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The Healthcare Information Sharing Based on the Third Party in China
------A Hospital Perspective

GU Aiming

Doctor of Management

Supervisors:
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University of Electronic Science and Technology of China

May, 2022

BUSINESS
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Marketing, Operations and General Management Department

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Declaration

I declare that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university and that to the best of my knowledge it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: Date: 2022.5.12

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作者申明

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Abstract

With the application of information technology in the medical system, many countries try to improve the quality of medical treatment and reduce the medical cost by healthcare information sharing (HIS). However, HIS is proceeding slowly in practice due to a variety of barriers. Although the governments have taken some steps to overcome these barriers, the successful implementation of HIS is still a challenge for them.

Existing studies on HIS focus on the barriers to HIS and the outcomes of HIS. The third party is often used as the organizational form to implement HIS. This form provides a new perspective to study the success of HIS. In addition, the success of HIS is impacted also by the maturity of HIS. Thus, the study of the relationships between the barriers to HIS, the third party, the maturity of HIS and the success of HIS is very important.

Based on the literature analysis, this study proposes a theoretical model of the success of HIS including the third party and the maturity of HIS. The measurement scale for the variables is developed and the questionnaires are distributed to the doctors and the nurses of five hospitals in Shanghai city and Zhejiang province, China. A total of 1145 questionnaires are received and 818 of them are valid. The reliability and the validity of the questionnaire are evaluated and the hypotheses are tested by structural equation modelling.

The main results include that: (1) The third party has a significant negative impact on the barriers to HIS, the significant positive impact on the maturity of HIS and the success of HIS, respectively. (2) The maturity of HIS has a significant positive on the success of HIS. (3) The technological and the organizational barriers to HIS has significant negative impact on the maturity of HIS. The technological and the human barriers to HIS has significant negative impact on the success of HIS. (4) The relationships between the variables are also investigated in the sample of Shanghai city and Zhejiang province. Based on the results, the theoretical inspiration and managerial implications are proposed.

Keywords: Healthcare information sharing; Barriers to healthcare information exchange; Third party; Maturity of information system; Success of information system

JEL: I18; M11

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Resumo

Com a aplicação das novas tecnologias da informação ao sistema de saúde, muitos países tentam melhorar a qualidade do tratamento médico e reduzir o custo médico através da partilha de informação sobre cuidados de saúde. No entanto, na prática, a partilha de informação médica está a avançar lentamente devido a um conjunto diversificado de barreiras. Embora os governos tenham tomado algumas medidas para ultrapassar estas barreiras, a implementação bem sucedida do sistema de partilha de informação médica ainda constitui um desafio.

Os estudos existentes sobre partilha de informação em saúde centram-se nas barreiras e nos resultados dessa partilha. A inclusão de uma terceira parte é apenas utilizada como forma de organização para implementar o sistema de partilha. Esta tese fornece uma perspetiva inovadora ao estudar o sucesso do sistema partilha de informação médica com a inclusão no sistema de uma terceira parte ou entidade. O sucesso do sistema é também influenciado pela sua maturidade. Assim, torna-se importante que, no estudo do sucesso do sistema de partilha, se incluam as relações entre as diferentes barreiras, a terceira parte, e a maturidade do sistema.

Com base na análise da literatura, este estudo propõe um modelo teórico explicativo do sucesso do sistema de partilha de informação em saúde, que inclui, para além das barreiras ao sistema, a terceira parte e a maturidade do sistema. São desenvolvidas e avaliadas escalas de medição dos diferentes construtos do modelo e a recolha de informação é feita através de um questionário distribuído aos médicos e enfermeiros de cinco hospitais da cidade de Xangai e da província de Zhejiang, na China. Receberam-se 1145 respostas ao questionário, dos quais 818 são considerados válidos. A fiabilidade e a validade do questionário são avaliadas, e as hipóteses são testadas através de modelos de equações estruturais.

Os principais resultados são: (1) A terceira parte tem um impacto negativo significativo nas barreiras ao sistema de partilha de informação médica, e impacto positivo significativo na maturidade e no sucesso do sistema. (2) A maturidade do sistema de partilha, por sua vez, tem um impacto positivo significativo no sucesso do sistema. (3) As barreiras tecnológicas e organizacionais ao sistema de partilha têm um impacto negativo significativo na maturidade. As barreiras tecnológicas e humanas têm impacto negativo significativo no sucesso do sistema de partilha. (4) Os modelos são comparados para as amostras da cidade de Xangai e da província de Zhejiang, permitindo encontrar diferenças significativas entre os dois grupos. Com base nos resultados, são adiantadas implicações teóricas e de gestão para o sistema de partilha de informação em saúde.

Palavras-chave: Partilha de informação sobre cuidados de saúde; Barreiras à troca de informação sobre cuidados de saúde; Terceira parte; Maturidade do sistema de informação; Sucesso do sistema de informação

JEL: I18; M11

摘 要

随着信息技术在医疗系统中的应用，许多国家尝试通过医疗信息共享（HIS）来提高医疗质量并降低医疗成本。然而，由于各种障碍，HIS 在实践中进展缓慢。尽管各国政府已经采取了一些措施来克服这些障碍，但 HIS 的成功实施仍然是一个挑战。

现有关于 HIS 研究侧重于 HIS 的障碍和 HIS 的结果，由于第三方通常被用作实施 HIS 的组织形式，所以对第三方形式的研究可以为实现 HIS 提供一个新的视角。HIS 的成功也受到 HIS 成熟度的影响，研究 HIS 的障碍因素时，探讨 HIS 的成熟度与 HIS 的成功之间的关系也非常重要，

本研究在文献分析的基础上，提出了 HIS 成功的理论模型，包括第三方和 HIS 的成熟度。制定了变量的测量量表，并向中国上海市和浙江省的五家医院的医生和护士发放了问卷，共发出问卷 1145 份，有效问卷 818 份。然后，评估了问卷的可靠性和有效性，并通过结构方程建模对假设进行检验。

主要研究结果包括：（1）第三方对 HIS 的障碍产生负面影响，而对 HIS 的成熟度和 HIS 的成功产生的积极影响。（2）HIS 的成熟对 HIS 的成功具有正面影响。（3）HIS 的技术和组织障碍对 HIS 的成熟度有负面影响。HIS 的技术和人为障碍对 HIS 的成功产生负面影响。（4）在上海市和浙江省的样本中也考察了变量之间的关系，通过上述研究，提出了研究的理论洞见和管理启示。

关键词：医疗信息共享；医疗信息障碍；第三方；信息系统成熟度；成功的信息共享系统

JEL: I18; M11

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Acknowledgements

As a doctor, how to improve the ability of treating patients and saving people is my bounden duty. To be a good doctor requires not only good medical technology, but also a comprehensive consideration of the balance between the effect and the cost of treatment. Since 1980, medical reform has been a hot topic all over the world. Patients, doctors, hospitals, governments, medical drugs and device suppliers have different interest perspectives on medical reform. At first, patients showed me the paper reports of the medical tests from other hospitals. Now, I can see the information of their examination and treatment in the different hospitals in the computer. I feel the benefits of healthcare information sharing to patients and doctors. The irrational growth of medical expenses has been controlled, and the problem of expensive medical treatment has been alleviated to a certain extent. However, in the process of healthcare information sharing, the unclear responsibilities of the government and the inadequate labor compensation of hospitals to doctors lead to the low enthusiasm of medical staff to participate in healthcare information sharing, which is also a practical problem. The core of healthcare information sharing is to realize the balance of all parties, especially the key stakeholders. Healthcare information sharing must be a "balanced result" that comprehensively considers the interests of all parties and the degree of realization. But what kind of healthcare information sharing can achieve this "balanced result"?

In 2017, I was honored to be a student of ISCTE – University Institute of Lisbon, Portugal (ISCTE-IUL) and University of Electronic Science and Technology of China (UESTC). I have learned so much in these five years. Thank all the professors who taught me. It was their wonderful speeches that enabled me to not only have a further and deeper understanding of management, but also have more in-depth thinking on the problems faced by the development of China's health industry in a relaxed classroom atmosphere.

In the process of completing my thesis, I reviewed the relevant courses I had studied in the past five years again and felt a lot of harvest. I recalled the teaching style of all professors and was full of gratitude in my heart.

I would like to thank my tutors, Professor Elizabeth Reis of ISCTE-IUL and Professor Ma Yongkai of UESTC, for their serious and patient guidance on the thesis. You gave me timely guidance in every aspect of writing. From the initial confusion to the final completion of the last word, you not only gave me direction like a lighthouse, but also gave me care like parents.

Thanks to my classmates, I have benefited a lot from the mutual exchange, encouragement and help in the past five years.

Thank my colleagues who support for my study. During my absence, your hard work has relieved me of my worries.

Finally, I would like to thank my wife and son for sharing my family responsibilities when I left home for study. Without your encouragement and support, I can't complete my current doctoral study.

I wish the professors of ISCTE-IUL and UESTC work smoothly, succeed in their carriers, and have good health and good luck.

致 谢

作为一名医生，怎样提高治病救人的能力是我义不容辞的责任。 要成为一名好医生，不仅需要良好的医疗技术，还需要综合考虑治疗效果和成本之间的平衡。自 1980 年以来，医疗改革一直是全世界的热门话题。患者、医生、医院、政府、医疗药品和设备供应商对医疗改革有不同的兴趣观点。起初，病人给我看了其他医院的医学检查的纸质报告。现在，我可以在电脑里看到他们在不同医院的检查和治疗信息。我感受到了共享医疗信息对患者和医生的好处。医疗费用的不合理增长得到控制，医疗费用昂贵的问题得到一定程度的缓解。然而，在医疗信息共享过程中，政府责任不明确，医院对医生的劳动报酬不足，导致医务人员参与医疗信息共享的积极性低，这也是一个现实问题。医疗信息共享的核心是实现各方的平衡，尤其是关键利益相关者的平衡。医疗信息共享必须是全面考虑各方利益和实现程度的"平衡结果"。但什么样的医疗信息共享才能达到这种"平衡的结果"呢？

2017 年，我很荣幸成为葡萄牙里斯本大学学院（ISCTE-IUL）和电子科技大学（UESTC）的学生。在这五年里我学到了很多东西。感谢所有教我的教授。正是他们的精彩演讲，使我不仅对管理有了更深入的了解，而且在轻松的课堂氛围中，对中国卫生产业发展面临的问题有了更深入的思考。

在完成论文的过程中，我再次回顾了过去五年学习的相关课程，感觉收获颇丰。我回想起所有教授的教学风格，心中充满了感激之情。

我要感谢我的导师，ISCTE-IUL 的 Elizabeth Reis 教授和 UESTC 的 Ma Yongkai 教授的认真且耐心的指导。你们在写作的各个方面都给了我及时的指导。从最初的迷茫到最后一句话的完成，你们不仅像灯塔一样给了我方向，还给了我像父母一样的关怀。

感谢我的同学们，在过去的五年里，我从相互的交流、鼓励和帮助中受益匪浅。

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最后，我要感谢我的妻子和儿子在我离家学习时分担了我的家庭责任。没有你们的鼓励和支持，我就无法完成目前的博士学习。

我祝愿 ISCTE-IUL 和 UESTC 的教授们工作顺利，在他们的事业中取得成功，身体健康，好运。

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Chapter1: Introduction

1.1 Research background

1.1.1 The current picture

According to the report of the 19th National Congress of the Communist Party of China in 2017, China will establish a high quality and efficient medical service system in an all-round way in the future. To a great extent, it depends on the success of the healthcare information sharing in the medical institutions because the healthcare information is the basis of medical diagnosis and has an important effect on the quality of the service provided to patients. Along with the development of the information technology (IT) such as cloud computing, internet of things and big data, healthcare information plays a more and more important role in improving the level and efficiency of the medical service.

This study specifically focuses on the healthcare information sharing (HIS) based on the third party. The healthcare information is the result of the patients' laboratory tests, imaging procedures and all the data generated during the period of receiving treatment. The information sharing means the method of making accessible the patient's digital information among the disparate healthcare entities when the patient switches from a service provider to another (Hemmat et al., 2017). The third party refers to an independent third organization, apart from sender and receiver of information, which is responsible for information sharing among different service providers (Everson, 2017).

Healthcare information sharing can at least provide two major benefits to the national healthcare system. Firstly, it contributes to reducing medical expenses such as the duplicate tests. Data from Chinese health statistics yearbook indicates that medical expenses per person increases every year and amounts to ￥3351 in 2016. Annual health spending in China is 6.23% of GDP in 2016, corresponding to an annual increase of 4.7% year between 2003 and 2016. Overuse of medical tests is a significant contributor to the rapid growth of medical expenses. Lammers et al. (2014) argued that the overuse and repeated inspection of radiology imaging procedure of the California's and Florida's healthcare systems for 2007-2010 range between 14.7% and 20.7%. With the data of 6,007 adult patients of a US teaching hospital in 1991, Bates et al. (1998) argue that unnecessary and overutilization of laboratory tests amount to 28% prior to their expiration. It is reported that 5% of the U.S. GDP is spent on tests and treatments that do not actually improve patients' health quality. The situation may be even more serious in China. For example, Ayabakan et al. (2017) found that the medical tests information sharing can significantly reduce the duplication rates of medical tests. Secondly, it contributes to using the healthcare resources in a more efficient way. According to Chinese health statistics yearbook of 2016, the bed utilization rate was 97.3% for general hospitals and was 54.1% for community health service centres (stations) in 2016. The problems of under and over-utilization of healthcare resources are associated. These two problems can be solved by a two-way referral system which depends on the level of healthcare information sharing, including medical tests information sharing, among the different healthcare organizations.

However, the National Health Commission of the People's Republic of China pointed out in the 13th Five-year Health Information Development Plan of the National Population in January 2017, that the overall planning and using of the healthcare information are still insufficient in China. Although the data base of the electronic medical record has basically been established, the information islands or information silos still exist in the healthcare service system. The information islands, formerly known as information silos, are the IT systems among which the information cannot be exchanged due to fragmented information from different providers (Feldman & Horan, 2011). Inter-organizational medical information sharing is associated with many barriers, such as content specifications, data standards, information infrastructure, information privacy, hospital performance, pressure from patients (Gold & Mclaughlin, 2016). Up to now, healthcare information sharing has been hard to implement successfully in China (Pan et al., 2021).

1.1.2 Theoretical background

HIS is a cross-disciplinary researching field of healthcare and information system and has not been thoroughly studied. Information system has been applied to in medical field since 1970s to improve the efficiency and the quality of medical service and has evolved from the electronic health records (EHRs) to health information exchanges (HIEs). The results of the academic studies have suggested that information technology has positive impact on the cost savings and quality improvements of medical services. In recent years, HIS began to receive more attentions from scholars because many countries have launched HIS plans based on EHRs to further improve the efficiency of their medical systems. However, these plans go slowly due to a lot of barriers.

Some studies focus on the barriers to HIS and argue that these barriers can be mainly divided into three categories: technological, organizational and human. It is difficult for the hospitals to overcome these barriers to implement HIS because of the lack of resources and incentives. Although the governments began to support HIS since 2000s, the barriers to HIS have not been effectively removed so far. Therefore, besides the barriers to HIS, the other elements that affect HIS should be incorporated in to the theoretical studies on HIS.

The third-party HIE strategies are often used by the governments to implement HIS in several forms, including community HIE, enterprise HIE and EHR vendor-mediated HIE. The third party is an organizational form through which the sender and the receiver of the healthcare information can share the data. However, the barriers to HIS still don not been eliminated by the third parties due to the conflicts of interests between the hospitals. Different from the third-party strategies in other countries, in China, the public hospitals account for a large proportion of the medical system and often act as the third parties in HIS. They always strongly supported by the local governments and play larger roles in Chinese HIS implementation. It is an interesting question that whether the third parties of HIS in China can make it easier for HIS to succeed.

The impact of the maturity of HIS on the success of HIS has been seldom studied in literature. The maturity of HIS will influence the goal, the foundation and the sustainability of a HIS plan. Without the high level of the maturity, the success of HIS may be still difficult to achieve although the barriers to HIS are low enough. China is a developing country and the maturity level of its information infrastructure is not as high as that in developed countries. The maturity of HIS may be another important element that hinders the success of HIS implementation. In addition, during the process of HIS implementation, the third party and the barriers to HIS may impact the maturity of HIS.

1.2 Research questions

1.2.1 Research problem

During the process of treatment, a typical patient is served by several different providers. Healthcare data generated in the course of providing the service is fragmented and difficult to share among the providers (Flanders, 2009). One of the main reasons is that medical institutions and doctors are not willing to share medical information with others. In China, most of the medical institutions compete in the market, so they lack incentives to provide information to others. At the same time, they are also reluctant to collect healthcare information from other providers due to inconvenience and time consuming. In addition, Johnson et al. (2011)argued that medical data may be distorted and inconsistent with medical records when they travel across the healthcare IT systems. The patients themselves often are not able to understand and remember the precise tests results. Therefore, it seems necessary the introduction, in the healthcare system, of a third party, independent from sender and receiver of data that would be responsible for healthcare information sharing.

In this study, we will find the ways to incentive the different healthcare parties including governments, hospitals, doctors and patients to share the healthcare information among different providers. First, this study will find the reasons and the paths leading to the failure of medical information sharing. Second, intervention policies will be proposed to realize the medical information sharing among providers to reduce healthcare cost by mitigating the overuse of the medical tests and imaging procedures and other ways.

This thesis aims at discussing the healthcare information sharing on the basis of the present problems in China and providing the government and medical institutions with solutions to reduce medical expenses and improve quality of services provided to patients.

1.2.2 Research questions

The main research question of this thesis is: *How to achieve the success of healthcare information sharing based on a third party?* This question can be divided into the four sub-questions presented in the following paragraphs.

The parties involved in this research are medical institutions, doctors, patients, governments and the third party. The medical institutions are the hospitals and the community health service centers. The hospitals and the policy makers often select the third-party vendors to set up the healthcare information systems. They create, manage, share and present the medical information (Gortzis, 2010). For example, in Belgium, the Flemish Government launched an information platform in order to secure data sharing in primary healthcare in 2013 (De Backere et al., 2018). The third-party services are popular in many areas such as logistics, law cases and accounting. The third party of logistics in supply chain management is responsible for packaging, warehousing, distributing, managing and shipping the products between the sellers and the buyers, responsibilities that can be considered similar to the ones in this research (Aguezzoul, 2014). So, the third party in this research means the third-party vendor who is responsible for collecting, storing, and exchanging the medical information among the providers. Recent studies of the third party logistics (3PL) focus on the benefits and risks of the outsourcing decision (Aguezzoul, 2014). So, the first research sub-question is: *How can the third party influence the healthcare information sharing in China?*

The first stream of research related to this study is on the necessity of medical information sharing. The main goal of medical information sharing is to decrease medical expenses by improving the quality, efficiency and safety (Goldstein, 2010). Medical tests information sharing is an important part of it. For example, Carr et al. (2014) found that the proportion of patients whose medical information is exchanged by the clinicians of different emergency departments in South Carolina is 5.39%; from these, 30.5% are laboratory tests and 47.6% radiologic procedures, resulting in 11.4% of admissions being avoided. Frisse et al. (2012) argued that health information exchange, including information of laboratory tests and imaging procedures, could save $1.9 million per year for all regional hospital emergency departments in Memphis, Tenessee, USA.

Based on the situation of the Chinese healthcare system, Chinese scholars have studied the impact of medical information sharing on medical service. They have generally argued that the main goal of Chinese medical informatization was to lower medical costs, improve healthcare service level and the patients' satisfaction (Gan et al., 2013; Zheng, 2010). The realization of clinical information sharing can reduce repeated tests and the excessive medicine use. And it is an important grasp on alleviating the expensive and difficult problem of making an appointment and seeing a doctor (J. Wang et al., 2010; Y. Zhang & Xiao, 2011). In recent years, some research has also been carried out about the practices of medical information sharing in some Chinese regions, such as Shenzhen, Shanghai, Xiamen, Dalian, Zhenjiang. The practices in these regions indicate that the quality and efficiency of the healthcare service has been improved (Chen et al., 2010; L. Li & Chen, 2014; You, 2013; Zha et al., 2012).

Second, this thesis also aims to study the factors which make it difficult to share healthcare information among the providers. It is common knowledge that there are some barriers to sharing medical information between providers, although the benefits are clear and the healthcare IT is ready for it. There are mainly two types of barriers, one is technology and the other is organizations and people. The technological barriers include data standards, data quality, incompatible systems, accessibility and the unbalance of information level across different regions (Bates, 2005; Vest & Kash, 2016; C. Williams et al., 2012). For medical information, the radiology and the laboratory tests information have some different standards, such as the Digital Imaging and Communications in Medicine (DICOM), the Picture Archival and Communications Systems (PACS), the Logical Observation Identifiers Names and Codes

(LOINC), the Electronic Medical Records (EMR) (Branstetter & Barton, 2007; Group, 2013; K. Kim, 2005). Medical information is difficult be shared by the healthcare entities due to a lack of wide adoption of the standards and existences of inconsistencies among providers (Ayabakan et al., 2017). Therefore, the second research sub-question is: *What is the effect of technological barriers on the healthcare information sharing in China?*

The other reason is about organizations and people. Medical institutions face competition from the others in the market and the pressure to improve performance. They may also have not enough resources to invest in technology and may worry about rewards that cannot cover costs. So, providers lack the incentives to share information with others even if they could do (Furukawa et al., 2014). Mennemeyer et al. (2021) and McGinn et al. (2011) argued that physicians were reluctant to adopt EMR because of productivity reduction, lack of data sharing capabilities, and need to incorporate other key interoperability features, although they received millions of dollars as incentives to share patients' health information by using EMR. Patient and public views about security and privacy of the medical information also hinder the medical information sharing (Quigley et al., 2014). For example, Papoutsi et al. (2015) reported that 79% of participants in their survey worried about the security of their electronic health records.

In China, the barriers during the process of medical information sharing include lack of top-level design, inadequate funds and insufficient investment, vague business model, immature information standards systems, and inaccuracy and unsafety of data (Liu et al., 2015; Na et al., 2015; Wan et al., 2012). Yang et al. (2019) argued that 42.4% of the doctors worried about the repeated tests and were reluctant to participate in the tiered medical services. So, the third research sub-question is: *What is the effect of the organizational and human barriers on the healthcare information sharing in China?*

Technological infrastructure limitations and management inefficiency in developing countries like China are usually seen as the key factors influencing the processes of healthcare (Akhlaq et al., 2016). Information managers in healthcare organizations often encounter mistakes with which they try to find solutions to deal. From the point view of organizational maturity, these errors can also be regarded as the result of the development of the organization to its current maturity (Fitterer & Rohner, 2010). The maturity models are based on the premise that people, organizations, functional areas and processes, evolve through a process of development and growth towards a more advanced maturity by accomplishing several stages (Carvalho et al., 2016). As a developing country, information system maturity may play a key role in healthcare information sharing in China. So, the fourth research sub-question is: *How do the information system maturity influence healthcare information sharing in China?*

The last stream of research related to this study is that of information sharing in economic and management literature. There is little research on medical information sharing, however, the study of information sharing in economics has been carried out for a long time. The major point is that information is asymmetric in organizations and getting information means costs (Akerlof, 1970; Stigler, 1961). Electronic Data Interchange has been reported as a way of information sharing across organizations (Jingquan Li et al., 2006). Information sharing among supply chain members, including information of demand, cost, product and inventory, is often regarded as a key factor to improve the efficiency of the overall supply chain (Carley & Zhiang, 1997). The contents, ways and incentive-compatible mechanisms of information sharing in e-government, financial institutions and key state projects in China have also been discussed (J. Li, 2003; A. Wang, 2014; Wu, 2012) .

This study differs from the literature above as follows. Firstly, the object of this study is healthcare information. The reasons that explain the difficulty to share healthcare information among the providers in China will be studied. And the incentives based on these reasons will be proposed. Secondly, it is the first time the role of the third party in the medical information sharing in China will be studied. Thirdly, this research relies both on quantitative and qualitative methods to assure validity and reliability of results, while most of previous research used qualitative methods.

1.3 Methodology

This study uses the Structural Equation Model (SEM) to investigate the elements that influence the success of HIS in China, and therefore the main research methodologies are around SEM. To accomplish the research goals, the theories of HIE, the maturity of information systems and the success of information system are used to develop the scale of the questionnaire. Theoretical hypotheses will be put forward based on widely literature view. SEM will be employed to test the hypotheses by the soft programs.

The followings are the main methodologies included in this study:

(1) Literature review

By retrieving, reading and summarizing the literature, the experience and the findings of the previous research provide the theoretical base and the research methods for this study. Through studying the literature, research status can also be grasped more systematically.

The key words, including third party, the maturity, the barriers, the healthcare information, the success of information system, will be used to search the literature in the academic databases, such as EBSCO, Elsevier, ProQuest, Science Direct, Springer Link, and CNKI. The literature will lend support to the theoretical model building.

(2) Questionnaire survey

In order to carry out the empirical research, the questionnaires will be sent out to the doctors of Chinese hospitals to collect the data. The initial questionnaire will be designed according to the results of the literature review. Then it will be modified by the results of the pro-tests. The final questionnaire will be formed by deleting some items and improving the description of the items that remain.

(3) Structural equation modeling (SEM)

SEM will be used to test hypotheses in this study. SEM is an empirical analysis method to explore the cause-effect path relationships between the latent variables and is widely use in management and economics. The structural equation model of HIS will be established and the parameters will be estimated by the data collected by the questionnaires. Then the model will be evaluated by the goodness of fit indices, such as RMSEA and CFI.

The statistical analysis, including descriptive statistics, internal consistency reliability, validity, correlation analysis, will be performed by SPSS software. The software AMOS will be used to conduct the confirmative factor analysis (Macfarlane et al.) and estimate the structural equation model.

1.4 Research path and structure

1.4.1 Research path

The purpose of this study includes two aspects. First, this study focuses on understanding the role that a third party can play in healthcare information sharing in the countries as China. Specifically, the relationships between third party and the barriers to HIS and the success of HIS. Second, this study is committed to explore the role of the maturity of information system in healthcare information sharing. In particular, in the context of China, the relationships between maturity of HIS and the third party, the barriers to and the success of HIS are investigated.

The main work of this study includes:

(1) building the theoretical model of the success of HIS on the basis of extensive literature review, which incorporates the third party and the maturity of HIS;

(2) evaluating the effects of the third party on the barriers to HIS, the maturity of and the

success of HIS;

(3) exploring the mediating role of the maturity of HIS between the third party, the barriers to HIS and the success of HIS.

Figure 1.1 illustrates the research path of this study.

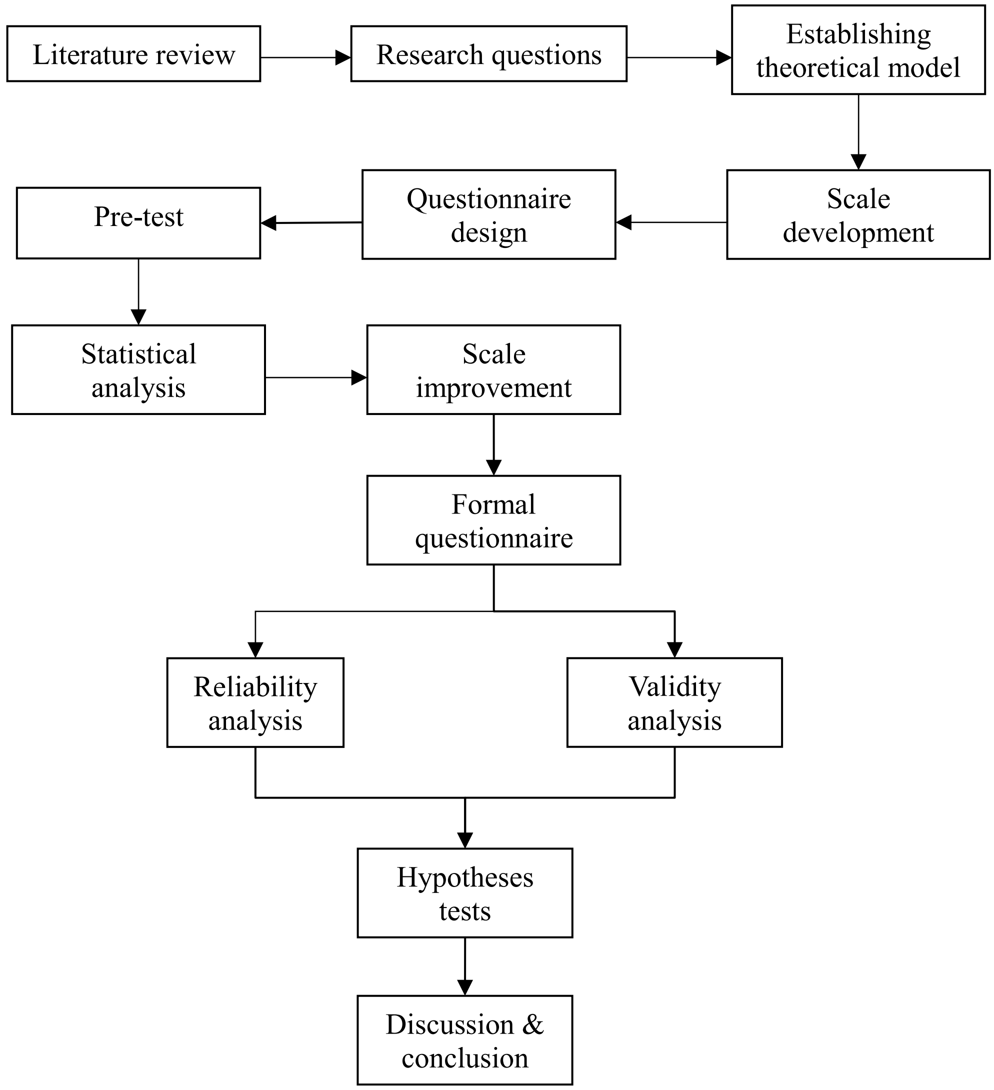

Figure 1.1 Research path

1.4.2 Research structure

This thesis is organized as follows:

Chapter 1: Introduction. Based on the research background, the research questions are raised. The research methodologies are introduced briefly and the research path is described in this chapter.

Chapter 2: Literature Review and Hypotheses. The previous research about HIS, the third party of HIS, the maturity of healthcare information technology (HIT), the success of HIT is reviewed systematically. The research hypotheses are proposed and the theoretical framework of the success of HIS in China is proposed.

Chapter 3: Research Methodology. The scale is developed on the basis of related theoretical research achievements. The questionnaire is designed and the is sent out to the doctors of five hospitals in China to collect the data. This chapter also conducts the descriptive statistical analysis and CFA and test the reliability and the validity of the questionnaire.

Chapter 4: Results. The hypotheses are tested. The causal relationships between the third party, the barriers to HIS, the maturity of HIS and the success of HIS are analyzed. In particular, nested models in which third parties have a direct impact on success are also studied. These relationships are also tested based on the data of the different region.

Chapter 5: Discussion and conclusion. In this chapter, the results of this study are discussed by comparing with the related literature. This chapter also includes innovations, research limitations and future research suggestions.

Chapter 2: Literature Review and Theoretical Model

This chapter, we review the related literature on healthcare information sharing (HIS), HIS around the world, outcomes of HIS, barriers to HIS, the third-party HIS, maturity of HIT, success of HIT. Based on literature review, the hypotheses of the relationships between the variables about HIS and theoretical model are proposed.

2.1 Healthcare information sharing

Today a patient often seeks treatment in several different organizations during their lifetime: a laboratory, a pharmacy, a physician office, a specialist, a hospital, and more (Brailer, 2005). Patient mobility between providers may be influenced by many factors, such as division of rural and urban areas, affiliation with different hospitals, specialty size, and closeness of the medical specialties, such as allergy and dermatology (Yaraghi et al., 2014). For example, using the data from 8,074 epilepsy patients treated in one of seven hospitals in New York from 2009 to 2012, Grinspan et al. (2014) find that 22% of the patients seek care from more than one hospital, in particular, children, people who regularly use medical services and people who live in the area of the study hospitals. Patient mobility not only results in more abundant health data, but greater decentralization and more difficulties for information sharing (Flanders, 2009). Healthcare Information Sharing (HIS) is very important for patients to make informed decisions about their healthcare and be involved in assessment of treatment options available to them. For example, high prevalence of chronic diseases results in patients' common need for information on nutrition and exercise (Clarke et al., 2016).

Healthcare Information (HI) refers to various data of the patients generated during their courses of treatments, such as medical tests, interventions, medication, and therapeutics (Dagnew et al., 2018; Hemmat et al., 2017). Paper records have their own limitations for proper communication between healthcare providers and timely access to the patient's data may be impossible (Garavand et al., 2016). In order to improve efficiency of health systems, Health Information Technology (HIT) has been used to manage health data since the 1970s (Ammenwerth et al., 2004; Kaplan, 2001). Limited, closed exchange networks emerged in the late 1980s (Heath et al., 2017). The World Health Organization has an eHealth department and the 58th World Health Assembly in Geneva in 2005 recognized the potential of eHealth to improve medical outcomes, and encouraged Member States to use information technologies in health systems and services (Sligo et al., 2017). Nowadays, HIT becomes the key point of healthcare policy in many countries. HIT refers to a conglomeration of technologies and tools that are used for the storage, retrieval, analysis, sharing, and application of healthcare information, data, and knowledge for the purposes of communication and decision-making (Karahanna et al., 2019).

The primary role of HIT is the application of information technology to enable and enhance the delivery of healthcare services (Bui et al., 2018). Besides digitalization of health information that hospitals use to care for their patients, clinicians, patients, and policymakers are looking ahead to sharing appropriate information electronically among organizations (Walker et al., 2005). With the rapid development of information technology, the main emphasis of HIS has been on the Electronic Health Records (EHRs) and Healthcare Information Exchanges (HIEs) although HIT contains a series of technologies such as Computerized Provider Order Entry (CPOE), electronic Medication Administration Records (eMAR) and Picture Archiving Communications Systems (PACS).

An EHR refers to a patient-oriented, massed, longitudinal system which collects patient healthcare data from a variety of data sources scattered in different places and over a wide area network (Boaden & Joyce, 2006). An EHR provides everyone with a summary, safe and private lifelong record of his or her main medical history and care within the medical system and shares electronical information with authorized medical institutions and the individual anywhere, anytime to support high-quality healthcare services (Ludwick & Doucette, 2009). For instance, Kalra et al. (2012) argue that EHR will demonstrate potential for improved clinical outcomes if it is combined with alerting or advisory systems in a focused clinical domain.

HIE is an electronic method to transfer patient information among various healthcare providers, which has potentially beneficial consequences, including improved operational efficiency, constantly access to past patient data, improved quality of healthcare, and decreased administrative cost (Ayer et al., 2019; Halamka, 2013). The focus of HIE is on the information flowing across the boundaries of medical facilities and medical data warehouses, in a typical manner not within a single organization or among affiliated hospitals, in the same time ensuring the information is kept integral, private, and safe (Eden et al., 2016). The barriers of HIS without HIE will be too high to adopt. For instance, Shapiro et al. (2007) conduct a survey of 371 emergency doctors of 12 hospitals in New York in 2005 and find that it is difficult to share health data across providers without HIE due to high odd of attempts failure and too much time spent on accessing data.

In healthcare practice, EHR always binds together with HIE and provide the foundation for HIE (AlHazme et al., 2016). For example, Hillestad et al. (2005) point out that electronic health records (EHR) can facilitate sharing information among hospitals and save $79 billion per year for US. Abramson et al. (2012) surveyed all New York State hospitals in 2009 and find that state initiatives funding community EHR implementation lead to higher participation in HIE among New York State hospitals than hospitals nationwide. Motulsky et al. (2018) conduct a descriptive study with usage data of 2015 obtained from the Ministry of Health of Canada and find that early HIE adopters were mostly in primary care settings, and were accessing it more frequently when using a certified EHR. In Canada, HIE were actively used by the majority of pharmacists (83%) and general practitioners (74%), while a minority of specialists (25%) and nurses (12%) used it at least once in 2015 (Motulsky et al., 2018). The brief history of HIE can be referred to (Caillouet, 2012).

Health information sharing means the method of making accessible the patient's digital information among the disparate healthcare entities when the patient switches from a service provider to another. Today, HIE is by far the most important means of health information sharing all over the world. It is HIE's responsibility to establish the functional architecture and governance structure, workflow and technique required to share patient information among healthcare providers (Heath et al., 2017). Shapiro et al. (2011) describe in detail 11 typical application scenarios of HIE such as reporting of laboratory diagnoses and argue that HIE is an important tool to share information among many stakeholders. A few HIE organizations has already existed for more than a decade, therefore, HIE can really provide valuable service to healthcare system in the long term (Deas & Solomon, 2012). HIE usually happens via regional health information exchange organizations (RHIOs), which obtain varying support at the state and federal levels. For instance, HIE can connect organizations in a community so that healthcare providers can share patient information to support coordinated care (Haque et al., 2018).

From the perspective of the way to send and receive information, there are three models of HIS which are realized by HIE: the direct project model, the non-directed model and the patient-centered model (C. Williams et al., 2012). The direct project model supports known parties, such as physicians and patients, to exchange information peer-to-peer. In this model, the sender and the recipient of medical information know who the other side is and patients' information can be exchanged directly between them via a safe network (Esmaeilzadeh, 2018). The primary goal of this model is to coordinate healthcare service among multiple providers by HIS. The non-directed model, or the query-based exchange, means that patients' medical information is gathered from different healthcare providers and are centrally stored in a hub (Campion et al., 2013). In this model, patients' information can be upload to the information center by doctors so that the other doctors can access it. This model is mainly used to support providers to delivery unplanned care by finding patients' information. Campion et al. (2013) give three examples of communities in New York State which use this model and find that patient summary data and detailed laboratory and radiology data are most frequently accessed by users. The third model is the patient-centered model in which patients can access to their own medical information and share it with other healthcare providers (Rudin et al., 2011). In this model, patients act as a mediating role during the process of HIS so that they can collect his own information from a doctor and share it with another. This model emphasizes the role of a patient in HIS by enabling them to manage their own healthcare information.

Some studies discuss how HIE usage is measured (Adler-Milstein et al., 2009; Liang et al., 2004). Vest and Jasperson (2010) review 16 studies published between 1991 and 2008 and indicate that HIE usage can be measured at three level: individual, organizational and network. The individual level is about HIE usage, including employment and information consumption. The former refers to work related phenomena such as access, frequency, the amount of time, or types of information looked for (Burtonjones & Straub, 2006). The latter includes user feedback, user satisfaction and usability (Grossman et al., 2006). At the organization level, HIE usage can be measured by four facets: breadth (number of participants), volume (quantity of data), diversity (types of data), and depth (degree of integration among exchange partners) (Massetti & Zmud, 1996). At the network level, system employment, which is defined as the probability of patients or encounters using HIE systems, is often used to measure HIE usage (Vest & Jasperson, 2010).

2.2 HIS around the world

Many countries realize the benefits from HIS and begin to prompted efforts to enhance data sharing in their healthcare systems, such as the USA, the UK, Korea, Australia and Canada (Akhlaq et al., 2016). The '2015 World Health Organization (WHO) Global Survey on eHealth' in the WHO European Region indicated that more than 70% of the Member States were equipped with eHealth policies nationwide and financial funds allocated to execution (Akhlaq et al., 2016). For instance, Finland began to implement EHR in 2008; Slovenia also start to develop eHIT project in 2008; Wales set up Informing Healthcare programme in 2004; England launched the National Programme for IT (NPfIT) in 2002 which may cost about ￡12.7 billion; Australia launched My Health Record project in 2012 (Lluch, 2011; Thomas, 2009).

Among developed countries, the USA is the most rapidly progress one and has already made considerable accomplishments. Wright et al. (2010) conduct a survey of 1296 licensed physicians in Massachusetts in 2007 and argue that physicians are not willing to pay for HIE although they perceive the benefits of HIE and want to participate in it. In order to promote clinical data sharing among healthcare providers, the US government signed the American Recovery and Reinvestment Act into law which incorporates the Health Information Technology for Economic and Clinical (HITEC) Act in 2009 (Adler-Milstein & Jha, 2014). The detailed explanation of HITEC can be found in (Kuperman, 2011). HITEC provides hospitals and health providers up to $27 billion as incentives for their meaningful uses of EHR to lower medical cost and improve quality of healthcare. Meaningful use simply requires the electronic exchange of information and means that healthcare providers should meet a set of standards defined by the Centers for Medicare & Medicaid Services (CMS) Incentive Programs when they access EHRs (Heath et al., 2017; Vest & Kash, 2016). From 2009, health information exchange was developed and funded by the US government in response to HITEC to facilitate healthcare information sharing and potentially decrease health care costs (Carr et al., 2014). After HITECH, about half of states enacted legislation to take advantage of the available grants for HIE (Adjerid et al., 2016). Hence, the EHR adoption rates of the US providers increased from 48% to 77% between 2008 and 2011 (Dranove et al., 2015). In New York State nursing homes, 54.4% participated in HIE in 2012 (Abramson et al., 2014). The odds of hospitals among which patient data is exchanged, including the results of test and radiology, nursing summaries, and lists of medicines, increased form 41 percent to 62 percent between 2008 and 2013 (Heath et al., 2017). Adler-Milstein et al. (2015) also find that the percentage of US hospitals with the ability to meet the meaningful use criteria increased from 5.8 in 2013 to 40.5 in 2015. Although the USA has made great progress in HIS, (Gold & Mclaughlin, 2016) argue that the progress of HITEC's implementation is slower than schedule due to limited ability of the hospitals, the diversity of EHRs, and the technical differences between the organizations.

There are two models to manage the nationwide HIS which are called "bottom-up" strategy and "top-down" strategy (Coiera, 2009). "Bottom-up" strategy refers to consolidate the community-based organizations with health information systems located in the same region into a system connected by agreed protocols (Zaidan et al., 2015). For instance, the US is the unique country to adopt the "bottom-up" strategy because its health information infrastructure is relatively mature (Hill et al., 2011). “Top-down” strategy means that HIS is centrally administrated by government entities. All the other countries adopt this model. For example, the National Health Service (NHS) in UK is responsible for setting standards and providing nationwide information sharing with the services of connectivity and software (Lenert et al., 2012). For this strategy, it is easy to neglect the needs and preferences of HIS users (health care providers) so policy makers should think it through carefully in order to implement HIS successfully (Zwaanswijk et al., 2011).

HIS in developing countries implements more slowly than developed countries. It is difficult for developing countries to develop appropriate integrated and scalable information systems due to the challenge of coping with fragmentation, multiple data sources, and lack of standards (Braa et al., 2007). Akhlaq et al. (2016) argue that the pictures of HIE implementation in low- and middle-income countries are not very encouraging. For example, HIT in Iran faces the challenges including decentralized information, incomplete local databases, no clear information strategy and lack of a formal system for recording information (Seyedin & Jamali, 2011). Rajagopal (2013) find that HIT can be used to improve healthcare delivery and reduce work load in India, however, it is difficult for patients to access the medical information from the hospitals according to their requirements. Wilms et al. (2014) study the National Health Information System in Tanzania and argue that all staff members had concerned about data accuracy and were limited to access to training. Alsadan et al. (2015) review 29 articles about HIT progress in Arab countries published between 2001 and 2014 and find that, compared with developed countries, they are mostly far behind in properly implementation of HIT systems due to lack of dedicated financial resources and professional incompetency. Alwan et al. (2016) discuss the gap of national health information systems between countries of the Eastern Mediterranean Region and developed countries. They argue that a lack of information standards is the core reason and these countries have not given enough political promise and precedence to HIS.

2.3 Outcomes of healthcare information sharing

2.3.1 Review studies

Some scholars review the literature about the impact of HIT on helthcare systems. Chaudhry et al. (2006) review 257 articals between 1995 and 2004 and find that HIT has positive impact on healthcare quality which mainly results from preventive health by strengthening adherence to medical guideline and surveillance and reducing malpractices. Goldzweig et al. (2009) use the same methodology as Chaudhry et al.'s to review 179 studies published from 2004 until 2007. They argue that the new studies find few benefits from HIT due to the paucity of meaningful data on the cost-benefit calculation of actual IT implementation. With the same inclusion criteria as Chaudhry et al. (2006) and Goldzweig et al. (2009), Buntin et al. (2011) review 154 studies on health information technology (HIT) published from 2007 until 2010 and find that 92 percent of those articles report the positive relationship between HIT and healthcare outcomes, including cost savings and quality improvement. However, they also report that less than 10% of the studies included in their work indicated negative findings related to the adoption of HIT (Buntin et al., 2011). Then Jones et al. (2014) follow the above three research and review 236 studies published between 2010-2013. They find that most of these articles still report the positive impact of HIT on quality and safety of healthcare, however, the results about efficiencies is mixed (Jones et al., 2014). Kruse and Beane (2018) review 37 articles about HIT on medical outcomes published from 2007 until 2017 and argue that HIT continues to show positive effect on a least one of phisical, psychological outcomes or continuity of care in terms of efficiency or effectiveness. Different from Buntin et al. (2011)Buntin et al. (2011), Kruse and Beane (2018) do not identify any negative impact as a result of the adoption of HIT.

Specifically, some review studies focus on the outcomes of HIS when HIE adoption become popular in many countries. Fontaine et al. (2010) review 39 peer-reviewed pubilications about HIE participation from 1990 through 2008 and argue that HIE can improve healthcare efficiency, including more easily accessible to patient information for extenal organizations and reduced emplyee time to process referrals and claims. Hersh et al. (2015) review 34 studies on outcomes of HIE published between 1990 and 2015 and find that HIE improves effectiveness of resource use, such as repeated inspections, expenses of emergency department, hospital admissions, and improves reports about public health, outpatient care quality, and claims handling. Rahurkar et al. (2015) systematically review the empirical literature on HIE published between 2003 and 2014 and argue that HIE use probably reduces emergency department usage and costs in some cases while effects of HIE on other outcomes are unknown. Generally speaking, most studies believe that HIS forms an essential basis to support a learning health system to increase the healthcare quality and efficiency.

2. Cost reduction of health care

Different metrics are used to measure the impact of HIS on healthcare system in practice. However, HIS is mainly designed to reduce healthcare costs and improve healthcare quality (Sataloff, 2009). For instance, with the survey data from 18 HIEs in the US in 2010, Khurshid et al. (2012) argue that metrics that most of the HIE efforts use to gauge return on HIS investment include reduced repeated examinations and readmission rates. They also argue that patient-centered nursing can greatly improve quality (Khurshid et al., 2012). Ahmadian et al. (2015) find that healthcare information systems in Iran are able to make information more accessible, cut costs and reduce healthcare errors. Many other scholars discuss the impact of HIS on these healthcare outcomes. Therefore, cost reduction and healthcare quality improvement are the most expected outcomes of policy makers and hospital managers from HIS.

Cost savings that come with HIS have been extensively studied in the literature. Most of the research focus on cost reduction at the patient level. An 1998 study argue that a Veterans Administration hospital can decrease $5 per emergency department visit through HIE use (Stair, 1998). Using the data from 2 hospitals of the Indiana Health Information Exchange system, Overhage et al. (2002) find that clinical information sharing with another hospital can decrease charges for emergency department care by approximately $26 per visit. Police et al. (2010) argue that HIT improves clinical outcomes, increases the use of vaccinations and improves medication adherence, lower cost for physician groups, improves staff productivity and enriches patient-provider interactions. Vedel et al. (2013) review the literature about HIT in geriatrics and gerontology and find that impact of HIT on clinical processes, productivity, efficiency and costs, clinicians' satisfaction, and patients' empowerment are positive. Saef et al. (2014) conducted a survey about how HIE influences emergency nursing in several hospitals in 2012 in the US. They argue that on average every patient could save Medicare-allowable reimbursement of about $1,947 and 82% of the patients could save 105 minutes during the cousre of treatments if they engaged in HIE. With the survey data of clinicians at an US urban academic emergency department in 2011, Carr et al. (2014) hold that the mean cost savings of $2699.77 per patient was obtained and the quality of care was improved through health information exchang among hospitals. In a regional referral system of South korea, H. Park et al. (2015) compare the medical costs of patients participating HIE with those without participating HIE after they were referred from a clinic to a large hospital between Jane 2008 and October 2009 and find that HIE is able to reduce the total charge by approximately 13%.

Some studies pay attention to cost savings at the national level. Shapiro et al. (2006) argue that HIS can save about $570 million-$2.9 billion in emergence departments in the US. Brailer (2005) believes that $77 billion would be saved for the USA annually if patients' information were shared seamlessly across different healthcare settings. Using the data from Dartmouth Health Atlas and two national datasets from 2003-2009 in the US, Adjerid et al. (2018) find that

HIE can siginificantly lower the healthcare spending, with an annual decrease of $139 per Medicare beneficiary (1.4% reduction on average) or a cost reduction of $3.12 billion if HIEs were carried out nationwide in 2015.

One kind of the medical waste is the excessive use of medical tests, such as laboratory and imaging tests, which can be avoided by information sharing among healthcare entities (Laborde et al., 2011; S. J. Wang et al., 2003). Some studies try to measure the economic impact of HIE on medical tests with emprical data from operational HIEs. 5% of the U.S. GDP is reported to be expended on unnecessary medical examinations and treatments (Bentley et al., 2008). Walker et al. (2005) believe that 13.7% of tests can be avoided by sharing health informaiton among outpatient providers and independent laboratories. In the HIE system developed by Arizona Medicaid, Hincapie et al. (2011) qulitatively study the physicians' opinions of HIE and find that avoiding duplitcate testing and efficiency improvement of data collection are mentioned most frequently. Using the inpatient visits' data of two hospitals in US from 2000 to 2009, Laborde et al. (2011) find that a lack of HIS among healthcare providers could result in duplicate diagnostic laboratory tests. Using claims data from the dominant health plan in Colorado from 2005-2013, Ross et al. (2013) argue that, in ambulatory settings, adpotion of HIE can significantly reduce labatory tests while can not reduce radiology testing rates or imputed costs for either of these two tests. With patient-visit data of a hospital in US from 2007 until 2009, Bailey et al. (2013) find that HIT can reduce repeated diagnostic imaging by 64% in emergency evaluation back pain. In another study, using the data from the MidSouth e-Health Alliance HIE system between 2007 and 2009, Bailey et al. (2013) find that HIE can significantly decrease the odds of diagnostic neuroimaging. Yaraghi et al. (2015) argue that, for an emergency department in New York, the use of HIE can reduce 52% of laboratory examinations and 36% of radiology tests ordered by each patient. By analyzing the data of the referral patients of a Korean hospital in 2009, H. Park et al. (2015) find that, compared with the patients who didn't participate in HIE, the total charges for four kinds of diagnostic tests - clinical laboratory tests, pathological diagnosis, function tests, and diagnostic imaging - of the patients participated in a HIE were reduced by 54%-80%.

Research on the duplicate testing goes on untill recently. For example, using data from Centers for Medicare & Medicaid Services and a regional organization of HIE in the US from 2012-2013, Eftekhari et al. (2017) analyze to what extent HIE could reduce duplicate healthcare services offered by doctors. They find that if HIE is used in the treatments, the repetition of the treatment procedures can be significantly reduced, however, diagnostic procedures are not associated with HIE usage (Eftekhari et al., 2017). Ayabakan et al. (2017) analyse the data of

39,600 patient visits of 68 US hospitals from 2005 to 2012 and find that the medical tests information sharing can significantly reduce the duplication rates of medical tests. Slovis et al. (2017) analyze the study records of HIE CT documented from 2009 to 2012 in New York City and argue that HIE could be used to build repeated CT alarm systems to lower CT scans that may be avoided.

2.3.2 Quality improvement of healthcare

Health information sharing among different providers can improve quality of care directly and indirectly through an increase in continuity of care (AlHazme et al., 2016; Athey & Stern, 2002; Pinsonneault et al., 2017). HIT can shorter emergency department length of stay, reduce diagnostic turnaround times, shorter time to the initiation of appropriate therapies, and increase in-person time with patients, while the time required by documentation increases (Jones et al., 2014).

First, timely access to patient health information can decrease delays in the process of healthcare service delivery and speed up the physician's decision about the best treatment plan (Esmaeilzadeh & Sambasivan, 2017). Tzeel et al. (2012) analyze the Wisconsin emergency departments data from more than 1,800 patients' visits and find that HIE availability in the care of patients can significantly reduce inpatient hospital days and length of stays. By analyzing the data on 2007–2010 National Hospital Ambulatory Medical Care Survey, Selck and Decker (2016) find that waiting times in hospital emergency departments are reduced in the presence of an advanced health information technology system. Ayer et al. (2019) use the data from the Healthcare Cost and Utilization Project in US to study the impact of HIE on the length of stay in an emergency department. They find that HIE adoption reduces length of stay by 10.2%, and this number will grow to 14.8% if the hospital is attached to a medical system or to 21.0% if a hospital equipped with HIE has been visited by a patient before (Ayer et al., 2019).

Second, HIS have the potentail to reduce the incidence of medication errors, especially at care transitions, by providing complete and accurate medication lists (Motulsky et al., 2018). Thus, patients can benefit from HIS significantly by reducing adverse drug effects, unnecessary hospitalizations and tests. Medication errors are found to be a major safety issue during admission to hospital. Hospital errors in prescription medication histories occurred in up to 67% of admitted patients (Tam et al., 2005). Jamal et al. (2009) argue that wide use of HIT increases clinician's adherence to guidelines and decrease the medical errors, as a result, may save up to 7.5 percent of health care expenditures of the USA. McCullough et al. (2016) find that mortality of patients can be reduced by HIT adoption according to the detailed analysis of all the hospital discharge data using US medicare insurance between 2002 and 2007.

Third, HIS can enhance degree of patient satisfaction. Several studies argue that HIS has a positive impact on patient satisfaction (Goldzweig et al., 2013). By analyzing the data of HIS system from 2002-2005 in the US, Ralston et al. (2007) argue that patient satisfaction has significant positive correlation with secure patient-provider messaging and review of medical test results. Using the data from 173 hospitals in the USA, Dobrzykowski and Tarafdar (2015) find that information exchange is positively assciated with communication between provider and patient, which leads to a higher level of patient satisfaction.

Some other benefits are also found by previous studies, such as improved security of health data, becoming research source (N. I. Ismail & Abdullah, 2017).

2.3.3 Uncertain outcomes

It is difficult to achieve their desired expectations and delivery benefits for all types of information systems (Shpilberg et al., 2007). Although HIS has been regarded as an efficient way to raise the productivity of medical care, some studies argue that the relationship between HIS and efficiency of healthcare is mixed. Some scholars argue that the impact of HIS on quality of care is also not significant, even negative. Vest (2009) analyze the master patient index/clinical dataset of the Integrated Care Collaboration of Central Texas between 2005 and 2007 and argue that the number of emergency department visits and hospitalizations is positively associated with the accessed HIE information. Using Medicare claims data of 3900 American hospitals from 1998 to 2005, Agha (2014) holds that health information technology (HIT) is associated with initial increases in billed charges of 1.3% and could not reduce health spending even five years after adoption. He also finds that HIT has little impact on the healthcare quality, such as mortality rate, length of stay, the rate of readmission in a month, the rate of adverse drug reactions, and medical complications (Agha, 2014). Bui et al. (2018) argue that widespread acquisition and use of EHRs and significant participation in HIEs does not automatically mean better health outcomes among New York State healthcare providers. Recently, Yeung (2019) analyzes the population-based data from 433 local health departments across the US and argues that impact of HIE adoption on population health at the county level is not significant.

A few review studies also argue that the outcomes of HIT are not clear, even negtive. Brenner et al. (2016) review 69 research articles on HIT from 2001-2012 and believe that effects of HIT on patient quality outcomes is mixed, rather than positive because demonstration of HIT benefits is challenging. Kash et al. (2017) review the studies on hospital readmission reduction strategies from 2006 to 2016 and argue that information exchange between providers can not significantly reduce avoidable readmission rates, althrough it has been suggested to. M. O. Kim et al. (2016) review 34 studies reporting problems with HIT from 2004-2015 and point out that system access, system configuration and software updates were linked to delayed care and patient harm and death.

Althrough the hospitals which adopt HIS may experience increases in costs, HIS can generates the spill over effects by which the other hospitals can reduce the costs because the benefits of HIS are able to go beyond the adopting hospital. Using the data from the Healthcare Information and Management Systems Society of the US between 1998 and 2012, Atasoy et al. (2017) find that although EHR adoptions increase the costs of the adopting hospitals, however, the operational costs of the neighboring hospitals significantly decrease due to information and patient sharing.

2.4 Barriers to healthcare information sharing

2.4.1 Classification of barriers

Greatly different from other sectors, adoption of information technology in healthcare is much slower (Cresswell & Sheikh, 2013). For example, in the US healthcare system, the number of organizations with no shared financial or governance structure which used a state or a community HIE to exchange clinical data declined from 119 in 2012 to 106 in 2014 due to a variety of barriers such as struggling to find a sustainable business model (Adler-Milstein et al., 2016). By analyzing the data of the American Hospital Association Annual Survey of Hospitals in 2014, Holmgren et al. (2016) find that only about a half hospitals and a third of office-based physicians exchanged health information with outside organizations, and only 21% of US hospitals engaged in four core domains of HIE (find, send, receive and use). Furthermore, the most successful applications of HIT don not come from HIS but from experience of local ones (Karsh et al., 2010). Prior studies have proved that HIT is difficult to be implemented which has been accompanied by a failure to achieve widespread recognition of the advantages of HIS (Lapointe et al., 2011). Barriers to successful implementation of HIT and HIS have been extensively discussed in literature.

At first, some studies focus on identifying what these barriers are. Rahimi and Vimarlund

(2007) find that economic and organizational aspects are the most prevalent researching objects in the literature between 2003 and 2005, including the system effectiveness, the healthcare quality, the satisfaction of user and patient, and the usability of system. Ward et al. (2008) argue that the attitude of healthcare staff is a key factor for IT to be accepted and effectively used in practice, which are influenced by flexibility and usability of the systems, confidence and experience of practitioners. Edwards et al. (2010) review 25 studies about the barriers to cross-institutional HIE and argue that the barriers include lake of data standards, concerns of data security, financial losses, and communicated systems. Police et al. (2010) hold that organizational barriers such as lack of sufficient training, a non-receptive practice culture and technological problems such as inadequate connectivity lead to ineffective HIT use. Quigley et al. (2014) conduct a qualitative study with data of interviews with parents of children of medical complexity and healthcare professionals in Canada and find that barriers to HIS are associated with three themes: the first one relates to the technology which can't provide a common platform to store and access data safely; the second one is the difficulty to integrate multiple healthcare systems; the third one is the lack of consistent policies, standards, and organizational priorities across organizations for HIS. Through semi-structured interviews of 15 key informants from three hospitals in New York state, Ancker et al. (2014) find that technical barriers (including the lack of a national unique identifier for patients, and the lack of consistent data standard) combined with organizational and managerial factors (including vendor mergers, relationships with individual healthcare organizations and organizational structure to support software development) are standing in the way of HIE. Haque et al. (2018) argue that process and technical factors including stakeholder engagement, interoperability, and data standards affect HIE use. Kuznetsov et al. (2018) hold that there are sevaral problems for information technology working effectively in healthcare sector, which include architecture compatibility, perception and interpretation of handwritten text, interpretation of medical terms, text formalization and standardization, creation of electronic medical notes, development of electronic medical records and databases, personalization and protection of information. Klapman et al. (2018) interview frontline physicians and nurses of five developed countries which have sound policies and strategies of HIE and find that HIE implementation faces a lot of challenges, such as difficulty to seek out information location, untimely receipt of information, and difficulty to get the required data within documents.

Two review studies also try to classify the barriers in HIS. Kruse (2014) review 28 articles about barriers to HIE published between 2009 and 2014 and holds that cost is consistently seen as a barrier in the literature because there is no viable business plan, which is followed by work process, impedes competition, value difficult to measure and technical aspect of HIE. Garavand et al. (2016) use the technology acceptance model to review 156 studies on the factors affecting the acceptance of HIT in the period of 2004-2014 and argue that the factors include ease of use, usefulness, facilities, users' attitudes and behavior, and social impact.

Some prior studies relate to the barriers to implementation of HIS. Implementation refers to the process of planning, testing, adopting, and integrating health information systems so that the technology becomes routinely used in the organization (Sligo et al., 2017). Rudin et al. (2009) interview key stakeholders participating in a HIE pilot project in 3 Massachusetts communities in 2007 and find that creating trust, satisfying the needs and benefit expectations of stakeholders, are all critical to the success of the project implementation. Feldman et al. (2014) conduct a case study of the Virginia statewide HIE between 2012-2013 and find that social reasons including successful leadership and inter-organizational governance are significant motivations for early implementation of HIE. Esmaeilzadeh and Sambasivan (2016) divide HIE into 4 stages: initiation, adoption decision, implementation and institutionalization, and discuss the barriers in these phases which are mainly composed of organizational and human factors. Akhlaq et al. (2016) review the articles about barriers to HIE in low- and middle-income countries which published between 1990 and 2014, and argue that the major challenges to implementing HIE in these countries are structural, political and financial considerations including the insufficient attention payed to information in decision-making, corruption, unsafe factors of data, unskilled professionals and weak infrastructure. Adler-Milstein et al. (2013) argue that while HIE is developing rapidly, sustainable use of HIE will be difficult due to financial issues. Langabeer II et al. (2016) empirically investigate the relationship between corporate strategies deployed and HIEs sustainability, and find that sustainability of HIE is significantly impacted by strategies of focus and cost leadership, but not by a differentiation strategy.

Another stream of research pays attention to classify the barriers. Using the data from 4830 hospitals in USA, Vest (2010) classifies the barriers of HIE adoption and implementation into three categories: technical, organizational and environmental. Dobalian et al. (2012) study the case of early HIE implementation in Long Beach and identifies 9 barriers: financial resources, patient privacy and concerns about misuse of data, industry competition, infrastructure, lack of a business case, leadership, competing priorities, training, and interoperability with existing systems. Yucel et al. (2012) perform a case study of a hospital in Turkey and argue that the risk factors which can affect the health information system implementation are technological, individual and organizational. Vest et al. (2013) believe that barriers to exchange health information in regional hospitals including: political and economic reasons, organizational issues, and geography. Stamatian et al. (2013) classify the barriers of implementation of health information systems in Europe and USA into four major categories: technical, organizational, behavioral/human and financial. Mastebroek et al. (2014) argue that six major themes relate to HIE: communication skills, organizational factors, record keeping and sharing, health literacy and self-advocacy, health professionals' knowledge and third parties. Najaftorkaman et al. (2015) conduct a systematic review of 79 papers published before 2013 to identify barriers to the acceptance of EHR and divide them to 8 categories: individual, organizational, technical and legal, behavioral, psychological, financial, environmental. Yusof (2015) points out that positive impact on adoption of health information system were associated with technical, human and organizational factors. Eden et al. (2016) review the studies on the barriers to HIE between 1990 and 2015 and identify 15 barriers which are categorized into three types: incomplete information, inefficient workflow, and unmet needs of users. Sligo et al. (2017) hold that implementation of health information systems is complex and the critical success factors are organizational, structural, technological, and human.

Recently, Karahanna et al. (2019) classifies the factors affecting organizational IT adoption into three groups: cultural capital, social capital and economic capital. Cultural capital is related to internal knowledge resources including IT sophistication, IT experience, absorptive capacity and integrated information delivery structures. Social capital refers to external knowledge resources including network connections, inter-organizational links and knowledge sharing with vendors. Economic capital is represented by financial resources, such as organizational size, slack resources, and financial readiness/resources. Although the classification method they use is different from prior studies, there is little difference in the contents.

It can be seen from above studies that technological, organizational, and human factors are the common factors with which they all agree. Ismail and Abdullah (2017) review 70 studies related to HIE published from 2010-2017 and argue that the issues of HIS can be divided into four categories: technological, organizational, human and environmental. The slight differences about these four factors among prior studies are the explanations.

2.4.2 Explanations of barriers

1. Technological barriers

Technology refers to internal and external technologies that include equipment and processes (Ismail & Abdullah, 2017). Most countries face technological challenges in implementation of health information sharing (Stamatian et al., 2013). For example, Ross et al. (2010) perform a case study including nine HIE practices from 2008-2009 in Colorado and find that although financial incentives and trust in HIE partners are the major issues related to HIE adoption, technical assistance and support are the most important factors which impact HIE implementation. Feldman and Horan (2011) perform a case analysis of a HIS system in the US and find that technical communications between HIE systems plays a key role in HIE success, including authorization to disclose information, standards for recording patients' medical information. S. C. Lin et al. (2018) analyze the data of 1,812 U.S. hospitals through April 2016 and find that technology capabilities and incentives lead to overall low meaningful use level of HIE.

For technological barriers, perceived usefulness and perceived ease of use are included in the sets of sub factors in almost all of the studies. Different studies include other different sub factors, such as compatibility, enjoyment, information quality and ineffective design (Yucel et al., 2012; Stamatian et al., 2013; Ismail & Abdullah, 2017). Hoque et al. (2017) collect data with a survey of more than 350 patients and find that perceived usefulness and perceived ease of use have significant impact on users' intention to e-Health.

Perceived usefulness is referred to the extent to which the individual believes that his or her job performance can be improved by using information system (Mohamad Yunus et al., 2013). Because healthcare providers used to record and report data with paper documents, it is not easy for them to turn to computer systems. For instance, up to half of the physicians in Finland still used paper daily or weekly in 2017 (Hyppönen et al., 2019). Furthermore, physicians may concern that health information systems are not yet usable enough to structure and/or code all aspects of documentation, resulting in most computerized records still being free-text (Kalra et al., 2012). Gagnon et al. (2012) review 101 studies on how healthcare professionals influence IT adoption and find that perception of system usefulness was the most common facilitating factor, followed by ease of use. Through obtaining patients' information electronically and timely, including medical test results, history of prior treatments and summary reports, doctors and nurses may perceive usefulness of HIS in many ways such as getting help from clinical guidelines and selecting the best treatment depending on patients' conditions (Yusof, 2015). Strauss et al. (2015) use the data from a hospital in Florida, which has 1018 beds and serve twenty-three counties, for qualitative and quantitative analysis of HIE requirements and find that 13.7 % of hospitalizations had at least one demand for medical information from the other providers to understand abnormalities of laboratory tests or imaging, treatment history of referred patients or severely ill patients, and evaluate patients' echocardiograms and bacterial cultures in other organizations. Dias et al. (2017) review 10 studies on the usability problems of Radiology Information System published from 2010 until 2016 and identify five main problems: adaptability and use efficiency, consistent standards, match between information system and work practice, recognition and documentation.

Perceived ease of use is defined as the extent to which an individual believes that using the system can be effortless. In other words, perceived ease of use indicates how difficult the users will feel to use health information systems. For instance, Fontaine et al. (2010) argue that a key technical barrier to communitywide HIEs is the poor interoperability among specific EHR systems, and one of the root causes is that there is no unified national standards for coding, storing, and retrieving data. By analyzing the observation and the interview data from six emergency departments and eight ambulatory clinics of USA in 2009, from the point view of primary exchange users, Unertl et al. (2012) identify two kinds of patterns in HIE-related workflow: nurse based and physician based. From patient point of view, the most important perceived concerns related to HIS are system break down, information safety and complex process of dealing with the system (H. Park et al., 2013) . Using the interview data from 4 urban emergency departments in the US, Thorn et al. (2014) argue that emergency physicians ubiquitously think HIE is not user friendly and disrupts workflow which may lead to large variations in using HIE and its access. Zaidan et al. (2015) also hold that sharing patient and healthcare information across provider boundaries is difficult due to the lack of interoperability of the providers' technologies and policies even when such sharing is achievable in Malaysia. Using quantitative and qualitative data from a public hospital between 2011 and 2014 in Florida, Strauss et al. (2015) argue that a lot of information received from outside organizations is not relevant to the purposes and late due to technical barriers, including difficulty to access and ineffective visualization of information. Gadd et al. (2011) conduct a survey to 345 American healthcare professionals in 2009 and find that system functionality is positive predictive of HIE system usability.

System quality refers to the expected characteristics of the information system that generates information (Delone & McLean, 1992). A. Ismail et al. (2010) conduct a qualitative study in Malaysia in 2009 and argue that the hospital information system quality consists of system development, support system and hardware. Data on patients' primary care visits for HIE, such as individual action plans and work-related primary care visits, are also regarded as a factor to improve system quality (Nissinen et al., 2016).

Information quality is regarded as expected characteristics of the information product- the system outputs, such as accuracy, meaningfulness, and timeliness (Ismail & Abdullah, 2017).

Several studies report that information quality is important for health information system to succeed (Y. C. Li et al., 2015; Rudin et al., 2011; Tham et al., 2010; Yusof, 2015). Information quality will fall when many data or information is lost (Tham et al., 2010).

Service quality is defined as the support quality of the information system department and IT support personnel asked by system users (Petter et al., 2008). Service quality has been extensively studied in service industries including healthcare (Anabila, 2019; Parasuraman et al., 1985). For example, Persijn et al. (2010) use the survey data of 82 patients of Brazil in 2006 to investigate the importance of service quality of information systems in hospitals.

Security and privacy are also used to evaluate the technical issues of HIS (Huang et al., 2014). One of the most important factors which impair HIS is the lack of patient participation and adoption, which results in incomplete information (Yeager et al., 2014). A huge challenge is posed by HIS to patient privacy because it increases the mobility of patient information has greatly increased (N. Shen et al., 2019). Although there are laws designed to protect privacy, patient trust for HIS may be weakened because of a perceived loss of control, such as some of authorized disclosures beyond clinical use (Wright et al., 2016). For example, personal health information can be used for marketing purpose (Grande et al., 2013). R. H. Miller (2012) studies five California health care entities' HIE activities between 2010 and 2011 and find that the overall challenge for HIE is to maximize the rewards while to minimize the risks of security breaches and misuse of data at the same time. Zwaanswijk et al. (2011) argue that the major obstacles of HIS are the confidentiality and safety of information in Netherlands. A 2012 empirical study firstly identifies the security concerns related to share health information electronically within the U.S. context (Patel et al., 2012). Cochran et al. (2015) argue that a major barrier to HIE is that sharing confidential healthcare information over the Internet is considered risky due to widespread fear of technology, unexpected improper sharing of information, and crimes against individuals. Invasion of health information privacy may cause harmful effects to patients, such as discrimination from economic and social aspects, implicit impact and control, intimidation, or examination (Alessandro et al., 2015). In the UK, Papoutsi et al. (2015) conduct a survey of 2761 participants including patients, health professionals and researchers between 2012-2013 and argue that 79% of the participants worry about the security and privacy of their record during the process of HIS. Furthermore, most of the participants who are worrying about EHR security are reluctant to support HIS development (Papoutsi et al., 2015). Previous research in HIE have found that patients are more willing to share their medical records with the one they trust (Whiddett et al., 2006). Platt et al. (2018) find that most Americans do not trust the organizations that own and share health information. Patients are often willing to share their information anonymously among medical staff, however, they don not want to share it when it's in more personal manner or with someone else, including government regulators and researchers (Whiddett et al., 2006). Recently, Esmaeilzadeh (2019) argue that patients' perceived risks of HIEs is significantly influenced by insufficient trust in HIE, the transparency of information sharing, and the extent to which data access is controlled.

2. Organizational barriers

The problems in healthcare information sharing will not be naturally solved by technological progress (Vest & Gamm, 2010) . The success of HIS depends on factors beyond technological issues and should take into account not only how usable they are for those who use them but also how well they integrate into organization (Eslami et al., 2017). Technology changes rapidly but healthcare providers are not able to accommodate quick changes due to their highly institutionalized structures and practices (Sligo et al., 2017). The medical field consists of mangy professional organizations, usually including two hierarchical structures for physicians and managers. Therefore, implementation of HIT is a complex socio-technical process because these systems will influence multiple organizational members and work processes, such as procurement of technology, compatibility with the existing IT infrastructure, and meeting the needs of any number of healthcare functions (Heeks, 2006; Yusof et al., 2008). Developing business in a complex and challenging makes it difficult for health providers to implement HIS plans (Heath et al., 2017). However, organizational factors don not receive enough attention due to precedence is given to technical barriers.

There have been many organizational barriers to healthcare information sharing among fragmented, and often competing, healthcare entities. Ismail and Abdullah (2017) argue that organizational barriers can be divided into three kinds: organizational size, managerial structure and timeliness. Organizational size significantly influences HIS adoption and implementation in hospitals. For example, Chang et al. (2007) conduct a survey in Taiwan in 2002 and argue that larger hospitals tend to adopt e-signature more than smaller hospitals do. Using survey data from Taiwan hospitals in 2007, C.-H. Lin et al. (2012) find that hospital's scale is a critical factor influencing the hospitals' adoption willing of The Health Level Seven (HIL7) system. The similar results can also be found in Hung et al. (2010) and C.-P. Lee and Shim (2007). Recently, Ahmadi et al. (2018) conduct a survey of Malaysian public hospitals in 2015 to study impact of hospital size on hospital information system adoption. They hold that no moderating effect of hospital size on the relationships between organization context and health information system adoption. Managerial structure including organizational planning, trainings and related activities in organizations require the assistance of information systems in hospitals (Sulaiman

& Wickramasinghe, 2014). For instance, Chan et al. (2010) believe that adequate training will help to reduce resistance and confusion of staff in the implementation of health care information systems in Singapore. Rahimi et al. (2009) believe that user involvement and training are the most important factors for healthcare information system implementation to improve organizational efficiency. Timeliness means that HIS can reduce the time needed to finish the work due to the accessible patients' information within and outside healthcare organizations (C. Williams et al., 2016).

A few other studies classify organizational barriers in different ways. Lluch (2011) reviews the articles about healthcare professionals' organizational barriers to HIT and classifies them into five types: structure of healthcare organizations, tasks, people policies, incentives, and information and decision processes. Structure of healthcare organizations includes hierarchy of organizational systems, lack of team work and cooperation, and conflict with professionals' e autonomy (Ludwick & Doucette, 2009). Tasks refer to changes in work processes and routines and from face-to-face interaction to new ways of working (Brokel & Harrison, 2009). People policies are related to distrust data, lack of training of HIT skill, lack of technological support, management, colleagues and policies, and lack of a legal framework for liability issues (Callen et al., 2008; Macfarlane et al., 2006). Incentives mean that HIT have a negative impact on the balance between the work and personal lives of physicians and the lack of reward systems leads to professionals' resistance to use HIT and share data (Boonstra & Broekhuis, 2010; Pagliari et al., 2009). Information and decision processes refers to changes in work flow and processes translated into a heavier workload for healthcare professionals and hence their resistance to these innovations (Flynn et al., 2009).

Sligo et al. (2017) divide the organizational barriers into three categories: communication in the organization, organizational structure and support from external organizations. First of all, poor communication between different levels of the organization make it difficult to facilitate work processes and highlight problems (Noel et al., 2004). Second, it is really tough for healthcare providers to change organizational structure to achieve HIS success. The changes include structures of management, governance and task (no longer output), which lead to the reduction of employee turnover rate, the enhancement of employee ability, the liberation of employees from other work and compensation for their role in the process of implementation, reasonable schedule for achieving objectives, carefully arranged logistics for innovation, understanding the continuity of implementation process (Doherty et al., 2012; Harrison & Kimani, 2009). For example, organizational decision makers should discuss, investigate and analyze the costs and the benefits of HIS and decide whether adopt HIS or not. If they are risk averse, they may be reluctant to promote HIS (Yusof et al., 2008). Continuity of patients' health information across different organizational boundaries is a significant challenge, such as information loss due to staff turnover or inconsistency in career (Mastebroek et al., 2014). Third, it is hard for healthcare providers to obtain support from external organizations such as government and other providers. Healthcare information systems are costly, so funding from government and collaboration among healthcare organizations are critical (Gabriel et al., 2014). Collaboration and share of patients and their data are basic requirements for the competing and adversarial parties to share health information. However, competition can create conflict and misalignment of incentives that become a barrier to HIE. Hospitals are reluctant to share healthcare information with others because they want to gain advantages in market competition and are afraid of the decrease of patients and related income (Fontaine et al., 2010). In addition, hospitals may try to create barriers of HIS to inhibit patients from seeking care elsewhere because they may not be able to get any benefit from cost savings which are instead captured by the third parties (Rahimi & Vimarlund, 2007). Adler-Milstein and Pfeifer (2017) argue that both vendors of EHR and providers often block the flow of information. They also suppose that the most common ways to block information flow among EHR vendors include limiting the interoperability between systems, asking for a lot of money for HIE, making the others access to patients information difficult (Adler-Milstein & Pfeifer, 2017).

3. Human barriers

Individuals including professionals and patients are of great importance during the success of HIS (Shea & Belden, 2016). Using the data from 21 healthcare organizations actively using HIE in the USA in 2008, Johnson et al. (2011) find that patients, nurses, clerks, and physicians are most likely to access HIE systems. They also hold that the data which is most frequently accessed is medical reports (100%), followed by patients' discharge summaries (96.9%) and results of medical tests (63%) (Johnson et al., 2011).

User's acceptance and satisfaction have big implications for the success of information systems in hospitals (Mohamad Yunus et al., 2013). User satisfaction refer to the response of the person receiving services to using an information system output (Delone & McLean, 1992). Mclane (2005) finds that a high level of user satisfaction is critical to the success of HIT implementation in the practice setting and end user's satisfaction is influenced by system usability. Shank and Shank (2012) conduct a survey of 32 hospitals in a Midwestern state of the USA in 2010, and find that 33% of them are negative about the impact of HIE mainly due to perceived cost and time burdens.

If information owners are reluctant to share high-quality information, HIS is unsustainable.

For instance, some American physicians have successfully lobbied the state legislature to prevent the wide uses of HIEs in local organizations (Vest & Gamm, 2010). Litwin (2011) finds that performance increase from HIT use are greater in those clinics achieving higher mean levels of employee involvement. Lloyd and Rissing (1985) find that physician is the primary cause of significant volumes of coding errors. Goldzweig et al. (2009) argue that perceived barriers to adoption of EHR mainly result from physicians, such as increase in their time, lack of computer skills, and difficult to find an EHR to meet the practice's requirements. Ten years later, Gardner et al. (2019) find that physicians still experience stress related to use of health information technology, such as poor time for documentation, excessive time on EHRs, and much more daily frustration. However, professionals with higher data processing skills are more likely to use health information to support their work (Dagnew et al., 2018). Therefore, it is significant for policy makers and hospitals' managers to deal with challenges related to professional training and behavior change during the process of HIS (Kalra et al., 2012; Ward et al., 2008).

User's skills and experience are important for HIS. Using the clinical data of patients in the Integrated Care Collaboration of Central Texas from 2006-2009, Vest et al. (2011) find that the odds of HIE usage are lower if the patients are unfamiliar to the facility or the physicians think that it is time consuming. Patel et al. (2012) argue that the reasons why consumers support HIE include their prior experience using the Internet to manage their healthcare and their perceptions regarding the potential benefits of HIE. Ingebrigtsen et al. (2014) review the studies of how clinical leadership influences HIT adoption between 2000 and 2013 and find that a hospital manager with information technology skills and IT project management experience may develop a vision that includes use IT in a long run. These leaders make it easier to successfully adopt and implement HIT.

4. Environmental barriers

Implementation of HIT always comes with a heavy cost and it is a significant barrier to the adoption of HIS such as HIE (Kristin et al., 2007). Start-up and operating costs consist of direct and indirect costs, such as hardware, software, and loss of efficiency because of changes in workflow and organizational structure at the beginning of implementation. Start-up cost for HIS is likely to connect the existing clinical information systems with the HIS network (Reed & Grossman, 2004). Operating cost include maintenance expenditure and membership or transaction fees (Grossman et al., 2006). An EHR implementation costs about at $5,500 to $36,000 per physician (Anderson, 2007). Patel et al. (2011) conduct a survey of 328 physicians in the U.S. in 2009 and hold that lack of financial support for the selection, launch and implementation of HIEs is the main barrier to HIE adoptions although most of the physicians believe that HIE will improve the healthcare efficiency. As a result, 2 to 6% of the healthcare cost of most countries are spend on IT (Ammenwerth et al., 2003; Lapointe et al., 2011).

Technological change is even regarded as the major cause of the increase of the proportion of the health sector in GDP during the past thirty years (Rye & Kimberly, 2007). In the USA, HIEs is likely to be closed down if the government cut its financial support for them (Kruse, 2014). Using the survey data from more 2,500 hospitals of the American Hospital Association between 2007-2009, A. R. Miller and Tucker (2014) argue that the larger the hospitals are, the less the external HIS activities will be because sharing patients' health information with outside hospitals may increase the hospitals' commercial costs. Rudin et al. (2014) review 17 studies on sustainability of HIE from 2003-2014 and find that approximately only one quarter of organizations engaged in HIE could maintain their financial stabilities. Khurshid et al. (2015) conduct a survey on operational HIE in the U.S. and find that the practice still lack evidence that HIE investment could yield positive returns and the future sustainability of HIEs was a serious issue.

Although information security has been paid much attention by patients, they are expected to accept having their health information shared through HIE due to perceived benefits (Esmaeilzadeh & Sambasivan, 2017). O'Donnell et al. (2011) propose that there are three main advantages of HIE from patients' points of view: improved integrity and precision of healthcare information; improved healthcare information security; the improvement in communicating with professionals. Using the telephone interview data of the households in the US in 2009, Gaylin et al. (2011) hold that a large majority of the sample hold that, for EHR, the benefits are greater than the risks (64%) and support HIS (72%). H. Park et al. (2013) find that experiencing the benefits, such as improved quality, reduced healthcare expenses and receiving convenient and expedited care delivery, can alleviate privacy concerns of patient and increase acceptance of HIE. Using the data from the eHealth Initiative's annual compilation in the 2004-2009 period, Adjerid et al. (2016) argue that privacy regulation alone will lead to a decrease in HIEs, however, the impact of privacy regulation on the developments of HIE efforts is positive if it can be combined with requirements for patients consent. Medford-Davis et al. (2017) interview 982 patients attending an emergency department in the US in 2015 and find that 92.4% of the patients felt ready to exchange medical information although patients fear for data privacy and security. Esmaeilzadeh (2018) make a qualitative research in the US in 2017 and finds that patients' perceived benefits and perceived risk of HIE are different, and the former is smaller than the latter, which in turn raises their chances for participating in HIE.

Besides perceived benefits, the establishment of legal norms relating to privacy of health information also contributes to alleviating patients' concerns about security of their medical data. Because existing health information systems are fragmented and don not have enough capability to manage and sharing health data and information, health information system does not gain enough attention from political commitment and priority in many countries (Alwan et al., 2016). However, healthcare consumers are in favor of HIS if someone can eliminate their concerns about how their records are protected during the sharing process and how the information are used (K. Kim et al., 2015). For instance, in the US, the passage of the Omnibus Rules of the Health Insurance Portability and Accountability Act (HIPAA) in 2013 requires better protection of business partner privacy and stronger regulation (Yaraghi & Gopal, 2018). Based on the public data on breach incidents from 2009 to 2017 presented by the Office for Civil Rights in the US, Yaraghi and Gopal (2018) find that the enactment of HIPAA had greatly reduced the number of hospital violations and at least 180 privacy violations were prevented, as a result, the privacy of 18 million Americans was protected.

Because the legal system related to privacy and security of data is increasingly complete, patients' concern is decreasing. By analyzing the data of 20,076 patients in Western New York, Yaraghi et al. (2015) investigate the factors influencing patients' willingness to exchange their healthcare information and argue that, for women, older patients who were served by more different doctors in the nursing process, the probability of sharing medical information was much higher. Using the data from the Northern California HIE Collaborative in the US from 2013-2015, Downing et al. (2017) indicate that if an organization can bind the consent of information sharing with the consent of treatment, which is neither specially asked for the consent of patients nor required by federal law, its exchange volume will significantly increase compared with the organizations that needed consent. Mello et al. (2018) review the key developments affecting the legal barriers to HIE from 2007-2017 in the US and find that many legal issues that have been considered as barriers by healthcare organizations to participate in HIE are quite tractable nowadays due to the increasingly perfect of the legal architecture. Shen et al. (2019) review 59 articles about the patient perception of HIE privacy published before 2017 and find that privacy concerns decreased since 2010 and the patients' views are complex and always changing.

In general, barriers to success of HIS that most studies consider are technological, organizational, human and environmental. Technological factors, including usefulness, ease of use, interoperability and user involvement, are found to be most effective on health information system implementation, then followed by organizational and human factors (Yucel et al., 2012).

2.5 The third-party HIS

2.5.1 HIE as a platform

Platforms are basic products, services or technologies on which other parties can build complementary products, services or technologies (Gawer & Henderson, 2005). Multilateral platforms (e.g. eBay) are both platforms and intermediaries of the market (Hagiu, 2007). A group on a platform refers to the users who possess a high degree of homogeneity in attitudes and behaviors (Yaraghi et al., 2014). Thus, distinct groups of consumers and "complementors" interact through multi-sided platforms and each group is called as one side of a platform (R. S. Lee, 2013).

In practice, besides patients and health providers, HIS are often led by a third party who are responsible for technical support and governance structure to facilitate HIS. Due to its multi-sided nature, HIE can also be seen as a multi-sided platform because it brings together many different organizations that need to share patients' information (Yaraghi et al., 2015). Compared with single-sided market, HIE platforms can collect, organize, and store the healthcare information from various organizations in a centralized manner, which make it easier to share health information.

Multi-sided platforms can increase its value by attracting more and more members over time due to network effect which means that the more members the platforms have, the greater value of the platform is for its members(R. S. Lee, 2013). There are two kinds of network effects: direct (within group) and indirect (between groups). Direct effects and indirect effects are driven by the benefits obtained by the members from the same group and the other group members, respectively (Weyl, 2010). For the first time, HIE was considered as a multisided platform and the network effects in of it were studied by Yaraghi et al. (2013). For example, a new hospital joins in the HIE platform will bring more patients' data and consequently increase the dataset resources accessed by all of its members, which increase the value of the platform for every member. By analyzing two datasets of a Regional Health Information Exchange Organization (RHIO) in New York from 2009-2011, Yaraghi et al. (2013) find that the direct effects within the same group of primary care doctors or specialists are weaker than the indirect effects between them on HIE platform. They also argue that the impact of specialists on primary care physicians is weaker than that of primary care doctors on specialists (Yaraghi et al., 2013). In another study, Yaraghi et al. (2014) use the same dataset to investigate the professional and geographical network effects on HIE growth. They find that, compared with the social infection and external factors previously studied, the direct network effect resulted from common patients among doctors has a greater impact on the adoption of HIE. They also argue that HIE adoption does be impacted by professional proximity because of common patients, i.e., doctors are more vulnerable to the adoption of doctors with similar specialties, because there are more common patients shared between them; the impact of geographical proximity on rural doctors is higher than that on urban doctors (Yaraghi et al., 2014).

Using the data from the same RHIO of Western New York between 2008 and 2011, Yaraghi et al. (2015) study the relationships among practices, doctors, and patients to fully understand the influencing factors of HIE adoption and use. They argue that there are four major kinds of users who use HIE platforms and compose the four sides of the platforms. These users include patients, medical data providers, healthcare providers and payers. Medical data providers include laboratories, radiology departments, and hospitals. Healthcare providers consist of independent doctors, private clinics, and other medical service providers. The differences between medical data providers and healthcare provider lie in the market structure, the numbers and the size. The latter are geographically widespread, more abundant in numbers, much smaller in size than the former and often use the data provided by the former. Payers refer to insurance companies and governments who pay for healthcare services (Yaraghi et al., 2015). Yaraghi et al. (2015) find that HIE benefits for a medical service are related to the number of patients shared with other medical services. If a medical service has more shared patients, a bigger share of market, and more dependence on other medical services, HIE will be implemented by it faster.

Patients' data can be looked at and downloaded by participants on HIS platforms although the information systems used by the healthcare organizations are different (Yaraghi et al., 2015). In general, HIS platform established by a third-party organization is an efficient way to solve the interoperability issues during the process of HIS.

2.5.2 The third-party HIE Strategies

A range of organizational forms have been used to facilitate HIS since 1990s. Traditionally, third-party entities also have been supported by policy makers to promote development of HIS (Everson, 2017). For instance, the regional health information exchange organization (RHIO), some studies call it community HIE, is often used as this independent third-party coordinator between healthcare organizations in an area (Vest et al., 2013). However, community HIE is difficult to align the interests of the relevant entities engaged in and to develop a technical structure acceptable to all. As a result, the development of community HIE is slow and new organizational forms are introduced.

From the perspective of by which organization HIS is led, there are three HIE strategies: most common community HIE, enterprise HIE (led by a medical institution), and electronic health record vendor-mediated HIE (Vest et al., 2013). These three strategies all use neutral organizations as independent third-parties to facilitate HIE.

1. Community HIE

Community HIE is a third-party organization established to provide local or regional information-sharing networks for healthcare organizations to connect with each other (Solomon, 2007). Community HIE organizations act as agents for consensus-building among providers so that they can participate in sharing patient's information when they need to do so. For example, in early 2005, 13 hospitals and many other organizations participated in the Indiana Health Information Exchange (IHIE), a nonprofit company, which offered clinical information sharing service for physicians in the Central Indiana region (Solomon, 2007). Frisse (2010) analyzes another community HIE which is run by the nonprofit organization-MidSouth eHealth Alliance Exchange in Memphis and includes all hospitals in a region consisting of three counties.

Community HIE is the earliest and the most frequently studied type of HIE which tries to improve healthcare delivery in a local area through quality assessment and more efficient transaction systems (Vest et al., 2013). The most important reason why hospitals participate in community HIE is to access patients' data generated by other providers from whom patients have received the care (Vest & Kash, 2016). Using the data of the patients during a 6-month period in 2009-2010 in the Rochester, New York area, Vest et al. (2015) find that the community HIE can reduce the readmission rate by 57% in the 30 days after hospital discharge and save more than $600,000 for these patients by avoiding unnecessary readmissions. Previous studies found that community HIE was used in about 2-4 percent of all visits (Johnson et al., 2011; Vest et al., 2011). In some particular kinds of visits such as back pain and headache, the use frequency of community HIE is much higher and up to 12.5%-21.9% (Bailey et al., 2013). At the physician or patient level, the use rates of community HIE fluctuate widely due to the differences of implementations and policies among providers. For instance, within the same community HIE, only 1% of the patients may use it in one community, however, more than 50% of the patients did in another community (Thorn et al., 2014).

Cooperation among providers plays a key role for the success of community HIE. However, cooperation is difficult to achieve due to competition among providers. As a result, community

HIE has been routinely resisted or rejected by the healthcare market since it appeared in 1990. In the U.S., about one third of hospitals participated in a community HIE in 2013, however, the total amount of community HIEs decreased in 2014 (Everson, 2017). Although community HIE may not be an ideal form, it is an important way to support HIE's public good qualities due to its broad membership and more emphasis on public health. Other barriers to community HIE include patients' consent, costs, technology and market factors (Vest & Kash, 2016).

2. Enterprise HIE

Enterprise HIE is convened by a large medical institution who gathers participants from providers to create a network system composed of multiple hospitals for information sharing in the interest of itself (Everson, 2017). Misalignment of the different providers' benefits and requirement of extensive cooperation are great challenges for community HIE (Cannoy & Carter, 2011). Enterprise HIE can be regarded as an alternative to community HIE because it can exclude competing organizations whenever the convener wants and avoid sharing information with competitors (Vest et al., 2013). For example, the main health maintenance organizations (HMO) in the state of Israel adopted an EHR information system and created a HIE network in 2004 which connected 7 general hospitals and many community clinics of HMO to allow patient's record to be shared at all points of care of HMO (Ben-Assuli et al., 2013).

Enterprise HIE connects the affiliated healthcare organizations in most cases, however, unaffiliated organizations may also be selected by the convener to participate in information sharing. A 2014 study finds that 14 percent of physicians exchanged medical information with providers outside their organizations while 39 percent shared data within organizations in the U.S. in 2013 (Furukawa et al., 2014). Enterprise HIE between unaffiliated organizations shows a rapid growth trend. The American Hospital Association's Information Technology survey reported that 58% of US hospitals shared information with outside organizations in 2012- an increase of 41 percent since 2008 and about double in percentage of hospitals which engaged in community HIE (Furukawa et al., 2013). Likewise, 15% of US physician offices exchanged data with other doctors in 2012- 50 percent more than joined in community HIE (Furukawa et al., 2014).

The primary reason of organizations with enterprise HIE is to leverage inter-organizational relationships to achieve a strategic goal, such as information integration of the disparate hospitals and direct control over the system. Convener of enterprise HIE should afford the operational costs and have the experience of HIT implementation. Therefore, the barriers to enterprise HIE are associated with organizational resources and health IT vendors (Vest & Kash, 2016).

3. EHR vendor-mediated HIE

EHR vendor-mediated HIE is convened by an EHR vendor who connect their customers to establish a network for medical information exchange by providing technical support (Everson, 2017). This model is relatively new in the practice of HIS so that there are only several studies on it until now. Kaelber et al. (2013) study a vendor-based HIE integrated in a commercial EHR called Care Everywhere which includes a hospital with 17 outpatient sites and is led by Epic Systems Corporation in northeast Ohio, USA. They find that 6.1% of all patients use HIE and also report that the same vender-based HIE is used by five other healthcare systems and covers more than 1500 sites in the U.S., exchanging information over 1.2 million times per month (Kaelber et al., 2013). Through analysis of the data from 4 large hospital emergency departments in Minnesota and western Wisconsin in 2012, Winden et al. (2014) find that about 1.46% of patient encounters use Care Everywhere to sharing information. Six other EHR vendors announced that they would collaborate with each other to develop HIE in 2013 in the U.S. (Everson, 2017). Generally speaking, at present the use rate of EHR vendor-mediated HIE is lower than that of community or enterprise HIE.

The relationship between the market share of EHR vendors and the HIS behavior of the hospitals has also been studied. Everson and Adler-Milstein (2016) analyze the data about EHR and HIE of all US hospitals from 2012 to 2013 and find that, on average, HIE activities of hospitals using EHR systems supplied by the dominant vendor are 45 percent more than those using a different vendor. In addition, they argue that the lower the vendor market dominance is, the less HIE activities between the hospitals using and not using the dominant vendor due to high costs and market competition. Therefore, policy makers should pay attention to competition behaviors among the vendors when they wanted to implement cross-vendor HIE (Everson & Adler-Milstein, 2016). Based on the data from the 2013 American Hospital Association's Information Technology Supplement, Castillo et al. (2018) find that three EHR vendors have 58% of the market, and if the proportion of the hospitals in a region served by the same EHR supplier is higher, the chances that these hospitals will share healthcare data with outside hospitals are higher. Specifically, they argue that, compared with the hospitals in a region that one EHR Vendor serves no more than one hospital, the hospitals using the same EHR vendor are more than 5 times more likely to share patients' information with the other hospitals (Castillo et al., 2018).

The relationship between the three kinds of HIEs has also been studied. Using the interview data of policy makers and healthcare professionals in New York and Texas in 2014, Vest and

Kash (2016) find that the health systems prefer enterprise HIE to community HIE because community HIE is mainly used to meet the need of the public interest and to create HIE networks at state or national level. If some enterprise HIEs need to connect with each other or providers have not participated in community HIE, EHR vendor-mediated HIE will be the best choice because of they are integrated into the EHR system at a high level (Vest & Kash, 2016).

2.6 Maturity of HIT

2.6.1 Maturity

Researches about maturity of an organization can be traced back to the initial findings in the 1970's (Gibson & Nolan, 1974). Maturity is often defined as a specific process during which an organization evolve from an initial state to a final and more advanced state (Cookedavies & Arzymanow, 2003; Fitterer & Rohner, 2010). From the beginning, maturity is used to represent how an organization improves its productivity by improving business processes and staff capability (Khoshgoftar & Osman, 2009). Whether an organization is more or less mature depends on which and how the indicators are used. Generally speaking, the indicators can be divided into three categories: process maturity, that is to say, to which extent an organization's specification process is perfect from definition to optimization (Fraser & Vaishnavi, 1997); object maturity, that is to say, to which extent a special object like an information system, an organization achieves a preconceived level of sophistication (Bosch, 2002); people capability, i.e. to which extent the personnel is able to create new knowledge and improve their skills (Nonaka, 1994).

Based on the indicators, a variety of maturity models are developed to measure the maturity of an organization such as the Capability Maturity Model (CMM) in the end of the eighties of twentieth century and the replacement of it-ISO/IEC 15504 (Haase et al., 1994; Paulk et al., 2002). Maturity model refers to an expected logical path formed by a series of successive stages from an original state to a final mature state (Poeppelbuss et al., 2011). In order to obtain and retain competitive advantage, these models are often used by companies to systematically address their problems and challenges and to compare their working methods and quality of outcomes with the best practices. Maturity models are developed in many domains including medical systems, software and system engineering, information systems and product quality (Caffery & Coleman, 2007; Heckman et al., 2015). These models differ in three aspects: number of stages, influencing factors and application fields (Becker et al., 2009).

2.6.2 IT and IS maturity

IT maturity is often regarded as features of the technical infrastructure and its internal management, for example, the tasks the IT department must complete well to successfully keep up with the organizational needs of information (ArikRagowsky et al., 2012). Information system (IS) maturity indicates IS planning and use capabilities within an organization, and it plays a key role in explaining the success of IS (Suh et al., 2017). Maturity of information system relates to how IT function, use, experience and management strategy evolve as time goes on. Two types of conception model are developed by scholars to characterize IT maturity.

The first one is the stage model. Nolan (1973) is the first study to divide the process of computer resource management into 4 stages: computer acquisition, intense system development, proliferation of control, and user/service orientation. In another study, Nolan (1979) indicates six stages of data processing growth: initiation, contagion, control, integration, data administration, and maturity. On the basis of the “stages” model proposed by Richard Nolan (Nolan, 1973), the stages used to measure IT maturity has been extensively studied in the literature (Deshpande, 1980). These research focus on the advantages of mature management practices for IT services. For example, there are many studies on the mature processes of software development and management, such as the Capability Maturity Model (Hunter et al., 1994), and the Capability Maturity Framework (Curley, 2006). Poeppelbuss et al. (2011) review 76 studies on maturity models published from 1996-2010 and argue that the CMM and its successor the CMM Integration are the most dominant foundations for maturity models research and they are frequently transferred to fields beyond software engineering.

The second one is the technology assimilation model which represents the entire diffusion process of IT, and the evolution of a firm’s IT management strategy as it turns to IT (Karimi et al., 1996). This model divides the process of IT diffusion into four stages: technology identification and investment, technology learning and adaptation, rationalization/management control, and maturity/widespread technology. The challenge and goals, management approaches and the growth process of assimilating technology will be different through these four stages (Karimi et al., 1996).

Then maturity models have been used for describe the application process of IT in an organization. For instance, Hirschheim et al. (2006) study the market maturity of IT function. Using the interview data of over 130 CIOs and IT directors in the USA from 2007-2010, ArikRagowsky et al. (2012) propose an organizational IT maturity model which refers to the ability of IT department employees and non-IT department employees to cooperate well on IT implementation to make the best use of IT and make business processes operate effectively. They believe that the IT maturity include six levels for organization: ignorance and lack of interest reign, willing to invest, trusting their IT partners, accepting of IT practices, and finally being responsible for their own use of information systems in pursuit of organizational goals (ArikRagowsky et al., 2012). From the perspective of lifecycle, Suh et al. (2017) expands IS maturity to IS governance maturity as a general IS management level including IS lifecycle: IS planning→IS implementation→IS operation→IS evaluation.

Although maturity models have been used in many fields, they are also criticized due to its failure to describe how to achieve at higher levels of maturity and the lack of theory basis (Biberoglu & Haddad, 2002; Pfeffer & Sutton, 1999). Most maturity models are summed up from the best practices or the factors driving IT success during the implementation of business processes. Validity and reliability of maturity models are often tested insufficiently in the literature.

2.6.3 Maturity model in healthcare organizations

The benefits of HIS cannot be achieved if the implementation processes are chaotic. Further, obstacles associated with HIS use may diminish over time due to maturity of HIS capability and coverage. For this reason, healthcare organizations can use maturity models to manage HIS more efficiently.

The studies on maturity models of HIS started not long ago and are limited. Using the interview data from five states in the US, Dullabh and Hovey (2013) argue that maturity of HIE at baseline is a critical element that influences HIE implementation. Using the data from an interoperable EHR of Canada in 2015, Gheorghiu and Hagens (2016) argue that the numbers of health professionals who access EHR will grow further as maturity of EHR use increases. Parker et al. (2016) review 18 US-based studies on the use of HIE to support and conduct clinical research published from 2003-2014, and find that most of the studies focus on the description and validation of the role of HIE in healthcare delivery and outcomes. They call for more studies of improving healthcare services and clinical outcomes when HIE matures (Parker et al., 2016). Adjerid et al. (2018) argue that HIE can reduce more healthcare spending when it is more mature. Yeager et al. (2017) conduct qualitative interviews with 23 HIE professionals with experience of more than 20 HIE efforts and argue that HIE maturity relates to where the technology is fully developed, system usage is widespread, and information systems are populated with data. These researches only briefly mention the maturity of health information system without getting into the details.

A few studies on the maturity models in healthcare settings have emerged in the past decade. In a 2011 study, Rocha (2011) presents few maturity models of information systems and technologies for medical practices. These models are insufficiently detailed, mainly developed by corporations or national health organizations, and include 5, 7 or 8 different maturity stages. He argues that the research of maturity models for health information technology was of its infancy at that time and new maturity models should be developed (Rocha, 2011). Carvalho et al. (2015) also find that it is early days in terms of developing maturity models in healthcare and there is no tool for measuring the maturity stages or building the properties of various maturity stages in a variety of situations. In another study, Carvalho et al. (2016) describe 14 IT maturity models used in health care practices of some countries, such as Australia and the UK. Carvalho et al. (2019) conducted a survey of 46 Portuguese healthcare IT experts and carried out individual interviews with 5 Portuguese IT professionals in 2016 to put forward a maturity model in healthcare information settings. They argue that the maturity model for medical information system consists of five stages including six maturity-influencing factors: data analysis, strategy, people, EHR, information security, and systems and IT infrastructure.

Recently, Khuntia et al. (2017) use the survey data of HIEs in the US between 2008 and 2010 to investigate how operational maturity of HIE influences the viability of HIE. They define operational maturity as “the functional and operational progress of a new venture through typical growth stages” and use a maturity model with seven phases proposed by the eHealth Initiative (ehealthinitiative.org) in the UK to gauge HIE maturity. The seven stages are composed of initiation, structure formation, plan, formulation, plan implementation, technology operation, commercial operation, and collaboration with stakeholders. This 7-stage maturity model works on a similar principle of the stage model discussed earlier except that it is used in HIE settings (Gilbert et al., 2006). They find that operational maturity of HIE is associated with more information service offerings provided by HIE and a key enabler and an intermediate step toward financial breakeven (Khuntia et al., 2017).

Up to now, most of the maturity models for healthcare information systems do not disclose the design process and their validation, not to speak of their impact on HIS. Therefore, maturity model application in health care should be perfected in the future.

2.7 Success of HIT

2.7.1 Information system success

Most of businesses wonder whether their investments on IT perform well and bring the expected return. Many studies try to find the relationship between IT and firm performance. Brynjolfsson and Yang (1996) review the studies about the impact of information technology on productivity published from 1980s to early 1990s and argue that empirical studies did not find a significant correlation between IT and productivity improvements. However, they argue that, since the mid-90s, scholars have illustrated that IT is not only related to increase in efficiency, but also to middle variables, consumer surplus, and economy's expansion. For example, Bowen et al. (2007) conduct a case study of a company whose main businesses are in Australia and New Zealand and argue that IT governance plays an important role in fostering project success and delivering business value. Using the panel data of the manufacturing firms in the US from 1978-1997, Kleis et al. (2012) find that for every 10% increase in IT investment, innovation output will increase by 1.7% if the input level related to innovation is given. Gunasekaran et al. (2017) review the articles about the linkage between IT and supply chain competitive advantage and find that IT can create competitive advantages within supply chains and logistics.

Information system success is different from above business success and should be carefully defined. Petter et al. (2012) argue that the measures of information system success ought to put much emphasis on measurement after the information systems have been developed and on its use. Delone and McLean (1992) review about 180 articles to see which factors influence information system success and firstly propose that the success can be divided into six major dimensions: system quality, information quality, use, users' satisfaction, individual impact, and organizational impact. The elaboration of quality and user satisfaction has been presented in subsection 2.4.2. Information use refers to consumption of information receiver on an information system output, including extent and hours of use, voluntary and anticipated use (Delone & McLean, 1992). Individual impact refers to the improvement in personal efficiency and decision-making. Organizational impact refers to improvement in organization performance. Use interacts with user satisfaction and both of them influence individual impact (Chung et al., 2015).

After publication of the first information system success model of Delone and McLean (1992), some scholars argued that the six dimensions are not enough to describe success of information system and added other dimensions to the model or proposed new models. For instance, Seddon (1997) incorporates perceived usefulness into the model and a process-oriented model has been developed to evaluate information system success (Byrd et al., 2006).

About ten years later, Delone and Mclean (2003) reviewed more than 100 articles on information system success published from 1992-2002 and updated their model by integrating individual and organizational impact into one dimension (i.e. net benefit), incorporating service quality into the model, adding intention to use to the use dimension, and proposing the casual relationship between these success dimensions. The model suggests that information quality, system quality and service quality have impact on intention to use, and users' satisfaction and the latter two variables influence and are influenced by net benefits. The benefit of information system refers to the strategic effects on business benefits directly or indirectly (Suh et al., 2017). It can be measure by different methods, such as indicators of strategic and operational (Fearon et al. (2014), econometrics-oriented and business process-oriented (Espinosa et al., 2006), and executives' recognized perceptions (Delone & Mclean, 2003).

Then the updated model has been widely used to measure the success of information system in the literature and seen as the most influential research in the present study of information system (Delone & Mclean, 2004; Espinosa et al., 2006). Petter et al. (2008) review 180 articles about information system success for the period of 1992-2007, and find that most of the studies validate the updated model by testing the relationship hypothesis between the different dimensions, however, the focus of these researches is only on one dimension, such as information quality or use. They also argue that a general effectiveness measure is not suitable to be used to measure multiple dimensions of success although some researchers do (Petter et al., 2008). The updated model has already been applied to a lot of domains, such as electronic commerce (Cui et al., 2019), social networks (Gao & Bai, 2014), and enterprise system (Suh et al., 2017).

The factors affecting information system success has also been studied in the literature. Petter et al. (2013) review more than 140 articles on the independent variables that affect information system success. They identify 15 factors and categorize them into five types: task characteristics, user characteristics, social characteristics, project characteristics, and organizational characteristics. Suh et al. (2017) extend the information success model of Delone and Mclean (2003) to 3 dimensions: quality, including quality of system, information and service; use, including information use and user satisfaction; benefit, including support from planning, management, sales and marketing, production and operations, improvements of product and service, relations of supplier and customer. Using the survey data of the firm executives of the companies of South Korea, EU and US located in Korea from 2008-2009, Suh et al. (2017) argue that information system investment significantly influences its success and information system maturity moderates the relationship.

2.7.2 Health information system success

A few studies use information system success model in healthcare setting. In order to use the framework of Delone and McLean (1992) to categorize the attributes applied to evaluate the success of patient care information systems, Der Meijden et al. (2003) review 33 studies about this issue from 1992-2001 and argue that most of the attributes can be assigned to the six dimensions mentioned earlier, however, contingent factors, such as organizational culture, cannot. Based on survey data from 38 hospitals of the US in 2009, J. Park et al. (2009) evaluate the performance of a health information system in terms of system success including user satisfaction and quality of system and information. Kivinen and Lammintakanen (2013) conduct a case study to represent viewpoints on the use of medical information in 2006 in Finland and argue that usage of healthcare management information system can be categorized into four types similar to (Delone & Mclean, 2003): system quality, information quality, use and user satisfaction, and development of information culture. Cho et al. (2015) use the six dimensions of Delone and Mclean (2003) to assess the performance of an information system implemented in three Korea hospitals in 2014. They apply three factors to indicate information system success: intention to use, user satisfaction and net benefits (Delone & Mclean, 2003).

The standard information system success model may need to be modified in healthcare industry. For example, Pai and Huang (2011) add perceived ease-of-use and perceived usefulness to Delone and Mclean (2003) model as the mediation variable between three quality factors and intention to use. They argue that the casual relationship between the six dimensions should be adjusted according to hospital information systems. Recently, using survey data from 172 respondents working in two hospitals in Italy, Lepore et al. (2018) study how hospital information system success is influenced by the cultural dimension based on Delone and Mclean (2003).

In general, information system success in healthcare setting has seldom been studied by now. Therefore, new studies in this area will contribute to understanding the factors influencing success implementation of HIS system and providing support for effective measures and policy-making to overcome the difficulties during the process of HIS.

2.8 Theoretical model

2.8.1 Third-party and barriers to HIS

As mentioned earlier, HIS can be led by a third-party organization. If the healthcare information network is not built up by a third party, it is difficult for a person to access to the patients' medical records except for the doctors, the patients, and the patients' family members. China is a big country with a large difference of regional economic development. As all the other countries except the USA, China used the "top-down" strategy to establish its healthcare information system due to the great impact of Chinese government activities on its economy. The Chinese HIS mode is based on the regional healthcare information platforms and is characterized by the administrative hierarchy consisting of the country, the province, the city, and the district. At each level, the framework of the HIS systems is centralized. Therefore, the HIS mode in China has a strong sense of the administration and the main engine of HIS are the policies of the health administration departments at all levels. For example, the HIS in Qinghai province is guided by the medical insurance policies (Guo et al., 2018). By 2019, 485 counties and districts in eighty cities of 11provinces have established the regional platforms of EHR systems and the data on these platforms has been shared in many ways (Zhu & Mao, 2019).

Community HIE is selected for HIS in most Chinese areas and led by the local governments. They are responsible for establishing healthcare information systems for the healthcare providers whose levels of information are low and integrating the segmented information systems of the different medical institutions into a platform for HIS. For instance, the health bureau of Lianzhou city in Guangzhou province built a platform for sharing healthcare information among all the hospitals in the city in 2012 (E. Zhang et al., 2016). In Wenzhou, a city in Zhejiang province, the government set up a Level-1 Platform for HIS by converting the medical data of 294 healthcare entities in the city to the national standard data and sharing these data on a city-level platform (He et al., 2016). In 2017, the Health Bureau of Xiamen city in Fujian province built a system for sharing medical inspection results among 15 municipal public hospitals and 26 community hospitals in the city. The inspection results have been read by the different hospitals more than 1.3 million times until 2019 (Yang et al., 2019).

Enterprise HIE is also applied to share healthcare information in China. For example, in Heilongjiang province, Harbin Medical University Affiliated Fourth Hospital constructed a platform to share medical image data among the local hospitals. However, this enterprise HIE system is mainly led by the regional government and shares the healthcare information on the third-party platform (Y. Zhao et al., 2016). In Beijing, Tianjin, Jiangsu, and Shenzhen, the medical clusters have been constructed to facilitate HIS and the tiered medical services. In a medical cluster, a hospital acts as the main unit to get all the hospitals in the medical cluster together and implements HIS which is the basis of the tiered services (Guo et al., 2018). For example, the Chongming county in Shanghai formed a medical cluster around the Xinhua hospital affiliated to Shanghai Jiaotong University and began to build a regional HIS platform in 2012 (Zha et al., 2012).

During the implementation course of HIS, it is easier and more efficient for the third parties to collect healthcare information from different providers than themselves because the third parties don not compete for patients with the providers in the market or they usually are the branches of the local governments with enough power and sources. They set data standards, store and manage the data, build the information sharing platforms, and provide the uniform accesses to different systems. For example, the China's Ministry of Health developed "the Basic Specification of Electronic Medical Records" in 2010 and it had been implemented since 2011. Recently, the General Office of the State Council issued "the Suggestions on Promoting the Development of the Internet Plus Healthcare" in 2018 and clearly stated that the related standard system should be perfected to accelerate the realization of HIS (Bing, 2019).

If the third parties dig deeper to do these jobs for facilitating the HIS, the HIS systems will be more usable because they can help or incentive the doctors and nurses get used to record and report data with computer systems and get the patients' data from other hospitals. The data quality will be better due to the same standard among all the hospitals. The third parties also have adequate technical sources to ensure the security of the data. The providers can save more time to deal with these technological works and will be much easier to share the patients' healthcare information with each other. Therefore, if the HIS is led by the third party, the technological barriers will be low. Hence, we propose the following hypothesis:

H1a: The presence of a third party in the HIS is associated with lower technological barriers.

When HIS is implemented in a healthcare entity, organizational barriers are associated with managerial activities, such as planning, training, team-work, incentive, and process change. In China, the healthcare service is mainly provided by the government, it is also responsible for making HIS plans for the hospitals under its jurisdiction. The related departments of the government set the goals and the schedules, tell what the hospitals to do, input resources, and use the political force to promote implementation of HIS. In the first stage of HIS, the local governments always focus on sharing the specific information and then gradually expand to more extensive information. For example, Xiamen and Zhenjiang took information sharing of chronic diseases as a starting point (Guo et al., 2018). These activities implemented by the governments are easier for the hospitals to accept and are important prerequisites for the comprehensive HIS.

The local governments act as the third parties in many regions of China, they guide the hospitals to work out their plans of HIS, invest a large amount of financial founds to help the hospitals to improve the information systems. For example, in Xiamen, the HIS project was planned by the Xiamen Municipal Government as a part of the citizen healthcare information system. It was included in the local government plan in 2003, the plan valuation and the bidding were finished in 2005, the implementation of the healthcare information system began in 2006, and it was upgraded in 2008 and was enabled in 2009 (You, 2013). In China, the government put forward to build the medical information sharing system in the new medical scheme of 2009. A total investment of ￥2.7 billion had also been planned by the Ministry of Finance of China to build the healthcare information system in 2010 (L. Zhao et al., 2013). From 2011-2015, each of 310 general hospitals at city level and each of 2572 general hospitals at county level received subsidies of ￥6.5 million and ￥2.8 million from China's Ministry of Health, respectively, to build their information systems (L. Li & Chen, 2014).

Because these third parties are often more influential in the eyes of public and more professional in information technology than the hospitals, they can provide more productive training for the medical workers and the patients to use the HIS systems. Even more, the local government can administratively lead the patients and doctors to participate in the activities of HIS. The third parties can also help the hospitals change the work processes and routines smoothly and introduce policies to lower the resistance of professionals. For example, in order to fulfill the HIS, the health bureau of Lianzhou city implemented the project of All-in-one Card, which used the medical cards as the carriers of the patients' healthcare information. The ID numbers are used by the All-in-one Card project as the unique identifications to collect and share the patients' information. If a patient's medical card is registered in a medical organization of the city, it can be used in any other hospital to meet a doctor and store his/her medical information. Thus, when a patient goes to a hospital, they can access to their previous healthcare data, such as the results of medical tests and his treatment history (Zhang et al., 2016).

The cooperation among the hospitals can be fostered by the governments through preventing the hospitals from creating barriers to HIS. The organization mechanism of Chinese HIS mode carries on the administrative system of the government and it promotes information sharing through the scheme development of the regional HIS platforms and maturity tests of the interconnection among these platforms. For example, the health department of Jiangxi province forced the 3A hospitals in its region to submit the first pages of the EHRs (J. Shen et al., 2016). In Beijing, the hospitals are asked to submit the patients' medical data to the related government departments at higher levels via the regional information platforms. These data include the outpatients' records, the medication information, the records of tests and inspections, the first page of the inpatients' medical records, and the summaries of the discharged patients. Although less than half of these data was shared among the hospitals in Beijing due to various reasons before 2019, the local government works on improving the level of HIS (Bai et al., 2019).

Therefore, we propose the following hypothesis:

H1b: The presence of a third party in the HIS is associated with lower organizational barriers.

In China, the government is deeply involved in HIS due to its medical management system. Even the enterprise HIE systems often get help from the governments. As the third party, the government usually improves the satisfaction of the HIS participants by providing them with additional public service. For instance, in Feidong county of Anhui province, the local government established the EHRs for farmers, workers, students, and civil servants by providing them with the free health check service (Fu, 2014). In Jiangsu province, to promote HIS, the health bureau of Nanjing city established management platforms at the municipal and the district levels and built three systems including data standardization, security, and intelligent service to meet the needs of hospitals (Guan et al., 2018).

In Chinese healthcare system, the information systems are often developed by computer professionals. The hospitals pay more attention to the hardware devices and many health professionals have not enough skills to deal with the work needed by HIS. For example, the staff of community health service in Guangdong province had different levels of computer skill, especially the older staff knew little about computer. Therefore, it was necessary to periodically hold training programs of computer skill for them (Z. Lin et al., 2015). The local governments or the third parties can develop training activities, such as organizing the expert lectures, running the training courses, and organizing the medical staff for a further study in the hospitals at the higher levels, to improve the professional levels and the standard operational capabilities of the primary hospital staff. Hence, we propose the following hypothesis:

H1c: The presence of a third party in the HIS is associated with lower human barriers.

If the three types of barriers are regarded as a whole, H1a-H1c can be summarized to the following hypothesis:

H1: The presence of a third party in the HIS is associated with lower barriers.

2.8.2 Third party and maturity of HIS

In practice, the HIS implementation is often divided to several stages and each stage has specific work to be finished. For example, the US issued the HITECH act in 2009 to clarify the concept of meaningful use of EHR and encourage the healthcare entities to use EHR. The next year the US defined the incentive mechanism of HIS in detail. In 2014, the US issued the Federal Health IT Strategic Plan 2015-2020 and set five goals for collecting, sharing and using healthcare information. In Canada, the federal government invested $500 million to set up the Canada Health Infoway Inc. in 2001 which is responsible for the operations of the HIS. The EHR solution blueprint was issued in 2006 to introduce the basic framework of regional information systems in Canada. By 2015, Canada pointed out five key paths to achieve interoperability among the information systems of the hospitals. In China, the outline of national health informatization development from 2002 to 2010 was issued in 2003 to carry out the pilot work of regional health informatization. China's State Council put forward to set up a practical health information sharing system in 2009 and planned to achieve HIS all over the country in 2020. Although the target has not been reached, the implementation of HIS can be seen as a process from the early preparation stage to the final stage of the extensive mature application and China is still working hard on it.

In each of the stages to realize HIS, the third parties can help the hospitals develop their HIS systems to a more mature levels of the stages. For example, the operational maturity of HIE is divided into seven stages according to the study of Khuntia et al. (2017). At the initiation stage, the third parties inform the hospitals that the existing technologies can efficiently realize HIS. Then the providers may recognize that HIS has significant beneficial effects on the cost and the quality of their healthcare services. At the structure formation stage, the hospitals can get help from the third parties, such as the local governments, to get organized and begin to define the vision and goal of HIS. At this stage, the Chinese local governments always input financial funds and set up legal and governance structure for HIS. In the plan formulation stage, the third parties can work together with the hospitals to transfer the vision and goals to specific business plan. Based on familiarization and enough resources in information management, the third parties can help the hospitals develop the HIS plans that suit them best. In the stage of plan implementation, the hospitals also can get help from the third parties to smoothly put the plans into practice, such as launching pilot projects and identifying multi-year budget. In the stage of technical operation, the third parties can help the hospitals generate and manage the data so that the data can be exchanged more effectively. At the stage of commercial operation, the local governments can introduce proper business model to operate HIS system and the viability of HIS will be enhanced. In the final stage of operational collaborations, the third parties can promote cooperation among hospitals to share healthcare information because the HIS projects in China are either driven by the local governments or a predominate hospital. Therefore, we propose the following hypothesis:

H2: The presence of a third party in the HIS is positively associated with higher maturity.

2.8.3 Barriers to HIS and maturity of HIS

We posit that the barriers to HIS have impact on the maturity of HIS. Moreover, they will influence every stage of HIS implementation, which is discussed in the following according to the maturity model used by Khuntia et al. (2017).

At the initial stage, the stakeholders have to recognize that HIS is one of the most important steps to deal with the rising cost of healthcare service and improve service quality. With the development of IT, if the levels of perceived usefulness and perceived ease of use of HIS are higher, it is easier for professionals to accept HIS.

At the structure formation stage, the organization should bring together all parties involved in HIS to form shared vison and goals. Effective communication and cooperation may prompt leaders of HIS projects to hold many meetings to discuss needs of different parties. Quality improvement of information system and deep cooperation among the stakeholders can help participants of HIS projects deliberate over and set up technological and legal frameworks to protect patients' information from being disclosed and abused.

At the stage of plan formulation, in order to efficiently transfer vision and goals to tactics and business plan, high information quality, system, and service are the preconditions and foundations. During HIS planning process, there may be a lot of conflicts among the hospitals, the professionals and the governments. Therefore, it is also necessary to enhance the efficiencies of communication and cooperation in and out of the organization to resolve these conflicts. Then the stakeholders' needs and requirements of HIS can be defined precisely and be included in the plan. Good cooperation with external organizations, such as the local governments, will be conductive to get financial support for organizational efforts.

At the stage of plan implementation, technical, financial, and legal issues can be facilitated by reducing the barriers to HIS. For example, for better implementing pilot project, good system and information quality are deemed essential. Perceived usefulness and perceived ease of use lay the solid foundations for professionals to use HIS systems. The mechanism for ensuring security and privacy of patients' data can encourage patients to participate in HIS, which helps carry out the plan successfully. Communication and cooperation of the stakeholders can help meet a specific need, solve the problems coming from the implementation, and get financial support on an annual basis. Changes in organizational structure, including clear governance structures and designated staff responsible for implementation, are contribute to implementing plan smoothly.

At the stage of technology operation, health information of the organization begins to be operational and patients' data should be exchanged among providers widely when required. By setting up and enforcing data standards, making HIS useful and easy to use, and improving qualities of system, information, and service, technological barriers can be reduced to achieve this goal. Good communication and governance structure help strengthen cooperation among organizations on information exchange platforms to share patients' health information. Perfected IT skills and continuous satisfaction improvement of professionals by training programs may also contribute to technology operation.

At the stage of commercial operation, the leading organization should figure out a business model to make HIS viable. The reduction of technological and human barriers can help promote the professionals to use HIS systems continuously. By reducing organization barriers, the interests of all parties may be properly balanced and the business model of HIS may be formed to make the operation of HIS sustainable. Many key factors to the HIS business model, such as how to charge for and how to give subsidies to HIS, will be fully discussed in the case of adequate communication among stakeholders.

At the final stage of operational collaborations, the organization should expand HIS to a broader alliance of stakeholders. Lower technological barriers may easy the anxiety of new participants to use HIS systems by providing unified data standards, sophisticated system, and established protection framework of patients' information. HIS new members are more likely to join the alliance if organizational barriers are lower because good communication and cooperation between the organization and new members can help new members overcome the difficulties of HIS implementation, as well as strong skills of staff do. Therefore, we propose the following hypotheses:

H3a: HIS technological barriers are negatively associated to its maturity.

H3b: HIS organizational barriers are negatively associated to its maturity.

H3c: HIS human barriers are negatively associated to its maturity.

If the three types of barriers are regarded as a whole, H3a-H3c can be summarized to the following hypothesis:

H3: Barriers are negatively associated to maturity of HIS.

2.8.4 Barriers to HIS and success of HIS

According to the information system success model of Delone and Mclean (2003), Suh, et al. (2017) argue that information system success consists of three dimensions: quality (including quality of information, quality of system and quality of service), usage (including usability, ease of use, and user's satisfaction) and benefit (including individual impact and organizational impact). In this study, due to healthcare background and the slow progress for HIS in China, quality and usage are both regarded as the barriers to HIS, which is in accordance with the most studies of HIS, such as Ismail and Abdullah (2017) and Sligo et al. (2017). We define success of HIS as benefit in Delone and Mclean (2003) and Suh, Chung, and Choi (2017), which is comprised of individual impact and organizational impact. Individual impact means the influence of the information product on the behavior of the recipient, such as decision making and personal productivity. Organizational impact means the impact of information product on organizational performance. Positive impact means that the performance of individuals and organizations are improved (Delone & Mclean, 2003).

First of all, if the barriers to HIS can be lowered, the organization may have greater chances to improve its operational efficiency. Based on good HIS environment, it is possible for hospitals to improve communication and coordination abilities, which can improve the levels of decision-making and help them optimize the healthcare resources distribution. If a hospital can know the medical history and the state of emergency patients in time through HIS, the hospital can save precious time for rescuing them and provide them with appropriate treatment. In China, more than eighty percent of high-quality medical resources are concentrated in large hospitals in big cities, while more than eighty percent of healthcare needs come from rural areas. Together with the difference in medical levels between small and large hospitals, the capacities of small hospitals remain idle while large hospitals are crowded with patients. When HIS is running smoothly, all the hospitals' efficiencies will be improved because small hospital and large hospital can complement each other's advantages. For example, it is possible for small hospitals to deal with common diseases and the city's major hospitals to focus on the diagnosis and treatment of difficult and serious diseases. Effective HIS mechanisms can also help hospitals develop new medical services and provide medical services for more patients, such as telemedicine consultation and medical examination for a patient of another hospital far away. Healthcare cost can be reduced by reducing the unnecessary medical tests and healthcare quality can be improved by reducing the length of hospital stay. In addition, through cross-organization collaboration based on good HIS, the hospitals can reduce repeated investment and maintenance costs of health information systems. Therefore, the hospitals may improve their productivities by increasing the revenues and reducing the costs at the same time. Thus, organizational impact will be more positive when the barriers to HIS are lower.

Second, individual impact can also benefit from lowering HIS barriers. On the one hand, based on high level of HIS, professionals can improve task productivities because they can save treatment time with quick and convenient access to the medical history information of patients. Professionals can also be more confident in providing patients with more effective treatments because they can improve quality of decision analysis by analyzing the patients' historical healthcare data. Thus, the behavior of professionals can be changed by HIS. On the other hand, when they seek medical service from a hospital to another, patient will perceive that the medical process is more continuous if his/her healthcare information is exchanged effectively among providers. And the problem of high cost of getting a treatment for a patient in China can also be partially solved by reducing the treatment cost based on HIS, such as avoiding repeated treatment and repeated inspection. Providers can find the common rules of some diseases by analyzing big data of the patients and effectively strengthen health and epidemic prevention work. The incidence of diseases can be lowered and patients' healthcare cost can be reduced indirectly. Therefore, when the providers know much more about patients' conditions through HIS, customer relationship can also be improved because patients will know more about the medical risk and have more faith in hospitals. We propose the following hypothesis:

H4a: HIS technological barriers are negatively associated to its success.

H4b: HIS organizational barriers are negatively associated to its success.

H4c: HIS human barriers are negatively associated to its success.

If the three types of barriers are regarded as a whole, H4a-H4c can be summarized to the following hypothesis:

H4: Barriers are negatively associated to success of HIS.

2.8.5 Maturity of HIS and success of HIS

HIS maturity will influence the two dimensions of success of HIS. When HIS is more mature, individual impact will be more positive. These positive impacts include but are not limited to higher quality and confidence of treatment decisions, saving time for decision and completing treatment, cost reduction and productivity improvement.

At the initial stage, a deeper understanding of HIS may result in the more pressing need of a professional or an organization for HIS. They can know more clearly about why and how to use HIS, which will cause them to accept HIS more readily and use it to do their daily jobs. With more and more application of HIS in patients' medical process, the efficiencies of professionals and healthcare entities will be improved.

At the structure formation stage, if the professionals and providers are better organized to define shared vision and goals, the needs of doctors and hospitals will be fully collected and the detailed analysis of needs contributes to reaching a consensus. Therefore, stakeholders will be better integrated into HIS and HIS will win support from them more easily. Through building a more appropriate legal and governance structure, all interested parties can feel more freely to participate in HIS. By removing the worries of stakeholders, the extensive use of HIS contribute to positively influence the efficiencies of individuals and organizations.

At the stage of plan formulation, when the vision and goals are transferred to business plan more efficiently, HIS will be more likely to improve the performance of individuals and organizations. During the process of formulating the HIS plan, clear and continuous communication and resolving conflicts can adequately reflect the needs and the requirements from all the stakeholders. This mechanism can facilitate the execution of HIS plan in the latter stage because a party involved in decision-making can improve the sense of responsibility, which will lead to better performances of individual and organization.

At the stage of plan implementation and technology operation, when the technical, financial and legal aspects of the plan are successfully implemented, the needs of the stakeholders can be met respectively. Sufficient financial supports from the local governments or the annual budgets of the hospitals provide adequate sources to ensure the smooth and orderly implementation of HIS plan. Based on more sophisticated governance and legal frameworks, behavior boundaries of professionals and hospitals will be well guided. With more technical supports for HIS, patients' healthcare data can be shared by the stakeholders and can be obtained and used by them in time. Therefore, the stakeholders can make more efficient decisions for patients' treatments and spend less time in decision-making. Misdiagnosis and missed diagnosis can drop off sharply through plan implementation and technology operation of HIS. The efficiencies of the professionals and hospitals are both improved by higher quality of services and more timely treatments.

At the stage of commercial operation, well established business model can make HIS viable. Maturity of HIS is the key of HIS to achieve the goal of sustainable operation. The high level of HIS maturity can raise more revenue for hospitals because it is positively associated with information services provided by the hospitals. More revenue helps hospitals improve economic return and overcome the high cost of HIS operation in a long run.

At the stage of operational collaborations, outside organizations increasingly participate in HIS. A wider range of partners can provide larger amount of patients' information and more opportunities for hospitals to offer healthcare services in cooperation with each other. Patients' healthcare costs can be reduced because of reduction in repeated treatments. Thus, the efficiencies of professionals and hospitals will be further improved by cooperation with more organizations for HIS. We propose the following hypothesis:

H5: HIS maturity is positively associated to its success.

In the previous analysis, we assume that the third party indirectly affects the success of HIS through the three different barriers and the maturity of HIS. However, the third party may have a direct impact on the success of HIS. For example, as the third party, the local government can formulate policies to give the doctors confidence to better finish their jobs when they implement HIS. Therefore, we add a hypothesis in this study as following:

H6: The presence of a third party in the HIS is positively and directly associated to its success.

2.9 Theoretical model

In view of previous discussion and theory background, this study investigates how to achieve the success of HIS in China and, specifically, pays attention to the third party. Hence, based on the literature and the hypotheses mentioned above, the conceptual model investigated in this study is summarized in figure 2.1 to explain the relationships among the third party, barriers to HIS, maturity of HIS and success of HIS.

The conceptual model showed by figure 2.1 suggests the impact of the third party on the success of HIS in China through the barriers to HIS and the maturity of HIS. On one hand, figure 2.1 aims to test the impact of the third party on the barriers to HIS and the maturity of HIS. The direct impact of third party on success of HIS is still tested which is showed in figure

2-1 as H6. On the other hand, figure 2.1 focus on testing the impact of the barriers to HIS and the maturity of HIS on the success of HIS.

In addition, the relationships between the three types of barriers as a whole (barriers) and other variables will also be tested.

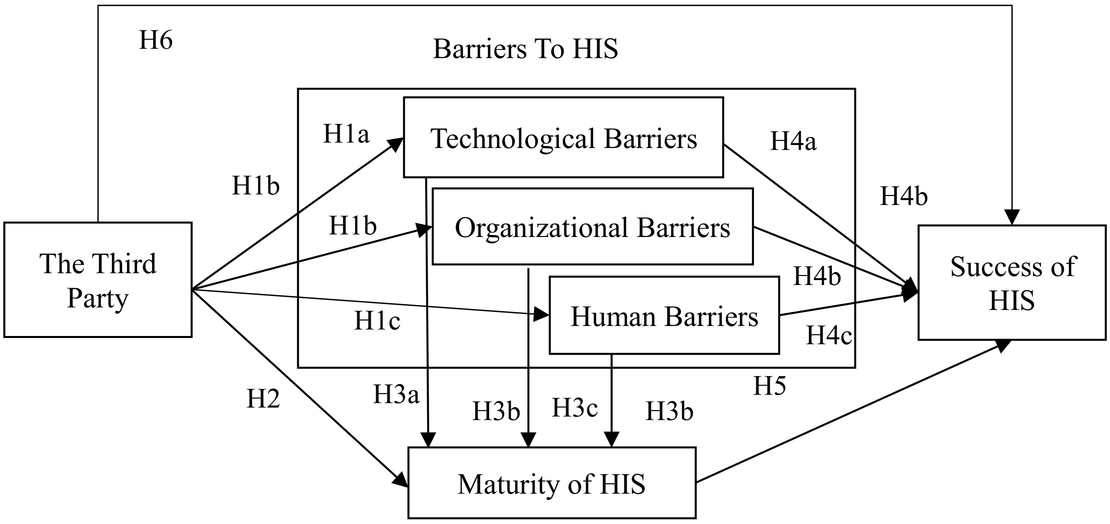

Figure 2.1 Theoretical model

Chapter 3: Methodology

In this chapter, we first developed the questionnaire for measuring variable according to the literature. Then the data was collected from five hospitals in Shanghai city and Zhejiang province. Next, the sample characteristics, reliability and validity of the questionnaire are analyzed.

3.1 Measures

The research strategy used by this study was survey. In order to measure the constructs and test the hypotheses, we searched existing scales in the previous literature to employ them directly or refine some to fit the research context of HIS. We measured all of the constructs with multi-item scales adapted from the related literature.

To collect the data of the measures, a survey questionnaire was designed for professionals, including doctors and nurses, and managers of hospitals. Because all the scales come from English language literature, this study used the methods provided by Sekaran (1983) to develop the questionnaire. At first, we designed the English version from the literature review. To assure content validity and cultural adaptions, several academic experts and professionals were invited to review and assess the questionnaire and it was improved according to their critiques, including the linguistic ambiguities and the perceived omission of HIS practices not covered by the survey. Then the original English version was translated into Chinese and the Chinese version was translated back into English again. The original and the latter English versions were compared side by side to improve the quality of the translation. Because some of the constructs have not been applied in the context of HIS, a pilot study was conducted with 12 professionals from the First Hospital of Jiaxing located in Jiaxing city, Zhejiang province, to ensure that every question could be properly understood by them and the questionnaire was modified further according to their feedback.

3.1.1 Third-party

The measure of the third-party is mainly drawn from Gortzis (2010). To study how to properly select the third-party vendor of a healthcare information system, Gortzis (2010) divided the most common issues of electronic clinical technologies into five categories: creation, management, sharing and presentation of data, and modules management. Therefore, they were chosen to measure the extent to which HIS is led by the third party. Thus, the measure of the third party consists of five items.

3.1.2 Barriers to HIS

Barriers to HIS consists of three dimensions: technological, organizational and human. Adapted from Ismail and Abdullah (2017), Suh et al. (2017), Mohamad Yunus et al. (2013), and Xu (2019), the scale items of technological barriers involve information quality, service quality, system quality, and security and privacy.

The measure of organizational barriers was adapted from Lluch (2011), with five dimensions as mentioned in the Chapter 2 and twelve items.

Perceived usefulness and ease of use reflect the users' experience about HIS, which may prevent professionals from sharing the patients' healthcare information in their daily work. Therefore, they are used to measure human barriers in this study and human barriers were measured by 11 items adapted from Ismail et al. (2010).

3.1.3 Maturity of HIS

We followed the work of Khuntia et al. (2017) to measure maturity of HIS because the maturity model in Khuntia et al. (2017) was developed specially for HIE context. This maturity model includes seven stages of the HIE operations, therefore, seven items were used to measure the maturity of HIS.

3.1.4 Success of HIS

The measure of success of HIS was divided into the individual impact and the organizational impact as Delone and Mclean (2003). We measure the individual impact with four items adapted from Lepore et al. (2018) and assess the organizational impact with five items adapted from Sabherwal (1999) and Almutairi and Subramanian (2005).

The survey items are summarized and shown in table 3.1. All the items were measured with a 7-point Likert scale with "1=strongly disagree" to "7=strongly agree".

Table 3.1 The measurement items

Construct	Dimension	Item code	Items
Third Party (Gortzis, 2010)		TP1	A third party leads various professionals to create the healthcare data simultaneously during the collaborative clinical procedures.
		TP2	A third party leads us to properly manage the healthcare data lifecycle needs for the architectures, the policies, the practices and the procedures.
		TP3	A third party leads us to share the healthcare data via a central database or a number of distributed databases.
		TP4	A third party leads us to collect the healthcare data from distributed, heterogeneous nodes and present the data to various end-users in numerous different formats.
		TP5	A third party leads us to manage the modules of the healthcare information system in a dynamic and flexible way to support the requirements of the collaborative clinical procedures.
Barriers to HIS (Technological barriers)	Information quality (Suh et al., 2017)	TB1-1	The patients' information in the healthcare information sharing system is not complete.
		TB1-2	The patients' information in the healthcare information sharing system is not relevant.
		TB1-3	The patients' information in the healthcare information sharing system is not reliable.
		TB1-4	The patients' information in the healthcare information sharing system is not timely.
	Service quality (Suh et al., 2017)	TB2-1	The service provided for the healthcare information sharing system is not reliable.
		TB2-2	The service provided for the healthcare information sharing system cannot be assured.
		TB2-3	The service provided for the healthcare information sharing system is not responsive.
		TB2-4	The service provided for the healthcare information sharing system is not empathetic.
		TB2-5	The persons who provide service for the healthcare information sharing system are lack of competence.
	System quality (Suh et al., 2017)	TB3-1	The healthcare information sharing system is not adaptable.
		TB3-2	The healthcare information sharing system is not available.
		TB3-3	The healthcare information sharing system is not reliable.
		TB3-4	The healthcare information sharing system is not usable.

		TB3-5	The healthcare information sharing system is not responsible.
	Security and privacy (Xu, 2019)	TB4-1	The healthcare information sharing system is collecting too much information about of the patients.
		TB4-2	The personal information of the patients could be misused when using healthcare information sharing system.
		TB4-3	The personal information of the patients could be accessed by unknown parties when using the healthcare information sharing system.
Barriers to HIS (Organizational barriers) (Lluch, 2011)	Structure of healthcare organizational systems	OB1-1	My organization is a hierarchical system.
		OB1-2	My organization is lack of team work and cooperation.
		OB1-3	I need the autonomy to do my job well.
	Tasks	OB2-1	The healthcare information sharing system changes the work processes and the routines in my organization.
		OB2-2	The healthcare information sharing system changes the face-to-face interaction into new ways of working.
	People policies	OB3-1	The professionals in my organization are lack of training and IT skills to operate the healthcare information sharing system.
		OB3-2	The professionals in my organization are lack of support from the management and the colleagues in integrating the healthcare information system in their daily practices.
		OB3-3	The professionals in my organization are lack of trust on the healthcare information sharing system and worry about the legal liability to use it.
		OB3-4	The professionals in my organization are lack of a legal framework to guide them to use the healthcare information sharing system.
		OB3-5	The professionals in my organization are lack of accountability to their employer and to policy makers.
	Incentives	OB4	The professionals in my organization are lack of incentives to use the healthcare information sharing system.
	Information and decision processes	OB5	The use of the healthcare information sharing system is a heavy workload for the professionals in my organization.
Barriers to HIS (Human barriers) (Ismail & Abdullah, 2017)	Perceived usefulness (Mohamad Yunus et al., 2013)	HB1-1	The healthcare information sharing system can not help me to accomplish task quickly.
		HB1-2	The healthcare information sharing system can not help me to improve my job performance.

		HB1-3	The healthcare information sharing system can not help me to increase my productivity.
		HB1-4	The healthcare information sharing system can not help me to enhance my effectiveness.
	Perceived ease of use (Mohamad Yunus et al., 2013)	HB2-1	The healthcare information sharing system is not easy for me.
		HB2-2	The healthcare information sharing system can not do what I want it to do.
		HB2-3	The healthcare information sharing system is not clear and understandable.
		HB2-4	I am not skillful at using this healthcare information sharing system.
		HB2-5	It is not easy to use the healthcare information sharing system.
		HB3	I am not satisfied with the healthcare information sharing system.
		HB4	I have not enough skill and experience to use the healthcare information sharing system.
Maturity of HIS (Khuntia et al., 2017)		MH1	My organization have recognized the need for health information sharing among multiple stakeholders in my province, region or community (public declaration by a coalition or political leader).
		MH2	The stakeholders of HIS have been organized, defined shared vision, goals, and objectives, identified funding sources, and set up legal and governance structures (multiple, inclusive meetings used to address needs and frameworks).
		MH3	My organization have transferred vision, goals and objectives to tactics and business plan, defined our needs and requirements, and secured funding (funded organizational efforts under sponsorship).
		MH4	The healthcare information sharing system is well under way with implementation-technical, financial and legal (pilot project or implementation with multi-year budget identified and tagged for a specific need).
		MH5	My organization become a fully operational health information organization and are transmitting patient data that is being used by healthcare stakeholders.
		MH6	My organization has a sustainable business model for healthcare information sharing.
		MH7	My organization have demonstrated the expansion to encompass a broader coalition of stakeholders than present in the initial operational model.
Success of HIS	Individual impact (Lepore et al., 2018)	SH_II 1	The healthcare information system improves the quality of my work.
		SH_II 2	The healthcare information system makes my job easier.

	SH_II 3	The healthcare information system saves my time.
	SH_II 4	The healthcare information system helps fulfil the needs and requirements of my job.
Organizational impact (Sabherwal, 1999)	SH_OI 1	The healthcare information system distinguishes my organization from the others.
	SH_OI 2	The healthcare information system reduces the administrative costs of my organization.
	SH_OI 3	The healthcare information system improves the efficiency of internal operations of my organization.
	SH_OI 4	The healthcare information system enhances the reputation of my organization.
	SH_OI 5	The healthcare information system makes my organization successful overall.

3.2 Population and sample

The study objects of this thesis are the hospitals and the HIS systems in China. Since professionals play the key role in the process of healthcare information sharing, the respondents are professionals and the data collected relates to their perceptions about the HIS systems. According to the standards of Chinese hospital stratified management, we selected the professionals from two hospitals in Shanghai city and three hospitals in Jiaxing city of Zhejiang province to distribute our questionnaires.

These five hospitals form three regional HIS systems, which all take the form of Enterprise HIE because they are led by a core hospital and prompted by the local governments. The hospitals selected in this study can well reflect the HIS status in China because they are located in two different provinces at the different levels of economic development. Shanghai is the most advanced place in China and there is a gap between Zhejiang province and Shanghai due to the much higher per capita GDP of Shanghai. However, Zhejiang also has a good economic foundation to implement HIS.

These hospitals are suitable for this study also because they indicate three different levels of HIS in China, i.e., the province-level, the city-level and the county-level, respectively. The two hospitals from Shanghai are both in a province-level HIS system. One of the hospitals in Zhejiang establish a HIS system at the county-level. The other two hospitals in Zhejiang are both in a city-level HIS system. These HIS systems at three different levels present a relatively full view of HIS in China.

The first hospital selected in Shanghai city is Xinhua Hospital Affiliated to Shanghai Jiaotong University Medical College (hereafter called Xinhua Hospital), which was founded in

1958 and the first comprehensive hospital designed and built by Shanghai since the foundation of New China in 1949. Xinhua Hospital is a large tertiary hospital with about 2,490 beds and more than 2,600 employees and ranks 24th among the Chinese hospitals. It attracts the patients from all over China, especially from the six provinces in East China, to seek medical services. Every year, Xinhua Hospital receives more than 4 million outpatients and 1.6 million patients are discharged from it. It has preliminarily established the system of tiered medical services of pediatrics and the regional medical consortium consisting of 28 hospitals among which the patients' healthcare information can be shared through an information system.

The second hospital selected from Shanghai is the Chongming Branch of Xinhua Hospital Affiliated to Shanghai Jiaotong University Medical College (hereafter called Chongming Hospital). It was founded in 1915 and the largest, comprehensive tertiary hospital with 1,000 beds and 1,288 employees in Chongming District, Shanghai. For Chongming hospital, the volume of emergency cases is more than 1.22 million per year and the discharged patients are 38 thousand per year. In 2018, Chongming hospital became a member of the medical consortium established by Xinhua hospital and can share the patients' information of clinical tests, diagnostic medical images, electrocardiography diagnosis with the other hospitals in the medical consortium.

The first hospital selected from Zhejiang province is the First Hospital of Jiaxing. It was founded in 1920 and the largest, comprehensive tertiary hospital with 1,500 beds and 2,367 employees in Jiaxing city. The First Hospital of Jiaxing provides the medical services for 1.45 million outpatients per year and 90,000 discharged patients per year. Being close to Shanghai, the First Hospital of Jiaxing works together with several hospitals in Shanghai and has also established a medical consortium with other 16 hospitals in Jiaxing city to improve service quality. A healthcare information platform has been set up for the medical consortium to exchange the patients' information if a patient was referred from a hospital to another.

The second hospital selected from Zhejiang province is the Wangdian people's Hospital of Jiaxing. It is a secondary hospital with 150 beds and 306 employees and the outpatient visits are 110,000 per year and the discharged patients are ten thousand per year. In 2020, the First Hospital of Jiaxing sent a team composed of twenty experts to help the Wangdian people's Hospital of Jiaxing to improve the management. And then it became one of the members of the medical consortium led by the First Hospital of Jiaxing and acts as a bridge between the First Hospital of Jiaxing and the community health stations in the local system of tiered medical services. The two hospitals in Zhejiang described above are in the same HIS system at the city-level.

The third hospital selected from Zhejiang province is the First People's Hospital of Jiashan which was founded in 1912. It is the largest comprehensive tertiary hospital with 840 beds and 1,295 employees in Jiashan county. In 2020, the total number of the patient visits to this hospital is 1.22 million, including 167,000 emergency room visits, 38,000 discharged patients and 13,000 operation inpatients. In 2019, the Medical Service Community of the First People's Hospital of Jiashan (MSCJ) was established according to the requirements of the medical reform in Zhejiang province. MSCJ consists of eight hospitals in Jiashan county and aims to implement the tiered medical services and provide continuous and accessible healthcare services for the local people through the construction of the hospital's informationization. Therefore, the First People's Hospital established a county-level HIS system itself.

3.3 Data collection

3.3.1 Questionnaire distribution

The questionnaire was distributed in the form of a non-random intentional choice of the hospitals and data was collected through the hospitals' administrative management systems. First, the questionnaire was sent to the leaders of the five hospitals. Second, all the hospitals have established the online working groups via the popular application of Wechat which is now widely used in the office settings of the Chinese enterprises. The leaders of the hospitals sent the questionnaire to the department directors by Wechat. Then the questionnaires were sent to the doctors and the nurses by their department directors.

The professional platform named "Wenjuanxing" (www.wjx.cn) was used to design the questionnaire. The leaders and the department directors send the link of the questionnaire on "Wenjuanxing" to professionals through Wechat. And "Wenjuanxing" was still used for the professionals to fulfill the questionnaires and collect the data.

From June 17 to September 17 in 2021, the electronic questionnaires were distributed anonymously to the doctors and nurses of above five hospitals. During this period, we reminded the professionals to fill in the questionnaires and the questionnaires were resent to the professionals every half month. Finally, a total of 1145 questionnaires were collected.

The characteristics of the professionals are listed in table 3.2.

Table 3.2 Demographic characteristics of respondents

Variable	Frequency	Proportion
Work unit		
Xinhua Hospital	321	39.2
Chongming Hospital	161	19.7
First Hospital of Jiaxing	90	11.0
Wangdian people's Hospital of Jiaxing	143	17.5
First People's Hospital of Jiashan	103	12.6
Gender		
Male	245	29.9
Women	573	70.1
Working years		
≤5	200	24.4
6-10	228	27.9
11-15	164	20.0
16-20	77	9.4
≥21	149	18.2

Then the questionnaires were screened in three ways. First, 4 invalid questionnaires were deleted due to the similarity of their IP addresses and answers. Second, 204 invalid questionnaires were deleted due to the average answer time per question was less than two seconds. Third, because they had more than half of the questions with the same answers in succession, 119 questionnaires were deleted. Finally, there were 818 questionnaires left after invalid questionnaires were deleted.

From table 3.2, we can see that about 59% of the respondents came from two Shanghai hospitals. Because the proportion of the female nurses in the professionals is high in China, about 70% of the respondents are female. Of all the professionals, 52.3% have worked for less than ten years and 27.6% have worked for more than sixteen years.

3.3.2 Common method variance

Common method variance refers to variance that is attributable to the measurement method rather than the constructs the measures represent. When using the same method (usually self-report survey method) to measure different variables, the correlation of the two variables will be affected by the common method variance. To avoid the common method variance caused by the same source of questionnaire data, the strict research design and statistical test were used in this study (Podsakoff et al., 2003).

In terms of research design, the common method variances of this study were controlled in three ways. First, every latent variable was measured by multiple items and the translations of the scale items between English and Chinese were repeatedly improved. Second, due to the political sensitivities of the public hospitals in China, in order to overcome the professionals' concerns about filling out the questionnaires and increase their willing to answer the questions, it was emphasized at the beginning of the questionnaire that the data collection would follow the confidentiality rules, data would be used for academic research only, and there were really no right or wrong answers. Third, in order to reduce the relevance between the answers to the questions before and after, the items of the different variables were placed in reasonable positions in the questionnaire.

Although the above steps have been taken to reduce the common method variance, it may still exist due to the data was selected at the same time. Therefore, this study also uses the statistical test-Harman's single-factor test to control the effects of the common method variance on the results as in Podsakoff et al. (2003). The Harman's single-factor test suggests that if the common method variance exists, one factor can explain the most of the covariance among the measures. The confirmatory factor analysis is often used by researchers to test whether one general factor can account for all of the covariation in the data.

The results of Harman's single-factor test are shown in table 3.3. GFI (Goodness-of-Fit Index), RMSEA (Root-Mean-Square Error of Approximation), NFI (Normed Fit Index), IFI (Incremental Fit Index), CFI (Comparative Fit Index) are all indices to test whether the model fit the data well. If the value of RMSEA is nearer to 0, the model fits the data better. If the values of GFI, NFI, IFI and CFI are closer to 1, the model fits the data better. The ideal and the loose values of these indices are also shown in table 3.3.

It can be seen from third column of table 3.3 that the overall fitting quality of the model is very poor (GFI=0.294, RMSEA=0.154, NFI=0.509, CFI=0.521), which means that one factor on which all the items were loaded didn't fit well with the data. Thus, the common method variance is not a serious problem in this study.

Table 3.3 Common method variance analysis results

Indicator name	range	Measurement	Ideal value	Loose value
χ^2	—	22905.88		
df	—	1127		
p	—	0.000	<0.05	
χ^2/df	—	20.325	<=3	<=5
GFI	0~1	0.294	>0.9	>0.8
RMSEA	0~1	0.154	<0.05	<0.08
NFI	0~1	0.509	>0.9	>0.8
IFI	0~1	0.522	>0.9	>0.8
CFI	0~1	0.521	>0.9	>0.8

3.3.3 Sample characteristics

Structural Equation Model (SEM) is usually used to investigate the complex relationships among the variables. SEM is a statistical method to study the relationships between latent variables based on covariance matrix of these variables, which consists of measurement model and structural model. The relationships between the latent variables and indicators are represented by the measurement model. The structural model is used to describe the relationships between latent variable. The measurement model and the structural model are combined to form a complete SEM.

The parameters of SEM were estimated by Maximum Likelihood in this study. This assumes that the data should follow multivariate normal distribution which can be tested by skewness and kurtosis of the items. Skewness reflects the asymmetry of the data. The negative value of skewness suggests that the distribution of data is left skewed and the positive value of skewness indicates the distribution of data is right skewed. Kurtosis reflects the flat or peak distribution of data. The positive value and the negative value of kurtosis indicate that the shape of data distribution is high and thin or short and fat, respectively.

The nearer to 0 the values of two coefficients are, the more the distribution of each variable is closer to normal distribution. According to the literature, if the absolute value of skewness is lower than 3 and the absolute value of kurtosis is lower than 8, the variable does not deviate much from normal distribution.

Table 3.4 lists the mean, standard deviation, skewness, and kurtosis of each left item for all samples after dropping the 12 items. In the fourth column, all samples are represented by ALL. The sixth and the seventh columns of table 3.4 show that, for all samples, the absolute values of the skewness and the kurtosis of the items are all lower than 1.74 and 3.10, respectively, which meet the above two conditions. Thus, maximum likelihood can be used to estimate the parameters of the SEM for all samples (Kline, 2013).

For the following group analysis, table 3.4 also presents the sample characteristics of the hospitals in Shanghai (SH) and Zhejiang (ZJ). When the samples are divided into two groups, the absolute values of the skewness of the items are all lower than 1.8 and the absolute values of the kurtosis of the items are all lower than 3.5, which indicates that the skewness and the kurtosis meet the condition that the variables are close to normal distribution. Therefore, we can also use maximum likelihood to estimate the parameters of the SEMs for Shanghai group and Zhejiang group.

Table 3.4 Sample characteristics

Variable	Num.	Item	Group	Mean	Std.	Skewness	Kurtosis
Maturity of HIS	7	MH1	ALL	6.24	1.067	-1.589	2.652
			SH	6.23	1.056	-1.653	3.385
			ZJ	6.26	1.083	-1.515	1.744
		MH2	ALL	6.17	1.139	-1.566	2.546
			SH	6.21	1.059	-1.544	2.812
			ZJ	6.11	1.246	-1.531	2.041
		MH3	ALL	6.01	1.256	-1.375	1.697
			SH	6.03	1.176	-1.225	1.238
			ZJ	5.98	1.364	-1.483	1.858
		MH4	ALL	6.03	1.235	-1.401	1.972
			SH	6.03	1.167	-1.205	1.33
			ZJ	6.02	1.329	-1.575	2.388
		MH5	ALL	5.95	1.407	-1.733	3.022
			SH	5.96	1.356	-1.710	3.152
			ZJ	5.95	1.479	-1.754	2.852
		MH6	ALL	5.88	1.415	-1.521	2.147
			SH	5.95	1.302	-1.599	2.838
			ZJ	5.79	1.559	-1.384	1.331
		MH7	ALL	5.99	1.288	-1.505	2.291
			SH	6.05	1.19	-1.553	2.932
			ZJ	5.92	1.415	-1.402	1.515
A third party	5	TP1	ALL	6.08	1.227	-1.588	2.601
			SH	6.05	1.196	-1.530	2.627
			ZJ	6.12	1.270	-1.675	2.641
		TP2	ALL	6.07	1.221	-1.500	2.224
			SH	6.04	1.182	-1.457	2.405
			ZJ	6.11	1.276	-1.565	2.074
		TP3	ALL	6.05	1.236	-1.577	2.673
			SH	6.02	1.221	-1.619	3.219
			ZJ	6.10	1.257	-1.540	2.04
		TP4	ALL	5.99	1.323	-1.562	2.372
			SH	5.96	1.292	-1.539	2.498
			ZJ	6.03	1.368	-1.605	2.278
		TP5	ALL	5.99	1.324	-1.538	2.277
			SH	5.95	1.306	-1.527	2.446
			ZJ	6.04	1.351	-1.570	2.137
Barriers to HIS (Technological barriers)	17	TB1-1	ALL	2.79	1.731	0.685	-0.531
			SH	2.77	1.712	0.729	-0.387
			ZJ	2.83	1.759	0.626	-0.709
		TB1-2	ALL	2.44	1.506	0.859	-0.051
			SH	2.44	1.499	0.824	-0.128
			ZJ	2.43	1.518	0.911	0.073
		TB1-3	ALL	2.17	1.374	1.192	0.961
			SH	2.15	1.345	1.222	1.084
			ZJ	2.20	1.414	1.153	0.817
		TB1-4	ALL	2.61	1.635	0.842	-0.118
			SH	2.56	1.594	0.891	0.005
			ZJ	2.69	1.691	0.774	-0.271
		TB2-1	ALL	2.71	1.669	1.097	0.5866
			SH	2.67	1.627	0.746	-0.327
			ZJ	2.76	1.729	0.682	-0.590
		TB2-2	ALL	2.56	1.633	1.028	0.300

			SH	2.53	1.584	0.886	-0.017
			ZJ	2.60	1.704	0.837	-0.246
		TB2-3	ALL	2.22	1.397	0.927	-0.064
			SH	2.2	1.397	1.165	0.823
			ZJ	2.26	1.399	0.943	0.030
		TB2-4	ALL	2.19	1.382	0.984	0.185
			SH	2.20	1.367	1.132	0.776
			ZJ	2.19	1.407	1.093	0.474
		TB2-5	ALL	2.53	1.586	0.901	-0.053
			SH	2.54	1.573	0.837	-0.129
			ZJ	2.51	1.608	0.980	0.171
		TB3-1	ALL	2.25	1.417	0.868	-0.113
			SH	2.22	1.365	1.084	0.564
			ZJ	2.29	1.490	1.097	0.547
		TB3-2	ALL	2.38	1.528	0.721	-0.443
			SH	2.35	1.493	1.004	0.239
			ZJ	2.42	1.579	1.053	0.350
		TB3-3	ALL	2.51	1.614	1.071	0.478
			SH	2.50	1.612	0.915	-0.116
			ZJ	2.52	1.619	0.947	0.027
		TB3-4	ALL	2.36	1.497	1.113	0.635
			SH	2.33	1.450	0.904	-0.059
			ZJ	2.40	1.563	1.068	0.392
		TB3-5	ALL	2.51	1.606	0.895	-0.010
			SH	2.48	1.581	0.889	-0.094
			ZJ	2.56	1.642	0.915	-0.010
		TB4-1	ALL	2.85	1.811	0.711	-0.559
			SH	2.91	1.777	0.628	-0.585
			ZJ	2.76	1.858	0.833	-0.480
		TB4-2	ALL	2.59	1.692	0.867	-0.163
			SH	2.62	1.697	0.813	-0.296
			ZJ	2.55	1.687	0.951	0.062
		TB4-3	ALL	2.7	1.752	0.794	-0.370
			SH	2.7	1.738	0.789	-0.327
			ZJ	2.7	1.776	0.804	-0.417
Success of HIS	9	SH_II 1	ALL	5.79	1.344	-1.053	0.689
			SH	5.74	1.346	-1.011	0.706
			ZJ	5.86	1.340	-1.124	0.718
		SH_II 2	ALL	5.68	1.468	-1.081	0.654
			SH	5.60	1.483	-1.003	0.483
			ZJ	5.80	1.441	-1.212	1.006
		SH_II 3	ALL	5.77	1.372	-1.039	0.588
			SH	5.67	1.429	-1.032	0.629
			ZJ	5.91	1.274	-0.992	0.211
		SH_II 4	ALL	5.80	1.331	-1.047	0.666
			SH	5.74	1.349	-1.017	0.656
			ZJ	5.90	1.300	-1.097	0.702
		SH_OI 1	ALL	5.19	1.73	-0.766	-0.227
			SH	5.15	1.708	-0.765	-0.143
			ZJ	5.25	1.761	-0.778	-0.318
		SH_OI 2	ALL	5.62	1.431	-0.938	0.455
			SH	5.55	1.431	-0.889	0.434
			ZJ	5.72	1.426	-1.025	0.556
		SH_OI 3	ALL	5.86	1.228	-0.954	0.539
			SH	5.80	1.197	-0.877	0.555

			ZJ	5.94	1.268	-1.080	0.617
		SH_OI 4	ALL	5.67	1.381	-0.916	0.425
			SH	5.60	1.374	-0.842	0.356
			ZJ	5.78	1.386	-1.041	0.623
		SH_OI 5	ALL	6.01	1.167	-1.174	1.259
			SH	5.99	1.147	-1.133	1.225
			ZJ	6.04	1.195	-1.236	1.346
Barriers to HIS (Organizational barriers)	12	OB1-1	ALL	4.31	2.091	-0.226	-1.207
			SH	4.32	2.089	-0.257	-1.165
			ZJ	4.29	2.097	-0.183	-1.264
		OB1-2	ALL	2.22	1.552	1.315	1.049
			SH	2.17	1.511	1.361	1.228
			ZJ	2.29	1.608	1.251	0.831
		OB1-3	ALL	4.51	1.902	-0.293	-0.929
			SH	4.47	1.910	-0.298	-0.894
			ZJ	4.56	1.893	-0.286	-0.981
		OB2-1	ALL	4.34	1.94	-0.190	-1.024
			SH	4.26	1.958	-0.156	-1.053
			ZJ	4.46	1.911	-0.238	-0.975
		OB2-2	ALL	5.37	1.613	-0.805	-0.060
			SH	5.38	1.605	-0.800	-0.080
			ZJ	5.35	1.627	-0.814	-0.018
		OB3-1	ALL	3.24	1.959	0.393	-1.064
			SH	3.15	1.946	0.494	-0.949
			ZJ	3.36	1.974	0.254	-1.176
		OB3-2	ALL	2.94	1.865	0.624	-0.72
			SH	2.90	1.827	0.639	-0.644
			ZJ	3.00	1.918	0.600	-0.822
		OB3-3	ALL	2.86	1.803	0.613	-0.714
			SH	2.83	1.799	0.631	-0.706
			ZJ	2.91	1.810	0.590	-0.716
		OB3-4	ALL	2.87	1.852	0.644	-0.739
			SH	2.78	1.801	0.705	-0.614
			ZJ	3.01	1.916	0.554	-0.895
		OB3-5	ALL	2.67	1.746	0.767	-0.483
			SH	2.61	1.725	0.824	-0.370
			ZJ	2.75	1.776	0.690	-0.613
		OB-4	ALL	2.89	1.842	0.609	-0.790
			SH	2.78	1.779	0.729	-0.517
			ZJ	3.06	1.919	0.447	-1.075
		OB-5	ALL	2.56	1.597	0.832	-0.139
			SH	2.57	1.606	0.800	-0.237
			ZJ	2.55	1.587	0.882	0.026
Barriers to HIS (Human barriers)	11	HB1-1	ALL	2.36	1.579	1.176	0.652
			SH	2.38	1.554	1.115	0.499
			ZJ	2.32	1.615	1.264	0.880
		HB1-2	ALL	2.29	1.550	1.274	0.981
			SH	2.33	1.592	1.255	0.856
			ZJ	2.22	1.489	1.295	1.169
		HB1-3	ALL	2.19	1.487	1.435	1.618
			SH	2.27	1.544	1.368	1.335
			ZJ	2.08	1.398	1.531	2.082
		HB1-4	ALL	2.15	1.460	1.458	1.679
			SH	2.24	1.514	1.347	1.240
			ZJ	2.03	1.371	1.638	2.529

HB2-1	ALL	3.32	2.016	0.398	-1.094
	SH	3.46	2.022	0.284	-1.169
	ZJ	3.13	1.994	0.572	-0.905
HB2-2	ALL	2.93	1.836	0.677	-0.575
	SH	2.97	1.826	0.588	-0.699
	ZJ	2.87	1.851	0.806	-0.368
HB2-3	ALL	2.70	1.725	0.848	-0.205
	SH	2.71	1.717	0.836	-0.265
	ZJ	2.70	1.741	0.870	-0.108
HB2-4	ALL	2.70	1.726	0.786	-0.426
	SH	2.72	1.747	0.766	-0.529
	ZJ	2.66	1.699	0.819	-0.254
HB2-5	ALL	3.02	1.880	0.621	-0.717
	SH	3.07	1.890	0.555	-0.843
	ZJ	2.94	0.867	0.722	-0.501
HB3	ALL	2.44	1.563	0.898	-0.037
	SH	2.43	1.573	0.922	0.026
	ZJ	2.45	1.550	0.865	-0.033
HB4	ALL	2.91	1.822	0.629	-0.682
	SH	2.90	1.817	0.626	-0.071
	ZJ	2.92	1.832	0.638	0.925

Whether for all samples, Shanghai group or Zhejiang group, the mean values of the items of a third party and maturity of HIS are all larger than 5.80, which suggests that, in China, the hospitals often rely on third parties for data management, and the maturity of HIS is relatively high.

3.4 Data analysis

3.4.1 Reliability and validity

In order to test the hypotheses, it is very important to ensure that the items of the scale are reliable. The factor loading of each item on the corresponding latent variable measures the item's reliability. If the factor loading of an item is less than 0.7, it should be dropped (Sawhney, 2013). Based on the raw data, preliminary confirmatory factor analysis was conducted to calculate all the items' factor loadings. Before that, the Kaiser-Meyer-Olkin (KMO) statistic and the Bartlett test of sphericity of the questionnaire data were used to assess whether it is suitable for factor analysis.

KMO-statistic is an index used to measure the sampling adequacy. The value of KMO is between 0 and 1. The closer the value of KMO to 1, the stronger the correlations between the variables and the more suitable the data for factor analysis. In practice, when it is larger than 0.9, the data is ideally suitable for factor analysis (Kaiser & Rice, 1974) .

The Bartlett test of sphericity is also used to test whether the variables are correlated. When the approximate Chi-square is large with little significance level (<0.01), the data is suitable for factor analysis (Kagaigai et al., 2021).

SPSS 25.0 was used to calculate the values of KMO and the Bartlett test of sphericity. Table 3.5 shows the results.

Table 3.5 KMO values and the Bartlett tests of sphericity for all the variables

Variable	Number of terms	Bartlett test of sphericity			KMO
		Approximate Chi-square	Degree of freedom	Sig.	
Maturity of HIS	7	5856.78	21	0.000	0.904
A third party	5	5342.717	10	0.000	0.895
Barriers to HIS (Technological barriers)	17	15761.868	136	0.000	0.963
Success of HIS	9	7039.896	36	0.000	0.939
Barriers to HIS (Organizational barriers)	12	5733.876	66	0.000	0.906
Barriers to HIS (Human barriers)	11	7539.827	55	0.000	0.921

As far as the overall questionnaire is concerned, the KMO value of is 0.972, which is larger than 0.9. And the Bartlett test of sphericity shows that the approximate Chi-square' value is large enough (52460.5) and significant with a probability lower than 0.001. The values of KMO and the results of Bartlett test of sphericity for all the latent variables can be found in table 3.5. All the values of KMO are larger than 0.89 and all the values of the approximate Chi-square are very large with the significance levels lower than 0.001. Therefore, it can be seen from table3.5 that, for the whole questionnaire and all variables, the KMO values and the significant levels of the Bartlett tests of sphericity meet the conditions for factory analysis.

Now, we conduct the factor analysis with AMOS 21.0. The results of the latent variables with the factor loadings of their items were listed in table 3.6. Factor loading means the correlation coefficient the item correlates with the factor it belongs to. The third column shows the factor loadings of all the items. Some of them are too small to explain the latent variables to which they belong. For example, the factor loadings of OB1-1, OB1-3, OB2-1, OB2-2 are less than 0.3, so they should be dropped from the scale. After these items have been dropped, we calculated the factor loading of every item again and dropped the items with low factor loading again. This process was repeated until all the items left were large enough to explain the variables. As a result, some items have to be dropped due to their low factor loadings (TB1-3, TB4-1, TB4-2, TB4-3, HB2-1, HB2-2, HB3, HB4).

Table 3.6 Factor loadings of items before and after items dropped

Variable	Item	Factor loading (before items dropped)	Factor loading (after items dropped)
A third party	TP5	0.899	0.898
	TP4	0.913	0.913
	TP3	0.959	0.959
	TP2	0.946	0.947
	TP1	0.896	0.896
Maturity of HIS	MH7	0.867	0.835
	MH6	0.826	0.786
	MH5	0.799	0.775
	MH4	0.912	0.926
	MH3	0.895	0.905
	MH2	0.875	0.887
	MH1	0.785	0.797
Success of HIS	SH_OI5	0.855	0.837
	SH_OI4	0.805	0.765
	SH_OI3	0.906	0.882
	SH_OI2	0.797	0.782
	SH_OI1	0.568	0.563
	SH_II4	0.899	0.916
	SH_II3	0.874	0.891
	SH_II2	0.799	0.811
	SH_II1	0.863	0.88
Barriers to HIS (Technological barriers)	TB4-3	0.695	dropped
	TB4-2	0.692	dropped
	TB4-1	0.534	dropped
	TB3-5	0.865	0.867
	TB3-4	0.866	0.866
	TB3-3	0.881	0.888
	TB3-2	0.908	0.914
	TB3-1	0.892	0.895
	TB2-5	0.886	0.893
	TB2-4	0.832	0.828
	TB2-3	0.866	0.859
	TB2-2	0.865	0.864
	TB2-1	0.871	0.878
	TB1-4	0.835	0.832
	TB1-3	0.786	dropped
	TB1-2	0.843	0.839
	TB1-1	0.803	0.801
Barriers to HIS (Organizational barriers)	OB1-3	0.185	dropped
	OB1-2	0.628	0.626
	OB1-1	0.220	dropped
	OB2-2	-0.209	dropped
	OB2-1	0.087	dropped
	OB3-1	0.716	0.716
	OB3-2	0.780	0.781
	OB3-3	0.843	0.842
	OB3-4	0.889	0.890
	OB3-5	0.902	0.902
	OB4	0.871	0.871

	OB5	0.768	0.766
Barriers to HIS (Human barriers)	HB-4	0.599	dropped
	HB-3	0.652	dropped
	HB2-1	0.581	dropped
	HB2-2	0.709	dropped
	HB2-3	0.812	0.720
	HB2-4	0.779	0.707
	HB2-5	0.734	0.623
	HB1-1	0.853	0.857
	HB1-2	0.862	0.917
	HB1-3	0.855	0.918
	HB1-4	0.842	0.901

Finally, 49 items were left after we removed these items from the latent variables-technological barriers, organizational barriers, and human barriers. All the factor loadings of the 49 items were larger than 0.71, as shown in the fourth column of table 3.6, which indicates that the data is suitable for further analysis.

The correlation coefficients of the latent variables concerned in this study are shown in table 3.7. The main research issues interested appear in it. It can be seen from table 3.8 that the third party is significantly and negatively correlated with all the three types of barriers (all $p<0.001$). And it shows the positive correlations with the success of HIS (0.483, $p<0.001$) and with the maturity of HIS (0.794, $p<0.001$). Thus, the third party plays a significant role in the HIS practices in China.

Table 3.7 Correlation matrix of the latent variables

	Human barriers	Organizational barriers	Technological barriers	Success of HIS	Maturity of HIS	A third party
Human barriers	**1**					
Organizational barriers	0.636^{***}	**1**				
Technological barriers	0.778^{***}	0.743^{***}	**1**			
Success of HIS	-0.540^{***}	-0.463^{***}	-0.540^{***}	**1**		
Maturity of HIS	-0.459^{***}	-0.449^{***}	-0.527^{***}	0.526^{***}	**1**	
A third party	-0.402^{***}	-0.359^{***}	-0.475^{***}	0.483^{***}	0.794^{***}	**1**

Note: ***$p<0.001$, **$p<0.01$, *$p<0.05$

In addition, the human barriers are significantly and positively correlated with the organizational barriers (0.636, $p<0.001$) and the technological barriers (0.778, $p<0.001$). There are significant and negative correlations between the success of HIS and all of the three types of barriers (the human barriers, -0.540, $p<0.001$; the organizational barriers, -0.463, $p<0.001$; the technological barriers; -0.540, $p<0.001$). These results are expected and consistent with the early research (Clarke et al., 2016).

3.4.2 Internal consistency

The internal consistency or reliability reflects the consistency and stability of the scale and is used to evaluate homogeneity between items within the same latent variable. The more consistent the items are, the smaller the random error of the scale is. The internal consistency is often evaluated by the Cronbach's α coefficient. The value of Cronbach'α coefficient is between 0 and 1 and the reliability is very good when it is larger than 0.9 (Suh, Chung, & Choi, 2017).

We calculated the Cronbach's α coefficients of all variables to evaluate the internal consistency of the questionnaire. The results are listed in the last two columns of table 3.8.

Table 3.8 Cronbach'α coefficients of items and variables

Variable	Num.	Item	Cronbach's α if item deleted	Cronbach's α
Maturity of HIS	7	MH1	0.946	0.947
		MH2	0.938	
		MH3	0.936	
		MH4	0.934	
		MH5	0.942	
		MH6	0.939	
		MH7	0.935	
A third party	5	TP1	0.962	0.965
		TP2	0.954	
		TP3	0.951	
		TP4	0.958	
		TP5	0.961	
Barriers to HIS (Technological barriers)	13	TB1-1	0.973	0.974
		TB1-2	0.972	
		TB1-4	0.972	
		TB2-1	0.972	
		TB2-2	0.971	
		TB2-3	0.972	
		TB2-4	0.973	
		TB2-5	0.971	
		TB3-1	0.971	
		TB3-2	0.971	
		TB3-3	0.971	
		TB3-5	0.972	
		TB3-5	0.972	
Success of HIS	9	SH_II 1	0.934	0.943
		SH_II 2	0.937	
		SH_II 3	0.932	
		SH_II 4	0.932	
		SH_OI 1	0.952	
		SH_OI 2	0.936	
		SH_OI 3	0.932	
		SH_OI 4	0.936	
		SH_OI 5	0.936	
Barriers to HIS	8	OB1-2	0.937	0.934
		OB3-1	0.93	

(Organizational barriers)		OB3-2	0.924	
		OB3-3	0.921	
		OB3-4	0.919	
		OB3-5	0.919	
		OB-4	0.921	
		OB-5	0.928	
Barriers to HIS (Human barriers)	7	HB1-1	0.919	0.933
		HB1-2	0.918	
		HB1-3	0.920	
		HB1-4	0.921	
		HB2-3	0.921	
		HB2-4	0.925	
		HB2-5	0.932	

We can see that the Cronbach's α coefficients of all items and latent variables are larger than 0.9, which supports the internal consistency of the scale. Within the constructs of three types of barriers and success of HIS, we have different dimensions, but these dimensions were analyzed together. There are three reasons for this:

First, if theses dimensions were analyzed separately, some dimensions would only have one or two items. For example, the dimensions of tasks, incentives and information decision process in organizational barriers. It is difficult to measure the variables effectively with less than three items.

Second, if each dimension is analyzed separately, the models will be too complex to complete parameter estimations. For instance, in the remaining 49 items in table 3.8, there are three, four, two and two dimensions within technological barriers, organizational barriers, human barrier and success of HIS, respectively. A total of more than 40 path parameters need to be estimated for each model if these models are analyzed based on the dimensions. This will make it difficult for the models to get good results.

Third, it is helpful to get better models. After the parameters were estimated, the fitting degrees of the models should be evaluated. If the dimensions were analyzed separately, it is very difficult to get models with good fit. For example, RMSEA is an ideal fitting index to evaluate the goodness of fit of a SEM and its value is sensitive and unfriendly to complex models.

For above reasons, the dimensions of one construct will be analyzed together rather than separately in the rest of this study.

3.5 Confirmatory factor analysis

To test whether the relationship between the latent variables and their measure items conform to the theoretical relationships, we run CFA based on maximum likelihood estimation method.

CFA is used to analyze the relationship between a latent variable and the measurement items. Composite reliability, convergent validity and discriminant validity of the scale are often used to evaluate whether the subordinate relationship between the items and the latent variables are correct or not.

The measurement model is shown as annex A. The fitting indices of the measurement model, IFI, CFI, NFI, RMSEA are calculated. The values of IFI (0.910) and CFI (0.910) exceed 0.9, NFI (0.889) exceeds 0.8 and RMSEA (0.067) is less than 0.08. The values of the fitting indices meet the cut-off requirements except GFI. Generally speaking, the fitting degree of the measurement model to the data is acceptable.

3.5.1 Composite reliability and convergent validity

Table 3.9 reports the estimates of the standardized coefficient of all the items, the composite reliability (CR) and AVE of all the latent variables. The fourth column and the fifth column are the standard errors (SE) and the t-statistic values of the standardized coefficients. If the factor loading (the standardized coefficient) of an item on its corresponding latent variable is not equal to zero, the data is in accord with the theoretical relationships. All of the p-values in the sixth column are less than 0.001, which shows that all the standardized coefficients are significant different from zero. Thus, the estimates of the standardized coefficients in the third column show that they range from 0.71 to 0.92 and are all above 0.70.

Table 3.9 Composite reliability and AVE

Variable	Item	Standardized coefficient	SE	t-value	P	SMC	CR	AVE
A third party	TP5	0.898				0.8064	0.9664	0.8519
	TP4	0.913	0.024	42.6	***	0.8336		
	TP3	0.959	0.02	48.9	***	0.9197		
	TP2	0.947	0.021	46.6	***	0.8968		
	TP1	0.896	0.023	40.0	***	0.8028		
Maturity of HIS	MH7	0.835				0.6972	0.9462	0.7163
	MH6	0.786	0.024	42.6	***	0.6178		
	MH5	0.775	0.038	26.8	***	0.6006		
	MH4	0.926	0.03	35.3	***	0.8575		
	MH3	0.905	0.031	34.0	***	0.8190		
	MH2	0.887	0.029	32.7	***	0.7868		
	MH1	0.797	0.029	27.5	***	0.6352		
Success of HIS	SH_OI5	0.837				0.7006	0.9480	0.6730
	SH_OI4	0.765	0.041	26.3	***	0.5852		
	SH_OI3	0.882	0.033	33.3	***	0.7779		
	SH_OI2	0.782	0.042	27.1	***	0.6115		
	SH_OI1	0.563	0.058	17.3	***	0.3170		
	SH_II4	0.916	0.036	34.7	***	0.8391		
	SH_II3	0.891	0.038	32.8	***	0.7939		

	SH_II2	0.811	0.043	28.3	***	0.6577		
	SH_II1	0.88	0.038	32.2	***	0.7744		
Barriers to HIS (Technological barriers)	TB3-5	0.867	0.034	32.4	***	0.7517	0.9720	0.7597
	TB3-4	0.866	0.032	32.4	***	0.7500		
	TB3-3	0.888	0.034	33.8	***	0.7885		
	TB3-2	0.914	0.031	35.6	***	0.8354		
	TB3-1	0.895	0.029	34.4	***	0.8010		
	TB2-5	0.893	0.033	34.2	***	0.7974		
	TB2-4	0.828	0.03	30.1	***	0.6856		
	TB2-3	0.859	0.03	32.0	***	0.7379		
	TB2-2	0.864	0.035	32.4	***	0.7465		
	TB2-1	0.878	0.035	33.2	***	0.7709		
	TB1-4	0.832	0.035	30.4	***	0.6922		
	TB1-2	0.839				0.7039		
	TB1-1	0.801	0.038	28.6	***	0.6416		
Barriers to HIS (Organizational barriers)	OB1-2	0.626				0.3919	0.9354	0.6468
	OB3-1	0.716	0.082	17.5	***	0.5127		
	OB3-2	0.781	0.08	18.8	***	0.6100		
	OB3-3	0.842	0.079	19.8	***	0.7090		
	OB3-4	0.89	0.083	20.5	***	0.7921		
	OB3-5	0.902	0.078	20.8	***	0.8136		
	OB4	0.871	0.082	20.2	***	0.7586		
	OB5	0.766	0.068	18.6	***	0.5868		
Barriers to HIS (Human barriers)	HB2-3	0.72				0.5184	0.9309	0.6623
	HB2-4	0.707	0.048	20.3	***	0.4998		
	HB2-5	0.623	0.033	28.9	***	0.3881		
	HB1-1	0.857	0.044	24.5	***	0.7344		
	HB1-2	0.917	0.044	26.0	***	0.8409		
	HB1-3	0.918	0.042	25.9	***	0.8427		
	HB1-4	0.901	0.042	25.4	***	0.8118		

Note: ***p<0.001

Convergent validity means that the correlation of the items measuring the same latent variable are high. When the standardized coefficients exceed than 0.7 and the values of AVE exceed 0.5, the convergent validity is acceptable. It can be seen from table 3.9 that the standardized coefficient and the AVE of each variable is larger than 0.7 and 0.64 respectively. Therefore, convergent validity of the data is acceptable.

CR is used to test whether the items of a latent variable can be combined together to measure this variable. It also reflects the internal consistency of the scale. The CR estimates in the eighth column of table 3.9 are all larger than 0.9 that exceed the recommended value of 0.7 (Kline, 2013). Again, we find that the reliability of the scale is acceptable.

Squared multiple correlations (SMC) are used to measure the reliability of a single item and reflects the extent the item is explained by the assigned latent variable. The item should be kept if the value of SMC is larger than 0.5 (Kline, 2013). The seventh column of table 3.9 shows that SMC are all larger than 0.5, which means that all the items should be kept.

3.5.2 Discriminant validity

Discriminant validity means that the correlation degrees between the items measuring different latent variables are poor. The comparison between the Average Variances Extracted (AVE) of each construct and the correlation coefficients between the latent variables are used to test discriminant validity. When the square root of a variable's AVE ($\sqrt{AVE}$) is larger than the absolute values of the correlation coefficients between this construct and all other constructs, the discriminant validity levels are acceptable (Suh, Chung, & Choi, 2017).

The $\sqrt{AVE}$ values of the human barriers, organizational barriers, technological barriers, success of HIS, maturity of HIS, third party are 0.814,0.804, 0.872, 0.820, 0.846, 0.923, respectively. These values are compared to the correlations between latent variables in table 3.7. It is clear that the absolute values of the correlations between one latent variable and all the others are less than the $\sqrt{AVE}$ value of this latent variable in all cases. For example, the correlation between human barriers and the organizational barriers is 0.636 and the square roots of the two variables' AVEs are 0.818 and 0.804, respectively. The former is lower than the latter two values. Therefore, we can conclude that the discriminant validity of the questionnaire is good enough for the variables in the model.

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Chapter 4: Results

In this chapter, we first analyze the first-order factor model in which the relationships between the three types of barriers and other variables are analyzed separately. Then the second-order factor model is tested in which we extract a second order "barriers" from the three types of barriers. Next, we analyze the first- and the second-order factor model when the direct impact of third party on success of HIS is considered.

4.1 Hypotheses testing for the first-order factor model

4.1.1 Goodness-of-fit of the first-order factor model

In order to test the hypotheses proposed in Chapter 2 and examine the respective impact of the three types of barriers on HIS, the second-order factor of barriers should be replaced by the first-order factors, i.e., technological barriers, organizational barriers and human barriers. And these three latent variables are interlinked with other three latent variables- third party, maturity and success of HIS- in a structural model. The fitting indies of the structural model of the first-order factor model in table 4.1 shows that it has a good fit (CFI=0.888, NFI=0.867, IFI=0.888, RMSEA=0.075).

Table 4.1 Fitting indices of the structural model

Indicator name	Range	Measurement	Ideal value	Loose value
χ^2	—	6223.42		
df	—	1113		
p	—	0.000	<0.05	
χ^2/df	—	4.592	<=3	<=5
GFI	0~1	0.75	>0.9	>0.8
RMSEA	0~1	0.075	<0.05	<0.08
NFI	0~1	0.867	>0.9	>0.8
IFI	0~1	0.888	>0.9	>0.8
CFI	0~1	0.888	>0.9	>0.8

The structural model of the first-order factor model is shown as figure 4.1. The difference between the first-order factor model and the second-order factor model is that the second-order factor of barriers are replaced by the three first-order factors in the former. The paths between barriers and the other latent variables are also replaced by the paths between the three new first-order factors and the other latent variables.

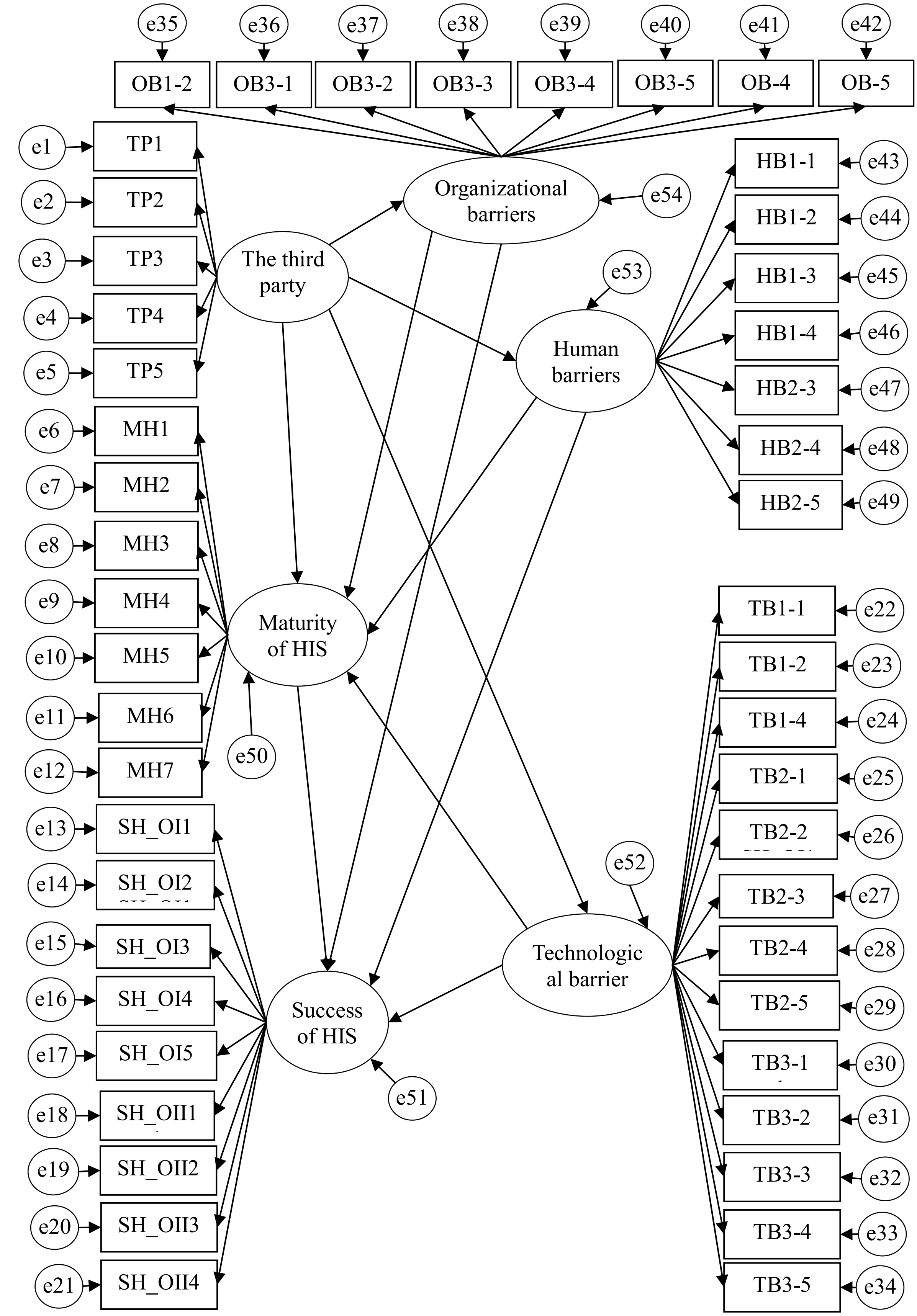


Figure 4.1 Structural model of the first-order factor model

The standardized coefficients of the items on the latent variables can be found in the third column of table 3.9. They are all significant ($p<0.001$) and larger than 0.7, therefore, the data can be used for further analysis.

4.1.2 Hypotheses testing for the first-order factor model

The path diagram of the structural model and the estimates of the path coefficients are shown in figure 4.2. H1a, H1b and H1c predict the relationship between the third party and the three types of barriers. Specifically, these barriers are lower when the HIS is more led by the third party. The links from the third party to the technological barriers (-0.491, $p<0.001$), the organizational barriers (-0.376, $p<0.001$) and the human barriers (-0.418, $p<0.001$), are all negative and significant. Therefore, these results show that the third party has a significant and negative correlation with all three types of barriers. H1a, H1b, and H1c are all strongly supported by the data.

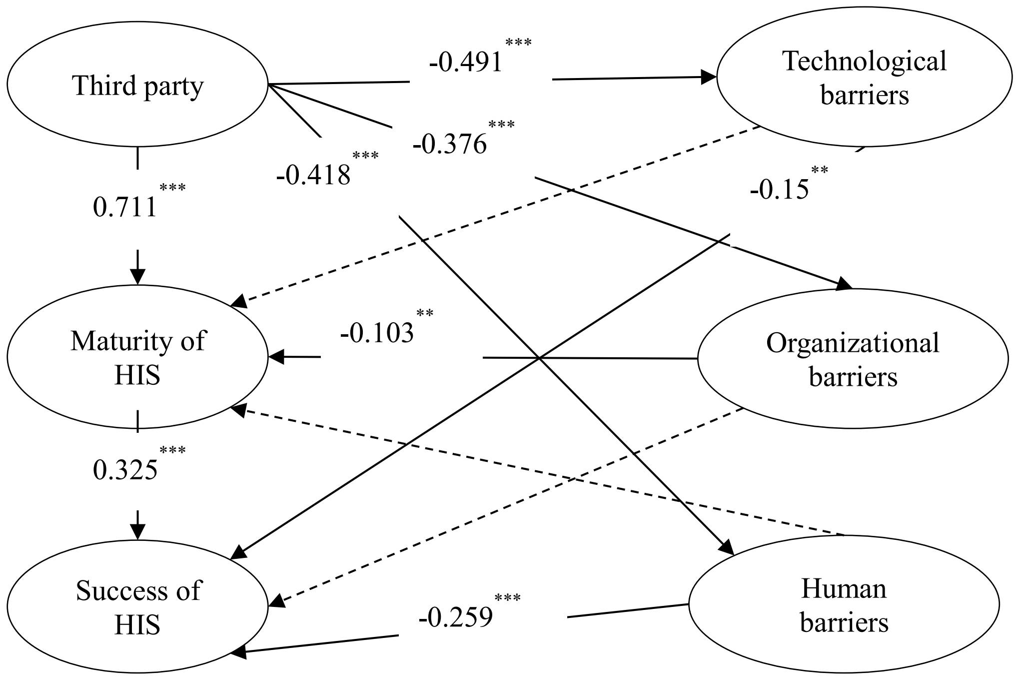


Figure 4.2 Path diagram of the structural model

Note: ***p<0.001, **p<0.01, *p<0.05

H2 claims that the third party has a positive impact on the maturity of HIS. The standardized path coefficients between them is 0.711 ($p<0.001$), which indicates that the third party is positively and significantly associated with the maturity of HIS. The results lend strong support for H2.

H3a, H3b and H3c predict the relationship between the three types of barriers and the maturity. The path coefficient from technological barriers to maturity is -0.078 and the p value is 0.056, which indicates the impact of technological barriers on the maturity of HIS is not significant. Therefore, the support for H3a is not found. The path coefficient from organizational barriers to maturity is -0.103 ($p< 0.01$), which indicates that organizational barriers is significantly and negatively associated with the maturity of HIS. Hence, H3b is supported. Although H3b is supported, the effects are very low due to the small value of the path coefficients. The path coefficient from human barriers to maturity of HIS is not significant. Thus, it is surprise to find that the impact of human barriers on the maturity of HIS is not as expected. H3c is not supported by the data.

H4a, H4b and H4c state that the three types of barriers are negatively corelated to the success of HIS. The estimate of -0.15 from technological barriers to success of HIS is significant ($p<0.01$), so the former has a significant and negative impact on the success of HIS. The results show support for H4a. However, we find that the effect is weak because of the low value of the path coefficient.

The link from organizational barriers to success of HIS is not significant, which indicates that there is no significant effect of the organizational barriers on success of HIS. Hence, support for H4b is not found. The path coefficient from human barriers to success of HIS is negative with a standardized estimate of -0.259 ($p<0.001$). This means that the human barriers have weak negative correlation with the success of HIS. Thus, the results provide strong support for H4c.

H5 predicts the relationship between maturity and success of HIS. The standardized estimate of the path coefficient from maturity to success of HIS is 0.325 at 0.001 significance level. Therefore, the success of HIS is significantly and positively affected by the maturity. H5 is strongly supported.

The results of the hypothesis testing stated above are summarized in table 4.2.

Table 4.2 Results of the path analysis for the structural model

Path	Std.	SE	t-value	p	Results
H1a Third party → Technological barriers	-0.491	.036	-14.22	***	Supported
H1b Third party → Organizational barriers	-0.376	.031	-9.69	***	Supported
H1c Third party → Human barriers	-0.418	.038	-11.24	***	Supported
H2 Third party → Maturity	0.711	.030	21.45	***	Supported
H3a Technological barriers → Maturity	-0.078	.035	-1.91	.056	Not Supported
H3b Organizational barriers → Maturity	-0.103	.038	-3.06	.002	Supported
H3c Human barriers → Maturity	-0.041	.031	-1.18	.237	Not supported
H4a Technological barriers → Success	-0.15	.040	-2.78	.005	Supported
H4b Organizational barriers → Success	-0.071	.044	-1.60	.110	Not supported
H4c Human barriers → Success	-0.259	.037	-5.44	***	Supported
H5 Maturity → Success	0.325	.033	8.64	***	Supported

Note: ***$p<0.001$

The estimates of standardized coefficients (Std.) of the paths and their standard errors (SE) are listed in the second column and the third column of table 4.2, respectively. The fourth column and the fifth column list the t-statistic values and the significant levels.

Generally speaking, the model provides strong support ($p<0.01$) for H1a, H1b, H1c, H2, H3b, H4a, H4c and H5 as we expect. H3a, H3c and H4b are not supported by the data because the path coefficients between the latent variables are not for a significant level of 0.05. Although H3b and H4a are both supported, the results also indicate that the path coefficients are all lower than 0.15. This suggests that the impact of organizational barriers on maturity of HIS and that of technological barriers on success of HIS are very small.

The total effect of the third party on the success of HIS is 0.463 which can be calculated from figure 4.2 and table 4.2. Thus, for the full sample, the success of HIS is significantly impacted by the third party.

4.2 The second-order factor model

4.2.1 Reliability and validity of the second-order factor model

In the original model, although human barriers, organizational barriers, and technological barriers meet the requirements of discriminant validity, it can be seen from table 3.8 that the correlation coefficients between them are all larger than 0.6. Therefore, the three variables are correlated. After testing the hypotheses and showing the impact of each barrier on HIS, we consider a second-order factor model by extracting a second-order factor from the three barriers and name it barriers. In other words, it is assumed that there is a second-order factor (barriers) that can influence the three first-order factors: technological, organizational and human barriers.

Now we call the original model in subsection 3.5.1 the first-order factor model. The second-order factor model is a simpler model than the first-order factor model because the number of parameters is reduced. At the same time, it can present us with the casual link between the overall barriers and other variables.

Next, we also conduct a CFA for the second-order factor model. The results that reflect the reliability and the validity tests of the second-order factor model are listed in table 4.3.

Table 4.3 Composite reliability and AVE of the second-order factor model

Variable	Item	Standardized coefficient	SE	P	SMC	CR	AVE
Barriers	Technological barriers	0.785			0.6162	0.8892	0.7289
	Organizational barriers	0.939	0.097	***	0.8817		
	Human barriers	0.83	0.095	***	0.6889		
Third party	TP5	0.898			0.8064	0.9665	0.8522
	TP4	0.913	0.024	***	0.8336		
	TP3	0.959	0.02	***	0.9197		

	TP2	0.947	0.021	***	0.8968		
	TP1	0.897	0.023	***	0.8046		
Maturity of HIS	MH7	0.834			0.6956	0.9462	0.7161
	MH6	0.785	0.024	***	0.6162		
	MH5	0.775	0.038	***	0.6006		
	MH4	0.927	0.03	***	0.8593		
	MH3	0.905	0.031	***	0.8190		
	MH2	0.887	0.029	***	0.7868		
	MH1	0.797	0.029	***	0.6352		
Success of HIS	SH_OI5	0.837			0.7006	0.9480	0.6727
	SH_OI4	0.765	0.041	***	0.5852		
	SH_OI3	0.881	0.033	***	0.7762		
	SH_OI2	0.782	0.042	***	0.6115		
	SH_OI1	0.563	0.058	***	0.3170		
	SH_II4	0.916	0.036	***	0.8391		
	SH_II3	0.891	0.038	***	0.7939		
	SH_II2	0.81	0.043	***	0.6561		
	SH_II1	0.88	0.038	***	0.7744		
Technological barriers	TB35	0.867	0.034	***	0.7517	0.9721	0.7599
	TB34	0.866	0.032	***	0.7500		
	TB33	0.888	0.034	***	0.7885		
	TB32	0.914	0.031	***	0.8354		
	TB31	0.895	0.029	***	0.8010		
	TB25	0.893	0.033	***	0.7974		
	TB24	0.828	0.03	***	0.6856		
	TB23	0.859	0.03	***	0.7379		
	TB22	0.865	0.035	***	0.7482		
	TB21	0.878	0.035	***	0.7709		
	TB14	0.832	0.035	***	0.6922		
	TB12	0.838			0.7022		
	TB11	0.801	0.038	***	0.6416		
Organizational barriers	OB12	0.626			0.3919	0.9354	0.6470
	OB31	0.716	0.082	***	0.5127		
	OB32	0.781	0.08	***	0.6100		
	OB33	0.842	0.079	***	0.7090		
	OB34	0.89	0.083	***	0.7921		
	OB35	0.903	0.078	***	0.8154		
	OB4	0.871	0.082	***	0.7586		
	OB5	0.766	0.068	***	0.5868		
Human barriers	HB23	0.721			0.5198	0.9310	0.6626
	HB24	0.708	0.048	***	0.5013		
	HB25	0.624	0.033	***	0.3894		
	HB11	0.858	0.044	***	0.7362		
	HB12	0.917	0.044	***	0.8409		
	HB13	0.917	0.042	***	0.8409		
	HB14	0.9	0.042	***	0.8100		

Note: ***p<0.001, **p<0.01, *p<0.05

Table 4.3 shows that the values of composite reliability all exceed 0.88. The values of SMC and the AVEs are larger than 0.5, respectively. These results indicate that the reliability and the validity are both acceptable.

The third column of table 4.3 shows the factor loadings of the second-order factor model. The main difference between this column and the third column in table 3.9 is that the second-order factor-barriers-appears. The first-order factors, technological, organizational and human barriers, are impacted by barriers. Their factor loadings on barriers are 0.785, 0.939 and 0.830, respectively. They are also significant at the 0.001 significance level, which suggests that the second-order factor of barriers significantly influences the three first-order factors. In other words, they become the formal indicators of barriers in the second-order factor model.

The correlation matrix of the latent variables and the square roots of AVEs for each of them are listed in table 4.4. The results show that the latent variables are significantly correlated ($p<0.001$).

The square roots of the AVEs for each latent variable are larger than the correlation coefficients between it and other latent variable, which provide support for the discriminant validity of the model.

Table 4.4 Discriminant validity of the second-order factor model

	A third party	Barriers	Maturity of HIS	Success of HIS
A third party	1			
Barriers	-0.497^{***}	1		
Maturity of HIS	0.795^{***}	-0.561^{***}	1	
Success of HIS	0.444^{***}	-0.593^{***}	0.53^{***}	1
Square root of AVE	0.9231	0.8538	0.8462	0.8202

Note: ***$p<0.001$, **$p<0.01$, *$p<0.05$

4.2.2 Goodness-fit of the structural model

The fitting indices of the structural second-order factor model are listed in annex B.

The fitting indices all meet the boundary requirements (CFI=0.91, NFI=0.888, IFI=0.91, RMSEA=0.067), which means that the structural model has an acceptable fit. And these values are similar to those in table 4.1, which indicates that, from the point of view of the goodness-of-fit, there is little difference between the second- and the first-order factor model.

The measurement and structural model of the second-order factor model is shown as figure 4.3. The second-order factor is barriers and the first-order factors are technological, organizational and human barriers. In this model, relationships between the first-order factors and other variables are replaced by the relationships between the second-order factor and other variables. The factor loadings of the items on variables and the first-order factors on the second-order factor are listed in the third column of table 4.3. It can be seen from table 4.3 that all the factor loadings are significant and larger than 0.7 except SH_OI1 on the success of HIS (0.563) and OB1-2 on organizational barriers (0.626).

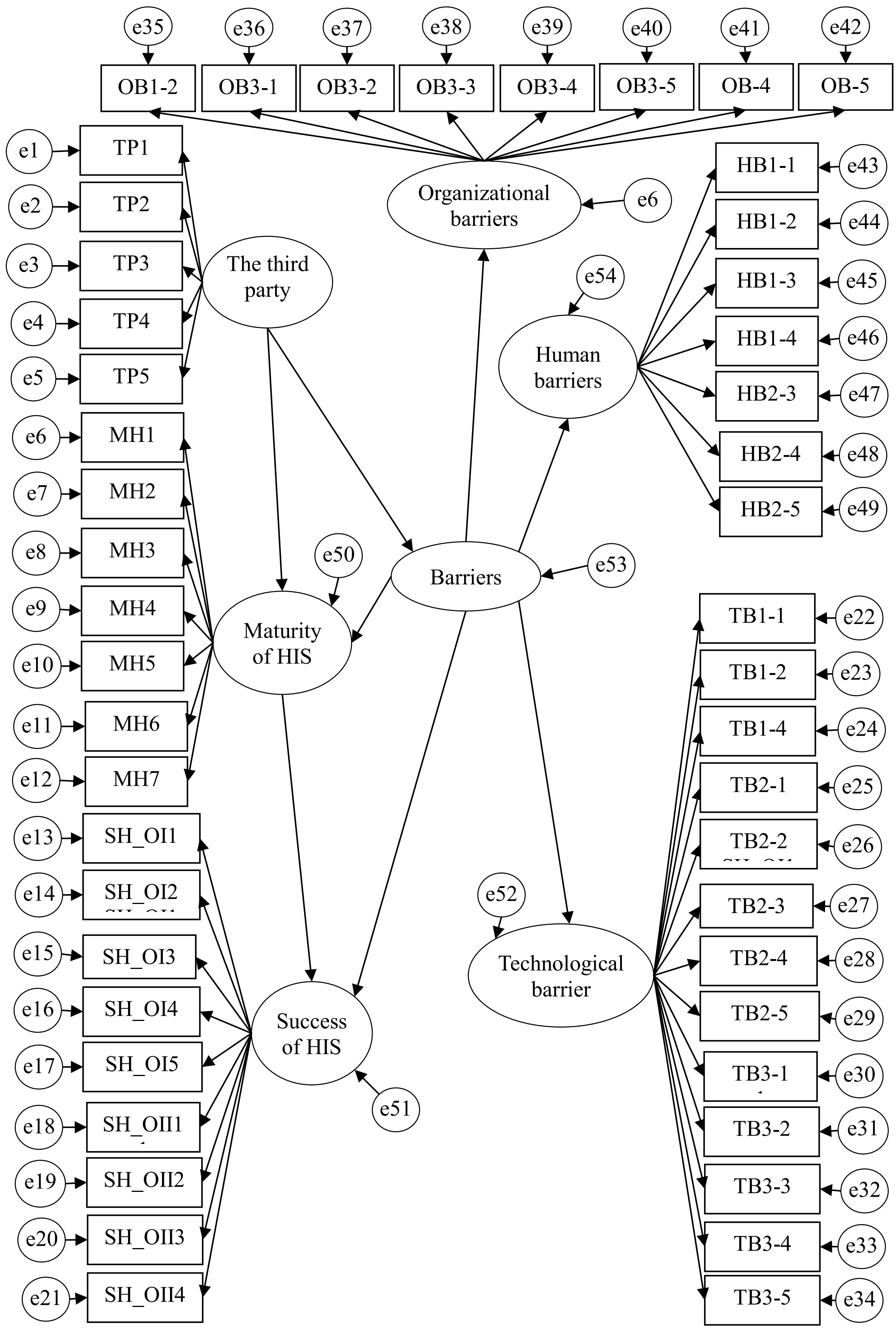


Figure 4.3 Measurement model and structural model of the second-order factor model

4.2.3 Hypotheses testing for the second-order factor model

The path model of the second-order model in figure 4.4 shows the path coefficients between the variables. As shown in figure 4.4, the path from the third party to the barriers is negative and significant (-0.497, $p<0.001$). This suggests that the third party can help the hospitals to reduce the barriers to implement HIS in China as H1. The third party also has a significantly positive association with the maturity (0.685, $p<0.001$), which is in accordance with H2. This also suggests that the third party is important for the developing countries like China to build a mature system of HIS.

The relationship between the barriers and the maturity is significant and negative (-0.22, $p<0.001$). So is the relationship between the barriers and the success of HIS (-0.432, $p<0.001$). These results are in line with H3 and H4 and show that the barriers can hinder the system of HIS from moving toward maturity and the HIS from success in China.

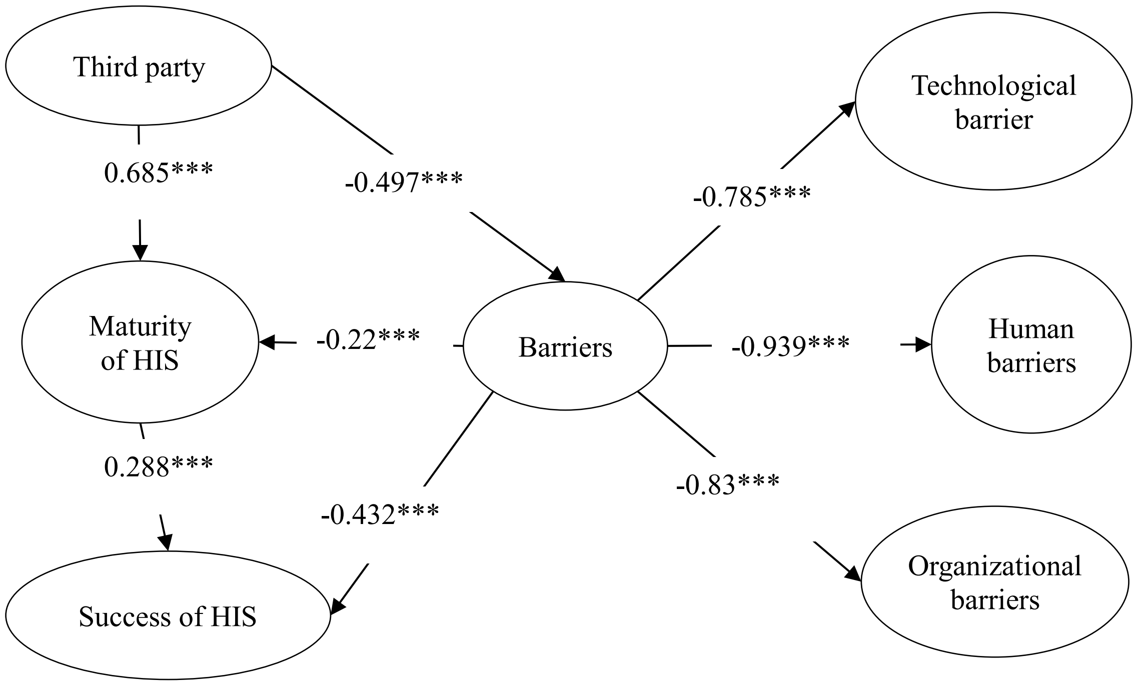


Figure 4.4 Path diagram of the second-order factor model

Note: ***p<0.001, **p<0.01, *p<0.05

The maturity is positively associated with the success of HIS (0.288, $p<0.001$). As expected by H5, this result shows the improvement potential of the success of HIS with respect to the maturity of HIS. The above results demonstrate that the three type of barriers as a whole are significantly influenced by the third party and have significant impact on the maturity and the success of HIS.

The total effect of the third party on the success of HIS is 0.443 which can be calculated from figure 4.4. Compared with the result of the first-order factor model in subsection 4.1.2

(0.463), the total effect of the second-order factor model is slightly lower. Thus, the third party still has a significant impact on success of HIS.

The hypotheses testing results for the second-factor model are summarized in table 4.5. Columns 2 to 5 show the standardized coefficients (Std.) of the paths, their standard errors, t-values and significant levels (p), respectively. It is clear that all the hypotheses are strongly supported by the data.

Table 4.5 Results of the hypotheses testing of the second-factor model

Path	Std.	SE	t-value	p	Results
H1 Third party → Barriers	-0.497	.028	-11.51	***	Supported
H2 Third party → Maturity	0.685	.030	20.81	***	Supported
H3 Barriers → Maturity	-0.220	.043	-7.29	***	Supported
H4 Barriers → Success	-0.432	.034	-9.53	***	Supported
H5 Maturity → Success	0.288	.058	7.61	***	Supported

Note: ***p<0.001

It can be seen from table 4.1 and annex B that the fitting indices for the second-order factor model are better than the first-order factor model. For example, the values of NFI, IFI and CFI of the second-order factor model are all larger than those of the first-order factor model. The value of RMSEA of the second-order factor model is lower than that of the first-order factor model.

Generally speaking, all the path coefficients of the second-order factor model are significant at 0.001 level and larger than 0.28. However, in the first-order factor model, the path from technological barriers to maturity of HIS, the link from the human barriers to maturity of HIS, and the path from organizational barriers to success of HIS are all not significant. In addition, the path coefficients from the three types of barriers to the other variables are small, especially from technological barriers to success of HIS (0.15).

For the two above reasons, the second-order factor model is better than the first-order factor model to describe the relationship between the variables.

4.3 Results for multiple-group test

4.3.1 Goodness-of-fit of the multi-group model

The data comes from five hospitals in two regions with different economic development levels. More importantly, the data reflects different levels of HIS. For these reasons, we are interested in the question: Does the results of section 4.2 remain unchanged in different regions? To answer this question, the sample was divided into two groups: Shanghai and Zhejiang hospitals.

We use the multiple-group SEM to test the hypotheses in these two different groups.

We test the measurement invariance to check whether the path coefficients of the structural model for the two groups are significantly different. First, a base line model was run in which all the path coefficients were freely estimated for Shanghai and Zhejiang hospitals. The fitting indices for the base-line model are listed in table 4.6. Most indices show that the base model for the samples in the two different areas fits the data well (NFI=0.83, IFI=0.87, CFI=0.87, RMSEA=0.058), which indicates that the base model is acceptable for the two different samples. Second, we run a parallel model in which the corresponding path coefficients for the two groups were assumed to be equal. Table 4.6 also gives the fitting indices for the parallel model (NFI=0.828, IFI=0.869, CFI=0.869, RMSEA=0.057). The results show that the model's goodness-of-fit is acceptable. The fitting indices for the base line model and the parallel model are slightly different, therefore, these goodness-of-fit of the two models are almost the same.

Table 4.6 Fitting indices for the base-line model and the parallel model

Model	χ^2	df	P	χ^2/df	GFI	NFI	IFI	CFI	RMSEA
Base line model	8316	2228	0.000	3.732	0.699	0.83	0.87	0.87	0.058
Parallel model	8413	2282	0.000	3.687	0.697	0.828	0.869	0.869	0.057

Based on the above analysis, the value of χ^2 in the base line model was compared with that in the parallel model. The results show that the difference between them is significant ($\triangle\chi^2$ =97.6, $\triangle df$=54, $p<0.05$). Therefore, it is not acceptable that the corresponding path coefficients of the structural models for the two different groups are the same.

The fitting indices of the structural models for Shanghai group (NFI=0.839, IFI=0.873, CFI=0.873) and Zhejiang group (NFI=0.818, IFI=0.866, CFI=0.865) are both acceptable. The fitting indices for Shanghai group are all slightly larger than those for Zhejiang group, therefore, the structural model fits better for the Shanghai group than for the Zhejiang group.

4.3.2 Results of the multi-group model

Figure 4.5 shows the path diagrams of the structural model for Shanghai and Zhejiang groups, respectively. The path coefficients with significant levels appear on the line between the latent variables.

For Shanghai group, H1a, H1b, and H1c are all strongly supported by the data because the path coefficients between third party and technological barriers (-0.478, $p<0.001$), organizational barriers (-0.334, $p<0.001$), and human barriers (-0.385, $p<0.001$) are all negative and significant. Thus, in developed regions like Shanghai, third party can significantly reduce the barriers to HIS.

Among the path coefficients between the third party and the three types of barriers in Shanghai group, the path coefficient between third party and technological barriers is the largest. Therefore, it seems that the role of third party in reducing technological barriers is greater than that of the other two barriers.

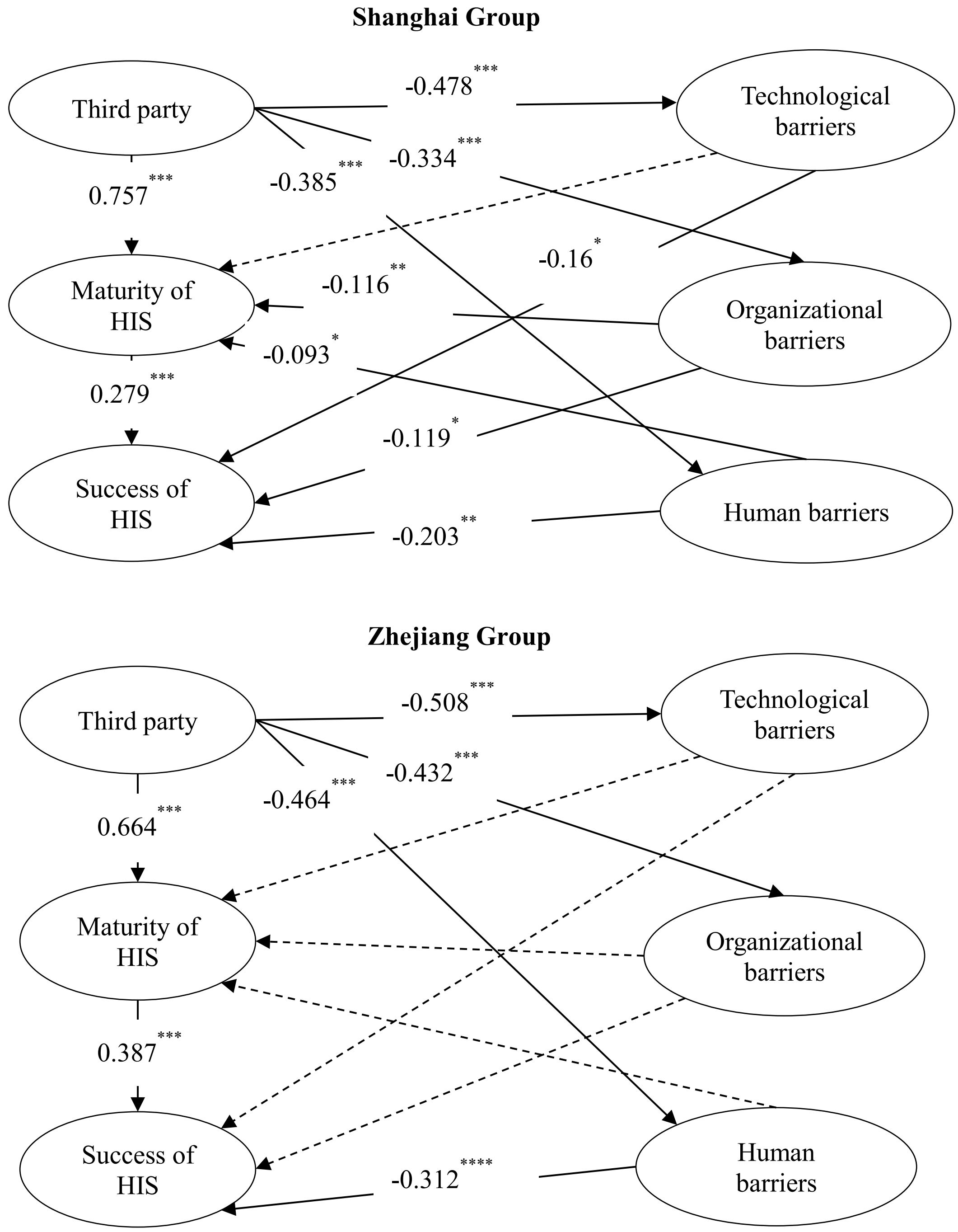


Figure 4.5 Path diagram of the structural model for Shanghai group and Zhejiang group

Note: ***p<0.001, **p<0.01, *p<0.05

In Shanghai group, the link between third party and maturity of HIS is positive and significant (0.757, p<0.001), which suggests that H2 is strongly supported in Shanghai group. Hence, the third party can greatly improve the maturity of HIS. The path coefficient between technological barriers and maturity is not significant, therefore, H3a is not supported by the data. Thus, the technological barriers have no significant impact on maturity of HIS. The link between organizational barriers and maturity of HIS is negative and significant (-0.116, $p<0.01$), which indicates that H3b is supported. Of cause, the path coefficient is relatively small, which means that the impact of organizational barriers on maturity of HIS is small. The link between human barriers and maturity of HIS is negative and significant (0.093, $p<0.05$), therefore, H3c is supported. On the other hand, the small path coefficients between maturity of HIS and organizational and human barriers indicate that organizational barriers and human barriers have small effects on maturity of HIS. The link between success of HIS and technological barriers (-0.16, $p<0.05$), organizational barriers (-0.119, $p<0.05$), and human barriers (-0.203, $p<0.01$) are all negative and significant, these results show that H4a, H4b, and H4c are all supported. The impact of organizational barriers on maturity of HIS is small due to the small value of the path coefficient between them. In general, the three types of barriers have significant and negative impact on success of HIS in Shanghai. The link between maturity of HIS and success of HIS is positive and significant (0.279, $p<0.001$), which indicates that H5 is supported. Hence, the maturity of HIS has a significant impact on success of HIS.

For Zhejiang group, the path coefficients between the third party and technological barriers (-0.508, $p<0.001$), organizational barriers (-0.432, $p<0.001$), and human barriers (-0.464, $p<0.001$) are all negative and significant, which indicates that H1a, H1b, and H1c are all strongly supported. Therefore, the third party plays a significant role in reducing barriers to HIS. Again, the results show that, compared with the other two barriers, the third party plays a greater role in reducing technological barriers due to the larger path coefficient. H2 is also supported because the link between third party and maturity of HIS is positive and significant (0.664, $p<0.001$). Thus, the third party also helps to improve the maturity of HIS in less developed regions like Zhejiang.

In Zhejiang group, because the path coefficients are not significant, H3a, H3b, and H3c are not supported. Thus, it is interesting to find that maturity of HIS are not significantly impacted by the three types of barriers. Among the hypotheses H4a, H4b and H4c, only H4c is supported, however, H4a and H4b are not supported. Hence, of the three types of barriers, only human barriers have negative and significant impact on the success of HIS (-0312, $p<0.001$). The link between maturity of HIS and success of HIS is positive and significant (0.387, $p<0.001$), thus, H5 is strongly supported. This suggests that human barriers have a significant impact on success of HIS.

Comparing the results of figure 4.2 with those of figure 4.5, we find that the impact of the third party on the three types of barriers in Shanghai group are similar to those in all samples. The impact of third party on maturity of HIS and that of maturity of HIS on success of HIS are the same. The small effect of technological barriers on the maturity of HIS becomes insignificant in Shanghai group.

On the other hand, although the impact of organizational barriers on success of HIS and human barriers on maturity of HIS become significant, the path coefficients are very small.

The main difference between figure 4.2 and 4.5 comes from the path coefficient from organizational barriers to maturity of HIS. It is small in all samples and becomes nonsignificant in Zhejiang group. Therefore, although the difference exists, the results for the Zhejiang group almost are the same as those for the all samples.

To further explore which path coefficients in the structural model are different between the samples of Shanghai (SH) and Zhejiang (ZJ), the results of hypotheses testing for the two different groups are shown in table 4.7.

It can be seen from table 4.7 that that the third party plays an important role in HIS of the two different regions. H1a, H1b, H1c are all strongly supported in both Shanghai and Zhejiang groups, which indicates that the third party is significantly and negatively associated with the three types of barriers. In addition, the path coefficients between the third party and the three types of barriers in Zhejiang group are all larger than the corresponding coefficients in Shanghai group. This indicates that the third party plays a greater role in reducing the barriers in Shanghai than in Zhejiang.

H2 also strongly supported in both Shanghai (0.757, $p<0.001$) and Zhejiang groups (0.664, $p<0.001$), which suggests that the third party has a significant and positive impact on the maturity of HIS in the two regions. The path coefficient of Shanghai group is larger than that of Zhejiang group, which suggests that the role of the third party in improving the maturity of HIS is greater in Shanghai than in Zhejiang.

The results show that the impact of three types of barriers on maturity of HIS in Shanghai group and Zhejiang group are slightly different. H3a is not supported in both Shanghai group and Zhejiang group, which means that technological barriers have not impact on the maturity of HIS for these two groups. H3b is supported in Shanghai group (-0.116, $p<0.01$), however, it is not supported in Zhejiang group. This indicates that the organizational barriers have a significant impact on the maturity of HIS in Shanghai but not in Zhejiang. H3c is supported in Shanghai group (0.093, $p<0.05$), however, it is not supported in Zhejiang group. Therefore, the human barriers are significantly related to the maturity of HIS in Shanghai but not in Zhejiang. Although H3b and H3c are supported differently in the two groups, it can be seen that the values of the path coefficients are all lower than 0.13 when they are significant. Therefore, there is little difference in H3a, H3b, H3c of the two groups.

Table 4.7 Results of the path analysis for the two groups

Path	Group	Std.	SE	t-value	p	Results
H1a Third party → Technological barriers	SH	-0.478	0.038	-6.56	***	Supported
	ZJ	-0.508	0.053	-9.42	***	Supported
H1b Third party → Organizational barriers	SH	-0.334	0.038	-6.58	***	Supported
	ZJ	-0.432	0.051	-7.24	***	Supported
H1c Third party → Human barriers	SH	-0.385	0.052	-7.99	***	Supported
	ZJ	-0.464	0.057	-7.91	***	Supported
H2 Third party → Maturity	SH	0.757	0.037	17.39	***	Supported
	ZJ	0.664	0.049	12.76	***	Supported
H3a Technological barriers → Maturity	SH	-0.012	0.04	-0.24	0.809	Not supported
	ZJ	-0.128	0.064	-1.94	0.053	Not Supported
H3b Organizational barriers → Maturity	SH	-0.116	0.046	-2.85	0.004	Supported
	ZJ	-0.082	0.063	-1.44	0.15	Not supported
H3c Human barriers → Maturity	SH	-0.093	0.037	-2.03	0.042	Supported
	ZJ	-0.015	0.054	-0.27	0.79	Not supported
H4a Technological barriers → Success	SH	-0.16	0.051	-2.15	0.031	Supported
	ZJ	-0.14	0.065	-1.80	0.073	Not Supported
H4b Organizational barriers → Success	SH	-0.119	0.06	-2	0.045	Supported
	ZJ	-0.014	0.064	-0.21	0.833	Not supported
H4c Human barriers → Success	SH	-0.203	0.048	-2.99	0.003	Supported
	ZJ	-0.312	0.057	-4.61	***	Supported
H5 Maturity → Success	SH	0.279	0.045	5.53	***	Supported
	ZJ	0.387	0.048	6.9	***	Supported

Note: ***$p<0.001$

H4a is supported in Shanghai group (-0.16, $p<0.05$) but not in Zhejiang group, which indicates that the technological barriers are only significantly associated with the success of HIS in Shanghai. H4b is supported in Shanghai group (-0.119, $p<0.05$), however, it is not supported in Zhejiang group. So, it is surprising to see that the organizational barriers do not have a significant impact on the success of HIS in Zhejiang. The effect in Shanghai group is weak due to the low value of path coefficient. H4c is supported both in Shanghai group (-0.203, $p<0.01$) and Zhejiang group (-0.312, $p<0.001$). This suggests that the impact of the human barriers on the success of HIS in these two regions are both significant and negative and the effect are larger in Zhejiang than in Shanghai.

H5 is supported in both Shanghai and Zhejiang groups, which suggests that the success of HIS in these two regions is significantly and positively affected by the maturity of HIS. However, the path coefficient between maturity of HIS and success of HIS in Zhejiang group is larger than that in Shanghai group, which indicates that maturity of HIS has a greater impact on success of HIS in Shanghai than in Zhejiang.

From figure 4.5 and table 4.7, the total effects of the third party on the success of HIS can be calculated for the two groups. For Shanghai group and Zhejiang group, the total effects are 0.501 and 0.402, respectively. Comparing the total effect of the two groups, it can be seen that the third party has a greater impact on success of HIS in Shanghai group than in Zhejiang group. If the total effects of the two groups are compared with the total effects of the full sample in subsection 4.1.2 (0.463) respectively, the total effect of Shanghai group is higher tan that of the full sample and the total effect of Zhejiang group is lower than that of the whole sample.

4.4 Results for the nested models

Now we test the model with H6 which suggests that third party has a directly impact on the success of HIS. From the point view of the theoretical model, H6 adds another path in the structural models discussed in the previous sections. For this reason, the structural models in section 4.1 and 4.2 are nested within the new structural models with the additional links from the third party to the success of HIS. Due to the new path added within the path diagram, the hypotheses should be tested again.

In the following analysis, the hypotheses in Chapter 2 are tested together with H6. Next, we present the analytical results of the second-order factor (barriers) model with the new path. Then the results of the multi-group analysis with H6 are stated.

4.4.1 The first-order factor model with the new path

Now we test the hypotheses from H1a to H5 stated in Chapter 2 with H6. The indices of goodness-of-fit for the new structural models are listed in annex C. The structural model of the first-order factor model with the new path is shown in annex D.

The values of the x^2/df, RMSEA, NFI, IFI and CFI are all between the ideal values and the loose values except GFI, therefore, most of the indices provide acceptable goodness-of-fit for the structural model.

Figure 4.6 shows the path diagram with the estimates of the path coefficients between the latent variables of the new structural model. It also provides the significance levels of the path coefficients.

The paths between the third party and the technological (-0.491), organizational barriers (-0.376) and human barriers (-0.418) are still negative and significant ($p<0.001$). Therefore, H1a, H1b and H1c are strongly supported. More importantly, compared the results in figure 4.6 with those in figure 4.2, the appearance of the new path does not change the values of the path coefficients between the third party and the three types of barriers. Thus, relationships between the third party and the three types of barriers are robust.

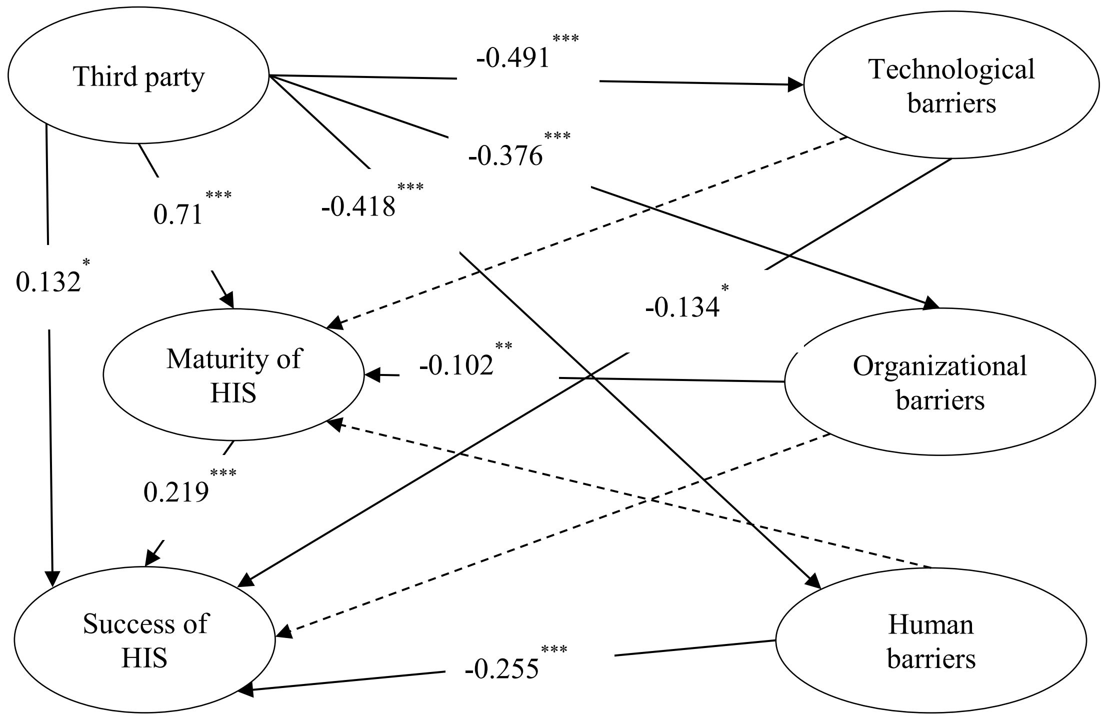


Figure 4.6 Path diagram of the structural model with the new path

Note: ***p<0.001, **p<0.01, *p<0.05

H2 is also strongly supported because the link between the third party and maturity of HIS is positive and significant (0.71, $p<0.001$). The path coefficient is slightly different from that in figure 4.2. That is to say, the new path from the third party to the success of HIS does not obviously change the impact of the third party on the maturity of HIS.

H3b are also supported. The value and the significant level of the path coefficient from the technological and organizational barriers to the maturity are the same as those in figure 4.2. The links from the technological barriers and human barriers to maturity of HIS are not significant ($p>0.05$) as in figure 4.2. Thus, H3a and H3c are not supported.

Although the path coefficient from human barriers to the success of HIS is slightly smaller than those in figure 4.2, the significant levels of them are at 0.05 and 0.001, respectively. Thus, H4a and H4c are all supported.

The link from the organizational barriers to the success of HIS in the former is not significant ($p>0.05$). Thus, H4b is not supported as in figure 4.2.

H5 is also strongly supported because the path coefficients from the maturity to the success of HIS is positive and significant (0.219, $p<0.01$). This result is the same as that of figure 4.2.

The new path from the third party to the success of HIS is 0.132 and significant at 0.05 level. Thus, H6 is supported. This result shows that the third party has a positive and significant impact on the success of HIS. In other words, the third party can affect the success of HIS directly and indirectly.

The standardized coefficients, standard errors, t-statistic and p values of the path can be found in the table 4.8.

Table 4.8 Results of the path analysis for the new structural model

Path	Std.	SE	t-value	p	Results
H1a Third party ⟶ Technological barriers	-0.491	.036	-14.21	***	Supported
H1b Third party ⟶ Organizational barriers	-0.376	.031	-9.69	***	Supported
H1c Third party ⟶ Human barriers	-0.418	.038	-11.22	***	Supported
H2 Third party ⟶ Maturity	0.71	.030	21.37	***	Supported
H3a Technological barriers ⟶ Maturity	-0.078	.035	-1.91	.056	Not supported
H3b Organizational barriers ⟶ Maturity	-0.102	.038	-3.05	.002	Supported
H3c Human barriers ⟶ Maturity	-0.043	.031	-1.22	.224	Not supported
H4a Technological barriers ⟶ Success	-0.134	.040	-2.51	.012	Supported
H4b Organizational barriers ⟶ Success	-0.079	.044	-1.80	.072	Not supported
H4c Human barriers ⟶ Success	-0.255	.036	-5.41	***	Supported
H5 Maturity ⟶ Success	0.219	.049	3.95	***	Supported
H6 Third party ⟶ Success	0.132	0.042	2.494	0.013	Supported

Note: ***p<0.001, **p<0.01, *p<0.05

The last column of it lists the results of the hypotheses for the new structural model. All the results of the hypotheses testing are the same as those in table 4.2. And the new added hypothesis for the direct impact of the third party on the success of HIS is also supported as expected.

Although H3b, H4a and H6 are supported, the path coefficients of them are all lower than 0.14. This suggests that the effects of organizational barriers on maturity of HIS and technological barriers on success of HIS are very low even if the path coefficient is significant. In addition, the direct effect of third party on success of HIS is also very small, which indicates that third party influences success of HIS mainly through maturity of HIS and the three types of barriers rather than directly.

The total effect of the third party on the success of HIS can be also calculated from figure 4.6 and table 4.8 and the result of calculation is 0.509. Compared with the result in subsection 4.1.2 (0.463), for the first-order factor model, adding a new path increases the total effect value by about 10%. Compared with the result in subsection 4.2.3, the total effect of the first-order factor model with the new path is also larger than that of the second-order factor model without new path (0.443). These results show that although the direct impact of the third party on success of HIS is relatively small, it still increases its overall impact on the latter.

4.4.2 The second-order factor model with the new path

Because we still use barriers extracted from the three types of barriers as the second-order factor, the measurement model, the reliability and validity of the second-order factor model with the new path are the same as those in subsection 4.2.1. The structural model of the second-order factor model is shown in annex E.

The fitting indices of the structural model of this subsection are listed in annex F.

It can be seen from this table that the values of CFI and IFI are all 0.91 and reach the ideal value. And the values of χ^2/df (4.68), RMSEA (0.067) and NFI (0.888) are between the ideal values and loose values. The only exception which makes the result mixed is that GFI (0.722) does not reach the loose value. Generally speaking, the model fits the data well.

Figure 4.7 shows the path diagram with the new path added in the second-order factor model. The path coefficients and the significant levels are also presented.

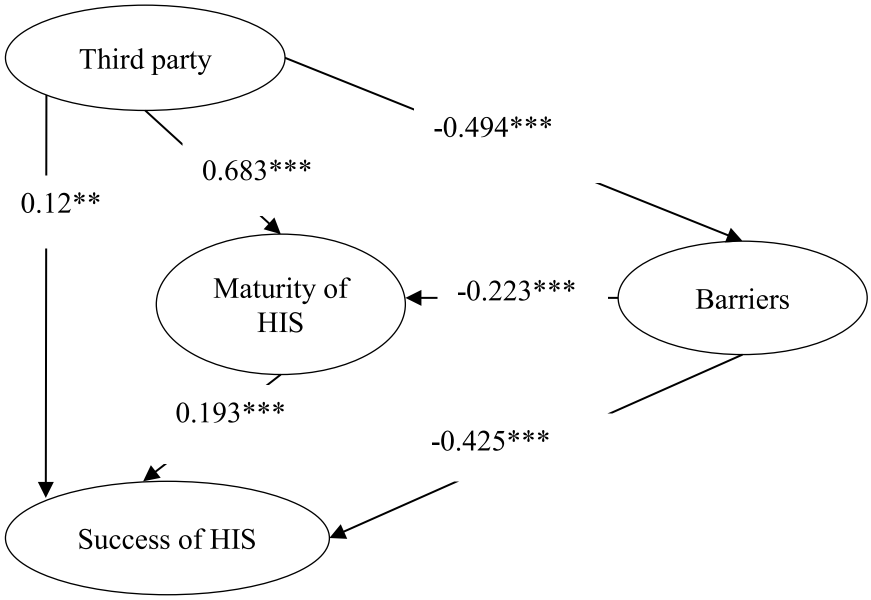


Figure 4.7 Path diagram of the second-order factor model with the direct effect of the third party on the success of HIS

Note: ***p<0.001, **p<0.01, *p<0.05

The effect of the third party on the success of HIS is significant and positive (0.12, p<0.05), however, it is low because of the low value of the coefficient. This suggests that the third party is directly and positively associated with the success of HIS. Thus, H6 is supported in the new second-order factor model.

The other path coefficients between the latent variables in figure 4.7 are also significant (p<0.001) and the same signs of the corresponding path coefficients in figure 4.4. The link from the third party to barriers is -0.494 (p<0.001), which indicates that H2 is strongly supported.

The path coefficient between maturity of HIS and success of HIS is 0.193, therefore, H5 is supported. These results indicate that the third party can influence success of HIS via maturity of HIS when the second-order factor of barriers are extracted and H6 is added to the model. At the same time, the relationship between the barriers and the other three latent variables-the third party (-0.494, $p<0.001$), the maturity of HIS (-0.223, $p<0.001$) and success of HIS (-0.425, $p<0.001$) are all negative and significant. Hence, H1, H3 and H4 are all supported when the second-order factor model includes the new path.

Based on above analysis, in the second-order factor model, third party has a direct impact on success of HIS besides the indirect impact on it via the barriers and the maturity of HIS. On the other hand, the direct effect is very small due to the small coefficient.

It can be calculated from figure 4.7 that the total effect of the third party on the success of HIS is 0.484. Compared with the total effect of the second-order factor model without the new path (0.443) in subsection 4.2.3, the emergence of the new path slightly increase the total effect.

Compared with the total effects of the first-order factor model of the full sample in subsection 4.1.2 (0.463) and Zhejiang group in subsection 4.3.2 (0.402), we can also see a small increase for the total effect with the new path. And it is slightly smaller than the total effects of the first-order model of Shanghai group in the subsection 4.3.2 (0.501) and the full sample in subsection 4.4.1 (0.509).

4.4.3 Multi-group test with the new path

The method in section 4.3 is used to test whether the path coefficients are different between Shanghai and Zhejiang groups with the addition of the new path. In a base-line model, the path coefficients of the two groups are freely estimated. In a parallel model, the corresponding path coefficients of the two groups are assume to be equal. The fitting indices of the two models are listed in table 4.9. Most of them show that the structural models are acceptable.

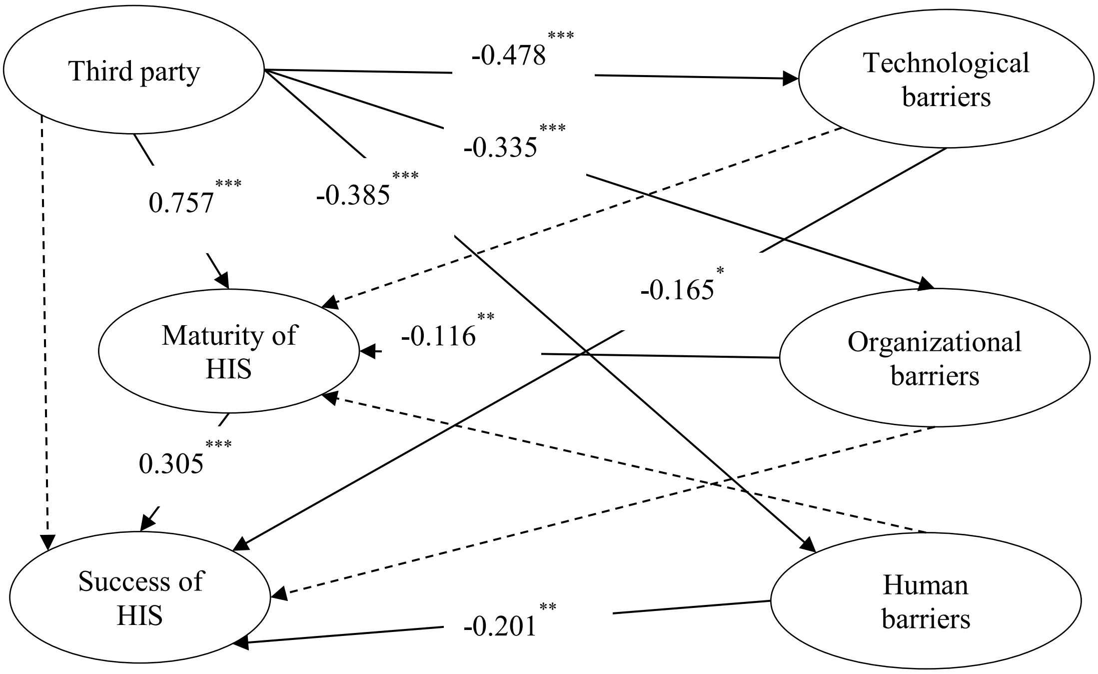
Table 4.9 Fitting indices for the base-line model and the parallel model with the new path

Model	χ^2	df	P	χ^2/df	GFI	NFI	IFI	CFI	RMSEA
Base-line model	8297	2226	0.000	3.728	0.70	0.831	0.87	0.87	0.058
Parallel model	8405	2281	0.000	3.685	0.697	0.829	0.869	0.869	0.057

The difference of the values of χ^2 and the degrees between the base-line model and the parallel model is $\triangle\chi^2=107.89$ and $\triangle df$=55, which is significant at 0.05 level. Therefore, the two groups have significantly different structural models.

The path diagram of Shanghai group and Zhejiang group can be found in figure 4.8 with the path coefficients and significant levels, respectively. The key difference between them is that the link from the third party to the success of HIS.

Shanghai Group



Zhejiang Group

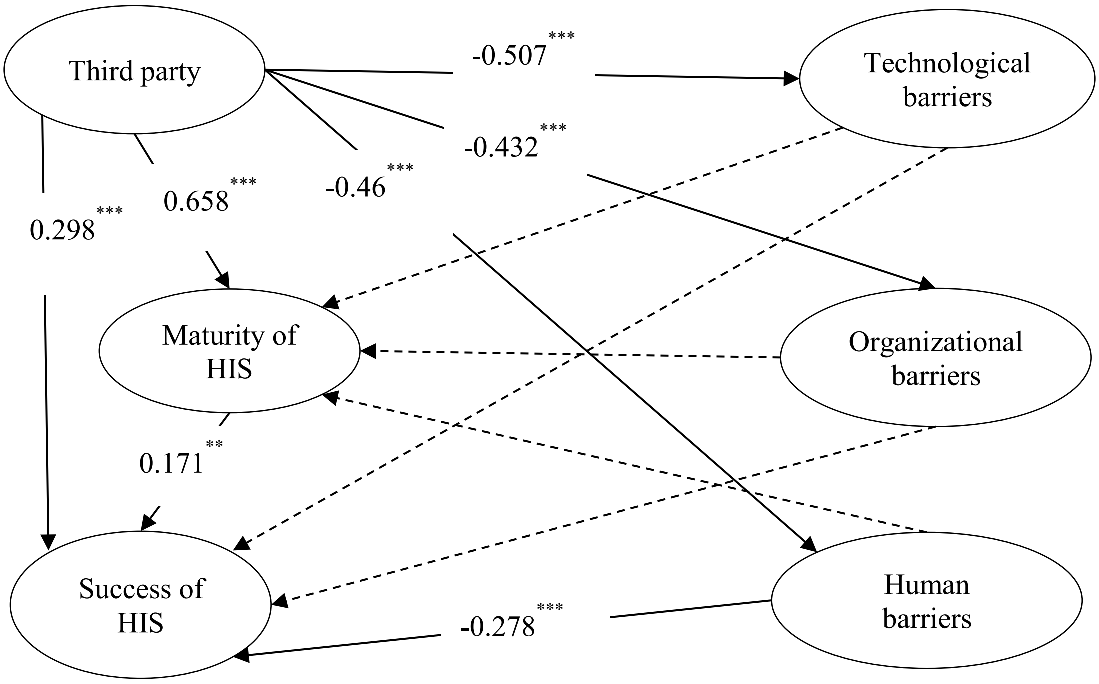


Figure 4.8 Path diagram of the structural model for Shanghai group and Zhejiang group with the direct effect of the third party on the success of HIS

Note: ***p<0.001, **p<0.01, *p<0.05

For Shanghai group, the path coefficients between third party and technological barriers (-0.478, p<0.001), organizational barriers (-0.335, p<0.001)), human barriers (-0.385, p<0.001) are all negative and significant. Thus, H1a, H1b and H1c are all supported. This suggests that even if the direct impact of the third party on success of HIS is considered, the third party can still significantly reduce the three types of barriers.

In Shanghai group, the link from the third party to maturity of HIS is positive and significant (0.757, $p<0.001$), which lends strongly support for H2. The path coefficients between the maturity of HIS and technological barriers and human barriers are not significant, hence, H3a and H3c are not supported. H3b is supported because the link from organizational barriers to maturity of HIS is negative and significant (-0.116, $p<0.01$). Therefore, among the three types of barriers, only organizational barriers are significantly associated with maturity of HIS when the new path is added. The links from technological barriers and human barriers to maturity of HIS are negative and significant. Thus, H4a and H4c are supported. H4b is not supported because the path coefficient between organizational barriers and success of HIS is not significant. The results about H4a, H4b and H4c show that success of HIS is significantly impacted by both technological barriers and human barriers, but not by organizational barriers. The path coefficient between maturity of HIS and success of HIS is positive and significant (0.305, $p<0.001$), which indicates H5 is supported. H6 is not supported because the link from third party to success of HIS is not significant. Therefore, third party has not a direct impact on success of HIS in Shanghai group.

After considering the direct impact of third parties on success, we can compare the results of Shanghai group with those in subsection 4.3.1 by figure 4.5 and figure 4.8. The impact of third party on the three types of barriers and maturity of HIS, the impact of technological barriers and organizational barriers on maturity of HIS are almost the same when considering or not considering the direct influence of third party on success of HIS. However, when the new path was introduced into the model, the influence of human barriers on maturity of HIS and organizational barriers on success of HIS are no longer significant. This suggests that, in Shanghai group, organizational barriers have no impact on success of HIS and human barriers have no impact on maturity of HIS if the direct impact of the third party on the success of HIS is considered. In addition, maturity of HIS has a little more impact on success of HIS when the new path is added.

For Zhejiang group, the path coefficients between the third party and technological barriers (-0.507, $p<0.001$), organizational barriers (-0.432, $p<0.001$) and human barriers (-0.46, $p<0.001$) are negative and significant. Hence, H1a, H1b and H1c are all supported. The link from third party to maturity of HIS is positive and significant (0.658, $p<0.001$), which shows that H2 is strongly supported. The path coefficients between maturity of HIS and the three types of barriers are all not significant, therefore, H3a, H3b and H3c are not supported. The path coefficients between success of HIS and technological barriers and organizational barriers are not significant, which indicates that H4a and H4b are not supported. H4c is supported because the link between human barriers and success of HIS is negative and significant (-0.278, p<0.001). H5 is supported due to the positive and significant path coefficient between maturity of HIS and success of HIS (0.171, p<0.01). H6 is supported because the link from third party to success of HIS is positive and significant (0.298, p<0.001). This is interesting because third party has a direct impact on success of HIS in Zhejiang group.

Compared figure 4.5 and figure 4.8, when the new path is added into the structural model, the results of Zhejiang group remain unchanged. However, most of the path coefficients corresponding to the Zhejiang group in figure 4.8 are slightly smaller than those in figure 4.5. This may be because the coefficient of the newly added path is significant.

All the statistical results are summarized in table 4.10. Next, we compare the results between the two groups with the new path.

Table 4.10 Results of the path analysis for the two groups with the new path

Path	Group	Std.	S.E.	T-value	P	Results
H1a Third party → Technological barriers	SH	-0.478	0.05	-10.61	***	Supported
	ZJ	-0.507	0.053	-9.41	***	Supported
H1b Third party → Organizational barriers	SH	-0.335	0.038	-6.58	***	Supported
	ZJ	-0.432	0.051	-7.24	***	Supported
H1c Third party → Human barriers	SH	-0.385	0.052	-8.00	***	Supported
	ZJ	-0.46	0.057	-7.86	***	Supported
H2 Third party → Maturity of HIS	SH	0.757	0.037	17.40	***	Supported
	ZJ	0.658	0.049	12.64	***	Supported
H3a Technological barriers → Maturity of HIS	SH	-0.012	0.04	-0.24	0.81	Not supported
	ZJ	-0.128	0.064	-1.93	0.054	Not supported
H3b Organizational barriers → Maturity of HIS	SH	-0.116	0.046	-2.85	0.004	Supported
	ZJ	-0.081	0.064	-1.43	0.154	Not supported
H3c Human barriers → Maturity of HIS	SH	-0.093	0.037	-2.03	2.03	Not Supported
	ZJ	-0.02	0.054	-0.37	0.714	Not supported
H4a Technological barriers → Success	SH	-0.165	0.052	-2.19	0.029	Supported
	ZJ	-0.121	0.063	-1.61	0.108	Not supported
H4b Organizational barriers → Success	SH	-0.115	0.06	-1.93	0.054	Not Supported
	ZJ	-0.013	0.063	-0.20	0.841	Not supported
H4c Human barriers → Success	SH	-0.201	0.048	-2.95	0.003	Supported
	ZJ	-0.278	0.055	-4.29	***	Supported
H5 Maturity of HIS → Success	SH	0.305	0.077	3.54	***	Supported
	ZJ	0.171	0.062	2.41	0.016	Supported
H6 Third party → Success	SH	-0.03	0.062	-0.37	0.708	Not supported
	ZJ	0.298	0.058	4.25	***	Supported

Note: ***p<0.001, **p<0.01, *p<0.05

The biggest difference between the results of the two groups is that the third party has a direct and significant impact on the success of HIS in Zhejiang group, however, this result is not found in Shanghai group. Thus, H6 is strongly supported by Zhejiang group but not by Shanghai group. This suggests that in less developed regions like Zhejiang, the third party can affect success of HIS directly and indirectly. However, in developed regions like Shanghai, the third party mainly affects success of HIS indirectly rather than directly.

In the two groups, the testing results of some other hypotheses are also different as the new path joins in. H3a, H3c and H4b are not supported by Zhejiang group and Shanghai group. This suggests that the impact of technological barriers on the maturity of HIS, the impact of human barriers on maturity of HIS and the impact of organization barriers on success of HIS are not significant in the two groups. H3b and H4a are supported by Shanghai group but not by Zhejiang group. These results show that the organizational barriers have negative impact on the maturity of HIS in Shanghai but not in Zhejiang. In addition, the technological have negative impact on the success of HIS in Shanghai but not in Zhejiang.

However, although the results of H3b and H4a are different between Shanghai and Zhejiang group, the differences are slight. The coefficients between the variables in these hypotheses are all lower than 0.17, which indicates that the effects are small even if they are significant.

H1a, H1b, H1c, H2, H4c and H5 are supported by both Shanghai and Zhejiang group. Therefore, the third party has a significant and negative impact on the three types of barriers both in Shanghai and Zhejiang. So does the impact of the third party on the maturity of HIS. In both Shanghai and Zhejiang, the impact of the human barriers on the success of HIS is significant and negative and the impact of the maturity of HIS on the success of HIS is significant and positive. These results show that, in both developed and underdeveloped areas, the third party plays an important role in reducing barriers to HIS and improving maturity of HIS. In addition, human barriers and maturity of HIS are important factors that affect success.

The total effects of the third party on success of HIS for the two groups can also be calculated from figure 4.8 or table 4.10. The total effect values of Shanghai group and Zhejiang group are 0.437 and 0.538. This indicates that the overall impact of the third party on the success of HIS in Zhejiang group is about 20% higher than that in Shanghai group. Therefore, the third party plays a greater role in promoting HIS in Zhejiang than in Shanghai.

Compared with the total effects of the first-order factor model without the new path for the full sample in subsection 4.1.2 (0.463), the total effects of the first-order factor model with the new path in Shanghai group and Zhejiang group are slightly smaller and larger, respectively. Compared with the total effects of the first-order factor models without the new path for the Shanghai group (0.501) and Zhejiang group (0.402) in subsection 4.3.2, the total effect of the first-order factor model of Shanghai group is slightly smaller. However, for Zhejiang group, the total effect increases by more than 30%. This provides another evidence that third party plays a greater role in HIS in Zhejiang than in Shanghai.

Compared with the total effect of the second-order factor model without the new path in subsection 4.2.3 (0.443), the total effect of Shanghai group is slightly smaller and that of Zhejiang group increases by more than 20%. Compared with the total effect of the second-order factor model with the new path in subsection 4.4.2 (0.484), the total effect of Shanghai group is slightly smaller and that of Zhejiang group is slightly larger. These results also show that the third party in Zhejiang has plays a greater role in promoting HIS.

From the above analysis of the total effect, it can be seen that in general, the role of third parties in information sharing is greater in the Zhejiang group than in the Shanghai group.

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Chapter 5: Discussion and Conclusion

5.1 Discussion

Healthcare information sharing is an effective way to reduce the medical expenses and improve the quality of medical services. In the practice, however, the successful implementation of it faces many challenges whether in developed or developing countries. In China, HIS is also in progress and important for the improvement of the healthcare system.

This study focuses on how to achieve the success of HIS based on third party and the main work of this study can be divided into four parts:

1. The theoretical model reflecting the success of HIS was established after the literature has been systematically reviewed. The hypothesized relationships among different variables, including the variables of third party, technological barriers, organizational barriers, human barriers, maturity of HIS and success of HIS, were prompted.

2. An original scale was developed to measure the latent variables used in this study. The scale was adapted from the literature and all the constructs are measured by more than three items.

3. To collect the data, the questionnaire was sent to the professionals (doctors and nurses) working in the five hospitals in Shanghai and Zhejiang province. 818 valid answers were left when invalid ones were deleted.

4. The validity and reliability of the scale were evaluated with different methods. The hypotheses with SEM were tested to explain how the success of HIS was influenced by the third party, the maturity of HIS and the three types of barriers. In addition, the second-factor structural models related to the three types of barriers were also established and tested.

The results of this study answer the research question of how to achieve the success of HIS by analyzing the relationships between the third party, the barriers to HIS and the maturity of HIS. There are several important implications that the countries like China should consider when they implement HIS.

5.1.1 The third party facilitating HIS

This study firstly focuses on the role a third party plays in HIS. The first sub-question how the third party can influence the healthcare information sharing in China is answered by analyzing the relationships between it and the barriers to HIS, maturity of HIS and success of HIS.

Although previous studies have classified HIS platforms based on third parties, they have not studied the role of third parties in reducing barriers to HIS (Castillo et al., 2018; Vest & Kash, 2016; Yaraghi et al., 2013). The results of this study show that the third party has moderate significant and negative impact on the three types of barriers or the barriers when they are treated as whole. And the path coefficients of the third party to the three different barriers (including the barriers as a whole) in all cases are between -0.334 and -0.508 ($p<0.001$). Thus, the hypothesis that the third party is important for reducing the technological, organizational and human barriers of HIS is supported. Due to the negative relationship between the barriers and the success of HIS, the first way that the third party influences the success of HIS is by acting on the barriers to HIS.

On the whole, the third party has a positive impact on the success of HIS although the results are different in different regions. The path coefficients between them are less than 0.3 and much less than those of the third party to the maturity of HIS. The absolute values of the path coefficients of the third party to the barriers to HIS are also much more than them. Therefore, it seems that the main role of the third party in HIS is to improve the maturity and reduce the barriers rather than directly promote the success of HIS.

This study highlights the importance of the third party in HIS. The findings show that the third party can influence the success of HIS directly and indirectly via the maturity of HIS and the barriers to HIS, which provides evidence for the important role of the third party plays in HIS. Although previous studies have proposed HIS models based on third parties, they did not mention the role of third parties in HIS. For example, Everson (2017), Solomon (2007), Vest et al. (2013) have proposed three types of HIS modes, i.e., community HIE, enterprise HIE and EHR vendor-mediated HIE, however, these studies only describe the work done by the third parties in HIS, such as data collection and exchange. They did not study the impact of the third parties on reducing barriers to HIS, improving maturity and success of HIS.

The third party can also influence the success of HIS via the path from the barriers to the maturity of HIS, however, the results are more questionable. In the Shanghai hospitals, the relationship between the technological barriers and the maturity of HIS is not significant. In the Zhejiang hospitals, the organizational and human barriers have no significant impact on the maturity of HIS. Therefore, the second way that the third party influences the success of HIS is different in the two regions. In regions with general economic development like Zhejiang, the third party can facilitate HIS via the path from the technological barriers to maturity. In the regions with a better-developed economy like Shanghai, the third party can facilitate HIS via paths from the organizational and human barriers to the maturity of HIS. Akhlaq et al. (2016) and Seyedin & Jamali (2011) have studied HIS in different countries, however, the research on HIS in regions with different levels of development within a country is rare. This study is very important to understand HIS within a country like China, because different regions within the same country are in the same medical system even though their development levels are different.

The third party also has a high significant and positive direct impact on the maturity of HIS in all cases. The path coefficients of the third party to the maturity of HIS in all cases are between 0.658 and 0.757 ($p<0.001$). It seems that the third party has a stronger impact on the maturity of HIS than on the barriers to HIS.

Therefore, the third party is important for improving the maturity levels of HIS. In previous studies, scholars have not studied the relationship between the third party and maturity of HIS. For example, Vest & Kash (2016) and Cannoy and Carter (2011) argue that the platform based on the third party is conducive to HIS, but it also faces many incentive problems, including difficulties in coordinating the interests of all stakeholders involved on the platform.

Many countries try to overcome the obstacles of HIS by strengthening the construction of information infrastructure and giving doctors subsidies (Gunasekaran et al., 2017; Lluch, 2011; Thomas, 2009). However, these measures may not be enough. At different stages of maturity of HIS, the hospitals need to complete many tasks, including setting goals, formulating and implementing plans, seeking financial support and finding sustainable operational models. In developing countries, therefore, the low maturity of HIS may be a problem for the implementation of HIS. Without the help of external forces, it is difficult to improve the maturity of HIS by the hospitals themselves. The third parties, whether the local governments, the core hospitals of the medical cluster, or the vendors of the healthcare information systems, can help the hospitals overcome the difficulties in improving the maturity levels of HIS. Previous studies on third-party HIE strategies mainly focused on the advantages and disadvantages and development of each third-party platform, and did not pay attention to the impact of third parties on maturity of HIS (Thorn et al., 2014; Vest et al., 2013). Because the maturity is positively associated with the success of HIS, the third way that the third party influences the success of HIS is by acting on the maturity of HIS.

Scholars' research on third-party HIS platforms does not involve the different roles played by third parties in different regions (Cannoy & Carter, 2011; Furukawa et al., 2014). It is interesting to find in this study that the relationship between the third party and the success of HIS is not significant in Shanghai group. However, the path coefficient between them in

Zhejiang group is 0.298 ($p<0.001$). Thus, the third party has a low direct impact on the success of HIS of Zhejiang group. This result indicates that the third party is more important to Zhejiang than to Shanghai. Thus, the fourth way the third party influences the success of HIS is the direct effect between them in the areas with general economic development level.

This finding suggests that the economically underdeveloped areas need more help from the third parties to successfully implement HIS. Part of the reason is that the hospitals in the economically developed regions implement HIS based on higher management levels, better information infrastructure and more financial aids. The third parties in regions like Shanghai influence the success of HIS via the indirect rather than direct paths. In the regions like Zhejiang, the low levels of management and infrastructure of the hospitals needs the third parties to directly help them to achieve both the organizational and individual success in the implementation of HIS.

These findings deepen the understanding of the third party in HIS. Previous research have not considered whether the role of third parties is different in different regions (Everson & Adler-Milstein, 2016; Furukawa et al., 2014). It can be seen from this study that the role of it is different in different regions. In developed regions, the third party is often acted by the large hospitals which organize other hospitals in the same regions to form medical consortiums. With the help from the local governments, they promote the success of HIS indirectly by improving the maturity of HIS and reducing the barriers to HIS. In less-developed regions, the hospitals implement HIS mainly by receiving the guidance from the hospitals in developed regions and the local governments. Thus, although developing countries lag behind developed countries in implementing HIS (Alsadan et al., 2015; Alwan et al., 2016), they can achieve success faster with the help of third parties.

This study is among the first to empirically prove the role of the third party in HIS. In previous studies, the third party has been mentioned, however, it has not been incorporated into the theoretical models (Cho et al., 2015; Khuntia et al., 2017) . The major reason is that other governments do not have as much influence on the healthcare system as Chinese government. China's medical resources are concentrated in public medical institutions. For example, in 2019, although the public medical institutions account for only about 35% of all the medical institutions, these public medical institutions have more than 72% of the beds, 78% of the medical technicians, 84% of total assets and 87% of the business income of the whole medical system. Therefore, compared with the governments in other countries, the Chinese government has a relatively greater impact on the medical system. In order to provide medical services to more people by reducing the medical expenses, Chinese government has a strong responsibility and motivation to promote the implementation of HIS. Based on China's special situation, it has become a wise choice to arrange a third party to coordinate the implementation of HIS. Although the findings in this study are directly related to China's medical management system, other developing countries like China can still benefit from arranging for the third parties to facilitate HIS when they decide to launch the plans of HIS.

5.1.2 Implications of the barriers to HIS

The barriers, as a whole, have significant and negative impact on the maturity and the success of HIS whether the direct impact of the third party on the success of HIS is considered or not, which indicates that the barriers have direct impact on the success of HIS and indirect impact through the maturity of HIS. Thus, it is important to reduce the barriers to improve the maturity levels of HIS and achieve the success of HIS.

Specifically, the results about the three types of barriers answer the second and the third sub-question of what the effects of technological, organizational and human barriers are on the healthcare information sharing in China. These three types of barriers have different impact on the maturity and the success of HIS. Next, they are individually discussed.

1. Technological barriers

As far as the technological barriers are concerned, they have four sub-dimensions: information quality, service quality, system quality and security and privacy. They have significant and negative impact on the maturity and the success of HIS whether the direct impact of the third party on the success of HIS is considered or not. Thus, the technological barriers can influence the success of HIS directly and indirectly via the maturity of HIS. This finding shows that the technological barriers hamper the success of HIS in developing countries like China and is consistent with previous studies (Feldman & Horan, 2011; S. C. Lin et al., 2018). Unlike developed countries, China launched its plan of HIS later in time and is still at the early stages of building the healthcare information system. There are many technological problems during the implementation process of HIS, such as imperfect information standards, incomplete data collection, untimely information transmission as discussed in the literature (N. I. Ismail & Abdullah, 2017; Stamatian et al., 2013). In practice, reducing the technological barriers is still an important task for the successful implementation of HIS.

On the other hand, the results of multi-group tests show that the impact of the technological barriers on the maturity and the success of HIS are slightly different between Shanghai group and Zhejiang group. In Shanghai group, the technological barriers have not significant impact on the maturity of HIS. However, in Zhejiang group, they have. This finding demonstrates that the maturity of HIS is not influenced by the technological barriers in the economically developed regions with better information infrastructure and higher management levels. In these regions, the hospitals have higher maturity of HIS because they have enough ability to make sound plans, get more adequate financial support, and are led by the stronger local governments to carry out the plans. Therefore, the maturity of HIS is not influenced by the technological barriers. As a result, the impact of the technological barriers on the success of HIS is direct but not indirect via the maturity of HIS.

In Shanghai group, the impact of the technological barriers on the success of HIS is not significant when the path from the third party to the success of HIS is considered. That is to say, in the developed regions, the technological barriers influence the success of HIS directly but not indirectly via the maturity of HIS. The technological barriers in developed regions don not become one of the major obstacles to the maturity of HIS due to better information infrastructure and more adequate financial support. Thus, the maturity of HIS is slightly or not impacted by the technological barriers.

These finding is interesting, because previous studies only focused on the direct impact of technical barriers on success of HIS and ignored the indirect impact (Dias et al., 2017; Hoque et al., 2017). This study finds that technical barriers will affect success of HIS via maturity of HIS in some cases. That is to say, the findings for technological barriers indicate that, in different regions, they affect the success of HIS in different ways. In economically developed regions, it is necessary to alleviate them to directly achieve the organizational and the human success of HIS. In less-developed regions, the reduction of technological barriers and the improvement of the success of HIS are mainly through the third parties.

2. Organizational barriers

Organizational barriers have five sub-dimensions: structure of healthcare organizational system, tasks, people policies, incentives and information decision process. Generally speaking, whether the direct impact of the third party on the success of HIS is considered or not, the organizational barriers are significantly and negatively associated with the maturity of HIS. Therefore, the organizational barriers can indirectly influence the success of HIS via the maturity of HIS. This finding coincides with the current theories (Eslami et al., 2017; Lluch, 2011; Sligo et al., 2017). On the other hand, the effects are very low due the low values of the path coefficients although they are significant.

The results become different when regional factors are taken into account. In Shanghai group, the results hold. However, in Zhejiang group, the organizational barriers have no significant impact on the maturity of HIS. This finding indicates that the reduction of the organizational barriers is very important for improving the maturity of HIS in developed regions, but they can not indirectly influence the success of HIS via the maturity in less-developed regions.

In Shanghai group, whether the direct impact of the organizational barriers on the success of HIS are significant or not depends on whether the new path is incorporated into the structural model. After the path from the third party to the success of HIS is considered, the relationship between the organizational barriers and the success of HIS changes from non-significant to significant. In multi-group analyses, the results about the relationship between the organizational barriers and the success of HIS are different. In the Shanghai group, the former always has a direct negative impact on the latter when the new path is not considered. In Zhejiang group, the relationship between the two is always nonsignificant. Thus, if HIS is mainly promoted by the third party, it is more important for the developed regions to reduce the organizational barriers.

From the above discussion, we find that the role of the organizational barriers varies greatly between the regions. They have significant negative impact on both the maturity and the success of HIS in developed regions like Shanghai. However, these impacts don not appear in the less-developed regions like Zhejiang. This is probably because the hospitals in China are run under highly hierarchical systems and the medical reform has not yet penetrated into the less-developed regions. As a result, the professionals of the hospitals in the less-developed regions feel that management systems are reasonable or difficult to be changed. In addition, the hospitals in developed regions have to corporate with the third parties to make plans of HIS, improve the maturity of HIS and overcome the barriers. The organizational barriers are major factors that influence the corporation in the implementation of HIS.

The hospitals in less-developed regions receive more guidance and help from the hospitals in developed regions through various channels, for example, being a member of a medical cluster led by a core hospital. In order to promote the cooperation among the hospitals, the third parties in the less-developed regions play more crucial roles in HIS. It is only necessary for these hospitals to follow the instructions from the third parties to implement HIS and the organizational barriers are no longer the problems.

These results are also interesting because previous studies have not considered the different roles played by organizational barriers in HIS in different regions (Adler-Milstein & Pfeifer, 2017; Mastebroek et al., 2014). This study shows that policy makers should consider their economic development level when implementing HIS in different regions, and reasonably allocate resources according to the actual situation of each region to reduce organizational barriers in HIS.

3. Human barriers

Human barriers have two sub-dimensions: perceived usefulness and perceived ease of use. If the two groups are analyzed together, the impact of human barriers on the maturity of HIS are always not significant whether the new path is considered or not. This finding is also a little surprise. However, the results of the multi-group analyses paint the different pictures and provide an explanation for it.

In Shanghai group, the maturity of HIS is negatively associated with the human barriers when the new path is not considered. In Zhejiang group, this relationship does not hold. Thus, the human barriers indirectly influence the success of HIS in developed regions rather than less-developed countries. This may be related to the quality of the professionals. Healthcare service is a kind of professional service which requires sufficient expertise. The professionals need to provide a patient with the customized medical plans according to the patient's condition. The doctors employed by the hospitals in developed regions like Shanghai have higher levels of education and have higher professional levels. They are more difficult to agree with the requirements of HIS and are more likely stick to their original practices which should be changed by HIS. Thus, the human barriers still have significant negative impact on the maturity of HIS in Shanghai. Due to worse medical conditions and lower medical treatment levels in less-developed regions like Zhejiang, the doctors are more willing to accept the guidance from the third parties and change the way they work according to the requirements of HIS. As a result, the human barriers have no significant influence on the maturity of HIS in Zhejiang.

In the literature, human barriers are considered to be obstacles that should be overcome in the implementation of HIS projects (Johnson et al., 2011; Mohamad Yunus et al., 2013). The findings of this study are essentially in accordance with this conclusion. The direct impact of the human barriers on the success of HIS are significant and negative in all cases. This finding indicates that reducing the resistance from the professionals is important to successfully implement HIS both in developed and less-developed regions. Although the introduction of the third parties contributes to reducing the human barriers, the third party cannot completely eliminate the direct negative impact of human barriers on success of HIS. Other ways are also needed to reduce the human barriers, such as training professionals to recognize the importance of HIS and master the skills required by HIS, improving the professionals' satisfaction of using the HIS systems.

However, as the technological barriers, we find that human barrier can influence success of

HIS via the maturity of HIS in some cases, which has not been mentioned in previous research (Gardner et al., 2019; Shank & Shank, 2012). This research shows that when implementing HIS in developed areas, in order to increase the possibility of success of HIS, policy makers still need to consider reducing human barriers to improve the maturity of information systems.

5.1.3 Implications for the maturity of HIS

The results of the maturity of HIS answer the fourth research sub-question of how the information system maturity influences healthcare information sharing in China. Scholars have proposed that maturity of HIS will affect HIS, but they have not made in-depth research on this aspect (Adjerid et al., 2018; Carvalho et al., 2019). It is an interesting finding of this study that the maturity of HIS has a significant positive impact on the success of HIS in all the cases. This relationship is significant at the 0.001 level in most cases, which indicates that the maturity of HIS is very important for the countries like China to implement HIS. With the rapid progress of information technology, the implementation of HIS has been equipped with the technical foundation. However, in practice, realizing it at low cost becomes a main problem. The improvement of the maturity of HIS can help the hospitals to more clearly recognize the importance of HIS by learning relevant government policies. If the maturity of HIS is higher, the hospitals will more fully communicate and discuss with each other about HIS and the HIS plans can be spread to other hospitals more easily when they are carried out. The HIS plans also will get more support from the hospitals and the doctors and can be developed and implemented more effectively. Thus, the success of HIS is more likely to be achieved at the organizational and the individual levels by improving the maturity of HIS. Previous studies proposed that maturity of HIS should be the base of implementation of HIS projects, this study provides evidence for this conclusion (Dullabh & Hovey, 2013; Parker et al., 2016).

When the impact of the third party on the success of HIS is considered, the path coefficient between the maturity and the success of HIS is 0.305 in Shanghai group and gets a minimum value of 0.171 in Zhejiang group. Thus, it seems that the maturity of HIS has a stronger impact on the success of HIS in developed regions than that in less-developed regions. That is to say, it is more important for developed regions to improve the maturity of HIS than less-developed regions when they decide to implement HIS plans.

These findings contribute to theoretical framework of HIS. Previous studies mainly focus on the impact of barriers to HIS on the success of HIS and rarely incorporate the impact of maturity of HIS into the theoretical models (Eden et al., 2016; Najaftorkaman et al., 2015). This study shows that the success of HIS is influenced not only by the three types of barriers as previous research discussed, but also by the maturity of HIS. Thus, the policy makers of HIS should deliberate on how to improve the maturity of HIS at the same time when they decide to implement HIS.

In previous studies (N. I. Ismail & Abdullah, 2017; Suh et al., 2017), the impact of the maturity of HIS on the success of HIS is seldom empirically studied. They often focus on all kinds of barriers to HIS and many solutions to these barriers have been proposed. This study is among the first to incorporate the maturity and the barriers into the models of HIS at the same time. Maybe the maturity of HIS in developed countries is not a problem, however, this study shows that it prevents HIS from being put into effect in developing countries like China.

5.1.4 Implications of success of HIS

As previous studies have pointed out, success of HIS consists of two dimensions: individual and organizational success (Cho et al., 2015; Delone & Mclean, 2003). Therefore, when implementing HIS, decision makers should use the indicators of these two dimensions to measure the success of HIS. In addition to the cost savings of the organization and the improvement of medical service quality, the success of HIS should also focus on whether it brings benefits to professionals, such as improving their work efficiency and saving their working time. The results of this study are the same as previous studies (Kivinen & Lammintakanen, 2013; Suh et al., 2017).

This study suggests that the success of HIS is influenced by many factors, such as the barriers to HIS, the third party, the maturity of HIS. In previous reach, the barriers to HIS are the main factors that hinder the success of HIS (Pai & Huang, 2011; Suh et al., 2017). However, we find that in some cases, such as in less-developed regions like Zhejiang, the technological and organizational barriers no longer influence the success of HIS due to the introduction of a third party. Third parties can help HIS platforms overcome these two barriers, so that they no longer hinder the success of HIS. Thus, when implementing HIS in different regions, if a third party is introduced, it is necessary to specifically analyze the impact of different barriers on success of HIS.

At the same time, the results of this study show that the third party and the maturity of HIS also have a significant impact on success. This means that simply reducing barriers to HIS may not be enough to achieve success of HIS. Giving full play to the role of third parties and improving maturity of HIS are also important ways to make HIS successful. Therefore, this study shows that the success of HIS is the result of multiple factors, which needs to be comprehensively considered in the implementation process.

5.1.5 Implications of policy makers

In addition to the theoretical implications discussed above, this study provides the policy makers with the framework to achieve the success of HIS. The third party and the maturity of HIS should be incorporated into the policy formulation besides the barriers to HIS. On the other hand, the regional differences should be considered when policies are formulated.

First, the government who wants to implement HIS should establish a third-party organization to help the hospitals and doctors to create, collect, manage and share the patients' information among the hospitals. In previous studies, although third-party HIS platforms have been studied, these studies did not pay special attention to the role that third parties can play in HIS (Everson, 2017; Vest & Kash, 2016). These studies often point out that governments worldwide have provided huge financial support for HIS, but ignore the role that third parties can play during the process of HIS implementation (Adler-Milstein & Jha, 2014; Thomas, 2009). From the perspective of the practice in China, a core hospital of a region often acts as the third party. In the presence of the third party, the hospitals can reduce the three types of barriers and improve the maturity of HIS because they can get guidance and support from it. They also can effectively resolve the conflicts among them by fully discussion led by the third party. Thus, the third party can improve the success of HIS indirectly. In less-developed regions, the third party can even directly improve the likelihood of HIS success.

Second, it is necessary for the policy makers to improve the maturity of HIS which can lead them to carefully consider the implementation process of HIS. Many stakeholders are involved and a lot of tasks should be completed in this process. Previous research shows that many governments have spent a lot of money on HIS to encourage doctors to use HIS systems (Heath et al., 2017; Lluch, 2011). If the maturity of HIS is low, HIS probably can not be carried out orderly and slides into chaos even with sufficient financial support. From building a consensus of HIS importance among the hospitals to extend the achievements of HIS to other hospitals, the policy makers can use the maturity of HIS as a guidance to look after the interests of all stakeholders and implement HIS step by step. Planning the process of HIS systematically and implementing the plan orderly improve the success of HIS.

Third, the policy makers should consider the differences between the regions when they decide to carry out HIS. Previous studies, such as Braa et al. (2007), Alsadan et al. (2015) and

Akhlaq et al. (2016), argue that there are great differences in the development level of HIS between developed and developing countries. However, they believe that to solve the problem of HIS in developing countries, it is still mainly to remove barriers, rather than considering the introduction of third parties and improving maturity of HIS at the same time. This study provides policy makers with more ways to achieve the success of HIS. In less-developed regions, the impact of organizational barriers on maturity and the success of HIS is not significant. Therefore, the policy makers of these regions don not need to spend a lot of resources on reducing organizational barriers. It seems that the introduction of the third party and the improvement of the maturity of HIS can solve the organizational barriers that the hospitals may encounter. So, it is more important for the policy makers of less-developed regions to bring the third party into full play and improve the maturity of HIS. In developed regions, the policy makers still need to find ways to reduce the organizational barriers. In addition, because the developed regions have better information infrastructure, the government can establish the pilot HIS projects first in developed regions and carry out HIS gradually all over the country.

Finally, reducing the barriers to HIS is still an important task for policy makers. As the previous research, this study also finds that the three types of barriers have negative impact on the success of HIS, see Feldman et al. (2014), for example. In developed regions, except the impact of the technological barriers on the maturity of HIS, the impact of all the barriers on the maturity and the success of HIS is significant. Thus, the policy makers can improve the success of HIS directly and indirectly by reducing all the three types of barriers. In less developed regions, the policy makers should spend more resources on reducing the technological and the human barriers. It is important for them to help the hospitals in these regions to establish favorable information infrastructure and train the doctors and the nurses to improve their skills of using information technology.

5.2 Conclusion

Although the barriers to patients' information sharing in healthcare has been studied extensively since 2000, little work has been done about the roles of the third party and the maturity in HIS. In China's practice, a third party is often introduced to overall plan and implement HIS together with local government (E. Zhang et al., 2016). Maturity of HIS reflects the extent to which the hospitals are prepared for HIS. In addition, most of previous studies are based on the experience and not deeply on theoretical research.

Generally speaking, to study how the success of HIS is achieved in China, we establish a theoretical model with new dimensions: the third party and the maturity of HIS. Through the survey data, this study provides a useful framework outlining how the above two the two dimensions, the barriers to HIS and the success of HIS interact. The research goals of this study are reached.

5.2.1 Research innovation

This study deeply investigates how the success of HIS in China is influenced by the third party, the barriers to HIS and the maturity of HIS and provides more insights into the relationships among them. Being different from the previous studies, the innovation of this thesis mainly includes the following.

Innovation 1: Incorporating third party into the theoretical model of the success of HIS.

Literature about the success of HIS seldom consider the impact of the third party. For example, in their review studies of HIS, Buntin et al. (2011), Jones et al. (2014) and Kruse and Beane (2018) do not discuss the effects of third party on HIS althrough they address the great impetus of the core hospitals, the governments and the communities to HIS. This study uses the empirical research method to investigate the impact of the third party on the success of HIS directly and indirectly via the barriers to HIS and the maturity of HIS. As in Ismail and Abdullah (2017), previous studies mainly consider the barriers to HIS and do not provide the results about the third party in HIS. Therefore, we extend the current literature of HIS by introducing the third party into the theoretical framework of HIS.

Innovation 2: Investigating the role of the maturity of HIS in success of HIS.

Previous studies seldom study what role the maturity of HIS plays in the implementation process of HIS, although it is important to the success of HIS. Since Nolan (1973) proposed his maturity model in IT, the studies of maturity mainly focus on IT in firms but not in the healthcare field. Even the few studies that have been published, such as Rocha (2011) and Carvalho et al. (2019), are only based on experience. Khuntia et al. (2017) study how operational maturity influences HIE, however, they didn't study the relationships between maturity and the other constructs. This study attempts to incorporate the maturity of HIS into the model of the success of HIS. The maturity of HIS is significantly influenced by the third party and the barriers to HIS. More importantly, it is necessary to improve the maturity of HIS to ensure the success of HIS. The theory about HIS is perfected by these findings.

Innovation 3: Investigating the different roles of the factors that influence success of HIS in different regions.

Extant literature did very little research about the regional difference of HIS. Although Alsadan et al. (2015) and Akhlaq et al. (2016) discuss HIE in developing countries, they still use the same theoretical framework from the studies in developed countries. Alwan et al. (2016) study the gap between a developing country and developed countries, however, their focus is on the healthcare systems, not HIS. This study uses survey data from both the developed and the less-developed regions in China to explore the impact of the different factors on the success of HIS in different economic developed regions. The results show that some factors influence the success of HIS, however, others factors do not. Policy makers should consider the regional differences when they decide to implement HIS.

5.3 Limitations and future research

5.3.1 Research limitations

Although this study is among the first to empirically investigate the theoretical framework of the success of HIS in China and includes the dimensions of the third party and the maturity to HIS, several limitations exist.

First, the data was collected by a questionnaire applied to doctors and nurses, therefore, we only identify the perceptions of these two professional groups. However, HIS has other stakeholders like the patients, the third parties (governments, IT companies, etc.). These groups should also be surveyed and represented in the sample to allow for the other multi-group analysis.

Second, the results of our study may increase validity and better applied to HIS practice if objective data can be collected from other sources, allowing for results triangulation. Although the measurement of the success of HIS in this study is divided into two dimensions, only data collected from survey was used. The individual and the organizational success of HIS can be measured by actual performance data, such as the average operation duration, the average length of stay, medical costs of patients, the average patient visits per professional, and bed utilization. Although the measurement of the third party and the maturity of HIS are reasonable and adapted from the literature, they are somewhat crude and can be refined with other data sources.

Third, the data didn’t allow us to test the hypotheses at three different levels of HIS due to the sample limitations. Ideally, we should estimate the multi-group models to verify whether the hypotheses still hold at the county, the city, and the province levels of HIS. The number of the valid answers of the questionnaire at the three levels limited the possibility of additional research.

Finally, from the literature review, several constructs have more than one dimension, but this study does not consider them to estimate the statistical models (SEM). The three reasons for this choice include the number of the items of each dimension (minimum three), too complex models and the need to get better models, as discussed in detail in the end of section 3.4.2.

5.3.2 Future research

HIS has received increasing attention from scholars in many countries and the research is on its way to prosperity. The limitations mentioned above provide opportunities for future research in this area.

First, the performance data of the professionals and the hospitals can be used to measure the success of HIS because the actual operational data can better reflect the individual and the organizational aspects of HIS success.

Second, in order to ensure the results are more generalizable, the professionals of the hospitals outside of Shanghai and Zhejiang province, the patients, the government official, and the IT companies can be included in the sample. Further research may enlarge the sample size enough to get more representative data to study the relationship between the variables.

Third, future research may utilize the data from HIS systems at the different levels to compare the results between them. Furthermore, to get a better understanding of HIS in a more macro perspective, additional studies of can be expanded to the impact of HIS on the medical system, such as the medical expenses and the overall patients' satisfaction.

Finally, the relationships among the dimensions of the variables, such as the three types of barriers to HIS, is another research direction in the future.

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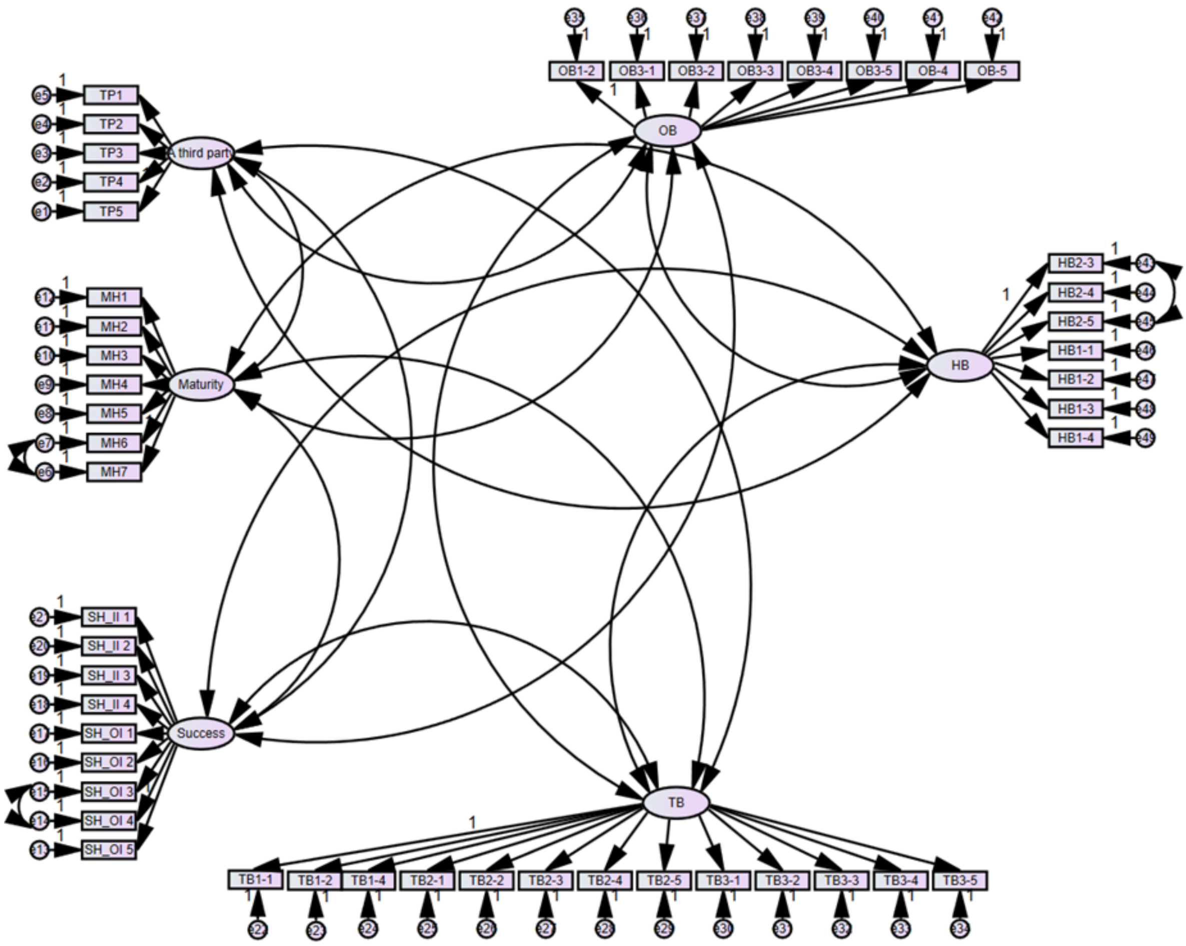
Annex A: The measurement model



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Annex B: Fitting indices of the structural second-order factor model

Indicator name	range	Measurement	Ideal value	Loose value
χ^2	—	5223.85		
df	—	1116		
p	—	0.000	<0.05	
χ^2/df	—	4.681	<=3	<=5
GFI	0~1	0.772	>0.9	>0.8
RMSEA	0~1	0.067	<0.05	<0.08
NFI	0~1	0.888	>0.9	>0.8
IFI	0~1	0.910	>0.9	>0.8
CFI	0~1	0.910	>0.9	>0.8

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Annex C: Fitting indices of the new structural model

Indicator name	Range	Measurement	Ideal value	Loose value
χ^2	—	6217.21		
df	—	1112		
p	—	0.000	<0.05	
χ^2/df	—	4.591	<=3	<=5
GFI	0~1	0.75	>0.9	>0.8
RMSEA	0~1	0.075	<0.05	<0.08
NFI	0~1	0.867	>0.9	>0.8
IFI	0~1	0.888	>0.9	>0.8
CFI	0~1	0.888	>0.9	>0.8

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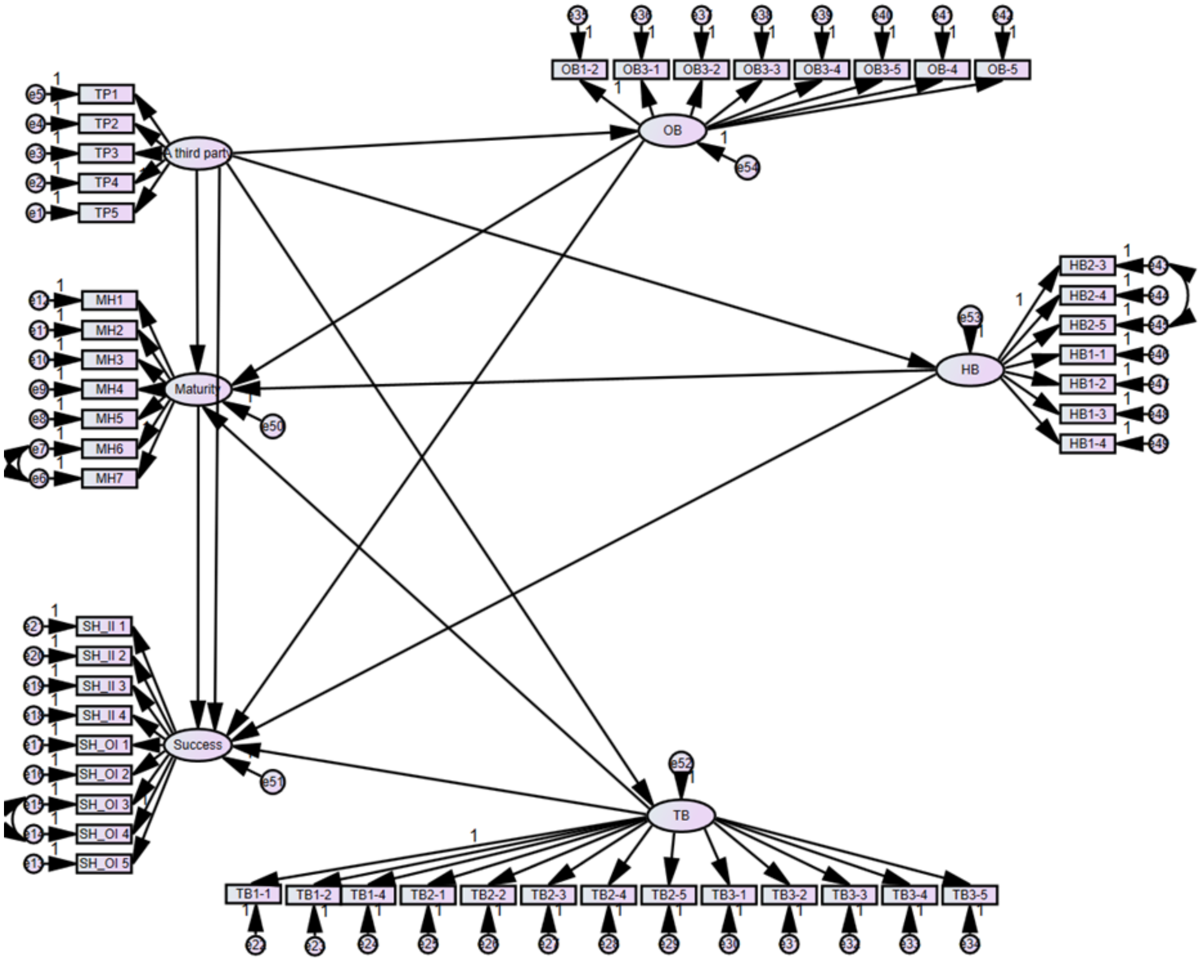
Annex D: The structural model of the first-order factor model with the new path



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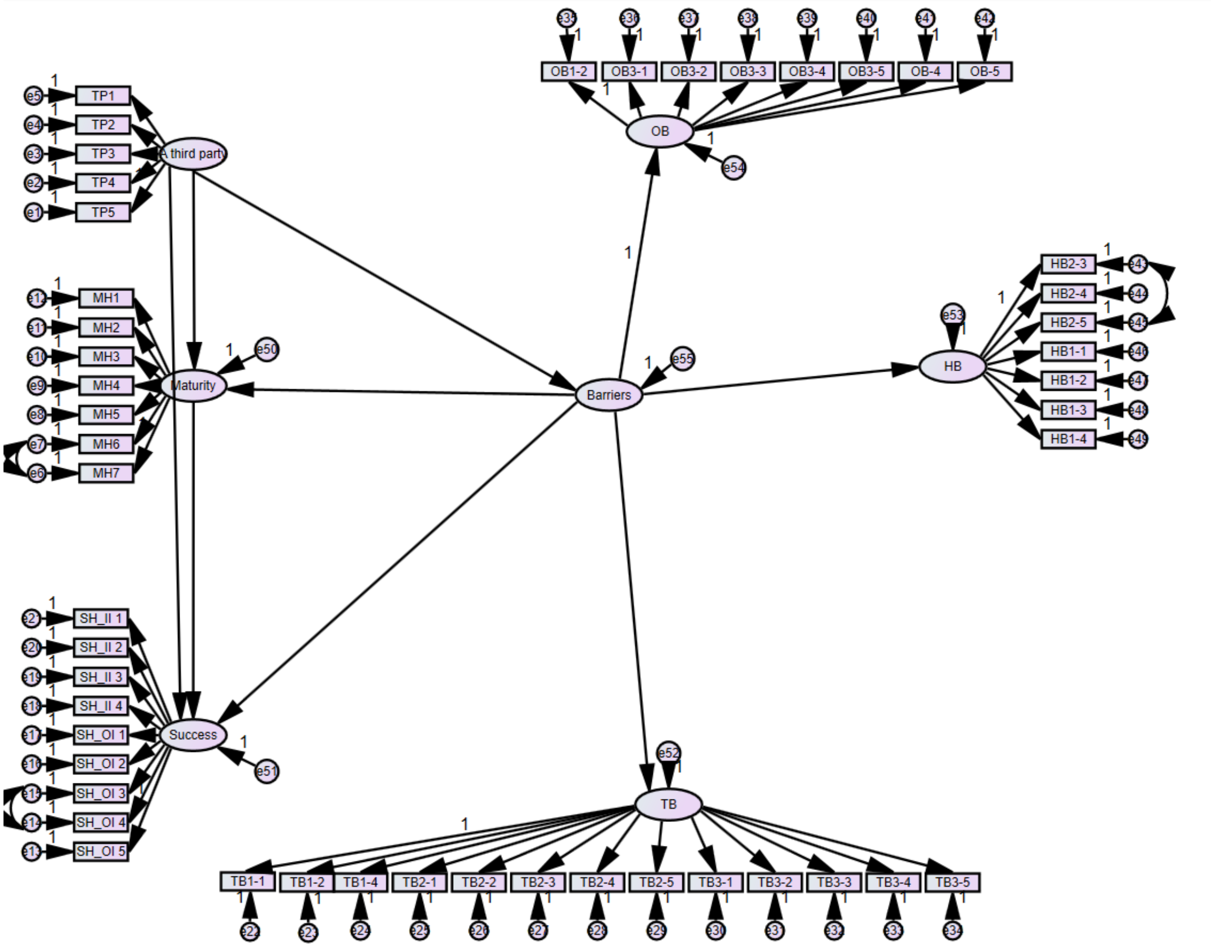
Annex E: The structural model of the second-order factor model with the new path



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Annex F: Fitting indices of the second-order factor model with the new path

Indicator name	Range	Measurement	Ideal value	Loose value
χ^2	—	5218.235		
df	—	1115		
p	—	0.000	<0.05	
χ^2/df	—	4.680	<=3	<=5
GFI	0~1	0.772	>0.9	>0.8
RMSEA	0~1	0.067	<0.05	<0.08
NFI	0~1	0.888	>0.9	>0.8
IFI	0~1	0.910	>0.9	>0.8
CFI	0~1	0.910	>0.9	>0.8