreover, there is no framework or model built for the purpose of answering the research questions argued by this thesis; thus one of the purposes of this thesis is to build a framework that can be used to predict hospital adoption of IT in China. Previous research (Chau and Tam, 1997; Thiesse *et al.*, 2011; Lin and Lin, 2008; Oliveira *et al.* 2014) that only adopts a quantitative method cannot explain but can only speculate on the reasons why certain factors are significant or insignificant. The research that only adopts a qualitative method (Liang *et al.*, 2017; Cao *et al.*, 2014) cannot offer the robustness of hypothesis testing or the precise assessment of data. Therefore, the research design of phase two of this study is set as a description design, which would enable this thesis to continue the study in the innovation adoption field and contribute to the existing knowledge, as descriptive research provides an accurate and detailed picture (Neuman, 2002).

5.5.2 Data Collection

The major survey phase is one of the main parts of this thesis, which bears the purpose of obtaining a quantitative result and to test the research hypotheses. This step uses a mixed strategy as it is done by contacting directors in major departments in hospitals in different cities in China, firstly to confirm their participation, and then to ask them to fill in the questionnaires that have been designed by the researcher and validated by the directors and experts in the hospitals in phase one. The reason for the questionnaire survey is not only because it is a method still used the most by researchers in IT studies (Chen & Hirschheim, 2004), it is also a quite commonly used strategy in innovation adoption research in the healthcare context and is a proven and validated method of doing research in this field (Hu *et al.*, 1999; Kijsanayotin *et al.* 2009; Wu *et al.,* 2011; Hung *et al.,* 2012; Phichitchaisopa and Naenna, 2013; Tsai, 2014; Deng *et al.,* 2014; Dwivedi, *et al.* 2016; Sezgin and Özkan-Yıldırım, 2016). It also has certain advantages as suggested by Crompton (1996), such as it covers much information and the format is simple, it is not difficult to administer and it is easy to input and analyse the data collected.

5.5.3 Research Instrument and Questionnaire Design

The research was initiated in the United Kingdom and the research targets are Chinese public hospitals and the fieldwork is intended to be done in China.

Therefore, it is a cross-cultural and cross-language study. Research instruments would, as a consequence, have to be translated into the local language, in this case Chinese. However, Lin *et al.,* (2005) argued that the translated instruments do not necessarily measure the same constructs like the original instruments do if a literal translation method is used because linguistic or cultural differences may occur.

Construct bias, method bias, and item bias are three major biases in cross-cultural studies (Van de Vijver & Hambleton, 1996). Construct bias occurs when the instruments that are used to measure constructs show significant discrepancy across cultures. Method bias includes many different factors but it mainly refers to issues around the measurements' administration procedure. Other examples of the factors of method bias are, for example, that the respondents are not familiar with the measures, or with the physical conditions where the survey has taken place. Item bias is regarded as a differential item functioning, which is caused by the measuring items' '*poor wording, inaccurate translations, inappropriateness of item content in a cultural group'.* (Van de Vijver & Hambleton, 1996, pp7). In this study, best efforts have been made to avoid the aforementioned biases and this is discussed below.

Brislin (1986) argued that the existing instruments developed and standardised in one culture '*can possibly be used for data gathering in another culture*' (pp138). There are many considerable advantages by using already established instruments for measurement, as they tend to be validated in a number of already published research papers. Therefore, the comparisons can be made between the data of the new and published literature, which provides a body of literature to be developed from commonly shared concepts, with operational definitions and thereby bringing certain standardisation into the research stream.

There are certain drawbacks by using the existing instruments as well. There are risks that the researcher might miss certain aspects of an event as viewed by people in another culture. Furthermore, the definitions or concepts provided by existing instruments might not exist at all in another culture. (Brislin, 1986). The disadvantages were eliminated in this research by consulting experts in the field as a result of the pilot study.

Three steps were taken in developing the items in the questionnaire: its acquisition, modification and translation. As suggested by Brislin (1986), by doing the literature review prior to the actual research, or by pre-testing, certain ambiguities or concerns could be brought out, prior to the data collection. All items were obtained from previous studies, the constructs and items were applied to different areas for study which were set in different countries with different cultures. Most of the items were measuring different technologies in adoption studies, therefore, certain modifications were required. Moreover, in order to get accurate translation results for data collection, modifications were usually done with existing instruments (Brislin, 1986). By following applicable guidelines based on experience in preparing instruments for measuring in more than twenty languages as suggested by Brislin, (1980) and Brislin (1986), such as to '*avoid metaphors and colloquialisms* (pp145); *use specific rather than general terms* (pp147)*; avoid words indicating vagueness regarding some event or thing* and *Use wording familiar to the translators* (pp148).', the researcher had a better and clearer understanding of the item in English, found the available Chinese language equivalent while avoiding the use of unfamiliar terms, and the items in Chinese would eventually be made readily understandable to the respondents. The items were modified during the process, when necessary, to fit the research subject and were then ready for translation.

To get an accurate translation and to avoid certain ambiguities, it is recommended that the technique of back-translating for cross-cultural and cross-language research is used. Brislin (1986) suggested back-translation and decentring for the translation procedure. Back-translation is defined as a procedure where "*an original translation would render items from the original version of the instrument to a second language, and a second translator—one not familiar with the instrument—would translate the instrument back into the original language*" (Geisinger, 1994, pp306). However, Hambleton (1993) argued that there has been evidence showing that if a translator knew that the work is to be back-translated, there would be a change in wording in order to ensure the second translation would reproduce the original text faithfully instead of using the most appropriate wording in the target language.

In order to resolve the issue argued by Hambleton (1993), the researcher adopted the technique suggested by Brislin (1986), which is to repeat the translation procedure for more than one round. To repeat the translation procedure, more than one translator is needed to work as a team. Each translator works with the finished result from the previous translator and each work independently.

This procedure is named decentring since no language is at the centre of the attention. The procedure can be repeated even more times, and the researcher then compares the final back-translated version with the original version. If there are no non-negligible discrepancies, the translation is assumed to be etic as '*there must be readily available words and phrases in the two languages which the translators could use*' (Brislin, 1986, pp160); otherwise, it is emic which indicates the concept might be only expressible in one language.

The researcher modified the questionnaire for it to be ready for translation. The researcher translated the questionnaire from English into Mandarin. It was then back-translated to ensure its accuracy by a native Mandarin speaker who had an English major in University and had passed a top-level (Level 8) national English test in China and had acquired a master's degree in one of the top ten Universities in the UK. The translation procedure was, however, only repeated once instead of it going onto the decentring process due to both the cost of time and the cost of translators.

5.5.4 Questionnaire

The questionnaire contains two parts; the first part includes two questions that require specific answers, i.e. the dependent variable question, which is whether the directors' hospitals were going to adopt MHS in the next three years, and also what the respondent's hospital level was. The second part consists of the Likert-Scale questions that are close-ended, which include constructs in the technological context (perceived ease of use, perceived usefulness, compatibility, IT infrastructure, system security and privacy of patients and system reliability), the organisational context (top management support, hospital level and organisational, i.e. hospital readiness) and the environmental context (government policy and regulation and external pressure).

The choice to use Likert Scale questions was due to the scale; they are a tool that can be used in quantitative data analysis (Ghauri and Grønhaug, 2005); and because the measures are derived from previous studies and modified, the use of Likert Scale questions is consistent with previous studies and is supposed to have comparable results.

5.5.5 Sampling

Representativeness is referring to the extent that the sample selected has the same distribution of characteristics as the original population. A sample can be called representative of the population if the characteristics it possesses are a close approximation to the same characteristics of the population, although only the part relative to the study should be representative (Babbie, 2012).

Probability sampling is used for choosing samples for the quantitative research of this study; it ensures that a sample of choice is representative of the population by using random sampling so that every sampling element within the sampling frame has an equal chance of being selected (Neuman, 2002). However, even when EPSEM (equal probability of selection method) is used in sampling, samples would rarely if ever fully represent the population from where they are selected. Still, evidence shows that samples selected by adopting a probability sampling method could generally provide more representativeness than when using other methods (Babbie, 2012).

Table 5.3 Public Hospital Comparison by Level, 2016, Source: China Statistics Yearbook of Health and Family Planning, (2017)

	Level 3	**Level 2 & Level 1 Combined**	**Level 2**	**Level 1**
Total Visits (10,000)	162,784.8	143,457.4	121,666. 5	21,790.9
Inpatients (10,000)	7,686.2	8,609.6	7,570. 3	1,039. 3
Hospital Bed Utilisation Rate	98.8%	-	84. 1%	58.0%
Average Income per Hospital (10,000 Chinese Yuan)	77,310.6	-	11,517.4	1,261. 6
Average Expenditure per Hospital (10,000 Chinese Yuan)	75016. 0	-	11,231. 0	1246.8
Hospital Medical Personnel	2,899,421	3,051,383	2,565,213	486,170
Number of Hospital Beds	2,213,718	2,820,724	2,302,887	517,837

The sampling of the hospitals is random, based on probability sampling in order to avoid the biases that could be caused by choosing only the convenient samples which '*runs a high risk of introducing biases into the samples*' (Babbie 2012, pp132). Random selection is a crucial part of probability sampling since each element has an equal opportunity of being selected regardless of any other events. In the context of Chinese healthcare, hospitals above and below level three have distinctive characteristics (Table 5.3). The researcher deliberately chose 50% of hospitals that are above level three and the rest below level three, within which the hospitals are randomly chosen. Final data include a total sample of 87 hospitals, where 51.7% of the sample hospitals is below level three and 48.3% is above level three (Table 5.4). The randomly selected samples give a representativeness of the whole population, but as argued by Babbie (2012), the researcher is aware that the sample can seldom be perfect.

Table 5.4 Sample Characteristic

Hospital Level		**Number**	**Percentage**	
Below 3	1	9	10.3%	51.7%
	2	36	41.4%	
Above 3	3B	8	9.2%	48.3%
	3A	34	39.1%	

5.5.6 Respondents

In the management structure of Chinese hospitals, the director of the hospital is the most important person in that particular hospital. Every big decision is either made or has to be approved by the hospital director. The researcher was informed of this information during the pilot study. However, the hospital director does not necessarily have a better understanding of IT; also it is extremely difficult, if not impossible, for the researcher to get hold of every public hospital director in the intended hospitals especially in the large level three hospitals. The researcher, therefore, chose as respondents' department directors who are in the management team of the hospitals, as those department directors play significant roles in the hospitals' operation and could affect the decision-making of the director of the hospital.

5.5.7 Fieldwork

The questionnaire was rectified using data gathered from the pilot study. The researcher went back to China again in 2016 in order to administer the field survey and where possible, start the final qualitative phase three of this study. The entire phase two questionnaire survey lasted for about three to four months.

The directors of various department in different hospitals were chosen as the main respondents of this study. The hospitals were randomly chosen within the sampling frame. The directors were contacted via telephone or WeChat by the researcher to ensure their participation, and a very good response rate was secured. A total of 100 directors were contacted, 50 working in hospitals with a level higher than three, the remaining 50 working in hospitals lower than level three. The final number of questionnaires collected was 91, with the very high response rate of 91% due to the network of healthcare professionals that the researcher has been in contact with. Four out of the 91 collected were not usable as the questionnaires were incomplete and no follow-up forms were signed. The final number of usable returned questionnaires was 87.

The main survey was conducted in two ways; in the province of Gansu, it was conducted by an interviewer-administered survey, which is also the place the interviewer started the survey. The researcher called the interviewees prior to the visits to interview them; still, there were cases where the interviews had to be cancelled due to emergency events. To ensure the efficiency of the interviews, all the visits were arranged in the daytime during normal working hours. Where a visit was successful, each interview took around 20 minutes for the directors to finish the questionnaire, and the directors seemed very busy and did not have much time to answer any extra questions apart from filling in the questionnaire; this was the cause of the change of method at the end of the visit to Gansu.

Because of the extremely limited time the researcher was given during the survey interviews and the times when, due to emergency events the interviews had to be cancelled, the researcher chose to use email as the way of making contact with the directors instead of the interviewer-administered survey in and around Shanghai. The directors were contacted first by either telephone or WeChat for their confirmation of participation, then the questionnaires were sent via email. The directors were asked to contact the researcher should there be any questions regarding the questionnaire.

5.5.8 Data Analysis

The researcher has followed the route of surveys in a similar field that many previous researchers have taken in innovation adoption studies within a healthcare background (Sezgin and Özkan-Yıldırım, 2016; Dwivedi, *et al.* 2016; Tsai, 2014; Hung *et al.,* 2012; Wu *et al.,* 2011; Hu *et al.*, 1999). After the acquisition of data, the researcher has chosen a highly quantitative approach to analyse the data. Quantitative analysis is defined as '*The numerical representation and manipulation of observations for the purpose of describing* *and explaining the phenomena that those observations reflect*' (Babbie, 2012, pp414). The use of quantitative analysis is in line with many previous publications (Wang *et al.*, 2016; Awa and Ojiabo, 2016; Gutierrez *et al.*, 2015; Ramdani *et al.*, 2009; Kuan and Chau 2001) and is a common method in the adoption of IT studies, as the goal is to validate and test the TOE model the researcher developed for MHS adoption in hospitals. The method used for this purpose was logistic regression. This choice of logistic regression was because the dependent variable was binary, since *'logistic regression is the preferred method for two-group (binary) dependent variables due to its robustness, ease of interpretation, and diagnostics'* (Hair *et al.,* 1998, pp330). This has been aligned with previously validated studies (Wang *et al.*, 2016; Awa and Ojiabo, 2016; Ramdani *et al.*, 2009; Chau and Tam, 1997).

5.5.9 Logistic Regression

Hosmer and Lemeshow (2013) stated that the distinction between the logistic regression model from the linear regression model is that the dependent variable in logistic regression is binary or dichotomous. To deal with a dependent variable that is dichotomous, OLS (ordinary least squares) or linear discriminant function analysis were traditionally used; however, both methods were later found to be problematic for dealing with dichotomous outcomes because of the strict statistical assumptions, which are '*linearity, normality, and continuity for OLS regression and multivariate normality with equal variances and covariance's for discriminant analysis*' (Peng *et al.,* 2002, pp3). The use of logistic regression to solve the dichotomous issue can be traced back to the late 1960s and early 1970s (Cabrera, 1994), as a logistic model assumes that the relationship between an independent variable and a dependent variable can be represented as a logistic function (Cleary & Angel, 1984).

The logistic regression was used to analyse and validate the model because the dependent variable is dichotomous, i.e. the question is whether hospitals would adopt MHS or not. In previous research a similar logit model was developed, used and validated in the study of innovation adoption (Chau and Tam, 1997; Kuan and Chau, 2001; Zhu *et al.* 2003; Pan and Jang, 2008; Soares-Aguiar and Palma-dos-Reis, 2008; Ramdani *et al.,* 2009).

The equation used to describe the outcomes is seen in the equation at 5.1.

$$\hat{Y}_i = \frac{e^u}{1+e^u} \quad (5.1)$$

In this equation the $\hat{Y}$ is the dependent variable, which is the probability of '*one outcome or another based on a nonlinear function of the best linear combination of predictors*' (Tabachnick & Fidell, 2007, pp440), and can be one of two outcomes. $\hat{Y}_i$ is the estimated probability of the *i*th case (*i* = 1,….., n), where u is the general linear regression equation.

$$u = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k \quad (5.2)$$

In the equation at 5.2 α is the constant (or intercept), βs are coefficients, and Xs are predictors for k predictors.

The simple logistic model form (5.3) thus is derived by creating the logit of the odds from the linear regression equation (5.2).

$$\ln\left(\frac{\hat{Y}_i}{1-\hat{Y}_i}\right) = \alpha + \sum \beta_k X_k \quad (5.3)$$

The equation at 5.3 shows the natural log of the probability of having one outcome divided by the probability of having the other outcome, thus the linear regression equation. Tabachnick & Fidell (2007) argued that the objective is to ‘*find the best linear combination of predictors to maximize the likelihood of obtaining the observed outcome frequencies’* (pp440).

Applying the logistic regression in the current study, taking equation 5.2 into equation 5.1, the probability of the adoption of MHS in the hospital is equation 5.4:

$$\hat{Y}_i = \frac{e^{\alpha + \beta_1 X_1 + \cdots + \beta_k X_k}}{1 + e^{\alpha + \beta_1 X_1 + \cdots + \beta_k X_k}} \quad (5.4)$$

Equation 5.4. shows $\hat{Y}_i$ being the probability of the *i*th event, α is the intercept, βs are coefficients and Xs are the set of predictors (Peng *et al.*2002; Tabachnick & Fidell, 2007).

5.5.10 Empirical Model

This research uses direct logistic regression, where all predictors are input into the equation simultaneously; this is due to the hypotheses in this study having no specific requirement about the input order or significance of independent variables (Tabachnick & Fidell, 2007).

The non-use of structural equations modelling (SEM) is due to the aim of this thesis, i.e. to find the relationships between adoption and various constructs (independent variables); the relationships between independent variables are not the purpose nor concern of this research. Moreover, some SEM applications treated ‘*binary and ordered categorical variables as if they were normally distributed*’ (Kupek, 2006, pp2), which is also a deterrent for the wider use of SEM. Therefore, the logistic regression is the best option for the purpose of this study.

Based on the TOE framework for MHS adoption in Chinese hospitals, applying the logistic regression equation above, the logistic model is specified as follows:

$$\text{Logit}(p) = \ln(P_i / 1-P_i) = \beta_0 + \beta_1 \times PU_i + \beta_2 \times PEoU_i + \beta_3 \times CM_i + \beta_4 \times SR_i + \beta_5 \times SSPP_i + \beta_6 \times ITI_i + \beta_7 \times TMS_i + \beta_8 \times OR_i + \beta_9 \times HL_i + \beta_{10} \times GPR_i + \beta_{11} \times EP_i + \varepsilon_i$$

Where:

PEoU Perceived Ease of Use	OR Organisation Readiness
CM Compatibility	HL Hospital Level
PU Perceived Usefulness	GPR Government Policy and Regulation
SR System Reliability	EP External Pressure
SSPP System Security and Privacy of Patients	ITI IT Infrastructure
TMS Top management support	

P the probability of MHS adoption

p/(1−p) the Odds

ε_i The error term normally means 0 and variance 1/ N. $(P_i / 1-P_i)$ $\varepsilon_i \approx N\,[0, 1/ N. (P_i / 1-P_i)]$

βs are the coefficients which imply that one unit change in independent variable X will result in β units change in the dependent variable, the likelihood of MHS adoption in hospitals.

5.5.11 Measurement

In any research, the validity of measures is vital and cannot be emphasised enough (Ramdani, 2008). The research in information systems is dynamic and changing constantly, valid measures are essential for the measurement of the particular construct (Straub *et al.* 2004).

Measures are presented in Table 5.5. All the measures have their validity and reliability demonstrated because they were obtained or adapted from previous research. A pilot study with directors in hospitals was also conducted in order to rectify the potentially misleading translations of the measures and to have the validity validated.

Table 5.5 Final Measures

	Construct	Measurement	Sources
Dependent variable	**Adoption of Mobile Health in Hospital**		
Technological Characteristics	**Perceived Usefulness PU**	Multi-items	(Hu *et al.,* 1999), (Davis *et al.,* 1989)
	Perceived Ease of Use PeoU		(Hu *et al.,* 1999), (Moore & Benbasat, 1991)
	Compatibility CM		(Wang, *et al.,* 2016), (Moore & Benbasat, 1991)
	System Security and Privacy of Patients SSPP		(Kim *et al.,* 2008), (Belanche-Gracia *et al.,* 2015)
	System Reliability SR		(Goodhue & Thompson, 1995)
	IT Infrastructure ITI		(Bhattacherjee & Hikmet, 2008)
Organisational Characteristics	**Top Management Support TMS**	Multi-items	(Wang *et al.,* 2016), (Ramdani *et al.,* 2009)
	Organisation Readiness OR		(Venkatesh *et al.,* 2008)
	Hospital Level HL	1 2 3 (A, B, C)	(Ministry of Health, 2009)
Environmental Characteristics	**Government Policy and Regulation GPR**	Multi-items	(Bernroider & Schmöllerl, 2013)
	External pressure EP		(Luo *et al.,* 2014)

Before the survey can take place, '*underlying concepts must be operationalised (made measurable) in such a way that they can be observed to confirm that they have occurred*' (Gray, 2013). Operationalisation is a process that converts variables into elements or factors that can be measured by defining the concepts in order to make them measurable, empirically and quantitatively (Shuttleworth, 2008). The definition of all the variables was developed or extracted and in order to convert variables from conceptual to operational ones, all the variables were operationalised by referring to previous validated studies. Table 5.5 shows the key constructs, their operational measurements and the sources for the measurements.

The measures of all variables apart from hospital level (HL) were the Likert Scale questions in the questionnaire, which are ordinal. The answers can be scored from 5 as in 'Strongly Agree' (SA) to 1 as 'Strongly Disagree' (SD). The hospital level is classed from 1 to 5 and stands for 5 different levels of hospitals. Some items of the measurements are negatively stated, for example '*I find Mobile Health INFLEXIBLE to interact with'.* (This was one option to answer question four under perceived ease of use in the questionnaire). The reason for using negation items in the measures are not only because of the ability to assess the seriousness of the respondents, but also because they tend to be more reliable when measuring. Marsh *et al.* (1984) argued that the reason for the questionnaire to include negatively worded items is to '*disrupt a response set where subjects respond favourably or unfavourably to all items*' (Marsh, *et al.* 1984, pp945). The negation items and the reverse scoring for the negatively worded items have been used extensively in field surveys in order to either guard against acquiescent behaviours (Cronbach, 1950) or to stop the tendency for respondents '*to generally agree with survey statements more than disagree*' (Barnette, 2000, pp361).

As the result of using negatively worded items, the scoring method for them is reversed. This was mentioned by Cronbach (1950) when doing data analysis; for instance, if the respondent chose 'Strongly Agree' with '*I find Mobile Health INFLEXIBLE to interact with*', instead of scoring 5 points for normal 'Strongly Agree' items, the answer scores 1 point.

The validity of constructs is proven by adopting previously used and validated measurements from acclaimed journal articles; moreover, the findings can be used to compare with previous studies that have used similar measurements in the same field of study.

5.5.12 Validity and Reliability

Straub (1989) argued that researchers of information systems would have to validate the research instruments. To ensure the model and measurements are fit and accurate, validity and reliability were tested. Validity is "*a term describing a measure that accurately reflects the concept it is intended to measure*" (pp191) and refers to '*the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration'* (pp191), and reliability is '*a matter of whether a particular technique, applied repeatedly to the same object*, *yields the same result each time'* (Babbie, 2012).

Validation of instruments, which includes content validity, construct validity and reliability, should be done prior to other core empirical validity (Cook and Campbell, 1979; Straub, 1989). The instrument of validation is required to ensure that '*constructs are likely to be real and reliable and the instrument is likely to be measuring the right content'* (Straub *et al.,* 2004, pp384). Babbie

(2012) also mentioned that face validity, criterion-related validity (or predictive validity), construct validity and content validity can be used to judge validity in several criteria.

Construct validity '*is an issue of operationalisation or measurement between constructs'* (Straub *et al.,* 2004, pp388), which is ensured because measures used in this research were taken or adapted from the previous study in the same field that was published in renowned academic journals.

Predictive validity '*establishes the relationship between measures and constructs by demonstrating that a given set of measures posited for a particular construct correlate with or predict a given outcome variable'* (Straub *et al.,* 2004, pp398). Similar to construct validity, predictive validity is validated as the constructs and measures were both extracted and adapted (measures) from reputable previous studies, from renowned academic journals.

Face validity implies that '*a test which is to be used in a practical situation should, in addition to having pragmatic or statistical validity, appear practical, pertinent and related to the purpose of the test as well; i.e., it should not only be valid, but it should also appear valid*' (Mosier 1947, pp192).

Content validity, sometimes referred to as instrumentation validity (Straub *et al.,* 2004), is a representation problem. Content validity validates whether the instrumentation (questionnaire items) is representative enough in order to measure the content of a construct (Cronbach and Meehl, 1955; Straub *et al.* 2004).

Face validity and content validity were ensured in this research by conducting a pilot study which included eight semi-structured interviews with eight directors and experts in three different hospitals to test and rectify the constructs and questionnaire items before carrying out the second phase survey. By doing a pilot study, measurements with potential misleading wording and ambiguities were corrected, and the content of questionnaire was checked to see that it met the intended purpose.

Factor analysis was also tested in order to further strengthen the validity of the model. As indicated in Table 5.6, all factor loadings were greater than 0.5 (Hair et al., 2010) which indicate that all factors fit well in the model and none should be eliminated.

Table 5.6 Factor Analysis

	PU	PE	SC	SS	ITI	SR	TMS	OR	GP	EP
PU1	.603									
PU2	.825									
PU3	.727									
PU4	.878									
PU5	.584									
PU6	.821									
PE1		.621								
PE2		.820								
PE3		.773								
PE4		.631								
PE5		.739								
PE6		.707								
SC1			.694							
SC2			.836							
SC3			.663							
SS1				.930						
SS2				.896						
SS3				.832						
ITI1					.688					
ITI2					.859					
ITI3					.721					
SR1						.821				
SR2						.956				
SR3						.772				
TMS1							.719			
TMS2							.819			
TMS3							.897			
OR1								.877		
OR2								.859		
OR3								.628		
GP1									.873	
GP2									.880	
EP1										.702
EP2										.823
EP3										.895
Eigenvalue	2.748	4.330	4.039	2.653	2.367	2.686	2.250	2.152	1.711	1.355
Variance	7.634	12.028	11.221	7.369	6.576	7.460	6.251	5.978	4.752	3.764

Extraction: principal component analysis
Rotation: orthogonal factor rotation

Compared with construct validity, which is the measurement problem between constructs, reliability is the measurement problem within a construct. The reliability test is used to ensure that the measures that '*should be related to each other within the same construct are, indeed, related to each other*' (Straub *et al.* 2004, pp406). If the reliability of the measures cannot be ensured, the data cannot be fully trusted and is not scientifically convincing. Straub *et al.* *(*2004) argued that reliability is, therefore, mandatory for scientific veracity. Cronbach (1951) stated that reliability is an assurance about the accuracy of measurements. In quantitative research, reliability can be tested by Cronbach's Alpha test which contains several sections.

5.5.13 Cronbach's Alpha

Table 5.7 Cronbach's Alpha

Cronbach's Alpha		**N of Items**
.800		11
	Corrected Item-Total Correlation	**Cronbach's Alpha If Item Deleted**
PU	.547	.778
PeoU	.622	.778
CM	.468	.786
SR	.584	.778
SSPP	.320	.797
ITI	.354	.794
TMS	.686	.764
OR	.552	.778
HL	.279	.799
GPR	.417	.790
EP	.546	.777

To test the reliability, Cronbach's Alpha is used to measure the internal consistency reliability, which is a widely-used reliability test indicator. The value of alpha is between zero and one, the higher the value, the higher the reliability. As shown in Table 5.7, the alpha of the model is 0.800, which indicates the model is a very good fit as Gliem and Gliem (2003) stated that the model is acceptable when the alpha is greater than 0.7 and is good when the alpha is greater than 0.8. There are other interpretations such as Nunnally's rule of thumb, which allows the lowest alpha value to be 0.6 for exploratory research and 0.7 for confirmatory research (Nunnally, 1967). Contrary to the general idea of the higher the better, Straub (2004) argued that if the alpha value reaches or is greater than .95, the reliability would be highly suspicious.

Beyond the Cronbach's Alpha value test of the model itself, the 'Item-Total Correlation' and 'Alpha If Item Deleted' are tested for further reliability validation. Gliem and Gliem (2003) argued that one of the most essential indicators is Cronbach's 'Alpha If Item Deleted'; it indicates what the alpha value of the model is when an individual item is removed. As shown in Table 5.7, the Cronbach's Alpha value suffers a decrease when each individual item is removed, which indicates all the items fit well and there is no need to remove any of the 11 constructs.

Item-total correlation has been widely used to check the homogeneity of a scale that consists of several items. The rule of thumb is that the result of the correlation of any item should exceed the number of 0.20. If the result is lower than the cut-off value of 0.2, that particular item should be dropped (Everitt and Skrondal, 2002; Streiner *et al.* 2015). In Table 5.7, it is clearly shown that all the predictors have an Item-total correlation above the cut-off point of 0.2, with only one below 0.3, and 8 out of 11 constructs have a value above 0.4 which indicates a very good discrimination.

Overall, the reliability of the model is confirmed by the Cronbach's Alpha test.

5.6 Phase Three: In-Depth Qualitative Study

5.6.1 Design

Phase three of this research used an explanation approach, as the purpose of phase three of the study is to answer all the 'why's: to be specific, to answer why certain factors are found to be significant or insignificant in a hospital's MHS adoption decision-making, why certain hospitals adopt while others do not, and why hospitals adopt MHS at all?

5.6.2 Data Collection

The third and final phase is the qualitative research which enables the researcher to unveil the reasons behind the adoption of MHS in hospitals as well as the reason behind the significance of factors. This phase was done by conducting in-depth interviews with one department director and one doctor in one same hospital, a total of six interviews in three hospitals in two cities were conducted. The in-depth interview has been used by many researchers as a technique for data collection (Johnson, 2002), in adoption studies (Liang, *et al.,* 2017) as well as in healthcare adoption studies (Cao *et al.,* 2014). The in-depth interview offers great depth and advantages; however, it also has certain risks, dangers and some ethical concerns such as the involvement of the researcher (Gubrium and Holstein, 2001). Gubrium and Holstein (2001) also confirmed that in-depth interviews are seldom conducted in isolation and serve as a sole data source in research. They are usually used in combination with data collected through other methods.

All six interviews were conducted by telephone. The telephone interview method was argued to be a versatile tool for data collection. Telephone interviews may actually allow informants to feel more free to disclose sensitive information (Novick, 2008) and is especially suitable for research interviews (Hopper, 1992). Compared with face-to-face in-person interviews, telephone interviews have many advantages (Novick, 2008), such as taking much less time and financial cost (Babbie, 2012; Chapple, 1999), increased access due to there being no geographical restraint (Sturges and Hanrahan, 2004), less space requirement (Sweet 2002), increased interviewer safety (Sturges and Hanrahan, 2004; Carr and Worth, 2001), ability to take notes unobtrusively (Carr & Worth, 200;1 Sturges & Hanrahan, 2004), more privacy for both parties (Sturges & Hanrahan, 2004), and allowing informants to remain comfortable, decreasing social pressure and increasing rapport (McCoyd & Kerson, 2006).

However, the most criticised aspect of telephone interviewing of telephone interviewing is the absence of visual cues, which includes the loss of nonverbal and contextual data and the loss or distortion of verbal data (Novick, 2008; Opdenakker, 2006; Sturges and Hanrahan, 2004; Sweet 2002; Chapple 1999; Cresswell, 1998). Yet, nonverbal data is not always essential or helpful, and it can be easily misinterpreted (Novick, 2008; Chapple 1999; Sturges and Hanrahan, 2004; Burnard 1994), not to mention that '*these data may not actually be used extensively in analyses that rely heavily on transcripts rather than on field notes'* (Novick, 2008, pp395). The contextual data is irrelevant in this study because the information required was MHS adoption related thus the surrounding environment of the informants did not matter at all. It has been argued that rapport might be reduced by using telephone interviews, where developing rapport is important to qualitative research interviews (Sweet 2002); however, informants might actually feel more relaxed without the interviewer's presence (Novick, 2008; Opdenakker, 2006; Chapple 1999). Moreover, before the formal interview process started, the researcher intentionally took a little time to chat with the informants in order to build rapport. Although it is argued that ‘*loss or distortion of data may occur if telephone interviews inhibit probing or in-depth discussion’* (Novick, 2008, pp396), others have stated that the quantity and quality of data obtained from telephone interviews are not affected compared with face-to-face interviews (Sturges & Hanrahan, 2004; Sweet, 2002). Moreover, Carr and Worth (2001) argued that the less probing behaviour during conversation pauses might actually enable the informants to reveal more than what might otherwise have been if they had been interrupted by the interviewer during a face-to-face interview.

5.6.3 Sampling and Informants

Phase three has also applied purposive and snowball sampling methods because the researcher needed trustworthy informants who would concentrate, would like to share their real thoughts with the researcher and would also sign the follow-up research forms. The purpose of this phase could not have been properly achieved if random sampling had been used because the quality of informants could not be guaranteed. Therefore, nonprobability sampling, purposive and snowball sampling in this case, fits this part of the research well. The three initial informants from three hospitals were chosen because, based on the contacts researcher had with them during the previous research phases, they showed great interest in the research and were being quite helpful; they also informed the researcher of their willingness to continue to participate in the research, and so it is expected that they would be likely to share their true thoughts with the author during the interviews. The rest of the informants were recommended by each of the initial interviewees during the interview process until the saturation point was reached. As a result, a total of six informants were selected and were from three hospitals (two in each hospital) in two regions.

5.6.4 Informants

The researcher chose as initial informants one director of the IT department in a level 3A hospital in Shanghai (D11), one director of a clinic laboratory in a level 3B hospital in Shanghai (D21) and one director of a urology department in a level 3A hospital in Gansu (D31); the initial informants recommended to the researcher one director of a sub-department in a level 3A hospital in Shanghai (D12), one doctor who is familiar with IT related issues in a level 3B hospital in Shanghai (D22) and 1 doctor who is familiar with IT related issue in a level 3A hospital in Gansu (D32). The reason for choosing all 3 informants who work in level 3 hospitals is that those three informants were more likely to share the true opinions with the researcher as they had been very helpful in the previous stages of this research and were interested in continuing to offer their help in this research. The informants varied from department to department, and this was the intention of the researcher as the qualitative research validity could be increased by using multiple sources of data (Yin, 1994); also the wider view from the different departments' perspective would definitely deepen the understanding behind the research questions.

Table 5.8 In-depth Interview Informants

Hospital Level & Location	Informants	Position
3A Shanghai	D11	Department Director
	D12	Sub-Department Director
3B Shanghai	D21	Department Director
	D22	Doctor
3A Gansu	D31	Department Director
	D32	Doctor

5.6.5 Fieldwork

The final phase of the study was conducted in early 2017, after the analysis of the data acquired from the survey. The purpose of the qualitative study is to probe for the reason why certain factors are significant while others are not in the quantitative result and to unravel the reasons behind hospital adoption of MHS.

For this study, a total of six in-depth interviews were conducted and was done by telephone interview. All six informants were contacted via email or social media, such as WeChat, first to determine the time for the interview as the researcher assumed each interview would take no less than one hour to finish. The researcher then contacted each informant by Skype call, each semi-structured interview lasting around one hour. During the entire interview process, certain biases were avoided by the researcher. For example, the "I-can-answer-any-question-bias" was eliminated by the researcher by always probing for more if the researcher suspected the informant was trying to answer something that they had no knowledge of. (Breislin, 1986).

5.6.6 Data Analysis

Although regression analysis could disclose the relationship between variables, it does not show the causality, as causality usually cannot be demonstrated by statistical analysis (Tabachnick and Fidell, 2007). Qualitative analysis is '*the non-numerical examination and interpretation of observations, for the purpose of discovering underlying meanings and patterns of relationships. This is most typical of field research and historical research'* (Babbie, 2012, pp390). This phase of the study is set to provide insights and deepen understanding of the reasons behind not only the adoption of MHS, but also the reason that certain factors are found to be significant but others are not. There is no better way to have the question investigated than the qualitative method because by applying a qualitative in-depth interview, insight and deeper understanding can be gained as the qualitative approach puts the emphasis on understanding (Ghauri, and Grønhaug, 2005).

After the interview, all the recordings were transcribed and translated into English and then coded for better understanding of the data. As Babbie (2012) has stated, '*The key process in the analysis of qualitative social research data is coding — classifying or categorizing individual pieces of data*' (pp396). It is suggested by Strauss (1987) and Neuman (2002) that the researcher should review the qualitative data on three occasions and use one of the three different coding methods each time. The first stage is to open code the qualitative data where the data are prepared into '*preliminary analytic categories or codes*' (pp481); the next stage is the axial coding, which is to organise and link the codes in order to disclose the major analytic categories; the third and final stage, the selective coding, is to examine the codes so that the data that '*supports the conceptual coding categories that were developed*' can be identified and selected (Neuman, 2002, pp484). The researcher has followed the three stages of the coding method in his qualitative data analysis.

5.6.7 Trustworthiness

The researcher has used the data collection method suggested by Yin (1994) and the four criteria of trustworthiness argued by Guba (1981) in order to ensure the rigour, trustworthiness and quality of the qualitative research.

The sample size was determined by saturation, in other words, by the interview results. Glaser and Strauss (1967) argued that the researcher can only count the number of samples at the end of study instead of knowing it at the beginning. Mason (2010) mentioned that the sample size of a qualitative study must be large enough to ensure that most of the important issues are uncovered but not too large so that the data are repetitive, and suggested the researcher follow the concept of saturation argued by Glaser and Strauss (1967). The author determined the saturation point was reached when not much further light was shed after collecting the new data. Yin (1994) suggested the use of multiple sources of data to increase the construct validity (Cao, *et al.,* 2014).

The informants consisted of three directors from different departments, a director of a sub-department, and two doctors from other departments. In order to ensure the trustworthiness of the qualitative study, four aspects of trustworthiness put forth by Guba (1981) were checked; these are: credibility compared to internal validity in quantitative research, transferability compared to external validity, dependability compared to reliability and confirmability compared to objectivity (Krefting, 1991). The researcher followed the methods argued by Shenton (2004) to ensure the trustworthiness of all four criteria.

Credibility was ensured because firstly, the research method adopted was well established as the questions in the data gathering session, i.e. the interview questions, as well as the method of data analysis, were derived from previous innovation adoption studies; then the honesty of informants was ensured because of the sampling methods, i.e. the purposive and snowball methods the researcher had used.

Transferability was established because all the information, which consisted of the participating organisation numbers, the location, the informants' attributes, the number of informants, the data collection methods, and the time period of the data collection, (Shenton, 2004) was disclosed in this thesis.

The thesis has also discussed in detail the research design, sampling and fieldwork to secure the dependability.

As for the confirmability, a decision trail (Sandelowski, 1986), especially regarding the research design, sampling, data collection methods and data analysis methods, was left so that an audit can be made by the readers to ensure its trustworthiness (Koch, 2006).

Despite following through various methods to ensure the trustworthiness of the qualitative study, as Patton (1990) argued, it is very difficult to ensure the real objectivity as the questionnaires and tests are also designed by humans; therefore, the researcher's biases that intrude the research are inevitable. Sandelowski and Barroso (2002) expressed a similar opinion; they stated that '*research findings in qualitative research are variously conceived as both a process and product in which the researcher is deeply and unavoidably implicated*' (pp 215).

The use of both qualitative and quantitative methods and data for analytic process can be quite time-consuming and costly (Driscoll *et al.,* 2007), but the chance to provide additional information by using both of the methods cannot be missed; some key insights were acquired during the process which helped the researcher to have a better and clearer understanding of the research questions. There are benefits that using both methods bring, such as being able to provide insight and to correct the survey questionnaire before the main survey by doing a pilot study, being able to explain rather than to guess why certain factors are found significant while others are not, being able to explain why hospitals adopt by doing the in-depth interviews; and these together outweigh the disadvantages that the use of the combination of the methods potentially have.

5.7 Summary

This chapter has discussed the issues relating to the research methods. Starting from the research stages which introduced the research order and the three phases of the research, this chapter then discussed the research design of the entire study, which includes the design for all three phases of the study. It went on to explain how data were collected, for both quantitative and qualitative data. The chapter then discussed how acquisition, modification and translation were done with the research instruments and how the final questionnaire was designed. Following that, the unit of analysis was discussed, which led to the sampling-related discussions. After that, the chapter went into the realm of the fieldwork, which included a pilot study, a field survey and an in-depth interview and how each of them was done. After the data collection in the field, there was then discussion on how the data was analysed.

Phase one of the study was the pilot study, which used a qualitative approach that included eight face-to-face semi-structured interviews with directors and doctors in three hospitals in two regions. The pilot study finalised the proposed framework by amending, adding and eliminating the initial constructs as well as validating the validity. With the finalised framework, phase two, the main survey was conducted. The main survey applied the quantitative method for data collection from 87 hospitals in two regions in order to find out the significant factors that impact the adoption decision of MHS in Chinese public hospitals. The collected data were analysed using logistic regression, the result was then transferred to phase three's qualitative in-depth interviews. In phase three's qualitative research, six in-depth interviews were conducted with directors and doctors in three hospitals. The data gathered were then put through the three stages of the coding process in order to answer the 'why' questions. The findings of all three phases are presented in the next chapter.

Chapter 6 Findings and Discussion

6.1 Introduction

This chapter starts by providing the result of the phase one pilot study. Then, the findings from the quantitative survey in phase two are discussed. Moving on from the brief introduction of the data, the full analysis result will be presented and discussed, including the model, result and model test. This chapter then focuses on the phase three qualitative part of this study. For all three characteristics, i.e. the technological, organisational and environmental characteristics, for each construct and each hypothesis, a detailed explanation from the qualitative research via in-depth interviews is given. The coding and qualitative result will also be presented in this chapter.

6.2 Phase One: Pilot Study Findings

In order to test and validate the draft framework, to add any potentially omitted factors derived from the research literature, to confirm and rectify the factors in the draft framework, as well as to do an initial test of the hypotheses, an empirical pilot study was conducted. The sole purpose of the study was to bring the factors used in the framework as much accuracy as possible, to validate the content (Straub *et al.* 2004), and to ensure the constructs fit in this research context. The pilot study consisted of 8 semi-structured interviews. The results of the pilot study confirmed that all three contexts in draft framework, which are the technological, environmental and organisational contexts, have a strong influence on an adoption decision. The characteristics of the informants of the pilot study can be found in Table 5.2 in chapter five.

6.2.1 Pilot Study Findings

The empirical findings from the pilot study showed that certain factors in the technological and organisational contexts needed to be amended or eliminated while all the factors in the environmental context remained unchanged. In the technological context, one factor has been eliminated, one has been merged with another factor; two new factors were added. In the organisational context, one factor has been removed, one has been merged with another factor and one new factor has been added.

In the technological context, the results of the pilot study indicate that perceived ease of use, compatibility, perceived usefulness, relative advantage, system reliability in draft framework are all influential; moreover, the convenience and system security, which are combined with and extended to usefulness and system security and patient privacy respectively, are found to be initially omitted factors.

- Perceived Ease of Use:

  H21 claimed that PEoU has an impact of between weak and strong, while the rest of the informants agreed that it has a normal to strong impact.

- Perceived Behavioural Control:

  H12 argued that PBC has a normal impact while the rest of the interviewees put PBC as having a weak, or having no influence.

- Compatibility:

  All participants agreed this has a very strong influence in an adoption decision; H21 stated that *'there is no hospital that would consider adopting MHS if it is not compatible with its current system'*.

- Perceived Usefulness:

  All interviewees agreed this is one of the most important reasons that hospitals would adopt any IT innovation. As H31 and H11 stated *'there would be no point adopting anything if it would not enhance the job performance of professionals.'*

- Relative Advantage:

  All interviewees agreed this is a strong factor in an adoption decision. H13 argued that '*For all technology innovations, if there is only a slight improvement compared to its predecessor and the cost is high, it is unlikely that the hospitals are going to adopt'.* Most of the informants, however, suggested combining RA with PU as '*perceived usefulness includes the meaning of relative advantage'* (H21).

- System Reliability:

  This is one of the most important factors agreed by all interviewees. H11, H21 and H31 all claimed that in the healthcare industry, especially in hospitals, unstable systems would cause a huge issue, financially and morally, even legally.

- Omitted Factors and Amendments:

  All interviewees mentioned that MHS will have to bring convenience to the current system. It would have to boost the efficiency of the doctors, nurses and other professionals, as well as to reduce their workload by digitising and mobilising their daily essential work such as patient records and checks.

  H13 mentioned system security first during the interview, and specifically explained the significance of such a feature. The MHS should not only be secured against cybercrimes as this would damage patient privacy, H13 also raised the concern that personnel, who have access to MHS, can now carry all the information anywhere even outside the hospital. This is proven to be a very strong factor as all other interviewees were agreed on it.

From the semi-structured interviews, one thing that every participant argued to be an important factor in MHS adoption is the convenience. MHS would have to enhance the job performance of professionals as well as to reduce the number of tasks at work which are currently necessary because of a lack of mobile health systems. Convenience is combined with perceived usefulness. Apart from the perceived usefulness and perceived ease of use, compatibility, system reliability, security and patient privacy also tend to be significant factors for adoption decisions. Perceived behavioural control has been eliminated; relative advantage is combined with perceived usefulness based on the opinions of the informants.

In the organisational context, it has been found that top management support and facilitating conditions are significant factors while price value is irrelevant and the different hospital levels had divided opinions on this. The current state of the hospital is a factor that was initially omitted; it includes three aspects, the IT infrastructure, the top management and a hospital's readiness. IT infrastructure is added to the technological context and a hospital's readiness is added to organisational context.

- Top Management Support:

  All interviewees claimed that top management support from the hospital is the decisive power for or against an adoption decision. The processes of technology adoption in hospitals are similar in all three hospitals. For an employee requesting technology adoption, they would have to report to the department director; if approved, it would be referred to the hospital director for final approval. For the adoption preferred by top management directly, the employees would not have much voting power on the decision, which could lead to a total waste of time and money, if the innovation is not as useful as top management thought it would be. H13 has demonstrated the latter with a ceiling rail system in her department as it had never been used since its installation.

- Price Value:

  All participants agreed this is irrelevant in a hospital's decision to adoption IT.

- Facilitating Conditions:

  More than half of the interviewees found this factor to be a strong predictor, as H13 had explained; knowing there are supports available for a newly adopted technology is important. All participants agreed that financial resources are needed for adoption.

- Hospital Level:

  Four out of eight participants figured that hospital level has little impact on an adoption decision. H21 also claimed that it is the other way around, i.e. IT level is one of the factors of how a hospital is ranked. However, the rest of the interviewees regarded the hospital level as influential.

- Omitted Factors and Amendments:

  H11 first brought up the 'current state of hospital'. It includes the IT infrastructure of a hospital, the attitude of the top management team and the technical support and financial resources available in a hospital. This factor is then added to the remaining interviews and all interviewees agreed that this is a normal to strong predictor. In this study the 'current state of hospital' has been divided into three parts: the IT infrastructure in the technological context, organisation (hospital) readiness and top management support in the organisational context in this study.

Though half of the interviewees chose hospital level as insignificant, its original form, organisation size, has proven to be a 'good' predictor and is one of the best predictors in organisational technology adoption (Jeyaraj *et al.,* 2006). From the interviews, it was also reflected that the hospitals' current IT infrastructure, as part of the 'current state of hospital', does matter in adoption decision-making. The IT Infrastructure is then added to the technological context. Hospital readiness, as part of the 'current state of hospital' is kept and the 'facilitating conditions' factor has been merged into 'hospital readiness' as the meaning it represents is included in hospital readiness. 'Price value' has been eliminated based on the views of the informants.

It has been found that all the factors in the environmental context are significant.

- Government Policy and Regulation:

  This factor had all the interviewees agreed on this being a very strong influential factor. H11, H13, H21, H22, H23 and H31 all expressed the view that any adoption would be impossible if regulation is opposed to relevant technology. H32 specifically stated that government regulation would definitely facilitate or hinder the progress of any adoption of innovation, if the government is against any technology use, as they could issue new stricter regulations which would hinder the adoption. Therefore, to keep hospitals up-to-date on government regulations is essential for innovation adoption to happen in the healthcare context.

- External Pressure:

  Most of the participants ruled external pressure to be a normal influential factor on adoption decisions. H23 and H32 explained that the reason this factor does not have a very strong impact is due to the lack of competition that a high-level hospital in China is facing.

- Omitted Factors and Amendments:

  H13 argued that in the Chinese context, guanxi is an important factor for any organisation to survive and prosper, especially in public sector industries. H11 later explained that the guanxi between the decision-maker and suppliers' matters. H32 added to the topic that guanxi is especially useful in his city because the smaller a city, the higher the influence of the connection. However, this factor is not added to the final framework due to the argument that H22 initiated, which was then agreed by the others, that guanxi does not matter at all when deciding whether to adopt MHS or not; it only matters after a hospital has already decided to adopt and is choosing which system to get from suppliers.

  It is suspected that most of the interviewees picked external pressure as being only normally influential because the lowest hospital level in the pilot study was 3B, still an above level three hospital, so their competitive advantage against other hospitals in the area is too powerful hence they might have a biased opinion on this factor. The result in the final study in this thesis would demonstrate if this suspicion is true.

  As a factor guanxi (Luo *et al.*, 2014) is a particular part of Chinese culture; although it was argued to be an important factor, it only matters after the adoption decision has been made therefore it is not added to this study.

  It was expected that external pressure would be a strong facilitator initially given the fact that the hospitals have to make a profit to fund themselves just like any private organisations, but the result from the pilot study argued that it has a normal impact.

6.2.2 Pilot Study Summary

The purpose of the pilot study was to bring validity to the framework by having face validity and content validity tested: to confirm, add or adjust constructs in the initial framework, as well as to have the initial hypotheses tested. From the study, it has been found that factors from all three characteristics from the TOE framework are very important elements. By doing the pilot study, it has been argued, but it remains to be tested in the main survey, that perceived ease of use, compatibility, perceived usefulness, system reliability, system's security and privacy for patients and hospitals' IT infrastructure are strong factors in the technological context; top management support, hospital readiness and hospital level as organisational factors all have a strong impact on an adoption decision; government policy and regulation and external pressure, as environmental factors, also influence the adoption of MHS. By doing the pilot study, more insights into the healthcare context in China are gained before the next stage of fieldwork is conducted.

6.3 Phase Two: Survey Results

6.3.1 Rate of Adoption

At the time of the survey, 37 out of 87 respondents were claiming that they were not going to adopt MHS in the next three years. However, 50 out of 87 responded with a positive result reporting that their hospitals either are adopting or are planning to adopt MHS in the next three years. The non-adopting hospitals possessed 42.5% of the total research sample while the adopting parties accounted for the remaining 57.5% (Figure 6.1).

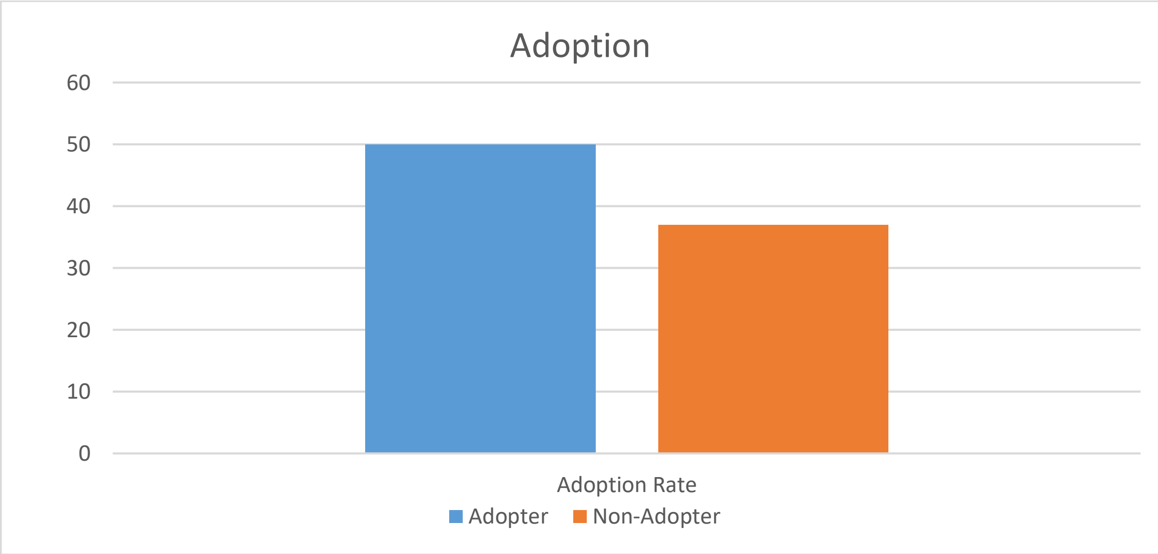

Figure 6.1 Adoption Rate

Among the 87 hospitals, 42 are above level three while 45 are below. In line with the research result that one of the best predictors is the size (Jeyaraj *et al. (*2006), the result of this study shows the alignment. For hospitals above level three, 35 out of 42 were planning to adopt MHS in the next three years, which in percentage terms is 83.33%, while only 18 hospitals below level three were going to adoption MHS, which accounted for only 40% of the total number of hospitals that are below level three (Figure 6.2).

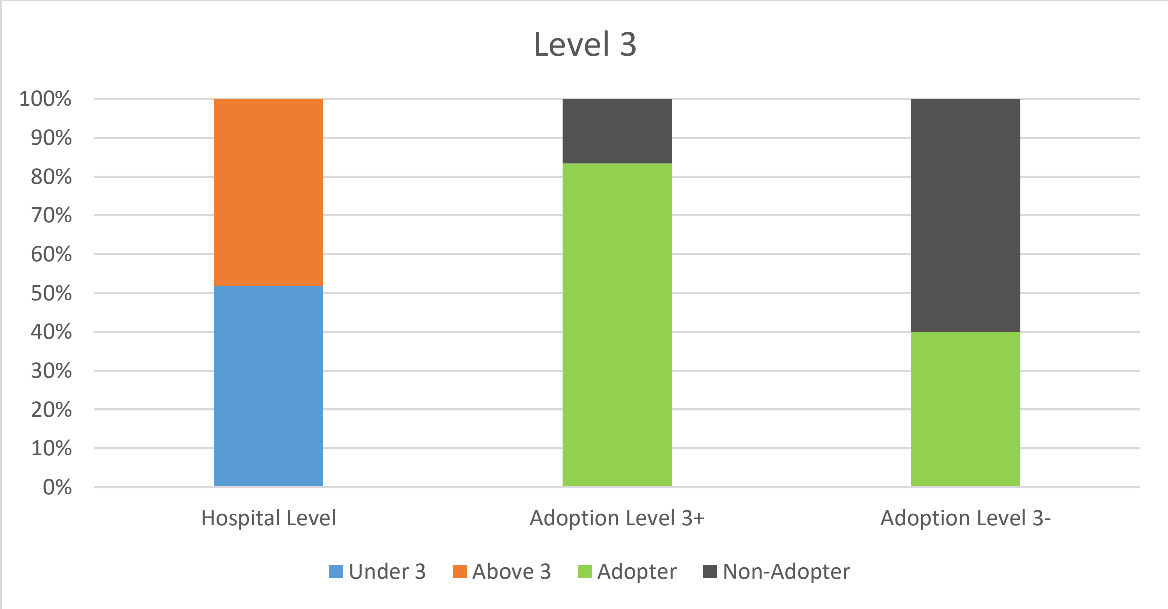

Figure 6.2 Hospital Level

6.3.2 Quantitative Test Result

The model tests each construct within the technological, organisational and environmental contexts which are proposed by the TOE model, and provides the result that shows if a certain construct is significant and how a construct is correlated to adoption.

Table 6.1 illustrates the result of logistic regression, which has demonstrated that the model is a very good fit overall

.

Table 6.1 Phase Two Result

Predictors	B	Wald	Sig.
PU Perceived Usefulness	-.096	.424	.515
PEoU Perceived Ease of Use***	.692	9.406	.002
CM Compatibility	.561	3.083	.079
SR System Reliability**	-1.291	6.123	.013
SSPP System Security and Privacy of Patients**	.473	3.828	.050
ITI IT Infrastructure**	-.574	4.784	.029
TMS Top Management Support***	1.466	9.614	.002
OR Organisation Readiness	.605	2.170	.141
HL Hospital Level***	1.069	8.345	.004
GPR Government Policy and Regulation**	-2.010	6.516	.046
EP External Pressure***	.703	3.972	.005
-2 Log likelihood (Initial Model)		118.658	
-2 Log likelihood (Final Model)		48.249	
Cox & Snell R Square		0.555	
Nagelkerke R Square		0.745	
Chi-square		70.409	

**Significant at 5 Percent Level ***Significant at 1 Percent Level

The initial model with N=87 has a -2 Log likelihood (-2LL) of 118.658, where the final model with N=87 has a -2 Log likelihood of 48.249. As -2LL is a significant drop from the initial model to the final model, it shows the model fits significantly better when it is with the independent variables (Menard, S, 2002). As also suggested by Hair *et al.* (1998), the differences in -2LL would show the improvement from having the set of independent variables to the null model which was without these variables.

Apart from the chi-square test, there are some R^2 – like tests which have been developed in different programs to represent the model fit. Those '*pseudo R^2*' (Hair *et al.,* 1998) measures can be interpreted similar to R^2 as in multiple regressions. The R Square of Cox & Snell shows that 55.5 percent of variables can be explained by the model; however, the Cox and Snell R Square cannot reach 1 (Hair *et al.* 1998). The Nagelkerke R Square shows that 74.5 percent of variables can be explained by the model, which is very high, thus showing a good fit for the model, and the Nagelkerke R Square can indeed reach 1 which can be used as a suitable figure to show the goodness of fit of the model. '*Both of these additional measures are interpreted as reflecting the amount of variation accounted for by the logistic model, with 1.0 indicating perfect model fit*' (Hair *et al.* 1998, pp325), where in this model it can be seen as the result is moderately strong at 0.745.

Hair *et al. (*1998) suggested that to further test the model for fitness and robustness, a researcher could randomly drop a certain number of observations. The researcher chose to drop 10 out of 87 observations and the result (Table 6.2) was almost unchanged. The only notable change was that the significance of the external pressure factor dropped from being significant at 1 percent level to being significant at 5 percent level.

The initial model with N=77 has a -2 Log Likelihood of 106.628, the final model with N=77 has a -2 Log likelihood of 43.259. So, again -2LL is a significant drop from the initial model to the final model in the model that had 10 observations dropped. Moreover, the R Square of Cox & Snell shows that 56.1 percent of variables can be explained while the Nagelkerke R Square shows that 74.8 percent of variables can be explained by the model, so the model has successfully passed the fitness and robustness test suggested by Hair *et al.* *(*1998).

Table 6.2 10 Random Cases Dropped

Predictors	B	Wald	Sig.
PU Perceived Usefulness	-.143	.847	.358
PEoU Perceived Ease of Use***	.695	8.449	.004
CM Compatibility	.553	2.994	.084
SR System Reliability**	-1.345	5.966	.015
SSPP System Security and Privacy of Patients**	.565	4.188	.041
ITI IT Infrastructure**	-.582	3.933	.047
TMS Top Management Support***	1.410	8.149	.004
OR Organisation Readiness	.696	2.267	.132
HL Hospital Level***	1.142	8.159	.004
GPR Government Policy and Regulation**	-2.177	6.530	.011
EP External Pressure**	.802	4.369	.037
-2 Log likelihood (Initial Model)		106.628	
-2 Log likelihood (Final Model)		43.259	
Cox & Snell R Square		0.561	
Nagelkerke R Square		0.748	
Chi-square		63.369	

**Significant at 5 Percent Level ***Significant at 1 Percent Level

6.3.3 Multicollinearity Test

Table 6.3 indicates that no correlation value between independent variables is greater than 0.9 which indicates the model is not likely to have a multicollinearity issue (Hair *et al.,* 1998).

	HL	PeoU	CM	PU	SR	SSPP	ITI	TMS	FC	GPR	EP
HL	1.000										
PEoU	.531	1.000									
CM	.384	.394	1.000								
PU	-.122	-.277	-.247	1.000							
SR	-.554	-.734	-.481	-.054	1.000						
SSPP	.471	.512	.278	.005	-.497	1.000					
ITI	-.202	-.440	-.366	.054	.507	-.368	1.000				
TMS	.567	.659	.489	-.235	-.694	.454	-.594	1.000			
FC	.269	.456	.440	.048	-.612	.476	-.496	.516	1.000		
GPR	-.562	-.786	-.579	.250	.708	-.575	.470	-.824	-.634	1.000	
EP	.575	.469	.332	-.098	-.496	.399	-.207	.512	.187	-.643	1.000

Table 6.3 Correlation

The variance inflation factor is related directly to the tolerance value; a large VIF value indicates a high possibility of multicollinearity among the independent variables. All the tolerances are greater than 0.1, none are above 0.9 which could be suspicious; no variance inflation factor (VIF) value is greater than the cut-off value of 10 (Hair *et al.,* 1998, 2010). Moreover, all of the VIF values are less than the cut-off value of maximum 5 (Rogerson, 2001) or even 4 (Pan & Jackson, 2008), which strengthens the indication that there is no multicollinearity issue in the model between independent variables.

Table 6.4 VIF (Variance Inflation Factor)

Collinearity Statistics		
	Tolerance	**VIF**
HL	.742	1.347
PEoU	.528	1.896
CM	.735	1.360
PU	.638	1.567
SR	.567	1.764
SSPP	.841	1.188
ITI	.742	1.347
TMS	.475	2.106
FC	.564	1.773
GPR	.564	1.773
EP	.543	1.840
Dependent Variable: Adoption		

On top of the ordinary variance inflation factor test, the value of each independent variable has been tested by setting every independent variable as dependent variable consecutively and testing it against the rest of the independent variables (Table 6.5).

The result again shows a very good result as no variance inflation factor value is greater than the cut-off value of 10, or even 4, as argued by Pan and Jackson (2008). The model is highly unlikely to have a multicollinearity issue.

Table 6.5 VIF (Variance Inflation Factor)

	Dependent Variable																					
	HL		**PEoU**		**CM**		**PU**		**SR**		**SSPP**		**ITI**		**TMS**		**OR**		**GPR**	**EP**		
IV**	T*	VIF	T*	VIF	T*	VIF	T*	VIF	T*	VIF	T*	VIF	T*	VIF	T*	VIF	T*	VIF	T*	VIF	T*	VIF
HL	-		.757	1.321	.743	1.347	.750	1.334	.746	1.341	.747	1.339	.745	1.342	.747	1.339	.754	1.326	.875	1.143	.744	1.344
PEoU	.538	1.860	-		.546	1.830	.531	1.884	.608	1.645	.528	1.895	.528	1.893	.534	1.873	.536	1.864	.528	1.896	.529	1.891
CM	.736	1.360	.762	1.313	-		.753	1.328	.737	1.357	.737	1.357	.741	1.349	.736	1.359	.756	1.322	.749	1.336	.751	1.332
PU	.644	1.552	.642	1.557	.654	1.530	-		.659	1.519	.668	1.497	.641	1.560	.651	1.536	.655	1.526	.638	1.566	.639	1.565
SR	.569	1.756	.653	1.531	.568	1.761	.585	1.710	-		.567	1.763	.584	1.713	.590	1.694	.570	1.753	.567	1.764	.567	1.764
SSPP	.847	1.181	.842	1.188	.843	1.186	.881	1.135	.842	1.188	-		.843	1.187	.852	1.174	.847	1.180	.855	1.169	.845	1.183
ITI	.745	1.342	.743	1.345	.748	1.336	.746	1.341	.764	1.308	.743	1.345	-		.844	1.184	.753	1.328	.744	1.345	.743	1.347
TMS	.478	2.093	.481	2.080	.475	2.105	.485	2.064	.494	2.023	.481	2.080	.540	1.851	-		.475	2.105	.488	2.051	.500	1.999
FC	.573	1.745	.573	1.744	.580	1.724	.579	1.727	.567	1.762	.568	1.761	.572	1.747	.564	1.773	-		.601	1.663	.628	1.593
GPR	.665	1.505	.564	1.773	.574	1.741	.564	1.772	.564	1.773	.573	1.745	.565	1.770	.579	1.727	.601	1.663	-	.599		1.670
EP	.545	1.837	.545	1.836	.555	1.802	.544	1.838	.543	1.840	.546	1.832	.544	1.839	.572	1.747	.605	1.653	.577	1.733	-	

**Independent Variables

6.3.4 Residual Test

Hair *et al. (*1998) stated that Casewise diagnostics '*can identify the classification accuracy of each case and its relative impact on the overall model estimation*' (pp253). The Casewise lists provide a list that consists of the cases in data which do not fit the predictive model, and are identified as outliers. If the number of the outliers is high, there might be a need to add additional independent variables (Hair *et al.,* 1998).

Table 6.6, Residual Test

Case	Observed	Predicted	Predicted Group	Temporary Variable	
	Adoption			Resid	ZResid
20	1**	.258	0	.742	1.698
23	1**	.275	0	.725	1.625
72	0**	.905	1	-.905	-3.090

Of the total residuals, 96.6% are within the range of +/- 2 standard deviation, 100% fall within +/- 2.5 standard deviation. Since only 3.4% of total residuals is between +/-2 and +/-2.5 deviation, the model is considered reasonably sound.

6.3.5 Predictive Power

Table 6.7 demonstrates that an overall 85.1% accuracy of the model is achieved, which suggests this model is a great fit with very high predictive accuracy.

Table 6.7, Predictive Power

Observed		Predicted		
		Adoption		Percentage Correct
		Non-adopters	Adopters	
Adoption	**Non-adopters**	30	7	81.1
	Adopters	6	44	88.0
Overall Percentage				85.1

6.4 Hypotheses Support

The hypotheses developed in chapter four have been tested by the model. The chosen logistic regression offered results on whether any hypothesis was supported or rejected.

Out of 11 total independent variables, 8 were found significant. The variables which have significant impact on adoption decisions of MHS in hospitals are: perceived ease of use, system reliability, system security and privacy of patients, IT infrastructure in the technological context; hospital level and top management support in the organisational context; and both government policy and regulation and external pressure in the environmental context. Among those significant variables, top management support, external pressure and organisation size, which were argued to be the best predictors for organisational IT adoption (Jeyaraj *et al.,* 2006), are indeed proven to be significant by this research.

The variables which were found to be insignificant in adoption decisions are perceived usefulness and compatibility in the technological context, hospital (organisation) readiness in the organisational context and none in the environmental context.

However, it is quite surprising that, in the hypothesis assumption argued in the previous chapter where system reliability and hospital IT Infrastructure were expected to be significant, they indeed are proven significant by the model, but they are negatively correlated with adoption decisions, which means they are barriers instead of facilitators.

Therefore, H2, H5, H7, H9, H10 and H11 are fully supported by the result of analysis, hypothesis H1, H3 and H8 are not supported, while H4 (system reliability) and H6 (IT infrastructure) are found significant, but contrary to expectation, they are found to have a negative impact on adoption decisions.

Table 6.8 Hypothesis Support

Hypothesis			Supported
Technological Characteristics	H1 Perceived Usefulness	Positively Impact the Likelihood of Adopting MHS	N
	H2 Perceived Ease of Use	Positively Impact the Likelihood of Adopting MHS	**Y**
	H3 Compatibility	Positively Impact the Likelihood of Adopting MHS	N
	H4 System Reliability	Positively Impact the Likelihood of Adopting MHS	**Partially, Negatively Sig**
	H5 System Security and Privacy for Patients	Positively Impact the Likelihood of Adopting MHS	**Y**
	H6 Hospital IT Infrastructure	Positively Impact the Likelihood of Adopting MHS	**Partially, Negatively Sig**
Organisational Characteristics	**H7 Top Management Support**	Positively Impact the Likelihood of Adopting MHS	**Y**
	H8 Organisational Readiness	Positively Impact the Likelihood of Adopting MHS	N
	H9 Hospital Level	Positively Impact the Likelihood of Adopting MHS	**Y**
Environmental Characteristics	**H10 Government Policy and Regulation**	Impact the Likelihood of Adopting MHS	**Y, Negatively Sig**
	H11 External Pressure	Positively Impact the Likelihood of Adopting MHS	**Y**

6.5 Phase Three: In-Depth Interview Findings

The regression analysis shows the relationship between the variables, but it does not imply what may have caused those relationships. To reveal the causality, in-depth interviews were conducted and the results answered many of the 'why' questions.

In order to process the raw qualitative data into usable information, coding, which was introduced in the previous chapter, is the adopted technique. Coding is an '*integral part of data analysis*' (Neuman, 2002, pp480) in a qualitative study and codes are tags and labels that give meaning to the descriptive or inferential information (Miles and Huberman, 1994) that is acquired during a research project.

This study followed the suggestion by Strauss (1987) and Neuman (2002) who advised the researcher to use three ways of coding for qualitative data and suggested the data be reviewed on three occasions, with different ways of reviewing each time. The three ways are open coding, axial coding and selective coding respectively. During axial coding, categories or concepts that clustered together were focused on, as it not only '*stimulates thinking about linkages between concepts or themes*', it also '*reinforces the connections between evidence and concepts'* (Neuman, 2002, pp484). The data and previously coded codes were examined for selective coding. The cases were compared and selected to illustrate a theme. By doing selective coding, the conclusions on the reasons why certain factors are significant are proposed by selecting and linking the data. The linkage between MHS adoption and the reasons behind the adoption is also revealed.

In the following section, the responses from the informants are coded using open coding and axial coding, direct quotes from informants are used in order to produce the insights on adoption of MHS in hospitals. At the end of each section, the conclusion for the reasons of the occurrence is provided. The sample characteristics of the informants can be found in table 5.5 in the previous chapter.

6.5.1 Technological Context

Perceived Usefulness

Although the phase two result shows that perceived usefulness is an insignificant factor in the adoption of MHS, potential adopters and non-adopters all recognise MHS as a very useful system. However, due to some hospitals having limited funding, and the fact that MHS is seen as 'the icing on the cake' instead of an essential system, and also some professionals and/or patients are reluctant to accept new technologies even though MHS is a useful tool, the factor 'perceived usefulness' is regarded as insignificant (Table 6.9).

Table 6.9 Perceived Usefulness being Insignificant

Support		**Reasons for being Insignificant**				
5/6						
D11	Y	Limited funding; MHS is not top priority				
D12	N	Disagree				
D21	Y	Limited funding; MHS is non-essential technology				
D22	Y	Reluctant to change; MHS is non-essential technology				
D31	Y	Not accepting new technology; Regional specificity				
D32	Y	Limited funding in rural hospitals				
Cause						
Cause (Insignificant)	**D11**	**D12**	**D21**	**D22**	**D31**	**D32**
Non-Essential Technology, Not Top Priority	**X**		**X**	**X**		
Limited Funding	**X**		**X**			**X**
Reluctant to Change to New Technology				**X**		
Patients Refuse to Use New Technology					**X**	
Region Specificity					**X**	

The result from phase two shows that, in this study, perceived usefulness is insignificant in impacting the adoption decision. However, it is suggested that whatever the hospital level, potential adopters and non-adopters agree that MHS is a very useful system in a hospital's daily operation. The first reason for being insignificant was argued by D11, D21 and D22, which is that MHS is a system that could bring benefits to hospitals, but it is not something essential that hospitals cannot live without. D11 stated that '*one cannot think about luxuries if one's basic needs are not met yet. So that should be the reasons why some hospitals think MHS is useful, but would not adopt it'*; D21 also mentioned that '*MHS is something that makes the current IT system much better, much more convenient for professionals, but it is the icing on the cake. If everything* *functions as normal in a hospital, without government investment, the hospital may not put adopting MHS as their priority because MHS is not essential'*; and D22 argued that 's*o MHS for them* (hospitals) *is something that is better to have but also OK to work without'.* Therefore, especially when the funding is limited, it is always important for hospitals to set priorities, which is always necessities first; as D11 argued, '*a hospital has limited funding and the director thinks the money should be better spent somewhere else* (instead of adopting MHS)*, such as to bring IT system up to date',* and D21 stated that '*without enough cash, one has to pick something cheaper as long as it functions'.* D32 also added that funding is limited especially in town and rural hospitals.

D22 also mentioned that reluctance to change might also be a reason, especially as MHS is not essential for a hospital. '*Most hospitals have their own IT systems implemented for a very long time now, and they are very used to the system as long as it functions well … They probably would not be too active to have MHS adopted just because of its usefulness'* (D22). D31 argued that it could be region-related as the economic status in different regions in China is very unbalanced and said '*it might be region related. The situation in China is distinctive. There are relatively huge economic differences between cities and rural areas. The southern part of China is highly developed with a much stronger economy while the northern part, northwest to be specific, is developing with weak economic status';* then D31 added that '*in less developed areas sometimes patients are not as technology accepting as in big cities … the weaker economic status of the area could lead to lack of knowledge in new technology from patients hence lack of support … so for MHS, maybe in some hospitals, the professionals would like to use it, but the patients are rejecting the use of system'.* D11 added to this argument by stating that '*in some regions, no* *hospitals are interested in newer technology even if they know MHS would bring benefits, but because the competition is not as intense, every hospital is adapted to a slower pace … they are all planning to adopt, but just at a much slower pace because the similar or surrounding hospitals are not in a hurry as well*'. D32 also stated that hospitals have to follow '*the direction government is pointing to*' regardless of the usefulness of MHS.

Perceived Ease of Use

The quantitative result shows that perceived ease of use is a significant factor. All informants agreed that it is an important thing to consider (Table 6.10). It is a significant factor because, currently, in hospitals in China, many renowned experts are not young, and MHS being easy to use would be important for them to simplify the learning process. In less developed areas, the professionals are likely to be less willing or capable to accept new technology, if it is not easy to use. Moreover, the easier MHS is to use, the faster professionals can work; MHS would never be adopted if it somehow reduces the efficiency of professionals due to complexity.

Table 6.10 Perceived Ease of Use being Significant

Support		**Reasons for being Significant**
6/6		
D11	Y	Lower complexity is better
D12	Y	Would not adopt if MHS reduces efficiency due to the complexity
D21	Y	Elderly experts require more effort
D22	Y	Age issue; MHS cannot be too difficult to use
D31	Y	Regional specificity, capability or willingness to accept new technology is lower in rural community or village hospitals; especially important in large hospitals, the easier to use, the quicker professionals can work
D32	Y	Age issue, many renowned experts are not young

Cause						
Cause (Significant)	**D11**	**D12**	**D21**	**D22**	**D31**	**D32**
Generation gap			**X**	**X**		**X**
Potential higher cost due to the complexity			**X**			
Region specificity					**X**	
Technology complexity	**X**	**X**		**X**	**X**	

D21 first raised the concern of ease of use for elderly professionals and argued that '*many of the current nurses in the clinical department are relatively young, it would be easy for them to use MHS. However, for elderly experts, professionals and professors, certain training might be required due to their slower pace of accepting newer technologies',* so although ease of use is not decisive, *'it will be a significant factor for hospitals to consider'* because if training is required for some elderly professionals, it would increase the cost of adoption. D22 added that '*tablets are widely used now especially amongst the young people*' and D32 stated that '*most of the experts in their fields are relatively not young. It could be a problem for them to use if the control is too complicated or the UI* (User Interface) is *not friendly'*.

D31 argued the importance of regional factors again by stating that '*just like I mentioned before, in town, rural community or village hospitals, the capability or willingness to accept new technology by their professionals is not as high as with doctors and nurses in large high-level hospitals due to various limitations'*.

D12 made the point that no adoption will ever take place if the efficiency of professionals is decreased by adopting new technology due to its complexity and stated that '*it would not work if the using of MHS actually reduces the efficiency of professionals because of the complexity of the system';* D22 added that '*MHS cannot be too difficult to use'.* D31 stated that the easier the system to use, the quicker work can be done especially with large patient volume in high-level hospitals. '*Especially for large hospitals with a high volume of patients, the easier the system is to use, the quicker professionals can work. Also, because MHS brings much more convenience to doctors and nurses for patient admissions and so on'* (D31). D11 then added that *'there are various ways to adopt MHS, therefore, whichever way would make MHS easier to use is the better way'.*

Compatibility

Compatibility (Table 6.11) is found to be insignificant in the phase two result. Although higher compatibility is more welcomed, the potential adopters are prepared for change. The systems or work routines can always be either made compatible during use or be completely replaced with enough funding.

D21 mentioned that hospitals could do a full IT system replacement with sufficient funding and provided an example, '*with enough funding, a hospital can replace a full IT system. For example, in some hospitals, the current IT system does not function very well, if the hospitals have enough financial* *support, they can simply replace an entire IT system to some systems that are better fitted with MHS'.* D22 argued that any hospital that wants to adopt a new innovation is prepared for change, '(Though) *MHS is not supposed to affect current working routine too much … the potential adopters are prepared for the change of work routines, therefore, it is not compulsory for MHS to be compatible with either current IT system, work routine or hospital value etc. Bringing in the MHS means everything is going to change to some* extent'.

Table 6.11 Compatibility being Insignificant

<table>
<tr><td colspan="2">Support</td><td colspan="6">Reasons for being Insignificant</td></tr>
<tr><td colspan="2">5/6</td><td colspan="6"></td></tr>
<tr><td>D11</td><td>Y</td><td colspan="6">New IT systems adjusted during use</td></tr>
<tr><td>D12</td><td>N</td><td colspan="6">Disagree</td></tr>
<tr><td>D21</td><td>Y</td><td colspan="6">Full IT system replacement with enough financial support</td></tr>
<tr><td>D22</td><td>Y</td><td colspan="6">Potential adopters are prepared for change</td></tr>
<tr><td>D31</td><td>Y</td><td colspan="6">Current system could be altered or reformed to be compatible</td></tr>
<tr><td>D32</td><td>Y</td><td colspan="6">Can be made compatible, hardware or work routine wise</td></tr>
<tr><td colspan="8">Cause</td></tr>
<tr><td colspan="2">Cause (Insignificant)</td><td>D11</td><td>D12</td><td>D21</td><td>D22</td><td>D31</td><td>D32</td></tr>
<tr><td colspan="2">Full IT system replacement</td><td></td><td></td><td>X</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Adopters prepared for change</td><td></td><td></td><td></td><td>X</td><td></td><td></td></tr>
<tr><td colspan="2">New system adaptability</td><td>X</td><td></td><td></td><td></td><td>X</td><td>X</td></tr>
</table>

D31 and D32 both stated that any systems that are currently not compatible can be made compatible with reformation and adjustment. D31 stated '*if MHS is not fully compatible with the current system, we could always alter or reform the system to make them compatible'* while D32 mentioned '*I think if a hospital decides to adopt, it will figure out a way to do it no matter the incompatibility* *with the current system. They can be made compatible. Regarding the compatibility of work routine etc., it would be even less a problem as people can adjust the routine*'. D11 also argued that '*all new IT systems are adjusted gradually during actual use'*.

System Reliability

To the researcher's surprise, system reliability is found to have a negative impact (Table 6.12) on an adoption decision of MHS. Although a stable system is needed, an occasional crash or downtime is expected in any IT system. It is not practical to expect an IT system to be fully stable and without any problems. The benefits MHS brings to hospitals overcomes the foreseeable problems. IT systems are always fine-tuned during use to be more stable. Some hospitals would choose not to adopt currently because of other IT priorities even though they think very highly of the system and thus assume the reliability of the system is high as well. The non-adopters lack the understanding of MHS which leads to the assumption that stability is high because MHS is a new IT system, while potential adopters have a better knowledge of the system, therefore, do not expect MHS to have unrealistic reliability. Regional specificity could also affect the decision as hospitals are more likely to adopt new technologies in more developed areas. The competition between hospitals also plays a role in adoption regardless of the stability of the system. Moreover, the MHS is currently 'the future' seen by some hospitals and many of the hospitals would adopt the MHS no matter what.

Table 6.12 System Reliability being Negatively Significant

Support		**Reasons for being Negatively Significant**
5/6		
D11	Y	All IT systems are fine tuned to be more stable after adoption; demands from departments and branches; region specificity; potential benefits take precedence
D12	N	Disagree
D21	Y	All new technologies have problems; benefits outweigh potential instability
D22	Y	Current IT systems not stable enough
D31	Y	Not practical to expect any IT system to be 100% stable and error free; occasional crash is expected; larger hospitals are more likely to run into stability issues; potential adopters have better knowledge; a future trend for hospitals to adopt MHS no matter what
D32	Y	The non-adopters lack the true knowledge of MHS which leads to the assumption that stability is high
Cause		

Cause (Negatively Significant)	**D11**	**D12**	**D21**	**D22**	**D31**	**D32**
Adopters' expectation of problems with new system	**X**		**X**		**X**	
Non-adopters' expectation of no problems with new system	**X**					**X**
Internal demands (departments and hospital branches)	**X**					
Region specificity	**X**					
Potential benefits exceeding expectation	**X**		**X**			
Problems with the existing system			**X**	**X**	**X**	
Following future trend	**X**		**X**		**X**	

D11 mentioned that, for any IT system, stabilisation can only be achieved by adjusting during actual use through time, arguing that '*all IT systems have the possibility to encounter problems which are quite normal. No IT system is stable on the first day it has been built, it is always a process to make the system more stable gradually through time. The system being unstable will not stop a hospital adopting MHS as long as it is needed*'. D11, D21, D31 and D32 expressed the view that there will be instability in any IT system when using a system, the ones who decided to adopt have a better understanding of the system and are certain of the potential instability issue, but the benefits MHS brings overrides the occasional downtime, and the ones that have no plan to adopt simply assume MHS is a perfect system. D21 and D31 also stated that temporary and occasional instability is totally expected. D21 stated that '*every new technology ever existed is not without problem*' and added to the point that stability is not the reason to reject MHS by stating that '*hospitals would not deem MHS 'unworthy' even if it is somewhat a little not fully stable temporarily during the run-in period, it is not a factor for hospitals to decide NOT to use it*'.

D31 then argued that potential adopters would have a better understanding of the system by stating '*the potential adopters would actively get more information about this system hence a better understanding; it is not practical to expect any IT system to be one hundred percent stable without any error or problem. System stability wise, the adopter, of course, expects it to be as high as possible, but occasional crash or downtime is also expected or allowed. For any large medical organisations, the larger your hospital is, more data storage and more usage of the IT system, thus it is more likely to run into some stability issues. So occasional problem should not hinder hospitals from adopting MHS*'.

D32 argued that non-adopters lack the knowledge of the system and added that '*some of the non-adopters might lack the true understanding of MHS which leads to some unrealistic expectations*', and D11 explained why MHS is not being adopted by some of the non-adopters by mentioning that '*some hospitals are building or improving their current IT systems and is progressing well. The adoption of MHS is not yet on their agendas because for example, a hospital would want to build or to perfect its IT platform first, to have everything* *connected before adopting MHS … Some hospitals will eventually adopt MHS, but only at a later time because they do not have the need for it due to the relatively low volume of patients in lower level hospitals such as level two hospitals in small cities or towns. During my visit to some low-level hospitals, they do not even have the system for appointment registration, as such system was implemented in our hospital years ago. They are, however, aware of the existence of MHS and the usefulness it possesses and possibly assume the system is perfect*'.

D11 also expressed the view that the convenience MHS brings, the internal demands from departments and other branches take precedence over the risk of system instability, 's*tability of IT system is not a reason to reject the adoption of MHS. MHS brings convenience and efficiency to the hospital … The adoption of MHS is not widely spread yet, regions also matter as in more developed areas it is more likely to see new technologies being adopted regardless of the reliability*. *The competition between large hospitals is also a factor that would affect the MHS adoption … If many hospitals in a developed region have adopted MHS, no matter the stability, the ones that do not yet have MHS in use would face problems of 'why not' from their own professionals and patients … There would also be reasons such as government policy that supports hospitals to reduce the trouble that patients are facing while visiting hospitals that affects the decision of adoption'*

D11 then added other reasons to strengthen the statement and argued that, *'whether to adopt also depends on how eagerly the doctors want it. There are always situations like the doctors on holiday or night shift doctors face an emergency patient that is beyond his or her capability while the department director is out of the country and the senior doctors are not available* *immediately as well. How we used to solve a problem like this was to take pictures of the patient situation and send it to the director or senior doctors via WeChat or message, which is a very low-end solution without MHS. A big high-level hospital like ours faces this kind of situation often, and we also have many hard-to-diagnose diseases, the first thing comes into our mind to solve problems like this is to use MHS, making it much easier for junior doctors to deal with some clinical treatments. By adopting MHS, we have connected all the patients' files as well as some work which previously needs to be done via various mobile phone applications. All patients' files and data are accessible via MHS unlike the limited partial accessibility we had on the computer, which is much more convenient for our department directors to make decisions. So from the demands' points of view, MHS needs to be built. Also, other branches of our hospital possess only limited medical human resources and capability. During the surgeries such as cardiac catheterisation or coronary angiography, especially when having difficulties to insert the cardiac catheter they often need help from our very renowned director of the department of cardiovascular medicine, who is often out of the country. With the help of MHS, directors have access to real-time surgery process, which not only includes video streaming, patient status as well, on his mobile phone where he could instruct other doctors where to insert the catheter and the advantage of doing so during the surgery thousands of miles away on MHS via his mobile phone. So MHS is very useful and increases the patients' safety and the success rate of surgical operations. MHS is also a product that was generated by demand. Being stable or not will not affect its adoption in hospitals'.*

D11 and D12 both expressed the opinion that because of the overwhelming benefits MHS brings to hospitals, reliability might be overlooked. D12 added to the argument that '*directors and managers of hospitals think MHS would have a significant increase in the quality of every aspect of hospitals' daily routine, such as in treatment, diagnosis, daily working routine etc.*' and D11 emphasised that '*MHS is going to be adopted because of the advantages it brings*'.

The stability issue is not too much a concern because most of the current IT systems of the hospitals have issues. As stated by D21, '*Our current HIS is not without problems. From my own experience, for the hospitals I have worked in, the unexpected shutdown happens, which causes chaos. There is one other problem which involves the database, the system just gets slower along the way. Especially in our Department of Radiology. I am not certain if the adoption of MHS will damage the stability of IS*'; and D31 '*… our current IT system is not at all stable, a system error just hit us last week, which brought us a lot of trouble. The patients needed medicine immediately, but with the IT system breakdown, no medicine could be received in the pharmacy. So at the moment the current IT system obviously has its flaws*'.

Lastly, D21 and D31 mentioned that MHS is a future trend for hospitals, so reliability should not be a hindrance to them being adopted, especially when external pressure forces hospital to change. As D21 mentioned, '*MHS is surely the right direction of the future hospitals*' and D31 added that '… *even some of the town or village hospitals in my region, which are considered less developed in China have adopted, maybe not fully, but have adopted MHS, so I do think it is a trend for the future for hospitals to adopt MHS no matter what*'.

System Security and Privacy of Patients

The factor 'system security and privacy of patients' (Table 6.13) is found to be significant in the adoption of MHS. After years of private data being leaked or sold to a third party without people knowing, privacy protection became a social problem in China. People are very sensitive about privacy, how and where the personal data was leaked is of great concern. Therefore, without proper protection of personal data in MHS, it is unlikely that the hospitals are going to adopt it. The system needs to be secure for patients to accept being treated on it.

Table 6.13 System Security and Privacy of Patients being Significant

Support		**Reasons for being Significant**
6/6		
D11	Y	Only authorised personnel are granted access
D12	Y	Essential
D21	Y	Would not adopt any MHS that cannot protect the privacy of patient securely; protect patients' data and privacy during medical treatment
D22	Y	Privacy protection is under a microscope; medical security is very important
D31	Y	Privacy and data of patients have often been leaked in recent years; protection of privacy needs to be done in MHS
D32	Y	Very serious social problem in China; people are aware of the situation and are trying to protect their privacy; MHS will have to be secure and able to protect the privacy for the patients to accept being treated on this system
Cause		

Cause (Significant)	**D11**	**D12**	**D21**	**D22**	**D31**	**D32**
High patient expectation of data protection	**X**	**X**	**X**	**X**	**X**	**X**
Accessibility of hospital data				**X**		

Most of the informants stated that the high privacy requirement is due to the current circumstances in China, as it has been under the spotlight because of serious personal data leakage over the years. D31 stated that '*it is to everyone's notice that in recent years, privacy and data of patients are often being leaked*'. D22 stated that '*this is very important as the privacy aspect is being highly regarded in China now*'; D32 added that '*after years and years of personal information being leaked or sold, it* (security and privacy) *is very* *important especially given the current circumstances in China. Everyone cares about their privacy very much, not only in hospitals'*, D32 also gave an example saying that '*the problem of personal information being leaked is very serious because there is no such thing as privacy in this country now. My ID number, contact number and all my personal data are known to some medical organisations which I have no idea how. People are aware of this situation and everyone is trying to protect their privacy'.* D11, D12, D21, D31 and D32 confirmed that there will be no adoption without the protection of privacy. '*Privacy of patients is very important to hospitals. I am 100% sure that we would not adopt any MHS that cannot protect Privacy of Patient securely'* (D21). D31 stated that '*the protection of privacy of patients is something that needs to be done in MHS'* and D32 added '*MHS will have to be secure and able to protect the privacy of patients in order for the patients to accept being treated on this system*', D12 also said that data security is essential to any IT system now.

D11 and D21 both stated that all hospital data are for internal and authorised personnel only, some data are strictly only for certain departments, and they expected no change after the adoption of MHS. D11 explained that '*only hospital authorised personnel would have access to view the system. Patients who registered with MHS in the hospital would have access to their own data because the hospital has allowed their access. Only professionals of the hospitals would have access to patients' data, sometimes one department is even limited to view data of patients only in their own department*'; while D21 stated that '*it is very important for us to protect the patients' data itself as well as protecting the privacy during medical treatment*' and '*in my honest opinion, it* (system security and privacy of patients) *is the top priority of any information system'.*

D22 added that, '… *because everything could be done via MHS, all data will go through the system, so to reduce* (security) *error is essential*'.

IT Infrastructure

The IT infrastructure (Table 6.14) is found to have a negative impact on adoption of MHS decisions. The reason for it to be negatively significant is mainly because, if current IT infrastructure is not satisfactory, it is possible that a complete replacement will be introduced in order to increase competitive advantage. Similarly, if a current system works perfectly, i.e. with good IT infrastructure, directors might not want to make the change. Other reasons include branches of high-level hospitals with poor IT infrastructure still adopting MHS in order to keep up or to be compatible with parent hospitals.

Table 6.14 IT Infrastructure being Negatively Significant

Support		**Reasons for being Negatively Significant**
6/6		
D11	Y	Hospitals with poor IT infrastructure could adopt MHS with fewer contents
D12	Y	The physical limitation to IT infrastructure, adopt MHS to break the limit at reasonable cost; adopter hospital's branches have poor IT infrastructure
D21	Y	IT infrastructure too poor the director wants a complete replacement; complaints from departments for current IT system lack of features
D22	Y	Reluctant to change if the current system is good; would want a better system if the current one is not to satisfaction
D31	Y	Current system not mobile thus not convenient; the worse the current IS, the lower the efficiency, therefore the more desire to adopt MHS
D32	Y	Hospitals with poor IT infrastructure lose patients overtime; looking to enhance patients experience by adopting new technologies

Cause						
Cause (Negatively Significant)	**D11**	**D12**	**D21**	**D22**	**D31**	**D32**
Legacy systems			**X**	**X**	**X**	
Resistant to change				**X**		
Weak position						**X**
Installation of system networking		**X**				
Internal demands			**X**		**X**	

D21 and D22 stated that the hospitals currently with weak or poor IT systems would rather have a full replacement of the current weak system than to upgrade. D31 argued that with poor IT systems, hospitals professionals would have a lower efficiency compared with hospitals with better IT systems, therefore, the more willingness to adopt MHS. D21 stated that '*in some hospitals, the directors think their current IT system is just poor, therefore, they want the MHS even more and to have a completely overhauled IT system. However, personally, I still think the MHS we are going to adopt should be connected to our current IT system, instead of completely overriding it. So, we* *should have a better IT Infrastructure in order to adopt MHS. MHS would not work as it should if the IT infrastructure is poor, it would be a waste*'; D22 argued that '*if the current IT system is somewhat not to satisfaction, the hospital would want a better system with newer technology*'. D31 added to the topic where *'the worse the current IT system in a hospital, the less efficient are their professionals, thus the more desire to adopt MHS as it brings a lot of benefit and convenience*'.

D22 also mentioned that the hospitals with good and up-to-date IT systems might be reluctant to change since '*if the current IT infrastructure/system is good and all the professionals are happy with it and are already used to it, the hospital might be reluctant to adopt something new*'. D32 mentioned that having poor IT infrastructure means being in a weak competitive position which eventually leads to adopting new IT systems. D32 specified that '*hospitals with poor IT infrastructure might lose patients overtime, which they would not want to happen; by adopting MHS or other new IT technologies, hospitals are looking to enhance their patients' experience in order to bring in more patients. The number of patients is a critical factor in hospitals as the new medical reformation and the gradual implementation of the separation of medical services kicks in. So the hospitals with poor IT infrastructure would want to adopt new technology more, in order not to be left behind*'.

D12 mentioned that there might be physical barriers that certain hospitals would like to break through within a reasonable cost, or the larger hospitals' branches with poor IT infrastructure adopting MHS just to keep up with parent hospitals. D12 stated that '*it is possible that some hospitals are large in physical size, or have a very complex building structure which makes wiring and cable connecting very difficult. By adopting MHS, they bypass the difficulties of wiring* *inside the hospital. Because of the building structure, the cost of rewiring might be too high; the hospital has a physically large size; many high-level hospitals (adopters) have branches (with poor IT infrastructure); all these elements will make them want to adopt MHS even if the current IT infrastructure is not up to date*'.

D21 provided an example explaining that demand might promote adoption, '*we adopted a new IS only a few years ago, it can fulfil our needs to a certain extent, but it is not without flaws. There are complaints from different departments, like the information system is not able to achieve some required result.* (Therefore, some would want to have a better system)'. D31 added an example saying that '*I think our current system has tied us to our department or office strictly. If I am out of office and receive a request from my patient, I probably cannot answer some of the requests before returning to my office in my department where the computer is connected to the hospital's IT system or database. With MHS I could treat patients with all his or her information anywhere*'.

D11 also suggested that hospitals with poor IT infrastructure could adopt MHS with fewer contents, D11 explained that '*software infrastructure depends on its contents. Normally, from a hospital's perspective, all IT systems are revolving around patients, patients are the core of the IT system. Basically, IT infrastructure provides the 'volume' of content. Hospitals with poorer IT infrastructure could adopt MHS, but the content or information it possesses would not be as rich as those with better IT infrastructure*.'

6.5.2 Organisational Context

Top Management Support

The result (Table 6.15) from phase two shows that top management support is a very important factor. It is quite clear that top management, i.e. the hospital directors, have absolute power in deciding anything and everything. If hospital directors decide against MHS adoption, no funding could be used to adopt. How the hospital directors perceive and value MHS, and how much they reckon MHS as ‘useful’, will have a drastic impact on an adoption decision. This is the most important facilitator in adoption.

Table 6.15 Top Management Support being Significant

<table>
<tr><th colspan="2">Support</th><th colspan="6">Reasons for being Significant</th></tr>
<tr><td colspan="2">6/6</td><td colspan="6"></td></tr>
<tr><td>D11</td><td>Y</td><td colspan="6">Nothing can be done without top management support; top management simply would not fund MHS if not supported</td></tr>
<tr><td>D12</td><td>Y</td><td colspan="6">The most important factor; hospitals could never adopt anything without directors’ approval in China; directors’ perception and value matter</td></tr>
<tr><td>D21</td><td>Y</td><td colspan="6">Top management team must value MHS in order for it to be adopted</td></tr>
<tr><td>D22</td><td>Y</td><td colspan="6">MHS would be adopted unless the top management is against the adoption; director has significant role in deciding anything</td></tr>
<tr><td>D31</td><td>Y</td><td colspan="6">Adoption of a technology is completely up to top management in China; absolute power</td></tr>
<tr><td>D32</td><td>Y</td><td colspan="6">Very influential and cultural factor; impossible to adopt MHS without top management support</td></tr>
<tr><td colspan="8">Cause</td></tr>
<tr><td colspan="2">Cause (Significant)</td><td>D11</td><td>D12</td><td>D21</td><td>D22</td><td>D31</td><td>D32</td></tr>
<tr><td colspan="2">Decision to adopt resides with hospital director; cultural factor</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td colspan="2">Business case feasibility</td><td></td><td>X</td><td>X</td><td></td><td></td><td></td></tr>
</table>

All of the informants argued that top management support is the single most important factor for any adoption in hospitals, as top management of hospitals have ‘absolute power’. D11 stated that ‘*if hospital director does not support me* *in adopting MHS, there is no way of doing it. This is the very initial condition of adopting MHS, I cannot do anything without their support*'; D12 argued that the top management support *'is the most important factor. The top managers of a hospital … would drastically impact the adoption decision*'; D21 added that '*we directors and management team including the director of the hospital all agree that MHS would be very useful and we will adopt it sometime in the future. Top management must value this project*'; D22 stated that '*unless the top management is hugely against the adoption, which would be very unreasonable and unlikely, MHS would be adopted'.* D31 added that top management '*will certainly play a decisive part, they have absolute power'.* D12, D22, D31 and D32 mentioned that this is a cultural factor in China. D12 stated that '*in China, hospitals would never adopt anything without the hospital directors' approval*', D22 added '*in the context of China, top management plays a significant role in deciding anything*', while D31 stated that '*in China, to adopt a technology or not is completely up to top management'* and D32 argued that top management support '*is a cultural factor. It would be impossible to adopt MHS without their support*'.

D12 and D21 mentioned that the perceptions of MHS and technology from directors of hospitals are very important and decisive, directors must value MHS first as they control the funding. D12 stated that '*if the director thinks adopting MHS is not urgent, he or she simply would not fund MHS. How they perceive MHS, how they value and how much they accept MHS as a new useful technology'* is crucial. And D21 added that '*If a director thinks IT system is important, he or she might invest time and money in IT systems*'.

Hospital Readiness

Hospital readiness (Table 6.16), which includes available financial, technical and human resources is to be found insignificant in the adoption of MHS. This is because there are other ways of funding apart from a hospital’s own profitability. Government funding can be applied for although not always granted; the government has been promoting innovation and technology since the 1990s (Ministry of Science and Technology, MoST) and is currently focusing on digitalisation and high-tech related innovation. To many high-level hospitals, the amount of investment is not too much so it is fully up to the directors. Technical support and after adoption support have been and always will be provided by suppliers.

Table 6.16 Hospital Readiness being Insignificant

Support		Reasons for being Insignificant
6/6		
D11	Y	MHS is not a very big financial commitment; financial support is up to top management and director; support is needed, and is always from the suppliers
D12	Y	Finance is not unneeded, but not a problem if top management is willing to in most high-level hospitals; government could have special funding; no need to have specialists apart from maintenance; government is supporting digitalisation and network related technology; MHS is easy to use, therefore no need for a support team
D21	Y	Applying for government (special) funds is possible, although not always granted; government offers special investment; could always hire new experts; suppliers will train IT department and professionals
D22	Y	Applying for appropriation is possible depending on management team; knowledge and support group available from the supplier; hospitals willing to invest in IT systems; would not care too much about the cost because of the potential return
D31	Y	Hospitals would apply for funding through many channels if MHS is useful
D32	Y	Government funding can be applied; IT department available; hospital could secure the funding from other channels; suppliers provide service

Cause

Cause (Insignificant)	D11	D12	D21	D22	D31	D32
Availability of government funding	**X**	**X**	**X**	**X**	**X**	**X**
Lost costs of MHS	**X**	**X**				
Business case feasibility				**X**		
Hire external MHS experts			**X**			
MHS Suppliers' support	**X**		**X**			**X**

All interviewees mentioned that government funding might be available to hospitals since hospitals in research are public sector organisations, and governments in China are currently paying a lot of attention to digitalisation. D12 argued that '*even if some hospitals had financial difficulties to adopt MHS, the government is paying a lot of attention to the IT system or new technologies. It is a common consensus between managers and government officers that digitalisation and network-related technology are priorities, the government* *would most likely provide funding, so it would not be too much of a problem'*. D21 added to the topic by providing an example and stated that '*once the hospitals decide they want to adopt MHS, they will figure out a way … such as when the government offers special investment which focuses on IT system … the government could have special funding, just towards one area. Applying for funds is possible, our hospital has applied for government funding a few years back for an overhaul of our IS, and have had the relatively obsolete system replaced. The hospital can apply for funding, but it is not necessarily for them to get the appropriation. If they do get the funds they will use money to do whatever they applied to do. However, if the application is refused the adoption will have to be delayed until next year. Hospitals need large amounts of funding every year in all aspects, such as new equipment, building, remodelling etc. A new information system is just one of the projects in the application*'; D22 argued that '*applying for appropriation is possible … If directors would like to adopt MHS, they could apply for funding. They will figure out a way if they really want to adopt. Hospitals are more willing to invest in IT systems. They would not think too long or too hard about whether they should adopt because of financial issues';* D31 provided an example saying that '*for example, in level two hospitals, even though the government funding is mostly for basic needs, if MHS could really bring many advantages such as reducing professionals' workload, providing a more convenient environment and improving diagnosis and treatment conditions for patients, hospitals would report the need for this system to government through many different channels. However, it would be a huge investment for all the hospitals to adopt MHS, therefore, hospitals would have to apply case by case*'. D32 added that 'a *hospital could secure the* *funding from other channels such as government funding, a town level hospital could apply for funding in its town government etc.*'.

D11 and D12 argued that the cost of adopting MHS would not be a problem for top-level hospitals as long as top management would like to adopt. D11 stated that '*financial support for adoption … is totally up to top management. It depends on whether the director of the hospital would want to adopt the system or not',* D12 added to the point that '*finance-wise, if top management decides to adopt, the cost of MHS would not be a problem for high-level hospitals … in most of the high-level hospitals, given that top management is willing to, this would not be a problem*'. D11 also mentioned that the cost of MHS '*is not a large amount of money. As long as the top management wants to adopt, funding is not a problem. The investment in MHS would not be very costly unless some large equipment is involved … very often some of the applications like a reservation system are all free of cost from the suppliers*'.

D22 stated that the potential gain from an adoption of MHS would offset the cost, '*adopting MHS is just like adopting other large equipment, hospitals would not care too much about the cost as long as they see the output and the potential gain'.*

Regarding the support for MHS, an IT system's after-sale support is always provided by the supplier. D21 also argued that hospitals could always hire new IT experts if needed or request the supplier to provide training sessions to hospital professionals. D11 explained the support for MHS in detail, '*without support the system will be dead in no time … All my years being a director of an IT department, there was no single system in existence that was without the after-adoption support. Whether there is a team available for maintenance,* *adjustment and improvement after the implementation of MHS is a useful factor. There will have to be follow-up services because many problems would not be revealed before the system is actually being used in practice. If there is no team to follow the system up, it will eventually be dead. Generally, whoever the hospitals purchase from would do the support work after the adoption. It is unlikely for the hospital to fully take over the supporting role. Even if the supplier whom the hospital purchased it from went bankrupt, the aftercare will be handled by the party who took over*'. D21 also explained the support resources available, '*if hospitals somewhat lack the experts in MHS, they could always hire new staff. MHS has its supplying companies to install it in the hospitals, and the suppliers will offer training to IT department and all other professionals. Therefore, if the hospitals' current staff do not have enough knowledge of using MHS or expertise, the suppliers will fill that gap*'. D32 also added that '*when adopting large equipment, the suppliers would have all services provided including fitting and fixing etc. The same would apply to MHS*'.

Hospital Level

Hospital level (Table 6.17), or organisation size in its original form, is found to be significant. The reasons for hospital levels being significant are because high-level hospitals have many more patients to treat, therefore, they are busier, have more departments and have a higher chance to run into difficult cases. By adopting MHS, some of the unnecessary workload and pressure can be eased, coordination between departments can be more effective. Directors in higher-level hospitals are generally more capable than lower hospitals' management team members. Moreover, the resource inequalities in hospitals of different levels or different regions also play an important part.

Table 6.17 Hospital Level being Significant

Support		**Reasons for being Significant**
6/6		
D11	Y	Top-level hospitals have higher patient volume and higher probability to take on tough cases; contents must be lacking even if low-level hospitals adopt MHS
D12	Y	Large hospitals often have more varied departments and require better coordination between departments; ease the workload of professionals; high-level hospitals in wealthy regions always have better IT
D21	Y	MHS will ease the pressure of many medical works as top-level hospitals tend to be busy; higher-level hospitals relatively have better financial status; the directors in higher-level hospitals have a better understanding in IS; lower-level hospitals are less busy, MHS would not bring them as many benefits
D22	Y	High-level hospitals more forward thinking; lower-level hospitals implement basic IT systems
D31	Y	Low-level hospitals possess fewer resources
D32	Y	Not only hospital level, but the regional factor is very significant; a top-level hospital would adopt new technologies much faster than smaller hospitals because it is more likely for top-level hospitals to get government support

Cause

Cause (Significant)	**D11**	**D12**	**D21**	**D22**	**D31**	**D32**
Higher-level hospitals covering more patients, treating tougher cases	**X**					
Coordination of resources		**X**				
Resources allocation requirement			**X**		**X**	**X**
Infeasibility of business case (Low-level hospitals)	**X**	**X**	**X**	**X**		
Reducing workload for healthcare professionals		**X**	**X**			
Forward thinking by directors			**X**	**X**		
Region Specificity					**X**	**X**

The higher the hospital level, the more volume of patients it will receive, and there is likely be more tough cases. D11 stated that '*top-level hospitals have a higher patient volume and a higher probability of running into tough cases. Therefore, it is more likely for top-level hospitals to adopt MHS with a greater extension of contents which would take up the full range of what MHS offers.*'

The departments in high-level hospitals would also be more varied. D21 mentioned that '*The larger or higher level a hospital is the more beds it has. Also, a large hospital often has somewhat more varied departments and requires better coordination between departments*'.

High-level hospitals tend to have a better financial status as well, as D21 argued, '*the higher-level hospitals relatively have better financial status … IT systems have been utilised in hospitals in Shanghai, especially in high-level hospitals';* D31 and D32 also argued that low-level hospitals occupy low-quality resources, and governments give better support for high-level hospitals. D31 provided an example saying that '*the higher a hospital level is, the more likely for it to adopt MHS because of the 'influence' it brings. For example, the low-level hospitals such as level two town hospitals or even level one community or village hospitals, the environments the hospitals are in, the resources they possess, the patients they have are all from small and sometimes under-developed villages. The patients there differ from the patients in big cities to a large extent. They would not fully understand why hospitals are providing new technology such as MHS and they might be reluctant to accept being treated using new technology'.* D32 added that '*a top-level 3A hospital would adopt new technologies much faster than smaller hospitals because it is more likely to get government support … the hospitals with relatively poor IT are mostly low-level or smaller hospitals, but this differs from region to region in China … larger and higher-level hospitals have an advantage in funding and government support. Large national or regional hospitals will get support to use new technologies even if a whole system needs replacement.*'

It is also argued that low-level hospitals do not require MHS, at least not the full system, MHS would not bring low-level hospitals as many benefits as it brings to high-level hospitals. Hence, high-level hospitals would make fuller use of the MHS than low-level hospitals. D11 provided an example, '*for community hospitals, even if they do adopt MHS, the contents must be much less, a reservation system might be enough, or maybe with mobile payments also. The MHS for community hospitals will never have as many contents or extensions as MHS in larger hospitals. For example, the community hospitals would never have the need to use the surgery instruction system used in our department of cardiovascular medicine*'. D21 stated that '*they (high-level hospitals) are more willing to adopt MHS than those lower level hospitals as lower-level hospitals are less busy, adopting MHS would not bring them too many benefits*'; while D22 argued that '*lower-level hospitals … are more likely to implement relatively basic IT systems, new innovations like MHS are probably not on their agendas yet',* D12 added that '*for low-level hospitals, it would not be as essential for them to adopt MHS* (as high-level hospitals)'.

Since top-level hospitals tend to be busier, MHS will ease the pressure and reduce the workload of professionals. D12 mentioned that '**…** *it would be inconvenient for large hospitals working without MHS. It would ease the workload of doctors and nurses*' while D21 argued that '*MHS will ease the pressure on many medical procedures, in Shanghai, the top-level hospitals are extremely busy*'.

D22 also mentioned that top management in high-level hospitals would be more forward thinking and more innovative, '*high-level and large hospitals are mostly equipped with better IT systems and hardware, they are willing to adopt new* *technologies because of their forward thinking*'; and D21 added that '*the directors in higher-level hospitals have a relatively better understanding in IT systems'*.

It seems that the regional factor again is one of the reasons. D32 argued that '*not only the hospital level, but the regional factor is very significant as well … hospitals in Beijing (a developed area) would be more advanced than hospitals in our region (less developed) in every aspect.*', D32 also provided an example, '*one hospital in our city has received government funding to adopt the 'da Vinci' Surgical System, but we did not, even though we are the same top-level hospitals. This is because we are not a provincial hospital like they are*'.

6.5.3 Environmental Context

Government Policy and Regulation

Government policy and regulation (Table 6.18) is found to be a significant factor and is having a negative impact on adoption decision. The less strict the policies and regulations issued by the government, the more likely hospitals are going to adopt due to more flexibility. The stricter law indicates less support from the government, therefore, hospitals are less likely to adopt. Toughening the policies and regulations also increase the (not only monetary) cost for hospitals to adopt new technologies.

Table 6.18 Government Policy and Regulation being Negatively Significant

Support		Reasons for being Negatively Significant
5/6		
D11	Y	The Government provides guidelines only for MHS
D12	Y	The less strict government regulations are, the more likely hospitals are going to adopt MHS
D21	Y	Increased cost (not only monetary) when strict or complex rules are in place
D22	Y	Less strict laws reflect that MHS is a new technology, innovative hospitals would adopt to increase competitive advantage
D31	Y	More flexibility without strict law, hence more likely to adopt
D32	N	Disagree

Cause						
Cause (Negatively Significant)	**D11**	**D12**	**D21**	**D22**	**D31**	**D32**
More flexibility with less strict government policies	**X**	**X**	**X**	**X**	**X**	
Strict policies lead to higher cost (not only financially)		**X**	**X**		**X**	

As seen in Table 6.18, D11, D12, D21 D22 and D31 all suggested that less strict government regulations, such as if governments only provide guidelines, the more likely hospitals are going to adopt MHS. D11 stated that '*government hardly regulates how to adopt MHS or what should be included* (therefore no strictness in regulation). *The government only encourages hospitals to do something to make patients' hospital visit easier or to make doctors' work more convenient. It encourages hospitals to consider various options';* D31 argued that it is more flexible for hospitals if the regulation is not strict, '*if the government has not issued any prohibition regarding this area … hospitals would have more flexibility in adoption hence they are more likely to adopt*'. D22 mentioned that '*less strict laws and policies in this area could reflect the fact* *that MHS is a new technology, hospitals that are innovative, or would like to keep ahead, would take the lead in this area by adopting MHS'.*

D12 argued that if some areas had very complicated legislation or regulation, it could prevent hospitals from adopting MHS and provided an example of e-signature, '*the less strict the government regulation is, the more likely the hospitals are to adopt MHS. For example, the e-signature, which is a part of MHS, because many important files or patient records require a signature from doctors, if the law does not strictly require that doctors have to sign in person, hospitals would definitely be interested in adopting an e-signature system within MHS. However, if the law forbids doctors from signing electronically, which means doctors still have to sign on paper with a pen, MHS would not be that interesting for hospitals to adopt then*'. D21 added that '*if the government sets a high standard for IT system, such as e-patient records, e-signatures etc.* (hospitals will have to comply)*, although currently there is not a detailed policy for MHS yet*'. D21 then argued that innovation and hospitals are always one step ahead of government regulations and policies, it is likely that technologies are adopted when there are few, and not very strict, regulations; and when the regulations and policies are rigid, it would potentially cost more (not only financially) to adopt, hence hospitals could delay or be against the adoption. D21 stated that 'b*efore the government turns its attention to this part (MHS), hospitals are one step ahead and if they think MHS is worth adopting, they will adopt*. *Later on, if the government issues some policies which are strict or complex, the directors of hospitals might think twice before they adopt because of the extra (not only monetary) cost they have to invest in for MHS. If they think the spending is too much they would delay in adopting MHS'.* D31 also stated that '*as the context is in China, if the government is restraining hospitals from adopting something, there is no way for hospitals to adopt such a thing*'.

External Pressure

External pressure (Table 6.19) is found to be a significant factor in the adoption of MHS. It is obvious that competition between public hospitals exists due to hospitals having to fund themselves like profit-making organisations. Hospitals compete for more patients, compete to not be left behind and compete for resources; therefore, to increase the competitive advantage is the reason that external pressure is found significant.

Table 6.19 External Pressure being Significant

Support		**Reasons for being Significant**
6/6		
D11	Y	Both compete for more patients and compete to not be left behind are important
D12	Y	The competition exists; not wanting to be left behind
D21	Y	The better service a hospital offers, the more patients and the better reputation it gets; hospitals with MHS have more competitive advantage
D22	Y	MHS increases a hospital's general competitive advantage
D31	Y	Everything else being equal, the hospital which adopted MHS would have a greater advantage
D32	Y	To enhance the competitive advantage, compete for patients and compete for resource, adopting MHS is important if other things are equal
Cause		

Cause (Significant)	**D11**	**D12**	**D21**	**D22**	**D31**	**D32**
Compete for more patients	**X**	**X**	**X**	**X**	**X**	**X**
Compete for resources						**X**

All interviewees mentioned that the same level hospitals have to compete with each other for patients, and also compete to be the leader instead of being left behind. D11 explained by stating that '*there are two types of competitiveness. Competition for more patients or for not losing patients and competition in order not to be left behind by other hospitals …* (Both are) *very important*'. D12 mentioned that '*the competition exists. For example, in some district in Shanghai, hospital rankings are released to the public* (so the patients can choose from the higher-ranked hospitals)*, and hospitals do not want to be left behind';* D21 added that '*there are already hospitals that have adopted MHS, and they are doing well. It is just competition, the better service a hospital offers, the more patients and the better reputation it gets … If one hospital really prospers with the adoption of MHS, if MHS is proven to be really helpful and helps professionals to a great extent, especially for the nursing department, clinical laboratory, radiology department, doctors and nurses could bring tablets with them all the time, doctors have access to everything even when they are out of hospital* (other hospitals would follow)'; D32 also argued that '*if all other hospitals have adopted MHS the patients will gradually flow to their hospitals, everything else being equal. If all patients were moving away to other hospitals because of their adoption of MHS, the non-adopting hospital would seriously consider adopting the technology as well*'.

Hospitals would adopt MHS to increase their competitive advantage. D21 mentioned that hospitals could provide a better service by adopting MHS, which in turn could improve its reputation and hence gain more competitive advantage, D21 stated that '*hospitals with MHS have more competitive advantage*'. D31 and D32 stated that the adoption of MHS would bring a competitive advantage, which would eventually lead to the non-adopters' reconsideration of the adoption of MHS. D31 mentioned that '*everything else being equal, the hospital who adopted MHS would have a greater advantage compared with the one* *without, which eventually would lead to a reconsideration of adopting MHS in the not-yet adopted hospital'* while D32 argued that '*to enhance the competitive advantage, adopting MHS is important if other things are equal*'. D22 also added that '*MHS could increase a hospital's general competitiveness so it is for the very top management to make the adoption decision*'.

D32 mentioned the example provided before, '*like the example I mentioned before, another hospital in our city received government funding for the adoption of the 'da Vinci' Surgical System, but we did not; government funding sometimes depends on whether the hospital is good enough to receive support for adopting new technologies*.

However, D12 also stated that it is the medical care, treatment, technique, diagnosis and service quality that are much more important than the efficiency MHS brings, and the core competitive advantage of a hospital is the quality of medical service it provides, as '*it is more of a psychological factor that one hospital would want to adopt MHS because the director sees it in other hospitals. A patient attends a hospital, not because of the efficiency of a hospital, it is the medical care, treatment, technique, diagnosis and service quality that are much more important. The core competitive advantage of a hospital is the quality of medical service it provides*', MHS is just icing on the cake. D32 argued similarly, which is that the professionals in a hospital are the best competitive advantage a hospital has.

6.6 Discussion

6.6.1 Technological Context

Within the technological characteristics, this study has found the factors of perceived ease of use, system reliability, system security and privacy of patients and IT infrastructure to be significant while the perceived usefulness and compatibility were found insignificant in adoption decision-making.

Perceived ease of use is a significant factor that affects the adoption decision of MHS and is in consonance with the result that previous studies have achieved (Tsai, 2014; Sezgin and Özkan-Yıldırım, 2016; Dwivedi *et al.,* 2011, Ramdani *et al.* 2013, Oliveira *et al.* 2014, Gutierrez *et al.* 2015, Wang *et al.* 2016).

A hospital's current *IT infrastructure* is found to be significant, but has a negative impact on an adoption decision, which is contrary to the previous finding that *IT Infrastructure* is a positive significant factor in the adoption studies model by Zhu, *et al.* (2006a), Zhu, *et al.* (2006b), Lin and Lin (2008), Oliveira *et al.* (2014), Gutierrez *et al.* (2015) and Wang *et al.* (2016). The reasons for negativity in this study are explained above. The researcher reckons the reason that the result from this study is different from many previous studies is the different industry background as this study is in the healthcare context. Another reason might be that this study used the pure IT infrastructure as a construct while most of the others used a construct that is consisting of IT infrastructure and other sub-factors, such as technology readiness, which consists of technology infrastructure and IT human resources (Zhu, *et al.* 2006b; Oliveira *et al.* 2014; Gutierrez *et al.* 2015), and also technology competence, which consists of technology infrastructure and IT skills (Zhu, *et al.* 2006a; Wang *et al.* 2016).

System security and privacy of patients is another significant factor that influences the adoption of MHS in hospitals. The result conforms to the finding from Kim, *et al. (*2008) and Zhu, *et al.* (2006a), who both argued that security and privacy are very important factors. Zhu *et al.* (2006a) mentioned that security concern is a more important inhibitor than the financial costs of a technology. The result confirms that the protection of privacy has a positive impact on the adoption of technology, and this was argued by Alaiad and Zhou (2014). Cao *et al.* (2014) suggested that privacy and security of patients' information have to be guaranteed when adopting HIT.

The result of the *system reliability* is a surprise to the researcher and initially seemed implausible. However, apart from the explanation given by the informants, exactly the same result has been found by Goodhue and Thompson (1995). The interpretation was that the adopters who depend heavily on IT system usage know the potential issues of the IT system, and also would be more frustrated by the 'instability' or the downtime of the system because of the high dependability, and therefore would tend to rate IT system as unreliable. As reported by Valaitis and O'mara (2005), *'some technical glitches will occur with the use of any technology'* (pp159) and is to be expected.

Perceived usefulness was found insignificant in the adoption of MHS in hospitals, which is the opposite of much previous research including the findings from Hu, *et al. (*1999), Kuan and Chau (2001), Zhu, *et al.* (2006a), Lin and Lin (2008), Alam (2009) and Ramdani *et al.* (2009), all of whom have suggested that perceived usefulness is significant for the adoption of technology in both the individual and the organisational contexts; but in line with Chau and Tam (1997), Thiesse *et al.* (2011, Partially) and Wang *et al.* (2016). Chau and

Tam (1997) argued that adopters and non-adopters '*are not significantly different in their beliefs about the benefits'* (pp14). Wang *et al.* (2016) argued that the insignificance was caused by the fact that the adopters and non-adopter think almost the same regarding the advantages technology brings, and this study reflected the same.

Contrary to the findings of Wang, *et al. (*2010), Zhu, *et al.* (2006a), Alam (2009), Ramdani *et al.* (2013) and Wang, *et al. (*2016), but in line with the findings from Lin and Lin (2008), Ramdani *et al. (*2009), Thiesse *et al. (*2011), Oliveira *et al.* (2014) and Gutierrez *et al.* (2015), *compatibility* is found to be insignificant. Lin and Lin (2008) argued that adopters might already have made the changes necessary for adoption. Ramdani *et al.* (2009) explained that the insignificance might be because the adopters do not have many things to integrate with the new adoption. Thiesse *et al. (*2011) think the reason for insignificance in their research lies with the sample, as the sample used contained only adopters. Oliveira *et al.* (2014) attributed the result to the nature of the technology being adopted in their research.

6.6.2 Organisational Context

Top management support and hospital level (organisation size) are found to be two factors that affect the adoption decision of MHS in hospitals in an organisational context while hospital readiness is found to be insignificant.

The result is in line with the statement made by Jeyaraj *et al. (*2006), that *top management support* (TMS) is one of the best predictors in organisational adoption research; TMS has also been found by Ramdani *et al. (*2009) as the most significant variable. Alam (2009), Thiesse *et al. (*2011) and Oliveira *et al.*

(2014) all found management support to be an important factor that influences the adopting of IT.

Organisation size, in this study the *hospital level*, is one of the best three predictors Jeyaraj *et al. (*2006) summarised in an adoption decision, although Thiesse *et al. (*2011) and Gutierrez *et al.* (2015) found it to be insignificant; most of the studies tend to agree with Jeyaraj *et al. (*2006) by reporting it as an impacting factor in an adoption decision (Zhu and Kraemer 2005; Zhu, *et al.* 2006a, 2006b; Ramdani *et al.* 2009, 2013; Oliveira *et al.* 2014 and Wang *et al.* 2016). Thong (1999) argued that the firm size is the most influential factor in determining the adoption of IS.

Hospital Readiness (organisation readiness) is found to be insignificant, which is contrary to the finding from Ifinedo (2012) and other studies (Kuan and Chau 2001; Zhu and Kraemer 2005; Zhu, *et al.* 2006b; Alam 2009; Ramdani *et al.* 2009, 2013; Thiesse *et al.*2011; Oliveira *et al.* 2014). This result of insignificance is very rare and the researcher recognises that the different result in this study is because of the uniqueness of the characteristics of the Chinese mainland public hospitals, which are public organisations that receive government subsidies but also operate as profit-seeking companies.

6.6.3 Environmental Context

All environmental factors are found to have a significant impact in a Chinese public hospital's adoption of MHS.

Government policy and regulation is found to be influential on the adoption decision of MHS. The result is similar to the findings from Bernroider and Schmöllerl (2013), which indicates that legislative regulation has a negative impact on IT decision- making. Zhu and Kraemer (2005) mentioned that regulatory support is more important in developing countries than in developed countries because, in most developing countries, markets tend to be asymmetric in information and immature in organisational structure, thus government regulation or lack of regulation plays a great role in developing countries.

External pressure is seen as one of the best three predictors in an organisational adoption study (Jeyaraj *et al.,* 2006); the result is in line with this argument as well as other research findings (Luo *et al.*2014; Lin and Lin, 2008; Zhu, *et al.* 2006a; Zhu, *et al.* 2006b; Hsu *et al.*2006; Gatignon and Robertson, 1989).

6.7 Reasons for MHS Adoption

The answer to the question why hospitals would adopt Mobile Health Systems is derived from the qualitative study, by doing selective coding; the reasons behind the decision are linked together through in-depth interviews.

Convenience has been repeatedly mentioned by all the informants. MHS brings convenience to not only a hospital medical professionals, but to hospital managers and patients as well.

MHS is expected to reduce the workload, to increase the efficiency and productivity of hospital professionals, as well as to allow professionals to work without any restraints as to their location. As D21 has mentioned, '*A good IT system like MHS would definitely reduce professionals' workload by increasing their productivity. Therefore, many top managers would like to invest in newer IT systems*'. It also provides functions such as mobile visual and audio transmission which allows experts to participate in a difficult operation even when the experts are not on site: the management function that '*helps the directors and managers manage hospital while being away*' (D21); the function that coordinates '*daily management works, monitoring and organising works*' (D31). MHS also makes patients' visit to hospitals easier. As D11 has mentioned, '*the fundamental value of MHS is to make patients' visits to hospitals easier, bringing convenience to both patients and doctors, as well as increasing professionals' efficiency. What MHS brings breaks the concept of region. A doctor could do what he or she usually does no matter where, within the hospital, out of the hospital or even out of the country.'*

The example D11 argued also showed the potential MHS brings, *'Other branches of our hospital possess only limited medical resources and capability. During surgical procedures, such as cardiac catheterisation or coronary angiography, especially when having difficulties inserting the cardiac catheter, they often need help from our very renowned director of the department of cardiovascular medicine, who is often out of the country. With the help of MHS, director have access to real-time surgery processes, which not only include a live video stream, live patient status and everything he could have seen during a real surgery can be seen, the director could instruct other surgeons where to insert the catheter and why during the surgery, but from thousands of miles away on MHS via his mobile phone.'*

Because of the convenience MHS provides, the increased efficiency is to be expected among hospitals professionals: a very simple example is that they do not have to return to their desktop computers anymore. As D31 has mentioned, *'The most important things to consider are how to maximise the efficiency of professionals in the hospital, how to provide better services etc.'.* D32 also argued that '*MHS serves as a tool where the main purpose is to increase the efficiency of professionals and make the work of doctors and nurses more convenient, and the sole purpose of MHS is to bring professionals convenience and increase their efficiency, we would not have wanted to use MHS otherwise*'.

However, with all the benefits MHS brings to the table, it is not deemed as an essential IT system. It is seen as 'the icing on the cake', hospitals are much better off with the system, but would still survive without it, which is the reason that some hospitals think MHS is useful but have decided not to adopt in the near future.

The second reason for adoption is to increase hospitals' competitive advantage. Since public hospitals need to generate their own revenue, competition among hospitals cannot be avoided. As D21 argued, '*the better the service a hospital offers, the more patients and the better the reputation it gets. Hospitals with MHS have a much more competitive advantage'*. D11 mentioned that if many hospitals in the developed region have adopted MHS, the ones that do not yet have MHS in use would face questions and complaints from professionals and patients. The external pressure forces hospitals in that particular area to adopt.

One last adoption reason is the government policy orientation. Especially in China, when government encourages hospitals to do something to make patients' hospital visits easier or to make the work of doctors more convenient, hospitals would then look into the solutions which include but are not limited to the adoption of MHS. D32 offered a typical example, '*The former Director of Health Department in our city preferred Chinese Medicine when he was the Director, suddenly many hospitals formed new Chinese Medicine departments or paid much more attention to the department within the hospital. The Chinese* *culture still encourages the idea that the inferior staff do what their superiors prefer them to do, no matter what'*.

The results of the quantitative study show that many factors are significant in adoption decision-making, however, most of them are facilitators or barriers in the adoption of MHS, instead of the real reasons behind the adoption, which are only revealed through the qualitative in-depth interview.

6.8 Summary

This chapter started by presenting the result from the pilot study. Then, the figures from the data were reported which indicated the hospitals' adoption rate among different levels of hospitals. The chapter then moved onto the quantitative part of the study and the empirical model used for this study is set up. The result is then presented, which showed that the significant variables of an adoption decision of MHS in hospitals in the technological contexts are perceived ease of use, system reliability, system security and privacy of patients and IT infrastructure; hospital level and top management support in the organisational context, and all the factors in the environmental context, which are government policy and regulation and external pressure, are found significant. The model then went through model robustness testing to ensure the model is fit with a sound predictive power of 85.1 percent and is unlikely to have a multicollinearity issue. The result of the qualitative research is then discussed factor by factor to explain the reason for certain constructs being significant and others not. After the discussion, the reason behind MHS adoption is proposed by analysing the data from the phase three study. Coding and categorising were used for the analytic process of the qualitative research section of this chapter.

Chapter 7 Conclusion

7.1 Research Question and Hypotheses

Health information technology is transforming the healthcare industry; by adopting HIT, hospitals could increase the efficiency of professionals as well as provide better quality medical service. Chinese public hospitals are unique organisations; they are technically public organisations because they receive funding from the government, but they operate like profit-seeking organisations; because the government subsidies only account for a tiny amount (9% in 2016) of their total income, they have to have their own profitability in order to survive.

The main purposes of this study are to develop a model that can be used to predict the adoption of Mobile Health System (MHS) in Chinese mainland public hospitals, to test the hypotheses, to explore why certain factors are significant in adoption decision-making while others are not, and also to reveal the reasons why hospitals adopt MHS at all. Those research questions emerged while doing the literature review. Although innovation adoption is a heavily studied and relatively mature area, the findings of the organisational innovation adoption are inconclusive and fragmented; in the healthcare context, most of the studies were concentrating on one of the health technologies adoption, such as the adoption of EHR, CDSS or PACS. The theories and models are diverse, so are the predictors developed within the models. Different theories and models combined with different factors under different backgrounds are used in adoption studies; there are hardly any conclusive models or factors that fit all organisational adoption studies due to various aspects. For example, in the healthcare context, Hu *et al. (*1999) applied TAM to study the adoption of telemedicine in Hong Kong; the factors included in the TAM model are perceived usefulness and perceived ease of use; Wu *et al. (*2011) studied mobile healthcare adoption in Taiwan, an integrated model of TAM and TPB was used and the factors included were attitude, perceived behavioural control, subjective norm, perceived usefulness, perceived ease of use, personal innovativeness and perceived service availability; Phichitchaisopa and Naenna (2013) applied UTAUT, which included performance expectancy, effort expectancy, social influence, facilitating conditions and provincial areas as constructs to study hospital information technology adoption and the place of research was Thailand; Sezgin and Özkan-Yıldırım (2016) integrated TAM, TPB and UTAUT to study HIT adoption in Turkey; the predictors used were behavioural intention, perceived ease of use, perceived usefulness, perceived behavioural control and system factors. Even if some of the studies were at the organisational level, the models used were initially created to study individual adoptions such as UTAUT. The models that can be applied to both individual and organisations such as TAM and IDT do not have sufficient constructs. For example, neither TAM nor IDT contains the three best organisational predictors argued by Jeyaraj (2006): top management support, external pressure and organisation size.

Moreover, most of the adoption studies, that used the traditional prominent models (Sezgin and Özkan-Yıldırım, 2016; Alaiad and Zhou, 2014; Tsai, 2014; Deng *et al.,* 2014; Sun *et al.,* 2013) to examine the factors that influence the adoption decision, only revealed the relationships between the variables because of the quantitative method only approach; the reason that a particular variable is significant, or why an organisation decides to adopt a technology cannot be accurately identified. The goal of this study was not only to develop a model that can be used to predict Chinese public hospitals' MHS adoption decisions, it also aims to find out why some elements are given more weight than others in adoption decision-making, and why hospitals adopt in the first place.

After the initial literature review, a draft conceptual framework has been built. The framework was built based on the TOE framework, which indicated that technological, organisational and environmental characteristics all have significant impacts on technology adoption in organisations. The initial framework included all three of the TOE categories, and there are multiple constructs within each category; all constructs were picked and categorised because they were found to be significant factors in previous healthcare IT adoption studies.

The initial framework and hypotheses were then being validated and tested during the pilot study, which was phase one of the study. The purpose of the pilot study was to get more practical insights from hospital directors and experts; to add, amend or eliminate initial factors derived from the literature review; to validate the content and face validity; and also to test the model before the main survey. The pilot study helped the researcher to finalise the conceptual framework. After making adjustments from the initially proposed framework, the finalised framework retained all three contexts, which indicated that the technological, organisational and environmental factors are assumed to have significant impacts on an adoption decision of MHS. The constructs that are hypothesised to be influential on an adoption decision in the technological contexts are perceived ease of use, perceived usefulness, compatibility, IT infrastructure, system security and privacy of patients and system reliability; the perceived significant organisational factors are top management support, hospital level and hospital readiness; and the finalised predictors in the environmental contexts are government policy and regulation and external pressure.

After the phase one pilot study, by using the questionnaire redesigned from the finalised framework, the phase two survey was conducted in hospitals in two regions. The purpose of this phase was to collect quantitative data for analysis in order to find the relationship between variables and to have all the hypotheses tested. Using the results derived from the quantitative study in phase two, the researcher then started the phase three qualitative study. Phase three research consisted of six in-depth interviews that explain the results from the phase two, i.e. why a factor is significant or insignificant in the adoption of MHS. By conducting all three phases, not only the framework used in the quantitative study was consolidated by the pilot study, but also the long-term criticism on adoption studies is addressed; this criticism argues that the result only tells the relationships between variables, but can only speculate the reasons behind the result; it is addressed by adopting a qualitative approach, by means of the phase three in-depth interview, after the phase two quantitative study. By having both quantitative and qualitative methods, the results this thesis presents are richer, more reliable and more rigorous than when using only a single method of data collection (Mingers, 2001; Ghauri and Grønhaug, 2005).

7.2 Research Summary

Chapter one is the introductory chapter, which first states the definitions of major terms such as HIT (Health Information technology), HIS (Health Information System), innovation, adoption and diffusion as well as MHS (Mobile Health System). The chapter then goes on to discuss the background of innovation, technology and the adoptions as well as to briefly discuss the theories in adoption studies. The rationale of the research and the gaps in current studies are then discussed; the gaps exist because the innovation adoption studies in the healthcare context are mostly specifically software-oriented; the existing mobile health adoption studies are at an individual adoption level; the healthcare studies in organisations within the Chinese context are very limited; and the adoption of MHS studies targeting the mainland Chinese public hospitals are non-existent. The gaps found in the literature led to the reasons for his study, which are to develop a theoretical model that can be used to predict MHS adoption in Chinese public hospitals: to identify the determinants of any adoption of MHS; to unveil the reasons why certain elements play an important role in an adoption decision; and finally to reveal why some hospitals adopt MHS while others do not. The chapter then briefly describes what each chapter consists of in this thesis.

The second chapter starts by introducing the background of the mobile health system, the emergence, development and the current state, as well as the possible components of the mobile health system. The chapter then introduces the background to the healthcare industry in China; it briefly discusses the national health spending as well as other figures such as hospital numbers and medical personnel; then the chapter discusses the government's orientation, the problems during the past years and the on-going Chinese health sector reform which focuses on five different areas, as well as the emergence of the WIT120 (Wise Information Technology of 120). A description of the Chinese public hospitals, their classification, the differences between different levels of hospitals are then discussed. The reason why Chinese public hospitals are different from other organisations is explained, i.e. they are public hospitals that receive government funding, but the funding only accounts for less than ten percent of total revenue and the hospitals are performing as profit-seeking organisations. The chapter then discusses the benefits of adopting IT, for example to improve medical safety and efficiency, and the barriers that hinder the hospitals from adopting the IT. The examples of the common barriers are time and financial issues, insufficient computer skills, confidentiality and privacy concerns and knowledge and attitudinal barriers.

Chapter three provides a review of the literature. It starts off by discussing the definition of innovation and technology, the different types of innovation and the process of innovation development. The definition of adoption and diffusion is then mentioned in the chapter with the innovation diffusion and adoption process, as well as the types of adopters. A brief discussion of innovation in the healthcare context is held in this chapter. The chapter then moves onto several theories and models of IT adoption. The most important and applied theories are discussed in detail; it starts by introducing TRA (Theory of Reasoned Action) (Fishbein and Ajzen,1975), the chapter then discusses IDT (Innovation Diffusion Theory) (Rogers, 1983), TAM (Technology Acceptance Model) (Davis, *et al.,* 1989), TPB (Theory of Planned Behaviour) (Ajzen,1991), TAM 2 (Venkatesh and Davis, 2000), UTAUT (Unified Theory of Acceptance and Use of Technology) (Venkatesh *et al.* 2003), TAM 3 (Venkatesh and Bala, 2008) and UTAUT 2 (Venkatesh *et al.* 2012). In the detailed discussion, the definition of the constructs within the theories, the development of the model, the studies that have applied the theory, and also the criticism, are all discussed. The discussion then moves onto the theory that this very study has applied, the technology-organisation-environment (TOE) framework.

Chapter four is the framework development chapter. The start of the chapter is the development of the preliminary conceptual framework. The dominant paradigm argued by Fichman (2004) is discussed with the revised dominant paradigm adjusted by Jeyaraj *et al.* (2006). The framework development process is shown in the chapter with the constructs chosen. The preliminary conceptual framework is then brought to test in the pilot qualitative study, which is discussed in the following chapters. The result from the pilot study is very constructive and leads to the addition, amendment and elimination of some of the constructs in the preliminary framework. After the pilot study, the framework with its finalised constructs are set and the predictors validated. This chapter then moves on to the hypotheses of this study. It is assumed that all three contexts, i.e. the technological, organisational and environmental characteristics, influence the adoption of MHS in hospitals. The hypotheses this study proposes are that the higher, better or greater is the perceived usefulness, perceived ease of use, compatibility, mobile health system reliability, mobile health system's security and privacy for patients, hospitals' IT infrastructure, top management support, organisational readiness, hospital level, external pressure, the higher the chance of Chinese public hospitals adopting a Mobile Health System, and also that government policy and regulation have a significant impact on an adoption decision.

The fifth chapter discusses the methodologies this thesis has applied. It starts with the discussion of the whole research order and the three phases of the study. The chapter then discusses the research design and the data collection methods. This thesis uses both a description and an explanation design because innovation adoption is not new; the description design allows this study to continue the stream in adoption studies; the explanation approach is used to answer the questions why certain elements matter in MHS adoption as well as why some hospitals adopt MHS while others do not. The data collection approaches are then detailed. The thesis uses the combination of both quantitative and qualitative approaches because both methods have their own strengths and weaknesses; the combination of the approach draws strength from both and they compensate each other's weaknesses (Jick, 1979; Neuman, 2002). Lack of either method would jeopardise the rigour of the study. After discussing the units of analyses, and which hospitals are used, the sampling frame is stated with an explanation, i.e. the reasons why those two regions have been chosen in this study. The fieldwork is then mentioned after the sampling frame discussion. The chapter then moves on to discuss each phase in detail. Phase one is the pilot study with face-to-face interviews with eight informants who are department directors and doctors in three hospitals in two cities, with the purpose of validating the validity, pre-testing the framework before the main survey and amending the constructs; this chapter discusses the design, and the data collection method of phase one, followed by the sampling and choice of informants and then the fieldwork. Phase two is the main quantitative survey in the hospitals where the purpose is to test the hypotheses and identify the significant predictors. The chapter again discusses the design and data collection method used in phase two, followed by the instruments and questionnaire design discussion, which includes the items' acquisition, modification and translation. The chapter then discusses in detail the sampling, the choice of respondents and then the fieldwork. How data was analysed is then discussed for phase two, which includes the choice of logistic regression, the empirical model this thesis has adapted, measures of the constructs, the reverse scoring and the validity and reliability of the model. The construct validity, predictive validity, face validity and content validity are all validated as well as the reliability as demonstrated by Cronbach's Alpha test. Phase three is the in-depth interviews qualitative study and the purpose is to explain the results from phase two. The design and data collection method of phase three are discussed, followed by the sampling method and the choice of six informants. Then, the fieldwork of phase three is mentioned as well as the data analysis method used. The trustworthiness of the study is also discussed in detail.

Chapter six includes the findings, analyses and discussions of the research result for all three phases. The chapter first discusses the empirical findings of the pilot study. A basic report of the adoption rate is presented with the data from the survey result, then the empirical model is applied in this study. The analytical result from SPSS is illustrated with various tests of the model's robustness such as the different methods of testing the multicollinearity issue and, finally, the results on whether the hypotheses were supported or rejected. The chapter then moves to the qualitative part of the study, which provides the coding and the conclusions derived from the three stages of coding as well as the discussion for each construct, and finally the reasons for adoption are proposed; these are the convenience, the competitive advantage MHS brings and the government orientation the hospitals follow.

Chapter seven, which is the current and final chapter, is the conclusion of the entire thesis. The chapter starts by reviewing the research questions and hypotheses this study proposes. The chapter then summarises each chapter written in the thesis. The findings and analysis results of both the quantitative and qualitative data are then discussed followed by some discussion of some of the research limitations. The chapter concludes by providing the implications of this research and its contribution to the adoption research field as well as putting forward suggestions for future and continuous research.

7.3 Findings

It is found that eight of the hypotheses are either fully or partially supported; among the eleven proposed factors, eight of them are significant factors in decisions to adopt MHS in Chinese public hospitals. Four out of six predictors in the technological context, two out of three in the organisational context and all the environmental factors are found to have significant impacts on hospitals' adoption of MHS.

Within the technological context, perceived ease of use, system reliability, system security and privacy of patients and IT infrastructure are found to be important factors. Perceived ease of use is an important factor to consider because some elderly experts and professionals might be slower in accepting new technologies, and the easier they are to use, the higher the efficiency of medical professionals. No hospital would adopt MHS if the efficiency of the professionals is reduced because of the complexity of using the system. To the researcher's surprise, system reliability is found to have a negative impact on the adoption of MHS. Firstly, this is because potential adopters have a better knowledge of the system and are expecting MHS to have certain problems as all other IT systems do, while non-adopters generally have less knowledge of the system and expect the system to be perfect and highly stable. No IT system is error free and one hundred percent stable; the benefits MHS brings is overwhelming, not to mention that MHS is a future trend. System security and privacy of patients is a significant factor, which is due to the fact that current privacy concerns are under the microscope in China after years of personal data being leaked and sold. Hospitals are unlikely to adopt without knowing that the system is fully secured and the data are safe. The current IT infrastructure has a negative influence on adoption decisions, because the professionals and directors would probably be reluctant to change if the current IT system works well; and if the current system could not fulfil the satisfy medical professionals, the hospitals are more likely to adopt a new system. Perceived usefulness and compatibility in the technological context were found to be insignificant. Regarding perceived usefulness, although all hospitals tend to think MHS is a useful system, it is not seen as an essential IT system; therefore, if certain hospitals had limited funding they would not choose to adopt MHS first even if they recognise the system as highly useful. Compatibility wise, because potential adopters are always prepared for change, and with enough funding or experience, the system can always be made compatible.

Top management support and hospital level (organisation size) are significant factors in the organisational context. Top management support is said to be the most important and decisive factor in the adoption of MHS because hospital directors have absolute power and their perception of MHS matters in adoption decisions. The level of hospital is the other important organisational factor because larger hospitals are busier and handle more, and tougher, cases. High-level hospitals also have more departments thus requiring better coordination. MHS tends to be more useful in higher-level hospitals rather than in the lower-level ones. Hospital readiness is, however, found not to be important in adoption decision-making, and this is because of the uniqueness of Chinese public hospitals, i.e. they are public organisations but they act as profit-seeking entities. Therefore, there are other sources of funding, such as government funding if MHS is highly desired, and the technical support and after-sale support is always provided by suppliers so it is not important for hospitals to have their own MHS support personnel.

All the environmental factors, which are government policy and regulation, and external pressures are significant elements in MHS adoption in hospitals. The less strict the laws and regulations are, the more likely the hospitals are going to adopt MHS. Hospitals tend to have more flexibility when the laws are not all binding. The policies and regulations must be supportive instead of simply being strict, which would increase the adoption cost (not only financially). External pressure is important because Chinese public hospitals are acting as profit-seeking organisations; thus competing for patients, competing so as not to be left behind and competing for resources are significant for all public hospitals.

It is found that the convenience MHS brings to the hospital, in reducing the workload, increases the efficiency of the professionals and breaks down the barriers of time and location, as well as making patients' visit to hospitals much easier in many aspects; the competitive advantage from using MHS increases in hospitals and finally, the current government policy orientation are the key reasons for the adoption of MHS.

7.4 Research Limitations

This study is subject to several limitations. Firstly, the sample size is not large enough. Due to the difficulties in accessing directors in Chinese mainland public hospitals, and the combination of research methods this study has applied which have limited the resources of the researcher, the sample size is smaller than ideal; Hair *et al. (*1998) suggested that it is best to have a sample size ten times the number of model coefficients for logistic regression. In this study, the sample size is eight times the number of independent variables instead of ten.

The second limitation is that, there was only one set of factors tested, there might be other factors that have not been accounted for during the study.

The third limitation in this study is that it did not take China's regional differences into account, as suggested by some of the informants during the in-depth interviews, which was too late as the main survey was already done. The status of different regions varies very much; thus the researcher hopes any future research could improve on this point.

The fourth limitation is that, due to the fact that MHS consists of many different technologies, some of the responses might be referring to only one of the several technologies included in MHS.

The final limitation is that, due to sampling methods used, the six final in-depth interview informants are all from above level three hospitals that are potential adopters, which could lead to a somewhat biased result.

7.5 Contributions, Implications and Future Research

This thesis contributes in several areas. It contributes to academia by continuing the research in IT adoption study, by being the first to study MHS adoption in Chinese mainland public hospitals and also by applying the combination of both quantitative and qualitative methods. It contributes to the practical world because vendors and governments could use the results of this research to promote MHS adoption.

This study contributes to the adoption research field by proposing an adoption framework based on TOE theory, having the constructs and content validated in pilot study interviews, and having the framework and hypotheses tested in a field survey, as well as proposing the reasons for certain factors to be significant while others are not, and for the reasons for adoption revealed. Another contribution is that it is extending the reach of the adoption and diffusion study from any software adoption to the adoption of a whole mobile IT system, a Mobile Health System, at the organisational level. It has also contributed to the field of mobile technology adoption study which has been a focus of interest for many years. The research has filled the gap in mobile health system adoption at the organisational level, and most importantly, in the unique context of Chinese public hospitals, where similar research has not previously existed. Chinese public hospitals are unique because such organisations are public organisations while the practical operating method of the hospitals is profit-making, which takes place in the context of a unique economic and political system.

As for the research method, this research contributes to the use of combining both quantitative and qualitative methods. Most research stops at the results of significant predictors and then offers the possible speculations for certain factors being significant or insignificant. The qualitative study in this thesis provides insights for the reasons some elements matter while others do not. The suggestions by Ghauri and Grønhaug (2005) were reflected well in this study, the qualitative approach in the pilot study leads to the quantitative survey, which then leads back the qualitative in-depth interview to reveal the 'whys'. This research shows that the combination of these two approaches fits the adoption study very well as the researcher no longer has to make it a matter of guesswork why the relationships between variables reflected in the quantitative result has occurred.

This study has also shown that the theory of TOE can be used as the basic framework for adoption studies in Chinese public hospitals as all three contexts are found to contain significant factors that are affecting adoption decision-making. As a generic model, TOE is proven again to be able to be applied at the organisational level. The model has great flexibility in practical use, especially in an organisational adoption study as, with the revised dominant paradigm argued by Jeyaraj *et al. (*2006), technological, organisational and environmental contexts affect the quantity and speed of adoption of innovation in organisations.

There was almost no knowledge regarding technology adoption in Chinese public hospitals at the organisational level; the result of this thesis has proven that TOE is a very adaptive model and is suitable for adoption study in such contexts given the researcher could validate the constructs in use within TOE. The use of TOE has led the researcher to the findings within both healthcare technology adoption and the Chinese context, and it has added knowledge to both contexts. The TOE theory was the first step in helping the researcher to understand the reasons why certain factors are significant as well as the reason behind the adoption.

The result of this study shows that in order for hospitals to accept and adopt MHS, the hospitals must have top management support and the higher the hospital level the better. Therefore, for providers and developers of MHS, to get the support from directors in high-level hospitals is essential for MHS adoption. Perceived ease of use of the system is a very important factor so more attention to the intuition, convenience of the system and more user-friendly UI might help convince hospitals to adopt. The system must be secure, the privacy and security of patient data must be sufficiently protected otherwise the hospitals are unlikely to adopt under current circumstances. All these facilitators are the very top reasons for the adoption, as they bring convenience to medical professionals and patients. Environmentally, the competition pressure of a certain hospital, as well as the government policy orientation, are things to consider before an MHS provider starts trying to market their product. The Chinese government and IT vendors could use these results to facilitate the adoption of MHS; also, IT vendors would understand the reasons behind the adoption so that more precise targeting could be set in the future.

Future and continued research should follow up the limitations of this study. One suggestion might be to conduct comparative research in two different regions of the adoption of MHS, with a sufficient sample size in each region, preferably in a developed and a less developed region, in order to examine the regional differences. Whether there are differences between adoption decisions in the same level hospitals based in different regions could then be tested. The continued research in a different country using the same model is welcome as well; by applying the same model, constructs and (translated) instruments to a different country with a different culture, the issue as to whether the model can be used as a generalised organisational framework in a healthcare context can be examined. Another suggestion is to test the proposed TOE model further, with the same structures, against other technology adoptions such as the adoption of Cloud computing, or in other contexts such as adoption in retail, in order to generalise the framework.

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Appendix

1.1 Pilot Study Questions (English Version)

1. What HIT does your hospital currently use?
2. What HIT does your hospital need in the future? Why?
3. What was the process of selecting HIT?
4. What challenges does your hospital face in the adoption of HIT? Why?
5. What are the technological factors you think impact the adoption of Mobile Health System in your hospital? Why?
6. What is the impact of (perceived ease of use, perceived behavioural control, compatibility, perceived usefulness, relative advantage and system reliability) on the adoption of Mobile Health System in your hospital?
7. What are the organisational factors you think impact the adoption of Mobile Health System in your hospital? Why?
8. What is the impact of (top management support, price value, hospital level and facilitating conditions) on the adoption of Mobile Health System in your hospital?
9. What are the environmental factors you think impact the adoption of Mobile Health System in your hospital? Why?
10. What is the impact of (government policy and regulation and external pressure) on the adoption of Mobile Health System in your hospital?
11. Do you think these questions represent this factor well? Why?

1.2 Pilot Study Questions (Chinese Version)

1. 请问有哪些医疗信息科技是您所在的医院正在使用的呢?
2. 请问有哪些医疗信息科技是您所在的医院未来打算使用的?为什么?
3. 您所在的医院选择使用某种信息科技的流程是什么?
4. 有哪些问题是您所在的医院要采纳某项科技时会遇到的?为什么?
5. 您认为有哪些科技方面的因素会影响医院采纳移动医疗系统的决定?为什么?
6. 您认为(易用性,行为控制性,兼容性,有用性,相对优势,系统稳定性)会如何影响您所在的医院采纳移动医疗系统的决定?
7. 您认为有哪些医院机构方面的因素会影响医院采纳移动医疗系统的决定?为什么?
8. 您认为(医院高层支持,移动医疗系统的性价比,医院等级,资源支持)会如何影响您所在的医院采纳移动医疗系统的决定?
9. 您认为有哪些大环境方面的因素会影响医院采纳移动医疗系统的决定?为什么?
10. 您认为(政府条例以及法规,外界竞争压力)会如何影响您所在的医院采纳移动医疗系统的决定?
11. 您是否认为这些问题能很好的反映出这个因素所代表的意思?为什么?

1.3 Consent Form (English Version)

This research is conducted by Binheng Duan (PhD Researcher) and his supervisor Dr Ben Ramdani and Dr Boyi Li (Doctor in Management Studies) in the University of Exeter in The United Kingdom. This research aims to examine the influential factors of Mobile Health System adoption decision by hospitals, under what circumstances would hospitals be willing to adopt Mobile Health. You will be completing a questionnaire if you consent to participate in this research. The questions asked do not require any personal data, the questionnaire does not include any of your personal aspects.

- **All information provided will be strictly confidential and will be used for the purpose of this research only.**
- **All participants will be anonymous.**
- **Your personal contact detail form (If you have filled the contact form) will be strictly confidential and only be used for the purpose of follow up research. Under NO circumstances would the researchers reveal your personal details to any third parties. If you would like to be contacted in the future for follow up study (Only If Necessary), please fill in the contact detail form.**
- **This interview is to be completed voluntarily, you could stop the interview at any time.**

Thank you in advance for your co-operation and for taking time out of your busy schedule to participate in this study.

If you would like to take part in this study, please sign your name in the box.

Name	
Hospital	
Department	
Signature	

If you would like to be contacted in the future for follow up study (if necessary), please fill in the contact table below.

Telephone/Mobile Number	
Email Address	

1.4 Consent Form (Chinese Version)

这项调查由英国埃克塞特大学的博士生段镔恒以及他的第一导师 Ben Ramdani 博士和第二导师 Boyi Li 博士发起。这项调查旨在鉴别影响医院决定是否采纳移动医疗系统的因素，医院会在什么情况下愿意使用移动医疗软件。如果您同意参与，您将会被要求完成一份调查问卷，调查问卷的问题不需要任何您的个人资料，您的隐私将完全不会被涉及到。

- **您提供的所有信息仅会被用作这项调查的目的。**
- **您将完全保持匿名。**
- **如果您填写了联系方式，您的联系方式将会完全保密，仅会被用于研究者在有需要的情况下联系您之目的。在任何情况下，研究者都不会将您的个人资料泄露给任何组织或个人。如果您愿意在未来被研究者联系到的话，请您填写联系方式。**
- **采访将在完全自主自愿的情况下进行，您可以在任何时候以任何理由终止采访。**

再次感谢您在百忙之中的参与。

如果您同意参与这项研究，请在如下的表格内签名.

姓名	
医院	
科室	
签名	

如果您愿意在将来（仅在必要时）被研究者联系到，请填写以下联系表格。

联系电话	
电子邮箱	

1.5 Questionnaire (English Version)

What is your hospital level?	3A	3B	3C	2	1
Will your Hospital adopt Mobile Health System in the next three years?	Y			N	

	Strongly Agree	Agree	Neutral	Disagree	Strong Disagree
Ease of Use					
Learning to use Mobile Health would NOT be easy for our Healthcare Professionals.					
Our Healthcare Professionals would find it easy to get Mobile Health to do what they need to do in their patient care and management.					
Our Healthcare Professionals' interaction with Mobile Health would be clear and understandable.					
I find Mobile Health INFLEXIBLE to interact with.					
It is NOT easy for our Healthcare Professionals to become skilful in using Mobile Health.					
Our Healthcare Professionals would find Mobile Health easy to use.					
Compatibility					
The changes introduced by Mobile Health are consistent with my hospital's existing beliefs/values.					
Mobile Health is compatible with my hospital's existing information infrastructure.					
The changes introduced by Mobile Health are consistent with my hospital's existing practice.					
Usefulness					
Using Mobile Health can enable our Healthcare Professionals to complete patient care more quickly.					
Using Mobile Health CANNOT improve our Healthcare Professionals' patient care and management.					
Using Mobile Health can increase our Healthcare Professionals' productivity in patient care.					
Using Mobile Health CANNOT enhance our Healthcare Professionals' service effectiveness.					

	Strongly Agree	Agree	Neutral	Disagree	Strong Disagree
Using Mobile Health can make our Healthcare Professionals' patient care and management easier.					
Our Healthcare Professionals would find Mobile Health NOT useful for their patient care and management.					
System Reliability					
Our Healthcare Professionals can count on the system to be "up" and available when they need it.					
The Mobile Health systems our Healthcare Professionals use are subject to unexpected or inconvenient down times which makes it harder to do my work.					
The Mobile Health systems our Healthcare Professionals use are subject to frequent problems and crashes.					
System Security and Privacy of Patients					
The Mobile Health system will not provide patients' personal information to other entities without their consent.					
The Mobile Health system will not cause the use of patients' personal information for other purposes without their authorization.					
The Mobile Health system has mechanisms to ensure the safe transmission of patients' information.					
IT Infrastructure					
The level of IT provided at our hospital is adequate to perform our job.					
Our hospital is keeping up with advances in IT.					
Our hospital would provide additional IT products to improve the quality of our work.					
Top Management Support					
Our top management is likely to be interested in adopting Mobile Health in order to gain competitive advantage.					
Our top management is willing to take the risks involved in the adoption of Mobile Health.					
Our top management is likely to invest funds in Mobile Health.					
Hospital Readiness					
We have the resources necessary to adopt The Mobile Health system.					

	Strongly Agree	Agree	Neutral	Disagree	Strong Disagree
We have the knowledge necessary to use the system.					
A specific person (or group) is available for assistance with system difficulties.					
Government Policy and Regulation					
The legislative regulation pledges your hospital to use Mobile Health.					
The compliance with the legislative regulations regarding the Mobile Health is enforced strictly.					
External Pressure					
It is very important for our hospital to adopt Mobile Health to remain competitive.					
Most hospitals use Mobile Health for daily jobs.					
Currently, our hospital's competitors are adopting Mobile Health.					

1.6 Questionnaire (Chinese Version)

请勾选正确选项

移动医疗定义：使用无线设备（手机、平板电脑等）上的移动医疗配套软件，通过无线网络来实施日常的医疗服务。

您所在的医院等级	三甲	三乙	三丙	二级	一级
您所在的医院在未来 3 年内是否有使用移动医疗系统的打算？	**是**			**否**	
	完全同意	同意	既不同意也不反对	不同意	完全不同意
易用性					
学习使用移动医疗对本院医生及护士来说**不容易**					
本院医生和护士用移动医疗软件去做他们日常的病人护理和管理**很容易**					
我与移动医疗的交互将会是**清楚明确**的					
我认为移动医疗使用起来很**死板**					
对本院医生及护士来说，想精通移动医疗的使用**并不容易**					
本院医生及护士将会认为移动医疗软件用起来**很简单**					
兼容性					
移动医疗带来的改变与医院现有的信仰与价值**并无冲突**					
移动医疗与医院正在使用的信息系统基础**兼容**					
移动医疗带来的改变与医院现有的工作**兼容**					
有用性					
使用移动医疗可以让本院医生及护士**更快的**完成病人护理					
使用移动医疗**并不能**改良本院医生及护士对病人的护理和管理					
在日常病人护理中，使用移动医疗**可以提高**本院医生及护士的生产力					
使用移动医疗**并不能**加快本院医生及护士的服务效率					

	完全同意	同意	既不同意也不反对	不同意	完全不同意
使用移动医疗可以让病人护理和管理**更加轻松**					
本院医生及护士会认为移动医疗对病人的护理和管理**并无用处**					
系统稳定性					
移动医疗系统会在本院医生及护士需要时**随时可用**					
因为会有无法预期的'**系统不可用**'的情况，移动医疗系统会让本院医生及护士的工作**更加困难**					
移动医疗系统将会**经常出问题或系统崩溃**					
系统及病人隐私安全性					
移动医疗系统**不会**在未经病人的许可下将病人的个人信息提供给第三方					
移动医疗系统**不会**在未经病人授权的情况下将病人的个人信息用作其他目的					
移动医疗系统**有**保障病人信息安全传输的机制					
医院 IT 基础					
医院现有的IT系统可以满足我的日常工作					
我们医院一直在IT方面保持更新					
我们医院愿意提供更多的IT产品以增进我们的工作质量					
医院高层支持					
为了增加医院的竞争力，本院高层管理者有很大可能**会对移动医疗感兴趣**					
本院高层管理者**愿意承担**采用移动医疗可能带来的风险					
本院高层管理者很有可能会在移动医疗上投入资金					
医院准备性					
我们有**必要的**购买/采用移动医疗系统的资源					
我们有**必要的**使用移动医疗系统的知识					

	完全同意	同意	既不同意也不反对	不同意	完全不同意
当系统遇到问题时，我们有专人或专家组可以提供帮助					
政府条例/法规					
现有法律法规**支持**医院使用移动医疗					
政府**严格的实施着**关于使用移动医疗的法律法规					
外界竞争压力					
对我们医院来说，使用移动医疗来保持竞争力是**非常重要**的					
大部分医院正在使用移动医疗来完成日常工作					
目前我们医院的竞争对手们正在采纳移动医疗					

1.7 In-Depth Interview Questions (English Version)

1. Regarding the technology itself, what do you think of MHS?
2. What are the main reasons for you to decide (plan) to adopt MHS?
3. What are the main benefits of MHS?
4. Some hospitals think very highly of MHS, but would not adopt, why?
5. Do you think the MHS will be easy to use? Why?
6. What benefits would it bring if MHS is easy to use?
7. Would it be problematic if MHS is difficult to get used to?
8. Do you think the MHS must be compatible with your current HIT? Why?
9. What if MHS and your current system is not compatible?
10. Do you get downtimes and crashes on your current system? Is this a huge problem for your hospital?
11. Are there any technical limitations to your current IT system?
12. What do you expect the reliability of MHS would be?
13. What do you expect the reliability of any new IT system?
14. Why do you think some hospitals are adopting MHS even if they are aware the system cannot be fully stable?
15. Are there any differences in perceptions between potential adopters and non-adopters?
16. What security and privacy challenges do you foresee?
17. What do you plan to do to ensure privacy and security of MHS?
18. What do patients think of their privacy and data security?
19. Do you think your hospital's current IT infrastructure is good? Why?
20. What if your hospital's current IT infrastructure is really poor, would you still consider adopting MHS?
21. Why do you think hospitals with poor infrastructure would want to adopt MHS?
22. Regarding the hospital (organisation) itself, what do you think of MHS?
23. How did top management react with the plan to adopt MHS?
24. How important is it that the director of your hospital agrees to use MHS?
25. How is your hospital going to pay for the adoption of MHS?
26. Is it likely that government is going to fund this for your hospital since your hospital is a public hospital?
27. Do you have a support team ready to support the use of MHS?

28. What if professionals need training?
29. What if you need MHS after-sale support?
30. What are the differences between your hospital and lower level hospitals in general?
31. What are the differences between your hospital and lower level hospitals regarding the adoption of MHS?
32. Regarding the environment itself, what do you think of MHS?
33. What is the current government standing in MHS adoption in hospitals?
34. If the law or regulation become stricter, would you still consider the adoption?
35. What is the effect on adoption of IT when government issues strict and complex regulations?
36. Are there any other hospitals that are using MHS?
37. Since you are a public hospital, do you face competition? And against whom?
38. Do you think the adoption of MHS is important for your hospital when facing competition?

1.8 In-Depth Interview Questions (Chinese Version)

1. 就科技方面来说，您如何看待移动医疗？
2. 您医院打算采纳移动医疗的最主要的原因是什么？
3. 移动医疗主要有哪些优势？
4. 有一些医院认为移动医疗很有用，但他们并没有打算去采纳，为什么？
5. 您认为移动医疗使用起来会很容易吗？为什么？
6. 移动医疗容易使用的话会带来哪些好处？
7. 如果移动医疗使用起来不容易的话会有哪些影响？
8. 移动医疗一定要和您现有的信息系统兼容吗？为什么？
9. 如果它们不兼容呢？
10. 您现在的系统会当机或者崩溃吗？这对医院来说是一个很严重的问题吗？
11. 您现有的信息系统有哪些不足和限制呢？
12. 您如何看待移动医疗的稳定性？
13. 您如何看待任何新的信息技术的稳定性？
14. 为什么有的医院明知系统不会完全稳定，但依然会去采纳移动医疗呢？
15. 就对移动医疗的认知来说，打算采纳者和不采纳者有什么分别吗？
16. 您认为会有哪些安全和隐私方面的挑战呢？
17. 您的医院会采取哪些措施来保障隐私及安全？
18. 病人自身如何看待隐私及安全呢？
19. 您认为您医院现有的信息技术基础处于哪个水平？为什么？
20. 如果您医院现有的信息技术基础很差，您医院还会去采纳移动医疗吗？
21. 您认为为什么有的医院现有的信息技术基础很差，但仍然打算采纳移动医疗呢？
22. 就医院自身方面来说，您如何看待移动医疗？
23. 顶层管理者，或院长对打算采纳移动医疗作何反应？
24. 院长同意使用移动医院在移动医疗的采纳决定有多重要？
25. 您的医院打算如何来承担移动医疗采纳的费用呢？
26. 您所在的是公立医院，政府会为移动医疗买单吗？
27. 您医院内有移动医疗的技术人员吗？

28. 如果您医院的医技人员需要移动医疗的培训怎么办？
29. 如果您需要移动医疗的售后支持怎么办？
30. 您的医院和低等级的医院有何不同？
31. 在采纳移动医疗方面，您的医院和低等级的医院有何不同？
32. 就大环境方面来说，您如何看待移动医疗？
33. 政府现在对医院采纳移动医疗有何看法？
34. 如果政府关于移动医疗的法律法规很严格的话，您的医院仍然会采纳移动医疗吗？
35. 政府颁布非常严格及复杂的信息技术的法律条款在医院的信息技术采纳应用方面有何影响？
36. 现在有其他医院正在使用移动医疗吗？
37. 您所在的公立医院存在竞争吗？对手是谁？
38. 您认为在竞争中采纳移动医疗对您医院是否重要？

1.9 Ethics Form

University of Exeter Business School

Ethics Form: PGR Research Projects

Please use the 'Guidance for completing Business School ethics form' to help you complete this form

This form is to be completed by PGR student and signed by the primary project supervisor. Only students with a lead supervisor in the Business School can apply for ethics clearance to the Business School ethics panel. Those with a lead supervisor in another school or institution should seek advice from their relevant ethics panels.

When completing the form be mindful that the purpose of the document is to clearly explain the **ethical considerations** of the research being undertaken. Please include relevant and adequate detail for the ethics review panel to make their decisions about the ethical considerations you have made for your project. Please note that it is the responsibility of the student and supervisors to identify where their research may raise ethical issues, familiarise themselves with the ethics procedures and submit their work for review well in advance of starting their project. **Retrospective ethics applications will not be considered.**

Once completed, please submit the form electronically to and post a hard copy to Business School Research Office, Forms will only be forwarded for approval once the hard-copy has been received.

University of Exeter's Ethics policy relating to research

The University of Exeter is research intensive and dedicated to furthering knowledge in a responsible and exacting manner. In the conduct of research by academic staff and students the University strives to protect the safety, rights, dignity, confidentiality and anonymity (except where covered by an appropriate protocol) of research subjects, the welfare of animals and the sustainability of the environment. The University also endeavours to safeguard the wellbeing, rights and academic freedom of researchers and the reputation of the University as a centre for properly conducted, high quality research. The University maintains a separate *Code of Good Practice in the Conduct of Research* which it requires all researchers to follow[1].

Ethical issues are manifest in a wide variety of research activities and arise especially when the conduct of research involves the interests and rights of others. The adoption of an ethical position in respect of such research requires that the researcher observes and protects the rights of would-be participants and systematically acts to permit the participants to exercise those rights in full accordance with UK law.

Ethical practice in such cases requires that participants and/or legal guardians, at a minimum, be fully informed, free to volunteer, free to

[1] http://www.exeter.ac.uk/research/toolkit/throughout/goodpractice/

opt out at any time without redress, and be fully protected in regard to safety according to the limits of best practice. The Business School follows the policy set by the University of Exeter.

The University also upholds principles of **integrity** and the need for researchers to be honest in respect of their own actions in research and their responses to the actions of other researchers. Researchers will be required to comply with requests to the University under the Freedom of Information Act 2000 and practice **openness** in their research endeavours wherever possible.

Part A: Background of the research project

Title of project	The adoption of Mobile Health in Hospitals: An Empirical Study in China.
Name of lead researcher / Primary investigator for this project and affiliation	Binheng Duan
Name(s) of other researchers and affiliation (s)	Dr Ben Ramdani
Start and estimated end date of project	01/04/2014 – 31/03/2018
Source of funding for the project	Self-Funding
Is this application being made prior to a grant application? Which funder?	No
Aims and objectives of the project	This study examines the adoption of Mobile Health in Chinese healthcare context. It will shed light on the factors influencing Hospitals' decision to adopt and use Mobile Health.
Is the main applicant employed by the UEBS for the duration of this project?	Yes

Note: only researchers employed by the Business School can apply for ethics clearance by the UEBS ethics panel.	

Part B: Ethical Assessment

Please complete the following questions in relation to your research project. If you answer Yes to any of the sections, please elaborate

	Yes	**No**
Research that may need to be reviewed by NHS NRES Committee or an external Ethics committee (If yes please provide details as an annex)		N
Will the study involve recruitment of patients or staff through the NHS or the use of NHS data or premises and/ or equipment?		N
Does the study involve participants age 16 or over are unable to give informed consent? (e.g.people with learning disabilities: see mental Capacity Act 2005. All research that falls under the auspices MCA must be reviewed by NHS NRES)		N
Research that may need a full review		N
Does the research involve other vulnerable groups: children, those with cognitive impairment, or those unequal relationships ?(e.g. your own students) Have you read the appropriate Act; ethical practices governing research with the group you aim to study?		N
Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? (e.g. students at school, members of self-help group, residents of a nursing home?)		N
Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people in non-public places?)		N
Will the study involve discussion of sensitive topics? (e.g. sexual activity, drug use)		N
Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants, or will the study involve invasive, intrusive or potentially harmful procedures of any kind?		N
Will tissue samples (including blood) be obtained from participants?		N
Is pain or more than mild discomfort likely to result from the study?		N
Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?		N
Will the study involve prolonged or repetitive testing?		N
Will the research involve administrative or secure data that requires permission from the appropriate authorities before use?		N
Is there a possibility that the safety of the researcher may be in question? (e.g. in international research: locally employed research assistants)		N
Does the research involve members of the public in a research capacity?	Y	
Will the research take place outside the UK?	Y	
Will the research involve respondents to the internet or other visual/ vocal		N

methods where respondents may be identified? (i.e. through the findings)		
Will research involve the sharing of data or confidential information beyond the initial consent given?		N
Will financial or other inducements (other than reasonable expenses and compensation for time) be offered to the participants?		N

[ESRC ethics initial checklist[2]]

Part C: Further and brief details for any sections answered 'Yes'. If you answered 'yes' to any of the above sections, please elaborate with detail here. Each in turn.

The research will be held in Shanghai, China. Directors of IT department in selected hospitals will be contacted and interviewed to participate in our study. Other members/Doctors will be interviews in preliminary study prior to the survey.

Part D: Project Summary (Ethical Considerations)

Provide an overall summary of the Research that will be employed in the study and methods that will be used **(no more than 250 words)**

Before the actual fieldwork, preliminary interviews will take place in hospitals and software companies. The interviewees will be directors of departments in hospitals and managers of companies. This is to rectify any potential mistakes/inaccuracies in questionnaires.

The researcher will go to every chosen hospital. Hospitals are ranked in three levels, level 3, 2 and 1 with the 3 being the highest level, within each rank there will be three sub-levels a, b and c. The chosen hospitals would be level 3a, 3b, 3c, 1a, 1b and 1c. The researcher will appear in hospitals and interview the Directors of IT department with designed questionnaires. The reason for using interview instead of other methods is mostly because of the access issue and to improve response rate.

Part E: Ethical Considerations for method(s).

[2] ESRC ethics initial checklist, Framework for Research Ethics (FRE), (2010).

List each of the methods you aim to use to recruit participants and describe the methods you will use to gain their 'informed consent' (If written consent will not be obtained for any of your methods, this must be justified). At the least the following should be considered for each method.

- Confidential and anonymity for all participants and organisations

- Storing of data according to the UK Data Protection Act and also any additional provisions you have to make for the data in other countries where your study is based. *[Note: If the project involves obtaining or processing personal data relating to living individuals, (e.g. by recording interviews with subjects even if the findings will subsequently be made anonymous), you will need to ensure that the provisions of the Data Protection Act are complied with. In particular you will need to seek advice to ensure that the subjects provide sufficient consent and that the personal data will be properly stored, for an appropriate period of time.]*

- Voluntary participation following informed consent

Please attach a copy of every Information Statement and Consent Form that will be used, including translation if research is to be conducted with non- English speakers. Document in verbatim to be provided in cases where consent is to be obtained verbally.

Preliminary Directors (Within Hospitals) and Managers (Within Companies) Interview Statement	Y
Interpreted Version for Preliminary Directors (Within Hospitals) and Managers (Within Companies) Interview Statement	Y

Will there be any possible harm that your project may cause to participants (e.g. psychological distress or repercussions of a legal, political or economic nature)? What precautions will be taken to minimise the risk of harm to participants?

None.

Part F: Data protection

How will you ensure the security of the data collected? What will happen to the data at the end of the project, (if retained, where and how long for). Please follow guidelines provided by the University of Exeter on Data protection to complete this section http://www.exeter.ac.uk/recordsmanagement/.

Data collected will be scanned first to personal laptop, and will be stored in one external hard disk in case of broken down of laptop hard disk. Same will happen to any other data generated from the original raw data. The original paper copy of data will be shredded.
All data will be stored up to five years after the completion of the research. And will be permanently deleted.

Part G: Notes and Additional Information: Please provide any additional information which may be used to assess your application in the space below.

Part G: Checklist: Please ensure that all sections are ticked before submission. The form will be rejected without review if any sections are incomplete.

All sections A, B, C (if relevant), D,E,F and G (if relevant) in this form have been completed	Y	The study has not started yet	Y
Number of methods to be used (note each below and place in tick in the box for consent forms attached to application form)	Y	The form has been signed and dated by the principle investigator/ lead researcher/supervisor	
Any other relevant documents have been attached (e.g. copies of CRB certificates)	-	Other attachments:	-
Where an ethics application has also been submitted to an external ethics panel (NRES) copies of approval letters have been attached	-		

Signatures:

I have considered all ethical implications for this project and declared all the relevant aspects

Name: Binheng Duan (PhD candidate)

Signature:

Part D: Supervisor's Declaration

As the supervisor for this research I can confirm that I believe that all research ethics issues have been

Name: Ben Ramdani (Primary Supervisor)

Signature: Ben Ramdani

Date: 31/08/2015

For administration use only: Ethical Approval

Comments of Research Ethics Officer and Research Strategy Group. *[Note: Have potential risks have been adequately considered and minimised in the research? Does the significance of the study warrant these risks being taken? Are there any other precautions you would recommend?]*	From the attached consent form, I can see that the researcher will collect written consent from all the research participants. Furthermore, I can confirm that the researcher will anonymise and protect the identity of the research participants. The data will not be attributable to the respondents or shared with third parties. It appears that the nature of the research is unlikely to cause distress or harm to the participants. The researcher has stated that members of the public will be involved when the fieldwork commences. I would advise the researcher to update the ethics form with any consent forms that are adopted at this later stage of the research.

This project has been reviewed according to School procedures and has now been approved.

Name: Adrian R Bailey (Research Ethics Officer)

Signature: A. R Bailey

Date: 07/12/2015