# Thai Hospitals' Adoption of Information Technology:
# A Theory Development and Nationwide Survey

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A Ph.D. study is a rewarding journey. As exhausting as it was, it feels great to have accomplished something and produced knowledge that helps form the shoulders of giants next generation's researchers and policymakers will stand on. There is no more noble pursuit than one of wisdom, no purer ambition than one to improve mankind's health, and no more rewarding journey than one of self-realization in this ambitious pursuit. I am both proud and humbled to finally live up to my father's vision when he first coined our family name, literally translated as "the family of philosophers in the sky." None of this would have been possible without his vision which turned our home into a small computer lab with little money that we had and helped me find my true passion that changed my life in ways I could have hardly imagined. The words of support and encouragement from research participants were also surprisingly heartwarming and reaffirming.

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# Dedication

This dissertation is dedicated to Mahidol University's Faculty of Medicine Ramathibodi Hospital, my alma mater and extraordinarily supportive academic home.

# Abstract

**Background:** With documented benefits and recent public policies, health information technology (IT) has received increasing attention in recent years. However, knowledge about Thailand's state of hospital IT adoption is lacking. The literature also identifies organizational management practices that are important to health IT implementation, but these factors are rarely included in quantitative analysis. Paucity of theoretical developments in the area also prevents a systematic approach to IT implementation.

**Objective:** To describe the current state of IT adoption in Thai hospitals and test a proposed model of organizational IT adoption that includes facilitating management practices and important hospital characteristics, motivated in part by Paré and Sicotte (2001)'s IT sophistication framework with modifications.

**Materials and Methods:** A nationwide mail survey was conducted using a developed instrument with established face and content validity in 1,302 hospitals in Thailand after a pilot study using five hospitals for pre-test purposes. Each hospital's IT chief or executive was asked to assess the degrees of specific technologies' adoption, IT-supported hospital functions, within- and outside-hospital information sharing, and presence of specific management practices, each in a 5-point Likert-type scale. Confirmatory and exploratory factor analyses were done, resulting in the rejection of the proposed model and a new set of IT adoption factors that fit the data better. Average scores for each of these new IT adoption aspects were analyzed descriptively to provide Thailand's baseline adoption levels. Construct and criterion validity was also assessed.

Path analysis was used to test the proposed model of hospital IT adoption and identify associated organizational factors. Estimates for adoption of basic electronic health records (EHRs), comprehensive EHRs, and computerized physician order entry (CPOE) were also computed from relevant IT-supported functions for cross-study comparisons.

**Results:** The nationwide survey received a 70% response rate, but responding hospitals tended to be somewhat larger and public. Thai hospitals overall had acceptable levels of IT adoption, but information sharing outside the hospitals was very limited. When both outpatient and inpatient settings were considered, about 50% of responding hospitals had complete or partial basic EHR adoption and only 5% had comprehensive EHR adoption, but 90% had CPOE for medication orders. Adoption estimates for the outpatient setting alone were somewhat larger than the inpatient setting. Significant correlations among the different aspects of IT adoption and between these constructs and other criterion variables provide evidence for construct and criterion validity. In path analysis, after respecifying the model based on the factor patterns discovered from the data, the final model indicated significant effects of public status on adoption of infrastructural technologies such as networking and master patient index, as well as on internal information sharing. Bed size was positively associated with infrastructural technologies adoption but negatively associated with the levels of IT-supported clinical functions. Teaching status was not associated with any aspects of IT adoption in the path model. As hypothesized, the extent of facilitating operational IT management was associated with the levels of technology adoption and use of IT to support clinical EHR workflows (order entry and results viewing) as well as inpatient clinical documentation. These latter three constructs were

also associated with the extent of internal information sharing, while the extent of external information sharing was associated with the levels of internal information sharing and IT support for inpatient clinical documentation.

**Discussion:** Thailand's adoption picture is very encouraging with many hospitals having some IT infrastructure in place, though adoption gaps still exist. The discovered IT adoption factors and the developed survey instrument had supporting evidence for its validity, and the final model resulting from path analysis provides a useful framework for health IT adoption in future IT adoption studies. The positive association between public status and IT adoption and lack of significant hypothesized association between IT adoption and bed size or teaching status were surprising but may reflect the unique health IT market and dynamics in Thailand.

**Conclusion:** Basic IT adoption in Thai hospitals appears to have passed the tipping point. Focus should be on adoption of more advanced technologies (such as comprehensive EHRs and clinical decision support systems) and ensuring that adoption translates into better processes and outcomes, as well as addressing barriers to health information exchange. The utility of the proposed framework is demonstrated, as is the importance of identified facilitating IT management practices. The final model from this study, named the Theory of Hospital Adoption of Information Systems (THAIS) here, should be cross-validated and refined in future studies.

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# Chapter One
# Introduction

## 1.1 Background and Significance

With decades of research, development, and advocacy, increased attention has been placed on the role of information technology (IT) in improving quality and efficiency of health care. Early works in the area led to the seminal report by the Institute of Medicine (IOM) advocating the adoption of computer-based patient records.[1] Subsequent well-known IOM reports[2,3] highlighted the role of electronic health records (EHRs), computerized physician order entry (CPOE), and other technologies in the transformation of the healthcare system and delivery in the United States.

In the past decade, the U.S. federal government has also played a significant role in promoting the adoption and use of health IT. President George W. Bush's 2004 Executive Order establishing the position of the National Health Information Technology Coordinator[4] has led to a number of significant initiatives, many of which continue today. Under President Barack Obama's leadership, emphasis on the values of health IT was prominent in the economic stimulus legislation.[5] In fact, the Health Information Technology for Economic and Clinical Health (HITECH) Act[6] and its "meaningful use" regulations[7] serve as today's hallmark of heavily-invested public policy aimed at increasing health IT adoption and use. The health IT adoption landscape has never before received this level of attention by informaticians, healthcare practitioners, administrators, researchers, and consumers worldwide.

Although the extent of health IT benefits may vary from one organization to another, the literature provides evidence that health IT generally improves care quality and reduces costs. Medication safety, guideline adherence, and surveillance and patient monitoring are among the documented quality benefits of health IT.[8,9] Furthermore, health IT has been linked to more efficient health care through reduction in healthcare costs[9,10] and improved financial performance of health care organizations.[11,12] While evidence to the contrary also exists,[13] it in fact underscores what experts have pointed out for years, that health IT is not a panacea that will fix all the problems in the system and yield the desirable impact in every case.[14,15] Blindly implementing health IT in a broken system would not lead to substantial improvements and could propagate underlying problems. Moreover, the most visible efficiency gains of health IT would result from the seamless exchange of health information across providers, a situation that first requires widespread IT adoption and hence has not been achieved in a large scale. This should not prevent us from facilitating the adoption and use of health IT, but it should remind us that we must adopt and use the technology appropriately. The heart of the United States' efforts that facilitate "meaningful" health IT use[6,7] is a key step in this direction and, with proper execution, would lead to realization of potential benefits of health IT as evidenced in the literature.

A considerable number of studies have investigated the extent of health IT adoption in the United States.[16-21] With the meaningful use efforts underway, the U.S. adoption rate of health IT is expected to rise substantially.[7] Other Western countries have already had much higher adoption rates than the U.S. and Canada.[17,22] While there are still rooms for improvement, many of these countries lead the way by having clear public policies and large-scale efforts to facilitate health IT adoption.[23] Such policies and efforts in developing countries, on the other hand, are still in their infancy if they exist at all, and their adoption pictures are still largely unclear.[24,25] These developing countries may have more pressing priorities,[25] and their resources to facilitate adoption may be limited.[26] However, given the relatively poor social and economic conditions of their populations, they are the most likely to benefit from improved quality, accessibility, and efficiency of health care that health IT has much to offer.

Thailand, one of the few middle-income developing countries that have introduced a series of health care reform initiatives,[27] still has no clear national roadmap toward widespread health IT adoption to improve quality and bring down costs. Without emphasis on health IT adoption, the country cannot achieve quality and efficient health care for all to the same extent as other countries. In the end, the social and economic disparities between Thailand and developed nations would widen. Health IT, therefore, is not a luxurious, lofty technology for developed nations but a rather vital investment for Thailand to bridge the disparity gap and sustainably compete in the twenty-first century.

In order for Thailand to strategically tackle the health IT adoption problem, knowledge about the current situation is critical. A large part of the country's health care is delivered through acute care hospitals, which are arguably the most influential strategic point for health IT to make a societal impact. With the health IT adoption picture in Thai hospitals still unclear, it is crucial that we capture the current state of Thai hospitals' adoption of IT. The knowledge can be used as the baseline adoption level against which progress over time can be tracked and the impact of adoption can be evaluated in future studies.

Additionally, relationships between health IT adoption and the adopting organization's characteristics have been studied considerably, but few studies explore the mechanisms through which these characteristics influence adoption. Moreover, the roles of certain organizational cultures and management practices on adoption are rarely investigated in quantitative studies, although they have been documented greatly in qualitative studies and case reports.[28] In addition, the adoption level is usually conceptualized as a simple construct of availability and use of certain technologies or functions. While these simple measurements still offer valuable descriptive information, they often limit the opportunities to link the empirical findings to build and improve theoretical knowledge on IT adoption. A theoretical framework would enable researchers to approach health IT adoption in a systematic way. It would also offer a useful guide for practitioners and policymakers to tackle such a complex structure and a dynamic process as health IT adoption.

With these gaps in the current literature in mind, this study uses the lack of knowledge about Thai hospitals' IT adoption as dual opportunities to validate a proposed framework of health IT adoption, while at the same time providing valuable information about the country's adoption state. The proposed model is motivated in part by Paré and Sicotte's IT sophistication framework,[29] as well as by qualitative evidence highlighting the crucial importance of certain organizational cultures and management practices. It breaks health IT adoption down into several aspects, each focusing on technologies, functionalities, information sharing within and outside the hospital, and the organizational cultures and management practices.

With the accumulating evidence in the literature, I believe it is time to move the health informatics field forward by developing and testing a model that helps explain not just if but how different organizational factors relate to greater IT adoption, with proper balance in emphasis among different components of organizational IT. Equally important, the practical knowledge about Thailand's IT adoption landscape would equip Thailand's policymakers with insights about the current state of hospital IT adoption, adoption gaps, and potential strategies to facilitate widespread adoption.

### 1.2 Study Goals and Specific Aims

The overall goals of this study are two-fold: to produce the much-needed local knowledge about Thai hospitals' IT adoption, and to contribute to the scientific foundations of biomedical and health informatics by obtaining empirical evidence that enhances our theoretical understanding of health IT adoption at the organizational level. This is achieved through two specific aims:

1. To describe the current state of IT adoption in Thai hospitals nationwide.
2. To test a proposed conceptual framework of IT sophistication and explore the relationships between organizational characteristics and these IT sophistication measures, using data collected from Thai hospitals.

# Chapter Two
# Literature Review

This chapter reviews the literature related to this dissertation study. The effects of health IT are reviewed in the first section, followed by a review of some theories related to IT adoption. Then, studies that assess the state of health IT adoption and associated organizational factors are summarized. Organizational cultures and management practices that have been found to play a role in health IT adoption are also discussed. Finally, a brief description of Thailand, its healthcare system, and the status of its national health IT environment is provided.

## 2.1 Effects of Health IT

The effects of health IT on health care have been examined in many experimental and observational studies. At least 21 systematic reviews and meta-analyses evaluated the relationship between health IT and care quality and efficiency.[8,9,30-48] The reviews have found improvements in the process of care as a result of clinical decision support systems (CDSSs),[30-37] CPOE,[8,38-40] and EHRs[41] in many evaluation studies. The evidence on improved clinical outcomes associated with health IT appears mixed,[8,30,32,33,37-44] though several methodological issues have been suggested.[8,9,30,33,39,43,47] With health IT's usage pattern varying from one setting to the next,[49] the roles of socio-cultural and organizational factors[41] as well as the implementation process[40] on differential effects have also been noted.

One large systematic review identified three key benefits of health IT on quality of care—increased adherence to guidelines, enhanced surveillance and monitoring, and reduced medication errors.[9] The improvement is most evident in the area of preventive health. On the efficiency front, the key benefit of health IT, as noted by the authors, is the reduction in unnecessary care utilization. Individual studies have also linked health IT to reduction in healthcare costs[9,10] and improved financial performance of health care organizations.[11,12] Another systematic review focused on the benefits of eHealth technologies specifically in developing countries.[45] The authors concluded that systems that enhance inter-institutional communications, assist medication order and management, and identify and track patients at risk of abandoning care are promising. This study provides evidence for positive effects of health IT in developing countries and reinforces the argument that health IT adoption in developing countries should be promoted.

Overall, there is much supporting evidence that health IT generally improves the process of care, but the ultimate impact on patient outcomes remains inconclusive. The effect of health IT also depends on a number of factors, including the setting, technology, functionalities, implementation, and target endpoints. One thing is clear from the literature—health IT is complex, heterogeneous, and context-dependent. Indeed, experts have said all along that health IT is not a panacea that will fix everything and yield positive values no matter what.[14,15,50,51] Risks and unintended consequences of health IT have also been well-documented in the literature.[52,53]

While the existence of risks and the inconclusive data on patient outcome effects may be disconcerting and deserve careful study, they do not negate the documented positive effects on process of care. As previously discussed, there are many issues with those outcome studies that should be addressed in future studies. A reasonable move while science improves and these issues are disentangled is not the halt of all health IT implementations, which could have detrimental effects on the care processes. Instead, we should continue to implement well-designed health IT, with appropriate evaluation. Research on health IT adoption would help provide data for such evaluation studies. The next sections discuss the theories and empirical studies on health IT adoption.

## 2.2 Conceptualizing Health IT Adoption

### 2.2.1 Diffusion of Innovations Theory

One of the most prominent theories in IT adoption is Rogers' diffusion of innovations theory.[54] In his theory, *an innovation* is defined as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption," and *diffusion* refers to "the process by which an innovation is communicated through certain channels over time among the members of a social system."[54] Since IT implementation in an organization generally introduces a new system aimed at changing how a certain task is conducted, such a technology is an innovation, and the spread of the technology within the organization is the diffusion process. In this theory, the innovation-decision process consists of 5 successive stages—knowledge, persuasion, decision, implementation, and confirmation. After acquiring knowledge of and forming an attitude toward an innovation, an individual engages in activities that lead to a decision whether to adopt or reject it. *Adoption* is defined as “a decision to make full use of an innovation as the best course of action available,” while *rejection* indicates “a decision not to adopt an innovation.”[54] Adoption of an innovation marks the point when it is implemented and put into use by an individual.

A similar process occurs when an innovation is adopted at the organizational level, although there are now two levels of decision-making processes. Innovation adoption at the organizational level introduces the innovation into the organization, kicking off the individuals’ adoption process. For the intended outcomes to be realized, the organization must first adopt and implement the innovation, and the individuals in the organization must then adopt and use it. This is in line with DeLone and McLean’s information systems (IS) success model (Figure 2.1), where success of an information system implementation originates from the inherent quality of an information system and the information it produces, leading to system use and user satisfaction which in turn creates individual and organizational impacts.[55,56]

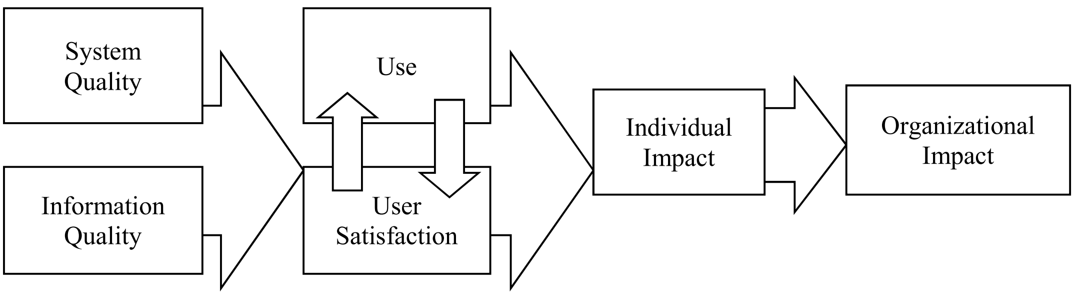



**Figure 2.1** DeLone & McLean’s original information systems success model. Reprinted by permission, DeLone WH, McLean ER, Information systems success: The quest for the dependent variable, Information Systems Research, volume 3, number 1, March, 1992. Copyright © 1992, the Institute for Operations Research and the Management Sciences, 7240 Parkway Drive, Suite 300, Hanover, Maryland 21076 USA. Note that an updated model has been reported (See reference 56) but for the purpose of this discussion, the simpler original model (as reported in reference 55) was used.

The diffusion of innovations theory is also well known for its classification of individuals and organizations based on how soon they adopt a particular innovation. The so-called *diffusion curve*, which Rogers argued approaches the normal distribution, categorizes individuals into 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards.[54] This theory provides a roadmap for understanding how people adopt an innovation and developing strategies to encourage their use.

### 2.2.2 Theories of Technology Acceptance

Another family of theories with extensive research focuses on user acceptance of technology. With their roots in social psychology and behavioral sciences, these theories view IT use as a behavior that can be explained, at least in part, by how the technology is viewed by the users, i.e., technology acceptance. Acceptance of technology is most often measured as the intention to use the technology.[57] In turn, the intention to use is explained by a number of constructs ranging from user attitudes and perceptions to other user characteristics.

One of the most studied theories of technology acceptance is the Technology Acceptance Model (TAM).[58-60] It originated from the Theory of Reasoned Action (TRA),[61,62] a classic general behavioral theory. TRA proposes that individuals' behavior is determined by their intention to perform the behavior, and this intention is in turn explained by their attitude toward the behavior and their perception of how other important persons think about them performing the behavior (*subjective norm*).[61] Like TRA, TAM proposes intention to use as the precursor of actual IT use and specifies attitude toward IT use as the predictor of behavioral intention. Unlike TRA, however, two new constructs are added to explain the attitude, namely *perceived usefulness* and *perceived ease of use* (Figure 2.2). The former construct refers to the degree to which the individuals believe using the technology would enhance their job performance, while the latter addresses their subjective belief that using the technology would be free of effort.[59,60]

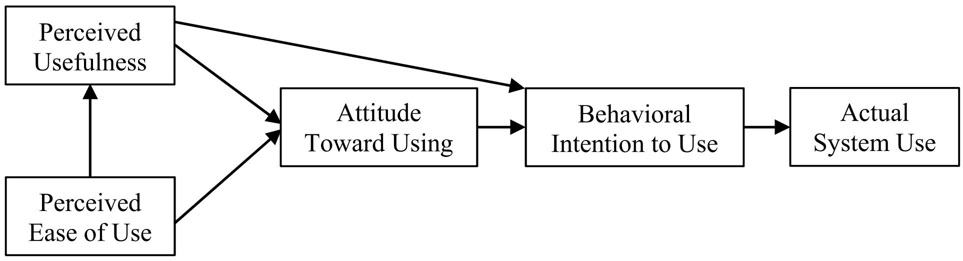



**Figure 2.2** The Technology Acceptance Model (TAM). Reprinted by permission, Davis FD, Bagozzi RP, Warshaw PR. User acceptance of computer technology: a comparison of two theoretical models, Management Science, volume 35, number 8, August, 1989. Copyright © 1989, the Institute for Operations Research and the Management Sciences, 7240 Parkway Drive, Suite 300, Hanover, Maryland 21076 USA.

While the validity and applicability of TAM have been studied extensively, it is not today's only model of IT acceptance and use. An updated version of TAM, called TAM2, was proposed with the removal of the attitude construct and addition of subjective norm and some other predictors.[63] In an effort to unify a multitude of models, Venkatesh et al. proposed the Unified Theory of Acceptance and Use of Technology (UTAUT) (Figure 2.3),[64] based upon similarities across prior models including TRA, TAM, TAM2, Theory of Planned Behavior (TPB),[65] and the diffusion of innovations theory, among others.

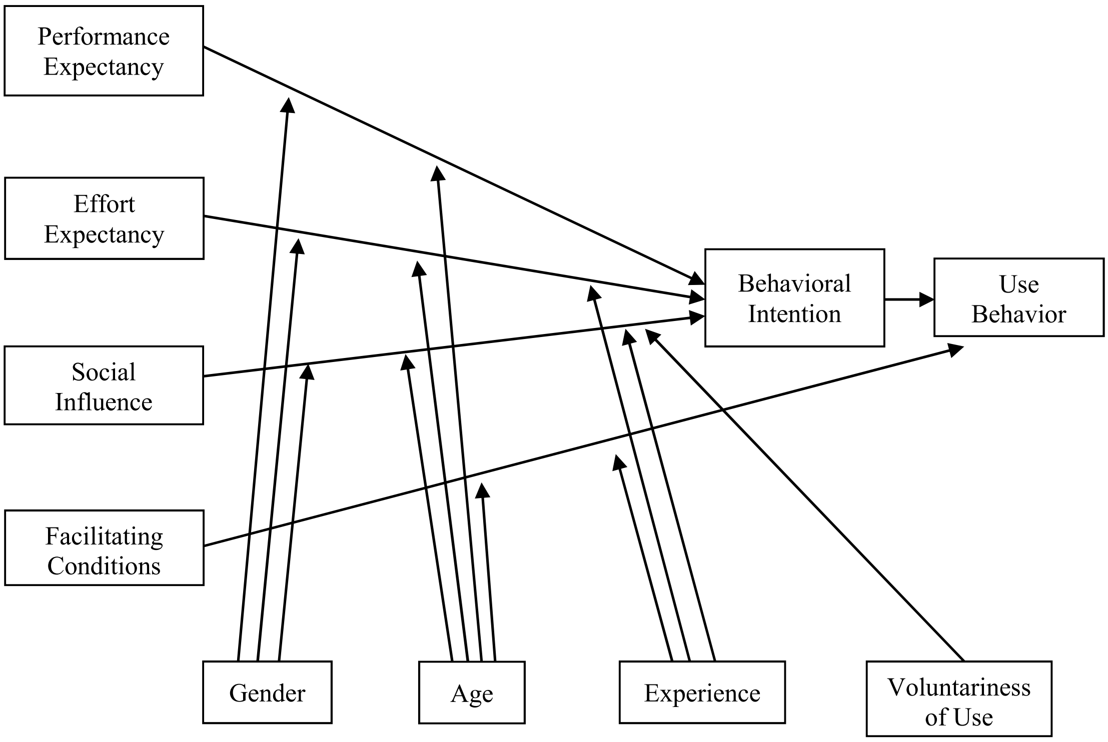



**Figure 2.3.** The Unified Theory of Acceptance and Use of Technology (UTAUT) model. Reprinted from Venkatesh V, Morris MG, Davis GB, Davis FD, User acceptance of information technology: toward a unified view, MIS Quarterly, volume 27, number 3, September, 2003. Copyright © 2003, Regents of the University of Minnesota. Used with permission.

TAM and closely related models, including TAM2 and UTAUT, have been recently reviewed, focusing specifically on their application in health IT acceptance and use.[57] The review noted evidence that supports the utility of the theories in health care, but pointed out remaining challenges and the need to contextualize TAM to health care in future research.[57] Nevertheless, with the focus on individual users' technology acceptance, these theories do not provide sufficient understanding of IT adoption at the organizational level.

### 2.2.3 Organizational IT Adoption Theories

At the organizational level, the theories of IT adoption are less well-established. Rogers' diffusion of innovations theory[54] explains the process of innovation diffusion at both the individual and organizational levels, but the theory does not provide a statistically testable model of organizational IT adoption. In a review by Theera-Ampornpunt, a striking 87% of health IT adoption studies at the organizational level used simple atheoretical measurements of availability and/or use of certain technologies or functionalities.[28] Holden and Karsh made a similar observation, noting that little attention is placed on theories in studies of clinicians' behavior toward health IT use,[66] though their comment was directed at adoption studies at the individual level. They also argued that a theoretical approach offers a systematic method to conduct the studies, thereby serving as a guide for researchers and reducing the influence of methodological biases in creating spurious findings. In addition, theories also help us relate findings from disparate studies in order to draw generalizable conclusions. Lastly, a good health IT adoption theory serves as a practical guide, providing useful strategies so more effective implementation can be conducted.[66] Similar arguments could be made for organizational IT adoption.

Theera-Ampornpunt[28] reviewed several theories of organizational IT adoption. *Incorporation* represents organizational processes to embed an innovation within the adopting organization.[67-70] Following incorporation of an innovation, the organization adjusts itself in various ways. This adjustment process eventually leads to the permanent adjustment in the organization such as changes in its governance structures, rules, and organizational procedures, called *routinization*.[70,71] This concept is echoed in the diffusion of innovations theory.[54] The incorporation concept gave rise to *infusion*, another aspect of innovation incorporation that involves adjustment in operational and managerial work systems and shifts in the related technological configurations.[70] High levels of work system adjustment suggest that the innovation has been "infused" or embedded deeply in the organization. Zmud and Apple[70] provided an instructive example—the increasingly advanced levels of personal computer (PC) use. Simple stand-alone uses imply superficial infusion of PCs in the organization, whereas more sophisticated concurrent PC uses by multiple distributed users, well-orchestrated with workflow linkages indicate that the technology is deeply embedded in the organization. The increasing levels of infusion result from the successive levels of functional configurations built onto the technologies achieved from prior configurations.[70]

A similar concept that views organizational IT as consisting of increasing levels of complexity is *IT maturity* (or *IS maturity*). It originated in the late 1960s when computer applications in business were observed to follow stages of development, from basic clerical applications to managerial and strategic ones.[72] This notion of application maturity led other researchers to propose their theories of IS development stages.[73,74] Nolan and also Nolan and Gibson proposed a model known as the stage hypothesis, which consists of 6 stages of organizational use of information systems—initiation, contagion, control, integration, data administration, and maturity.[74-82] In this model, use of information systems in an organization is a growth process that involves both the increasingly matured configurations and advanced IT management and data administration activities. The model is outdated in today's revolutionized organizational IT environment, but its view of organizational IT as a dynamic evolutionary process associated with operational and managerial complexity is a foundation to more modern theories.

Burke and Menachemi proposed a concept called *IT munificence* that offers a conceptual perspective on *IT capabilities* of hospitals.[83] Drawing from the diffusion of innovations theory and the strategic contingency theory, they developed measures of a hospital's technology base and stakeholder capability by measuring the numbers of automated application systems in each category of hospital functions, the number of shared applications available across the enterprise (i.e., systems integration), and the extent of information available to stakeholders outside the hospital (clinicians, the public, and externals business stakeholders). The hospital functions were classified into 3 clusters—clinical, administrative, and strategic. Clinical IT supports a hospital's primary mission on patient care, whereas administrative systems support other organizational functions with no direct involvement in patient care. Strategic systems, on the other hand, provide strategic information to executives for planning, oversight, and other management tasks. The IT munificence construct provides one systematic framework of IT adoption that attempts to "open the black box" of hospital IT.[83]

### 2.2.4 IT Sophistication

Another recent conceptual framework of organizational IT adoption is *IT sophistication*. The first conceptualization of this model by Raymond and Paré was motivated in part by the idea of evolutionary stages of organizational IT in the IT maturity concept.[84] In addition to IT maturity, IT sophistication was also influenced by the *technical sophistication* and *organizational sophistication* concepts used in a study of IT impact on user satisfaction and job performance.[85] In that study, technical sophistication focuses on hardware and software systems and recently implemented applications, whereas organizational sophistication assesses the level of planning, organization, and control activities associated with managing an organization's IT resources.[85] Raymond and Paré defined IT sophistication as "a construct which refers to the nature, complexity and interdependence of IT usage and management in an organization."[84] The construct has four dimensions—technological sophistication, informational sophistication, functional sophistication, and managerial sophistication, each representing the respective component of organizational IT.[84]

Paré and Sicotte[29] modified the original IT sophistication construct to study hospital IT adoption in Canada. The model consists of three dimensions—technological sophistication, functional sophistication, and integration sophistication. The definitions of these dimensions are provided in Table 2.1. In each of these dimensions, three core domains are assessed—patient management and patient care activities; clinical support activities such as laboratory, pharmacy, and radiology; and administrative functions. Figure 2.4 depicts their IT sophistication model.

**Table 2.1** Definitions of Paré & Sicotte's IT sophistication constructs. Reprinted from Int J Med Inform, volume 63, number 3, Paré G, Sicotte C, Information technology sophistication in health care: an instrument validation study among Canadian hospitals, 205-223, Copyright © 2001, with permission from Elsevier.

| Construct | Definition |
|---|---|
| IT Sophistication | The diversity of technological devices and software applications used to support patient management and patient care, clinical support, and administrative activities, as well as the extent to which computer-based applications are integrated (electronic and automatic transfer of information) |
| Technological Sophistication | The diversity of the hardware devices used by health care institutions, referring to various domains such as the newest ones including medical imaging, bar coding devices, data warehousing, wireless networks and PACS [picture archiving and communication system] equipment |
| Functional Sophistication | The proportion and diversity of processes or activities (e.g., vital sign recording, medication administration, staff scheduling, post-operative report dictation) being supported by computer-based applications |
| Integration Sophistication | The degree to which computer-based applications are integrated both internally via a common database and externally via electronic communication links |

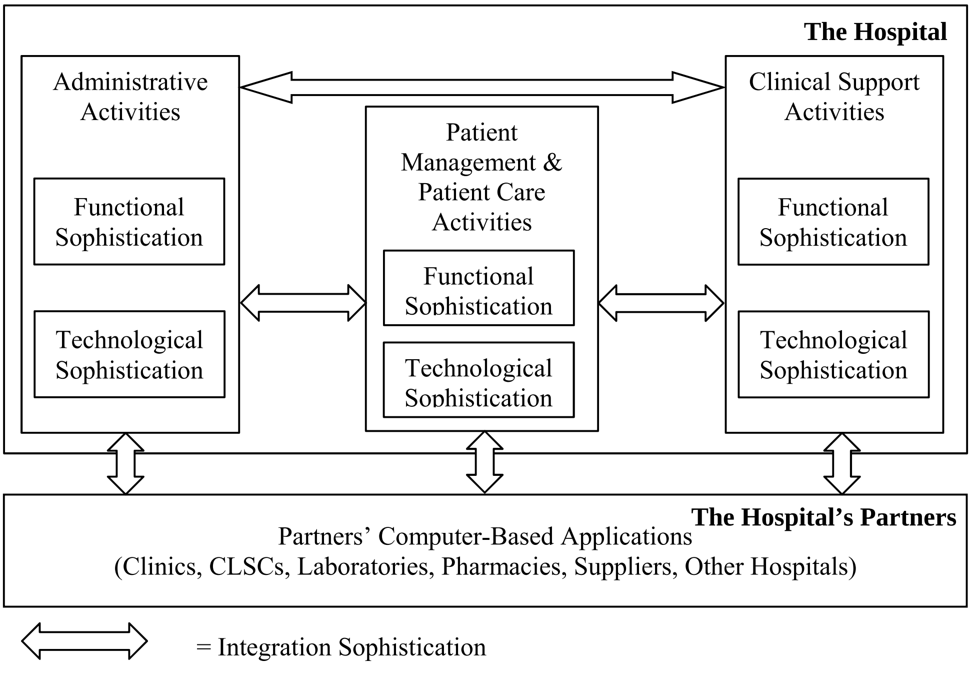



**Figure 2.4.** IT sophistication framework in hospitals. Reprinted from Int J Med Inform, volume 63, number 3, Paré G, Sicotte C, Information technology sophistication in health care: an instrument validation study among Canadian hospitals, 205-223, Copyright © 2001, with permission from Elsevier.

Paré and Sicotte also reported their development and validation of the IT sophistication questionnaire based on initial in-depth interviews, a pre-test, and a survey of hospital information system directors in Quebec and Ontario. The construct validity, concurrent validity, and internal consistency reliability of IT sophistication have been established.[29] Paré and Sicotte's IT sophistication model has been used in various studies, including a health IT adoption study of hospitals in Iowa[86,87] and another study in Georgia,[88,89] as well as an evaluation study in Texas.[90] In addition, it has been applied to study IT adoption in Missouri's nursing homes.[91]

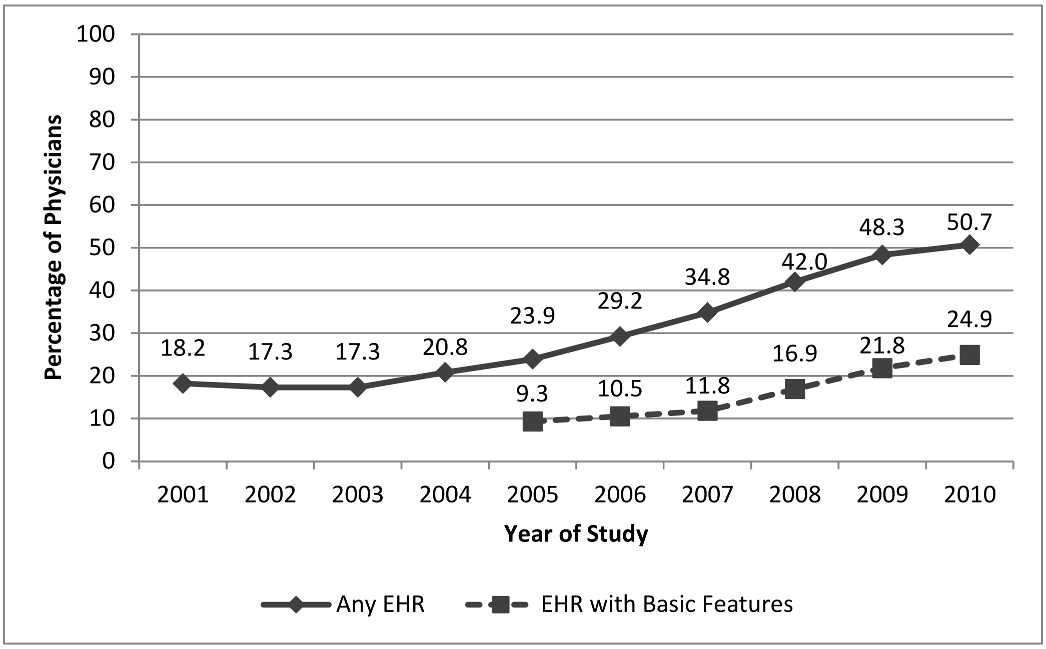
The conceptualization of health IT adoption into the technological, functional, and information exchange components has several strengths. First, the model recognizes that available technologies, as important as they are, are but one piece of the IT adoption puzzle. A technology available but not used would not yield desirable impact. In addition, as argued by the IT maturity concept, a single technology can be used in several ways, supporting an organization's functions to a different degree. Assessing the functional aspect of adoption, measured by the extent to which the technology is used to support the organization's activities, prevents us from the overemphasis on the technology's availability. By measuring the functional aspect of adoption, a better picture that provides clues on where in the evolutionary stages an organization's information systems stand emerges. Furthermore, by having an integration sophistication component similar to IT munificence,[83] the model emphasizes the significance of the information exchange component of health IT, which is critical to the quality and efficiency gains the health informatics community so desires. Unlike the simplistic measurement of IT adoption as availability or use in many studies, IT sophistication helps provide a systematic, balanced way to view IT adoption, which could prove helpful in guiding IT implementation efforts toward success.

## 2.3 Empirical Studies of Health IT Adoption

### 2.3.1 State of Health IT Adoption in the United States

Many empirical studies have attempted to assess the state of health IT adoption in the United States, according to a methodological review by Theera-Ampornpunt.[28] A review by Jha et al.[16] suggested that as of 2005, the best estimate of EHR use by ambulatory physicians was about 24%. Subsequent studies conducted between 2005 and 2007 suggested that the ambulatory EHR adoption level ranged from 17–35%,[17-19,92] with the wide range mostly attributable to differential methods and definitions. The National Center for Health Statistics conducts an annual survey known as the National Ambulatory Medical Care Survey (NAMCS), collecting patient visit data on a nationally-representative probability sample of non-federal office-based physicians.[92] Findings from the annual NAMCS studies provide a longitudinal trend of EHR adoption among office-based U.S. physicians. In 2005, about 23.9% of U.S. physicians used any EHR system, but only about 9.3% used an EHR system with all four features deemed important—computerized order entry for prescriptions, computerized order entry for tests, electronic test results viewing, and physician notes.[93] The estimates had since increased to 48.3% of physicians using any EHR system and 21.8% using one with those specific features in 2009.[94] Figure 2.5 illustrates the trend of EHR adoption among ambulatory physicians from 2001 to 2010.[18,92-96]

In the inpatient setting, a 2006 survey by the American Hospital Association (AHA) found that 11% of U.S. hospitals had fully implemented an EHR system,[20] while recent AHA surveys of U.S. hospitals suggested that the EHR adoption level, using a stringent EHR definition, was around 9% in 2008[21] and 12% in 2009.[97] The estimates of CPOE adoption among U.S. hospitals ranged from 5% in 2003 to 17% in 2008 and 34% in 2009.[20,21,97-99] With a low adoption rate, health IT adoption in the U.S. remains a challenge, though the trend is encouraging and the meaningful use regulations are expected to accelerate this.[7]




**Source:** National Ambulatory Medical Care Survey (NAMCS) 2001-2010 (References 18 and 92–96). EHR = electronic health record

"Any EHR" refers to percentage of physicians reporting use of an EHR system regardless of features used. "EHR with Basic Features" indicates percentage of physicians who reported using all of the following EHR features: patient demographics, problem lists, physician clinical notes, laboratory test results, imaging results, and computerized order entry for prescriptions (2005 and 2006 estimates based on a less stringent definition, specifically computerized order entry for prescriptions and tests, test results, and clinical notes; no data available prior to 2005). Estimates for 2010 are preliminary.

**Figure 2.5.** EHR adoption by U.S. physicians by year.

### 2.3.2 State of Health IT Adoption in Other Western Countries

Fewer studies evaluated the state of health IT adoption in other countries,[28] but there is reliable evidence to suggest that many Western countries have enjoyed high IT adoption rates, especially in the ambulatory setting. Protti reported on a qualitative comparative study on IT adoption in general practice of 10 countries (Australia, Austria, Denmark, England, Germany, the Netherlands, New Zealand, Norway, Scotland, and Sweden).[23] The study found that general practice offices in most of the countries had adopted IT to a great extent, with electronic prescribing one of the most common clinical applications. Use of other functions such as receiving discharge summaries, viewing laboratory results, and health information exchange (HIE) were less common in some of the countries.[23] One of the study's strengths is its description of the social contexts that influence IT use in these countries, highlighting the roles of public policy. The author reviewed how the government mandate for electronic billing, financial incentives, influence from professional organizations, system accreditation, and empowerment and assembly of practicing physicians might have explained the satisfactory levels of adoption in these countries.[23] In another large-scale quantitative study of primary care physicians in seven countries conducted in 2006, the majority of respondents in Australia, Germany, the Netherlands, New Zealand, and the United Kingdom clearly had in their practices a clinical information system with moderate to high functionalities.[17] Primary care physicians in the U.S. and Canada, on the other hand, mostly had unsophisticated systems with few functions. The authors concluded that the importance of nationwide policies cannot be overstated and suggested a redesign of the U.S. system to incentivize better performance.[17] Finally, Jha et al.[22] conducted a literature review as well as expert interviews on health IT adoption and use in these seven countries in 2006. The findings indicated that EHR use among general practitioners in four countries (Australia, the Netherlands, New Zealand, and the United Kingdom) was almost universal (more than 90%), with Germany having a moderate level of use (40–80%) but the U.S. and Canada lagged far behind (10–30%).[22] In contrast, less than 10% of hospitals in virtually all of the seven countries were estimated to have key components of an EHR,[22] suggesting that more efforts are still necessary in these nations' hospital settings.

### 2.3.3 Antecedents of Organizational Health IT Adoption

Several organizational characteristics have been linked to health IT adoption. Findings from many studies supported the positive relationships between health IT adoption and size of the organization,[20,87,100-105] multi-hospital system affiliation,[100-102,106] teaching status,[20,98,102,104] urban location,[20,100-102,107] for-profit status,[100-102,108] annual budget,[29,86] operating revenues or financial performance,[20,100,108] IT investment,[29] patient mix,[100,102,103,108,109] service volume,[100,103,109] size of IT workforce,[29,86] accreditation status,[102] and chief information officer (CIO)'s education[29] and experience.[29,86,87,110] Non-significant or conflicting findings, however, also exist for multi-hospital system affiliation,[87] non-governmental status,[98] for-profit status,[98] IT investment,[86] and CIO's educational level.[86]

Researchers have offered a number of explanations for the relationships between health IT adoption and characteristics of the adopting organization. Organizational size is perhaps one of the most commonly studied organizational factors within and outside informatics.[87] Kimberly and Evanisko[111] provided two alternative mechanisms that explain the association between organizational size and hospital adoption of innovations. The first mechanism posits that increased size *facilitates* adoption by making the organization better able to afford the innovations. Larger organizations generally have access to more capital resources[100,101] and possess greater internal resources and skills,[87,100] enabling them to acquire and implement technologies to a greater degree. Furukawa et al. also suggested that larger hospitals are more likely to benefit from economies of scale when they acquire health IT.[102] Alternatively, increased size also creates operational and administrative complexity that *necessitates* IT adoption.[111] Jaana et al. argued that larger hospitals not only have more resources but they are also more complex and geographically dispersed, requiring them to have more sophisticated IT infrastructure.[87]

The observed findings that teaching hospitals are more likely to adopt IT have been suggested to result from their emphasis on quality improvement,[98,104] their tendency to adopt health IT to support their research and academic missions,[102] their culture for innovation, the presence of local expertise, and the familiarity of their staff to changes and technologies.[112] The relationships between health IT adoption and other organizational factors are more straightforward. Privately-owned, for-profit hospitals usually have broader access to capital resources and operate under market pressure, leading to adoption of IT to improve efficiency and quality, compared to public and non-profit hospitals that usually operate under a tighter budget and less market pressure. Accredited hospitals are attentive to quality and safety issues and will likely adopt health

IT for quality improvement purposes. Finally, hospitals with positive margin or higher operating revenues, higher investment in IT, larger IT workforce, and a more competent and experienced CIO are also more likely to successfully acquire and implement health IT than their counterparts.

Although the literature provides considerable evidence and insights on the facilitating organizational factors of health IT adoption, some studies employed simple univariate statistical analysis such as t-tests and chi-square tests.[101,113] Others used somewhat more sophisticated techniques such as multiple linear regression[100,114,115] or multivariate logistic regression.[21,98,102,103,116,117] These techniques are reasonable, or sometimes necessary, in the early stages of empirical research on organizational IT adoption. However, these techniques have some limitations that prevent us from fully understanding the relationships between the hospital characteristics and IT adoption. First, univariate analysis cannot account for the confounding effects of other factors. For instance, since teaching hospitals are on average larger than non-teaching hospitals, it is possible that the association between teaching status and IT adoption could be explained by hospital size. It is important that we use statistical methods that can control for the effects of other factors to prevent spurious or misleading conclusions. Even if multivariate techniques are used, most studies often focus solely on *if* the associations between a number of independent variables and the level of adoption exist and not *how* these variables relate to one another and the mechanisms through which they lead to adoption. With the accumulating empirical evidence as a base, it is important that future IT adoption studies contribute to the field's scientific knowledge by building and refining theories that explain the mechanism of organizational health IT adoption and serve as a practical guide for efforts to facilitate adoption.

### 2.3.4 Roles of Organizational Cultures and Management Practices

The importance of certain organizational cultures and management practices on health IT adoption and use has been discussed in much of the literature. They have been the subject of myriads of case studies and lessons learned on health IT implementation successes and failures, as well as qualitative studies and viewpoint articles. Theera-Ampornpunt[28] in his review of health IT adoption literature identified at least ten of these "managerial" success factors as presented in Table 2.2.

**Table 2.2** Organizational cultures and management practices related to successful health IT adoption and supporting evidence. Adapted from Theera-Ampornpunt N. Measurement of health information technology adoption: a review of the literature and instrument development [master's Plan B project]. Minneapolis (MN): University of Minnesota; 2009 Aug. Instrument development; p. 78-9.

| Organizational Cultures and Management Practices | Supporting Evidence (List of Reference Numbers) |
|---|---|
| Clear vision of what IT initiatives will achieve | 119, 121, 125, 128, 130, 146, 148 |
| Management support of IT implementation projects | 119–121, 125, 128, 130, 133, 136, 138, 143, 146, 147 |
| Shared commitment among stakeholders | 119, 126, 127 |
| Communications of project plans and progresses | 118, 121, 122, 124, 125, 128, 129, 148–151 |
| Physician and non-physician user involvement | 114, 119, 121, 124–145 |
| Attention to workflow changes during implementation | 118–121, 125, 130, 150, 152–154 |
| Well-executed project management | 118–121, 133, 147 |
| Adequate user training | 118, 119, 121, 124, 125, 129, 131, 139, 141, 143, 146, 147, 150, 151 |
| Organizational learning | 118, 119 |
| Organizational innovativeness | 54, 112, 143, 156, 157 |

In a workshop at the American Medical Informatics Association (AMIA) 2006 Annual Symposium sponsored by ten AMIA working groups, participants shared experience and discussed aspects of health IT implementation.[118] The need to address sociological and cultural issues emerged as part of the consensus. Implementation challenges include the complexity in project communications and workflow implications, as well as the need to link IT implementation to quality improvement efforts. When asked to draw lessons from research and experience, participants noted the importance of proper management of risks, projects, and changes; sufficient training; attention to lessons learned in the past and from others; and the identification of incentives that will help engage stakeholders.[118] An expert consensus echoed a similar theme when considerations crucial to a successful CPOE implementation were identified (Table 2.3).[119] Also, Lorenzi et al.[120] classified health IT implementation issues into 4 categories—design, management, organization, and assessment. While design issues focus mainly on the system usability and performance, workflow issues were also raised. Management issues concern the management of organizational change and the implementation process, while organizational issues underscore the role of the organization's management.[120] These issues were reiterated in a recent compilation of lessons drawn from reported health IT successes and failures.[121] The same cross-cutting point emerges from all of these, that a successful health IT implementation requires not only a well-design, high-quality technology but also a well-executed implementation process backed by an environment of collaboration, support, and engagement in the organization.

**Table 2.3** Considerations for a successful implementation of computerized physician order entry (CPOE). Reproduced from J Am Med Inform Assoc, Ash JS, Stavri PZ, Kuperman GJ, volume 10, number 3, 229-234, Copyright © 2003 with permission from BMJ Publishing Group Ltd.

| Considerations |
|---|
| Motivation for implementation |
| CPOE vision, leadership, and personnel |
| Costs |
| Integration: Workflow, health care processes |
| Value to users/Decision support systems |
| Project management and staging of implementation |
| Technology |
| Training and Support 24 x 7 |
| Learning/Evaluation/Improvement |

Change management is among the most emphasized managerial processes of health IT implementation. Its role in biomedical and health informatics was reviewed by Lorenzi and Riley a decade ago,[122] and a textbook[123] has been dedicated to this complex topic. Change management is multi-faceted, but a consistent set of guides to managing change emerges from the literature. Riley and Lorenzi suggested that to minimize change resistance and gain acceptance of physicians, an implementation effort must involve physician champions; create a sense of ownership through communications and physicians' involvement; understand their values; be attentive to the climate in the organization; and provide adequate training and support.[124] Similarly, Nagle and Catford recommended focus on leadership and engagement, communication, process and workflow integration, education and training, and evaluation.[125]

Engaging users is at the crux of any successful IT implementation. Since users are the ones most affected by the changes introduced by IT implementation, not involving users in the project greatly risks project failure. Ives and Olson[126] suggested multiple reasons user involvement is critical to success. An obvious reason is because it allows the implementer to better understand the needs and requirements of the users. The implementation team can also leverage the expertise of the users about their tasks and how the organization functions, information helpful to the project. Additionally, implementers can assess the importance of specific features to the users, thereby efficiently prioritizing the implementation. On the other hand, involving users allows them to better understand the system and develop realistic expectations, provides them venues to negotiate and resolve potential conflicts, and creates a sense of ownership. These will help reduce the risks of resistance later in the course of the implementation.[126] The benefits of user involvement in health IT implementation were studied by Paré et al.,[127] who found that user participation helps develop the feeling of ownership toward CPOE. The need to engage users in health IT implementation has been documented consistently in the literature.[114,124,125,128-143] Also noted is the importance of involving non-physician stakeholders, including nurses, pharmacists, management, and users in other departments.[136,141,144,145]

Organization's leadership support is also influential to IT implementation success.[119,128,130,133,136,138,143,146,147] Management support refers to not only the provision of adequate financial and human resources but also the visible, unwavering, and committed political support. This will send a clear signal to the entire organization that the project is important to the organization and that additional support will be provided if needed for its success, dispelling fear and uncertainty that could lead to change resistance.

Other aspects of change management are worth noting as well. Communications of project goals, plans, and progresses have been discussed as important,[122,128,129,148-151] as is a clear, shared vision within the organization.[119,125,128,130,146,148] As previously noted, the necessity to adequately assess and consider workflow implications of the implementation can never be overstated,[119,125,130,150,152-154] especially since health IT can result in power shift among various users and lead the project toward conflicts if not properly handled.[131,132,155] Finally, adequate training also prepares the users for the changes introduced by the new system.[119,124,125,129,131,139,141,143,146,147,150,151]

Project management refers to a systematic process to create a project plan, manage schedule and resources, track progress, and coordinate with various parties. With the complex, dynamic, and perhaps even chaotic nature of health IT implementation, effective project management helps keep various parts of the project under control. It is not surprising, therefore, that project management is also frequently listed as important to health IT implementation success.[118,119,121,133,147]

Lastly, two organizational cultures have been linked to IT implementation success. Organizational learning, referred to as the culture in which an organization learns from its past experience to improve how it operates in the future, was noted previously as relevant to successful implementation.[118,119] Another notion, termed organizational innovativeness in this dissertation, refers to the organizational environment in which a hospital is open to new ways of conducting its operations. This concept, applied to organizations, is parallel to Rogers' diffusion of innovations theory which categorizes people based on their tendency to adopt an innovation.[54] The role of organizational innovativeness has been investigated in a study which found that organizations with developmental or innovative culture were more likely to implement quality improvement processes.[156] Because many implement health IT to pursue quality gains, it can be argued that innovative organizations would be more likely to adopt health IT. Others also described the culture of innovation or cultural readiness to change as influential to health IT adoption.[112,143,157]

In summary, various organizational cultures and management practices are described as success factors of health IT adoption. Table 2.2 listed ten factors and the supporting evidence based on a review by Theera-Ampornpunt.[28] It is important to note that most of the cited evidence is based on case studies, lessons learned, expert opinions, and qualitative studies. Few quantitative studies have investigated the relationship of these managerial factors and health IT adoption. The 2006 AMIA workshop previously described called for more qualitative and longitudinal studies of successful and failed IT projects throughout their stages of implementation,[118] but surprisingly it did not argue for quantitative investigations of these important issues.

## 2.4 Thailand

### 2.4.1 Thailand: An Overview

The Kingdom of Thailand is a sovereign nation located in Southeast Asia, bordering Myanmar and Laos to its north, Laos and Cambodia to its east, the Gulf of Thailand and Malaysia to its south, and Myanmar and the Andaman Sea to its west (Figure 2.6). It has a land area of approximately 197,256 square miles (510,890 square kilometers), about 2.5 times the size of Minnesota. Bangkok is its capital, and there are 76 other provinces in 6 geographic regions (north, central, northeast, east, west, and south).[158] As of December 2010, Thailand officially has a population of more than 63.8

million,[159] about 12 times that of Minnesota. Three quarters of the population are Thai, 14% are Chinese, and the remaining 11% are of other ethnic groups. An overwhelming number of people (94.6%) are Buddhists, 4.6% are Muslims, and less than 1% are Christians.[160]


**Figure 2.6.** Map of Thailand. Reproduced from The world factbook [Internet]. Washington, D.C.: Central Intelligence Agency; 2011. Available from: https://www.cia.gov/library/publications/the-world-factbook/graphics/maps/newmaps/th-map.gif

Thailand is a unitary state governed by constitutional monarchy and parliamentary democracy. King Bhumibol Adulyadej, Rama IX, is the current head of state and has reigned since 1946. The King exercises the sovereign power through the National Assembly, the Council of Ministers (also known as the Cabinet), and the Courts, which serve as the legislative, executive, and judicial branches of government, respectively. Thailand's prime minister serves as the head of government. While Thailand has been a constitutional monarchy since 1932, there has been periodic political instability, the recent ones being the 2006 coup d'état and the 2010 violent clashes between the government and the opposition. Since then, a democratic election has been held in July 2011 and a new government has taken office, leading Thailand toward a path of political stability amid ongoing polarized and at times divisive and confrontational political views.

According to the World Bank, Thailand was previously a lower-middle-income country but has recently been classified as upper-middle-income.[161] As of 2010, the country ranks 92th on the United Nations Development Programme (UNDP)'s Human Development Index, a composite index of social and economic indicators measuring health, education, and living standards of the people.[162] The life expectancy at birth is 70 years.[163] A comparison of social and economic indicators between Thailand and the United States is presented in Table 2.4. Overall, Thailand still lags behind the United States on economic development, social development, healthcare quality, healthcare resources, and technological infrastructure. It is noteworthy, however, that Thailand spends far less money per capita on health care with relatively scarce healthcare resources but has achieved reasonable care quality.[164]

**Table 2.4** Comparison of social and economic indicators of Thailand and the U.S.

| Indicator | Thailand | United States |
|---|---|---|
| **Population Indicators*** | | |
| Population | 66,720,153 (July 2011 est.) | 313,232,044 (July 2011 est.) |
| Age structure<br>0–14 years<br>15–64 years<br>65 years and over | (2011 est.)<br>19.9%<br>70.9%<br>9.2% | (2011 est.)<br>20.1%<br>66.8%<br>13.1% |
| Median age (years) | 34.2 (2011 est.) | 36.9 (2011 est.) |
| Population growth rate | 0.566% (2011 est.) | 0.963% (2011 est.) |
| Birth rate (births per 1,000 population) | 12.95 (2011 est.) | 13.83 (2011 est.) |
| **Economic Indicators†** | | |
| GDP (current US$) | 318,847 million (2010) | 14,582,400 million (2010) |
| GDP per capita (current US$) | 4,679 (2010) | 47,084 (2010) |
| GDP growth (annual %) | 7.8 (2010) | 2.9 (2010) |
| GNI, (PPP int. $) | 561,499 million (2010) | 14,561,698 million (2010) |
| GNI per capita, (PPP int. $) | 8,240 (2010) | 47,020 (2010) |
| Inflation, consumer prices (annual %) | 5.5 (2009), -0.8 (2010) | 3.8 (2009), -0.4 (2010) |
| **Social Indicators‡** | | |
| Human Development Index | 0.654 (2010) Rank 92th | 0.902 (2010) Rank 4th |
| Adult literacy rate (% of aged 15 and above) | 94.7 (2010) | 99.0% (2009 est.) |
| **Infrastructure Indicators§** | | |
| Internet users (per 100 population) | 21.2 (2010) | 79.0 (2010) |
| Mobile cellular subscriptions (per 100 population) | 100.81 (2010) | 89.86 (2010) |
| Households with computer (%) | 19.6 (2008) | 72.5 (2008) |
| Households with Internet (%) | 8.6 (2008) | 62.5 (2008) |
| ICT Development Index | 3.27 (2008) Rank 76th | 6.54 (2008) Rank 19th |
| **Health Indicators‖** | | |
| Total health expenditure (% of GDP) | 4.0 (2010) | 16.0 (2010) |
| Total health expenditure per capita (PPP int. $) | 323 (2010) | 7,536 (2010) |
| Government health expenditure per capita (PPP int. $) | 261 (2009) | 3,602 (2009) |
| Government expenditure on health (% of total government expenditure) | 14.0 (2009) | 18.7 (2009) |
| Physician density (per 10,000 population) | 3.1 (2007) | 26.7 (2007) |
| Hospital bed density (per 10,000 population) | 22 (2008) | 31 (2008) |
| Life expectancy at birth (years) | 70 (2009) | 79 (2009) |
| Infant mortality rate (per 1,000 live births) | 12 (2009) | 7 (2009) |
| Adult mortality rate (between 15 and 60 years per 1,000 population) | 205 (2009) | 106 (2009) |

**Sources:** *CIA's World Factbook †World Bank ‡United Nations Development Programme §International Telecommunication Union ‖World Health Organization
est. = estimate, N/A = data not available, GDP = gross domestic product, GNI = gross national income, ICT = information and communications technology, PPP int. $ = Purchasing Power Parity at international dollar rate.

### 2.4.2 Thailand's Healthcare System

Thailand has a pluralistic healthcare system, with both public and private health care providers serving the population, although public providers including public hospitals and community health centers constitute a large part of the system. The nation's healthcare system is financed predominantly by public funds. It had undergone a number of gradual, piecemeal changes since 1975, until the health care reform in 2001 brought the nation to universal coverage.[165,166]

There are currently three main health care schemes in Thailand. The Civil Servant Medical Benefit Scheme (CSMBS) emerged in 1980 as a fringe benefit for the government's active and retired civil servants and their dependents.[167] It is a non-contributory fee-for-service scheme covering most healthcare services (except some non-essential prescriptions and other services deemed unnecessary) delivered by public providers. Recently, the coverage extended to certain services provided by some private hospitals. The scheme is known for uncontrollably escalating costs and has been characterized as an inequitable, pro-rich scheme,[168] though there have been recent efforts to contain costs through the introduction of diagnosis-related group (DRG)-based inpatient payments and the rationing of high-cost medications.

The Social Security Scheme (SSS) is another health insurance scheme with mandated tripartite contributions from the employee, employer, and the government.[169] It pays participated public and private hospitals a capitation fee for providing the registered employees outpatient and inpatient services. While this scheme is highly successful in containing costs through capitation-based payments, it suffers from instances of poor quality through cream skimming, cost shifting, under-provision of care, and ineffective regulatory oversight.[169,170] Other schemes also exist, including the legally-mandated, employer-funded Workmen Compensation Scheme for occupational injuries and voluntary private insurance schemes, but these schemes were limited in scale and expenditure.[167,171]

Finally, a Universal Coverage (UC) scheme was implemented in 2001, providing coverage to all Thai people uncovered by the CSMBS or SSS. It was motivated by the ineffectiveness of other schemes that targeted the poor.[172,173] To be covered, registration is required, and UC members must seek services at the registered community health center or the public hospital in their residential area, which would refer them to more sophisticated providers if necessary. Because of its broad population coverage and deeply covered benefit packages, it provides effective risk pooling to the population as well as financial protection and more equitable access to the poor. Lessons learned from the capitation-based SSS and the fee-for-service CSMBS led to the UC scheme's mixed mode of payment to providers—capitation fees for outpatient and DRG-based payment for inpatient services.[165,166,174] The National Health Security Office (NHSO) serves as the purchaser who allocates funding to the participating public providers. Many studies have reviewed and evaluated this scheme, noting success, issues, and lessons learned.[27,164,165,174-190] Table 2.5 compares three schemes that predominate in Thailand.

**Table 2.5** Comparison of three main public health insurance schemes in Thailand.

| Characteristic | CSMBS | SSS | UC |
|---|---|---|---|
| Scheme nature | Fringe benefit | Compulsory | Compulsory |
| Population covered (% of total population)* | Government employees and dependents (9%) | Employees in the formal private sector (16%) | Others not covered by CSMBS and SSS, registration required (75%) |
| Financing Source | General tax, non-contributory | Tri-partite contribution from employee, employer, and the government | General tax |
| Mode of provider payment | Fee-for-service (recent efforts for DRG-based inpatient payment) | Capitation for outpatient and inpatient | Capitation for outpatient; DRG-based payment with global budget for inpatient |
| Care provider | Public for outpatient; public and private for inpatient | Participating public or private provider (or its network) as annually chosen by employee for both outpatient and inpatient | Public community health center or district hospital registered by patient, or referred public hospital; except accidents and emergencies |
| Key strengths | Patient satisfaction | Cost containment | Universal coverage, equitable and effective financial protection, and strengthened primary care |
| Key issues | Cost containment | Lowered quality by some providers to minimize costs | Low capitation fees leading to poor financial performance of many providers; increased utilization, with relatively scarce health care resources |

CSMBS = Civil Servant Medical Benefit Scheme, DRG = Diagnosis-related group, SSS = Social Security Scheme, UC = Universal Coverage Scheme.
***Source of population coverage:** Prakongsai P, Limwattananon S, Tangcharoensathien V. The equity impact of the universal coverage policy: lessons from Thailand. Adv Health Econ Health Serv Res. 2009;21:57-81. (Reference 165).

The country’s health care is delivered through a number of public and private entities. A community health center located in every subdistrict, usually staffed by 2–5 non-physician professionals, serves as the government’s primary care unit close to people’s home. Recently, these community health centers have been upgraded to the so-called "health promotion hospitals," with plans to enhance their capability, though their functions do not appear to change and virtually all are still not staffed by physicians. Patients who need medical care by physicians can also go to the district hospital in their district. Apart from these community health centers and district hospitals, the Ministry of Public Health also has provincial and regional hospitals with increasing levels of capability, typically located in the urban areas. Other general and specialty hospitals within the Ministry of Public Health also exist. In addition, there are university hospitals (all public) with the highest level of capability, as well as hospitals under other ministries' oversight. Private providers include private hospitals, private physician's clinics, and private pharmacies. As of November 2010, the distribution of public and private hospitals is displayed in Table 2.6

**Table 2.6** Distribution of public and private hospitals in Thailand by category.

| Hospital Category | Number of Hospitals | Percentage of All Hospitals |
|---|---|---|
| District hospitals (MOPH) | 737 | 56.4% |
| General hospitals (MOPH) | 68 | 5.2% |
| Regional hospitals (MOPH) | 26 | 2.0% |
| Other hospitals under MOPH* | 50 | 3.8% |
| Other public hospitals outside MOPH† | 111 | 8.5% |
| Private hospitals | 315 | 24.1% |
| **Total** | 1307 | 100.0% |

*Including general and specialty hospitals under other departments within the Ministry of Public Health.
†Including university hospitals, military hospitals, autonomous public hospitals, prison hospitals, hospitals of state enterprises, and public hospitals under local governments.
MOPH = Ministry of Public Health
**Source:** Bureau of Policy and Strategy, Ministry of Public Health (November 2010).

### 2.4.3 Health IT Environment in Thailand

While much has been talked about on health care reform in Thailand, few discussions on the country's health IT situation exist in the literature, and there has been no national policy to systematically facilitate health IT adoption to date. Theera-Ampornpunt[191] suggested that Thailand can learn greatly from the initiatives in the

United States, including HIE efforts, pay for performance, and biomedical and health informatics research, although contextual differences of the two countries must be taken into account. In a more recent publication,[192] he reviewed the policy contents in the HITECH Act and drew lessons Thailand could learn from such a large-scale national policy. The analysis highlighted the needs for strong political support, adequate funding, a national body, an evidence base, and full understanding about the roles of standards and interoperability.[192] Annual conferences have been organized by the Thai Medical Informatics Association for twenty years, and academic institutions have recently sharpened their focus on health IT, but little was translated into national policy.

This lack of policy has been noted in a study by Kijsanayotin et al.[193] that convened a meeting with national experts as part of the World Health Organization (WHO)'s Global Observatory for eHealth (GOe) survey.[194] In that study, experts agreed that national policy and strategy on eHealth are still absent, as is the national eHealth governance body. Some enabling factors exist such as exposure of health science students and practitioners to IT and use of some information standards, though much still remain to be done on health information privacy laws and development of other necessary standards. Overall, the authors concluded that eHealth efforts in Thailand exist but are largely fragmented, and there is an urgent need to close the foundational gaps so that sustainable eHealth environment can be achieved. Among the recommendations are: 1) creation of a multi-stakeholder, national eHealth authority, 2) incorporation of eHealth strategy into the national ICT framework, 3) the promulgation of health information privacy legislations, 4) development of national health information standards, and 5) more systematic capacity building.[193]

In addition to the lack of enabling policies, the evidence base on Thailand's health IT adoption is also limited. An early effort by the Ministry of Public Health in the area of telemedicine has been documented,[195] but limited IT skills and user acceptance together with technological, social, political, and economic challenges at the time led to the project's discontinuation.[196] More recently, the adoption and user acceptance of IT in a representative sample of Thailand's community health centers has been studied by Kijsanayotin et al.[196-199] The study, conducted in 2005, found that basic infrastructural technologies such as PCs were pervasive, though Internet connectivity existed in less than half and most centers connected through low-bandwidth dial-up.[196] The technology acceptance among the respondents was reasonably high, but their basic IT knowledge was still relatively low.[196,197] Users also complained about their workloads in data management and reporting activities.[197] The UTAUT model[64] was applied to study how attitudes relate to acceptance and use, and findings provide support for the validity of this model in the health IT context of developing countries.[198] However, the study focused on basic IT such as PCs and Internet connectivity, and only examined the status of IT adoption in small community health centers. While the role of community health centers in Thailand's primary care makes this study useful, the adoption picture is incomplete and limited policy implications can be drawn without knowledge about Thai hospitals' adoption of information technology. This is especially important given that hospitals serve as a large part of patient care in Thailand, and many of the documented benefits of health IT relate to more sophisticated clinical settings like hospitals where the need to prevent dangerous errors and deliver high-quality care is paramount.

The first and only national survey of Thai hospitals' IT adoption before this current study was conducted by Pongpirul et al. in 2004.[200] Using a mixed-mode survey, the researchers found that among the 39% of hospital responded, 88% used a computerized hospital information system, defined as an information system that utilizes computers and electronic devices in the management of information directly related to patient care.[200] While this is highly encouraging, the study suffered from a number of methodological concerns that limited its utility. First, the survey had a relatively low response rate, and the use of electronic mail as one of the methods to deliver the questionnaires to respondents raises concerns about possible biases and non-representativeness in the respondents, an issue acknowledged by the researchers.[200] In addition, the definition of a computerized hospital information system can be interpreted in a number of ways by the respondents, and the binary yes/no measurement makes it hard to distinguish low-adoption hospitals from high-adoption hospitals. This underscores the need to graduate from the technological approach of adoption measurement to a more functional one, as Theera-Ampornpunt argued in his methodological review.[28] The study was also conducted several years ago, while the health IT landscape in Thailand has changed greatly and attention has much increased since then. In summary, there is a serious lack of the current state of health IT adoption among Thai hospitals that makes it challenging for policymakers to formulate much-needed appropriate policy.

Another study assessed attitudes toward IT of hospital providers and local public health administrators.[201] Its key findings echoed perspectives of health informatics experts on the people issues, noting that shortage of IT staff, the lack of appropriate skills, and limited user involvement are among the pressing issues. Other challenges were also revealed, including inadequate financial investments, technical issues, poor coordination among the departments within the Ministry of Public Health, and high workload.[201] Similar organizational problems were noted in another article that focuses on provider attitudes on IT quality improvement initiatives according to Thailand's hospital accreditation processes.[202] It demonstrated that managing a hospital IT's environment is a challenging task that requires not only leadership and facilitating organizational conditions but also full collaboration by relevant stakeholders.[202]

In summary, this chapter reviewed the potential benefits of health IT, surveyed a number of IT adoption theories and argued for a better conceptualization of organizational health IT adoption. It also underscored the roles of organizational factors as well as the organizational cultures and management practices on successful adoption. Finally, it noted the lack of national policy on health IT and clear IT adoption picture in Thai hospitals, emphasizing the need to capture such knowledge to drive policymaking. At the same time it also suggested that organizational and management issues are also important in Thailand's context. The next chapter presents this study's conceptual framework and hypotheses.

# Chapter Three
# Conceptual Framework and Hypotheses

This chapter presents this study's conceptual framework and hypotheses to be investigated. It begins with the high-level conceptual framework and then proposes the research questions and hypotheses that will be discussed throughout the rest of the dissertation.

## 3.1 Conceptual Framework

It has been previously argued that the theoretical approach to measuring health IT adoption in health care organizations not only provides a systematic way to tackle the adoption problem, but also improves the understanding of complex and dynamic IT adoption processes and helps push the science forward. By breaking down health IT adoption into technologies, functions, and information sharing aspects, Paré and Sicotte's IT sophistication framework[29] provides a balanced lens for conceptualizing health IT adoption and serves as the foundation of this study. However, the original model falls short of a complete picture of organizational IT adoption. Without the managerial dimension representing important IT management activities as initially included in Raymond and Paré's early work on the model,[84] their importance is de-emphasized. Realizing that successful and sustainable adoption of health IT would require certain management practices and organizational cultures, these should be captured and incorporated into the IT sophistication construct. These management practices and cultures are not merely success factors or antecedents to successful adoption that an organization must *possess*, but they are rather dynamic processes and values that an organization must *adopt and implement* together with the adoption and implementation of technologies.[55] The level of *sophistication* of these aspects in an organization is also a good indicator of how much emphasis the organization puts on the non-technical aspects of IT implementation. With supporting evidence suggesting ten management practices that are critical to successful health IT implementation (presented in Table 2.2), this study restores Raymond and Paré's managerial sophistication dimension,[84] with some changes in its definition and operationalization, and proposes a modified conceptual framework of IT sophistication as displayed in Figure 3.1.

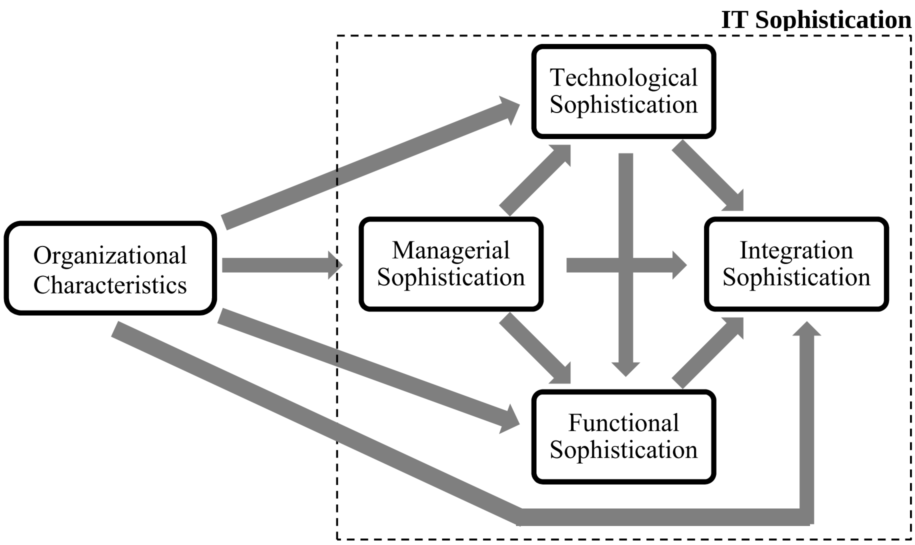



**Figure 3.1.** The conceptual framework of this study.

This conceptual framework keeps all three dimensions in Paré and Sicotte's IT sophistication framework,[29] namely, *technological sophistication*, *functional sophistication*, and *integration sophistication*, each representing the technological, functional, and information sharing components of hospital IT adoption. With the addition of a new *managerial sophistication* dimension, it makes clear that the roles of organizational cultures and management practices cannot be ignored. Unlike Paré and Sicotte's framework (Figure 2.4),[29] however, this study does not differentiate activities that support patient care, clinical support, and administration, to avoid too much complexity. Definitions of the four dimensions are provided in Table 3.1.

**Table 3.1** Definitions of the IT sophistication constructs used in this study.

| Construct | Definition |
|---|---|
| IT Sophistication | The extent to which information technology and associated management practices and organizational cultures are adopted and employed in a health care organization |
| Technological Sophistication | The extent to which information technology, including hardware devices and software applications, is made available in an organization to support its operations |
| Functional Sophistication | The extent to which work processes within an organization are assisted by computerized information systems |
| Integration Sophistication | The extent to which electronic information exchange takes place among information systems within an organization and with information systems of outside entities |
| Managerial Sophistication | The extent to which organizational cultures and management practices that facilitate successful adoption of information technology are present and employed in the organization |

This multifaceted framework proposes that the four dimensions of IT sophistication are interrelated. On the right hand side of Figure 3.1, it posits that hospitals with conducive cultures and management practices, such as those that are innovative or those that manage changes and IT projects well, would be more likely to succeed in their IT implementation endeavors. This would lead to increased levels of sophistication in their technology base (technological sophistication), their operations that are supported by information systems (functional sophistication), and their information exchange (integration sophistication). Consistent with the original IT sophistication model,[29] technological sophistication is expected to associate with functional and integration sophistication. This is because when a hospital adopts a technology, it also adopts the associated functionalities, which computerize part of the work processes. This, in turn, generates more electronic data that enable information exchange within and outside the hospital. The direct path between technological sophistication and integration sophistication reflects the plausible positive direct effect of adopting some technologies, such as infrastructural IT and certain enabling health IT, on information exchange above and beyond the effect of increased functional sophistication.

The left part of the framework suggests that organizational characteristics of the adopting hospitals, such as size, teaching status, and for-profit status, influence how the hospitals adopt technologies and functions. The associations between various organizational characteristics and adoption of technologies and functionalities have been reviewed in Chapter 2. It is proposed that these organizational factors exert their effects on technological, functional, and integration sophistication directly, as well as indirectly through appropriate organizational cultures and management practices that are known to facilitate IT adoption (managerial sophistication). The next section details the research questions and hypotheses of this study.

## 3.2 Research Questions and Hypotheses

As stated in Chapter 1, this study aims to assess the state of IT adoption in Thai hospitals while at the same time use the empirical data to test the conceptual framework as presented in Figure 3.1, thereby improving the theoretical knowledge of health IT adoption at the organizational level. Research questions related to Thailand's state of hospital IT adoption are as follows:

**Research Question 1:** What is the extent of IT adoption in Thai hospitals nationwide?

**Research Question 2:** Are there variations in the IT adoption levels among hospitals in different geographic regions of the country?

Given the descriptive nature of the above research questions and the lack of reliable baseline information about Thai hospitals' IT adoption, no specific a priori hypotheses are proposed for this part of the study. Hypothesis testing is especially irrelevant when a study is a census study where all hospitals are included in the sample and thus any observed difference, large or small, is a real difference and statistical inference is not necessary.[28] Nevertheless, this study will attempt to examine for statistically significant differences when possible (such as in Research Question 2) to assist readers familiar with statistical inference in their interpretation. It should be noted that the statistical significance in this case should be interpreted *as if* the study sample came from a hypothetical population of similar hospitals.

The other part of the study uses the same empirical data to evaluate the proposed model of IT adoption. The analysis first assesses whether the observed data support the proposed conceptualization of hospital IT adoption into four dimensions of IT sophistication (managerial, technological, functional, and integration sophistication). This analysis answers the following research question.

**Research Question 3:** Do the data support the conceptualization of hospital IT adoption into four IT sophistication dimensions as proposed? If not, what pattern do the data reveal that will guide the subsequent model testing?

Then, guided by the underlying structure revealed from the observed data, a model of relationships among the facets of IT adoption and between these aspects and hospital characteristics is tested. Figure 3.2 shows the originally proposed model, although the model may undergo a series of respecifications informed by the discovered structure of the data. The model can be broken down into two components, one that tests the interrelationships between the various aspects of hospital IT adoption and another that assesses the direct and indirect effects of hospital characteristics on these dimensions of IT adoption. Results from the first part would enhance our understanding about how different components of IT adoption interact with one another. This is accomplished by the following research question and its accompanying sets of hypotheses.

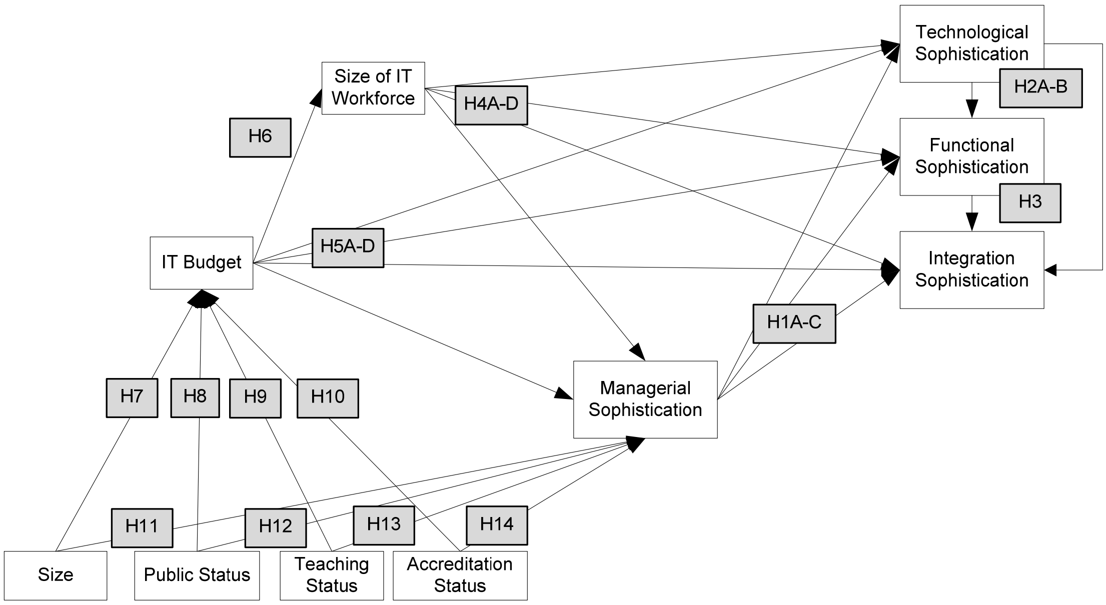



**Figure 3.2.** The hypothesized model of hospital IT adoption. Each number in a shaded box corresponds to a proposed set of hypotheses.

**Research Question 4:** Are the associations hypothesized in the model statistically significant?

This research question examines the interrelationships among the constructs in the model in Figure 3.2, which can be accomplished by testing the following hypotheses.

**Hypothesis 1A:** There is a significant positive direct effect of managerial sophistication on technological sophistication.

**Hypothesis 1B:** There is a significant positive direct effect of managerial sophistication on functional sophistication.

**Hypothesis 1C:** There is a significant positive direct effect of managerial sophistication on integration sophistication.

**Hypothesis 2A:** There is a significant positive direct effect of technological sophistication on functional sophistication.

**Hypothesis 2B:** There is a significant positive direct effect of technological sophistication on integration sophistication.

**Hypothesis 3:** There is a significant positive direct effect of functional sophistication on integration sophistication.

As previously discussed, significant positive associations between technological, functional, and integration sophistication have been documented by Paré and Sicotte,[29] although how they operationalized the constructs was different from this study. Since these three dimensions represent three important components of any information system, I hypothesize that the significance of these associations can also be observed in this study. In addition, given the extensive literature evidence of the importance of organizational cultures and management practices on IT adoption, it is hypothesized that managerial sophistication is positively associated with the other three IT sophistication dimensions. Unlike Paré and Sicotte[29] who examined bivariate correlations among these dimensions, however, this study also uses a multivariate approach and examines if significance associations exist after adjusting for the effects of other covariates. The presence of most, albeit not necessarily all, of the hypothesized associations would lend support to the construct validity of the dimensions. Explanation of different types of validity evaluated in this study is provided in Chapter 4.

The remaining part of the framework theorizes how different organizational factors lead to increased levels of IT sophistication, building upon knowledge from the existing literature. The following hypotheses present how this study frames these relationships.

**Hypothesis 4A:** There is a significant positive direct effect of the size of IT workforce on managerial sophistication.

**Hypothesis 4B:** There is a significant positive direct effect of the size of IT workforce on technological sophistication.

**Hypothesis 4C:** There is a significant positive direct effect of the size of IT workforce on functional sophistication.

**Hypothesis 4D:** There is a significant positive direct effect of the size of IT workforce on integration sophistication.

**Hypothesis 5A:** There is a significant positive direct effect of IT budget on managerial sophistication.

**Hypothesis 5B:** There is a significant positive direct effect of IT budget on technological sophistication.

**Hypothesis 5C:** There is a significant positive direct effect of IT budget on functional sophistication.

**Hypothesis 5D:** There is a significant positive direct effect of IT budget on integration sophistication.

With evidence from previous studies,[20,29,86,100,108] organizational resources devoted to IT, as indicated by IT budget and size of IT workforce, are believed to lead to more technological, functional, integration, and managerial sophistication. Paré and Sicotte found significant positive associations of annual IT budget and the number of IT staff on technological, functional, and integration sophistication,[29] while Jaana et al. observed a significant positive association between all three IT sophistication dimensions and the number of IT staff as well as annual hospital budget, but not annual IT budget.[86] Wang et al. found that cash flow and total operating revenue were positively associated with hospital IT adoption, but they did not examined the size of hospital IT workforce and IT budget specifically.[100]

**Hypothesis 6:** There is a significant positive direct effect of IT budget on the size of IT workforce.

This hypothesis does not directly relate to the conceptualized model of hospital IT adoption, but it proposes a plausible relationship between IT budget and the size of IT workforce, which is another independent variable of IT adoption. It is expected that the size of IT workforce would require financial resources, which is reflected by this hypothesized relationship.

**Hypothesis 7:** There is a significant positive direct effect of hospital size on IT budget.

**Hypothesis 8:** There is a significant negative direct effect of public status on IT budget.

**Hypothesis 9:** There is a significant positive direct effect of teaching status on IT budget.

**Hypothesis 10:** There is a significant positive direct effect of accreditation status on IT budget.

**Hypothesis 11:** There is a significant positive direct effect of hospital size on managerial sophistication.

**Hypothesis 12:** There is a significant negative direct effect of public status on managerial sophistication.

**Hypothesis 13:** There is a significant positive direct effect of teaching status on managerial sophistication.

**Hypothesis 14:** There is a significant positive direct effect of accreditation status on managerial sophistication.

The literature contains evidence for positive relationships between hospital size,[20,87,100-105] for-profit status,[100,101,108] teaching status,[20,98,102,104] and accreditation status[102] on one hand, and IT adoption on another. However, the mechanisms that explain how these variables exert their effects on IT adoption are unclear, and some conflicting findings exist for for-profit status.[98,102] In this study, these hospital characteristics are believed to lead to hospital IT sophistication through increased IT budget, either because of their differential availability of financial resources or their functional requirements, or both. In addition, different types of hospitals may have different management practices that may explain different levels of IT sophistication beyond the effect of IT budget alone, so the framework also includes their direct effects on managerial sophistication.

Given the limited theoretical knowledge on how various hospital characteristics lead to health IT adoption at the organizational level, the conceptual framework in this study should be viewed as a somewhat exploratory investigation (as opposed to an entirely confirmatory analysis). It builds on earlier studies and attempts to explore how different organizational characteristics lead to aspects of IT adoption. Data from Thai hospitals will determine if the model as proposed is supported by empirical data, but it is very much possible that the model needs to undergo a series of modifications in order to better explain the observed relationships. Moreover, data quality issues may arise that limit the usefulness of some variables. These constraints would dictate necessary changes to the model, and hence the hypotheses. Therefore, some of the hypotheses presented in this chapter may need to be modified or dropped and some additional hypotheses may be added as model modifications take place. Such changes in the hypotheses, if required, will be noted in the results along with the respective modification steps.

# Chapter Four
# Methodology

This chapter describes the methods conducted in this study to investigate the research questions and hypotheses in Chapter 3.

### 4.1 Study Design, Population, and Sample

In order to achieve the study objectives, a nationwide cross-sectional survey of Thai hospitals, named the Thai Hospitals' Adoption of Information Technology Survey (THAIS), was conducted. The target population of this observational study consists of all hospitals in Thailand that provide medical services. Hospitals that provide exclusive dental services without medical services were not part of the study, nor were the almost-10,000 so-called "health promotion hospitals" recently upgraded from the Ministry of Public Health's primary care community health centers as described in Chapter 2. The excluded organizations only provide very limited services to patients, are not staffed by physicians, and generally do not operate in the same way as traditional hospitals included in this study. All other hospitals in Thailand, including specialty hospitals and all public and private hospitals regardless of ownership, constitute the study population.

A list of all currently operating hospitals and their contact information, obtained from the Ministry of Public Health's Bureau of Policy and Strategy Web site[203] in November 2010, served as the study's sampling frame, where all hospitals in the list were selected except five hospitals already participated in the pilot study (described in the next section). There were a total of 1,302 hospitals included in the main survey. A census (rather than a probability or non-probability sampling) was chosen for several reasons. This study was the first large-scale national study to establish the baseline of current hospital IT adoption. A census, without the statistical uncertainty inherent in probability sampling, would provide a more precise estimate of Thai hospitals' current state of adoption, giving policymakers more confidence in the findings. In addition, a census would allow comparisons among different categories of hospitals, even if some categories might have a small number of hospitals, without concerns about underrepresentation of these categories. Also, the size of the target population is not prohibitively large and is financially and practically feasible for a survey in Thailand. Similar primary surveys of this scale have been conducted elsewhere.[21,197,204-206]

The argument for a census in this particular study can be demonstrated by simple sample size calculations. One might be interested in obtaining an estimate of Thai hospitals' adoption level of an EHR system with key functionalities experts identified as important, such as clinical documentation, order entry, and electronic viewing of laboratory and radiology results.[207] To obtain a 95% confidence interval of such an estimate with a 2.5% margin of error (i.e., a 5% confidence interval width), one would need to conduct a probability survey with 984 hospitals in the sample, assuming that 20% of Thai hospitals currently adopt such an EHR system. In the context of assessing the conceptual model in Figure 3.2, experts suggest a rule of thumb of 5-20 cases per estimated parameter in the model,[208-210] with a ratio of 20 cases per parameter considered ideal.[209] Another recommendation considers an absolute sample size of 200 cases only a moderate size.[209,210] This suggests a sample size of 145-580 hospitals for the relatively complex model used in this study. When considering the possibility of nonresponses, using the entire population as the sample seemed an appropriate course of action.

## 4.2 Survey Development

### 4.2.1 Initial Development

Paré and Sicotte's[29] original survey instrument was obtained from the authors,[86] and it was used as a base for the development. Potential issues in the original instrument were identified and a new instrument was developed in English, taking these issues and other possible improvements into account. Details of the instrument development were previously reported,[28] and they are repeated here for completeness. One major improvement was the restructuring of the question format, especially for functional sophistication items, from simple checklists of whether the work processes are computerized to 5-point scales asking the extent of work processes assisted by computerized information systems. This was done in order to balance the *depth* and *breadth* of organizational IT adoption, a point suggested by Ash in her study of EHR diffusion.[114] A binary checklist of whether a process is computerized allows a researcher to gauge a crude level of vertical "infusion" of IT in the organization, but it ignores the horizontal "diffusion" across departments. Given that many technologies are not rolled out in a "big bang" approach across an organization as large and complex as a typical hospital, a Likert-type scale[211] would enable a finer level of adoption measurement, taking the innovation diffusion process within an organization into account.[54]

Another improvement on the original instrument was the extensive addition of work processes and activities essential to most hospitals.[28] The original instrument contained only a handful of work processes in each activity domain, which did not seem adequate to capture the extent of IT-supported functions of a hospital. Many activities that are typical and important to most hospitals were added to the instrument, including those related to patient management, outpatient and inpatient care, nursing, pharmacy, and finance. Similarly, some additional technologies and applications that are most likely relevant in today's hospitals were also added. While this added some complexity to the survey, the items in the original survey were deemed inadequate and somewhat outdated, especially when considering that the survey was developed a decade ago. Other improvements included revisions of survey structure, item wording, and other design features to minimize misunderstanding and enhance interpretability of respondents, as well as inclusion of appropriate questions about the characteristics of the hospital and the respondent relevant to this study.

A last major addition to the instrument involved the items for the proposed managerial sophistication. After identifying ten management practices and organizational cultures related to health IT adoption in the literature (Table 2.2), eleven survey items were developed.[28] Each of the identified management practices and organizational cultures was translated to one survey item, except user involvement which led to two items—one on the extent of involvement and another on the multidisciplinary nature of user involvement, both of which were considered essential to success according to the review. While a single item might not represent the full scope of these practices, adding too many items would increase the cognitive burden of respondents, reduce the feasibility of the survey, and threaten the response rate. Therefore, only their most salient points, as the literature review suggested, were captured in the developed items. Any possible addition of new items or improvement of existing items was considered areas for future research.

### 4.2.2 Face and Content Validity

As previously reported,[28] interviews were conducted with five experts to establish the face and content validity of the modified survey instrument. The experts had backgrounds in medicine, nursing, pharmacy, and health informatics. Some were familiar with the U.S. healthcare system, some with Thailand's healthcare system. Some also had experience managing IT in a hospital setting. Details of the individual experts' background and areas of expertise are displayed in Table 4.1.

**Table 4.1** Background and areas of expertise of five experts interviewed. Adapted from Theera-Ampornpunt N. Measurement of health information technology adoption: a review of the literature and instrument development [master's Plan B project]. Minneapolis (MN): University of Minnesota; 2009 Aug. 165 p.

| Expert | Familiarity with Thai Healthcare System | Familiarity with U.S. Healthcare System | Experience Managing IT in Hospital Setting | Background and Areas of Expertise |
|---|---|---|---|---|
| A | | ✓ | | Pharmacy, Medicine, Health Informatics |
| B | ✓ | | ✓ | Medicine, Public Health, Health Informatics |
| C | ✓ | | | Pharmacy, Health Informatics |
| D | | ✓ | ✓ | Medicine, Health Informatics |
| E | | ✓ | | Nursing, Health Informatics |

The experts were provided with the draft questionnaire in advance of the individual interview, and were asked to review the specific items related to four IT sophistication dimensions. Specifically, the concepts of face validity and content validity were described, and the experts were asked to comment on the items' face and content validity. Face validity is "a judgment by the scientific community that the indicator really measures the construct."[212] It addresses whether, on the face of it, the definition and method of measurement seem to fit together. To establish face validity, the five experts were provided the definitions of the IT sophistication dimensions and were asked if they thought the questions and items addressed the corresponding dimensions of IT sophistication. Content validity, a close concept to face validity, ensures that the full content of a definition is represented in a measure.[212] In this case, the experts were asked to check the list of items in each of the IT sophistication dimensions and suggest any items that seemed to be missing or identify existing items that did not seem to represent the corresponding dimension.[28] Comments related to other survey questions and the overall survey design were also welcome, though they were not related to instrument validation. All interviews were conducted in person and lasted for 1–2 hours on average, with the exception of an interview with one expert (Expert B), in which case a telephone interview with e-mail follow-up was done because of geographical distance. In addition, the initial survey instrument was translated into Thai by the author, and the translation was also reviewed by the two Thai experts (Experts B and C) along with their instrument validation.

Several changes were made to the instrument based on the comments from the experts. Wording and translated wording of some items were revised and new items deemed relevant and important were added. Modifications of other items related to hospital and respondent characteristics were also made. Experts also expressed concerns that the survey was relatively long, and thus some less important and redundant questions were removed. The resulting survey instrument, as previously reported,[28] consisted of 38 questions (some with multiple items), and this was later revised by removing more ancillary questions to shorten the survey further. The finalized questionnaire to be used in the pilot testing contained 25 questions (see Appendix A).

### 4.2.3 Pilot Study

Before conducting the nationwide survey, a pilot study was conducted between July and September 2010 with five hospitals to pre-test the survey instrument as well as to provide estimates for measurement reliabilities. The five pilot hospitals were chosen partly based on ease of access and likely cooperation, but care was taken to include hospitals of varying sizes and types so that the pilot sample roughly represented the nationwide sample. The participating hospitals included a large public university hospital, a private hospital, a district hospital, a provincial hospital, and a regional hospital. The latter three hospitals were under the oversight of the Ministry of Public Health, but they provided different levels of service. The five hospitals were distributed geographically. The identities of these hospitals could not be revealed because confidentiality was part of the agreement to gain access to their respondents.

A contact person was identified for each of the hospitals, and an initial telephone contact was made to each of them explaining the study and the need to conduct a pilot survey prior to a nationwide study. They were asked for permission to conduct the pilot study at their hospital, and they were given an opportunity to discuss this within their hospital before agreeing to participate. All five hospitals agreed to be part of the study. After permission was granted, a package containing a cover letter, informed consent documents, and ten identical questionnaires were mailed to each hospital (see Appendix

A for a copy of these documents). In order to assess how different respondents of the same hospitals would respond, the hospitals were instructed to forward the questionnaires to ten of their employees who belonged in one of the three groups—A) IT executives or other IT staff members responsible for administering, developing, or maintaining the information systems, B) health care professionals who were users of the hospitals' information systems, C) the hospital director or other hospital executives. The choice of respondents was at the hospitals' own discretion, as was the specific number of respondents in each group, to allow them to determine the most appropriate respondents within each group. It was anticipated that by allowing the hospitals to select their respondents, this group of respondents would likely capture those who would have been the target respondents in the nationwide survey. Each questionnaire was accompanied by a separate stamped and addressed return envelope so that full confidentiality of their responses was guaranteed. A 150-baht (about US$5) incentive was promised for each completed questionnaire, if the respondents voluntarily provided information for the incentive mailing. The data collection period lasted for about 8 weeks.

The revised and Thai-translated survey instrument that resulted from validation with experts was used for the pilot study. It contained 25 questions organized in the A4-sized booklet format, with a total of 16 folded pages (equivalent to 8 full A4-sized pages). There were 3 sections in the questionnaire, asking about the hospital's general information, IT adoption and use, and the respondent's information, respectively. The first section gathers information about the hospital's general characteristics, including bed size, public status, teaching status, the number of IT staff, and IT budget. Because some experts have concerns about the accuracy of information about IT budget, the instrument included questions that asked for the absolute amount of hospital and IT budgets, as well as a question that allowed them to estimate the ratio of IT budget to the hospital budget if they could not obtain the absolute amount. This would help determine how much variation existed among various respondents of the same hospitals. It also contained items measuring the managerial sophistication dimension. The second section inquired about the hospital's technological, functional, and integration sophistication. Finally, the last section asked about the respondent's demographic information, education, and experience. To gauge the burden to respondents, a final question asked how much time they used in completing the survey. The questionnaire ended with blank spaces for any open-ended comments and voluntary contact information for the incentive mailing.

**Table 4.2** Survey questions of the four IT sophistication dimensions as appeared in the pilot survey instrument.

| Dimension | Survey Question (See Appendix A) | Number of Items in the Question |
|---|---|---|
| Technological Sophistication | #15 | 19 |
| Functional Sophistication | #14 | 51 |
| Integration Sophistication | #16-17 | 12 for each question |
| Managerial Sophistication | #9 | 11 |

Table 4.2 identifies the survey questions measuring the sophistication dimensions in the pilot survey instrument (see Appendix A for reference). The technological sophistication question contained 19 items asking the extent to which each specific technology was made available in the entire hospital, from a scale of 1 to 5, 5 being extensively available. The technologies inquired included Internet access, networking technologies, computerized order entry, the picture archiving and communication system

(PACS), and barcoding, among others. Integration sophistication was measured by two questions, each with 12 items, asking the extent that the information systems in each of the 13 hospital settings were linked to other systems within and outside the hospital, again from a scale of 1 to 5. There were 51 items inquiring about the functional sophistication, i.e., the extent that each activity was supported by computerized information systems in the entire hospital, from 1 (not supported at all by computers) to 5 (fully supported by computers). The activities listed included various activities related to emergency room, patient management, inpatient care, outpatient care, nursing, surgery, laboratory, imaging, pharmacy, public health, finance, human resource management, materials management, and miscellaneous administrative functions. The managerial sophistication dimension was represented by eleven 5-point Likert-type items asking the respondent's level of agreement to the statements about the hospital's management practices and organizational cultures. All of the items in every dimension included a "Not Applicable" option in case certain activities, statements, or technologies did not apply in a particular hospital (such as when a hospital did not provide surgical services).

#### 4.2.4 Instrument Modification

Findings from the pilot study were used to identify potential issues before launching the nationwide survey. Variation of responses among the respondents of the same hospital on items asking about objective hospital characteristics, where responses from all respondents were expected to be the same, would indicate either a problem with the survey design, or the fact that respondents were unreliable sources of the information. Particular emphasis was placed on the accuracy of IT budget reported by respondents, because some experts expressed concerns about potential problems. While certain information such as the hospital's bed size was available from authoritative sources and could serve as the "gold standard" against which responses could be compared, such authoritative information was not available to this study for IT budget, size of IT workforce, and some other variables. In these cases, the degree of variation among the respondents of the same hospitals would help determine what should be done, if any.

For subjective questions on the four IT sophistication dimensions, where some variations were expected, intraclass correlations were computed as a measure of interrater reliability. Interrater reliability provides information about the degree of consistency among results of different raters, in this case respondents, who are measuring the same thing, such as the level of IT sophistication of the same hospital.[212] A sizeable reliability would indicate that responses of different respondents within the same hospital were expected to be consistent and thus response bias due to different respondents or differing job roles should be inconsequential. Because respondents of different hospitals were not the same, calculation of intraclass correlation coefficients was based on a one-way random-effects model[213] (Shrout and Fleiss's so-called Case 1),[214] but nonresponses led to unbalanced data, requiring the use of a formula provided by Donner,[215] reproduced here with slight notational changes:

$$\mathrm{r_A} = (\mathrm{MSB} - \mathrm{MSW})/[\mathrm{MSB} + (\mathrm{n_0} - 1)\mathrm{MSW}] \tag{4.1}$$

where $\mathrm{r_A}$ is the one-way random-effects analysis of variance (ANOVA) estimator of intraclass correlation, MSB is the mean square between-group, MSW is the mean square within group, and $\mathrm{n_0} = [\mathrm{N} - \sum_{\mathrm{i}=1}^{\mathrm{k}} \mathrm{n_i^2}/\mathrm{N}]/(\mathrm{k}-1)$, with N being the total number of observations, $n_i$ the number of observations within each group, and k the total number of groups. A value of intraclass correlation close to one suggests a very reliable instrument, and a value, high or low, that is nonetheless significantly different from zero in an F-test indicates that respondents in the same hospital tended to answer in a similar way compared with respondents from other hospitals beyond chance.[215] Given that only five hospitals were in the pilot study, and measurements of subjective opinions (such as used in IT sophistication questions) tend to have small or moderate intraclass correlations (e.g., less than 0.5),[216] it was expected that intraclass correlation in this study would not be very high. Müller and Büttner[217] made a similar remark in his critical review of intraclass correlations, that its interpretation is problematic, given their dependence on the population's variance, thus lacking the absolute meaning. They noted that it does not make much sense to judge an intraclass correlation's value greater than 0.75 as indicating good reliability, or vice versa.[217] Therefore, this study used intraclass correlations only as a guide together with other information, with no clear-cut point indicating good or poor reliability. As is common in other scales, Cronbach's coefficient alpha was also calculated to evaluate the internal consistency of the items of the same IT sophistication question. Given its extensive use, a conventional guideline for interpreting Cronbach's coefficient alpha was used to determine the internal consistency reliability. A coefficient alpha's value of 0.70 is considered acceptable especially during instrument development,[218] although a value of 0.60 or 0.50 was sometimes considered sufficient.[219] The values of coefficient alpha as well as item-total correlations, alpha after an item was removed, and an individual item's standard deviation, were used to inform the decisions on if changes were necessary for the particular item, or if the item needed to be dropped. Data analysis in the pilot study was performed with SAS 9.2 (SAS Institute Inc., Cary, NC). Findings from the pilot study which led to specific changes in the survey instrument are presented in Chapter 5.

### 4.2.5 Final Survey Instrument

Based on some pilot respondents' self-reported time to complete the questionnaire (reported in Chapter 5), a number of survey questions have been substantially shortened and less important items dropped to reduce the respondents' burden and increase the response rate. The final survey instrument in Thai that was used in the nationwide survey consisted of 24 questions in 12 folded pages (equivalent to 6 full A4-sized pages). The questionnaire comprised three same sections as the pilot questionnaire, namely general information of the hospital, the IT adoption and use profile, and information of the respondents. The first section included questions asking about the hospital's public status, teaching status, numbers of total and IT staffs, amounts of total and IT budgets in the 2010 fiscal year (or if unknown, a subjective estimate of the ratio of IT budget to hospital budget), and the level of agreement to each managerial sophistication item. The section on IT adoption and use profile assessed the number of PCs in use in the hospital, the vendor of the main hospital information system (if any), the year the current system was first implemented, the levels of technological and functional sophistication, and two separate questions for internal and external integration sophistication. It also included a single question asking about the respondent's summary judgment about the hospital's overall IT utilization in a scale of 1 to 5. The last section asked about the respondent's gender, age, educational level, levels of training in IT, health science, and management training, duration of IT experience at any workplace in years, and role in the hospital. It also had spaces for open-ended comments and for voluntary contact information for mailing of incentives and study results. Table 4.3 lists the respective IT sophistication questions in the final questionnaire (see Appendix B for reference), and compares the numbers of items in these questions in the pilot and nationwide surveys.

**Table 4.3** Survey questions of the four IT sophistication dimensions as appeared in the final survey instrument used in the nationwide study.

| Dimension | Survey Question (See Appendix B) | Number of Items for This Dimension in Pilot Questionnaire | Number of Items for This Dimension in Final Questionnaire |
|---|---|---|---|
| Technological Sophistication | #14 | 19 | 10 |
| Functional Sophistication | #13 | 51 | 25 |
| Integration Sophistication | #15-16 | 12 for each question | 10 for each question |
| Managerial Sophistication | #8 | 11 | 11 |

Like the pilot study, the technological sophistication asked about the extent of availability of each technology in the hospital. The specific technologies included such infrastructural technologies as Internet access, hospital Web site and local area network (LAN), as well as health IT used for patient care—master patient index, CPOE, electronic medication administration records, EHRs, laboratory information systems, PACS, and use of barcoding technologies for patient care. Functional sophistication examined the extent of hospital operations supported by computerized information systems in areas from patient management and outpatient/inpatient care to nursing, pharmacy, and billing. Other functional areas present in the pilot study, while useful, were deemed less critical and therefore dropped.

The question format and item structure for internal and external integration sophistication were substantially revised because of poor findings in the pilot study. Instead of asking the extent of information exchange within and outside the hospital *for each departmental domain*, the questions now asked for the extent of information exchange, again within and outside the hospital, but *for each of the types of health information*, including patient demographics; outpatient and inpatient clinical notes, diagnoses, and medications prescribed; surgical procedures; laboratory test results; and medical images and radiological results. The restructuring was considered conceptually more appropriate than the original structure used in the pilot study because integration sophistication represents the *information exchange* component of IT, and therefore its items should represent various types of *information* being exchanged rather than various hospital departments exchanging the information.

The wording of some managerial sophistication items was revised to fix problems identified in the pilot study, but because each item represented an identified culture or practice based on the literature, none was dropped. All IT sophistication items were in a 5-point Likert-type format, with 5 being the highest level of sophistication. However, unlike the pilot questionnaire, the "Not Applicable" option was removed because some pilot respondents mistook it as the total absence of adoption for that specific item (when they should have chosen the choice with a lowest score of 1). Question wording was revised to instruct respondents to skip an item instead if the item was not relevant to their hospitals (e.g., when a hospital did not have a radiology department and thus had no functions related to medical imaging).

### 4.3 Survey Methodology

In December 2010, a self-administered paper-based questionnaire was sent via registered postal mail to the director of each hospital in the sample. In university hospitals, where IT responsibilities are usually overseen by another executive rather than the hospital director, the questionnaire was addressed to the dean, who had the ultimate oversight. The hospitals' mailing addresses, as obtained from the Ministry of Public Health, were verified against the addresses from the hospital Web sites, if any, and/or other business listing Web sites when possible, and any changes were made to the master data file. Following recommendations by Dillman,[220] a prenotice letter preceded the actual questionnaire to inform the target hospitals that an important survey was arriving and that they would be asked for their help. The questionnaire was mailed out approximately one week afterwards, in a stamped and addressed envelope accompanied by a cover letter, an endorsement letter, informed consent documents, and a return envelope.

The cover letter asked the recipient to forward the questionnaire to the person responsible for managing information systems in the hospital, such as the chief information officer, an IT manager or administrator, or someone in an equivalent capacity. Given that this person is most likely involved and well-informed in the hospital's IT implementation projects, it was believed that information elicited from this person would be accurate and complete, regardless of the size and type of the hospital. Respondents were also allowed to consult other persons or data sources if necessary. Similar surveys in other countries also targeted these individuals and did not report serious problems with the responses.[29,86] Nevertheless, the survey also asked for information about the respondents' roles in the hospital, which would permit identification of possible biases and remedial actions if necessary.

The endorsement letter presented a statement explaining the importance of this study on national policymaking to facilitate health IT adoption in the country and asking the target hospitals to participate. It was signed by the Director of Cluster for Health Information Development, Bureau of Policy and Strategy, Ministry of Public Health, who was also the president of the Thai Medical Informatics Association at the time.

Finally, the informed consent documents consisted of three pages explaining the purpose of the study, the participant's risks and benefits of participation, the voluntary nature of the study, how the study protects data privacy, and the researcher's contact information. The last part displayed the informed consent statement, which indicated that consent was implied when the questionnaire was returned to the researcher. An explicit consent statement with the respondent's signature was not used because it could reveal the identity of some respondents who might not feel comfortable identifying themselves, thereby jeopardizing the responses. A waiver for informed consent documentation was granted as part of the ethical approval process. The described documents and their English-translated versions are presented in Appendix B.

The cover letter also mentioned a 150-baht (about US$5) monetary incentive provided to respondents of completed and returned questionnaires, as well as an offer to provide the study results upon request, if they expressed their wishes to receive one or both of these at the end of the survey. The amount of the monetary incentive was comparable to 1–2 hours of wage for a typical intermediate-level hospital worker. Therefore, it should not lead to ethical concerns of perceived coercion by respondents, yet it should be sufficient to trigger the social exchange behavior central to survey studies.[220] Nevertheless, because of limited budget, the incentive was not provided upfront when mailing the questionnaire but instead it was provided only to respondents who returned the questionnaires and voluntarily provided information for the incentive mailing. It was believed that this should nevertheless encourage respondents to complete the survey.

Six weeks following the initial questionnaire mailout, a letter and the replacement questionnaire, as well as the endorsement letter, the informed consent documents, and the stamped, addressed envelope, were sent via registered postal mail again to nonrespondents, to provide them a second opportunity to respond in case the original questionnaire was lost, never received, or forgotten. The final follow-up via telephone, emphasizing the importance of their responses, and any necessary third questionnaire mailing were planned for if the response rate from the first two rounds was not satisfactory, but these contacts were never made because the response rate at the time was deemed sufficient. The survey closed in April 2011, 16 weeks after the first survey mailing. The entire survey implementation process is depicted in Figure 4.1.

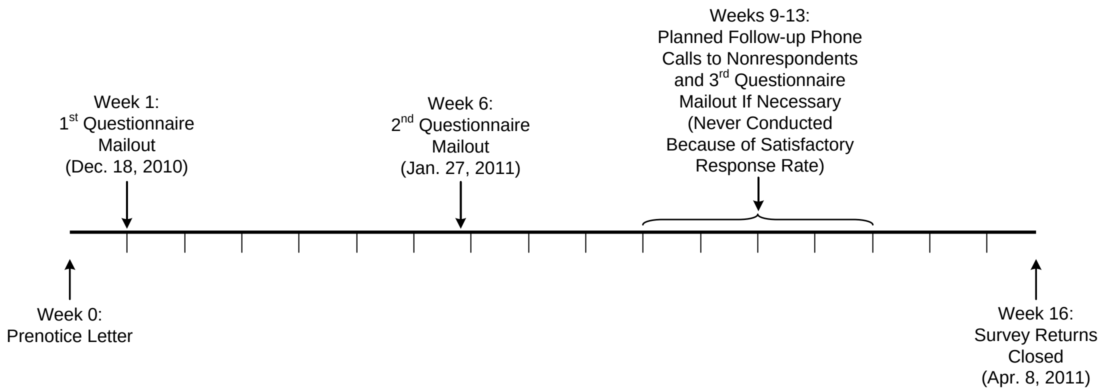



**Figure 4.1.** Timeline of survey implementation.

Several strategies were deliberately used to ensure an acceptable response rate. First, the monetary incentive for completed questionnaires and the offer to provide study results upon the study's completion, if indicated by respondents, should encourage many target respondents to respond. In addition, the study name as well as the design of the survey and the accompanying documents tried to instill a sense of professionalism of the study. Similarly, official sponsorship from one of the country's prestigious medical schools and endorsement from an authoritative and influential figure, who served as the high-ranking IT director in the Ministry of Public Health and also the president of the Thai Medical Informatics Association at the time, would enhance the credibility and image of the study. Finally, several contacts, with a prenotice letter and the replacement questionnaires were employed, and if the response rate was still unsatisfactory, the planned follow-up telephone calls for nonrespondents would have been made, although this was not the case. Most of these are strategies survey experts believe would trigger the social exchange behavior and have been shown to improve survey response rates in general.[220] The relatively favorable response rates in prior health IT studies in Thailand, from 39–98%,[197,200,221] suggest that this study should receive sufficient responses.

## 4.4 Dependent and Independent Variables

The dependent variables of this study were the average scores of the 5-point Likert-type survey items that belong to the constructs of hospital IT adoption, excluding the ones marked as "Not Applicable" (pilot study) or missing (both pilot and nationwide studies). However, use of the IT sophistication scores in the proposed model in Figure 3.2 was predicated on the assumption that the observed data supported the proposed conceptualization of hospital IT adoption according to factor analysis to be described in the next section. If the data indicated otherwise, alternative measures of hospital IT adoption would be used instead. These alternative measures would still be based on average scores of these 5-point Likert-type survey items, but the meaning of these measures and identification of items belonging to these measures could not be specified beforehand and would need to be determined from the observed data (as reported in the next chapter). The resulting "factor scores" are continuous variables with a minimum value of 1 and a maximum value of 5, with 5 being the highest, most preferable level.

Organizational characteristics of a hospital that served as the variables in the conceptual model included hospital size, public status, teaching status, IT budget, and size of IT workforce. Public status was dichotomized into public or private hospitals (non-profit private hospitals are rare in Thailand), and teaching status, defined as whether or not the hospital regularly teaches medical students, into teaching or non-teaching hospitals. Hospitals' registered bed size, as obtained from the Ministry of Public Health, was used as a measure of hospital size. Accreditation status was initially asked in the pilot study by asking the respondents to choose among the four levels of progress toward accreditation of their hospital, but results indicated that respondents were unreliable sources of this information and authoritative data were not available to this study. Therefore, accreditation status was dropped from the analysis. Lastly, the size of IT workforce was measured by the number of IT personnel in the hospital as provided by the respondents, and IT budget referred to the approximate proportion of hospital budget devoted to IT, including hardware, software, personnel, consulting, and outsourcing.

## 4.5 Data Analysis

### 4.5.1 Descriptive Analysis of Respondents

In order to assess whether we should be concerned about the nonresponse bias that could arise from differences between respondents and nonrespondents, basic characteristics about responding and nonresponding hospitals—such as the hospital's bed size, public status, and geographic regions—were compared using information obtained from the Ministry of Public Health using t-tests for continuous variables (e.g., bed size) or chi-square tests for categorical variables (e.g., public status and geographic regions) as appropriate.

### 4.5.2 Factor Analysis of Survey Items

Because other analyses are predicated on the validity of the proposed constructs of IT adoption (managerial, technological, functional, and integration sophistication), factor analysis was first conducted to test if the conceptualization fitted the collected data and to reveal any insights that will guide the rest of the analyses.

Confirmatory factor analysis of all IT sophistication dimensions was performed to assess the factorial validity of the proposed constructs. In confirmatory factor analysis, statistical tests are performed to check the extent to which the factor structure hypothesized by the researcher fits the data. Ideally, items of each IT sophistication dimension should correlate well with one another in a relatively uniform fashion. The lack of statistical fit between the hypothesized factor patterns of survey items and the data, as measured by a likelihood ratio chi-square statistic (discussed in more detail in subsection 4.5.5), would indicate that either the proposed constructs are not unidimensional or some items may correlate with other constructs to which they do not supposedly belong.

A lack of evidence for factorial validity, a probable outcome in this relatively underdeveloped research endeavor, would suggest that the hypothesized structures may deserve a second look. To this end, exploratory factor analysis was also performed on the items of all IT sophistication dimensions combined. As the name implies, exploratory factor analysis employs statistical methods to explore (rather than test) the underlying structure of the studied construct by identifying the *factors* based on the data.[223] Steps involved in exploratory factor analysis include determining the number of factors to retain; extracting the factors from the data; rotating the factors to convert them to a simple structure solution that maximizes interpretability, using either an orthogonal (assuming independent factors) or oblique rotation (with possibly correlated factors) algorithm; and finally interpreting the factors.[223] By performing exploratory factor analysis on the survey items, an underlying structure of the items could be revealed in ways that would inform proper specification of path analysis models. Findings might also provide better understanding about how the items relate or if an item exhibits a potential issue.

In this study's exploratory factor analysis, the appropriate number of factors was determined based on recommended criteria, i.e., selecting factors with eigenvalues larger than one, and examining the scree plot.[223] The analysis used as factor extraction methods principal components analysis and principal axis factoring. The former method seeks a linear combination of items that maximizes the variance extracted to the factors, whereas the latter attempts to extract the least number of factors that account for the common variance among the items. The resulting structure was then rotated to enhance interpretability using the oblique Promax rotation. The oblique rotation, where the underlying factors were presumed to be correlated, was used because of the possible overlaps between different information systems and hence the factors in each dimension. The resulting factor structure and factor pattern matrices were subsequently interpreted by examining their pattern of factor loadings. A factor loading is essentially a correlation coefficient between an item and a factor, and when squared, reflects the proportion of variance in the item uniquely explained by the factor. An item that has a factor loading greater than 0.40 belongs to the respective factor,[223] but because factors may be correlated, some items may load on two or more factors. Another value, a communality, is the sum of squared factor loadings for all factors of a given item and reflects the proportion of variance in the item explained by all of the factors, and is a measure of the item's reliability. In an oblique rotation, the resulting *factor structure matrix* contains the simple zero-order correlations between the items and the factors without controlling for between-factor correlations, whereas the *factor pattern matrix* contains the loadings representing the unique contribution of each item to the factors controlling for correlations among the factors.[223] Both matrices provide information that help interpret the factors. Pett et al.[223] recommend that the researcher first interpret the factor structure matrix, then check the factor pattern matrix to compare decisions, and report both matrices.

In this study, the meaning of each factor discovered through exploratory factor analysis was interpreted based on their member items, while problematic items (e.g., ones with no factor loadings greater than 0.30 or low communalities)[223] were considered if they should be dropped. Items that loaded substantially on multiple items were determined on a case by case basis, using the magnitude of the loadings as a guide but also the conceptual fit of the items to the factors, as exemplified by Pett et al.[223] Substantively meaningful factors were identified based on the final factor pattern, which was then used to compute descriptive statistics of the factor scores (subsection 4.5.3), assess validity and reliability of the survey items (subsection 4.5.4) and specify appropriate path models (subsection 4.5.5).

### 4.5.3 Descriptive Analysis of Hospital IT Adoption

To obtain a national estimate of health IT adoption and compare geographic variations, several analyses were conducted. First, the factor scores of the important factors revealed from exploratory factor analysis above, calculated by averaging the scores of the identified items belonging to the factors, were used to gauge the national and regional averages of the aspects of health IT adoption. Regional comparisons among hospitals in six geographic regions of Thailand were also performed to reveal adoption gaps from a geographic standpoint that policymakers should pay attention to. Hospital and respondent characteristics, including bed size, public status, teaching status, and respondents' age and gender were also used to compare the scores in univariate analyses.

Descriptive statistics included means and standard deviations for continuous variables and proportions for categorical variables. Statistical inferences were made using t-tests, chi-square tests, one-way ANOVA, Pearson product-moment correlations, and univariate simple linear regression depending on the nature of the variables. However, it should be repeated that this study was a census so sampling errors were not part of the estimates and statistical inferences should be interpreted *as if* the respondents came from a hypothetical population. Also, given that these univariate analyses were not adjusted for potential confounders, they should be interpreted with caution.

One descriptive analysis that was particularly interesting was the distribution of different health IT products, based on a survey item asking for the name of the product of the main hospital information system, if any. The distribution could inform us about the current state of health IT environment, such as the relative competitiveness or monopoly among the vendors. It would also be interesting to compare the distribution in this study and that of the previous study[200] conducted in 2004, to illustrate how much the local health IT environment has changed in the past six years.

Additionally, responses to certain survey items were used to assess the level of adoption of specific technologies. For instance, functional sophistication responses that indicate complete or partial computerization (a score over 1 on the items) on demographics, medication order entry, laboratory results viewing, and clinical notes, were used to assess the proportion estimates of hospitals with *basic EHR adoption* in outpatient, inpatient, or both settings. This definition was similar to the list of key functionalities recommended by the IOM, including electronic documentation of clinical notes, computerized medication order entry, and electronic viewing of laboratory results,[207] though viewing of imaging results was not included in this study because in Thailand, radiologic reports are available only in some medium-sized to large hospitals with radiologists. It was also similar to the definition of basic EHR systems in studies by Jha et al.,[16,21,97] although some items such as problem lists, medication lists, radiologic reports, and diagnostic test results were deemed too detailed and thus not measured in this study. We also imposed a more restrictive definition of an EHR system, called *comprehensive EHR*, that was close to, though still less stringent than, the definition used by Jha et al.[16,21,97] For the estimate of comprehensive EHR adoption, this study used a score of at least 4 (from a 5-point scale) on all the basic functions and also on laboratory and imaging order entry, image viewing, drug allergy checking, and drug interaction checking. Responses to medication, laboratory, and imaging order entry were also employed, counting a score above 1 on all relevant items as partial or complete adoption, to provide adoption estimates of medication order entry and all-order order entry functions in the hospitals' outpatient, inpatient, and both settings. These analyses would also enable comparisons with similar studies in other countries and show how Thailand ranks with other countries. Table 4.4 summarizes the definitions used by Jha et al.[21] and this study.

**Table 4.4** Functions used as definitions of EHR and CPOE adoption in Jha et al. and this study.

| Functions | Jha et al. | | This Study | | |
|---|---|---|---|---|---|
| | Basic EHR System with Clinical Notes* | Comprehensive EHR System* | Basic EHR System†‡ | Comprehensive EHR System†‡ | CPOE† |
| **Clinical documentation** | | | | | |
| Demographics | ✓ | ✓ | ✓ | ✓ | |
| Physicians' notes | ✓ | ✓ | ✓ | ✓ | |
| Nursing assessments | ✓ | ✓ | § | § | |
| Problem lists | ✓ | ✓ | | | |
| Medication lists | ✓ | ✓ | | | |
| Discharge summaries | ✓ | ✓ | § | § | |
| Advanced directives | | ✓ | | | |
| **Test and imaging results** | | | | | |
| Laboratory reports | ✓ | ✓ | ✓ | ✓ | |
| Radiologic reports | ✓ | ✓ | | | |
| Radiologic images | | ✓ | | ✓ | |
| Diagnostic-test results | ✓ | ✓ | | | |
| Diagnostic-test images | | ✓ | | | |
| Consultant reports | | ✓ | | | |
| **Computerized provider-order entry** | | | | | |
| Laboratory tests | | ✓ | | ✓ | ‖ |
| Radiologic tests | | ✓ | | ✓ | ‖ |
| Medications | ✓ | ✓ | ✓ | ✓ | ✓ |
| Consultation requests | | ✓ | | | |
| Nursing orders | | ✓ | | | |
| **Decision support** | | | | | |
| Clinical guidelines | | ✓ | | | |
| Clinical reminders | | ✓ | | | |
| Drug-allergy alerts | | ✓ | | ✓ | |
| Drug-drug-interaction alerts | | ✓ | | ✓ | |
| Drug-laboratory interaction alerts | | ✓ | | | |
| Drug-dose support | | ✓ | | | |

EHR - electronic health record.
*Jha et al. (reference 21) defined a basic EHR system as one with electronic functionalities in at least one clinical unit and a comprehensive EHR system as one with electronic functionalities in all clinical units.
†This study estimated three proportions for each definition: outpatient, inpatient, and both settings.
‡A basic EHR system was defined in this study as a response with a score over 1 in a 5-point scale on all of the relevant functional items. A comprehensive EHR system was defined as a response with a score of at least 4 in a 5-point scale on all of the relevant functional items.
§A function that was included in estimates for inpatient and both settings, but not for outpatient.
‖A function that was included in estimates of all-order CPOE adoption but not medication-order CPOE.

### 4.5.4 Validity and Reliability of Survey Instrument

In addition to confirmatory factor analysis of survey items as described above, additional analyses were conducted to assess the measurement validity and reliability of the developed survey items. Neuman[212] described measurement validity as the fit between how a construct is conceptualized and operationalized. Four types of measurement validity were enumerated—face validity, content validity, criterion validity, and construct validity. As face and content validity of this study's survey instrument has been reported in an earlier section, the focus in this section is on the latter two.

Criterion validity uses an external criterion as a standard against which an indicator is compared, and the comparison could be made using a concurrent measurement of the criterion (concurrent validity) or using a future measurement of the criterion (predictive validity).[212] In this cross-sectional large-scale study, establishing concurrent validity was more practical, and it was done in two ways. First, a 5-point Likert-type scaled summary judgment question in the questionnaire that asked about the hospital's overall IT utilization was used as a criterion against which the IT adoption factor scores as revealed by the exploratory factor analysis were compared. This indicator was reverse coded so that a significant positive correlation between a factor score and this indicator would provide support for criterion validity for that aspect of IT adoption. The size of the correlation coefficient would indicate the strength of the support. Another item, the number of PCs in use in the hospital, was also used as a criterion since one would expect high-adoption hospitals to have more PCs on average than low-adoption hospitals. The number of PCs *per bed* was also used as a criterion to adjust for bed size.

Second, as discussed in the previous subsection on descriptive analysis, certain organizational characteristics were analyzed with the discovered factor scores. For those "criterion" characteristics that literature evidence suggests were associated with IT adoption such as bed size, being a teaching hospital, and being a for-profit (private) hospital, a statistical significance (using t-tests, chi-square tests, and correlations as appropriate) would lend another set of evidence for criterion validity. This method of establishing criterion validity has been used by Paré and Sicotte,[29] as well as others,[86] though some relationships were found to be insignificant. Also, literature evidence is conflicting for some characteristics. Given the difference between Thailand's health care and health IT environment and that of other countries[191] and the dearth of literature evidence in Thailand's context, this method has its limits, but it was performed because it could provide insights into how similar (or different) Thailand's context is compared to that of others, and also because previous researchers in this line of research had used it for validation purposes.

Another type of validity investigated was construct validity. This type of validity indicates whether multiple indicators of the same construct operate in similar ways (convergent validity) and multiple indicators of different constructs do not (discriminant validity).[212] In this study, convergent validity of the IT sophistication constructs was examined by assessing if the different factors identified from exploratory factor analysis were significantly correlated in a bivariate manner. Similar analysis was also done by Paré and Sicotte[29] who proposed the original model of hospital IT sophistication, although with this study's factor pattern based on exploratory factor analysis results, the conceptual and operational definitions differed from those used by Paré and Sicotte.[29] Discriminant validity could also be evaluated at the same time, as a significant but not very high correlation between two factors would suggest that the two constructs are not exactly the same. This would provide further support for the validity of the IT adoption framework with multiple related, but distinct dimensions. In addition to bivariate correlations, construct validity among the IT adoption factors was also evaluated in a multivariate manner as part of the proposed model (see next subsection) using path analysis. A significant direct relationship between any two factors, after adjusting for other variables, would provide an even stronger evidence for construct validity. However, it is possible that after adjusting for other factors, some of the individual relationships would become non-significant, so the evidence of construct validity of these factors should be interpreted altogether.

Pearson product-moment correlation and one-way ANOVA were mainly used, but when the distribution of a variable is highly non-normal, Spearman's rank correlation coefficient was also computed given its non-parametric nature. The size of a correlation coefficient was interpreted using Cohen's suggestion,[222] i.e., a correlation below 0.3 was considered weak, that between 0.3 and 0.5 was considered moderate, and that above 0.5 was a strong correlation. Cronbach's coefficient alpha, item-total correlations, and Cronbach's alpha if an item is removed were calculated in the same way as in the pilot to provide another set of reliability estimates of the instrument and identify any issues.

### 4.5.5 Developing A New Theoretical Framework

Path analysis was employed in order to develop a new theoretical framework guided in part by the proposed conceptual model in Figure 3.2 and also from findings of the exploratory factor analysis as described. Considered a special case of structural equation modeling, path analysis is a statistical analysis technique that models systems of structural relationships between a set of observed variables.[224] A full structural equation model is a general model that posits relationships among observed and unobserved (latent) variables. The model consists of two parts—the measurement part that models the relationships between observed and latent variables, and the structural part that models the relationships between latent variables. Confirmatory factor analysis, which specifies how multiple individual items relate to one or more latent factors, is a special case of structural equation modeling where the model only contains the measurement part. Path analysis, on the other hand, is another special case of structural equation modeling where the model consists of only the structural part. Therefore, in a path analysis, the researcher specifies how the various observed variables relate to one another in a system of relationships.

Structural equation modeling is designed for analysis of multiple related regression equations simultaneously.[224] With the focus on the structural relationships among observed variables, path analysis can be considered as a system of multiple linear regressions conducted at the same time in the same model. It is a powerful technique to evaluate a system of relationships together rather than each individual relationship separately as in regression, yet it is not difficult to understand and interpret. With the study's goal to fill the void in the theoretical understanding of hospital IT adoption that led to the proposed conceptual framework, path analysis using the average dimensional scores is a fitting analysis method. Given that many studies of organizational adoption of health IT relied on univariate or multivariate regression, path analysis is a step forward toward better theoretical understanding.

In path analysis, a path diagram (similar to Figure 3.2) specifies the hypotheses in the path model that are being tested with the data. The path diagram contains rectangles that represent observed variables, single-headed arrows that reflect hypothesized directional effects of one variable on another, and double-headed curved arrows that represent covariances (non-directional relationships) between two independent variables. Each directional arrow represents a *direct effect* of one variable on another in a similar manner to linear regression. An *indirect effect*, on the other hand, is the effect of a variable on another variable through one or more variables in the model that serve as *mediators*. If there are multiple variables exerting an effect directly on another variable, each arrow represents a direct effect after adjusting for other variables in the same way as in multiple linear regression, with these multiple variables serving as independent variables in the equation. Unlike regression, however, the terms *exogenous* and *endogenous variables* are used in path analysis instead of dependent and independent variables because a dependent variable in one relationship could be an independent variable in another relationship. An exogenous variable has a direct effect on one or more variables, without any variable exerting an effect upon it. An endogenous variable, on the contrary, is influenced by one or more variables, but it may or may not have an effect on other variables. Like regression, a direct effect in path analysis implies an associative relationship between the variables, but whether the relationship is truly causal could not be evaluated in the model and must be determined based on other factors, including study design (e.g., cross-sectional versus longitudinal), the nature of the variables, plausible directions of causal effects, and the possibility of confounding.

As outlined by Kline,[209] evaluation of the conceptual framework consists of a series of steps, from model specification, evaluation of model identification, model estimation and evaluation, model respecification, and reporting of results. The initially specified model to be evaluated has been discussed in detail in Chapter 3 (see Figure 3.2 for the model's path diagram), but in light of the findings from confirmatory and exploratory factor analyses and some data quality issues, this initial model was modified before the path analysis commenced (discussed in detail in Chapter 5). In path analysis, this model specification step also involves specification of the mathematical model in the analysis software. Thus, the mathematics of path analysis is briefly reviewed here before subsequent steps are discussed.

While the path diagram depicts the relationships among the variables in a pictorial format, the same relationships could be specified mathematically using matrix algebra. The general equation for path analysis of observed variables is:[226]

$$\mathbf{y} = \mathbf{B}\mathbf{y} + \boldsymbol{\Gamma}\mathbf{x} + \boldsymbol{\zeta} \tag{4.2}$$

where

| | | |
|---|---|---|
| $\mathbf{B}$ | = | m x m coefficient matrix |
| $\boldsymbol{\Gamma}$ | = | m x n coefficient matrix |

$\mathbf{y}$ = p x 1 vector of endogenous variables

$\mathbf{x}$ = q x 1 vector of exogenous variables

$\boldsymbol{\zeta}$ = p x 1 vector of errors in the equations

The general form of the question is somewhat similar to a linear regression equation, where the dependent variable appearing on the left side of the equation is a linear combination of products between the independent variables and their coefficients, as well as the error term. Unlike linear regression that contains one dependent variable, however, an equation for path analysis, with multiple endogenous variables, needs to be written in matrix form. The presence of the vector $\mathbf{y}$ on the right hand side signifies that an endogenous variable may exert an effect on other endogenous variables. The matrices $\mathbf{B}$ and $\boldsymbol{\Gamma}$ contain the regression coefficients for the endogenous and exogenous variables on some other endogenous variables, respectively. Some of the elements in these matrices are specified as zero if no direct relationship between the corresponding variables was specified in the hypothesized model, while other elements are freely estimated. The vector $\boldsymbol{\zeta}$ contains errors in the equations, called *disturbances* in structural equation modeling, which represent residual effects of some other variables not specified in the model. The disturbances are assumed to be independent of elements in $\mathbf{x}$. Two additional matrices, $\boldsymbol{\Phi}$ and $\boldsymbol{\psi}$, are also part of the path analysis model. The matrix $\boldsymbol{\Phi}$ is the covariance matrix of $\mathbf{x}$ (representing covariances among exogenous variables), while $\boldsymbol{\psi}$ is the covariance matrix of error terms in $\boldsymbol{\zeta}$ (representing covariances among the disturbance terms).

After relationships among the variables are specified in a path diagram (or equivalently in a mathematical model), the researcher must determine if the model is identified before proceeding. *Identification* refers to a property of the specified model that indicates if it is theoretically possible for an estimation algorithm to derive a unique estimate of every parameter in the model.[209] Underidentified models cannot lead to parameter estimates that are unique because the amount of input information (variances and covariances of the observed variables in the case of structural equation models) is insufficient, regardless of the sample size. There are several rules that help determine a model's identification,[209,226] but one of them is relevant in this study. Models that are *recursive* (i.e., with uncorrelated disturbances and no feedback loops or reciprocal effects) are always theoretically identified.[209,226] The initial path model in this study, as depicted in Figure 3.2, is a recursive model, and therefore is theoretically identified.

Once a model is determined to be identified, model estimation can proceed. In this step, the collected data are subjected to the analysis software, which will use an estimation algorithm together with the specified model to derive a unique set of parameter estimates that maximizes the fit between the estimated model and the data. The most commonly used estimation algorithm is maximum likelihood. In a series of iterative estimation, it uses an initial set of start values to derive parameter estimates that increasingly improve the fit between the estimated model and the observed data. The iterative estimation stops when it converges to a final solution that maximizes the fit (or equivalently, minimizes the fit function) based on pre-specified criteria, unless the algorithm could not converge because of problems in the data, the model, or the start values.[209]

The maximum likelihood estimator assumes a multivariate normal distribution of endogenous variables, although Kline noted that the algorithm works fine for 90% or more of the models described in the literature.[209] When endogenous variables are continuous but severely non-normal, maximum likelihood estimates are relatively accurate in large samples, but their estimated standard errors tend to be too low, leading to inflated type I error. In addition, the tests of model fit also tend to be too high, leading to increased rejection of true models.[209] Methods for correcting these issues are available, including the Satorra-Bentler statistic[227] that adjusts the value of the chi-square test statistic downward based on the degree of kurtosis. In this study, the IT sophistication scores serving as endogenous variables were derived from averages of individual items, thus they are continuous. To assess if non-normality was an issue, skewness and kurtosis were examined for the endogenous variables. Second, third, and fourth moments about the mean were used to calculate the skew index and kurtosis index as described by Kline.[209] Consistent with existing guidelines,[209] an endogenous variable with an absolute skew index value greater than 3.0 was considered extremely skewed, and that with an absolute kurtosis index greater than 10.0 was considered to be problematic, although some simulation studies found problems with models with a skew index over 2.0 or a kurtosis index over 7.0.[228] Because a special form of maximum likelihood estimator that handles missing data automatically (full-information maximum likelihood) was available in the analysis software, survey responses with missing data were included in the model without deletion or imputation. Such an estimation method partitions the responses into subsets, each with the same pattern of missing observations, and statistical information was extracted from these subsets and used to calculate the parameter estimates and standard errors. Computer simulation studies found that this special maximum-likelihood-based method generally outperforms classical methods such as listwise deletion, pairwise deletion, and various imputation methods.[209,229-231]

Before interpreting the estimates, it is important that the overall model fit is evaluated. A goodness-of-fit statistic provides a measure of fit between the estimated model and the observed data. A likelihood ratio chi-square test statistic is a commonly accepted statistic computed from maximum likelihood estimation. A likelihood ratio chi-square test evaluates the null hypothesis (called the exact-fit hypothesis in the structural equation modeling context) that the discrepancies between the variance-covariance matrix of the estimated model and the observed data are due to chance, given that the specified model is correct. A p-value over 0.05 is generally considered acceptable and suggests that the null hypothesis that there was no discrepancy between the estimates and the data apart from chance cannot be rejected.[209] On the other hand, a p-value below 0.05 suggests a significant discrepancy between the estimated model and the data, in which case model respecification is recommended. In addition to chi-square test statistics which some experts have noted are too sensitive to negligible model misspecifications in large sample sizes,[232] other fit indices, called approximate fit indices, that are not sensitive to sample size are also available. These include the root mean square error of approximation (RMSEA),[233] the comparative fit index (CFI),[234] the Tucker-Lewis index (TLI),[235] and the standardized root mean square residual (SRMR).[236] Cutoff values for these fit indices were provided based on simulation studies, including 0.95 for CFI and TLI, 0.06 for RMSEA, and 0.08 for SRMR,[237] though the practice of using these approximate fit indices in general and the cutoff values in particular has been strongly discouraged in recent publications.[209,238] This is because these approximate fit indices disregard deviations between the model and the data beyond chance, and there is no direct correspondence between these values and the seriousness or type of misspecification.[209] While chi-square test statistics are imperfect and sensitive to sample size, they provide some assessment of the degree of discrepancies that are unlikely to be due to chance. This would be helpful in model evaluation when determining if the model should be respecified. Following this recent trend in the methods of structural equation modeling, this study used a chi-square test statistic with a significance level ($\alpha$) of 0.05 as the main criterion. Other approximate fit indices are also reported and interpreted for completeness, but they did not play a key role in determining the respecification.

After model estimation, inspection of model fit statistics was performed, together with examination of the parameter estimates and the pattern of residuals to identify possible issues, a method recommended by Kline.[209] If the chi-square test rejects the null hypothesis, the modification indices and the pattern of residuals were examined to suggest possible options to modify the model, together with substantive reasons. A modification index[239,240] estimates the amount of reduction in the model chi-square statistic if a particular constrained-to-zero parameter were freely estimated,[209] or equivalently a new specific effect were added to the model. A large modification index value for a particular effect, as calculated by the software with the model estimation, would indicate that adding the corresponding path in the path diagram would result in a substantially reduced chi-square value, indicating a better fit. Large and significant values of modification indices were considered based on substantive grounds. In addition, factor patterns observed from exploratory factor analysis were also used to inform the respecification. This approach was used because results from confirmatory factor analysis (as reported in Chapter 5) suggested that the proposed conceptual model in Chapter 3 was not a good fit to the data, and it was helpful to use interpretable factor patterns from the subsequent exploratory factor analysis to suggest a new way of conceptualizing hospital IT adoption. While this method takes advantage of chance by using observed findings to respecify and test a model against the same data, it was more appropriate than developing a new IT adoption theory based on the proposed IT sophistication conceptual model that did not fit the data. Moreover, with enough sample size and response rate, the study's power would be relatively high to counter the effect of chance capitalization.

Considering both the modification indices and other substantive reasons, the model was respecified, and the model estimation and evaluation were repeated as previously described. This respecification was repeated until the chi-square test statistic was not significant at $\alpha = 0.05$. The exact respecification steps taken and their justification are described in detail in Chapter 5.

Once the final model is reached, the significance and path coefficient estimate of each path in the model were reported and interpreted in the same manner as in linear regression. Examination of the final results would provide answers to the hypothesized relationships in the model and the effect size of the direct and indirect effects of each variable. Each path coefficient in the unstandardized model is interpreted as a regression coefficient, i.e., a unit change in the dependent variable associated with a one-unit change in the independent variable, after adjusting for covariates. Because the hypotheses in Chapter 3 argue for effects in a particular direction, a one-tailed significance testing was employed for each path coefficient.

In addition, the standardized path coefficients also reflect the relative effect sizes of the different independent variables on the same dependent variable because they refer to one standard deviation change in the dependent variable associated with one standard deviation change in the independent variable. Finally, the standardized estimates for the variance of disturbance terms also reflect the proportion of unexplained variance. Therefore, an $R^2_{smc}$ value representing the proportion of variance explained for each endogenous variable was computed as 1 minus the standardized variance estimate of the appropriate disturbance term.

As noted, model respecification uses empirical data to modify the model and then use the same data to derive the estimates and model fit statistics, experts caution against over-interpretation of the chi-square tests. This is because model respecification, especially when done repeatedly until a non-significant chi-square fit statistic is achieved, capitalizes on chance.[209] When a model is respecified and evaluated based on the same data, it is not appropriate to draw definitive conclusions about the model's appropriateness. The respecification may be necessary, especially in the early stages of theory building such as in this study where empirical evidence is limited.[209] Such an exploratory investigation is acceptable, and in fact takes advantage of advanced modeling techniques such as structural equation modeling to discover a model that best corresponds to the data.[209] However, to be fully embraced, the final model needs to be cross-validated using a fresh dataset in a more confirmatory mode. Because this study focuses on the initial theory development using IT sophistication framework, a confirmatory cross-validation of the final model is considered out-of-scope. The final model of this study should therefore be interpreted as a plausible but not definitively validated model of organizational adoption of health IT. Future studies are encouraged to use the product of this study to validate or improve the model.

Because measures of instrument reliability, such as Cronbach's coefficient alpha, were available for the factor scores, they were also incorporated in the model using the method suggested by Kline.[209] That is, the respective constructs in the final model from the previous steps (without measurement errors) were converted into latent variables measured by a single observed indicator each, and the variances of the error terms of these indicators were fixed as one minus the respective reliability coefficients, rather than letting them be estimated as free parameters. The reliability coefficients were computed as Cronbach's coefficient alpha from the items that belong to the corresponding constructs based on exploratory factor analysis findings. This specification was equivalent to incorporating measurement errors of the sophistication constructs into the model. Similar model estimation and evaluation were performed, and results were compared with the final model without reliability measures incorporated. Consistent results would provide additional confidence in the conclusions, whereas inconsistent results would allow us to inspect the analysis in more detail and gain insights about the relationships among the variables.

### 4.5.6 Content Analysis of Open-Ended Survey Comments

To qualitatively analyze the open-ended comments in the nationwide survey responses, content analysis was also performed. Hsieh and Shannon's[241] conventional approach to qualitative content analysis was employed, whereby the responses were used in an inductive approach to identify the emergent themes that capture the essence of the comments. The resulting themes and subthemes of responses are reported, with some original quotes that represent the themes cited to enrich the analysis.

### 4.5.7 Analysis Software

SAS 9.2 (SAS Institute Inc., Cary, NC) was used for descriptive analysis, exploratory factor analysis, and instrument validation. Confirmatory factor analysis and path analysis employed Mplus 6.11 (Muthén & Muthén, Los Angeles, CA). Finally, NVivo 9.1.106.0 (QSR International Pty Ltd., Victoria, Australia) was used for content analysis of open-ended comments.

## 4.6 Funding and Ethical Considerations

This study was funded for the amount of 200,000 baht (about US$6,700) under grant number RD53065/year 2010 from the Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand. This study was considered exempt by the Institutional Review Board (IRB) of the University of Minnesota (Study No. 1005E82796), and it was approved by the Committee on Human Rights to Researches Involving Human Subjects of the Faculty of Medicine Ramathibodi Hospital, Mahidol

University (Study ID 05-53-05). Per a request by the Prasat Neurological Institute, one of the target hospitals, an application for ethical approval was also submitted to the Institute, and it was subsequently approved. Copies of the letters of ethical approval were available in Appendix C. The funding agency did not have an influence on the content, conduct, interpretation, or dissemination of this study outside the scope of ethical considerations and oversight of the research grant, and did not have access to the study data.

# Chapter Five
# Results

This chapter reports on the analysis results of this study based on the research questions and hypotheses in Chapter 3 and the methodology in Chapter 4. The results start from the pilot study and subsequent instrument modification and then mainly follow the structure laid out in the Data Analysis section of Chapter 4.

## 5.1 Pilot Study Results and Instrument Modification

From a total of 50 questionnaires mailed to five hospitals in the pilot study (ten questionnaires each), 32 questionnaires were returned, yielding an overall pilot response rate of 64%. The response rate for each pilot site varied from 40% to 90%. Table 5.1 reports the overall and site-specific descriptive statistics for respondent characteristics. Overall, respondents had an average age of 40 years and about 60% were male. About 87% were at least college-educated, and the majority had some IT and management training, but the pattern varies somewhat among the hospitals. Many of the respondents were non-IT hospital employees, but a sizeable percentage of them were IT operational staff or hospital executives. Respondents reported an average duration to complete the questionnaire of 27 minutes (SD 18), ranging from 5 minutes to 90 minutes.

**Table 5.1** Descriptive statistics for respondent characteristics of the pilot study by site.

| **Respondent Characteristic** | **Overall** | **Site 1** (District Hospital) | **Site 2** (Private Hospital) | **Site 3** (Provincial Hospital) | **Site 4** (Regional Hospital) | **Site 5** (University Hospital) |
|---|---|---|---|---|---|---|
| Age (years) | 40.5 ± 9.1 (26-58) | 33.8 ± 5.1 (28-40) | 35.4 ± 9.0 (26-45) | 36.9 ± 7.5 (26-49) | 46.9 ± 10.1 (31-58) | 44.2 ± 7.0 (30-55) |
| Gender | | | | | | |
| Female | 41% | 50% | 40% | 43% | 43% | 33% |
| Male | 59% | 50% | 60% | 57% | 57% | 67% |
| Level of education completed | | | | | | |
| Below bachelor's | 13% | 50% | 0% | 29% | 0% | 0% |
| Bachelor's | 53% | 50% | 80% | 71% | 57% | 22% |
| Master's or higher | 34% | 0% | 20% | 0% | 43% | 78% |
| Level of IT training | | | | | | |
| No training | 22% | 50% | 20% | 0% | 14% | 33% |
| Non-degree training | 59% | 50% | 60% | 71% | 71% | 45% |
| Degree received | 19% | 0% | 20% | 29% | 14% | 22% |
| Level of clinical training | | | | | | |
| No training | 44% | 50% | 20% | 100% | 29% | 22% |
| Non-degree training | 12% | 25% | 20% | 0% | 14% | 11% |
| Degree received | 44% | 25% | 60% | 0% | 57% | 67% |
| Level of management training | | | | | | |
| No training | 41% | 50% | 60% | 43% | 43% | 22% |
| Non-degree training | 47% | 50% | 20% | 43% | 43% | 67% |
| Degree received | 12% | 0% | 20% | 14% | 14% | 11% |
| Roles of respondents* | | | | | | |
| Director or senior executives | 19% | 25% | 20% | 0% | 43% | 11% |
| Management with direct IT oversight | 3% | 0% | 0% | 0% | 0% | 11% |
| Non-executive IT manager | 3% | 0% | 0% | 14% | 0% | 0% |
| IT specialist or staff | 19% | 0% | 20% | 29% | 14% | 22% |
| User involved in IT projects | 31% | 50% | 20% | 43% | 14% | 34% |
| User not involved in IT projects | 25% | 25% | 40% | 14% | 29% | 22% |
| Others | 3% | 0% | 0% | 0% | 14% | 0% |

Data are mean ± SD (range) or frequency in %. Significance tests not done due to low sample size.
*Total percentage might exceed 100% because of possible multiple selections.

Table 5.2 shows the site-specific descriptive statistics for basic hospital characteristics. Data in Table 5.2 could illustrate if reliability is a problem for basic hospital characteristics where all respondents of the same hospitals should be similar. The numbers of hospital beds were reliable in smaller hospitals (Sites 1–2) where almost all respondents reported the same numbers, but the numbers varied greatly for the largest hospital in the pilot study (Site 5). When checked against the authoritative source, respondent-reported numbers did not necessarily agree with authoritative numbers in medium to large hospitals. The public status, on the contrary, was in total agreement. Responses for teaching status of the smaller hospitals (Sites 1–2) and the university hospital (Site 5) were in agreement among the respondents, but non-negligible disagreements existed for medium hospitals, presumably because medical students occasionally rotated to these hospitals and thus responses depended on how the question was interpreted. The responses for accreditation status was quite different for some hospitals (Sites 1, 2, and 4), and even if the responses were similar, they did not necessarily agree with the authoritative source (for example, Site 3).

**Table 5.2** Descriptive statistics for basic hospital characteristics of the pilot study by site.

| Hospital Characteristic | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 |
|---|---|---|---|---|---|
| Response rate | 40% | 50% | 70% | 70% | 90% |
| Hospital beds | 30 ± 0 | 120.2 ± 0.4 (120-121) | 360 ± 0 | 303.1 ± 9.4 (282-307) | 1,058.1 ± 187.1 (863-1,500) |
| No. of beds from authoritative source* | 30 | 120 | 335 | 305 | 938 |
| Public status | | | | | |
| Public | 100% | 0% | 100% | 100% | 100% |
| Private | 0% | 100% | 0% | 0% | 0% |

**Table 5.2** Descriptive statistics for basic hospital characteristics of the pilot study by site (continued).

| Hospital Characteristic | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 |
|---|---|---|---|---|---|
| Teaching status | | | | | |
| Teaching - part of a medical school | 0% | 0% | 0% | 0% | 100% |
| Teaching - affiliated with but not part of a medical school | 0% | 0% | 83% | 57% | 0% |
| Non-teaching | 100% | 100% | 17% | 43% | 0% |
| Accreditation status | | | | | |
| Not accredited & without plan | 25% | 0% | 0% | 0% | 0% |
| Not accredited, with plan but no significant progress | 75% | 40% | 0% | 14% | 0% |
| Not accredited, with plan and significant progress | 0% | 40% | 0% | 86% | 0% |
| Accredited | 0% | 20% | 100% | 0% | 100% |
| Status from authoritative source† | Level 2 progress (expired) | Level 1 progress (expired) | Level 2 progress (expired) | Level 2 progress (active) | Accredited |
| Number of IT staff | | | | | |
| None | 0% | 0% | 0% | 0% | 0% |
| 1-5 | 75% | 80% | 100% | 43% | 0% |
| 6-20 | 25% | 20% | 0% | 57% | 22% |
| 21-50 | 0% | 0% | 0% | 0% | 11% |
| 51 or more | 0% | 0% | 0% | 0% | 67% |
| 2009 total budget (million baht) | 22.00 [n=1] | 300.00 [n=1] | 578.00 [n=1] | 368.39 ± 93.68 (300.00-475.00) [n=3] | 7,000.00 ± 1,414.21 (6,000.00-8,000.00) [n=2] |
| 2009 IT budget (million baht) | 0.40 [n=1] | 10.00 [n=1] | 2.10 ± 1.56 (0.30-3.00) [n=3] | 5.47 ± 0.66 (5.00-5.93) [n=2] | 93.00 ± 39.96 (50.00-129.00) [n=3] |
| Number of computers in hospital | 23.8 ± 4.8 (20-30) | 106.7 ± 90.2 (20-200) | 170.0 ± 108.9 (10-300) | 207.1 ± 82.2 (100-290) | 2,350.0 ± 1,332.3 (100-4,000) |
| Percentage of 2009 IT budget according to provided amount (calculated from ratio of 2009 IT budget to 2009 total budget) | 1.82% [n=1] | 3.33% [n=1] | 0.52% [n=1] | 1.38% [n=2] | 1.25% [n=1] |

**Table 5.2** Descriptive statistics for basic hospital characteristics of the pilot study by site (continued).

| Hospital Characteristic | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 |
|---|---|---|---|---|---|
| Subjective estimated percentage of 2009 IT budget (if amount not provided above) | | | | | |
| Below 1% | 0% | 0% | 20% | 0% | 0% |
| 1-4% | 75% | 40% | 60% | 86% | 17% |
| 5-8% | 25% | 40% | 20% | 14% | 50% |
| Above 8% | 0% | 20% | 0% | 0% | 33% |

Data are mean ± SD (range) or frequency in %. n = number of item responses.
Significance tests not done due to low sample size.
***Source of bed size:** Ministry of Public Health's Bureau of Policy and Strategy (September 2010).
†**Source of accreditation status:** Healthcare Accreditation Institute (Public Organization), Thailand (September 2010).

The numbers of IT staff as reported by each hospital's respondents were largely different except in Site 3. As for total and IT budgets, the problem was more serious. All hospitals had only one to three respondents who reported the approximate amount of these budgets in fiscal year 2009, suggesting that most respondents did not have access to this data or were not confident enough in their estimates. When more than one responded, the numbers greatly differed. For those who could not provide the numeric amount, the subjective estimated percentages of IT to total budget, using four interval categories in the questionnaire, also varied and were mostly not in agreement with the calculated ratios from the provided amounts. Finally, the ranges for the number of computers in each hospital were also very wide. In summary, most of the respondents did not agree on most hospital characteristics and using the questionnaire as it was would raise doubts about the study's validity.

The fact that variations existed among respondents on some hospital characteristics is not surprising, but the degree of variation is concerning for some of the questions. For bed size, a more reliable authoritative data source was available, thus this question was dropped from the questionnaire. Some differing interpretations existed for the current wording of teaching status, but no other data source existed, so a rewording was desirable. Accreditation status would be interpreted widely among the respondents of the main survey, but the authoritative data were not readily accessible for all hospitals. It was decided that this variable be dropped from the questionnaire and the proposed model along with associated hypotheses because of potential issues, and assessing its effect on IT adoption is left for future research with better data quality. The number of computers was also quite unreliable, especially in larger hospitals, but no other source was available and like Paré & Sicotte,[29] it was used only as one of several criteria to evaluate criterion validity. This item was therefore retained.

For the hospitals' total and IT budgets, the survey questions were extremely unreliable, and no other data sources were available. However, given that IT budget is central to the proposed model, the questions were retained in the nationwide questionnaire. Depending on how good the model fit was, this variable might need to be dropped from the model because of poor reliability, in which case the proposed model and its associated hypotheses would need to undergo revision. This part of the analysis will be discussed later in the chapter. The detailed changes in the survey items are provided in Appendix D.

Descriptive statistics of the IT sophistication scores for each site are provided in Table 5.3. The mean scores for all sites in each dimension (second column) ranged from 3.48 to 4.03 on 5-point Likert-type scales except integration sophistication outside the hospital with a mean score of 2.25. This suggests that the pilot hospitals, on average, had reasonable IT sophistication scores in most dimensions, but they generally had low level of external information exchange. It also indicates that information exchanges within (internal integration) and outside (external integration) the hospitals are two distinct dimensions and should be treated separately.

**Table 5.3** Descriptive statistics for IT sophistication scores of each site in the pilot study.

| Construct | Overall* | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 |
|---|---|---|---|---|---|---|
| Managerial Sophistication | 3.64 ± 0.43 (3.18-4.17) | 3.18 ± 0.17 (3.00-3.36) | 4.17 ± 0.42 (3.64-4.73) | 3.86 ± 0.50 (3.09-4.73) | 3.78 ± 0.39 (3.36-4.27) | 3.23 ± 0.85 (1.91-4.18) |
| Technological Sophistication | 3.48 ± 0.28 (3.09-3.76) | 3.09 ± 0.24 (2.79-3.37) | 3.42 ± 0.62 (2.74-4.11) | 3.74 ± 0.95 (2.37-5.00) | 3.36 ± 0.46 (2.89-4.25) | 3.76 ± 0.45 (3.11-4.29) |
| Functional Sophistication | 4.03 ± 0.34 (3.50-4.42) | 3.50 ± 0.51 (3.00-4.14) | 4.42 ± 0.38 (4.06-5.00) | 4.10 ± 0.59 (3.30-5.00) | 4.19 ± 0.47 (3.73-5.00) | 3.96 ± 0.32 (3.47-4.37) |
| Integration Sophistication (Within Hospital) | 3.79 ± 0.26 (3.44-4.17) | 3.78 ± 0.33 (3.36-4.08) | 4.17 ± 1.15 (2.50-5.00) | 3.83 ± 0.64 (3.17-4.67) | 3.72 ± 0.49 (3.00-4.27) | 3.44 ± 0.74 (2.33-4.25) |
| Integration Sophistication (Outside Hospital) | 2.25 ± 0.89 (1.11-3.56) | 1.11 ± 0.04 (1.09-1.17) | 2.53 ± 1.35 (1.00-3.58) | 3.56 ± 0.78 (2.83-4.71) | 1.98 ± 0.90 (1.00-3.25) | 2.06 ± 0.54 (1.17-2.82) |
| Overall IT Sophistication† | 3.44 ± 0.37 (2.93-3.88) | 2.93 ± 0.19 (2.75-3.18) | 3.70 ± 0.68 (3.21-4.18) | 3.88 ± 0.62 (3.26-4.68) | 3.40 ± 0.26 (3.14-3.81) | 3.29 ± 0.42 (2.60-3.83) |

Data are mean ± SD (range).
Scores are average of non-missing 5-point Likert-type items (range from lowest to highest = 1-5).
Each dimension might be based on different number of responses since some respondents might not have responded in any item of certain dimensions.
*Unweighted average of mean scores for all sites.
†Unweighted average of technological, functional, integration (within), integration (outside), and managerial sophistication scores.

Because responses of the same site are measuring the same thing, but with different "judges," the standard deviations of each site's scores could tell us how varied the responses were. Most standard deviations for technological, functional, and managerial sophistication were well below 1.0, indicating relatively small variations. Some standard deviations for integration sophistication (both within and outside the hospital) were larger than 1.0 and the score ranges were wide. This suggests that these integration items could be interpreted much differently by respondents and thus they deserve a closer look.

The intraclass correlation and Cronbach's coefficient alpha for each IT sophistication dimension are presented in Table 5.4. The intraclass correlation was moderate (0.50) for external integration sophistication. The intraclass correlations for the managerial sophistication and overall IT sophistication were weak-to-moderate, and they were statistically different from zero, suggesting that respondents from the same hospitals tended to be similar beyond chance. While the correlations were not strong, a value lower than 0.50 is to be expected in subjective responses, according to Donner and Koval,[216] and echoed by Müller and Büttner[217] who cautioned against setting an arbitrary value for good reliability such as 0.75.

**Table 5.4** Intraclass correlation and Cronbach's alpha of each site's IT sophistication dimensions in the pilot study.

| Construct | Intraclass Correlation | Cronbach's Alpha |
|---|---|---|
| Managerial Sophistication | 0.2585* | 0.9106 |
| Technological Sophistication | 0.0354 | 0.8083 |
| Functional Sophistication | 0.1991 | 0.9263 |
| Integration Sophistication (Within Hospital) | 0.0000 | 0.8896 |
| Integration Sophistication (Outside Hospital) | 0.5021* | 0.9734 |
| Overall IT Sophistication | 0.3047* | 0.9558 |

*p < 0.05 on F-test.

On the other hand, the intraclass correlations for technological, functional, and internal integration sophistication were poor and not significantly different from zero. One possible explanation is the large variations between respondents in different roles in the same hospital, but limiting the analysis to those who were IT executives or IT operational staff and thus should know their IT environment best did not improve the correlations (results not shown). Another possible explanation is the subjective nature of these items, possibly coupled with respondents' cognitive burden due to the length of some of these items. The use of only five hospitals in the pilot study was also a practical constraint that limited the ability to differentiate between-hospital and within-hospital variations effectively. Because of these methodological weaknesses and since others have also criticized the utility and meaning of intraclass correlation,[217] the intraclass correlations were used only as a descriptive guide. Nevertheless, it is important to check these items closely to correct identifiable issues.

In a stark contrast to intraclass correlation, Cronbach's alpha indicates that all dimensions had very satisfactory internal consistency reliability. Technological sophistication had the lowest alpha value (0.81), but this is still well-above the 0.70 criterion suggested by Nunnally and Bernstein.[218] A somewhat lower reliability on this dimension was expected because in theory, Cronbach's alpha measures how responses from different items are similar. Since a hospital may adopt a particular technology (e.g., Internet access) but does not necessarily adopt other separate technologies (e.g., computerized order entry), a reliability coefficient this high is reasonable. Other dimensions had a reliability coefficient of 0.89 or higher. While intraclass correlation and Cronbach's alpha measure two different aspects of reliability, the favorable alpha values still suggest that the items of each dimension are internally consistent overall. It is possible, however, that a particular item might have a problem that needed to be fixed.

In order to identify potential issues with the individual IT sophistication items, the item-total correlation and the Cronbach's alpha value if the item is removed were used to see if an item was similar to the remaining items and rightly belonged to the group. A well-behaved item should have at least a moderate (e.g., > 0.30) item-total correlation and the Cronbach's alpha if the item is removed should not substantially increase. The results for each dimension are displayed in Table 5.5. One item in the managerial sophistication dimension (*clear vision of IT projects*) has a weak item-total correlation and the Cronbach's alpha increases when the item is dropped. A possible explanation is that some respondents could interpret the item as asking about the hospital's overall vision and mission statement as opposed to vision of the IT projects. Because the literature suggests that clear vision of IT projects is still an important factor, this item was retained but reworded for clarity. Analysis of the nationwide responses (presented later in the chapter) would determine if this decision should be reconsidered. Other items in this dimension were also retained, but slight rewording of some items was also made for better clarity (see Appendix D).

**Table 5.5** The item-total correlation and Cronbach's alpha if an item is removed for each item in the IT sophistication dimensions in the pilot study.

| Construct | | Item-Total Correlation | Cronbach's Alpha If Item Removed |
|---|---|---|---|
| **Managerial Sophistication** (Cronbach's alpha = 0.9106) | | | |
| a. | Our hospital is open to new ways of conducting operations. | 0.6291 | 0.9042 |
| b. | Our hospital sets clear visions and goals on what we wish to achieve with IT projects. | 0.2930 | 0.9201 |
| c. | When a new technology is introduced, we clearly communicate the goals, plans, and progress to key stakeholders. | 0.7347 | 0.8985 |
| d. | Those who will use the information systems are fully involved early in our IT projects. | 0.6668 | 0.9036 |
| e. | Our top-level management fully supports the use of IT. | 0.5123 | 0.9093 |
| f. | We have a multi-disciplinary team of users involved in our IT projects. | 0.5206 | 0.9106 |
| g. | Before new IT is implemented in our hospital, the workflow changes required are carefully considered. | 0.8245 | 0.8928 |
| h. | The majority of hospital employees are committed to achieving the envisioned organizational goals. | 0.6866 | 0.9011 |

**Table 5.5** The item-total correlation and Cronbach's alpha if an item is removed for each item in the IT sophistication dimensions in the pilot study (continued).

| Construct | | Item-Total Correlation | Cronbach's Alpha If Item Removed |
|---|---|---|---|
| i. | Before a new system is introduced, we adequately provide training to those who will use the system. | 0.8333 | 0.8932 |
| j. | When our hospital is conducting an IT project, we have a process in place to track its progress and manage it. | 0.8188 | 0.8939 |
| k. | Our hospital learns from the past experience to improve its operations. | 0.7753 | 0.8958 |
| **Technological Sophistication** (Cronbach's alpha = 0.8083) | | | |
| a. | Internet access | 0.3019 | 0.8039 |
| b. | Hospital Web site | 0.4511 | 0.7954 |
| c. | Hospital intranet (internal Web site) | 0.4231 | 0.7994 |
| d. | Hospital e-mail system | 0.2632 | 0.8085 |
| e. | Local area network (LAN) | -0.0203 | 0.8132 |
| f. | Wireless networks | 0.0569 | 0.8162 |
| g. | Data warehouse | 0.2235 | 0.8074 |
| h. | Computerized order entry | 0.2175 | 0.8100 |
| i. | Electronic medical record/electronic documentation of clinical care | 0.2155 | 0.8085 |
| j. | Disease management systems | 0.4965 | 0.7927 |
| k. | Laboratory information system | 0.3815 | 0.8016 |
| l. | Pharmacy information system | 0.3286 | 0.8029 |
| m. | Electronic medication administration records | 0.3345 | 0.8024 |
| n. | Picture archiving and communication system (PACS) | 0.6227 | 0.7817 |
| o. | Radiology information system | 0.6384 | 0.7810 |
| p. | Telemedicine (remote provision of medical services or consultation through IT) | 0.6164 | 0.7843 |
| q. | Teleconferencing | 0.4723 | 0.7939 |
| r. | Barcoding | 0.4711 | 0.7939 |
| s. | Enterprise resource planning (ERP) system to manage finance, human resources, and materials of the organization | 0.5773 | 0.7880 |
| **Functional Sophistication** (Cronbach's alpha = 0.9263) | | | |
| **Patient Management** | | | |
| 1. | Patient registration | 0.6352 | 0.9247 |
| 2. | Insurance eligibility verification | 0.6070 | 0.9250 |
| 3. | Outpatient appointment scheduling | 0.1804 | 0.9270 |
| 4. | Patient management within outpatient clinics | 0.3669 | 0.9254 |
| 5. | Inpatient admissions | 0.7013 | 0.9240 |
| 6. | Inpatient discharges | 0.5680 | 0.9247 |
| 7. | Patient referral to another facility | 0.6598 | 0.9227 |
| 8. | Bed occupancy and availability check | 0.6066 | 0.9232 |
| **Inpatient Care** | | | |
| 9. | Inpatient medication order entry | 0.4513 | 0.9251 |
| 10. | Inpatient lab order entry | 0.5050 | 0.9251 |
| 11. | Inpatient imaging order entry | 0.5659 | 0.9237 |
| 12. | Inpatient lab results reporting | 0.4985 | 0.9252 |
| 13. | Inpatient imaging results reporting | 0.3427 | 0.9260 |

**Table 5.5** The item-total correlation and Cronbach's alpha if an item is removed for each item in the IT sophistication dimensions in the pilot study (continued).

| Construct | Item-Total Correlation | Cronbach's Alpha If Item Removed |
|---|---|---|
| 14. Inpatient clinical notes | 0.4899 | 0.9244 |
| 15. Discharge summary documentation | 0.6413 | 0.9239 |
| **Outpatient Care** | | |
| 16. Outpatient medication order entry | 0.4082 | 0.9251 |
| 17. Outpatient lab order entry | 0.6983 | 0.9239 |
| 18. Outpatient imaging order entry | 0.7594 | 0.9218 |
| 19. Outpatient lab results reporting | 0.7309 | 0.9242 |
| 20. Outpatient imaging results reporting | 0.6464 | 0.9230 |
| 21. Outpatient clinical notes | 0.4876 | 0.9244 |
| **Nursing** | | |
| 22. Care planning | 0.4212 | 0.9252 |
| 23. Order review and processing | 0.3501 | 0.9257 |
| 24. Medication administration and documentation | 0.2084 | 0.9270 |
| 25. Documentation of nursing assessment | 0.3881 | 0.9256 |
| **Surgery/Operating Room (OR)** | | |
| 26. Surgery appointments and scheduling | 0.4976 | 0.9245 |
| 27. Patient management within operating rooms | 0.5367 | 0.9241 |
| 28. Operative note documentation | 0.4562 | 0.9248 |
| 29. Anesthetic note documentation | 0.4306 | 0.9250 |
| 30. Case service charging | 0.5586 | 0.9243 |
| **Laboratory** | | |
| 31. Specimen handling | 0.6193 | 0.9236 |
| 32. Results capture from automated equipments | 0.5828 | 0.9241 |
| 33. Results entry for non-automated tests | 0.5434 | 0.9243 |
| 34. Results validation and confirmation | 0.5783 | 0.9243 |
| **Radiology and Imaging** | | |
| 35. Imaging appointments and scheduling | 0.5533 | 0.9238 |
| 36. Image capture from imaging devices | 0.1236 | 0.9296 |
| 37. Imaging reports entry | 0.4885 | 0.9245 |
| 38. Image viewing by radiologists | 0.1871 | 0.9286 |
| 39. Image viewing by attending physicians | 0.2123 | 0.9281 |
| **Pharmacy** | | |
| 40. Pharmacist's review of medication orders | 0.4304 | 0.9250 |
| 41. Outpatient medication dispensing | 0.4590 | 0.9247 |
| 42. Outpatient pharmacy inventory control | 0.5283 | 0.9244 |
| 43. Inpatient medication dispensing | 0.5398 | 0.9245 |
| 44. Inpatient pharmacy inventory control | 0.4769 | 0.9247 |
| **Finance** | | |
| 45. Billing, claims, and reimbursement | 0.2705 | 0.9263 |
| 46. Accounting | 0.2162 | 0.9267 |
| **Human Resource Management** | | |
| 47. Personnel records | 0.4885 | 0.9245 |
| 48. Staff workload management | 0.5379 | 0.9240 |
| **Materials Management** | | |
| 49. Inventory management | 0.1786 | 0.9269 |

**Table 5.5** The item-total correlation and Cronbach's alpha if an item is removed for each item in the IT sophistication dimensions in the pilot study (continued).

| Construct | Item-Total Correlation | Cronbach's Alpha If Item Removed |
|---|---|---|
| **Administration/Miscellaneous** | | |
| 50. Internal communications | 0.3669 | 0.9254 |
| 51. Public relations and external communications | 0.4333 | 0.9249 |
| **Internal Integration Sophistication** (Cronbach's alpha = 0.8896) | | |
| a. ER | 0.7276 | 0.8759 |
| b. Patient registration, admissions, discharges, and transfers | 0.6425 | 0.8787 |
| c. Inpatient | 0.7566 | 0.8731 |
| d. Outpatient clinics | 0.7403 | 0.8726 |
| e. Nursing | 0.5714 | 0.8829 |
| f. Surgery/OR | 0.6886 | 0.8762 |
| g. Laboratory | 0.6466 | 0.8792 |
| h. Radiology | 0.4266 | 0.8914 |
| i. Pharmacy | 0.6312 | 0.8787 |
| j. Finance | 0.4352 | 0.8899 |
| k. Human resource management | 0.5276 | 0.8855 |
| l. Others | 0.5422 | 0.8840 |
| **External Integration Sophistication** (Cronbach's alpha = 0.9734) | | |
| a. ER | 0.8145 | 0.9726 |
| b. Patient registration, admissions, discharges, and transfers | 0.8662 | 0.9708 |
| c. Inpatient | 0.9250 | 0.9695 |
| d. Outpatient clinics | 0.9459 | 0.9689 |
| e. Nursing | 0.9491 | 0.9687 |
| f. Surgery/OR | 0.9563 | 0.9686 |
| g. Laboratory | 0.9277 | 0.9692 |
| h. Radiology | 0.9095 | 0.9699 |
| i. Pharmacy | 0.8907 | 0.9701 |
| j. Finance | 0.5619 | 0.9782 |
| k. Human resource management | 0.6672 | 0.9758 |
| l. Others | 0.9332 | 0.9692 |
| **Overall IT Sophistication** Cronbach's alpha = 0.9558 | | |

Items were analyzed within each IT sophistication dimension. Shaded cells indicate potential issues.

The item-total correlations suggested that six initial items on the technological sophistication dimension were problematic. Less important items, such as *hospital e-mail system* or *wireless networks* were dropped, as were items with weak-to-moderate item-total correlations with which respondents are unlikely to be familiar and varied interpretation is likely (e.g., *disease management systems*; *pharmacy information system*). Important but problematic items (e.g., *computerized order entry*; *electronic medical* *record/electronic documentation of clinical care*) were revised to increase clarity. In some cases when the respondents might not be familiar with the terminology (e.g., *electronic medication administration records*), the translated wording in Thai added a brief description. An additional item was also added (*master patient index*) because it was considered important but missing from the pilot questionnaire.

For the functional sophistication items, eight of the 51 items had low item-total correlations. These findings were considered together with the time some respondents used to complete the questionnaire, where they took on average 27 minutes and the longest time was 90 minutes. Many items were removed, including several problematic items (e.g., *image capture from imaging devices*; *image viewing by radiologists*) and other non-essential items that reflect either trivial administrative functions or less common clinical functions (e.g., *internal communications*; *inventory management*; *operative note documentation*). Some items had a low item-total correlation but they were retained on substantive grounds because they were considered important hospital functions (e.g., *outpatient appointment scheduling*), in some cases with rewording (e.g., *medication administration and documentation*) or item splitting (e.g., *image viewing by attending physicians*; *billing, claims, and reimbursement*). Two items were added because they were considered important but missing clinical decision support features (*automatic drug allergy checking*; *automatic drug interaction checking*). The resultant functional sophistication question had 25 items, and the specific changes are documented in Appendix D.

While the item-total correlations for integration sophistication dimensions (both internal and external) did not reveal serious problems with the individual items, and the dimensions' Cronbach's alpha values were satisfactory, a major change was made to questions of these two dimensions. This is partly motivated by the poor intraclass correlation of internal integration sophistication which suggests that most respondents of the same hospitals interpreted the question differently. The initial structures of these two dimensions are parallel to each other, measuring the extent of information sharing within and outside the hospital for the specific hospital departments. It is likely that respondents would interpret differently if information exchange in a large inter-departmental information system (such as an EHR system or a CPOE) should fall under which department (e.g., *pharmacy*; *inpatient*; or other clinical domains). This could be responsible for the poor interrater reliability. An overhaul of the question structure was therefore made, by asking the extent of information exchange for specific types of information (i.e., *demographic information*; *laboratory results*; *medical images and results*; *operations and procedures*; *history and medical documentation*; *diagnoses*; *medication orders*) rather than for specific hospital departments. The latter three types of information were also split into outpatient and inpatient services given their likely separate implementation in Thai hospitals. The restructuring was considered conceptually more appropriate because as Raymond and Paré[84] suggested when they first conceptualized IT sophistication, each dimension should represent the respective components of organizational IT environment. The technological, functional, and managerial sophistication reflect the technologies, the hospital functions supported by the technologies, and the associated management practices, respectively. The integration sophistication (both internal and external) should represent the information being exchanged. The restructured items put the focus on the specific types of information, rather than the specific hospital units or departments as initially structured. The specific wording changes are also presented in Appendix D.

**5.2 Descriptive Statistics of Nationwide Study's Respondents**

From a total of 1,302 hospitals to which the questionnaires were mailed in the nationwide study, 4 were deemed ineligible (1 returned mail because out of business; 2 not operating as a hospital; and 1 duplicate listing). For the remaining eligible hospitals, 908 hospitals completed and returned questionnaires, 2 refused to participate, and 388 did not respond. One questionnaire did not answer any of the IT sophistication items and therefore was excluded from further analysis except the respondents' descriptive statistics presented next. The overall response rate, using the American Association for Public Opinion Research (AAPOR)'s response rate 1 (RR1) definition,[242] was 69.9%. Comparisons of responding and non-responding hospitals, using data from authoritative source, are presented in Table 5.6. Respondents tended to be larger (mean difference = 34.6 registered beds; $t = 3.32$; $p = 0.0009$) and public ($RR_{response} = 1.50$; $\chi^2 = 71.36$; $p < 0.0001$) hospitals, and were more likely to come from the northern and less likely from the central regions ($\chi^2 = 22.59$; $p = 0.004$), when compared to non-respondents.

**Table 5.6** Comparison of descriptive statistics for responding and non-responding hospitals.

| Characteristic | Overall | Responding Hospitals | Non-Responding Hospitals |
|---|---|---|---|
| N of eligible hospitals | 1,298 | 908 | 390 |
| Bed size** | 106.9 ± 189.0 | 117.5 ± 200.0 | 82.9 ± 159.1 |
| Public status** | | | |
| Private | 311 (24.0%) | 158 (17.4%) | 153 (39.2%) |
| Public | 987 (76.0%) | 750 (82.6%) | 237 (60.8%) |
| Geography* | | | |
| Central | 434 (33.4%) | 282 (31.1%) | 152 (39.0%) |
| East | 97 (7.5%) | 71 (7.8%) | 26 (6.7%) |
| North | 144 (11.1%) | 123 (13.5%) | 21 (5.4%) |
| Northeast | 352 (27.1%) | 244 (26.9%) | 108 (27.7%) |
| South | 198 (15.3%) | 135 (14.9%) | 63 (16.2%) |
| West | 73 (5.6%) | 53 (5.8%) | 20 (5.1%) |

Data are mean ± SD (% within column). Percentages may not sum to 100% because of rounding.
*p < 0.01, **p < 0.001.

## 5.3 Factor Analysis of Survey Items in the Nationwide Study

As described in Chapter 4, further analyses of the nationwide study responses were predicated on whether the proposed constructs of hospital IT adoption (represented as the dimensions of IT sophistication as discussed in Chapter 3) were supported by the observed data. The next subsection reports findings that evaluate this assumption.

### 5.3.1 Confirmatory Factor Analysis

Confirmatory factor analysis was performed to assess if the proposed structures of IT sophistication constructs fitted the data. The path diagram in Figure 5.1 shows the first structure being tested, with the managerial sophistication proposed as a latent (unobserved) construct that is measured by eleven observed survey items. Table 5.7 shows the model fit statistics for this model testing.

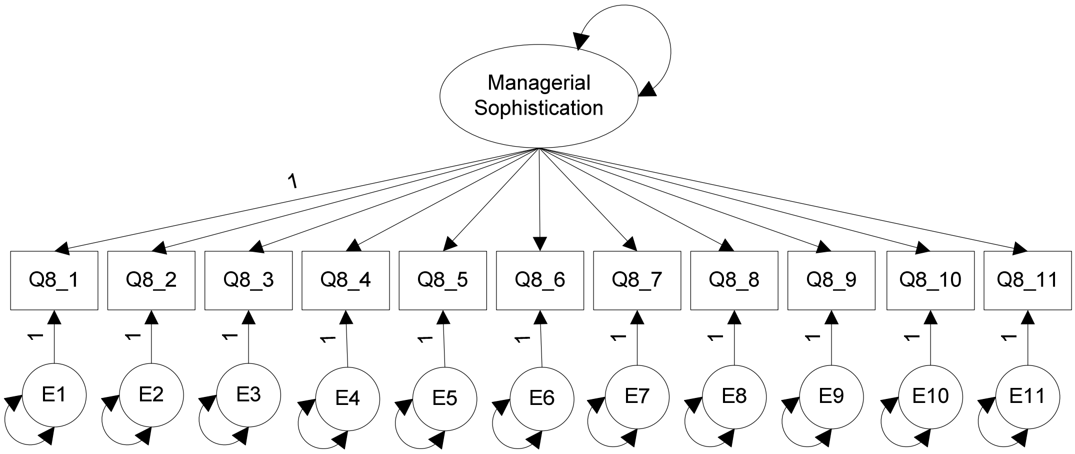



**Figure 5.1.** Path diagram for confirmatory factor analysis of managerial sophistication. The numbers in the rectangles refers to the corresponding survey items in Question 8 of the survey instrument (see Appendix B). As in any standard confirmatory factor analysis, E1-E11 are measurement errors to be estimated in the model for the respective survey items.

**Table 5.7** Values of fit statistics for the confirmatory factor analysis model in Figure 5.1.

| Index | Value of Fit Statistics for the Estimated Model |
|---|---|
| $\chi^2_M$ | 913.651 |
| $df_M$ | 44 |
| Chi-square p-value | < 0.0001 |
| RMSEA (90% CI) | 0.148 (0.140–0.156) |
| Close-fit hypothesis p-value | < 0.0001 |
| CFI | 0.820 |
| TLI | 0.775 |
| SRMR | 0.066 |

CFI - comparative fit index, CI - confidence interval, RMSEA - root mean square error of approximation, SRMR - standardized root mean square residual, TLI - Tucker-Lewis index.

The fit statistics show that the model in Figure 5.1 performed very poorly, as witnessed by the rejection of chi-square likelihood ratio test at $\alpha = 0.05$ and reinforced by poor values of other fit statistics. Inspection of the modification indices, which estimate the reduction in chi-square test statistics associated with adding a relationship to the model, suggested that the items do not correlate in a uniform, uni-dimensional manner (results not shown). Several items were correlated with one another to a greater extent than others. This suggests that what is conceived as facilitating organizational cultures and management practices in fact consists of multiple sub-dimensions. It would be important to conduct exploratory factor analysis of these items to reveal the underlying factor patterns that emerge from the data, which would inform the development of a theory in the path analysis section. Confirmatory factor analysis of other IT sophistication dimensions is considered next.

Figure 5.2 shows the path diagram for confirmatory factor analysis of the technological sophistication dimension. Table 5.8 shows the model fit statistics resulting from the analysis.

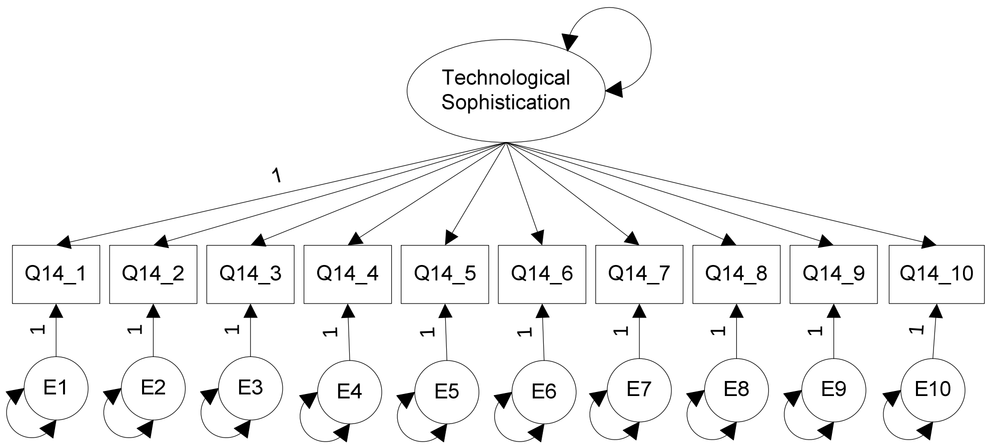



**Figure 5.2.** Path diagram for confirmatory factor analysis of technological sophistication. The numbers in the rectangles refers to the corresponding survey items in Question 14 of the survey instrument (see Appendix B). E1-E10 are measurement errors to be estimated in the model for the respective survey items.

**Table 5.8** Values of fit statistics for the confirmatory factor analysis model in Figure 5.2.

| Index | Value of Fit Statistics for the Estimated Model |
|---|---|
| $\chi^2_M$ | 636.121 |
| $df_M$ | 35 |
| Chi-square p-value | < 0.0001 |
| RMSEA (90% CI) | 0.138 (0.129–0.147) |
| Close-fit hypothesis p-value | < 0.0001 |
| CFI | 0.716 |
| TLI | 0.635 |
| SRMR | 0.089 |

CFI - comparative fit index, CI - confidence interval, RMSEA - root mean square error of approximation, SRMR - standardized root mean square residual, TLI - Tucker-Lewis index.

Like the managerial sophistication dimension, confirmatory factor analysis of technological sophistication items showed that the items did not belong to one single factor in a uniform manner. This is not very surprising because we would expect that hospitals do not adopt various technologies in a uniform way. In other words, some technologies may often be adopted together although adopting these technologies may not be related to the decision to adopt some other technologies. Exploratory factor analysis would offer clues to help us understand which technologies form a coherent cluster of adoption.

Next, confirmatory factor analysis of 25 functional sophistication items was performed (Figure 5.3). Table 5.9 reports the model fit statistics of this analysis. The tested model again did not fit the data well at all, and inspection of the modification indices showed aggregation of certain IT-supported hospital functions (results not shown). This indicates IT-supported functions that are often implemented together (for instance, laboratory test order entry and results viewing). Again, exploratory factor analysis would help us discover functions that are often implemented together, which would be useful information for the subsequent path analysis.

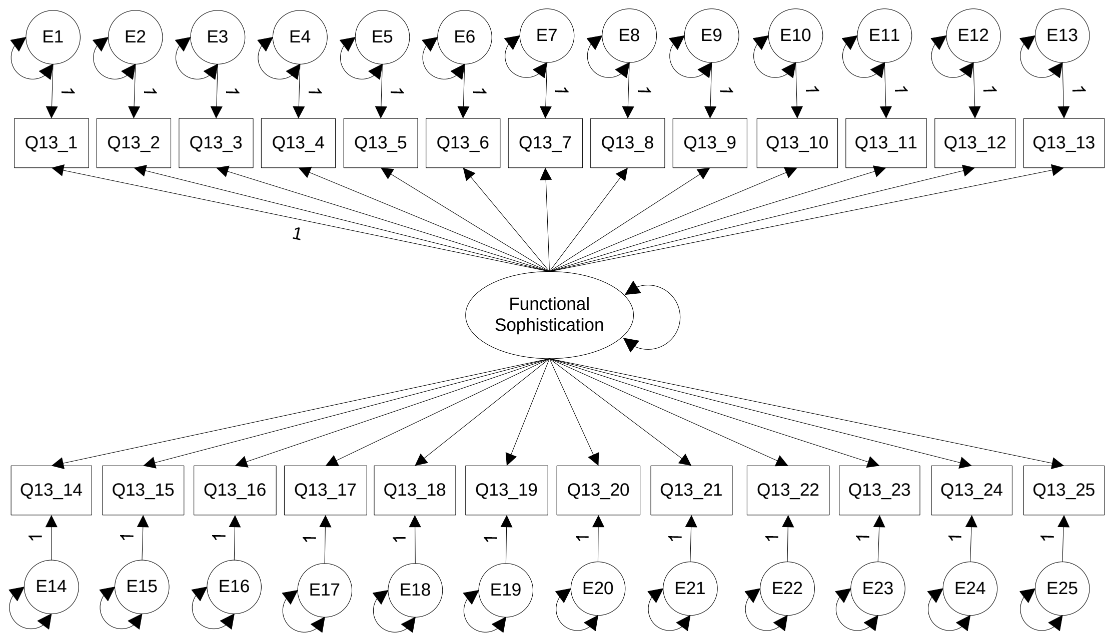



**Figure 5.3.** Path diagram for confirmatory factor analysis of functional sophistication. The numbers in the rectangles refers to the corresponding survey items in Question 13 of the survey instrument (see Appendix B). E1-E25 are measurement errors to be estimated in the model for the respective survey items.

**Table 5.9** Values of fit statistics for the confirmatory factor analysis model in Figure 5.3.

| Index | Value of Fit Statistics for the Estimated Model |
|---|---|
| $\chi^2_M$ | 6889.940 |
| $df_M$ | 275 |
| Chi-square p-value | < 0.0001 |
| RMSEA (90% CI) | 0.163 (0.160–0.166) |
| Close-fit hypothesis p-value | < 0.0001 |
| CFI | 0.591 |
| TLI | 0.554 |
| SRMR | 0.100 |

CFI - comparative fit index, CI - confidence interval, RMSEA - root mean square error of approximation, SRMR - standardized root mean square residual, TLI - Tucker-Lewis index.

As noted in the pilot study findings, data suggested that the levels of information sharing within and outside the hospitals are two distinct dimensions. The proposed integration sophistication dimension in Chapter 3 was therefore split into internal and external integration sophistication and analyzed separately. Confirmatory factor analysis of internal integration sophistication is depicted in Figure 5.4 and results are reported in Table 5.10. The model also performed poorly according to the model fit statistics. Exploratory factor analysis would show the underlying pattern in the data.

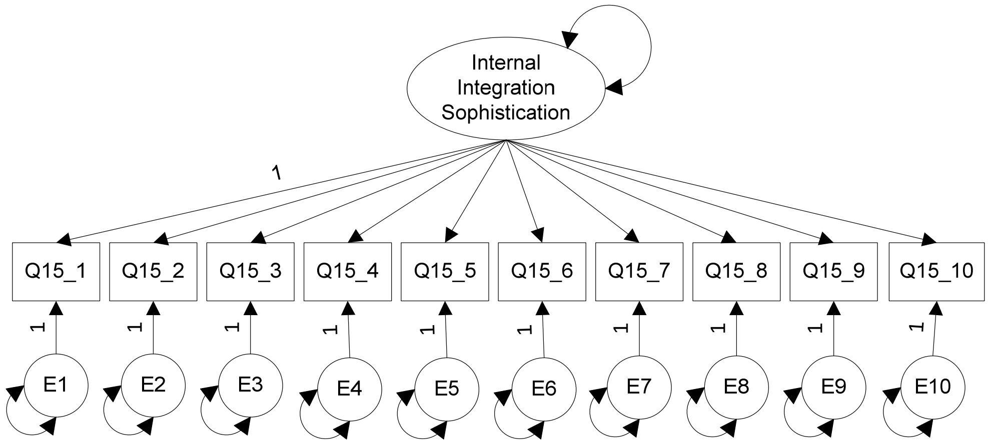



**Figure 5.4.** Path diagram for confirmatory factor analysis of internal integration sophistication. The numbers in the rectangles refers to the corresponding survey items in Question 15 of the survey instrument (see Appendix B). E1-E10 are measurement errors to be estimated in the model for the respective survey items.

**Table 5.10** Values of fit statistics for the confirmatory factor analysis model in Figure 5.4.

| Index | Value of Fit Statistics for the Estimated Model |
|---|---|
| $\chi^2_M$ | 932.262 |
| $df_M$ | 35 |
| Chi-square p-value | < 0.0001 |
| RMSEA (90% CI) | 0.169 (0.160–0.178) |
| Close-fit hypothesis p-value | < 0.0001 |
| CFI | 0.873 |
| TLI | 0.836 |
| SRMR | 0.051 |

CFI - comparative fit index, CI - confidence interval, RMSEA - root mean square error of approximation, SRMR - standardized root mean square residual, TLI - Tucker-Lewis index.

Finally, Figure 5.5 shows the path diagram for confirmatory factor analysis of external integration sophistication. According to model fit statistics in Table 5.11, the model performed poorly and was rejected. Modification indices suggested that there were correlations among some of the survey items beyond what could be explained by the latent construct *external integration sophistication* alone (results not shown).

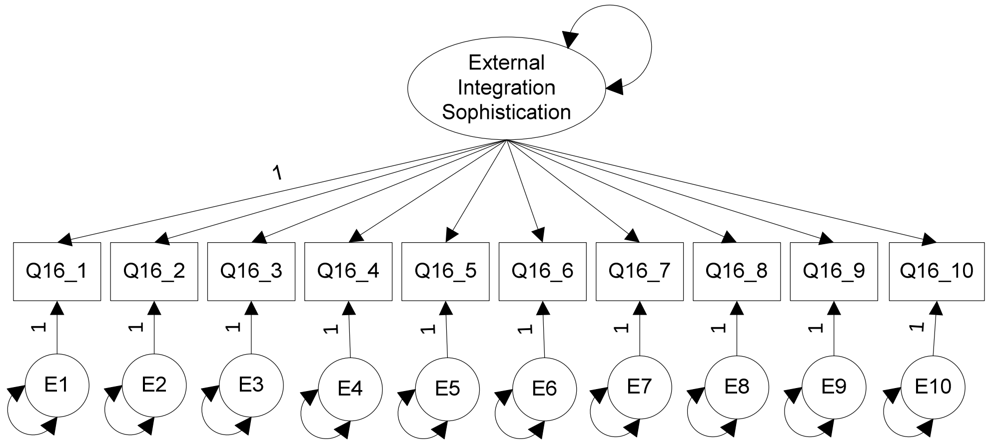



**Figure 5.5.** Path diagram for confirmatory factor analysis of external integration sophistication. The numbers in the rectangles refers to the corresponding survey items in Question 16 of the survey instrument (see Appendix B). E1-E10 are measurement errors to be estimated in the model for the respective survey items.

**Table 5.11** Values of fit statistics for the confirmatory factor analysis model in Figure 5.5.

| Index | Value of Fit Statistics for the Estimated Model |
|---|---|
| $\chi^2_M$ | 1437.904 |
| $df_M$ | 35 |
| Chi-square p-value | < 0.0001 |
| RMSEA (90% CI) | 0.212 (0.202–0.221) |
| Close-fit hypothesis p-value | < 0.0001 |
| CFI | 0.880 |
| TLI | 0.845 |
| SRMR | 0.040 |

CFI - comparative fit index, CI - confidence interval, RMSEA - root mean square error of approximation, SRMR - standardized root mean square residual, TLI - Tucker-Lewis index.

In summary, confirmatory factor analysis showed that survey items of all of the proposed IT sophistication dimensions did not behave as anticipated. Poor performance was also observed when confirmatory factor analysis was done with the items of all the proposed dimensions included in the same model and correlations among the dimensions specified (results not shown). Before moving on to path analysis to test the hypothesized model in Chapter 3, the decision was then made to conduct exploratory factor analysis of all the items combined in order to reveal the underlying pattern of factors which would help inform how subsequent analyses should be conducted.

### 5.3.2 Exploratory Factor Analysis

Exploratory factor analysis was performed to reveal the underlying factors and the pattern of factor loadings for the survey items. Interpretation of the factor patterns could help us understand the nature and relationships among the items in each factor. The factor patterns were discovered using two extraction methods, namely principal component analysis (PCA) and principal axis factoring (PAF) and their results were compared. Because the two methods use different approaches as discussed in Chapter 4, they might lead to different factor patterns, and thus this study explored both. However, given the lengthy output associated with each method, only findings from PCA but not PAF were reported. Important differences between PCA and PAF are noted.

The following discussion reports on the results of exploratory factor analysis of all IT sophistication items using the PCA extraction. The scree plot, which plots the eigenvalue for each factor identified in a descending order, is shown in Figure 5.6. The eigenvalues reflect the amount of variance in the survey items explained by the corresponding factors. Figure 5.6 shows that the eigenvalues drop sharply after the first factor, and after the first 6-7 factors, the drop ceases and the “elbow” of the curve can be seen. On the other hand, if another criterion, namely selecting factors with eigenvalues larger than one, was used, eleven factors could be identified. These factors and the factor loadings of each survey item on these factors are presented in Tables 5.12–5.13.

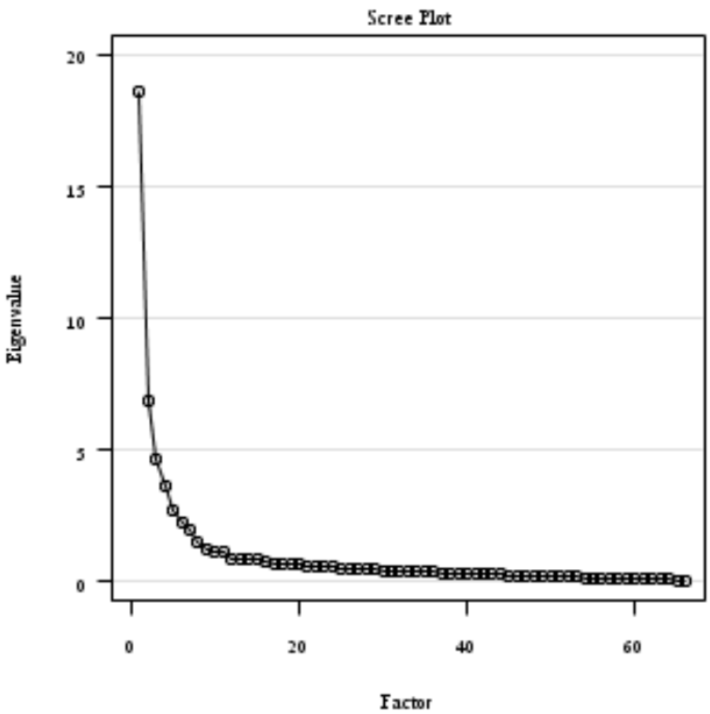



**Figure 5.6.** The scree plot for exploratory factor analysis of survey items based on the principal component analysis (PCA) extraction method.

Table 5.12 reports the results based on the factor structure matrix, which ignores the correlations among the discovered factors. On the other hand, Table 5.13 is based on the factor pattern matrix, which partials out the correlations among the factors. Factor loading patterns based on these two matrices are compared to assist in factor interpretation. The factors reported in the columns of Table 5.12 are shown in descending order of their eigenvalues, with each row representing each survey item. The value in each cell is the item's factor loading, which reflects the correlation between the item and the respective factor and when squared, indicates the proportion of variance in that item explained by that factor. The last column, communalities, shows the proportions of variance in the items explained by all factors.

**Table 5.12** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation.

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Managerial Sophistication** ("To what extent do you agree or disagree with each of the following statements?") | | | | | | | | | | | | |
| M1. Our hospital is open to new ways of conducting operations. | 0.1460 | 0.0347 | 0.1845 | 0.4284 | 0.0702 | 0.1336 | 0.1889 | 0.1567 | 0.0254 | 0.8337* | 0.0683 | 0.7105 |
| M2. Our top-level management fully supports the use of IT. | 0.2517 | 0.0834 | 0.1848 | 0.4334 | 0.0954 | 0.1330 | 0.2407 | 0.2165 | 0.0571 | 0.8437* | 0.1197 | 0.7280 |
| M3. Our hospital sets clear vision, goals, and plans on IT works. | 0.2163 | 0.1075 | 0.2503 | 0.6538 | 0.0670 | 0.2530 | 0.2378 | 0.2363 | 0.0721 | 0.7100* | 0.2517 | 0.6723 |
| M4. Our hospital communicates goals, plans and progress on IT works to stakeholders clearly. | 0.2463 | 0.1252 | 0.2639 | 0.6902* | 0.0726 | 0.2456 | 0.2336 | 0.2321 | 0.0799 | 0.6131 | 0.2487 | 0.6171 |
| M5. Those who will use the information systems are fully involved in hospital IT development. | 0.1392 | 0.1135 | 0.1662 | 0.7572* | 0.0899 | 0.1520 | 0.1365 | 0.1509 | 0.0129 | 0.3756 | 0.0702 | 0.5878 |
| M6. The team of users involved in our IT development comes from several disciplines. | 0.2252 | 0.1465 | 0.1988 | 0.7547* | 0.0822 | 0.1089 | 0.1725 | 0.1777 | 0.0178 | 0.2298 | 0.0290 | 0.6036 |

**Table 5.12** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M7. The majority of hospital employees are committed to achieving the envisioned organizational goals. | 0.1838 | 0.0700 | 0.1805 | 0.6539* | 0.0502 | 0.2141 | 0.2144 | 0.1916 | -0.0198 | 0.4441 | -0.0509 | 0.4888 |
| M8. In our hospital's IT development, the workflow changes are carefully considered. | 0.2525 | 0.0990 | 0.2392 | 0.7466* | 0.0745 | 0.2431 | 0.2303 | 0.2505 | -0.0007 | 0.4811 | 0.0647 | 0.5965 |
| M9. Our hospital provides training to those who will use the system adequately. | 0.2471 | 0.1329 | 0.2298 | 0.7562* | 0.0899 | 0.1793 | 0.3249 | 0.2475 | 0.0325 | 0.1771 | 0.1589 | 0.6329 |
| M10. Our hospital has a process in place to track work progress and manage IT works appropriately. | 0.2394 | 0.1423 | 0.2861 | 0.8154* | 0.1183 | 0.2513 | 0.2498 | 0.2091 | 0.0583 | 0.2897 | 0.1916 | 0.6850 |
| M11. Our hospital uses our past experience as lessons driving our current works. | 0.2548 | 0.1167 | 0.2795 | 0.7503* | 0.0919 | 0.2575 | 0.3178 | 0.2142 | 0.0034 | 0.3556 | 0.0674 | 0.5828 |
| **Functional Sophistication** ("How much is each of the activities supported by computerized information systems in your hospital?") | | | | | | | | | | | | |
| F1. Patient registration and recording of patient's demographic information | 0.5259 | 0.1055 | 0.3544 | 0.2813 | 0.0534 | 0.2248 | 0.6522* | 0.5536 | 0.2185 | 0.2377 | -0.1191 | 0.5356 |

**Table 5.12** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F2. Outpatient appointment scheduling | 0.6200* | 0.1965 | 0.3888 | 0.2825 | 0.1342 | 0.3008 | 0.3500 | 0.5719 | 0.2101 | 0.1737 | 0.0847 | 0.5026 |
| F3. Viewing the list of hospitalized patients | 0.6140* | 0.1518 | 0.4151 | 0.2763 | 0.1215 | 0.3274 | 0.5490 | 0.5928 | 0.0085 | 0.1766 | -0.1288 | 0.5337 |
| F4. Outpatient medication order entry | 0.6745* | 0.1286 | 0.3596 | 0.1751 | 0.0188 | 0.2789 | 0.4691 | 0.4429 | 0.4897 | 0.1421 | -0.1148 | 0.6537 |
| F5. Outpatient lab order entry | 0.8550* | 0.1299 | 0.4599 | 0.2067 | 0.0649 | 0.3100 | 0.4200 | 0.3976 | 0.3153 | 0.1793 | 0.1768 | 0.8077 |
| F6. Outpatient lab results viewing | 0.8250* | 0.1384 | 0.4697 | 0.1867 | 0.1109 | 0.2817 | 0.3631 | 0.4098 | 0.2935 | 0.2117 | 0.2725 | 0.7851 |
| F7. Outpatient imaging order entry | 0.8334* | 0.1197 | 0.4386 | 0.2418 | 0.1653 | 0.3110 | 0.3605 | 0.4056 | 0.2725 | 0.2297 | 0.0963 | 0.7359 |
| F8. Electronic image viewing (instead of using films) for outpatients | 0.1726 | 0.0619 | 0.0400 | 0.0990 | 0.9090* | 0.1504 | 0.0504 | 0.1758 | -0.0811 | 0.0896 | 0.1328 | 0.8336 |
| F9. Documentation of history & physical examination of outpatients | 0.5797 | 0.1180 | 0.4399 | 0.1776 | 0.0062 | 0.4613 | 0.3186 | 0.3241 | 0.6072* | 0.1832 | 0.0481 | 0.6754 |
| F10. Inpatient medication order entry | 0.7900* | 0.1694 | 0.4868 | 0.2151 | 0.0771 | 0.4888 | 0.4322 | 0.4220 | 0.1139 | 0.1487 | -0.2045 | 0.7149 |
| F11. Inpatient lab order entry | 0.9130* | 0.1547 | 0.5056 | 0.2389 | 0.1109 | 0.4084 | 0.3803 | 0.4034 | 0.1018 | 0.2022 | 0.0214 | 0.8502 |
| F12. Inpatient lab results viewing | 0.8474* | 0.1668 | 0.5053 | 0.2373 | 0.1593 | 0.3498 | 0.2906 | 0.4231 | 0.0855 | 0.2081 | 0.1471 | 0.7542 |
| F13. Inpatient imaging order entry | 0.8207* | 0.1488 | 0.4374 | 0.2372 | 0.2022 | 0.3828 | 0.2930 | 0.3727 | 0.0624 | 0.1522 | -0.0288 | 0.7090 |

**Table 5.12** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F14. Electronic image viewing (instead of using films) for inpatients | 0.1790 | 0.0484 | 0.0487 | 0.1001 | 0.9185* | 0.1880 | 0.0619 | 0.1963 | -0.0780 | 0.0851 | 0.1003 | 0.8565 |
| F15. Documentation of history, physical examination & progress note of inpatients | 0.3546 | 0.2250 | 0.3414 | 0.1978 | 0.2299 | 0.8417* | 0.1907 | 0.2266 | 0.1715 | 0.1531 | 0.0451 | 0.7334 |
| F16. Discharge summary documentation | 0.5263 | 0.2600 | 0.4665 | 0.2625 | 0.0916 | 0.6557* | 0.3470 | 0.3563 | 0.1897 | 0.1481 | -0.1043 | 0.5535 |
| F17. Documentation of medication administration to patients | 0.3832 | 0.1909 | 0.3725 | 0.1998 | 0.1018 | 0.8558* | 0.2384 | 0.2177 | 0.1266 | 0.1580 | 0.0813 | 0.7438 |
| F18. Nursing documentation | 0.3249 | 0.2292 | 0.3361 | 0.2084 | 0.1769 | 0.8798* | 0.1827 | 0.2273 | 0.1632 | 0.1291 | 0.0661 | 0.7949 |
| F19. Outpatient medication dispensing | 0.6028 | 0.1167 | 0.4064 | 0.1851 | 0.0368 | 0.2367 | 0.6863* | 0.6579 | 0.2635 | 0.1922 | -0.2612 | 0.6940 |
| F20. Inpatient medication dispensing | 0.6603* | 0.1353 | 0.4565 | 0.1927 | 0.0900 | 0.3589 | 0.6333 | 0.6356 | 0.0294 | 0.2217 | -0.3199 | 0.7082 |
| F21. Pharmacy inventory control | 0.2521 | 0.1421 | 0.2247 | 0.2035 | 0.2453 | 0.1603 | 0.2987 | 0.7276* | -0.0707 | 0.1423 | 0.0735 | 0.6140 |
| F22. Automatic drug allergy checking | 0.5895 | 0.1388 | 0.4513 | 0.2020 | 0.1181 | 0.2867 | 0.4632 | 0.7882* | 0.3101 | 0.1852 | 0.0282 | 0.7177 |
| F23. Automatic drug interaction checking | 0.4455 | 0.1854 | 0.3503 | 0.2240 | 0.1288 | 0.2418 | 0.2538 | 0.7035* | 0.2746 | 0.2136 | 0.1268 | 0.6154 |
| F24. Patient billing | 0.5812 | 0.0833 | 0.3328 | 0.1894 | 0.0996 | 0.3174 | 0.5561 | 0.5970* | -0.1913 | 0.2036 | 0.0959 | 0.6159 |
| F25. Reimbursement claims | 0.5222 | 0.1219 | 0.3497 | 0.2270 | 0.0583 | 0.3627 | 0.5810 | 0.6520* | -0.1486 | 0.2102 | 0.1492 | 0.6542 |

**Table 5.12** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Technological Sophistication** (“To what extent is each of the technologies made available in your hospital?”) | | | | | | | | | | | | |
| T1. Internet access | 0.1799 | 0.1391 | 0.2808 | 0.1912 | -0.0595 | 0.1619 | 0.6911* | 0.1239 | 0.2631 | 0.1591 | 0.0901 | 0.6407 |
| T2. Hospital Web site | 0.2049 | 0.1389 | 0.1536 | 0.3197 | 0.1967 | 0.1950 | 0.4266* | 0.2199 | -0.0402 | 0.2294 | 0.3586 | 0.3987 |
| T3. Local area network (LAN) | 0.4422 | 0.1199 | 0.3912 | 0.2214 | 0.0872 | 0.2068 | 0.7789* | 0.4209 | 0.1588 | 0.2273 | 0.0307 | 0.6391 |
| T4. Master Patient Index | 0.3561 | 0.1060 | 0.3659 | 0.2681 | 0.0605 | 0.1954 | 0.7136* | 0.4611 | 0.1779 | 0.1428 | -0.0409 | 0.5387 |
| T5. Computerized physician order entry | 0.5120 | 0.1560 | 0.4943 | 0.2039 | 0.0627 | 0.3204 | 0.4222 | 0.3592 | 0.6439* | 0.1676 | 0.1072 | 0.6595 |
| T6. Electronic medication administration records | 0.3773 | 0.1626 | 0.3449 | 0.1659 | 0.0453 | 0.5454* | 0.4049 | 0.3251 | 0.4771 | 0.1086 | -0.0462 | 0.5394 |
| T7. Electronic medical records that documents clinical care in the system | 0.4104 | 0.1996 | 0.4860 | 0.1595 | -0.0232 | 0.4275 | 0.4289 | 0.3189 | 0.5955* | 0.1845 | 0.0180 | 0.6018 |
| T8. Laboratory information system | 0.3138 | 0.0929 | 0.2569 | 0.1453 | 0.1654 | 0.1598 | 0.2177 | 0.3375 | 0.1147 | 0.1566 | 0.6164* | 0.5581 |
| T9. Picture archiving and communication system (PACS) for electronic storage of medical images instead of films | 0.1121 | 0.0540 | 0.0023 | 0.0583 | 0.9133* | 0.0873 | 0.0325 | 0.1426 | -0.1046 | 0.0622 | 0.1847 | 0.8474 |
| T10. Barcode use in patient care | 0.1372 | 0.2324 | 0.1500 | 0.1782 | 0.4998* | 0.1759 | 0.0910 | 0.0882 | -0.0489 | 0.1302 | 0.4119 | 0.3962 |
| **Internal Integration Sophistication** (“To what extent is each type of information shared or transmitted among the information systems within your hospital?”) | | | | | | | | | | | | |
| II1. Patient’s demographic information | 0.4606 | 0.2218 | 0.8306* | 0.2878 | 0.0604 | 0.2919 | 0.4333 | 0.4297 | 0.2473 | 0.1833 | 0.0279 | 0.7257 |
| II2. Outpatient’s history and medical documentation | 0.4439 | 0.2616 | 0.8116* | 0.2242 | -0.0045 | 0.4240 | 0.3346 | 0.3004 | 0.4903 | 0.2010 | 0.0696 | 0.7848 |

**Table 5.12** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II3. Outpatient's diagnoses | 0.4843 | 0.2277 | 0.8896* | 0.2279 | 0.0013 | 0.2993 | 0.4127 | 0.3749 | 0.4010 | 0.1939 | 0.0590 | 0.8562 |
| II4. Outpatient's medication orders | 0.5130 | 0.1972 | 0.8726* | 0.2323 | 0.0369 | 0.2626 | 0.4235 | 0.3753 | 0.3089 | 0.1897 | 0.0411 | 0.8063 |
| II5. Inpatient's history and medical documentation | 0.3973 | 0.2605 | 0.7533* | 0.2912 | 0.0466 | 0.6335 | 0.2872 | 0.2366 | 0.2674 | 0.1834 | 0.0903 | 0.7250 |
| II6. Inpatient's diagnoses | 0.4726 | 0.2768 | 0.8823* | 0.2520 | 0.0529 | 0.4050 | 0.3986 | 0.3782 | 0.1778 | 0.1747 | -0.0019 | 0.7878 |
| II7. Inpatient's medication orders | 0.5554 | 0.2543 | 0.8548* | 0.2675 | 0.0893 | 0.4409 | 0.3841 | 0.3315 | 0.0103 | 0.1841 | -0.0439 | 0.7924 |
| II8. Surgical operations and procedures | 0.4803 | 0.2950 | 0.7860* | 0.2283 | 0.1489 | 0.4315 | 0.3041 | 0.3556 | -0.0404 | 0.1699 | 0.1384 | 0.6858 |
| II9. Laboratory results | 0.6298 | 0.1783 | 0.7709* | 0.2559 | 0.1573 | 0.2852 | 0.3021 | 0.3587 | 0.0260 | 0.2578 | 0.3003 | 0.7600 |
| II10. Medical images and results | 0.2093 | 0.1957 | 0.2849 | 0.1805 | 0.7616* | 0.2851 | 0.0875 | 0.1875 | -0.0920 | 0.1084 | 0.1617 | 0.6465 |
| **External Integration Sophistication** ("To what extent is each type of information shared or transmitted between your hospital's information systems and other information systems outside your hospital?") | | | | | | | | | | | | |
| EI1. Patient's demographic information | 0.1174 | 0.8862* | 0.2390 | 0.1494 | 0.0669 | 0.1814 | 0.1497 | 0.1479 | 0.0992 | 0.0419 | 0.0338 | 0.7959 |
| EI2. Outpatient's history and medical documentation | 0.1264 | 0.8980* | 0.2761 | 0.1450 | 0.0429 | 0.2530 | 0.1145 | 0.1173 | 0.1470 | 0.0599 | 0.0842 | 0.8202 |
| EI3. Outpatient's diagnoses | 0.1415 | 0.9210* | 0.2455 | 0.1119 | 0.0487 | 0.1460 | 0.1576 | 0.1828 | 0.1194 | 0.0234 | 0.0234 | 0.8728 |
| EI4. Outpatient's medication orders | 0.1460 | 0.9310* | 0.2608 | 0.1363 | 0.0836 | 0.2059 | 0.1495 | 0.1734 | 0.0867 | 0.0281 | 0.0586 | 0.8733 |
| EI5. Inpatient's history and medical documentation | 0.1473 | 0.9006* | 0.2625 | 0.1636 | 0.1214 | 0.3290 | 0.1150 | 0.1017 | 0.0577 | 0.0732 | 0.1038 | 0.8245 |
| EI6. Inpatient's diagnoses | 0.1450 | 0.9248* | 0.2392 | 0.1375 | 0.0757 | 0.1812 | 0.1411 | 0.1566 | 0.0268 | 0.0248 | 0.0235 | 0.8660 |

**Table 5.12** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EI7. Inpatient's medication orders | 0.1687 | 0.9274* | 0.2775 | 0.1673 | 0.1270 | 0.3033 | 0.1388 | 0.1499 | -0.0107 | 0.0817 | 0.0902 | 0.8695 |
| EI8. Surgical operations and procedures | 0.1803 | 0.9040* | 0.2701 | 0.1443 | 0.1284 | 0.2216 | 0.1565 | 0.1769 | -0.0196 | 0.0548 | 0.0823 | 0.8274 |
| EI9. Laboratory results | 0.2433 | 0.8410* | 0.2882 | 0.1646 | 0.1596 | 0.2976 | 0.0924 | 0.1123 | 0.0123 | 0.1126 | 0.1882 | 0.7438 |
| EI10. Medical images and results | 0.1311 | 0.5813* | 0.1532 | 0.1247 | 0.4956 | 0.2869 | 0.0304 | 0.0697 | -0.0171 | 0.1186 | 0.2650 | 0.5611 |
| Variance Explained by Factor, Ignoring Other Factors | 13.6822 | 9.2238 | 12.4723 | 7.5857 | 4.2838 | 8.1711 | 8.6295 | 8.8244 | 3.3229 | 4.6272 | 1.7695 | |
| **Inter-factor Correlations** | | | | | | | | | | | | |
| Factor 1 | 1 | | | | | | | | | | | |
| Factor 2 | 0.1623 | 1 | | | | | | | | | | |
| Factor 3 | 0.5375 | 0.2810 | 1 | | | | | | | | | |
| Factor 4 | 0.2602 | 0.1605 | 0.2844 | 1 | | | | | | | | |
| Factor 5 | 0.1500 | 0.1179 | 0.0680 | 0.1118 | 1 | | | | | | | |
| Factor 6 | 0.4196 | 0.2607 | 0.4220 | 0.2571 | 0.1766 | 1 | | | | | | |
| Factor 7 | 0.4759 | 0.1361 | 0.4047 | 0.2809 | 0.0288 | 0.2834 | 1 | | | | | |
| Factor 8 | 0.5423 | 0.1474 | 0.3852 | 0.2472 | 0.1515 | 0.2764 | 0.5492 | 1 | | | | |
| Factor 9 | 0.1420 | 0.0602 | 0.1957 | 0.0334 | -0.1147 | 0.0792 | 0.1321 | 0.0931 | 1 | | | |
| Factor 10 | 0.2267 | 0.0599 | 0.2144 | 0.4371 | 0.0818 | 0.1923 | 0.2216 | 0.2131 | 0.0439 | 1 | | |
| Factor 11 | 0.0267 | 0.0951 | 0.0770 | 0.1333 | 0.1656 | 0.0411 | -0.1055 | -0.0873 | 0.0042 | 0.1529 | 1 | |

M = Managerial sophistication, F = Functional sophistication, T = Technological sophistication, II = Internal integration sophistication, EI = External integration sophistication. Number of factors based on eigenvalues > 1. Factor extraction method = Principal component analysis. Rotation method = Promax. Correlations among factors not accounted for in factor loadings (factor structure matrix). Shaded cells indicate factor loadings ≥ 0.40.
*Factor on which each item has the highest factor loading.

From the factor loading pattern above, the following interpretation is offered:

**Factor 1** The extent of IT adoption to support clinical workflows, including order entry for medications, laboratory tests, and imaging as well as electronic results viewing for laboratory tests for outpatient and inpatient settings; outpatient appointment scheduling; and inpatient medication dispensing.

**Factor 2** The extent of information sharing with outside entities.

**Factor 3** The extent of information sharing within the hospital (except imaging).

**Factor 4** The extent of facilitating operational management practices in IT implementation.

**Factor 5** The extent of PACS adoption, electronic image viewing, and internal sharing of imaging information (but not external sharing), as well as the adoption of barcoding technologies.

**Factor 6** The extent of IT adoption to support inpatient clinical documentation (clinical notes, discharge summaries, medication administration records, and nursing documentation).

**Factor 7** The extent of adoption of basic infrastructural technologies (networking, Web site, master patient index), and also adoption of IT to support outpatient medication dispensing.

**Factor 8** The extent of IT adoption to support pharmacy and billing functions (including inventory control and CDSS alerts).

**Factor 9** The extent of IT adoption to support other clinical functions (outpatient clinical notes) and the adoption of CPOE technologies and electronic clinical documentation technologies.

**Factor 10** The extent of facilitating high-level executive management practices related to organizational IT.

**Factor 11** The extent of adoption of laboratory information system.

Consider next the factor loading pattern based on the factor pattern matrix as shown in Table 5.13.

**Table 5.13** Rotated factor pattern matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation.

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Managerial Sophistication** ("To what extent do you agree or disagree with each of the following statements?") | | | | | | | | | | | | |
| M1. Our hospital is open to new ways of conducting operations. | -0.0630 | -0.0166 | 0.0458 | 0.0974 | 0.0222 | -0.0328 | 0.0121 | -0.0291 | -0.0061 | 0.8161* | -0.0733 | 0.7105 |
| M2. Our top-level management fully supports the use of IT. | 0.0838 | 0.0368 | -0.0470 | 0.0774 | 0.0269 | -0.0800 | 0.0399 | -0.0143 | 0.0197 | 0.8075* | -0.0145 | 0.7280 |
| M3. Our hospital sets clear vision, goals, and plans on IT works. | -0.0642 | -0.0126 | -0.0005 | 0.4060 | -0.0483 | 0.0647 | 0.0042 | 0.0616 | 0.0289 | 0.5036* | 0.1345 | 0.6723 |
| M4. Our hospital communicates goals, plans and progress on IT works to stakeholders clearly. | -0.0041 | -0.0020 | 0.0038 | 0.5005* | -0.0433 | 0.0384 | -0.0097 | 0.0420 | 0.0360 | 0.3618 | 0.1347 | 0.6171 |
| M5. Those who will use the information systems are fully involved in hospital IT development. | -0.0290 | 0.0140 | -0.0135 | 0.7649* | 0.0164 | -0.0256 | -0.0825 | 0.0090 | 0.0040 | 0.0778 | -0.0528 | 0.5878 |
| M6. The team of users involved in our IT development comes from several disciplines. | 0.1166 | 0.0502 | -0.0020 | 0.8257* | 0.0131 | -0.1209 | -0.0633 | -0.0133 | -0.0031 | -0.1091 | -0.0772 | 0.6036 |

**Table 5.13** Rotated factor pattern matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M7. The majority of hospital employees are committed to achieving the envisioned organizational goals. | -0.0093 | -0.0237 | -0.0172 | 0.5836* | -0.0158 | 0.0556 | -0.0074 | -0.0016 | -0.0471 | 0.2151 | -0.1582 | 0.4888 |
| M8. In our hospital's IT development, the workflow changes are carefully considered. | 0.0315 | -0.0240 | -0.0052 | 0.6611* | -0.0267 | 0.0402 | -0.0469 | 0.0531 | -0.0379 | 0.1901 | -0.0481 | 0.5965 |
| M9. Our hospital provides training to those who will use the system adequately. | 0.0318 | -0.0035 | -0.0309 | 0.7996* | -0.0041 | -0.0382 | 0.1546 | 0.0285 | -0.0037 | -0.2219 | 0.1092 | 0.6329 |
| M10. Our hospital has a process in place to track work progress and manage IT works appropriately. | -0.0056 | -0.0197 | 0.0470 | 0.8224* | 0.0161 | 0.0325 | 0.0283 | -0.0048 | 0.0238 | -0.1058 | 0.0950 | 0.6850 |
| M11. Our hospital uses our past experience as lessons driving our current works. | 0.0118 | -0.0257 | 0.0422 | 0.7048* | 0.0076 | 0.0420 | 0.1198 | -0.0603 | -0.0420 | 0.0208 | -0.0263 | 0.5828 |
| **Functional Sophistication** ("How much is each of the activities supported by computerized information systems in your hospital?") | | | | | | | | | | | | |
| F1. Patient registration and recording of patient's demographic information | 0.2214 | -0.0064 | -0.0265 | 0.0683 | 0.0086 | -0.0600 | 0.4198* | 0.1839 | 0.1216 | 0.0489 | -0.0781 | 0.5356 |

**Table 5.13** Rotated factor pattern matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F2. Outpatient appointment scheduling | 0.4197* | 0.0583 | -0.0137 | 0.1036 | 0.0042 | 0.0059 | -0.0792 | 0.3623 | 0.1246 | -0.0467 | 0.0841 | 0.5026 |
| F3. Viewing the list of hospitalized patients | 0.3422* | 0.0149 | 0.0474 | 0.0726 | 0.0166 | 0.0285 | 0.2066 | 0.2512 | -0.1021 | -0.0288 | -0.1081 | 0.5337 |
| F4. Outpatient medication order entry | 0.5869* | 0.0253 | -0.1027 | 0.0063 | -0.0101 | -0.0075 | 0.1462 | 0.0384 | 0.4023 | -0.0132 | -0.1047 | 0.6537 |
| F5. Outpatient lab order entry | 0.8895* | -0.0089 | -0.0294 | -0.0130 | -0.0482 | -0.0510 | 0.0755 | -0.0857 | 0.1927 | -0.0293 | 0.1722 | 0.8077 |
| F6. Outpatient lab results viewing | 0.8361* | -0.0048 | 0.0188 | -0.0579 | -0.0165 | -0.0842 | 0.0049 | -0.0097 | 0.1766 | 0.0148 | 0.2597 | 0.7851 |
| F7. Outpatient imaging order entry | 0.8651* | -0.0169 | -0.0225 | 0.0264 | 0.0639 | -0.0552 | -0.0272 | -0.0578 | 0.1730 | 0.0363 | 0.0505 | 0.7359 |
| F8. Electronic image viewing (instead of using films) for outpatients | 0.0505 | -0.0418 | -0.0531 | -0.0073 | 0.9110* | -0.0121 | 0.0080 | 0.0315 | 0.0257 | 0.0148 | -0.0086 | 0.8336 |
| F9. Documentation of history & physical examination of outpatients | 0.3981 | -0.0504 | 0.0347 | -0.0183 | -0.0405 | 0.2622 | -0.0167 | -0.0020 | 0.5232* | 0.0260 | 0.0299 | 0.6754 |
| F10. Inpatient medication order entry | 0.7165* | 0.0202 | 0.0561 | 0.0150 | -0.0212 | 0.1857 | 0.0328 | -0.0756 | -0.0131 | -0.0220 | -0.2358 | 0.7149 |
| F11. Inpatient lab order entry | 0.9681* | 0.0064 | 0.0384 | 0.0135 | -0.0257 | 0.0339 | -0.0405 | -0.1236 | -0.0329 | 0.0040 | -0.0225 | 0.8502 |
| F12. Inpatient lab results viewing | 0.8669* | 0.0142 | 0.0978 | 0.0130 | 0.0059 | -0.0253 | -0.1520 | 0.0100 | -0.0370 | 0.0068 | 0.0973 | 0.7542 |
| F13. Inpatient imaging order entry | 0.8785* | 0.0107 | 0.0244 | 0.0636 | 0.0837 | 0.0409 | -0.1177 | -0.0870 | -0.0379 | -0.0347 | -0.0938 | 0.7090 |

**Table 5.13** Rotated factor pattern matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F14. Electronic image viewing (instead of using films) for inpatients | 0.0316 | -0.0655 | -0.0507 | -0.0078 | 0.9211* | 0.0351 | 0.0045 | 0.0509 | 0.0290 | 0.0071 | -0.0396 | 0.8565 |
| F15. Documentation of history, physical examination & progress note of inpatients | 0.0124 | 0.0023 | -0.0238 | -0.0123 | 0.0996 | 0.8380* | -0.0651 | 0.0080 | 0.1276 | 0.0000 | -0.0096 | 0.7334 |
| F16. Discharge summary documentation | 0.2341 | 0.0678 | 0.0897 | 0.0683 | -0.0173 | 0.4866* | 0.0029 | 0.0214 | 0.0919 | -0.0377 | -0.1426 | 0.5535 |
| F17. Documentation of medication administration to patients | 0.0480 | -0.0365 | 0.0004 | -0.0222 | -0.0501 | 0.8620* | -0.0010 | -0.0258 | 0.0513 | -0.0082 | 0.0580 | 0.7438 |
| F18. Nursing documentation | -0.0446 | -0.0008 | -0.0329 | 0.0107 | 0.0309 | 0.9098* | -0.0730 | 0.0456 | 0.1141 | -0.0386 | 0.0277 | 0.7949 |
| F19. Outpatient medication dispensing | 0.2777 | 0.0083 | 0.0148 | -0.0450 | 0.0052 | -0.0736 | 0.3729* | 0.2857 | 0.1519 | 0.0401 | -0.2049 | 0.6940 |
| F20. Inpatient medication dispensing | 0.3598* | 0.0077 | 0.0867 | -0.0650 | 0.0176 | 0.0489 | 0.2710 | 0.2230 | -0.0977 | 0.0807 | -0.2971 | 0.7082 |
| F21. Pharmacy inventory control | -0.2070 | 0.0305 | 0.0253 | 0.0399 | 0.1086 | -0.0124 | -0.0721 | 0.8684* | -0.1067 | -0.0253 | 0.1239 | 0.6140 |
| F22. Automatic drug allergy checking | 0.1764 | -0.0219 | 0.0783 | -0.0334 | 0.0033 | -0.0038 | -0.0293 | 0.6810* | 0.2136 | -0.0157 | 0.0814 | 0.7177 |
| F23. Automatic drug interaction checking | 0.0757 | 0.0514 | 0.0332 | 0.0252 | -0.0057 | 0.0086 | -0.2474 | 0.7557* | 0.2123 | 0.0359 | 0.1480 | 0.6154 |
| F24. Patient billing | 0.3205 | -0.0468 | -0.0387 | -0.0731 | -0.0699 | 0.0815 | 0.3017 | 0.3262* | -0.3100 | 0.0150 | 0.1720 | 0.6159 |
| F25. Reimbursement claims | 0.1496 | -0.0270 | -0.0318 | -0.0443 | -0.1296 | 0.1536 | 0.3149 | 0.4505* | -0.2718 | -0.0063 | 0.2459 | 0.6542 |

**Table 5.13** Rotated factor pattern matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Technological Sophistication** ("To what extent is each of the technologies made available in your hospital?") | | | | | | | | | | | | |
| T1. Internet access | -0.1361 | 0.0489 | 0.0545 | 0.0020 | -0.0321 | 0.0011 | 0.8945* | -0.3243 | 0.1756 | 0.0167 | 0.1526 | 0.6407 |
| T2. Hospital Web site | -0.0388 | 0.0333 | -0.1109 | 0.1439 | 0.0970 | 0.0494 | 0.4807* | -0.0141 | -0.0773 | 0.0222 | 0.3741 | 0.3987 |
| T3. Local area network (LAN) | 0.0839 | -0.0050 | 0.0728 | -0.0433 | 0.0618 | -0.0757 | 0.7659* | -0.0572 | 0.0491 | 0.0479 | 0.0903 | 0.6391 |
| T4. Master Patient Index | -0.0571 | -0.0228 | 0.0924 | 0.0845 | 0.0416 | -0.0486 | 0.6473* | 0.0992 | 0.0831 | -0.0660 | 0.0262 | 0.5387 |
| T5. Computerized physician order entry | 0.2301 | -0.0140 | 0.1602 | 0.0059 | 0.0500 | 0.0526 | 0.1582 | 0.0238 | 0.5592* | -0.0144 | 0.0974 | 0.6595 |
| T6. Electronic medication administration records | 0.0349 | -0.0058 | -0.0311 | -0.0097 | 0.0064 | 0.4527* | 0.1974 | 0.0550 | 0.4147 | -0.0443 | -0.0319 | 0.5394 |
| T7. Electronic medical records that documents clinical care in the system | 0.0498 | 0.0312 | 0.1761 | -0.0645 | -0.0378 | 0.2382 | 0.2013 | 0.0094 | 0.5014* | 0.0478 | 0.0178 | 0.6018 |
| T8. Laboratory information system | 0.0947 | -0.0430 | 0.0253 | -0.0567 | 0.0122 | -0.0018 | 0.0838 | 0.3083 | 0.0612 | -0.0317 | 0.6620* | 0.5581 |
| T9. Picture archiving and communication system (PACS) for electronic storage of medical images instead of films | -0.0003 | -0.0352 | -0.0519 | -0.0384 | 0.9216* | -0.0600 | 0.0457 | 0.0325 | 0.0100 | 0.0027 | 0.0542 | 0.8474 |
| T10. Barcode use in patient care | -0.0124 | 0.1276 | 0.0251 | 0.0387 | 0.4216* | 0.0234 | 0.0974 | -0.0360 | -0.0255 | 0.0009 | 0.3293 | 0.3962 |
| **Internal Integration Sophistication** ("To what extent is each type of information shared or transmitted among the information systems within your hospital?") | | | | | | | | | | | | |
| II1. Patient's demographic information | -0.0482 | -0.0107 | 0.7968* | 0.0597 | 0.0203 | -0.0938 | 0.0747 | 0.1139 | 0.0874 | -0.0278 | -0.0170 | 0.7257 |
| II2. Outpatient's history and medical documentation | -0.0198 | 0.0234 | 0.7157* | -0.0205 | -0.0315 | 0.1108 | -0.0148 | -0.0188 | 0.3422 | 0.0322 | 0.0066 | 0.7848 |

**Table 5.13** Rotated factor pattern matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II3. Outpatient's diagnoses | -0.0063 | -0.0102 | 0.8623* | -0.0242 | -0.0181 | -0.0941 | 0.0539 | 0.0298 | 0.2295 | 0.0114 | 0.0093 | 0.8562 |
| II4. Outpatient's medication orders | 0.0662 | -0.0321 | 0.8535* | -0.0126 | 0.0155 | -0.1496 | 0.0751 | 0.0013 | 0.1383 | 0.0054 | -0.0115 | 0.8063 |
| II5. Inpatient's history and medical documentation | -0.0854 | -0.0106 | 0.6282* | 0.0621 | -0.0379 | 0.4196 | -0.0309 | -0.0717 | 0.1292 | -0.0225 | 0.0193 | 0.7250 |
| II6. Inpatient's diagnoses | -0.0390 | 0.0291 | 0.8607* | 0.0009 | -0.0040 | 0.0380 | 0.0319 | 0.0333 | 0.0032 | -0.0148 | -0.0625 | 0.7878 |
| II7. Inpatient's medication orders | 0.1568 | 0.0149 | 0.8047* | 0.0196 | 0.0111 | 0.0645 | 0.0203 | -0.0953 | -0.1679 | -0.0047 | -0.1233 | 0.7924 |
| II8. Surgical operations and procedures | 0.0555 | 0.0583 | 0.7367* | -0.0318 | 0.0281 | 0.0965 | -0.0443 | 0.0631 | -0.1989 | -0.0174 | 0.0746 | 0.6858 |
| II9. Laboratory results | 0.3619 | -0.0438 | 0.6692* | -0.0240 | 0.0310 | -0.1289 | -0.0646 | 0.0055 | -0.1343 | 0.0511 | 0.2330 | 0.7600 |
| II10. Medical images and results | -0.0490 | 0.0334 | 0.2339 | 0.0353 | 0.7247* | 0.0751 | -0.0323 | 0.0070 | -0.0526 | -0.0159 | 0.0139 | 0.6465 |
| **External Integration Sophistication** ("To what extent is each type of information shared or transmitted between your hospital's information systems and other information systems outside your hospital?") | | | | | | | | | | | | |
| EI1. Patient's demographic information | -0.0422 | 0.8991* | -0.0013 | 0.0247 | -0.0177 | -0.0550 | 0.0346 | 0.0256 | 0.0464 | -0.0097 | -0.0414 | 0.7959 |
| EI2. Outpatient's history and medical documentation | -0.0442 | 0.8915* | 0.0270 | 0.0018 | -0.0536 | 0.0336 | -0.0169 | -0.0025 | 0.0876 | 0.0079 | 0.0022 | 0.8202 |
| EI3. Outpatient's diagnoses | -0.0060 | 0.9473* | -0.0045 | -0.0183 | -0.0361 | -0.1117 | 0.0235 | 0.0699 | 0.0606 | -0.0149 | -0.0425 | 0.8728 |
| EI4. Outpatient's medication orders | -0.0200 | 0.9386* | 0.0026 | -0.0010 | -0.0169 | -0.0436 | 0.0147 | 0.0536 | 0.0284 | -0.0275 | -0.0153 | 0.8733 |
| EI5. Inpatient's history and medical documentation | -0.0167 | 0.8797* | -0.0125 | 0.0057 | 0.0049 | 0.1214 | -0.0021 | -0.0505 | 0.0048 | 0.0104 | 0.0088 | 0.8245 |
| EI6. Inpatient's diagnoses | 0.0152 | 0.9461* | -0.0083 | 0.0121 | -0.0240 | -0.0696 | 0.0140 | 0.0275 | -0.0316 | -0.0229 | -0.0535 | 0.8660 |

**Table 5.13** Rotated factor pattern matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 | Factor 10 | Factor 11 | Comm-unalities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EI7. Inpatient's medication orders | -0.0041 | 0.9128* | 0.0055 | -0.0026 | -0.0015 | 0.0676 | 0.0016 | -0.0004 | -0.0726 | 0.0182 | -0.0014 | 0.8695 |
| EI8. Surgical operations and procedures | 0.0281 | 0.9032* | 0.0163 | -0.0132 | 0.0101 | -0.0387 | 0.0233 | 0.0308 | -0.0823 | -0.0053 | 0.0024 | 0.8274 |
| EI9. Laboratory results | 0.1481 | 0.8127* | 0.0064 | -0.0159 | 0.0235 | 0.0484 | -0.0573 | -0.0688 | -0.0477 | 0.0411 | 0.0846 | 0.7438 |
| EI10. Medical images and results | -0.0006 | 0.5187* | -0.0503 | -0.0430 | 0.4049 | 0.1176 | -0.0176 | -0.0613 | 0.0051 | 0.0572 | 0.1374 | 0.5611 |
| Variance Explained by Factor, Eliminating Other Factors | 3.6523 | 6.7669 | 3.3568 | 3.2232 | 3.1311 | 2.4062 | 1.8344 | 1.6098 | 1.9256 | 1.4820 | 1.3000 | |
| **Inter-factor Correlations** | | | | | | | | | | | | |
| Factor 1 | 1 | | | | | | | | | | | |
| Factor 2 | 0.1729 | 1 | | | | | | | | | | |
| Factor 3 | 0.5711 | 0.2926 | 1 | | | | | | | | | |
| Factor 4 | 0.2871 | 0.1718 | 0.3120 | 1 | | | | | | | | |
| Factor 5 | 0.1742 | 0.1160 | 0.0749 | 0.1305 | 1 | | | | | | | |
| Factor 6 | 0.4417 | 0.2790 | 0.4530 | 0.2804 | 0.2001 | 1 | | | | | | |
| Factor 7 | 0.5072 | 0.1515 | 0.4568 | 0.3246 | 0.0472 | 0.2790 | 1 | | | | | |
| Factor 8 | 0.5636 | 0.1768 | 0.4272 | 0.3000 | 0.2054 | 0.2789 | 0.6171 | 1 | | | | |
| Factor 9 | 0.0808 | 0.0224 | 0.1419 | -0.0080 | -0.1634 | 0.0637 | 0.1711 | 0.1069 | 1 | | | |
| Factor 10 | 0.2265 | 0.0417 | 0.2063 | 0.3987 | 0.0918 | 0.1821 | 0.2320 | 0.2350 | 0.0098 | 1 | | |
| Factor 11 | -0.0686 | 0.0381 | -0.0097 | 0.0589 | 0.1054 | -0.0104 | -0.1685 | -0.1812 | -0.0406 | 0.1198 | 1 | |

M = Managerial sophistication, F = Functional sophistication, T = Technological sophistication, II = Internal integration sophistication, EI = External integration sophistication. Number of factors based on eigenvalues > 1. Factor extraction method = Principal component analysis. Rotation method = Promax. Correlations among factors accounted for in factor loadings (factor pattern matrix). Shaded cells indicate factor loadings ≥ 0.40.
*Factor on which each item has the highest factor loading.

The factor loading pattern in Table 5.13 is very similar to that of Table 5.12. However, it reveals that *viewing the list of hospitalized patients* (F3), *Outpatient medication dispensing* (F19), *Inpatient medication dispensing* (F20), and *Patient billing* (F24) failed to load substantially on any factor when inter-factor correlations have been taken into account. These findings, together with the fact that they are not substantively important clinical functions of health IT, suggest that they should be dropped. With few exceptions, findings based on another factor extraction method, principal axis factoring (PAF), were similar (results not shown). One difference between the factor structure matrices of PCA and PAF was the item *Our hospital sets clear vision, goals, and plans on IT works* (C3) which in PAF belonged to Factor 4.

Since the scree plot in Figure 5.6 suggests that the first 6-7 factors were most relevant, a separate exploratory factor analysis was done by restricting the number of factors retained to 7 factors (instead of using the criterion of eigenvalues larger than one which led to 11 factors). Findings from the factor structure matrix based on the PCA extraction method are reported in Table 5.14. Results from the PCA's factor pattern matrix and the PAF extraction method were not reported but essentially similar.

**Table 5.14** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation and restricting the number of factors to 7.

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Communal-ities |
|---|---|---|---|---|---|---|---|---|
| **Managerial Sophistication** ("To what extent do you agree or disagree with each of the following statements?") | | | | | | | | |
| M1. Our hospital is open to new ways of conducting operations. | 0.1390 | 0.0303 | 0.6061* | 0.1825 | 0.2032 | 0.1086 | 0.0843 | 0.3757 |
| M2. Our top-level management fully supports the use of IT. | 0.2454 | 0.0789 | 0.6132* | 0.1856 | 0.2700 | 0.1162 | 0.1138 | 0.3922 |
| M3. Our hospital sets clear vision, goals, and plans on IT works. | 0.2162 | 0.1086 | 0.7594* | 0.2526 | 0.2791 | 0.2237 | 0.1139 | 0.5841 |
| M4. Our hospital communicates goals, plans and progress on IT works to stakeholders clearly. | 0.2472 | 0.1274 | 0.7594* | 0.2668 | 0.2700 | 0.2230 | 0.1154 | 0.5814 |
| M5. Those who will use the information systems are fully involved in hospital IT development. | 0.1420 | 0.1179 | 0.7382* | 0.1626 | 0.1378 | 0.1282 | 0.1020 | 0.5535 |
| M6. The team of users involved in our IT development comes from several disciplines. | 0.2264 | 0.1522 | 0.6902* | 0.1949 | 0.1648 | 0.0962 | 0.0841 | 0.4918 |
| M7. The majority of hospital employees are committed to achieving the envisioned organizational goals. | 0.1771 | 0.0734 | 0.6738* | 0.1699 | 0.1907 | 0.1744 | 0.0539 | 0.4605 |
| M8. In our hospital's IT development, the workflow changes are carefully considered. | 0.2515 | 0.1039 | 0.7641* | 0.2305 | 0.2347 | 0.1983 | 0.0985 | 0.5876 |
| M9. Our hospital provides training to those who will use the system adequately. | 0.2394 | 0.1408 | 0.6814* | 0.2292 | 0.3143 | 0.1593 | 0.1128 | 0.4803 |

**Table 5.14** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation and restricting the number of factors to 7 (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Communal-ities |
|---|---|---|---|---|---|---|---|---|
| M10. Our hospital has a process in place to track work progress and manage IT works appropriately. | 0.2375 | 0.1488 | 0.7640* | 0.2864 | 0.2483 | 0.2316 | 0.1437 | 0.5901 |
| M11. Our hospital uses our past experience as lessons driving our current works. | 0.2413 | 0.1220 | 0.7304* | 0.2731 | 0.2782 | 0.2221 | 0.1039 | 0.5411 |
| **Functional Sophistication** ("How much is each of the activities supported by computerized information systems in your hospital?") | | | | | | | | |
| F1. Patient registration and recording of patient's demographic information | 0.5066 | 0.1077 | 0.2935 | 0.3549 | 0.6820* | 0.2712 | 0.0285 | 0.5144 |
| F2. Outpatient appointment scheduling | 0.6381* | 0.2013 | 0.2804 | 0.3865 | 0.4783 | 0.3155 | 0.1589 | 0.4587 |
| F3. Viewing the list of hospitalized patients | 0.6015* | 0.1582 | 0.2829 | 0.3930 | 0.5683 | 0.2749 | 0.1310 | 0.4698 |
| F4. Outpatient medication order entry | 0.6740* | 0.1257 | 0.1623 | 0.3815 | 0.5412 | 0.4343 | -0.0424 | 0.5677 |
| F5. Outpatient lab order entry | 0.8516* | 0.1299 | 0.2193 | 0.4747 | 0.4688 | 0.3838 | 0.0664 | 0.7381 |
| F6. Outpatient lab results viewing | 0.8296* | 0.1387 | 0.2156 | 0.4842 | 0.4441 | 0.3409 | 0.1319 | 0.6948 |
| F7. Outpatient imaging order entry | 0.8353* | 0.1191 | 0.2615 | 0.4463 | 0.4121 | 0.3681 | 0.1552 | 0.7005 |
| F8. Electronic image viewing (instead of using films) for outpatients | 0.1816 | 0.0592 | 0.1127 | 0.0250 | 0.0689 | 0.0889 | 0.8812* | 0.7871 |
| F9. Documentation of history & physical examination of outpatients | 0.5908 | 0.1136 | 0.1779 | 0.4726 | 0.4177 | 0.6397* | -0.0384 | 0.5752 |
| F10. Inpatient medication order entry | 0.7755* | 0.1717 | 0.2185 | 0.4711 | 0.4003 | 0.4799 | 0.0528 | 0.6411 |
| F11. Inpatient lab order entry | 0.9043* | 0.1570 | 0.2604 | 0.4960 | 0.3734 | 0.3934 | 0.1175 | 0.8276 |
| F12. Inpatient lab results viewing | 0.8524* | 0.1701 | 0.2637 | 0.4964 | 0.3358 | 0.3220 | 0.1915 | 0.7453 |

**Table 5.14** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation and restricting the number of factors to 7 (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Communal-ities |
|---|---|---|---|---|---|---|---|---|
| F13. Inpatient imaging order entry | 0.8182* | 0.1511 | 0.2427 | 0.4234 | 0.2894 | 0.3568 | 0.1993 | 0.6886 |
| F14. Electronic image viewing (instead of using films) for inpatients | 0.1881 | 0.0460 | 0.1116 | 0.0318 | 0.0799 | 0.1240 | 0.8875* | 0.8063 |
| F15. Documentation of history, physical examination & progress note of inpatients | 0.3552 | 0.2265 | 0.2139 | 0.3326 | 0.1861 | 0.8104* | 0.2398 | 0.6982 |
| F16. Discharge summary documentation | 0.5204 | 0.2626 | 0.2583 | 0.4570 | 0.3424 | 0.6538* | 0.0815 | 0.5180 |
| F17. Documentation of medication administration to patients | 0.3759 | 0.1940 | 0.2225 | 0.3622 | 0.2120 | 0.8056* | 0.1315 | 0.6618 |
| F18. Nursing documentation | 0.3265 | 0.2321 | 0.2174 | 0.3266 | 0.1814 | 0.8394* | 0.1990 | 0.7346 |
| F19. Outpatient medication dispensing | 0.5882 | 0.1186 | 0.1939 | 0.4034 | 0.7409* | 0.2991 | -0.0054 | 0.6295 |
| F20. Inpatient medication dispensing | 0.6394* | 0.1397 | 0.2217 | 0.4301 | 0.6296 | 0.3191 | 0.0696 | 0.5459 |
| F21. Pharmacy inventory control | 0.2829 | 0.1529 | 0.2172 | 0.1971 | 0.4902* | 0.0563 | 0.3214 | 0.3545 |
| F22. Automatic drug allergy checking | 0.6174 | 0.1445 | 0.2104 | 0.4502 | 0.6731* | 0.3273 | 0.1433 | 0.5753 |
| F23. Automatic drug interaction checking | 0.4903 | 0.1912 | 0.2397 | 0.3498 | 0.5029* | 0.2657 | 0.1770 | 0.3527 |
| F24. Patient billing | 0.5630 | 0.0933 | 0.2387 | 0.3015 | 0.5691* | 0.1741 | 0.1771 | 0.4586 |
| F25. Reimbursement claims | 0.5089 | 0.1332 | 0.2719 | 0.3211 | 0.6263* | 0.2235 | 0.1511 | 0.4627 |
| **Technological Sophistication** (“To what extent is each of the technologies made available in your hospital?”) | | | | | | | | |
| T1. Internet access | 0.1225 | 0.1359 | 0.2022 | 0.3067 | 0.5866* | 0.2609 | -0.0988 | 0.4190 |
| T2. Hospital Web site | 0.1792 | 0.1426 | 0.3507 | 0.1544 | 0.3985* | 0.1389 | 0.2488 | 0.2701 |
| T3. Local area network (LAN) | 0.3960 | 0.1206 | 0.2510 | 0.3970 | 0.7286* | 0.2409 | 0.0685 | 0.5408 |
| T4. Master Patient Index | 0.3223 | 0.1087 | 0.2595 | 0.3696 | 0.6989* | 0.2353 | 0.0395 | 0.4984 |
| T5. Computerized physician order entry | 0.5182 | 0.1512 | 0.1927 | 0.5340* | 0.5324 | 0.5256 | 0.0106 | 0.4964 |

**Table 5.14** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation and restricting the number of factors to 7 (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Communal-ities |
|---|---|---|---|---|---|---|---|---|
| T6. Electronic medication administration records | 0.3741 | 0.1606 | 0.1519 | 0.3650 | 0.4522 | 0.6696* | 0.0015 | 0.5219 |
| T7. Electronic medical records that documents clinical care in the system | 0.4087 | 0.1949 | 0.1637 | 0.5193 | 0.5050 | 0.6080* | -0.0741 | 0.5290 |
| T8. Laboratory information system | 0.3296 | 0.0977 | 0.1830 | 0.2695 | 0.3558* | 0.1385 | 0.2678 | 0.2183 |
| T9. Picture archiving and communication system (PACS) for electronic storage of medical images instead of films | 0.1203 | 0.0513 | 0.0730 | -0.0110 | 0.0517 | 0.0224 | 0.8923* | 0.8105 |
| T10. Barcode use in patient care | 0.1377 | 0.2327 | 0.2017 | 0.1489 | 0.1051 | 0.1174 | 0.5389* | 0.3309 |
| **Internal Integration Sophistication** ("To what extent is each type of information shared or transmitted among the information systems within your hospital?") | | | | | | | | |
| II1. Patient's demographic information | 0.4575 | 0.2240 | 0.2858 | 0.8324* | 0.4907 | 0.3383 | 0.0563 | 0.7164 |
| II2. Outpatient's history and medical documentation | 0.4481 | 0.2588 | 0.2288 | 0.8342* | 0.4104 | 0.5587 | -0.0324 | 0.7477 |
| II3. Outpatient's diagnoses | 0.4836 | 0.2267 | 0.2328 | 0.9054* | 0.4856 | 0.4085 | -0.0184 | 0.8360 |
| II4. Outpatient's medication orders | 0.5077 | 0.1971 | 0.2390 | 0.8815* | 0.4735 | 0.3411 | 0.0206 | 0.7969 |
| II5. Inpatient's history and medical documentation | 0.3929 | 0.2617 | 0.2947 | 0.7561* | 0.2949 | 0.6613 | 0.0520 | 0.7171 |
| II6. Inpatient's diagnoses | 0.4648 | 0.2793 | 0.2587 | 0.8762* | 0.4197 | 0.4171 | 0.0545 | 0.7707 |
| II7. Inpatient's medication orders | 0.5377 | 0.2580 | 0.2827 | 0.8349* | 0.3433 | 0.3902 | 0.0979 | 0.7185 |
| II8. Surgical operations and procedures | 0.4746 | 0.3005 | 0.2538 | 0.7651* | 0.3123 | 0.3466 | 0.1987 | 0.6231 |
| II9. Laboratory results | 0.6285 | 0.1822 | 0.3020 | 0.7625* | 0.3423 | 0.2349 | 0.2157 | 0.7149 |
| II10. Medical images and results | 0.2144 | 0.1954 | 0.1908 | 0.2663 | 0.0916 | 0.2034 | 0.7572* | 0.6325 |
| **External Integration Sophistication** ("To what extent is each type of information shared or transmitted between your hospital's information systems and other information systems outside your hospital?") | | | | | | | | |
| EI1. Patient's demographic information | 0.1172 | 0.8855* | 0.1339 | 0.2400 | 0.1689 | 0.1940 | 0.0662 | 0.7903 |

**Table 5.14** Rotated factor structure matrix for survey items in the nationwide study, using principal component analysis (PCA) with Promax rotation and restricting the number of factors to 7 (continued).

| Item | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Communal-ities |
|---|---|---|---|---|---|---|---|---|
| EI2. Outpatient's history and medical documentation | 0.1291 | 0.8967* | 0.1359 | 0.2810 | 0.1408 | 0.2759 | 0.0478 | 0.8148 |
| EI3. Outpatient's diagnoses | 0.1440 | 0.9202* | 0.0956 | 0.2476 | 0.1942 | 0.1681 | 0.0474 | 0.8635 |
| EI4. Outpatient's medication orders | 0.1477 | 0.9309* | 0.1208 | 0.2600 | 0.1764 | 0.2080 | 0.0911 | 0.8708 |
| EI5. Inpatient's history and medical documentation | 0.1452 | 0.9002* | 0.1616 | 0.2596 | 0.1112 | 0.3098 | 0.1352 | 0.8229 |
| EI6. Inpatient's diagnoses | 0.1437 | 0.9252* | 0.1225 | 0.2337 | 0.1495 | 0.1651 | 0.0835 | 0.8626 |
| EI7. Inpatient's medication orders | 0.1656 | 0.9283* | 0.1702 | 0.2681 | 0.1350 | 0.2567 | 0.1505 | 0.8639 |
| EI8. Surgical operations and procedures | 0.1776 | 0.9051* | 0.1422 | 0.2608 | 0.1614 | 0.1790 | 0.1502 | 0.8247 |
| EI9. Laboratory results | 0.2435 | 0.8410* | 0.1787 | 0.2835 | 0.0954 | 0.2587 | 0.1898 | 0.7322 |
| EI10. Medical images and results | 0.1352 | 0.5794* | 0.1489 | 0.1482 | 0.0380 | 0.2359 | 0.5126 | 0.5444 |
| Variance Explained by Factor, Ignoring Other Factors | 13.5303 | 9.2576 | 8.1842 | 12.4585 | 10.1416 | 8.6712 | 4.5132 | |
| **Inter-factor Correlations** | | | | | | | | |
| Factor 1 | 1 | | | | | | | |
| Factor 2 | 0.1657 | 1 | | | | | | |
| Factor 3 | 0.2775 | 0.1586 | 1 | | | | | |
| Factor 4 | 0.5221 | 0.2793 | 0.2922 | 1 | | | | |
| Factor 5 | 0.4791 | 0.1531 | 0.2926 | 0.4402 | 1 | | | |
| Factor 6 | 0.4072 | 0.2447 | 0.2234 | 0.4494 | 0.3064 | 1 | | |
| Factor 7 | 0.1731 | 0.1323 | 0.1629 | 0.0527 | 0.0330 | 0.0670 | 1 | |

M = Managerial sophistication, F = Functional sophistication, T = Technological sophistication, II = Internal integration sophistication, EI = External integration sophistication. Number of factors restricted to 7 based on scree plot. Factor extraction method = Principal component analysis. Rotation method = Promax. Correlations among factors not accounted for in factor loadings (factor structure matrix). Shaded cells indicate factor loadings ≥ 0.40.
*Factor on which each item has the highest factor loading.

Table 5.14 shows that when forced to retain only 7 factors, some of the factors revealed from the earlier analysis were combined into a single factor. These included items related to management practices that were previously split into 2 factors but now combined (operational management practices and high-level executive management practices); IT adoption to support pharmacy and billing functions that was combined with adoption of basic infrastructural technologies; and items related to use of IT to support inpatient clinical documentation that were combined with technological adoption of electronic medical records and electronic medication administration records. On the other hand, the factor loading patterns of other factors were virtually unchanged, including the previously identified factors on IT adoption to support clinical workflows, information sharing within the hospital, information sharing outside the hospital, and the factor related to PACS and imaging items. One item, adoption of laboratory information system, failed to load substantially on any factor.

From these exploratory factor analysis results, the following decisions were made:

1. Items that failed to load substantially on any factor or performed poorly were dropped, including:
   - *Viewing the list of hospitalized patients* (F3)
   - *Outpatient medication dispensing* (F19)
   - *Inpatient medication dispensing* (F20)
   - *Patient billing* (F24)
   - *Laboratory information system* (T8; Factor 11)

Factor loadings of these items suggested that they were not associated with other items in a coherent manner. They also did not represent substantively important clinical functions or health IT but rather reflect mostly non-clinical operational functions. Retaining of these items might jeopardize the validity of further analyses.

2. Factors that only explained a small amount of the items' variance and did not appear to be substantively meaningful or very important to the purpose of this study were dropped, including:
   - PACS adoption, electronic image viewing, internal sharing of imaging information, and adoption of barcoding technologies (Factor 5)
   - IT adoption to support pharmacy and billing functions (Factor 8)
   - IT adoption to support other clinical functions and technologies (Factor 9)
   - The extent of facilitating high-level executive management practices related to organizational IT (Factor 10)

In Thai hospitals, PACS is not widely adopted except in large, mostly teaching hospitals. Including this factor (Factor 5) would not help explain much of the hospital IT adoption processes in Thailand. The fact that adoption of barcoding technologies (which are not heavily adopted in Thai hospitals) belonged to this factor also raises a concern on whether this factor simply refers to miscellaneous, less adopted technologies. Similarly, the aggregation of pharmacy functions such as inventory control, CDSS alerts together with billing and reimbursement items suggest that this factor may simply reflect another miscellaneous group of mostly non-clinical items. The reason that CDSS alerts belong to this factor might be because in many hospitals, the CDSS features are implemented to support the work processes of the pharmacy (e.g., with pharmacists as primary users of these features) rather than to support the clinical workflows of physicians (Factor 10). For Factor 9, even though this factor contains some clinically important items such as adoption of CPOE and electronic clinical documentation technologies, the hospital functions that are supported by these technologies have already been represented in other factors, and little additional amount of variance was explained by this factor. The fact that these items in Factor 9 did not belong together with those other factors suggests that these items may behave erratically, perhaps because of problematic interpretation of these items. Lastly, the three managerial items focusing on high-level executive IT management did not belong with another factor on IT management, indicating that the two managerial factors operate at different levels of IT adoption. Since Factor 10 explained little variance in the data, its items were unlikely to be very important to hospital IT adoption in this population. For these reasons, these factors were dropped.

3. Items that did not appear to be conceptually coherent with or relevant to other items in the same factor were also dropped, including:
   - *Medical images and results* (EI10) (inconsistent with other imaging items)
   - *Outpatient appointment scheduling* (F2)

While the extent of information sharing for medical images and results *outside the hospitals* belonged with the extent of external information sharing for other types of information, the extent of information sharing for this information type *within the hospitals* did not belong with the extent of internal information sharing for other information types. Instead, it formed a new factor together with other PACS and imaging-related items. This constrasting finding suggests that items related to PACS and imaging did not behave coherently. In order to make the constructs on internal and external information sharing conceptually similar, this item was therefore dropped. For the item *outpatient appointment scheduling*, it does not represent a clinically important function unlike other items in the same factor (e.g., order entry and results viewing). The fact that it loaded on another factor (Factor 8 which was dropped) almost equally well reinforces the argument that this item does not contribute much to the substantive meaning of Factor 1 to which it belonged. This item was thus removed from Factor 1.

4. Finally, an item that had a large overlap with another item in the same factor was dropped:
   - *Electronic medication administration records* (T6) (overlapped with *Documentation of medication administration to patients* (F17) and also failed to load substantially in PAF factor pattern matrix [results not shown])

While these two items refer to two different aspects of IT adoption (technological vs. functional), they are closely related conceptually, and since other items in the same factor focused on the functional aspect, the item on technological adoption of electronic medication administration records was therefore removed.

With these decisions, the following factors were retained and used in subsequent analyses:

**Factor 1** The extent of IT adoption to support clinical workflows of EHR systems not related to clinical notes, including order entry for medications, laboratory tests, and imaging as well as electronic results viewing for laboratory tests, both in outpatient and inpatient settings (F4-F7, F10-F13).

**Factor 2** The extent of information sharing with outside entities (EI1-EI9).

**Factor 3** The extent of information sharing within the hospital (II1-II9).

**Factor 4** The extent of facilitating operational management practices in IT implementation (C4-C11).

**Factor 5** The extent of IT adoption to support inpatient clinical documentation (clinical notes, discharge summaries, medication administration records, and nursing documentation) (F15-F18).

**Factor 6** The extent of adoption of basic infrastructural technologies (Internet, Web site, LAN, master patient index) (T1-T4).

These modified factor patterns appeared more conceptually interpretable and parsimonious than the original factor patterns discovered through exploratory factor analysis. While items related to adoption of basic infrastructural technologies were combined with another factor when restricting the number of factors retained to seven, these items still represent an important and distinct aspect of IT adoption uncaptured by other factors, namely the adoption of basic technologies that serve as the technological infrastructure of the hospital beneath other health IT. The decision therefore was made to include this factor as part of further analyses. Next, descriptive analysis is described.

## 5.4 Descriptive Analysis of Hospital IT Adoption in the Nationwide Study

Table 5.15 shows other descriptive statistics among the respondents. The majority of respondents were male (67%), received a bachelor's degree (60%), had non-degree training in IT (54%), graduated in a health science-related area (58%), but had no formal training in management (45%). Their average age was 39 years, and they had worked in IT-related capacities for an average of 8 years. Many of them had IT responsibilities (17% as an IT executive; 31% as an IT chief; and 20% as a non-executive IT staff member), were hospital executives (18%), or were users involved in IT projects (13%).

**Table 5.15** Descriptive statistics of respondents.

| Characteristic | No. of Responses* | Statistic† |
|---|---|---|
| Gender | 893 | |
| Female | 296 | 33.1% |
| Male | 597 | 66.9% |
| Age (years) | 889 | 39.2 ± 8.8 (22.0-79.0) |
| Educational level achieved | 902 | |
| Below bachelor's | 42 | 4.7% |
| Bachelor's (including M.D.)‡ | 543 | 60.2% |
| Master's degree or higher (including specialist physician) | 317 | 35.1% |
| IT training | 901 | |
| No formal training | 170 | 18.9% |
| Non-degree training | 491 | 54.5% |
| Received a degree | 240 | 26.6% |
| Health science training | 900 | |
| No formal training | 255 | 28.3% |
| Non-degree training | 126 | 14.0% |
| Received a degree | 519 | 57.7% |
| Management training | 899 | |
| No formal training | 401 | 44.6% |
| Non-degree training | 336 | 37.4% |
| Received a degree | 162 | 18.0% |
| Duration in IT-related job at any workplace (years) | 862 | 8.3 ± 5.9 (0.1-32.0) |
| Job role | 894 | |
| Director or senior executive | 157 | 17.6% |
| Hospital executive with direct IT oversight | 148 | 16.6% |
| IT manager/head of IT unit | 277 | 31.0% |
| Non-executive IT specialist | 181 | 20.2% |
| Hospital worker with past/present role in IT projects | 113 | 12.6% |
| Hospital worker without role in IT projects | 18 | 2.0% |

*Numbers may not sum up to all respondents because of missing data.
†Data are mean ± SD (range) or frequency in %.
‡In Thailand, an M.D. degree is a 6-year bachelor's degree because there are no pre-medical years.

The majority of responding hospitals were public (83%), non-teaching (79%) hospitals, and they had on average 368 total employees and 4 IT employees (see Table 5.16). Almost half did not provide either the amount of total budget or IT budget or both, but some of them provided the subjective estimate of the ratio between the two amounts. This suggests that respondents of many hospitals did not have access to this information, and its accuracy among those who provided was doubtful. Among those who provided the amounts, the ratio of IT budget to total budget was 2.7% on average, and more than half of the hospitals had an IT/total budget ratio from 1–4%. The hospitals had 126 PCs on average, though the range was very wide. Three quarters of the respondents thought their hospitals had high or very high overall IT utilization.

**Table 5.16** Descriptive statistics of responding hospitals.

| Characteristic | Number of Responses* | Statistic† |
|---|---|---|
| Public status | 908 | |
| Private | 158 | 17.4% |
| Public | 750 | 82.6% |
| Teaching status | 901 | |
| Non-teaching | 716 | 79.5% |
| Teaching | 185 | 20.5% |
| Total employees | 890 | 368.2 ± 573.5 (10-5269) |
| IT employees | 901 | 4.3 ± 5.3 (0-60) |
| Total budget (million baht) | 443 | 146.67 ± 313.60 (0.25-3,067) |
| IT budget (million baht) | 598 | 2.77 ± 8.79 (0-100) |
| Ratio of IT budget to total budget‡ | 416 | 2.7% ± 4.6% (0-43.3%) |
| < 1% | 135 | 32.5% |
| 1-4% | 218 | 52.4% |
| 5-8% | 40 | 9.6% |
| > 8% | 23 | 5.5% |
| Subjective estimate of IT budget to total budget ratio§ | 612 | |
| < 1% | 158 | 25.8% |
| 1-4% | 353 | 57.7% |
| 5-8% | 69 | 11.3% |
| > 8% | 32 | 5.2% |

**Table 5.16** Descriptive statistics of responding hospitals (continued).

| Characteristic | Number of Responses* | Statistic† |
|---|---|---|
| Extent of overall IT utilization | 905 | |
| Very low | 5 | 0.6% |
| Low | 35 | 3.9% |
| Moderate | 169 | 18.7% |
| High | 454 | 50.2% |
| Very high | 242 | 26.7% |
| Total PCs in use | 883 | 126.1 ± 218.6 (0-3,000) |

*Numbers may not sum up to all respondents because of missing data.
†Data are mean ± SD (range) or frequency in %. Percentages may not sum to 100% because of rounding.
‡Calculated only from respondents who provided both amounts
§Some respondents also provided budget amounts for calculation above.

Table 5.17 shows the average score of each identified aspect of adoption (based on exploratory factor analysis above) for all hospitals nationwide from a scale of one to five. Most of the nationwide scores were in the moderate-to-high range, except external information sharing that was relatively low. The regional scores for all aspects of IT adoption were highest in the north and northeast regions, with the south, east, and west regions among the lowest except for external information sharing where the east and central regions had the lowest scores. The differences between the highest and lowest regional scores were statisticaly significant in all aspects, but the significance varied across aspects for scores in the middle of the ranges.

**Table 5.17** Descriptive statistics for IT adoption factor scores nationwide and by geographic region.

| Region | IT Adoption Factor | | | | | |
|---|---|---|---|---|---|---|
| | Extent of Facilitating Operational Management Practices* | Extent of IT Support for Clinical Workflows* | Extent of IT Support for Inpatient Clinical Document-ation | Extent of Adoption of Basic Infrastructural Technologies* | Extent of Internal Information Sharing* | Extent of External Information Sharing* |
| **Nation-wide** | 3.57 ± 0.67 | 4.18 ± 1.05 | 3.04 ± 1.35 | 4.31 ± 0.71 | 3.81 ± 1.07 | 2.34 ± 1.25 |
| **Central** | $3.57^{a}$ ± 0.63 | $4.17^{a}$ ± 1.10 | $2.99^{ab}$ ± 1.36 | $4.28^{ab}$ ± 0.73 | $3.76^{ab}$ ± 1.09 | $2.26^{ab}$ ± 1.24 |
| **East** | $3.58^{ab}$ ± 0.65 | $4.09^{ab}$ ± 1.21 | $2.89^{ab}$ ± 1.32 | $4.25^{ac}$ ± 0.70 | $3.59^{a}$ ± 1.20 | $1.94^{a}$ ± 1.12 |
| **North** | $3.69^{a}$ ± 0.69 | $4.24^{a}$ ± 0.84 | $3.16^{a}$ ± 1.35 | $4.37^{bc}$ ± 0.69 | $3.97^{bc}$ ± 1.03 | $2.42^{bc}$ ± 1.28 |

**Table 5.17** Descriptive statistics for IT adoption factor scores nationwide and by geographic region (continued).

| Region | IT Adoption Factor | | | | | |
|---|---|---|---|---|---|---|
| | **Extent of Facilitating Operational Management Practices*** | **Extent of IT Support for Clinical Workflows*** | **Extent of IT Support for Inpatient Clinical Document-ation** | **Extent of Adoption of Basic Infrastructural Technologies*** | **Extent of Internal Information Sharing*** | **Extent of External Information Sharing*** |
| **North-east** | $3.61^{a} \pm 0.69$ | $4.31^{a} \pm 1.00$ | $3.21^{a} \pm 1.32$ | $4.42^{c} \pm 0.69$ | $3.96^{c} \pm 1.01$ | $2.55^{c} \pm 1.33$ |
| **South** | $3.40^{b} \pm 0.64$ | $3.93^{b} \pm 1.11$ | $2.82^{b} \pm 1.26$ | $4.20^{a} \pm 0.64$ | $3.65^{a} \pm 1.03$ | $2.29^{ab} \pm 1.13$ |
| **West** | $3.48^{ab} \pm 0.84$ | $4.20^{ab} \pm 1.04$ | $3.05^{ab} \pm 1.51$ | $4.17^{ab} \pm 0.82$ | $3.69^{abc} \pm 1.15$ | $2.28^{ac} \pm 1.19$ |

Data are mean ± SD. Each factor refers to the identified and retained factor discovered from the observed data through exploratory factor analysis (see text on subsection 5.3.2. for detailed operationalization). For each regional comparison within the same column, scores with different letters were significantly different ($p < 0.05$) while scores sharing the same letter were not distinguishable.
*Scores that were significantly different among geographic regions in one-way analysis of variance F-test ($p < 0.05$).

The distributions of scores for each aspect of IT adoption are depicted in the corresponding histograms in Figures 5.7–5.12.

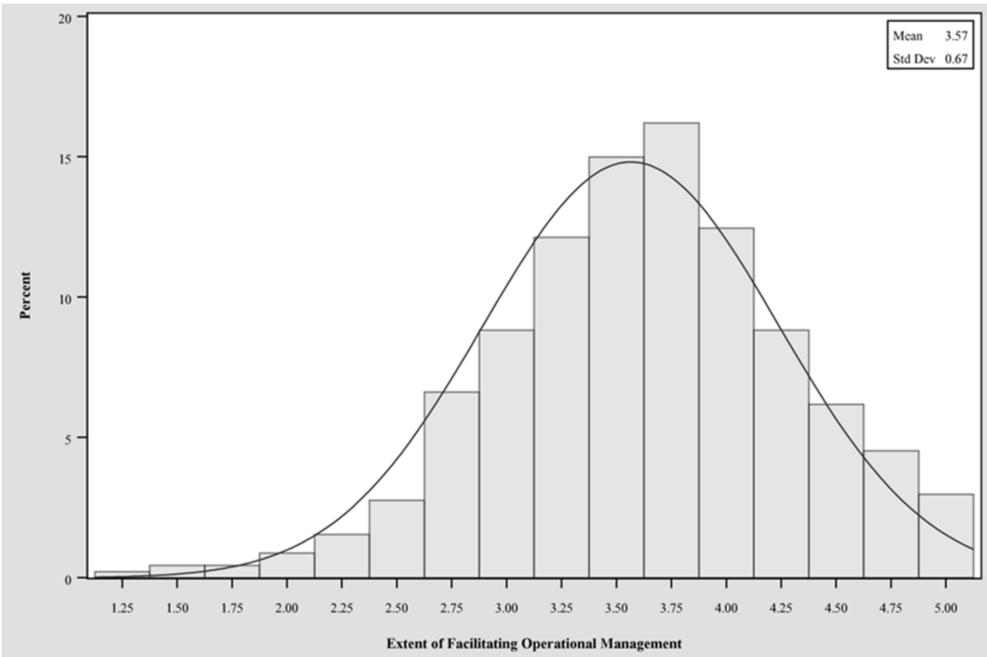



**Figure 5.7.** The histogram of scores for the extent of facilitating operational management practices. The curve shows the superimposed normal distribution with the same mean and variance.

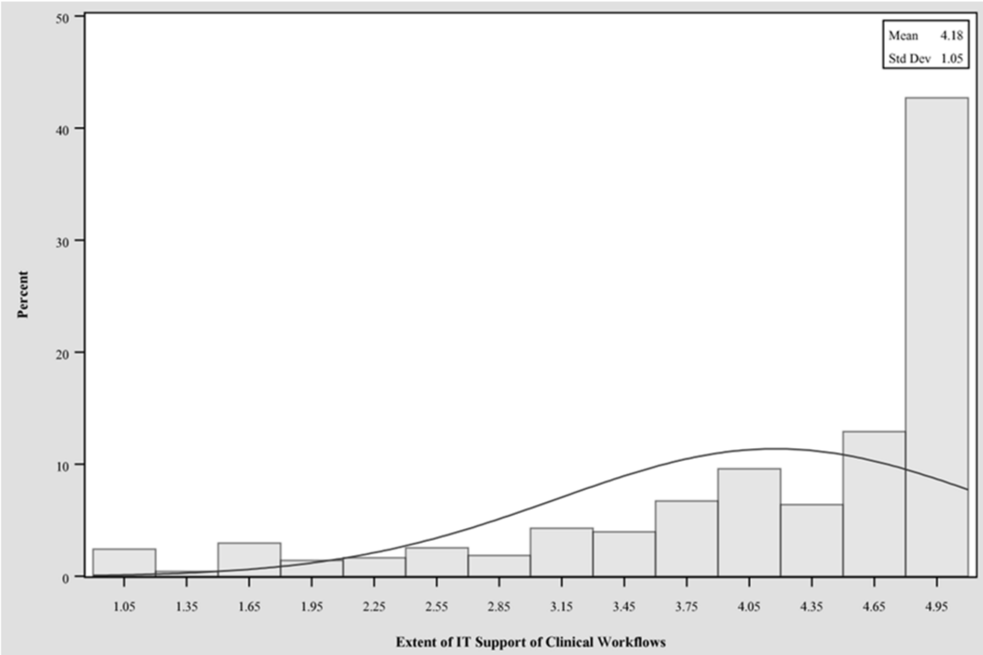



**Figure 5.8.** The histogram of scores for the extent of IT support for clinical workflows. The curve shows the superimposed normal distribution with the same mean and variance.

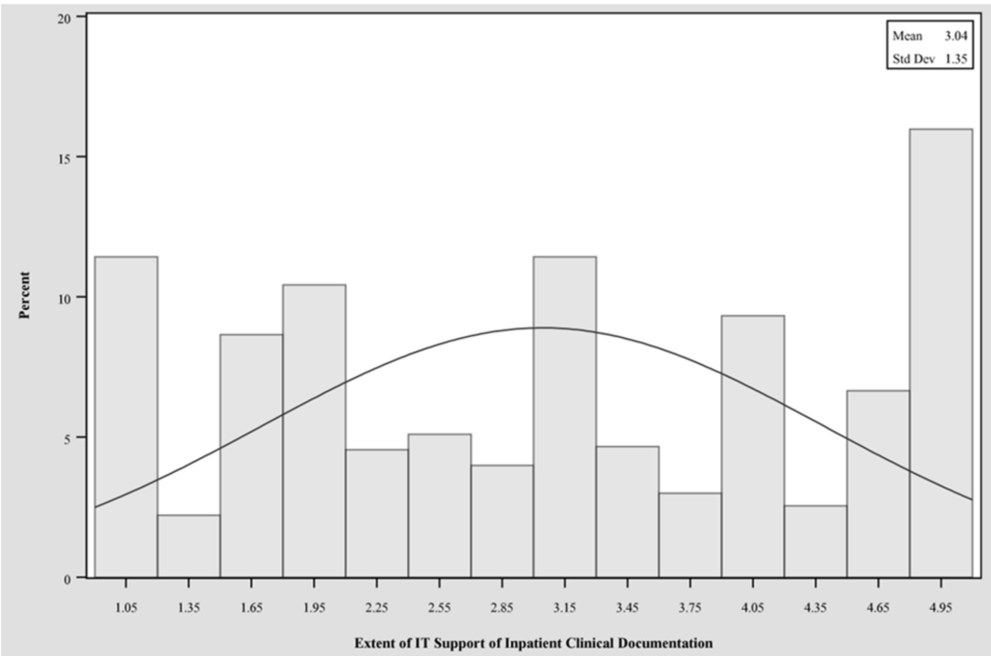



**Figure 5.9.** The histogram of scores for the extent of IT support for inpatient clinical documentation. The curve shows the superimposed normal distribution with the same mean and variance.

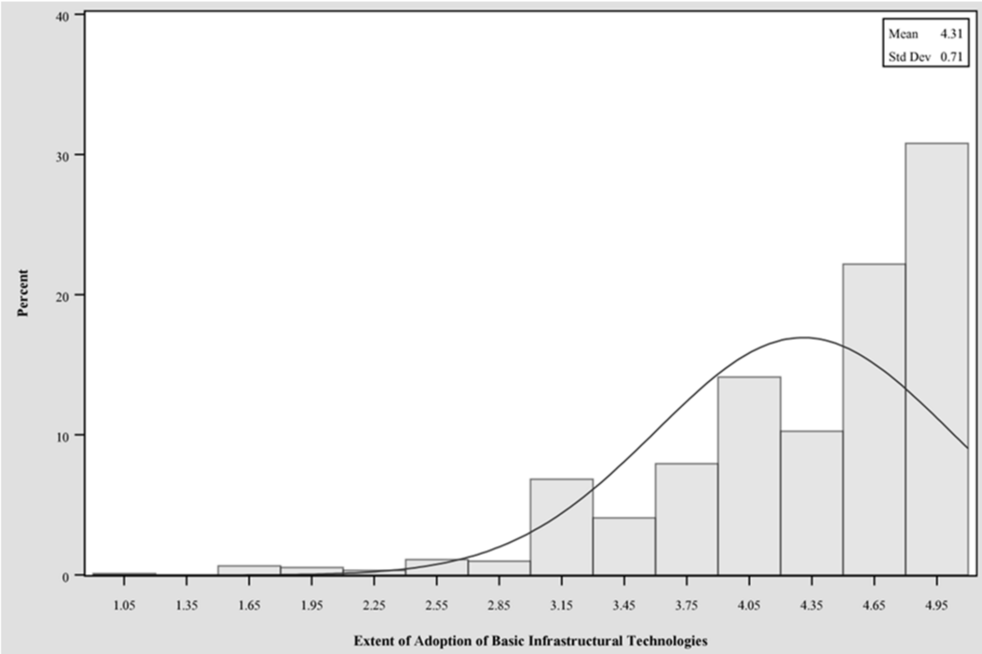



**Figure 5.10.** The histogram of scores for the extent of adoption of basic infrastructural technologies. The curve shows the superimposed normal distribution with the same mean and variance.

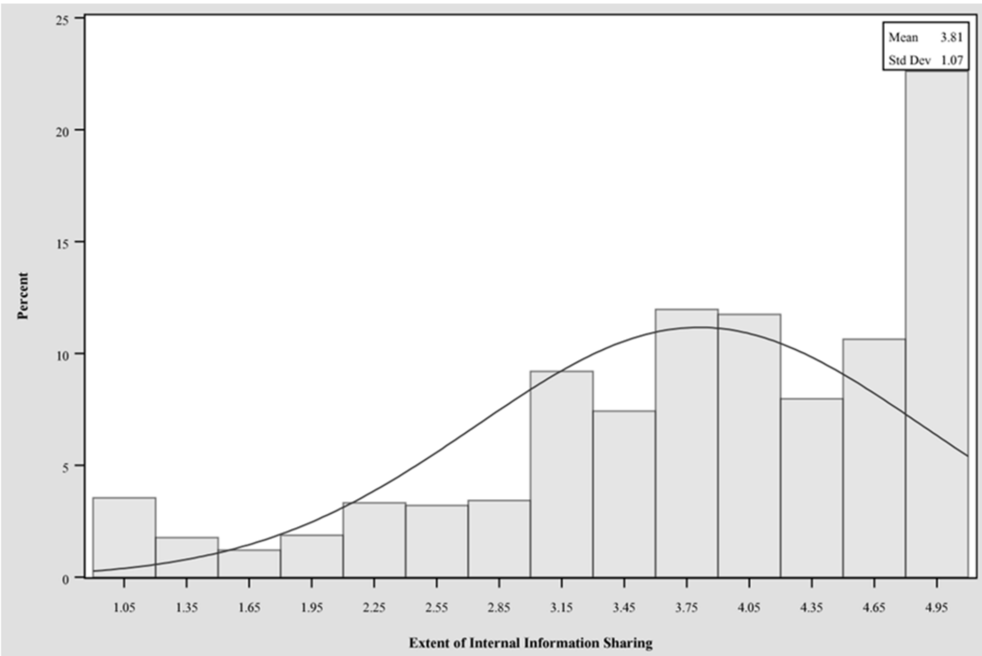



**Figure 5.11.** The histogram of scores for the extent of internal information sharing. The curve shows the superimposed normal distribution with the same mean and variance.

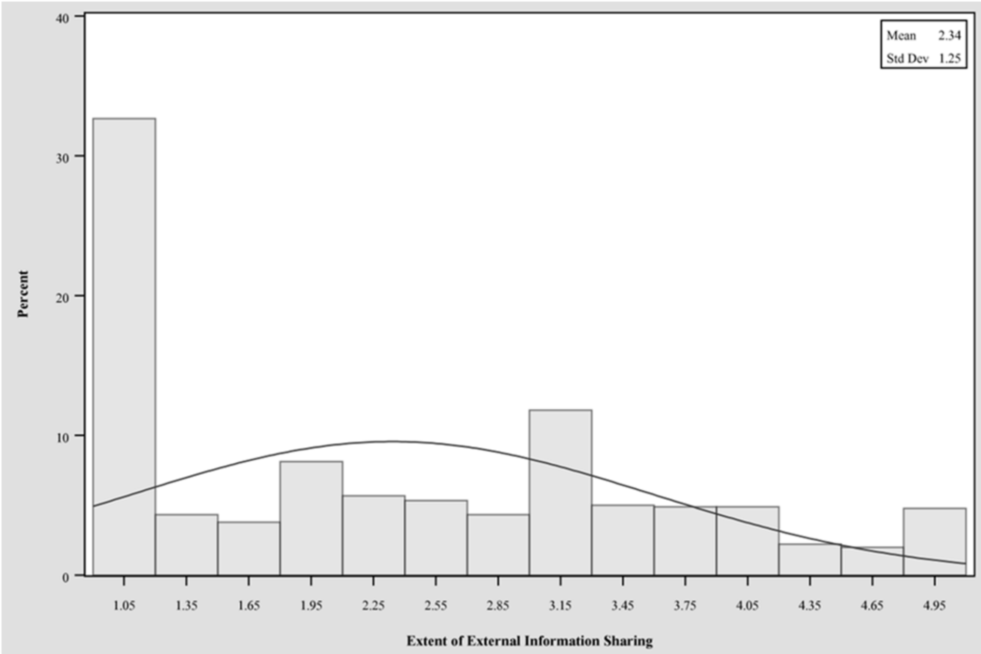



**Figure 5.12.** The histogram of scores for the extent of external information sharing. The curve shows the superimposed normal distribution with the same mean and variance.

It can be seen from the histograms that the scores for the extent of facilitating operational management practices were approximately normally distributed. The scores for the extent of IT support for clinical workflows, the extent of adoption of basic infrastructural technologies, and the extent of internal information sharing were skewed to the left. Unlike other dimensions, the scores for the extent of external information sharing were clearly skewed to the right, with about one-third of the hospitals having a score of 1.20 or below (Figure 5.12). The different patterns of distributions for internal and external information sharing (Figures 5.11 and 5.12) also reinforce the observations from the pilot study and exploratory factor analysis that these two aspects of IT adoption are likely distinct and separate.

The descriptive statistics of individual IT adoption items are presented in Appendix E. Most of the items had a score in the medium to high range, except external integration items where the items mostly had an average below 2.5 from a scale of one to five. Another noticable departure from other items was the very low scores for items related to PACS and electronic image viewing in every dimension. Adoption of barcoding technologies also had a low average score.

Findings from univariate analyses of scores for the six aspects of IT adoption based on hospital and respondent characteristics are shown in Table 5.18. In a univariate simple linear regression, hospital bed size had a significant positive association with the extent of facilitating operational management and the extent of infrastructural technologies adoption, but it was negatively associated with the extent of IT support for inpatient clinical documentation. Upon closer look, two hospitals with more than 1,500 beds were obvious outliers in these analyses (see Figure 5.13). When these two outliers were excluded, the significance patterns of the bivariate associations between scores of these aspects of IT adoption with bed size did not change.

**Table 5.18** Univariate analyses of scores for aspects of IT adoption and characteristics of hospitals and respondents.

| Character-istics | IT Adoption Factor | | | | | |
|---|---|---|---|---|---|---|
| | **Extent of Facilitating Operational Management Practices** | **Extent of IT Support for Clinical Workflows** | **Extent of IT Support for Inpatient Clinical Document-ation** | **Extent of Adoption of Basic Infra-structural Technologies** | **Extent of Internal Information Sharing** | **Extent of External Information Sharing** |
| Bed size | (0.00029)* | (-0.00026) | (-0.00064)** | (0.00035)** | (-0.00023) | (-0.00004) |
| Public status | | ** | *** | *** | *** | ** |
| Private | 3.58 ± 0.72 | 3.94 ± 1.26 | 2.68 ± 1.32 | 4.10 ± 0.83 | 3.29 ± 1.24 | 2.09 ± 1.16 |
| Public | 3.56 ± 0.66 | 4.23 ± 0.99 | 3.12 ± 1.34 | 4.35 ± 0.67 | 3.92 ± 1.00 | 2.39 ± 1.26 |
| Teaching status | * | | | *** | | ** |
| Non-teaching | 3.54 ± 0.69 | 4.16 ± 1.07 | 3.03 ± 1.37 | 4.26 ± 0.74 | 3.77 ± 1.11 | 2.27 ± 1.25 |
| Teaching | 3.67 ± 0.60 | 4.21 ± 0.97 | 3.07 ± 1.26 | 4.50 ± 0.52 | 3.92 ± 0.92 | 2.59 ± 1.23 |
| Age in years | (0.003) | (-0.005) | (-0.033)*** | (0.001) | (-0.010)* | (-0.012)* |
| Gender | | | *** | * | | * |
| Female | 3.54 ± 0.71 | 4.16 ± 1.10 | 2.82 ± 1.31 | 4.22 ± 0.78 | 3.76 ± 1.10 | 2.19 ± 1.22 |
| Male | 3.58 ± 0.66 | 4.19 ± 1.02 | 3.15 ± 1.35 | 4.35 ± 0.67 | 3.85 ± 1.05 | 2.40 ± 1.27 |

**Table 5.18** Univariate analyses of scores for aspects of IT adoption and characteristics of hospitals and respondents (continued).

| Character-istics | IT Adoption Factor | | | | | |
|---|---|---|---|---|---|---|
| | Extent of Facilitating Operational Management Practices | Extent of IT Support for Clinical Workflows | Extent of IT Support for Inpatient Clinical Document-ation | Extent of Adoption of Basic Infra-structural Technologies | Extent of Internal Information Sharing | Extent of External Information Sharing |
| IT experience of respondent in years | (0.021)*** | (0.021)*** | (-0.003) | (0.015)*** | (0.013)* | (0.011) |
| Education† | | | *** | | | |
| Below bachelor's | $3.65^{a} \pm 0.81$ | $4.13^{a} \pm 1.23$ | $3.82^{a} \pm 1.40$ | $4.24^{ab} \pm 0.68$ | $4.01^{ab} \pm 1.18$ | $2.38^{a} \pm 1.35$ |
| Bacheolor's | $3.56^{a} \pm 0.67$ | $4.21^{a} \pm 1.03$ | $3.17^{b} \pm 1.32$ | $4.27^{a} \pm 0.73$ | $3.86^{a} \pm 1.04$ | $2.38^{a} \pm 1.26$ |
| Master's or higher | $3.56^{a} \pm 0.66$ | $4.13^{a} \pm 1.06$ | $2.72^{c} \pm 1.31$ | $4.37^{b} \pm 0.67$ | $3.71^{b} \pm 1.09$ | $2.27^{a} \pm 1.22$ |
| IT Training† | *** | *** | *** | *** | *** | ** |
| No training | $3.28^{a} \pm 0.70$ | $3.85^{a} \pm 1.25$ | $2.41^{a} \pm 1.29$ | $4.06^{a} \pm 0.89$ | $3.47^{a} \pm 1.19$ | $2.07^{a} \pm 1.24$ |
| Non-degree | $3.62^{b} \pm 0.66$ | $4.19^{b} \pm 1.04$ | $3.00^{b} \pm 1.31$ | $4.36^{b} \pm 0.65$ | $3.85^{b} \pm 1.06$ | $2.34^{b} \pm 1.27$ |
| Degree | $3.67^{b} \pm 0.64$ | $4.38^{c} \pm 0.83$ | $3.59^{c} \pm 1.24$ | $4.37^{b} \pm 0.63$ | $3.98^{b} \pm 0.94$ | $2.51^{b} \pm 1.20$ |
| Health Training† | | | *** | | | |
| No training | $3.59^{a} \pm 0.70$ | $4.24^{a} \pm 0.98$ | $3.46^{a} \pm 1.30$ | $4.24^{a} \pm 0.73$ | $3.82^{a} \pm 1.05$ | $2.34^{a} \pm 1.25$ |
| Non-degree | $3.58^{a} \pm 0.62$ | $4.18^{a} \pm 1.03$ | $3.29^{a} \pm 1.29$ | $4.34^{a} \pm 0.67$ | $3.84^{a} \pm 1.03$ | $2.43^{a} \pm 1.27$ |
| Degree | $3.55^{a} \pm 0.67$ | $4.14^{a} \pm 1.09$ | $2.77^{b} \pm 1.31$ | $4.33^{a} \pm 0.70$ | $3.80^{a} \pm 1.09$ | $2.31^{a} \pm 1.25$ |
| Management Training† | ** | | | *** | | |
| No training | $3.48^{a} \pm 0.69$ | $4.14^{a} \pm 1.02$ | $2.97^{a} \pm 1.33$ | $4.21^{a} \pm 0.76$ | $3.80^{a} \pm 1.07$ | $2.25^{a} \pm 1.24$ |
| Non-degree | $3.66^{b} \pm 0.63$ | $4.18^{a} \pm 1.10$ | $3.12^{a} \pm 1.36$ | $4.41^{b} \pm 0.63$ | $3.83^{a} \pm 1.08$ | $2.46^{b} \pm 1.28$ |
| Degree | $3.59^{ab} \pm 0.66$ | $4.27^{a} \pm 0.99$ | $3.05^{a} \pm 1.32$ | $4.33^{ab} \pm 0.70$ | $3.81^{a} \pm 1.03$ | $2.31^{ab} \pm 1.18$ |

Data are mean ± SD or (linear regression coefficient).
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ for comparison within each cell.
†For comparisons based on education or training levels within the same cell, scores with different letters were significantly different ($p < 0.05$) while scores sharing the same letter were not distinguishable.

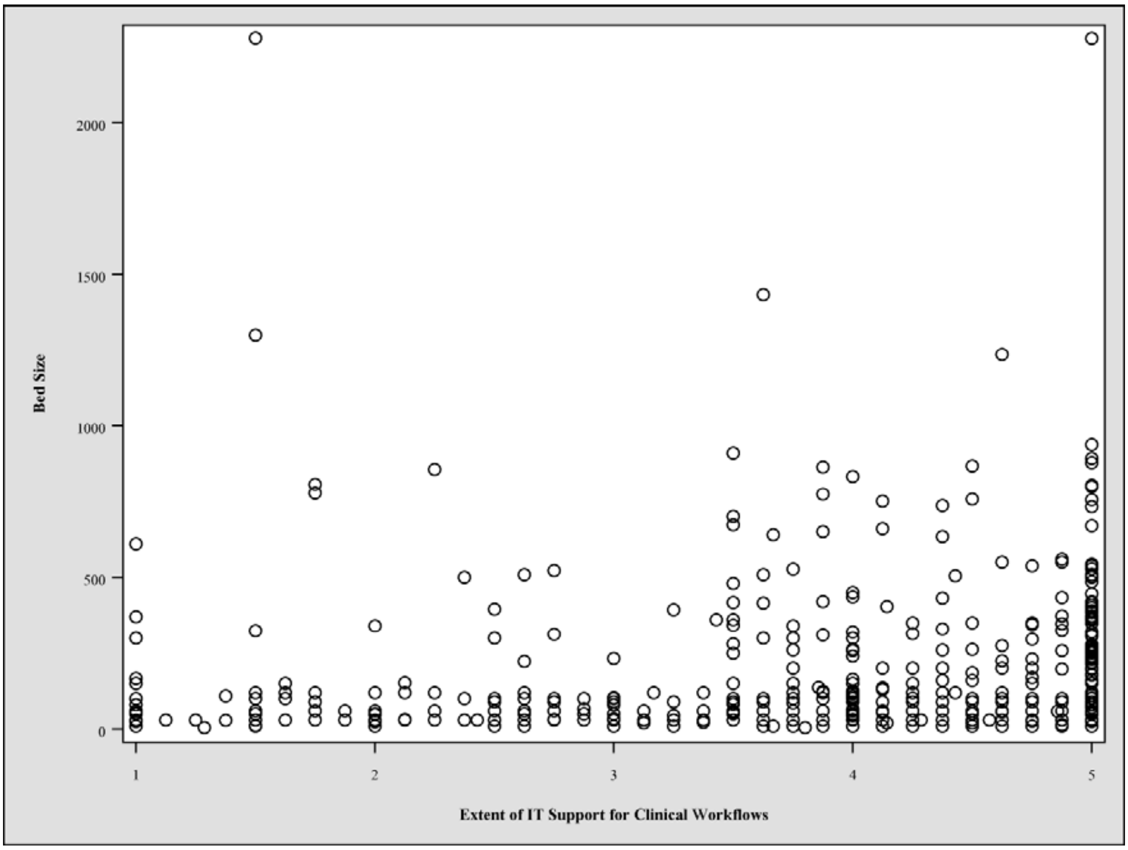



**Figure 5.13.** Scatterplot of scores for the extent of IT support for clinical workflows and hospital bed size, showing outliers.

Public hospitals tended to adopt IT to support their functions and share information within and outside the hospitals to a significantly greater degree than private hospitals, although the extent of facilitating operational management in the organization was not different. Teaching hospitals also had significantly higher scores than non-teaching hospitals, although the differences were significant only for the extent of facilitating operational management, the extent of infrastructural technologies adoption, and the extent of external information sharing. Age and gender of respondents were associated with some aspects of IT adoption but not others. This is likely due to confounding effects between respondent and hospital characteristics since public hospitals had significantly younger respondents (mean difference = 3.6 years; $t = 3.80$; $p = 0.002$) and tended to have male respondents, although the latter was not statistically significant ($RR_{male} = 1.12$; $\chi^2 = 3.26$; $p = 0.07$) (results not shown on the table). Respondents' IT experience was significantly associated with most of the dimensions of IT adoption except the extent of IT support for inpatient clinical documentation and the extent of external information sharing, but it was also associated with public status (mean difference = -2.5 years; $t = 3.83$; $p = 0.0002$) and bed size (Pearson $r = 0.18$; $p < 0.0001$). Also noteworthy were the significant positive relationships between bed size and respondent age (Pearson $r = 0.23$; $p < 0.0001$), teaching status and bed size (mean difference = 181.2 beds; $t = 7.44$; $p < 0.0001$), and teaching status and public status (all teaching hospitals were public), though bed size and public status were not significantly associated (mean difference = 9.0 beds; $t = 0.81$; $p = 0.42$). The patterns of significance held when the two outlying hospitals with more than 1,500 beds were excluded (results not shown).

The scores for most aspects of IT adoption were not significantly different across educational levels of respondents or levels of health science training, with the exception of the extent of inpatient clinical documentation, although lower educational levels in this case were associated with higher scores. This is likely due to confounding effects because higher educational levels were associated with larger bed sizes ($F = 16.66$; $p < 0.0001$). It is striking to note, however, that the levels of IT training were associated with highly significant differences in all dimensional scores. The associations between the levels of management training and IT adoption scores were mixed. These observed associations were not adjusted for other confounding effects. They merely provided preliminary information before path analysis was performed.

Table 5.19 shows the frequency distribution of the different products and vendors of the main hospital information system used in the responding hospitals, as reported by the respondents. The distribution is also depicted in Figure 5.14 to allow easy comparison with the distribution from an earlier national study in 2004 (reproduced in Figure 5.15).[200]

**Table 5.19** Frequency distribution of different health IT products used as the main hospital information system in the responding hospitals.

| Product/Vendor | Frequency (%) |
|---|---|
| HOSxP | 449 (50.17%) |
| Self-developed or outsourced | 142 (15.87%) |
| Hospital OS | 64 (7.15%) |
| SSB | 32 (3.58%) |
| Mit-Net | 22 (2.46%) |
| MRecord | 21 (2.35%) |
| H.I.M. Professional | 20 (2.23%) |
| MedTrak/TrakCare | 19 (2.12%) |
| HoMC | 18 (2.01%) |
| No hospital information system used | 14 (1.56%) |
| Thiades | 14 (1.56%) |
| HIMS | 11 (1.23%) |
| Abstract ePHIS | 10 (1.12%) |
| HI | 8 (0.89%) |
| InterMediSoft | 7 (0.78%) |
| Datasoft MIS | 6 (0.67%) |
| Medical 2020 | 6 (0.67%) |
| EZ-Hosp InfoSystem | 5 (0.56%) |
| PMK | 5 (0.56%) |
| BIT (Korea) | 3 (0.34%) |
| JHCIS | 2 (0.22%) |
| Benchmark | 1 (0.11%) |
| Doctor Com | 1 (0.11%) |
| EHOSP | 1 (0.11%) |
| EMR Soft | 1 (0.11%) |
| HIS | 1 (0.11%) |
| HIS 2000 | 1 (0.11%) |
| Kluay Nam Thai Health Software | 1 (0.11%) |
| Matrix Hos | 1 (0.11%) |
| Medico | 1 (0.11%) |
| Micron | 1 (0.11%) |

**Table 5.19** Frequency distribution of different health IT products used as the main hospital information system in the responding hospitals (continued).

| Product/Vendor | Frequency (%) |
|---|---|
| Microsoft Amalga | 1 (0.11%) |
| Naval Medical Department | 1 (0.11%) |
| Rajavithi Hospital | 1 (0.11%) |
| SINAP | 1 (0.11%) |
| Stat | 1 (0.11%) |
| Thai Traditional Medicine Specialized Software | 1 (0.11%) |
| ZoneHos | 1 (0.11%) |

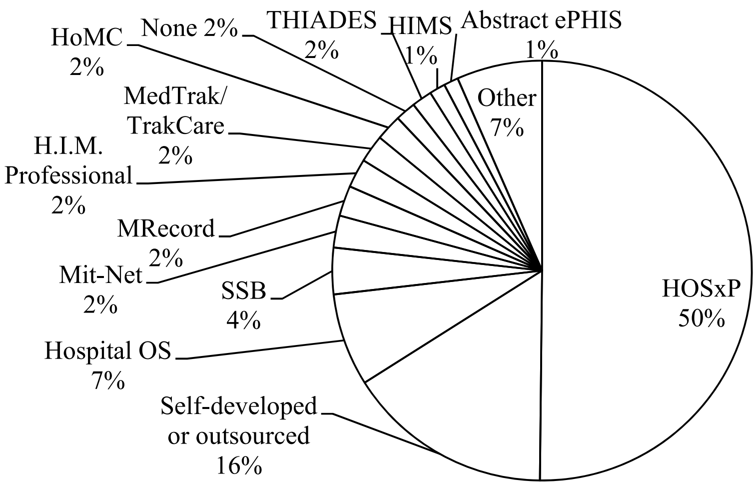



**Figure 5.14.** Distribution of hospital information system vendors/products in Thailand, 2011.

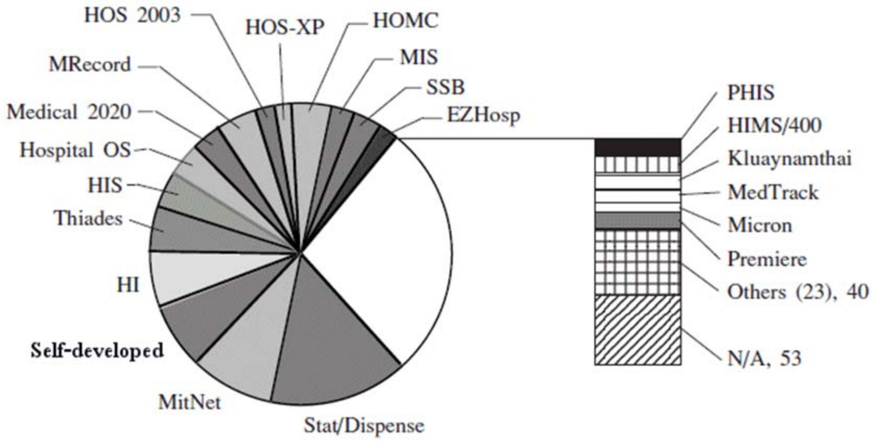



**Figure 5.15.** Distribution of hospital information system vendors/products in Thailand, 2004. Reprinted by permission, Pongpirul K, Sriratana S, Computerized information system in hospitals in Thailand: a national survey, Journal of Health Science, volume 14, number 5, September-October 2005. Copyright © 2005, Journal of Health Science.

From Figures 5.14 and 5.15 it is interesting to note how much market share HOSxP (Bangkok Medical Software Co., Ltd., Bangkok, Thailand) has received in the past six years. Only a very small fraction of the 446 hospitals in 2004 used HOSxP, presumably because it was in the early phase of development. In early 2011, 50% of the 891 hospitals that provided this information to the current study used this product. The market shares for the top four commercial products in 2004 (Stat/Dispense, 17%; Mit-Net, 9%; HI, 5%; and Thiades, 4%)[200] have shrunken greatly to 0.1%, 2.5%, 0.9%, and 1.6% in 2011, respectively. Another local vendor, Hospital OS (Open Source Technology Co., Ltd., Phuket, Thailand), has also gained market share, although at a much slower rate than HOSxP. The percentage of hospitals using self-developed solutions as the main hospital information system has risen from 8% in 2004 to 15.9% in 2011. The relatively low response rate in the 2004 study by Pongpirul[200] might have accounted for some of the differences, but it alone could not explain the large market share HOSxP now enjoyed.

To allow cross-study and cross-country comparisons, this study also used the functional sophistication responses that indicate complete or partial computerization of certain functions (a score over 1 on all relevant items) to estimate the proportion of hospitals with EHR and order entry adoption. The national and regional estimates are presented in Table 5.20. When using a basic definition of an EHR, with demographics, medication order entry, laboratory results viewing, and clinical notes, about 86.6%, 50.4% and 49.8% of responding hospitals nationwide were estimated to have adopted an EHR system in the outpatient, inpatient, and both settings, respectively. When a more comprehensive definition of an EHR was used, with at least a score of 4 on all the basic functions (with 5 being the highest level of IT-supported functions) and also on laboratory and imaging order entry, image viewing, drug allergy checking, and drug interaction checking, 10.6% of the hospitals nationwide had comprehensive EHR in outpatient, 5.7% in inpatient, and 5.3% in both settings. As for order entry features, more than 90% of Thai hospitals nationwide implemented complete or partial computerized order entry for medications, and about 80% implemented complete or partial order entry for medications, laboratory tests, and imaging. The EHR and order entry estimates varied somewhat geographically but none of the differences were statistically significant.

**Table 5.20** National and regional proportion estimates of EHR and order entry functions adoption in Thai hospitals.

| Estimate | Nationwide | Central | East | North | Northeast | South | West |
|---|---|---|---|---|---|---|---|
| Basic EHR, outpatient | 86.6% | 84.0% | 83.1% | 91.1% | 90.2% | 83.6% | 86.8% |
| Basic EHR, inpatient | 50.4% | 53.7% | 45.1% | 50.4% | 54.1% | 40.3% | 49.1% |
| Basic EHR, both settings | 49.8% | 52.3% | 43.7% | 50.4% | 53.7% | 40.3% | 49.1% |
| Comprehensive EHR, outpatient | 10.6% | 12.8% | 7.0% | 8.9% | 10.7% | 9.7% | 9.4% |
| Comprehensive EHR, inpatient | 5.7% | 6.4% | 5.6% | 5.7% | 6.1% | 3.7% | 5.7% |
| Comprehensive EHR, both settings | 5.3% | 6.0% | 4.2% | 4.9% | 5.7% | 3.7% | 5.7% |
| Order entry of medications, outpatient | 96.5% | 94.6% | 93.0% | 99.2% | 97.5% | 97.8% | 96.2% |
| Order entry of medications, inpatient | 91.4% | 90.3% | 84.5% | 94.3% | 94.2% | 89.2% | 92.5% |
| Order entry of medications, both settings | 90.2% | 89.3% | 84.5% | 93.5% | 93.0% | 86.6% | 90.6% |
| Order entry of all orders, outpatient | 88.6% | 88.9% | 84.5% | 91.1% | 90.6% | 85.8% | 84.9% |
| Order entry of all orders, inpatient | 81.7% | 85.3% | 76.1% | 77.0% | 84.7% | 76.3% | 81.1% |
| Order entry of all orders, both settings | 79.4% | 82.9% | 73.2% | 74.8% | 82.8% | 73.1% | 79.2% |

Responses with missing values on all relevant items were excluded. No regional variations at $p < 0.05$.
See Table 4.4 for a detailed comparison of estimate definitions.

## 5.5 Validity and Reliability of Survey Instrument

Since confirmatory factor analysis (subsection 5.3.1) indicated that the proposed conceptualization of IT adoption in Chapter 3 was not supported by the collected data, the important analysis which is reported in this section assesses the validity and reliability of the IT adoption "factors" discovered from the data through exploratory factor analysis (subsection 5.3.2). Considering first the criterion validity, specifically concurrent validity, relationships between the several criteria and the six IT adoption factor scores were evaluated. This section then reports the results on construct validity.

The criteria used to evaluate criterion validity of the IT adoption factors were the summary question asking about the hospitals' overall IT utilization in the view of the respondents, the number of PCs in use in the hospital, and the organizational factors that literature evidence suggests are likely to be associated with IT adoption. The relationships between the criteria and the IT adoption factor scores are displayed in Table 5.21.

Table 5.21 indicates that all of the IT adoption factors identified from the exploratory factor analysis, each reflecting a particular aspect of hospital IT adoption, were significantly and positively associated with the respondents' responses to the summary question on overall IT utilization. The mean factor scores also increased in a dose-response fashion when the respondents perceived that their hospitals utilized IT to a higher level. Using another criterion, the number of PCs in use, its associations with the IT adoption scores as measured by Pearson product-moment correlations were also significant with the exception of the extent of infrastructural technologies adoption and the extent of external information sharing, but all associations were significantly positive when Spearman's non-parametric rank correlations which are more robust to non-normality were used instead (results not shown). When the number of PCs in use per hospital bed was used as a criterion instead to adjust for the confounding between hospital size and the number of PCs, all IT adoption factor scores became significantly and positively associated with the number of PCs per hospital bed, regardless of whether Pearson or Spearman correlations were used. None of the patterns of associations changed and the magnitude of associations only changed slightly when two outliers with more than 1,500 beds were excluded (results not shown).

**Table 5.21** Relationships between the six IT adoption factor scores and the criterion variables.

| Criterion | IT Adoption Factor | | | | | |
|---|---|---|---|---|---|---|
| | **Extent of Facilitating Operational Management Practices** | **Extent of IT Support for Clinical Workflows** | **Extent of IT Support for Inpatient Clinical Document-ation** | **Extent of Adoption of Basic Infra-structural Technologies** | **Extent of Internal Information Sharing** | **Extent of External Information Sharing** |
| **Overall IT Utilization†** | *** | *** | *** | *** | *** | *** |
| Very low | $2.40^{a} \pm 0.86$ | $2.15^{a} \pm 1.60$ | $2.00^{abc} \pm 1.54$ | $3.20^{a} \pm 1.10$ | $2.29^{a} \pm 1.49$ | $2.11^{abcd} \pm 1.02$ |
| Low | $2.64^{a} \pm 0.76$ | $2.68^{a} \pm 1.35$ | $1.98^{a} \pm 1.16$ | $3.22^{a} \pm 1.09$ | $2.86^{a} \pm 1.38$ | $1.52^{a} \pm 0.92$ |
| Moderate | $3.24^{b} \pm 0.60$ | $3.67^{b} \pm 1.20$ | $2.60^{b} \pm 1.23$ | $4.06^{b} \pm 0.73$ | $3.35^{b} \pm 1.11$ | $2.11^{b} \pm 1.12$ |
| High | $3.56^{c} \pm 0.58$ | $4.27^{c} \pm 0.91$ | $3.04^{c} \pm 1.30$ | $4.35^{c} \pm 0.61$ | $3.85^{c} \pm 0.95$ | $2.36^{c} \pm 1.21$ |
| Very high | $3.97^{d} \pm 0.57$ | $4.61^{d} \pm 0.71$ | $3.53^{d} \pm 1.33$ | $4.58^{d} \pm 0.58$ | $4.24^{d} \pm 0.97$ | $2.57^{d} \pm 1.39$ |
| **No. of PCs** | (0.00044)*** [0.1435]*** | (0.00039)* [0.0839]* | (0.00017) [0.0207] | (0.00054)*** [0.1698]*** | (0.00035)* [0.0710]* | (0.00023) [0.0426] |
| **No. of PCs Per Bed** | (0.0229)* [0.0736]* | (0.0720)*** [0.1390]*** | (0.0928)*** [0.1251]*** | (0.0425)*** [0.1274]*** | (0.0786)*** [0.1492]*** | (0.0529)* [0.0862]* |

Data are mean ± SD or (linear regression coefficient) [Pearson product-moment correlation coefficient].
**p < 0.01, ***p < 0.001 for significance testing within each cell.
†For comparisons within the same cell, scores with different letters were significantly different (p < 0.05) while scores sharing the same letter were not distinguishable.

Associations between the IT adoption factor scores and other organizational characteristics that served as additional criteria were already presented in Table 5.18. Teaching status, respondents' IT experience, and levels of IT training of respondents were found to be significantly associated with some IT adoption factor scores. The significance patterns for bed size were mixed. Contrary to the literature, public hospitals in Thailand tended to have significantly higher scores in almost all IT adoption factors.

With respect to construct validity, Pearson product-moment correlations among the IT adoption factor scores were assessed. As evident in Table 5.22, all bivariate correlations were statistically significant at $p < 0.001$. The correlations among the levels of IT support for clinical workflows, IT support for inpatient clinical documentation, and internal information sharing were strong, which provide further support for these factors' validity since hospital IT used to support clinical workflows and documentation is expected to be well-integrated and generate health information that is shared internally within the realm of patient care.

Other correlations were weak-to-moderate in range. Particularly noteworthy is the extent of external information sharing, which had relatively weak associations with other dimensions. Also of particular interest to this study are the associations between the scores on the extent of facilitating operational management practices and other IT adoption factors that were mostly moderate in range, reinforcing this study's argument that theis managerial aspect often uncaptured in IT adoption studies is important to hospital IT adoption.

To assess the sensitivity of these findings to outliers and violations to distributional assumptions, outliers were also excluded and Pearson product-moment correlations reassessed. Spearman's rank correlation coefficients were also computed with and without outliers. None of the significance disappeared and no correlation coefficients changed substantially (results not shown).

**Table 5.22** Correlations among the IT adoption factor scores of hospitals nationwide.

| IT Adoption Factor | IT Adoption Factor | | | | | |
|---|---|---|---|---|---|---|
| | Extent of Facilitating Operational Management Practices | Extent of IT Support for Clinical Workflows | Extent of IT Support for Inpatient Clinical Document-ation | Extent of Adoption of Basic Infra-structural Technologies | Extent of Internal Information Sharing | Extent of External Information Sharing |
| **Extent of Facilitating Operational Management Practices** | 1 | | | | | |
| **Extent of IT Support for Clinical Workflows** | 0.3018*** | 1 | | | | |
| **Extent of IT Support for Inpatient Clinical Document-ation** | 0.2571*** | 0.4709*** | 1 | | | |
| **Extent of Adoption of Basic Infra-structural Technologies** | 0.3703*** | 0.3763*** | 0.2646*** | 1 | | |
| **Extent of Internal Information Sharing** | 0.3106*** | 0.5991*** | 0.5092*** | 0.4133*** | 1 | |
| **Extent of External Information Sharing** | 0.1731*** | 0.1881*** | 0.2697*** | 0.1853*** | 0.3037*** | 1 |

***$p < 0.001$.

As done in the pilot study, Cronbach's coefficient alpha was also evaluated to assess internal consistency reliability of each IT adoption factor's items. In addition, item-total correlations were also examined for each factor's items to check how they performed and identify any potential issues. Results are presented in Table 5.23. The

Cronbach's alpha for the extent of adoption of basic infrastructural technologies was the lowest, at 0.64, while other dimensions had a value of 0.86 or above. Most items had a strong (above 0.50) item-total correlation and the Cronbach's alpha did not increase substantially if they were removed, indicating that they belonged to the group of items in their dimensions. An exception was the item *Hospital Web site* (under the factor *Extent of adoption of basic infrastructural technologies*), which had a weak-to-moderate item-total correlation and the Cronbach's alpha if the item was removed increased. However, since in Thailand, having a hospital Web site is one of the indicators that help differentiate hospitals based on their IT capabilities, this item measures a important aspect of Thai hospitals' IT adoption and was retained for path analysis, which is presented next.

**Table 5.23** The item-total correlation and Cronbach's alpha if an item is removed for each item in the IT adoption factors in the nationwide study.

| Construct | Item-Total Correlation | Cronbach's Alpha If Item Removed |
|---|---|---|
| **Extent of Facilitating Operational Management Practices** (Cronbach's alpha = 0.8818) | | |
| 1. Our hospital communicates goals, plans and progress on IT works to stakeholders clearly. | 0.6252 | 0.8693 |
| 2. Those who will use the information systems are fully involved in hospital IT development. | 0.6587 | 0.8660 |
| 3. The team of users involved in our IT development comes from several disciplines. | 0.6364 | 0.8691 |
| 4. The majority of hospital employees are committed to achieving the envisioned organizational goals. | 0.5733 | 0.8743 |
| 5. In our hospital's IT development, the workflow changes are carefully considered. | 0.6762 | 0.8643 |
| 6. Our hospital provides training to those who will use the system adequately. | 0.6365 | 0.8683 |
| 7. Our hospital has a process in place to track work progress and manage IT works appropriately. | 0.7182 | 0.8603 |
| 8. Our hospital uses our past experience as lessons driving our current works. | 0.6673 | 0.8653 |
| **Extent of IT Support for Clinical Workflows** (Cronbach's alpha = 0.9334) | | |
| 1. Outpatient medication order entry | 0.6317 | 0.9340 |
| 2. Outpatient lab order entry | 0.8358 | 0.9205 |
| 3. Outpatient lab results viewing | 0.7754 | 0.9241 |
| 4. Outpatient imaging order entry | 0.7972 | 0.9223 |
| 5. Inpatient medication order entry | 0.7174 | 0.9283 |
| 6. Inpatient lab order entry | 0.8830 | 0.9157 |

**Table 5.23** The item-total correlation and Cronbach's alpha if an item is removed for each item in the IT adoption factors in the nationwide study (continued).

| Construct | Item-Total Correlation | Cronbach's Alpha If Item Removed |
|---|---|---|
| 7. Inpatient lab results viewing | 0.7856 | 0.9234 |
| 8. Inpatient imaging order entry | 0.7596 | 0.9268 |
| **Extent of IT Support for Inpatient Clinical Documentation** (Cronbach's alpha = 0.8632) | | |
| 1. Documentation of history, physical examination & progress note of inpatients | 0.7395 | 0.8139 |
| 2. Discharge summary documentation | 0.5690 | 0.8786 |
| 3. Documentation of medication administration to patients | 0.7368 | 0.8151 |
| 4. Nursing documentation | 0.8081 | 0.7838 |
| **Extent of Adoption of Basic Infrastructural Technologies** (Cronbach's alpha = 0.6374) | | |
| 1. Internet access | 0.4903 | 0.5413 |
| 2. Hospital Web site | 0.3373 | 0.7277 |
| 3. Local area network | 0.5752 | 0.5122 |
| 4. Master Patient Index | 0.4622 | 0.5408 |
| **Extent of Internal Information Sharing** (Cronbach's alpha = 0.9411) | | |
| 1. Patient's demographic information | 0.7670 | 0.9350 |
| 2. Outpatient's history and medical documentation | 0.7853 | 0.9336 |
| 3. Outpatient's diagnoses | 0.8452 | 0.9306 |
| 4. Outpatient's medication orders | 0.8277 | 0.9316 |
| 5. Inpatient's history and medical documentation | 0.7192 | 0.9379 |
| 6. Inpatient's diagnoses | 0.8369 | 0.9307 |
| 7. Inpatient's medication orders | 0.7993 | 0.9328 |
| 8. Surgical operations and procedures | 0.7223 | 0.9377 |
| 9. Laboratory results | 0.7010 | 0.9384 |
| **Extent of External Information Sharing** (Cronbach's alpha = 0.9731) | | |
| 1. Patient's demographic information | 0.8611 | 0.9707 |
| 2. Outpatient's history and medical documentation | 0.8734 | 0.9701 |
| 3. Outpatient's diagnoses | 0.9080 | 0.9686 |
| 4. Outpatient's medication orders | 0.9174 | 0.9682 |
| 5. Inpatient's history and medical documentation | 0.8742 | 0.9701 |
| 6. Inpatient's diagnoses | 0.9099 | 0.9686 |
| 7. Inpatient's medication orders | 0.9087 | 0.9686 |
| 8. Surgical operations and procedures | 0.8780 | 0.9699 |
| 9. Laboratory results | 0.8014 | 0.9731 |
| **Overall** Cronbach's alpha = 0.9455 | | |

Items were analyzed within each IT adoption factor.

## 5.6 Developing A New Theoretical Framework

This section reports on the path analysis results and the model respecification steps taken. Because the initial model as hypothesized in Chapter 3 did not reflect the underlying factor structure in the data as the confirmatory and exploratory factor analyses revealed, the model needed to undergo an initial respecification. Data quality issues were also another important reason for the initial respecification. Subsequent model respecification was then made, guided by model fit statistics, until the model fit was acceptable. The two outlying hospitals with more than 1,500 beds were excluded.

### 5.6.1 Model Testing and Respecifications

An initial respecification was necessary before further analysis because of issues encountered after the data collection period. First, hospital accreditation status was not readily available to this study, requiring this variable and the associated hypotheses to be dropped from the model. The distinction between information sharing within (internal integration) and outside (external integration) the hospitals was also clearly demonstrated in descriptive analyses during the pilot and nationwide studies. These two dimensions, while both assessing the extent of information sharing, measure two separate properties of the hospitals' information systems. They therefore should be separated into two constructs in the model as opposed to one combined integration construct.

As the findings from the pilot study and the descriptive analysis of the nationwide study showed, inaccurate and missing data on total and IT budgets of the hospitals were a great concern. The large numbers of missing responses for total and IT budgets suggested that many respondents did not have access to such information or were not confident enough to provide an estimate. Among those who provided an estimate of total and/or IT budgets in the pilot study, results showed that there were large variations of the estimates even within the same hospitals, indicating a very poor reliability for this variable. In terms of the data distribution, the skew index and kurtosis index for this variable were extremely high and well above the recommended cutoff values as cited in Chapter 4 (skew index = 7.3; kurtosis index = 69.2), suggesting severe non-normality. Because of these threats to validity and reliability of this measure together with the fact that no other reliable source of IT budget data was available, this variable had to be dropped from the model. Size of IT workforce was also dropped, because it was closely linked to IT budget in the initial model, its reliability was also called into question in the pilot study, and it was also highly non-normal (skew index = 4.1; kurtosis index = 26.1).

The six IT adoption factors discovered through exploratory factor analysis (subsection 5.3.2) were used instead of the original constructs. While scores in some factors did not have a normal distribution, their skew and kurtosis indices were well below the recommended threshold,[209] so no corrective action was done. Several relationships in the respecified model resembled the initial model in Chapter 3.

Figure 5.16 shows the respecified model before path analysis commenced.

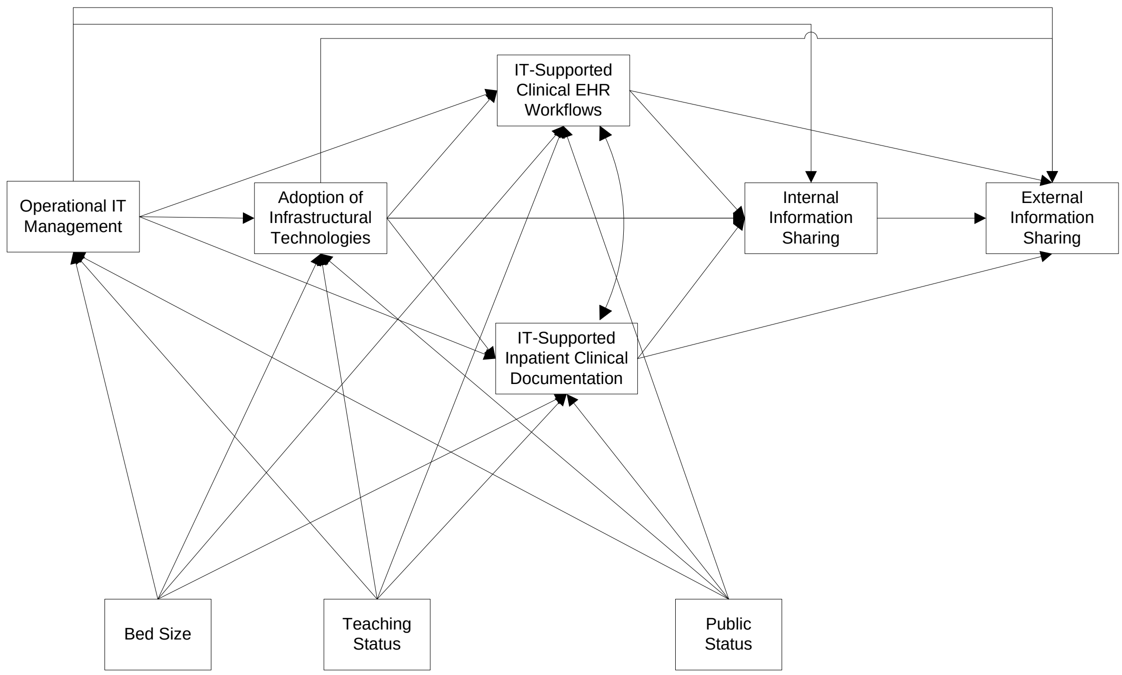



**Figure 5.16.** The initial respecified path model (Round 1).

The model in Figure 5.16 shows hypothesized interrelationships among the factors identified and retained from exploratory factor analysis. Like the original model in Chapter 3, it was hypothesized that bed size, teaching status, and public status have direct effects on how well the hospital managed their IT implementation (the extent of facilitating *operational IT management)*, which in turn has a direct effect on the extent of infrastructural technologies (networking, Web site, master patient index) adopted. The three hospital characteristics were hypothesized to have direct effects on the extent of *adoption of infrastructural technologies* as well. The levels of important *clinical EHR workflows* (order entry and results viewing) and *inpatient clinical documentation* that are supported by IT are believed to be influenced by hospital characteristics, the extent of facilitating operational IT management practices, and the extent of infrastructural technologies adoption. The levels of clinical EHR workflows and inpatient clinical documentation supported by IT are also hypothesized as correlated given their conceptual overlap and the observed strong bivariate correlation reported in the previous section. The levels of information sharing within and outside the hospital were hypothesized as depending upon the extent of facilitating operational management, how much infrastructural technologies are adopted, and how much of clinical EHR workflows and inpatient clinical notes are supported by IT. Finally, the information sharing outside the hospital was hypothesized to be associated with the extent of within-hospital information sharing as well.

This led to a revised set of hypotheses as follows.

## Revised Hypotheses

**Hypothesis R1:** There is a significant positive direct effect of hospital size on the extent of facilitating operational IT management.

**Hypothesis R2:** There is a significant positive direct effect of teaching status on the extent of facilitating operational IT management.

**Hypothesis R3:** There is a significant negative direct effect of public status on the extent of facilitating operational IT management.

**Hypothesis R4:** There is a significant positive direct effect of hospital size on the extent of adoption of infrastructural technologies.

**Hypothesis R5:** There is a significant positive direct effect of teaching status on the extent of adoption of infrastructural technologies.

**Hypothesis R6:** There is a significant negative direct effect of public status on the extent of adoption of infrastructural technologies.

**Hypothesis R7:** There is a significant positive direct effect of hospital size on the extent of clinical EHR workflows that are supported by IT.

**Hypothesis R8:** There is a significant positive direct effect of teaching status on the extent of clinical EHR workflows that are supported by IT.

**Hypothesis R9:** There is a significant negative direct effect of public status on the extent of clinical EHR workflows that are supported by IT.

**Hypothesis R10:** There is a significant positive direct effect of hospital size on the extent of inpatient clinical documentation that is supported by IT.

**Hypothesis R11:** There is a significant positive direct effect of teaching status on the extent of inpatient clinical documentation that is supported by IT.

**Hypothesis R12:** There is a significant negative direct effect of public status on the extent of inpatient clinical documentation that is supported by IT.

**Hypothesis R13:** There is a significant positive direct effect of the extent of facilitating operational IT management on the extent of adoption of infrastructural technologies.

**Hypothesis R14:** There is a significant positive direct effect of the extent of facilitating operational IT management on the extent of clinical EHR workflows that are supported by IT.

**Hypothesis R15:** There is a significant positive direct effect of the extent of operational IT management on the extent of inpatient clinical documentation that is supported by IT.

**Hypothesis R16:** There is a significant positive direct effect of the extent of adoption of infrastructural technologies on the extent of clinical EHR workflows that are supported by IT.

**Hypothesis R17:** There is a significant positive direct effect of the extent of adoption of infrastructural technologies on the extent of inpatient clinical documentation that is supported by IT.

**Hypothesis R18:** There is a significant positive direct effect of the extent of facilitating operational IT management on the extent of internal information sharing.

**Hypothesis R19:** There is a significant positive direct effect of the extent of adoption of infrastructural technologies on the extent of internal information sharing.

**Hypothesis R20:** There is a significant positive direct effect of the extent of clinical EHR workflows that are supported by IT on the extent of internal information sharing.

**Hypothesis R21:** There is a significant positive direct effect of the extent of inpatient clinical documentation that is supported by IT on the extent of internal information sharing.

**Hypothesis R22:** There is a significant positive direct effect of the extent of facilitating operational IT management on the extent of external information sharing.

**Hypothesis R23:** There is a significant positive direct effect of the extent of adoption of infrastructural technologies on the extent of external information sharing.

**Hypothesis R24:** There is a significant positive direct effect of the extent of clinical EHR workflows that are supported by IT on the extent of external information sharing.

**Hypothesis R25:** There is a significant positive direct effect of the extent of inpatient clinical documentation that is supported by IT on the extent of external information sharing.

**Hypothesis R26:** There is a significant positive direct effect of the extent of internal information sharing on the extent of external information sharing.

The model fit statistics of the path model in Figure 5.16 are reported in Table 5.24. The likelihood ratio chi-square test (the exact-fit hypothesis) was rejected ($\chi^2_M$ = 33.9; $p < 0.0001$), indicating that the estimated model differed from the population covariances beyond chance. Approximate fit statistics such as RMSEA and TLI also did not perform very well. The RMSEA and its close-fit hypothesis p-value were in a borderline range. Inspection of the standardized residuals (results not shown) indicated a large discrepancy between the model and the data on public status and internal information sharing. The five largest modification indices, which estimate the reduction in the model fit chi-square statistic if a specific new path was added to the model, along with their expected parameter changes are presented in Table 5.25.

**Table 5.24** Values of fit statistics for path analysis of the model in Figure 5.16.

| Index | Value of Fit Statistics for the Corresponding Estimated Model |
|---|---|
| $\chi^2_M$ | 33.911 |
| $df_M$ | 6 |
| Chi-square p-value | < 0.0001 |
| RMSEA (90% CI) | 0.072 (0.050–0.096) |
| Close-fit hypothesis p-value | 0.053 |
| CFI | 0.978 |
| TLI | 0.879 |
| SRMR | 0.022 |

CFI - comparative fit index, CI - confidence interval, RMSEA - root mean square error of approximation, SRMR - standardized root mean square residual, TLI - Tucker-Lewis index.

**Table 5.25** Top five largest modification indices for the estimated model in Figure 5.16.

| Relationship | Modification Index | Expected Parameter Change |
|---|---|---|
| Public → Internal information sharing | 26.947 | 0.368 |
| Public ↔ Internal information sharing | 25.880 | 0.050 |
| Internal information sharing ↔ Adoption of infrastructural technologies | 13.356 | -0.298 |
| Internal information sharing → Adoption of infrastructural technologies | 13.355 | -0.478 |
| Internal information sharing → Clinical EHR workflows | 9.799 | -1.228 |

The largest modification index from Table 5.25, the direct effect of public status on the extent of internal information sharing, suggests that the model fit chi-square statistic would drop 26.95 points if the effect was added to the model. Its expected parameter change also indicates a considerable increase from zero in the parameter estimate (the path coefficient). While supporting evidence for the association between public status and the extent of information sharing within the organization is lacking, the effect could theoretically be explained. Considering Thailand's context, public hospitals have adopted information systems at a fast pace in the past few years. Many of them implemented the hospital information system for the first time, making it relatively easy to implement an integrated solution when compared to private hospitals, many presumably having legacy systems that made it difficult to achieve a high degree of integration. Another plausible explanation is the organizational cultures that are somewhat different between public and private hospitals. For instance, private hospitals may be more reluctant to make their patients' information easily exchanged even within their own hospitals because their target consumers are generally of higher socio-economic status and thus tend to have increased privacy concerns than those of public hospitals. Other suggested paths had considerably lower modification indices. For these reasons, the decision was made to respecify the model by adding the direct effect of public status on the extent of internal information sharing. The respecified model, as depicted in Figure 5.17, was then estimated and reevaluated.

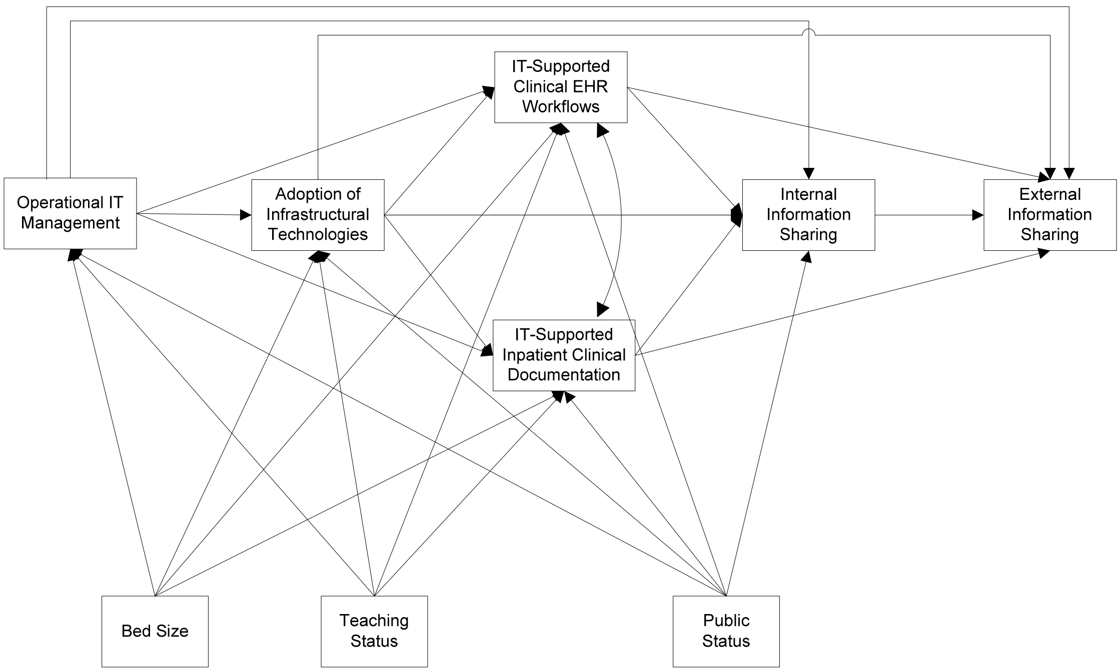



**Figure 5.17.** The respecified path model (Round 2). The direct path from public status to the extent of internal information sharing was added.

Table 5.26 reports the values of model fit statistics based on the respecified model in Figure 5.17. The likelihood ratio chi-square p-value was considerably above the significance level of 0.05 ($\chi^2_M$ = 6.5; p = 0.26), and all approximate fit indices appeared satisfactory, indicating a good fit. Modification indices and standardized residuals suggested that additional improvements in the chi-square statistic could be made if the path from teaching status to the extent of external information sharing was freed (results not shown). However, this was not done because the respecifications that had been done already took some advantage of chance by fitting the model against the same data.

Further capitalization on chance could lead to overfitting of the model that makes it less generalizable. The decision therefore was to retain this model (Figure 5.17). Its path coefficients, significance pattern, and $R^2$ are evaluated next (see Table 5.27).

**Table 5.26** Values of fit statistics for path analysis of the model in Figure 5.17.

| Index | Value of Fit Statistics for the Corresponding Estimated Model |
|---|---|
| $\chi^2_M$ | 6.523 |
| $df_M$ | 5 |
| Chi-square p-value | 0.2586 |
| RMSEA (90% CI) | 0.018 (0.000–0.053) |
| Close-fit hypothesis p-value | 0.932 |
| CFI | 0.999 |
| TLI | 0.992 |
| SRMR | 0.011 |

CFI - comparative fit index, CI - confidence interval, RMSEA - root mean square error of approximation, SRMR - standardized root mean square residual, TLI - Tucker-Lewis index.

**Table 5.27** Results of path analysis for the estimated model in Figure 5.17.

| Relationship | Parameter Estimate | P-value | Standardized Estimate |
|---|---|---|---|
| **Direct Effects** | | | |
| Bed size → Operational IT management | $0.280\times10^{-3}$ | 0.049 | 0.072 |
| Public status → Operational IT management | -0.045 | 0.464 | -0.025 |
| Teaching status → Operational IT management | 0.088 | 0.159 | 0.053 |
| Operational IT management → Adoption of infrastructural technologies | 0.381 | < 0.001*** | 0.362 |
| Bed size → Adoption of infrastructural technologies | $0.459\times10^{-3}$ | 0.001** | 0.112 |
| Public status → Adoption of infrastructural technologies | 0.259 | < 0.001*** | 0.139 |
| Teaching status → Adoption of infrastructural technologies | 0.058 | 0.334 | 0.033 |
| Adoption of infrastructural technologies → Clinical EHR workflows supported by IT | 0.449 | < 0.001*** | 0.303 |
| Operational IT management → Clinical EHR workflows supported by IT | 0.312 | < 0.001*** | 0.200 |
| Bed size → Clinical EHR workflows supported by IT | $-0.464\times10^{-3}$ | 0.023* | -0.076 |
| Public status → Clinical EHR workflows supported by IT | 0.185 | 0.034 | 0.067 |
| Teaching status → Clinical EHR workflows supported by IT | -0.069 | 0.438 | -0.027 |
| Adoption of infrastructural technologies → Inpatient clinical documentation supported by IT | 0.385 | < 0.001*** | 0.202 |
| Operational IT management → Inpatient clinical documentation supported by IT | 0.382 | < 0.001*** | 0.190 |
| Bed size → Inpatient clinical documentation supported by IT | $-1.133\times10^{-3}$ | < 0.001*** | -0.146 |
| Public status → Inpatient clinical documentation supported by IT | 0.327 | 0.005** | 0.092 |
| Teaching status → Inpatient clinical documentation supported by IT | 0.021 | 0.862 | 0.006 |

**Table 5.27** Results of path analysis for the estimated model in Figure 5.17 (continued).

| Relationship | Parameter Estimate | P-value | Standardized Estimate |
|---|---|---|---|
| Operational IT management → Internal information sharing | 0.119 | 0.006** | 0.075 |
| Adoption of infrastructural technologies → Internal information sharing | 0.232 | < 0.001*** | 0.154 |
| Clinical EHR workflows supported by IT → Internal information sharing | 0.389 | < 0.001*** | 0.383 |
| Inpatient clinical documentation supported by IT → Internal information sharing | 0.199 | < 0.001*** | 0.251 |
| Public status → Internal information sharing | 0.368 | < 0.001*** | 0.131 |
| Internal information sharing → External information sharing | 0.245 | < 0.001*** | 0.209 |
| Operational IT management → External information sharing | 0.117 | 0.072 | 0.063 |
| Adoption of infrastructural technologies → External information sharing | 0.091 | 0.158 | 0.051 |
| Clinical EHR workflows supported by IT → External information sharing | -0.064 | 0.195 | -0.053 |
| Inpatient clinical documentation supported by IT → External information sharing | 0.147 | < 0.001*** | 0.158 |
| **Non-Directional Associations** | | | |
| Clinical EHR workflows supported by IT ↔ Inpatient clinical documentation supported by IT | 0.459 | < 0.001*** | 0.385 |
| **Disturbance Variances** | | | |
| Operational IT management | 0.446 | < 0.001*** | 0.989 |
| Adoption of infrastructural technologies | 0.411 | < 0.001*** | 0.824 |
| Clinical EHR workflows supported by IT | 0.901 | < 0.001*** | 0.819 |
| Inpatient clinical documentation supported by IT | 1.579 | < 0.001*** | 0.873 |
| Internal information sharing | 0.605 | < 0.001*** | 0.531 |
| External information sharing | 1.385 | < 0.001*** | 0.885 |
| $\mathbf{R^2_{smc}}$ | | | |
| Operational IT management | 0.011 | 0.108 | |
| Adoption of infrastructural technologies | 0.176 | < 0.001*** | |
| Clinical EHR workflows supported by IT | 0.181 | < 0.001*** | |
| Inpatient clinical documentation supported by IT | 0.127 | < 0.001*** | |
| Internal information sharing | 0.469 | < 0.001*** | |
| External information sharing | 0.115 | < 0.001*** | |

*p < 0.025, **p < 0.01, ***p < 0.001. All p-values reported were two-tailed p-values from analysis output, but significance testing for path coefficients as indicated by the asterisks (*) was one-tailed.

Table 5.27 shows that, consistent with the hypotheses, how well the organizations manage IT (the extent of facilitating operational IT management) had significant positive associations with the extent of adoption of infrastructural technologies (networking, Web site, master patient index), the extent of IT support on clinical EHR workflows (order entry and results viewing), and the extent of IT support on inpatient clinical documentation. The extent of adoption of infrastructural technologies was also associated with the levels of IT support on clinical EHR workflows and inpatient clinical documentation. These four constructs in turn had significant positive effects on the extent of internal information sharing. However, only the levels of IT support for inpatient clinical documentation and internal information sharing had significant positive associations with the extent of external information sharing outside the hospitals.

None of the hospital characteristics had a significant association with the extent of facilitating operational IT management in a one-tailed test. Larger and public hospitals were significantly associated with higher levels of infrastructural technologies adoption, but teaching hospitals were not. Bed size was *negatively* associated with the levels of IT support for clinical EHR workflows and inpatient clinical documentation. Public status had a significant association with only the level of IT support for inpatient clinical documentation but not clinical EHR workflows. Teaching status was not associated with either. As the largest modification index in the first round of model testing suggested, which led to an addition of the effect of public status on the extent of internal information sharing, this effect was significant in the positive direction. The hypothesized non-directional association between the levels of IT support for clinical EHR workflows and inpatient clinical documentation was also statistically significant and positive.

The $R^2$ values suggested a considerably high proportion of variance for the extent of internal information sharing explained by variables in the model. The proportions of variance explained for other constructs were relatively small but significant, except that of the extent of facilitating operational IT management which was negligible and non-significant.

The comparison of standardized path coefficients can help us assess the relative importance of the explanatory variables of each endogenous variable. Considering first the predictors of the extent of adoption of infrastructural technologies, the positive effect of the extent of facilitating operational IT management was considerably higher than the effects of bed size (per bed) and public status (as indicated by the absolute value of its standardized path coefficient). The levels of IT-supported clinical EHR workflows and inpatient clinical documentation had as its strongest predictor the extent of adoption of infrastructural technologies, followed by the positive effect of facilitating operational IT management and the very small negative effect of bed size. The effects on the extent of internal information sharing were strongest for the extent of IT-supported clinical EHR workflows, followed by the extent of IT-supported inpatient clinical documentation, the extent of adoption of infrastructural technologies, public status, and the extent of facilitating operational IT management, respectively. The extent of internal information sharing, in turn, had a stronger effect on the extent of external information sharing than the extent of IT-supported inpatient clinical documentation.

Figure 5.18 shows the final model with the estimated unstandardized path coefficients reported. It shows that in this population, none of the hospital characteristics had a significant effect on how well the organizations manage their IT environment. Bed size had a positive association with the extent of infrastructural technologies adoption but a negative association on the levels of IT-supported clinical EHR workflows and inpatient clinical documentation, while public status appeared to be positively associated with the levels of technology adoption, IT-support inpatient clinical documentation, and information sharing within the hospitals. The levels of facilitating operational IT management and infrastructural technologies adoption appeared to be significant predictors of other downstream constructs from the levels of clinical functions supported by IT and the extent of internal information sharing, but not the extent of external information sharing. This outside-hospital information sharing was influenced only by the extent of inpatient clinical documentation that is supported by IT and the level of information sharing that already exists in the hospital.

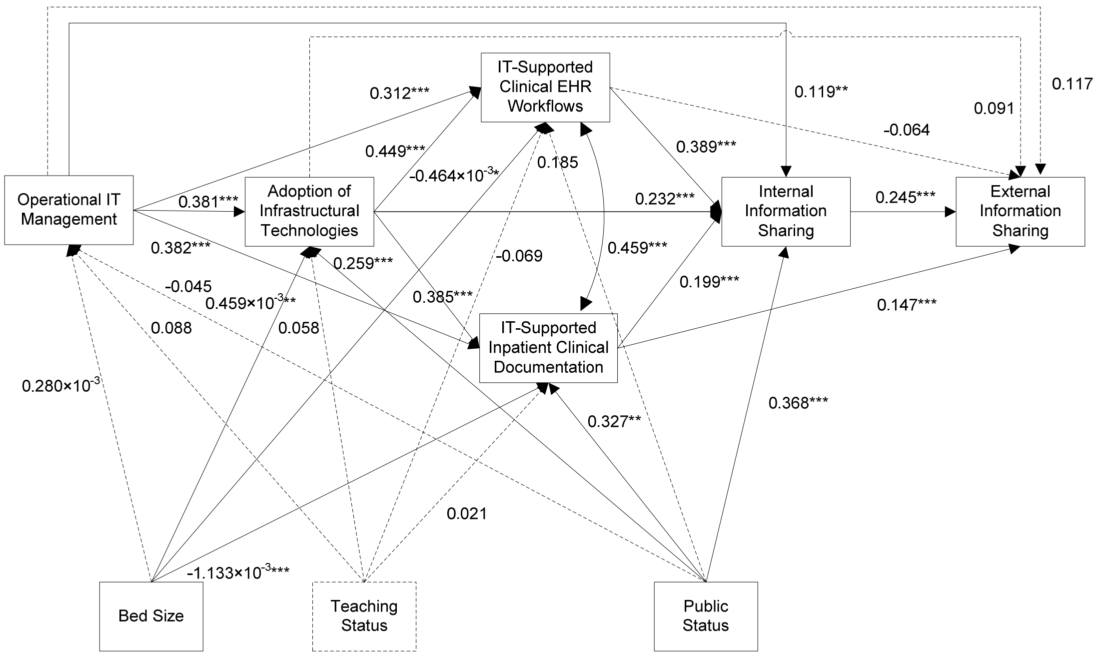



**Figure 5.18.** Final IT adoption model and unstandardized parameter estimates without measurement errors. Dashed lines indicate non-significant effects based on a one-tailed test. The rectangle with dashed borders indicates a variable without any significant hypothesized effects on other variables. *p < 0.025, **p < 0.01, ***p < 0.001.

Table 5.28 reveals the effect decomposition of the variables in the model in Figure 5.17. For each pair of independent and dependent variables of interest, total indirect effects show the changes in the dependent variable that are a result of changes in the independent variables through other variables in the model, whereas total effects are a combination of all direct and indirect effects related to these two variables. The magnitude of the standardized estimates can be used to gauge the relative strength of the effects in the model.

**Table 5.28** Effect decomposition of variables in Figure 5.17.

| Relationship | Parameter Estimate | P-value | Standardized Estimate |
|---|---|---|---|
| Bed size → Adoption of infrastructural technologies | | | |
| Total effects | $0.566 \times 10^{-3}$ | < 0.001*** | 0.138 |
| Total indirect effects | $0.107 \times 10^{-3}$ | 0.052 | 0.026 |
| Public status → Adoption of infrastructural technologies | | | |
| Total effects | 0.242 | < 0.001*** | 0.130 |
| Total indirect effects | -0.017 | 0.465 | -0.009 |
| Teaching status → Adoption of infrastructural technologies | | | |
| Total effects | 0.092 | 0.156 | 0.053 |
| Total indirect effects | 0.034 | 0.162 | 0.019 |
| Operational IT management → IT-supported clinical EHR workflows | | | |
| Total effects | 0.483 | < 0.001*** | 0.309 |
| Total indirect effects | 0.171 | < 0.001*** | 0.110 |
| Bed size → IT-supported clinical EHR workflows | | | |
| Total effects | $-0.122 \times 10^{-3}$ | 0.583 | -0.020 |
| Total indirect effects | $0.342 \times 10^{-3}$ | < 0.001*** | 0.056 |
| Public status → IT-supported clinical EHR workflows | | | |
| Total effects | 0.280 | 0.003** | 0.102 |
| Total indirect effects | 0.095 | 0.022* | 0.034 |
| Teaching status → IT-supported clinical EHR workflows | | | |
| Total effects | 0.000 | 0.997 | 0.000 |
| Total indirect effects | 0.069 | 0.092 | 0.027 |
| Operational IT management → IT-supported inpatient clinical documentation | | | |
| Total effects | 0.528 | < 0.001*** | 0.264 |
| Total indirect effects | 0.147 | < 0.001*** | 0.073 |
| Bed size → IT-supported inpatient clinical documentation | | | |
| Total effects | $-0.808 \times 10^{-3}$ | 0.004** | -0.104 |
| Total indirect effects | $0.325 \times 10^{-3}$ | 0.001*** | 0.042 |

**Table 5.28** Effect decomposition of variables in Figure 5.17 (continued).

| Relationship | Parameter Estimate | P-value | Standardized Estimate |
|---|---|---|---|
| Public status → IT-supported inpatient clinical documentation | | | |
| Total effects | 0.403 | 0.001** | 0.114 |
| Total indirect effects | 0.076 | 0.075 | 0.022 |
| Teaching status → IT-supported inpatient clinical documentation | | | |
| Total effects | 0.090 | 0.472 | 0.027 |
| Total indirect effects | 0.069 | 0.092 | 0.021 |
| Operational IT management → Internal information sharing | | | |
| Total effects | 0.501 | < 0.001*** | 0.315 |
| Total indirect effects | 0.382 | < 0.001*** | 0.240 |
| Bed size → Internal information sharing | | | |
| Total effects | $-0.044\times10^{-3}$ | 0.772 | -0.007 |
| Total indirect effects | $-0.044\times10^{-3}$ | 0.772 | -0.007 |
| Public status → Internal information sharing | | | |
| Total effects | 0.609 | < 0.001*** | 0.217 |
| Total indirect effects | 0.240 | < 0.001*** | 0.086 |
| Teaching status → Internal information sharing | | | |
| Total effects | 0.050 | 0.447 | 0.019 |
| Total indirect effects | 0.050 | 0.447 | 0.019 |
| Adoption of infrastructural technologies → Internal information sharing | | | |
| Total effects | 0.484 | < 0.001*** | 0.320 |
| Total indirect effects | 0.252 | < 0.001*** | 0.167 |
| Operational IT management → External information sharing | | | |
| Total effects | 0.321 | < 0.001*** | 0.172 |
| Total indirect effects | 0.204 | < 0.001*** | 0.110 |
| Bed size → External information sharing | | | |
| Total effects | $-0.038\times10^{-3}$ | 0.684 | -0.005 |
| Total indirect effects | $-0.038\times10^{-3}$ | 0.684 | -0.005 |
| Public status → External information sharing | | | |
| Total effects | 0.208 | < 0.001*** | 0.063 |
| Total indirect effects | 0.208 | < 0.001*** | 0.063 |
| Teaching status → External information sharing | | | |
| Total effects | 0.044 | 0.214 | 0.014 |
| Total indirect effects | 0.044 | 0.214 | 0.014 |
| Adoption of infrastructural technologies → External information sharing | | | |
| Total effects | 0.238 | < 0.001*** | 0.134 |
| Total indirect effects | 0.147 | < 0.001*** | 0.083 |
| IT-supported clinical EHR workflows → External information sharing | | | |
| Total effects | 0.032 | 0.484 | 0.027 |
| Total indirect effects | 0.096 | < 0.001*** | 0.080 |

**Table 5.28** Effect decomposition of variables in Figure 5.17 (continued).

| Relationship | Parameter Estimate | P-value | Standardized Estimate |
|---|---|---|---|
| IT-supported inpatient clinical documentation → External information sharing | | | |
| Total effects | 0.196 | < 0.001*** | 0.210 |
| Total indirect effects | 0.049 | < 0.001*** | 0.052 |

*p < 0.05, **p < 0.01, ***p < 0.001. All p-values reported were two-tailed.

Although the size of IT workforce in the hospitals was dropped from the model because of some data quality concerns, it was also used in a separate path analysis to check how the pattern of relationships changed. First, a path model similar to Figure 5.17 was specified with the absolute number of IT staff serving as a proxy measure for IT budget. The number of IT staff was specified as an endogenous variable of the three hospital characteristics (bed size, public status, and teaching status) and a predictor of the levels of facilitating operational IT management, adoption of infrastructural technologies, IT support for clinical workflows, and IT support for inpatient clinical documentation. The direct paths between hospital characteristics and these IT adoption constructs were retained. Findings showed size of IT workforce to be positively associated with bed size and negatively associated with public status (results not shown). It was also associated with the level of facilitating operational management. Additionally, it appeared to be a mediator for the effect of bed size on the extent of infrastructural technologies adoption, but the direct effects of bed size on the levels of IT support for clinical workflows and inpatient clinical documentation were unchanged (with size of IT workforce having no direct effect). Likewise, the direct effects of public status on the levels of infrastructural technologies adoption and IT support for clinical workflows remained, and the direct effect of public status on the extent of IT support for clinical EHR workflows became significant. Other relationships in the model were similar. Overall, this demonstrates that size of IT workforce, and IT budget of which it is a proxy measure, did not explain most of the observed effects between hospital characteristics and IT adoption, except the effect of bed size on the extent of infrastructural technology adoption. Because data on the size of IT workforce deserve more attention regarding their reliability, they were left out of the final model of this study.

### 5.6.2 Model Estimation with Measurement Reliabilities Incorporated

When measurement errors of the instrument were taken into account, the model as depicted in Figure 5.17 was again reestimated and the results were compared with when measurement errors were absent. Variance of each measurement error term was defined as 1 minus the respective reliability coefficient, times variance of the factor score. The error variance for each of the six factors was fixed at this value. The Cronbach's alpha was used as a measure of internal consistency reliability for each construct in the model. The values of their Cronbach's alpha and the calculated measurement error variance are reported in Table 5.29.

**Table 5.29** Cronbach's alpha of the constructs in the path model in Figure 5.17.

| Construct | Cronbach's alpha | Measurement Error ([1-Alpha]*Variance) |
|---|---|---|
| Operational IT management | 0.881785 | 0.053574 |
| IT-supported clinical EHR workflows | 0.933353 | 0.073576 |
| IT-supported inpatient clinical documentation | 0.863226 | 0.247488 |
| Adoption of infrastructural technologies | 0.637356 | 0.180963 |
| Internal information sharing | 0.941129 | 0.067567 |
| External information sharing | 0.973065 | 0.042159 |

Using values in Table 5.29, the model in Figure 5.17 was reestimated. Table 5.30 shows the model fit statistics. The model was an excellent fit to the data and the fit statistics had negligible changes from those in Table 5.26. Table 5.31 reports the unstandardized and standardized parameter estimates of this model.

**Table 5.30** Values of fit statistics for path analysis of the model in Figure 5.17, with measurement errors taken into account.

| Index | Value of Fit Statistics for the Estimated Model |
|---|---|
| $\chi^2_M$ | 6.365 |
| $df_M$ | 5 |
| Chi-square p-value | 0.2723 |
| RMSEA (90% CI) | 0.017 (0.000–0.052) |
| Close-fit hypothesis p-value | 0.937 |
| CFI | 0.999 |
| TLI | 0.993 |
| SRMR | 0.010 |

CFI - comparative fit index, CI - confidence interval, RMSEA - root mean square error of approximation, SRMR - standardized root mean square residual, TLI - Tucker-Lewis index.

**Table 5.31** Results of path analysis for the estimated model in Figure 5.17, with measurement errors taken into account.

| Relationship | Parameter Estimate | P-value | Standardized Estimate |
|---|---|---|---|
| **Direct Effects** | | | |
| Bed size → Operational IT management | $0.279\times10^{-3}$ | 0.050 | 0.077 |
| Public status → Operational IT management | -0.045 | 0.464 | -0.027 |
| Teaching status → Operational IT management | 0.089 | 0.155 | 0.057 |
| Operational IT management → Adoption of infrastructural technologies | 0.433 | < 0.001*** | 0.484 |
| Bed size → Adoption of infrastructural technologies | $0.435\times10^{-3}$ | 0.001** | 0.133 |
| Public status → Adoption of infrastructural technologies | 0.262 | < 0.001*** | 0.177 |
| Teaching status → Adoption of infrastructural technologies | 0.054 | 0.364 | 0.039 |
| Adoption of infrastructural technologies → Clinical EHR workflows supported by IT | 0.784 | < 0.001*** | 0.436 |
| Operational IT management → Clinical EHR workflows supported by IT | 0.210 | 0.003** | 0.131 |
| Bed size → Clinical EHR workflows supported by IT | $-0.619\times10^{-3}$ | 0.003** | -0.106 |
| Public status → Clinical EHR workflows supported by IT | 0.100 | 0.280 | 0.037 |
| Teaching status → Clinical EHR workflows supported by IT | -0.095 | 0.299 | -0.038 |
| Adoption of infrastructural technologies → Inpatient clinical documentation supported by IT | 0.658 | < 0.001*** | 0.297 |
| Operational IT management → Inpatient clinical documentation supported by IT | 0.316 | 0.001** | 0.159 |
| Bed size → Inpatient clinical documentation supported by IT | $-1.271\times10^{-3}$ | < 0.001*** | -0.176 |
| Public status → Inpatient clinical documentation supported by IT | 0.258 | 0.032 | 0.078 |
| Teaching status → Inpatient clinical documentation supported by IT | 0.004 | 0.971 | 0.001 |

**Table 5.31** Results of path analysis for the estimated model in Figure 5.17, with measurement errors taken into account (continued).

| Relationship | Parameter Estimate | P-value | Standardized Estimate |
|---|---|---|---|
| Operational IT management → Internal information sharing | 0.058 | 0.311 | 0.035 |
| Adoption of infrastructural technologies → Internal information sharing | 0.392 | < 0.001*** | 0.214 |
| Clinical EHR workflows supported by IT → Internal information sharing | 0.374 | < 0.001*** | 0.366 |
| Inpatient clinical documentation supported by IT → Internal information sharing | 0.223 | < 0.001*** | 0.269 |
| Public status → Internal information sharing | 0.320 | < 0.001*** | 0.117 |
| Internal information sharing → External information sharing | 0.247 | < 0.001*** | 0.207 |
| Operational IT management → External information sharing | 0.099 | 0.239 | 0.050 |
| Adoption of infrastructural technologies → External information sharing | 0.183 | 0.151 | 0.083 |
| Clinical EHR workflows supported by IT → External information sharing | -0.110 | 0.060 | -0.091 |
| Inpatient clinical documentation supported by IT → External information sharing | 0.177 | < 0.001*** | 0.179 |
| **Non-Directional Associations** | | | |
| Clinical EHR workflows supported by IT↔ Inpatient clinical documentation supported by IT | 0.400 | < 0.001*** | 0.406 |
| **Disturbance Variances (After taking measurement errors into account)** | | | |
| Operational IT management | 0.392 | < 0.001*** | 0.119 |
| Adoption of infrastructural technologies | 0.221 | < 0.001*** | 0.363 |
| Clinical EHR workflows supported by IT | 0.760 | < 0.001*** | 0.067 |
| Inpatient clinical documentation supported by IT | 1.279 | < 0.001*** | 0.137 |
| Internal information sharing | 0.499 | < 0.001*** | 0.059 |
| External information sharing | 1.327 | < 0.001*** | 0.027 |
| **$R^2_{smc}$ (For latent variables after taking measurement errors into account)** | | | |
| Operational IT management | 0.013 | 0.107 | |
| Adoption of infrastructural technologies | 0.304 | < 0.001*** | |
| Clinical EHR workflows supported by IT | 0.260 | < 0.001*** | |
| Inpatient clinical documentation supported by IT | 0.181 | < 0.001*** | |
| Internal information sharing | 0.534 | < 0.001*** | |
| External information sharing | 0.129 | < 0.001*** | |

**p < 0.01, ***p < 0.001. Significance testing for path coefficients was one-tailed.
Shaded cells indicate relationships with a different statistical pattern when compared to estimated model without measurement errors.

Most of the parameter estimates had similar values and statistical significance as those in Table 5.27 without the measurement errors. When measurement errors were taken into account, two significant direct effects disappeared—the positive effect of public status on the extent of IT-supported inpatient clinical documentation and that of facilitating operational IT management on the extent of internal information sharing. The model with measurement errors along with the resulting path coefficients is depicted in Figure 5.19.

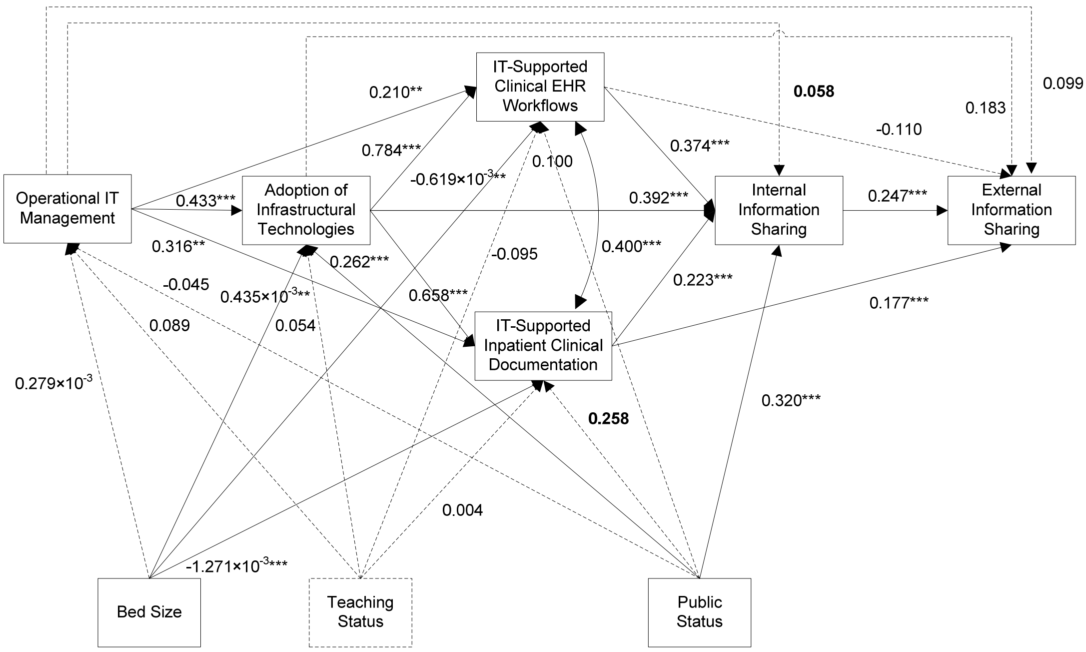



**Figure 5.19.** Final IT adoption model and unstandardized parameter estimates with measurement errors taken into account. Dashed lines indicate non-significant effects based on a one-tailed test. The rectangle with dashed borders indicates a variable without any significant hypothesized effects on other variables. Coefficients in bold face changed the significance pattern from the model in Figure 5.18 without errors. *p < 0.025, **p < 0.01, ***p < 0.001.

## 5.7 Content Analysis of Open-Ended Comments

Open-ended comments of survey responses were analyzed using qualitative content analysis. Apart from response clarifications and instructions for incentive and results mailing, six themes and 19 subthemes emerged (Table 5.32).

**Table 5.32** Emerging themes and representative quotes from content analysis of open-ended comments.

| Theme and Subtheme (Frequency) | Sample Quotes |
|---|---|
| **1. Standards & Interoperability** | |
| 1.1 Desires or support for a single centrally-developed health IT solution for interoperability (19) | "Hospital information systems should be designed centrally (such as by an NHSO contract) and then provide training to people across the country for alignment and ease of maintenance." *(a small district hospital)*<br><br>"If there is a central agency that could develop a hospital information system and deploy it across the hospitals, Thailand would save a lot of money and both public and private sectors would benefit." *(a medium-sized private hospital)*<br><br>"The entire health system, especially hospitals, should have the same hospital information system for accurate and fast data aggregation." *(a medium-sized district hospital)*<br><br>"There should be one software solution for the country linking health centers, hospitals, departments, and divisions via the Internet." *(a small district hospital)*<br><br>"The same hospital software should be developed for use nationwide to enable data interchange, but it should be done by the Ministry rather than by a vendor like HOSxP that we need to rely on to deploy." *(a medium-sized district hospital)*<br><br>"I wish Thailand has only one hospital information system solution, such as HOSxP." *(a medium-sized district hospital)*<br><br>"Existing software for healthcare services should be combined into one solution if possible. Please keep in mind HOSxP that we currently use." *(a small district hospital)* |
| 1.2 Redundancies, inefficiencies, fragmented systems, and collaboration (7) | "I wish a main, central program is developed so that whenever a government department wants certain information, they can pull it from this program using another developed program or a tool, because the more programs, the more complicated it is." *(a small district hospital)*<br><br>"In the Ministry of Public Health, each department develops its own programs, so users have to do things several times, without integration, slowing the development." *(a small district hospital)*<br><br>"...reduce reports and allow us to send electronic files instead." *(a small public hospital)*<br><br>"Development at the provincial level is not in the same direction since the beginning. Each hospital separately develops [its systems], so linking data or unifying the systems is difficult because of paid investments." *(a large district hospital)* |

**Table 5.32** Emerging themes and representative quotes from content analysis of open-ended comments (continued).

| Theme and Subtheme (Frequency) | Sample Quotes |
|---|---|
| 1.2 Redundancies, inefficiencies, fragmented systems, and collaboration (7) (continued) | "With respect to hospital information systems, we should work in networks because each place has vastly different knowledge and capabilities. Most work to respond to budget to be received." *(a small district hospital)*<br><br>"I wish redundant data reporting is studied. How can we use IT to reduce the documentation steps, especially online data, because it creates a lot of problems to the local workers?" *(a small district hospital)*<br><br>"I would like [the researcher's] organization to be involved with other health care organizations such as NHSO, the Bureau of Policy and Strategy, the Thai Health Coding Center, etc." *(a small district hospital)* |
| 1.3 Centralized data center (5) | "Government agencies have had ideas about a centralized data center. This should be fully supported because there is much redundant data exchange nowadays." *(a medium-sized private hospital)*<br><br>"...a provincial data center is being developed." *(a large district hospital)*<br><br>"Currently the Ministry of Public Health or NHSO or the organizations responsible for IT focus on data centralization which is inconvenient and inflexible. It should be distributed at the provincial level, and more provincial-level personnel development should be done." *(a medium-sized provincial hospital)* |
| 1.4 Standard data sets (3) | "The root of the IT problems in Thailand is standard data set both for back and front offices and academic information systems. Software applications are simply the mask or conduit for information. A good system is smart, fast, and more comprehensive, only if we have a stable standard data set that does not change or expand too frequently. Data can then be exchanged for both the public and private sectors, and software houses can then develop solutions to compete for every platform." *(a large tertiary public hospital)*<br><br>"I wish the Bureau of Policy and Strategy [Ministry of Public Health] and NHSO have the same standard data set." *(a small district hospital)*<br><br>"Hospital information systems should have the same standard data set for ease of administration." *(a medium-sized public specialty hospital)* |
| 1.5 General support for interoperability (3) | "I wish for development of universal information standards in Thailand for data sharing and transfer." *(a small public hospital)*<br><br>"I would like to see information of hospitals interoperable nationwide like banks." *(a small district hospital)*<br><br>"I would like to see the exchange of health information like the citizen registration system that is accessible anywhere, anytime, from any hospital." *(a large district hospital)* |

**Table 5.32** Emerging themes and representative quotes from content analysis of open-ended comments (continued).

| Theme and Subtheme (Frequency) | Sample Quotes |
|---|---|
| 1.6 Needs for a customized solution that fits local requirements (1) | "Our hospital uses HOSxP but it does not fit our specialty needs so a lot of designed data structure is not used. A self-developed solution would fit best with our local context. If the government could develop a solution that is comparable to that of vendors, data can be exchanged. A central solution would be nice." *(a large public specialty hospital)* |
| **2. Barriers to Adoption** | |
| 2.1 Inadequate financial resources (5) | "There is no budget from the central administration to support [IT development]. We used only our own budget. Don't really have much money, but want timely data." *(a small district hospital)*<br><br>"I wish there is more budget from the Ministry for IT development than this, and also ongoing capability development..." *(a small district hospital)*<br><br>"There are only people wanting good stuffs, good programs, good machines, but low prices, so we haven't bought and haven't used the good stuffs, good programs." *(a small district hospital)*<br><br>"In a small hospital, there is no budget for IT, so development is very difficult." *(a small district hospital)* |
| 2.2 Regulatory barriers (2) | "Electronic documents are not yet legally admissible evidence." *(a medium-sized private hospital)*<br><br>"...the bureaucratic regulations are also barriers to machine or outsourcing procurement." *(a small military hospital)* |
| 2.3 Lack of political will (1) | "IT development in Thailand's health care has no clear direction and is uncoordinated because the Ministry of Public Health is not committed or sincere to lead. When it leads, there is always corruption. It should start to sincerely and seriously lead for once." *(a large public general hospital)* |
| 2.4 Lack of value Proposition (1) | "Certain technologies, such as laboratory information systems, PACS, or electronic documents, have large expenses that outweigh the returned values." *(a medium-sized private hospital)* |
| **3. Human Resource Issues** | |
| 3.1 Job recruitment and job security (17) | "IT workers are considered temporary workers. No permanent position is available in public organizations, making it a challenge." *(a small district hospital)*<br><br>"There need to be job positions on hospital IT. Many hospitals now use other employees to administer IT." *(a small district hospital)*<br><br>"The Office of the Permanent Secretary of the Ministry of Public Health does not specify that IT specialist is a necessary job position in district hospitals." *(a small district hospital)*<br><br>"I have long wanted to have an IT position for IT administrator for more than a decade, but not necessarily with an IT-related degree but with real-world IT experience. Please advocate for us." *(a small district hospital)* |

**Table 5.32** Emerging themes and representative quotes from content analysis of open-ended comments (continued).

| Theme and Subtheme (Frequency) | Sample Quotes |
|---|---|
| 3.1 Job recruitment and job security (17) (continued) | "Findings should be used to facilitate job opportunities and recruitment of qualitified individuals because today we work like someone without important roles but do everything by ourselves." *(a medium-sized district hospital)*<br><br>"There should be a permanent civil servant position for computer specialists in the hospitals because temporary position holders will quit often, leading to lack of development continuity." *(a small district hospital)*<br><br>"There is no IT specialist position in 30-bed district hospitals, so the workload falls to other health care professionals." *(a small district hospital)*<br><br>"There should be a study on roles of system administrators, which will show the competency on system administration. There are so many technologies nowadays but very few system administrator positions." *(a small district hospital)*<br><br>"IT workers are usually public health civil servants assigned to work in IT, so there is no IT career development, leading to frequent changes in the responsible person." *(a small district hospital)*<br><br>"Support for medical informatics personnel from the central government is very little." *(a small district hospital)*<br><br>"There is still a lack of incentive to hire employees who know both IT and health care among public organizations (because of complexity in a health care unit, those who know both will understand data flow or can be more effective system analysts) as well as to train and keep them..." *(a small military hospital)* |
| 3.2 Human resource development (11) | "Technology evolves continuously, but employees are not willing to change or use IT to appropriately improve their jobs." *(a small district hospital)*<br><br>"For the computer systems in the hospital, most of the users are public health professionals with no direct training, leading to potential data errors and needs for more learning, which some units don't have time. Computer or IT specialists also don't fully understand the nature of health care, leading to data errors, poor responsiveness, and inability to educate health care personnel." *(a medium-sized district hospital)*<br><br>"I want to see educational opportunities for system administrators and workers in district hospitals to improve their knowledge." *(a small district hospital)* |

**Table 5.32** Emerging themes and representative quotes from content analysis of open-ended comments (continued).

| Theme and Subtheme (Frequency) | Sample Quotes |
|---|---|
| **4. Other Policy Issues** | |
| 4.1 Privacy issues (6) | "Sharing of patient information needs to consider access and patient rights too (it wasn't mentioned)." *(a large district hospital)*<br><br>"[Patient information] was confidential and should not be disclosed unless the patient consents...Hospital IT has increasingly advanced but we need to consider confidentiality and patient rights as well. But disclosing information to patients may sometimes lead to lawsuits to doctors and the hospital (being instigated to misinterpret the hospital)." *(a medium-sized district hospital)*<br><br>"Patient information is confidential, unless the patient is referred to another hospital." *(a medium-sized private hospital)* |
| 4.2 Budget allocation (4) | "...there should be a central agency overseeing the allocation of budget to hospitals, not letting NHSO be the sole decider." *(a small district hospital)*<br><br>"...budget should be allocated to health providers adequately and appropriately to their level of care." *(a small district hospital)*<br><br>"The government should fund a vendor that has developed a solution meeting hospital requirements, such as the current system we are using (Hospital OS)." *(a medium-sized district hospital)*<br><br>"I want the Ministry to allocate budget specifically for IT administration, because the individual organizations sometimes are not efficient in systematic management." *(a small district hospital)* |
| 4.3 User issues (3) | "Developing IT systems needs time and open mind of users to develop to the full potential and also for their own development." *(a small district hospital)*<br><br>"Use of the systems by physicians is often not fully cooperated." *(a small provincial hospital)*<br><br>"If possible, there should be a person for quality control of the hospital information systems because most people don't see the importance." *(a small district hospital)* |
| 4.4 Management support (2) | "Senior management of the organization must have IT vision. It will help improve the organization's mission quickly." *(a small district hospital)*<br><br>"...some hospitals don't quite see the importance of IT works..." *(a medium-sized military hospital)* |
| 4.5 General support for health IT efforts (4) | "We believe IT is important in today's era." *(a small public hospital)*<br><br>"There should be development of information systems specifically for hospital operations because it would help the job and reduce the workload of workers at all levels." *(a medium-sized private hospital)* |

**Table 5.32** Emerging themes and representative quotes from content analysis of open-ended comments (continued).

| Theme and Subtheme (Frequency) | Sample Quotes |
|---|---|
| 4.5 General support for health IT efforts (4) (continued) | "There is hopefully a possibility for telepsychiatry development in Thailand." *(a medium-sized public specialty hospital)* |
| **5. Thoughts for This Study** | |
| 5.1 Support the study's efforts (14) | "I agree for conducting this study." *(a large public specialty hospital)*<br><br>"My thanks to the researcher who sees the importance of hospital information systems and conducts research to improve medical informatics in Thailand." *(a small district hospital)*<br><br>"Study results should be used to maximize benefits." *(a small military hospital)*<br><br>"I hope the study truly benefits utilization of IT." *(a medium-sized private hospital)*<br><br>"I hope the Ministry of Public Health uses results from this study to improve hospital information systems into the same direction." *(a small district hospital)*<br><br>"I'm glad someone is trying to improve and collect this information in Thai hospitals. I support this study and I am willing to provide data." *(a medium-sized private hospital)* |
| **6. Others** | |
| 6.1 Miscellaneous (5) | "...physical space for education and training within the hospital is also limited (no training room)." *(a large district hospital)*<br><br>"Newly developed programs should be sent via e-mail." *(a medium-szied district hospital)*<br><br>"I want health information systems software that has easy-to-use and simple user interface, not burdening the users." *(a medium-sized district hospital)*<br><br>"Information systems need to develop continuously and align with the main systems. We now use HOSxP because it fits with NHSO which needs data for budget management and result-driven management, migrating from Oracle to HOSxP, which has a tendency for continuing development and receives funding." *(a medium-sized district hospital)*<br><br>"Servers and other equipments need to have national-standard high quality (even for small hospitals) because data must be shared with comparable equipments." *(a medium-sized district hospital)* |

NHSO - National Health Security Office. One response may belong to several themes.

One of the most prominent themes was comments related to standards and interoperability. At least 19 respondents expressed wishes to see a centrally-developed hospital information system that could be used in hospitals nationwide (Subtheme 1.1). Several of these respondents suggested that such homogeneity would reduce inefficiencies or enable health information exchange among the providers (Subtheme 1.2). One comment, in contrast, noted the poor organizational-technology fit between the health IT solutions in the market and their local requirements (Subtheme 1.6). Other subthemes on standards and interoperability included centralized data center (Subtheme 1.3), standard data set (Subtheme 1.4), and general support for standard and interoperability efforts (Subtheme 1.5). Another theme highlighted barriers to health IT adoption from inadequate financial resources (Subtheme 2.1) to regulatory barriers and bureaucracies (Subtheme 2.2), lack of political will from the government and bureaucrats (Subtheme 2.3), and lack of perceived value proposition for certain technologies (Subtheme 2.4).

Human resources were another clear theme that emerged. The challenges in recruiting qualified job applicants and ensuring their job security were most frequently cited (Subtheme 3.1). There were many outcries on the lack of a permanent civil servant position in IT roles in small to medium-sized public hospitals that makes organizational IT management very difficult. The need for continuing education and adequate training was also highlighted, as was the importance of those who know both IT and health care (Subtheme 3.2).

Other policy issues that were noted included the need to consider privacy rights of patients (Subtheme 4.1), the importance of appropriate and adequate allocation of financial resources (Subtheme 4.2), user-related challenges (Subtheme 4.3), and management support (Subtheme 4.4). A number of respondents also expressed support and enthusiasm for health IT adoption in Thailand (Subtheme 4.5), as well as support and appreciation for this study's efforts in improving the health IT situation in Thailand (Subtheme 5.1).

Other comments that might indicate potential issues for specific survey questions are presented in Table 5.33. These might be useful for future studies that use a similar survey instrument. Some respondents noted that the interpretation of some questions is subjective. For Question 13 on functional sophistication, some respondents were not sure if they should answer the availability of functions in the system or the actual use. For Question 15 on internal integration sophistication, issues arose when only one or a few systems were used across the departments, and hence it was unclear to them if this indicates a highly integrated environment (a high score) or one with little information exchange "across" the systems (a low score). Lastly, for Question 16 on external integration sophistication, several respondents expressed concerns about privacy issues, while others were unsure if only clinical use cases such as referrals should be considered or if administrative data reporting was included, and if so, information exchange to what organizations should be counted. More clarifications or examples might prove helpful in future studies.

**Table 5.33** Open-ended comments that might suggest potential issues of survey questions.

| Survey Questions (Frequency) | Sample Quotes |
|---|---|
| Q13 [Functional Sophistication] (3) | "Some questions could be interpreted in different ways. For example, on Q13 the support by computerized information systems may vary by respondents." *(a medium-sized private hospital)*<br><br>"I don't quite understand Q13. Each department can only access each data type by the nature of its job." *(a medium-sized private hospital)*<br><br>"The term 'support' makes it hard to answer in the case where the function is supported but some user groups do not use, such as doctors who wouldn't enter inpatient medication orders through the program." *(a medium-sized district hospital)* |
| Q15 [Internal Integration Sophistication] (3) | "Not sure if 'between systems' is the same as between departments?" *(a medium-sized private hospital)*<br><br>"We have only one system." [responded missing on all items] *(a small district hospital)*<br><br>"Unclear wording." *(a small public general hospital)* |
| Q16 [External Integration Sophistication] (9) | "I chose a score of 1 because I understand the question asks about information being exchanged via the network (the Internet)." *(a small district hospital)*<br><br>"Patient information is confidential and can't be disclosed. Patients must give consent." *(a medium-sized district hospital)*<br><br>"On Q16, it's not clear if sending administrative reports is considered an information exchange, or only patient referrals are considered." *(a small district hospital)*<br><br>"Access to patient information from outside needs to go through the hospital's board or the director." *(a medium-sized district hospital)*<br><br>"Does it include NHSO and the Social Security Office's systems? The question is not clear." *(a large public specialty hospital)* |

NHSO - National Health Security Office. One response may contain multiple issues. Question numbers refer to the corresponding questions in the final survey instrument used in the nationwide study (see Appendix B).

# Chapter Six
# Discussion and Conclusion

This last chapter interprets and discusses the results reported in Chapter 5. The knowledge that could be used to drive public policy and further advance the science of health IT adoption is drawn. The significance and limitations of this study are noted, and opportunities for future research are suggested. The chapter ends with the conclusion of this study.

## 6.1 Study Summary

The knowledge gap in Thailand's state of hospital IT adoption and the paucity of theoretical advances on hospital IT adoption at the organizational level served as dual opportunities for this study. With Paré and Sicotte's IT sophistication[29] at the core of its conceptual framework, this study has proposed a breakdown of hospital IT adoption into separate components, from technologies to functions and information exchange. Unlike Paré and Sicotte, however, a new dimension was added—the organizational cultures and management practices that are important to IT adoption and implementation. Using literature evidence from case studies and lessons learned from IT implementation successes and failures, as well as opinions from biomedical and health informatics experts, this study identified at least ten IT management characteristics that should be linked to IT adoption. A new "managerial" aspect of IT adoption was proposed, and a quantitative study of the conceptual framework was conducted.

The proposed conceptual framework led to the development of a new survey instrument, extensively modified from Paré and Sicotte's original instrument.[29] Evaluation of face and content validity was done, as was a pilot study to pre-test the instrument. After a number of improvements, a nationwide survey of Thai hospitals was conducted. The analyses could be largely categorized into four groups—descriptive analysis of the state of IT adoption and associated organizational factors; instrument validation; the proposed framework's evaluation and improvements; and content analysis of open-ended comments. The following sections discuss findings from these analyses.

## 6.2 State of IT Adoption in Thai Hospitals

### 6.2.1 Survey Respondents

The nationwide survey received a satisfactory 70% response rate among the 1,298 eligible hospitals. However, comparing with nonresponding hospitals, respondents were 35 beds larger on average and about 50% more likely to be public hospitals. Geographic variations of respondents also existed, with fewer hospitals in the central region and more hospitals in the northern region responding. Larger hospitals are expected to have higher degree of IT adoption, according to the literature. With evidence from the literature suggesting a link between for-profit status and IT adoption, public hospitals are expected to have lower levels of IT adoption (although findings ultimately suggested the contrary). There is no evidence to suggest that hospitals in the northern region behave differently than hospitals in other regions, though hospitals in the central regions are mostly in the urban area. These urban hospitals may have higher functional needs, increased patient volumes, intense competition, and better access to financial resources and IT expertise, all of which could lead to higher IT adoption. These significant differences could not be ignored when findings are generalized, and they suggest that the observed findings might overestimate the true level of IT adoption.

The descriptive statistics of respondent characteristics appeared reasonable. About two thirds of the respondents were male, consistent with the tendency of male predominance among IT professionals. Most of the respondents were at least college-educated and received some training in IT and health science. The high proportion of respondents who were serving in IT-related or executive roles suggests that findings should reflect the real IT environment in the hospitals.

### 6.2.2 State of IT Adoption

This subsection offers discussions related to Research Questions 1–2 (see Chapter 3). The research questions are reiterated here for ease of reference.

**Research Question 1:** What is the extent of IT adoption in Thai hospitals nationwide?

**Research Question 2:** Are there variations in the IT adoption levels among hospitals in different geographic regions of the country?

Because the proposed model of IT sophistication did not fit the data well according to confirmatory factor analysis, the scores for six IT adoption factors revealed from the data through exploratory factor analysis were used to assess the state of IT adoption. To answer Research Question 1, the scores suggest that hospitals nationwide on average have a relatively high level of IT support for clinical workflows such as order entry for medications, laboratory tests, and imaging, as well as for results viewing. Likewise, responding hospitals on average have greatly adopted infrastructural technologies such as networking and master patient index that are fundamental to hospital operations, and they also share information internally to a considerable degree. Strikingly, the level of information exchange outside the hospitals is considerably low, however. This indicates a sizeable potential barrier toward HIE that leverages patient health information across disparate providers to improve individual and population health. More studies should attempt to identify major barriers of HIE that need to be addressed.

Geographic differences (Research Question 2) in the scores of several aspects of IT adoption exist. The southern, western, and eastern parts of the country have lower average scores than other regions in almost all aspects of IT adoption, while the northern and northeastern regions have highest scores. The presence of geographic differences is not surprising, although the high scores of the northeastern region were not expected given the region's mostly rural environment and a larger, relatively poor population compared to other regions. This finding is encouraging because it provides evidence that rural hospitals do not necessarily have the biggest barriers toward health IT adoption. It would be interesting to study why these regions outperform others. Policymakers should also focus on other low-adopting regions to ensure that the geographic adoption gap is not large.

When adoption of EHR and computerized order entry is specifically considered, the findings are even more encouraging. More than 80% of hospitals nationwide and in all regions have adopted basic EHR systems in the outpatient setting. The situations are less satisfactory in the inpatient setting and when both settings are considered, where most regions have an adoption rate between 40–50%. When a more stringent, comprehensive definition of EHR is considered, with laboratory order entry, imaging order entry, image viewing, drug-allergy alerts, and drug-drug-interaction alerts added, the nationwide adoption rate drops to 11% in the outpatient setting and about 5–6% in other settings. Overall, the outpatient setting witnesses a higher adoption rate than the inpatient setting, and most hospitals still have only "basic EHR" functions. An overwhelming 96% of hospitals have implemented computerized order entry for medication orders in the outpatient setting, with the adoption rates in inpatient setting and both settings combined still very high (higher than 90%) nevertheless. When all orders are considered, slightly lower but still very high adoption rates (79–89%) are observed. The high adoption rate of computerized order entry functions suggests that the potential to implement clinical decision support features to enhance patient safety appears feasible.

Nevertheless, the impressively high adoption rates need to be considered in conjunction with how the estimates were operationalized in this study. For example, for basic EHR and all CPOE estimates, responses greater than 1 (Not supported at all by computers) for all relevant functions were considered an indicator of adoption, although the adoption could be partial (e.g., in some units or by some users). In an attempt to conduct sensitivity analysis by changing the definitions to consider only responses of 4 or 5 (5 = Fully supported by computers) in a 5-point scale for all relevant functions, some adoption estimates decrease considerably (results not previously shown). The adoption rates for basic EHR drop from 87% to 64% in the outpatient setting and from 50% to 24% for inpatient and both settings combined. Nevertheless, the adoption rates drop only 7–14% for medication-order CPOE, from 96% to 89% in the outpatient setting, from

91% to 78% in the inpatient setting, and from 90% to 76% in both settings combined. Similarly, all-order CPOE estimates decrease from 89% to 73% in the outpatient setting, from 82% to 62% in the inpatient setting, and from 79% to 59% in both settings combined. While this demonstrates the dependencies of adoption estimates on exact definitions, a well-known methodological issue,[25,243] the estimates are still surprisingly high for outpatient basic EHR and CPOE systems.

Another interesting finding is the changes in the health IT adoption landscape among Thai hospitals that have occurred in the last six years. Comparing the distributions of hospital information system vendors/products in 2004 and 2011 reveals a big leap on the market share of HOSxP (50% of all hospitals in 2011), with some visible increases for Hospital OS but noticeably reduced market shares of most other products. This is consistent with the actual market situation in Thailand based on the researcher's experience in the field, as well as an unscientific survey recently presented in a national conference in health informatics in 2010.[244]

Both HOSxP and Hospital OS are open-source software solutions developed in Thailand, specifically targeting small to medium hospitals because of their less complex environments and less demanding requirements. Both are led by health care professionals with understanding of typical hospital workflows and with experience in hospital IT administration and software development. The products are therefore considered to meet requirements of many small-scale hospitals. With their open-source nature, these two products are allowed to be implemented and customized by the adopting hospitals, and the developers were mainly paid nominally for implementation, technical support, and consulting services. One of these products (Hospital OS) also received research and development funding by governmental agencies. While the long-term sustainability of their business models is unclear, the low fees coupled with well-designed open-source solutions and the desperate needs of many public hospitals at the time to find the right solution in an affordable price led to their widespread adoption.

In 2004, HOSxP was in its early phase of development, explaining its low adoption rate in a previous study. Since then, the product has matured and an increasing number of hospitals adopting it led to a snowball effect where the successful adoption and user satisfaction in early-adopting hospitals had an influence on their peer hospitals. This is interestingly similar to the concepts of *subjective norm* in TAM2[63] and *social influence* in UTAUT,[64] though these concepts operate in a different level of adoption than this study. Moreover, health officials in some provinces have mandated that all public hospitals in the provinces use the same product (mostly HOSxP), which intensified the snowball effect even further and had sparked interests and debates in the local health informatics community.[244,245]

It is important to note, however, that the majority of the hospitals that have adopted HOSxP or Hospital OS are relatively small public hospitals, mostly district hospitals under the purview of the Ministry of Public Health. Many medium-sized and large hospitals view these products and many other solutions in the market as either unfit to their higher levels of requirements or requiring extensive customizations. Use of commercial products from other countries exists but in a very small percentage and only among large and mostly private hospitals. This observation can be explained by the products' high costs, different internal workflows, and extensive modifications needed for claims and reimbursements in Thailand's predominantly publicly-funded health care. A non-negligible 16% of hospitals use self-developed or outsourced solutions specifically designed for their environment, suggesting that a homogeneous health IT adoption of the same product by most hospitals nationwide—a so-called "one country, one system" idea as previously suggested by a number of respondents mostly from small district hospitals—is impratical, as echoed by Theera-Ampornpunt.[245] This adoption landscape is much different from that of most developed countries, and lessons drawn from Thailand's situation might benefit other countries in their pursuit of widespread hospital IT adoption.

### 6.2.3 International Comparison

Cross-country and cross-study comparisons of health IT adoption are challenging endeavors given the different methodologies and definitions employed.[25,243] Nevertheless, it is important that the adoption situations in different countries are compared to assess the gaps and draw implications for public policy.

To enable cross-study comparisons, EHR and CPOE adoption was defined to be as close to a recent study of U.S. hospitals by Jha et al.[21] as possible (see Table 4.4 for definitions). Unfortunately, some definitional differences still exist because of some remaining operationalization differences. The definitions for this study are less comprehensive than those used by Jha et al,[21] though the differences are generally in less important features. Therefore, for comparison purposes, the adoption rates in this study should overestimate the true adoption rates if the exact same definitions were used.

In the ambulatory setting, the preliminary NAMCS findings in 2010 suggest about 25% adoption rate of basic EHR systems (with demographics, problem lists, clinical notes, laboratory results viewing, imaging results viewing, and CPOE for medications) among U.S. office-based physicians.[94] The adoption estimate among Thailand's independent physician offices is not available (but presumably low based on an assessment by experts and especially since most physician offices are solo or small practices with minimal IT capabilities). However, when the ambulatory setting of Thai hospitals nationwide is considered, the estimate (87%) is much higher than that of the physician's offices in the U.S. (but note the somewhat less restrictive definitions for Thailand).

In the inpatient setting, Thailand's 2011 estimate of EHR adoption meeting at least basic functional requirements (50%) outperforms the 2008 (9%)[21] and 2009 (12%)[97] estimates in U.S. hospitals. Even when only responses with a score of 4 or 5 in a 5-point scale for relevant functions were considered, the estimated adoption rate of 24% is still much higher (although again, the definition was slightly less restrictive; see Table 4.4). The comprehensive EHR estimate is also more than doubled for Thailand (6% for the inpatient setting) when compared to 1.5% (2008)[21] and 2.7% (2009)[97] for the U.S. The computerized order entry feature for medication orders is also highly adopted in Thai hospitals (91% in 2011) compared to 17% (2008)[21] and 34% (2009)[97] in the U.S. When only responses with a score of 4 or 5 were considered, the estimate (78%) is still much larger than U.S. estimates.

When compared to other Western countries, basic EHR adoption in Thai hospitals' ambulatory setting closely followed the universal adoption rate of Australia, the Netherlands, New Zealand, and the United Kingdom.[22,23] However, it should be noted that independent physician offices not part of a hospital were not considered in this study, suggesting that the true ambulatory EHR adoption rate overall in Thailand likely lags behind that of these countries. For the inpatient setting, the best reliable estimates for these European countries in 2006 put the EHR adoption rate to less than 10% in virtually all of the studied countries.[22] This suggests that Thailand may have adopted health IT to a greater extent than most of these countries, though the five-year time lag between the two studies makes a definitive conclusion impossible. Overall, Thailand's adoption picture appears very promising and serves as a high-adopting example among developing countries.

#### 6.2.4 Organizational Factors Associated with IT Adoption

Considering next the relationships between organizational factors of responding hospitals and the levels of IT adoption in various aspects. Univariate analyses suggested significant associations between being a teaching hospital and higher scores in some aspects such as adoption of basic infrastructural technologies, external information sharing, and the extent of facilitating operational management practices. This is in line with the literature, which suggests that teaching hospitals are more likely to adopt IT.[20,98,102,104] A similar pattern was observed for public status, except for the extent of facilitating operational management. However, the observed associations were in the opposite direction from that hypothesized. Public (i.e., not-for-profit) hospitals had significantly higher IT adoption scores, in contrast to most of literature evidence,[100-102,108] but consistent with some others.[98] One possible explanation is the enthusiasm of health IT adoption among small to medium-sized public hospitals (predominantly district hospitals under the oversight of the Ministry of Public Health) as previously discussed. Such enthusiasm-induced snowball effect in public hospitals, coupled with the need for better information management due to higher patient volumes and demanding data reporting, could explain why public hospitals in Thailand are more likely to be IT adopters than private hospitals. In addition to these demand-side factors, appealingly affordable, customizable solutions of two major open-source products also serve as supply-side facilitators of adoption.

When public status was analyzed in the path model controlling for other hospital characteristics, the relationships persisted for the extent of adoption of infrastructural technologies, the extent of inpatient clinical documentation supported by IT, and the extent of information sharing within the hospitals. The observed relationships disappeared, however, for the extent of facilitating operational management and the extent of clinical workflows supported by IT, when other variables have been controlled for. On the other hand, teaching status was not associated with any aspect of hospital IT adoption in the multivariate analysis.

One interesting finding is that size had mixed effects on hospital IT adoption. In univariate analyses, hospital size is positively associated with the extent of facilitating operational management and the extent of adoption of basic infrastructural technologies, but it is negatively associated with the extent of inpatient clinical documentation supported by IT. Similarly, in path analysis, hospital size was found to be positively associated with adoption of infrastructural technologies but negatively associated with the levels of IT-supported clinical EHR workflows such as order entry and results viewing as well as inpatient clinical documentation. This greatly contrasts to the overwhelming literature evidence[20,87,100-105] that suggests that organizational size is strongly and positively associated with IT adoption.

Kimberly and Evanisko provided two key mechanisms that explain the tendency of larger organizations to adopt IT—the facilitative and necessitative mechanisms.[111] In the first mechanism, larger hospitals have better access to capital resources,[100,101,111] possess more internal expertise,[87,100,111] are in a more powerful negotiating position,[246] and can more easily leverage economies of scale.[102] This is in line with the resource dependence theory,[247] which was used by Kazley and Ozcan[246] to argue that larger hospitals adopt IT to help them secure necessary resources through increased demands from patients and more effective financial reimbursements, thereby reducing their dependence on external resources. The second mechanism, on the other hand, argues that larger hospitals are more complex,[111] and in some cases geographically dispersed,[87] requiring use of IT for better information management.

The lack of positive associations between organizational size and IT adoption is not a new phenomenon, however. As early as 1981, Gremillion[248] studied use of information systems in units of the U.S. Forest Service and found the lack of significance between organizational size and IT use. It was noted that observed findings were in contrast to existing theories and empirical evidence at the time. Two explanations were offered—the existence of an adoption threshold and the role of effective change strategies.[248] In the first explanation, there might be a threshold for the relationship between organizational size and IT use, where organizations smaller in size than a certain threshold are unlikely to adopt and use IT, while organizations larger than the threshold would likely adopt IT. The effect of size may be insignificant if the study focuses on organizations that are either below or above the threshold (e.g., among organizations that are mostly larger than the threshold). The second reasoning posits that IT adoption and use is a function of how well the organization manages change to overcome resistance. Gremillion concluded that in his study evidence suggested the second explanation was likely.[248]

In this study, the lack of a significant positive association between organizational size and some of the IT adoption scores does not appear to be related to presence of an adoption threshold as Gremillion proposed.[248] Bivariate scatterplot of hospital bed size and overall scores for any factor (see Figure 5.13, for instance) did not reveal a relationship predicated on a certain threshold. Many small hospitals in this study had high IT adoption scores, while large hospitals not necessarily did. Even if such a threshold exists, hospital size would be a prohibitive threshold rather than a facilitative threshold as Gremillion argued, since two of the three significant effects of bed size were negative. The notion that when a certain point is reached, hospitals are less likely to adopt IT is theoretically plausible. For instance, when the organization's complexity reaches a certain point, the costs to adopt IT, in financial or managerial terms, may outweigh the benefits. The observed negative effects of bed size on the levels of IT-supported clinical

EHR workflows (order entry and results viewing) and inpatient clinical documentation may in theory result from such a mechanism, since larger hospitals generally have more complex workflows and generate larger amount of patient information that could make it harder to fully implement IT to support their patient care processes. However, the lack of observed threshold effect in this study argues against this explanation. The presence of a small but positive association of bed size and adoption of infrastructural technologies (networking, Web site, and master patient index) is in line with the literature.

Gremillion's second rationale, however, is interestingly similar to a key argument of this study. He suggested that it is not how large the organization is, but rather how well the organization manages change, that leads to IT adoption.[248] Coincidentally, this study echoes that statement, arguing that the extent of facilitating organizational cultures and management practices aimed at increasing the success rate of IT adoption that exists is related to the degree of IT adoption. This is confirmed by the observed significant bivariate associations between scores of facilitating operational management and scores of other dimensions, and by the observed effects in the path model between the operational IT management construct on the levels of infrastructural technologies adoption, IT support for clinical workflows, and IT support for inpatient clinical documentation. However, the lack of a significant association between hospital size and the extent of facilitating operational IT management suggests that, while operational IT management is important to other aspects of hospital IT adoption, small and large hospitals do not differ in how well they manage IT implementation, thereby defeating Gremillion's second explanation for the lack of positive effect.[248]

Yet another explanation pertinent to this study is, as previously discussed, the unique nature of Thailand's health IT market. The presence of two popular open-source hospital information system products, locally designed specifically for small and medium-sized hospitals and available economically, led to great enthusiasm among small and medium-sized hospitals. Despite arguments to the contrary, plausible explanations on why public hospitals may adopt more IT could still be offered using Kimberly and Evanisko's two mechanisms.[111]

First, while it's true that larger hospitals would have access to more *facilitative* resources that put them in a better position to adopt IT, smaller hospitals would more easily implement the systems because of their less complex environment, provided that economical solutions are available. In other words, in a market condition where cost-effective solutions that fit the requirements are available, smaller size would *facilitate* adoption because of its relatively more agile, flexible, and less bureaucratic nature. This explanation is supported by the fact that the local hospital information system solutions were designed specifically for small hospitals. Medium-sized and large hospitals are left to struggle with either high investments of costly commercial products that do not necessarily fit their requirements, or the quest for sufficient expertise, executive leadership, and financial resources to self-develop or outsource the development. Many may decide to postpone the adoption decision and wait for the right solutions to be developed or discovered. The researcher's personal experience and the relatively large proportion of self-developed or outsourced systems (Figure 5.8) provide triangulating evidence for this argument.

Secondly, while organizational complexity *necessitates* IT adoption,[111] complexity is not necessarily a property of large hospitals alone. Smaller hospitals may have *relative complexity* because of their limited staffs and other resources. For instance, since all hospitals (or at least all public hospitals) need to send a number of administrative data reports to the Ministry of Public Health, smaller hospitals might have higher relative complexity because they have more limited resources to process the reports. This could explain why complexity and demanding requirements also *necessitate* small hospitals to adopt IT. Open-ended comments of some respondents in this study as well as triangulated findings from a study of Thailand's community health centers[197,249] and the researcher's personal experience suggest that this high administrative workload is present for small hospitals, reinforcing the plausibility of this mechanism. A health IT adoption in South Korean hospitals found that the complexity of the tasks hospital staff perform (*task complexity*) was associated with EHR adoption, potentially because more complex tasks *require* the use of EHR systems to improve effectiveness and efficiency, which further reinforces this argument.[250]

The resource dependence theory could also be used to explain this observation. Small district hospitals depend mostly on claims reimbursements from the government for hospitalized patients enrolled in the universal coverage (UC) scheme. Larger hospitals have higher proportions of patients who pay out-of-pocket or are reimburse through the fee-for-service Civil Servant Medical Benefit Scheme (CSMBS), both of which serve as a great source of income. Small district hospitals as well as some provincial hospitals, therefore, have smaller buffers for unrecuperated expenses and thus have greater needs to secure financial resources through reimbursements. These hospitals therefore have a greater tendency to adopt IT to capture information needed for reimbursements as well as for other reporting purposes.

## 6.3 Instrument Validation

### 6.3.1 Face and Content Validity

As previously reported, face and content validity has been established through interviews with five experts. Experts agreed that the survey instrument appears to measure what it intends to measure (face validity) and important concepts have been adequately captured (content validity). The survey instrument underwent a series of modifications to reduce misinterpretation and cognitive burden of respondents. The Thai-translated version was also reviewed by two Thai experts. Additionally, a pilot study was also done to identify any remaining issues, the results of which led to a restructuring of the questions on internal and external integration sophistication. The restructured questions were conceptually more logical because they better represent the informational component of organizational IT. In summary, the face and content validity was reasonably established.

### 6.3.2 Construct Validity

One analysis that could also provide insights on construct validity is factor analysis. Confirmatory factor analysis was performed to answer the following research question.

**Research Question 3:** Do the data support the conceptualization of hospital IT adoption into four IT sophistication dimensions as proposed? If not, what pattern do the data reveal that will guide the subsequent model testing?

Contrary to the proposed conceptual model, confirmatory factor analysis of the IT sophistication dimensions as conceptualized in Chapter 3 indicates that the hypothesized structure does not fit the data well. Several reasons could be offered. First, the items that supposedly belong to each IT sophistication dimension may not be truly unidimensional, or there may be non-negligible associations between some of the items that are conceptually close beyond what could be explained by the single underlying latent factor (the respective IT sophistication dimension). An alternative explanation is this study's very large sample size and high power that makes it sensitive to small effects not included in the confirmatory factor analysis models. Inspection of the residuals and modification indices indicates that the first explanation is likely. In order to develop and test a theory of hospital IT adoption as proposed, exploratory factor analysis was therefore performed to reveal the pattern of factors from the data that will suggest the proper model in path analysis.

Findings from exploratory factor analysis of all IT sophistication items suggest that some items form factors that do not follow the IT sophistication model as proposed. Specifically, the functional sophistication items do not aggregate into one single dimension but instead form several factors, each with items that are related (order entry of medications and laboratory tests, for example). Some of the factors included both the functional sophistication items and the technological sophistication items (such as adoption of PACS technologies and the extent of IT support on electronic image viewing). These "cross-dimensional" factors suggest that Paré and Sicotte's breakdown of IT sophistication into technologies and functions (among other dimensions)[29] may not be supported by the data when factorial validity is concerned. This is not unexpected because when a hospital adopts a technology (such as an EHR system), they will implement system functionalities that support related operations (such as order entry and clinical notes), which will lead these technological and functional items to aggregate with one another.

The discovered factor patterns from this study are conceptually similar to the concept of technology clusters introduced by Rogers' diffusion of innovations theory[54] and used in Burke and Menachemi's IT munificence concept.[83] Instead of breaking hospital IT into technologies and functions separately, the discovered patterns suggest that we should view hospital IT as consisting of different information systems (e.g., EHR systems) each with a coherent set of functions (e.g., order entry and results viewing). Infrastructural technologies (such as networking, hospital Web site, and master patient index) should be considered separately from other information systems since they focus almost exclusively on the technological aspect but not the functional one). Exploratory factor analysis also shows some of the managerial sophistication items to be of lesser important to hospital IT adoption, and these items were later dropped before subsequent analyses were performed.

While the initial conceptual framework as presented in Chapter 3 did not differentiate between internal and external information sharing, findings from the pilot study, the main study's descriptive analysis, and their Pearson product-moment correlation indicated that both are obviously separate dimensions. The mean scores of these two dimensions were different, and their correlation was weak-to-moderate in size, indicating that they do not measure the same thing and are not part of one uniform construct. After items related to medical imaging were excluded since they did not appear to behave coherently with other items, exploratory factor analysis suggests that items in each of these two dimensions form a single, distinct factor, thereby arguing in favor of these two dimensions' separation.

The observed significant correlations for the scores of all IT adoption factors discovered through exploratory factor analysis offer support for their construct validity. The strength of the correlations, mostly in the weak-to-moderate range, provides evidence for both convergent and discriminant validity. A weak or moderate but significant correlation between two dimensions of the overarching IT sophistication construct suggests that the two dimensions are likely related beyond that occurs by chance, hence establishing convergent validity for IT sophistication. The not-so-strong correlations, on the other hand, indicate that they are two distinct dimensions that do not have a high overlap, thus demonstrating discriminant validity. The significant relationships among the IT adoption factors in path analysis, after adjusting for other factors and hospital characteristics, strengthen the evidence for construct validity. In summary, this study provides considerable evidence for convergent and discriminant validity of the newly discovered IT adoption constructs.

### 6.3.3 Criterion Validity

Criterion validity (specifically concurrent validity) was evaluated in this study using a number of criterion variables. First, a summary 5-point Likert-type question asked respondents for overall perception of their hospital's IT utilization. While inevitably subjective, the degree of perceived overall IT utilization should be higher on average for hospitals that adopt IT to a greater extent. This finding was observed for the scores of all IT adoption factors. The mean scores were consistently higher in a dose-response fashion for increasing levels of overall IT utilization.

The number of PCs in use in the hospitals was also a criterion used to assess concurrent validity. High-adoption hospitals are expected to have more PCs to support their operations. While the numbers provided are likely inexact estimates (as witnessed in the pilot study), they should still be correlated with the levels of IT sophistication on average. Findings confirmed the significant relationships (except for the extent of IT support for inpatient clinical documentation and the extent of external information sharing). The relatively weak correlations suggest that the number of PCs, which has been used as a measure of organizational IT adoption in some studies,[28] is not a good proxy for IT adoption. When the number of PCs *per hospital bed* was used as a criterion variable instead, all significance remained, and in fact the significant correlations between the criterion and scores of the extent of IT support for inpatient clinical documentation and the extent of external information sharing emerged, all reinforcing their criterion validity.

Apart from these two criterion variables, certain organizational characteristics such as bed size, teaching status, for-profit status, respondents' IT experience, and the level of IT training, were also used. The significant positive relationships were observed for teaching status, respondents' IT experience, and levels of IT training, but not others. The plausible explanations for the observed negative relationships between for-profit status and IT adoption scores (or conversely, positive relationships between public status and the scores) and the insignificant or mixed effects of bed size have been offered in the previous section (subsection 6.2.4). While the evidence appears mixed, the insignificant or opposite effects, as argued, may result from Thailand's local context that differs from that of the vast majority of the literature. The significant associations between the IT adoption scores and respondents' perceived overall IT utilization and the number of PCs in use per hospital bed provide reasonable evidence of concurrent (criterion) validity.

### 6.3.4 Reliability

This study assessed two types of reliability—interrater reliability and internal consistency reliability. Interrater reliability was measured in the pilot study by intraclass correlations as noted in Chapter 4. Results from multiple respondents in the same hospitals served as the different raters of the same object of measurement. Unfortunately, findings suggest that the instrument, specifically the version used in the pilot study, suffered from poor interrater reliability of several IT sophistication dimensions. Subjective interpretation of each IT sophistication dimension is inevitable and would explain some of the poor interrater reliability.[216] Other experts cautioned against using an arbitrary cutoff value (such as 0.75) for good interrater reliability because of its problematic conceptualization.[217] The fact that only five hospitals were included in the pilot study and the various respondent roles recruited could also contributed to the poor response agreement.

Nevertheless, results prompted many improvements in the survey instrument, including dropping non-essential items (which likely resulted in differing responses), improving the wording, and restructuring of the integration sophistication dimensions. The cover letter used in the nationwide survey also emphasized the need for IT executives or IT staff members as respondents if possible to reduce the likelihood of large variations. It is believed that with the improvements made, the nationwide survey instrument likely performs better.

After the factor patterns based on the data were revealed through exploratory factor analysis, the internal consistency reliability of the six IT adoption factors were assessed. All factors except the adoption of basic infrastructural technologies had a value for Cronbach's alpha of at least 0.86 in the nationwide study. With experts recommending a criterion of 0.70 for acceptable reliability, these factors seem to perform well overall. The relatively low Cronbach's alpha for the extent of adoption of basic infrastructural technologies (0.64) may be because it consists of only four items and some items such as hospital Web site did not perform very well. Nevertheless, it represents an important aspect of hospital IT adoption that is distinct from other factors.

In summary, this study began with a conceptual model based on Paré and Sicotte's IT sophistication framework,[29] modified by adding a new dimension focusing on facilitating IT management practices and using a newly developed survey instrument that improves upon their original work. While the instrument has face and content validity, the conceptualized model of hospital IT adoption does not fit the observed data according to confirmatory factor analysis. This indicates that while Paré and Sicotte's IT sophistication framework[29] may be useful, it does not fully reflect the reality of hospital IT adoption, at least in the context of Thailand. Nevertheless, their model served as a starting point, which together with this study's subsequent analyses led to a new set of IT adoption constructs that is revealed from the observed data. Analyses provided reasonable evidence supporting these IT adoption constructs' construct validity, criterion validity, and reliability. There are certainly rooms for improvement (such as finding ways to improve the reliability of the extent of infrastructural technologies adoption), and it remains to be seen if future validation studies could reproduce this study's findings.

### 6.4 Evaluation of the Proposed Conceptual Framework

The path analysis to evaluate the hypothesized model (Figure 3.2) needed to undergo an initial model respecification because accreditation status information was unavailable to this study; IT budget and size of IT workforce were extremely unreliable; and the proposed structures of IT sophistication dimensions did not fit the data well, requiring new factors discovered through exploratory factor analysis to be used instead. When this initial respecified model was evaluated, the first step was to evaluate its model fit statistics.

The respecified model (Figure 5.16) did not have a good model-data fit. But with addition of an effect to the model, informed by model diagnostic information, the resulting model (Figure 5.17) fitted the data well. However, the respecifications necessarily capitalize on chance, so these model fit statistics need to be interpreted with caution until it is cross-validated in independent samples. The model respecifications led to a new set of hypotheses as summarized in Table 6.1 that replaces the initial set of hypotheses in Chapter 3. To answer the last research question, the revised list of hypotheses as shown in Table 6.1 is evaluated.

| **Research Question 4:** Are the associations hypothesized in the model statistically significant? |
|---|

**Table 6.1** Summary of tested hypotheses and their findings.

| Hypothesis | Finding |
|---|---|
| **R1:** There is a significant positive direct effect of hospital size on the extent of facilitating operational IT management. | Not supported; No significant effect |
| **R2:** There is a significant positive direct effect of teaching status on the extent of facilitating operational IT management. | Not supported; No significant effect |
| **R3:** There is a significant negative direct effect of public status on the extent of facilitating operational IT management. | Not supported; No significant effect |
| **R4:** There is a significant positive direct effect of hospital size on the extent of adoption of infrastructural technologies. | Supported |
| **R5:** There is a significant positive direct effect of teaching status on the extent of adoption of infrastructural technologies. | Not supported; No significant effect |
| **R6:** There is a significant negative direct effect of public status on the extent of adoption of infrastructural technologies. | Not supported; Significant effect in the opposite direction (positive) |
| **R7:** There is a significant positive direct effect of hospital size on the extent of clinical EHR workflows that are supported by IT. | Not supported; Significant effect in the opposite direction (negative) |
| **R8:** There is a significant positive direct effect of teaching status on the extent of clinical EHR workflows that are supported by IT. | Not supported; No significant effect |
| **R9:** There is a significant negative direct effect of public status on the extent of clinical EHR workflows that are supported by IT. | Not supported; No significant effect |
| **R10:** There is a significant positive direct effect of hospital size on the extent of inpatient clinical documentation that is supported by IT. | Not supported; Significant effect in the opposite direction (negative) |
| **R11:** There is a significant positive direct effect of teaching status on the extent of inpatient clinical documentation that is supported by IT. | Not supported; No significant effect |
| **R12:** There is a significant negative direct effect of public status on the extent of inpatient clinical documentation that is supported by IT. | Not supported; Significant effect in the opposite direction (positive) only when not accounting for measurement errors, but no significant effect when accounting for errors |
| **R13:** There is a significant positive direct effect of the extent of facilitating operational IT management on the extent of adoption of infrastructural technologies. | Supported |
| **R14:** There is a significant positive direct effect of the extent of facilitating operational IT management on the extent of clinical EHR workflows that are supported by IT. | Supported |
| **R15:** There is a significant positive direct effect of the extent of operational IT management on the extent of inpatient clinical documentation that is supported by IT. | Supported |
| **R16:** There is a significant positive direct effect of the extent of adoption of infrastructural technologies on the extent of clinical EHR workflows that are supported by IT. | Supported |
| **R17:** There is a significant positive direct effect of the extent of adoption of infrastructural technologies on the extent of inpatient clinical documentation that is supported by IT. | Supported |

**Table 6.1** Summary of tested hypotheses and their findings (continued).

| Hypothesis | Finding |
|---|---|
| **R18:** There is a significant positive direct effect of the extent of facilitating operational IT management on the extent of internal information sharing. | Supported only when not accounting for measurement errors, but no significant effect when accounting for errors |
| **R19:** There is a significant positive direct effect of the extent of adoption of infrastructural technologies on the extent of internal information sharing. | Supported |
| **R20:** There is a significant positive direct effect of the extent of clinical EHR workflows that are supported by IT on the extent of internal information sharing. | Supported |
| **R21:** There is a significant positive direct effect of the extent of inpatient clinical documentation that is supported by IT on the extent of internal information sharing. | Supported |
| **R22:** There is a significant positive direct effect of the extent of facilitating operational IT management on the extent of external information sharing. | Not supported; No significant effect |
| **R23:** There is a significant positive direct effect of the extent of adoption of infrastructural technologies on the extent of external information sharing. | Not supported; No significant effect |
| **R24:** There is a significant positive direct effect of the extent of clinical EHR workflows that are supported by IT on the extent of external information sharing. | Not supported; No significant effect |
| **R25:** There is a significant positive direct effect of the extent of inpatient clinical documentation that is supported by IT on the extent of external information sharing. | Supported |
| **R26:** There is a significant positive direct effect of the extent of internal information sharing on the extent of external information sharing. | Supported |
| **R27*:** There is a significant positive direct effect of public status on the extent of internal information sharing. | Added during respecification according to model diagnostics; Supported |

An asterisk (*) indicates a hypothesis added during the model respecifications. The numbers of all hypotheses are prefixed by R to indicate that all were part of a revised set of hypotheses that was necessitated by the data, not the initial set of hypotheses as proposed in Chapter 3.

Overall, most of the hypothesized relationships among the six constructs (Hypotheses R13-R26) were supported by the data based on the final respecified model, with a few exceptions. The extent of external information sharing was not directly associated with the extent of facilitating operational IT management, the extent of adoption of infrastructural technologies, or the extent of IT support for clinical EHR workflows (order entry and results viewing), although it was positively associated with the extent of IT support for inpatient clinical documentation. This latter association seems logical because the extent of inpatient clinical documentation supported by IT would determine the amount of patient information that is available in the electronic format, a prerequisite for information sharing within or outside the hospitals. The significant association between the extent of facilitating operational IT management and the extent of internal information sharing disappeared when measurement errors were included in the model, suggesting that much of the effect of IT management performance on information sharing is mediated through other variables in the model such as adoption of infrastructural technologies and the extent of IT support for clinical functions.

It was surprising that most of the hypotheses involving hospital characteristics and other IT adoption constructs were not supported. Teaching status was not associated with any other constructs, while public status was positively associated with adoption of infrastructural technologies contrary to its hypothesized negative effect. Hospital size had mixed effects, from a positive association with infrastructural technologies adoption to negative associations with the levels of IT-supported clinical EHR workflows and inpatient clinical documentation. Plausible reasons for unsupported hypotheses on size and public status have been offered earlier in the chapter.

Several plausible explanations for the insignificant effect of teaching status in the model are offered here. First, being a teaching hospital may in fact not be associated with more sophisticated IT environment, especially when other characteristics have been adequately adjusted for. Second, respondents may have interpreted the survey question on teaching status differently. It is possible, based on the survey wording, that respondents would indicate that their hospitals are teaching hospitals because medical students are rotated there as part of the hospitals' affiliation with a medical school. Apart from having medical student rotations, these hospitals might not have other high-quality processes and capabilities that true teaching hospitals have. This could dilute any effect inherent in teaching status, if any, and contribute to the lack of significance. Descriptive statistics show that about 21% of the hospitals were teaching hospitals, a likely inflated proportion. The second explanation is therefore likely. Unfortunately, higher quality data were not available for teaching status to remediate this possible issue. Finally, the observed associations between teaching status on one hand and bed size and public status on another, as noted in Section 5.4, might create a multicollinearity problem which results in unstable estimates with large standard errors. This could potentially lead to the observed significant associations between IT adoption and other hospital characteristics but not between IT adoption and teaching status, even if the teaching status in fact has a real effect on IT adoption. However, the standard errors for the parameter estimates of these characteristics in the path model were not much higher when compared to those of other variables, and the large sample size in the path analysis should result in reasonably stable and precise parameter estimates. Therefore, the effect of multicollinearity, if any, should be small. Nevertheless, the findings did not substantially differ from the previously analyzed model when either public status or teaching status was excluded.

The positive association between public status and internal information sharing beyond the effects of technology adoption and IT-supported clinical functions was discovered, at least in this population, based on the model diagnostic information. Public hospitals tend to have highly integrated internal IT environment, a likely effect of adopting one or a few main information systems, as discussed previously, as opposed to the best-of-breed approach often found in large and private hospitals. Whether this effect is unique to Thailand's situation or it is present in other countries is unclear.

In summary, this study provides empirical evidence against the conceptualization of hospital IT adoption as consisting of technogies, functions, and integration as suggested by Paré and Sicotte's IT sophistication framework.[29] While the framework may be useful for IT implementers, it does not reflect how hospital IT adoption works in reality. The use of their framework in this study gave rise to a new conceptual model informed by the observed data. The resulting model still retains some features of the original model, such as the existence of constructs that focus on the technological, functional, and information integration aspects of IT adoption. Unlike the original model, however, the use of health IT to support hospital functions is broken down into two aspects, one focusing on clinical workflows such as order entry and results viewing; and another on inpatient clinical documentation. The levels of information sharing within and outside the hospitals are also considered separate constructs. The importance of facilitating IT management practices such as change management, user involvement, and workflow considerations was also clearly demonstrated. It is important to note that the items that constitute the extent of IT support for clinical workflows are very similar to what experts have identified as important EHR functions,[16,21,97,207] although some functions such as problem lists, medication lists, and radiologic reports viewing were not measured in this study. Overall, this study benefits from the ideas behind the IT sophistication framework but offers an improved model that should be useful and relevant to future hospital IT adoption endeavors.

### 6.5 Open-Ended Comments

Emerging themes from the open-ended comments were not less interesting. Many respondents expressed hope or support for a centrally-developed hospital information system that can be used in hospitals (or at least public hospitals) nationwide. Several respondents cited the inefficiencies of the current heterogeneous environment and cost savings that could be made with a homogenous platform, while others suggested that it is the way to bring about HIE that would benefit both patients and providers. Theera-Ampornpunt[245] suggests that this “one size fits all” idea originates from misconceptions about standards and interoperability where many people believe that the only effective way to exchange data between hospitals is when the hospitals use the same system. The smaller-scale “one province, one system” initiatives[244] mandated by health officials in a few early-adopting provinces also exacerbate this misunderstanding. In his papers,[192,245] Theera-Ampornpunt argues that the idea is not realistic in a scale any larger than a province and more harms could be made to the hospitals and patients because of poor organization-technology fit. This position is echoed by one of the respondents in this study who noted that in her specialy hospital, the technology available in the market does not really meet the hospital’s needs. The considerable proportion of hospitals that use self-developed or outsourced solutions also reaffirms that the goal of homogeneous environment is unrealistic. Efforts toward standards, interoperability, and HIE should address this misconception.

Nevertheless, the frequent mentions of concepts related to standards and interoperability, including standard data sets and unique identifiers, offer some encouragement. With the initial IT implementation successful in many hospitals, the focus now turns to how to best utilize the information and leverage the existing infrastructure to benefit individual and population health. Enthusiasms on standards and interoperability could pave a way toward dialogue for HIE collaboration. Policymakers should also seize this opportunity to provide building blocks for sustainable HIE developments. Some respondents' concerns on information privacy when asked about external information sharing, could be an important barrier toward HIE. Policymakers should address this privacy issue through proper regulations, governance, and education that would enable information exchange to benefit patients while at the same time protect their privacy.

Another prominent theme was the human resource issues. An overwhelming number of respondents, mostly from small to medium-sized public hospitals, cited recruitment and job security of hospital IT staffs as a serious concern that prohibits sustainable IT development within the hospitals. Similar themes were documented by Pongpirul et al. in a qualitative study of hospital representatives from five provinces in Thailand,[201] which provide triangulation for this study's findings. A parallel human resource issue was the ongoing development and training of IT and hospital personnel. This issue was also found in a study of health IT adoption in Thailand's community health centers by Kijsanayotin.[249] Policymakers should take serious note of these issues, especially given that they have been documented in the literature for many years and still echoed, in a particularly emphatic tone at times, in this study.

Barriers to IT adoption were also remarked by some respondents. Inadequate financial resources were frequently cited as an issue, which is also reinforced by some respondents who suggested that budget allocation procedures from the top down need to better facilitate hospital IT adoption. Regulatory barriers include procurement bureaucracies and perceived lack of validity for electronic data, although the Electronic Transactions Act has actually been enacted since 2001. The lack of the Ministry of Public Health's political will and leadership in IT development was also mentioned. Policymakers need to address all of these issues in order to facilitate widespread adoption.

One last theme that was clearly evident but unexpected by the researcher is the support and enthusiasms expressed for this study. Comments suggest that these respondents felt they were left alone to struggle with few if any studies on this important issue being conducted. The disenfranchised feelings could explain the very satisfactory response rate this study enjoyed. It is important that this line of research continues so that an open line of communications is maintained between academic researchers and IT workers in the field. In addition to the substantive research questions being addressed, this would make it possible for information and attitudes of local workers to be gauged, fed to policymakers, and ultimately addressed.

## 6.6 Study Implications

### 6.6.1 Implications for Thailand's Public Policy

This study has several important implications for public policy. First, descriptive statistics suggest that IT adoption is lower among hospitals from southern, western, and eastern regions. Policymakers should focus more on these regions, identifying systematic barriers that could be addressed. They would also benefit from better insights from other regions with higher adoption, such as the northeastern and the northern regions. Lessons drawn from these regions would not only benefit other regions across Thailand but could also be useful for other developing countries with similar endeavors.

Comparing across different aspects of IT adoption, the relatively high degrees of infrastructural technologies adoption, IT-supported hospital functions, and information sharing within the hospitals overall are encouraging. They suggest that many hospitals already have some IT infrastructure in place to help them conduct their operations. The low level of external information sharing indicates the virtually complete absence of HIE in Thai hospitals nationwide. It is important to identify perceived and actual barriers of HIE that need to be addressed before a large-scale HIE becomes a reality. At the very least, the privacy issues raised by some respondents need to be addressed. The realistic path forward for large-scale interoperability also needs to be clearly laid out and communicated to stakeholders, in parallel to efforts to develop national standards on health IT as experts have recommended.[193]

The adoption rates of EHR and CPOE in Thailand are very encouraging. More studies should be conducted to independently confirm this observation, looking more closely into these technologies. With the relatively high EHR adoption in the outpatient setting, the focus of policymakers and hospital executives should be on how to translate high adoption in the ambulatory setting into the less-adopted inpatient setting. Another important question that is relevant to researchers, hospital executives, and policymakers alike is whether adopting such health IT leads to improved clinical processes and patient outcomes, and how the providers and patients feel about the systems, especially given the dearth of this evidence in Thailand and inconclusive evidence in some areas in the literature.

Contrary to the conventional wisdom, public hospitals in Thailand do not lag behind private hospitals on IT adoption. To the contrary, private hospitals may have a lesser tendency to adopt technologies and exchange information within their walls. If a true HIE is envisioned, private hospitals deserve a close look by policymakers to ensure that they are not left behind and that incentives and value propositions encourage them to participate.

Finally, policymakers need to fix the job recruitment and job security issues as many respondents outcried. Specifically, hospitals need to have permanent IT positions to allow them to sustainably develop and maintain their IT environment, a critical component of today's and future's health care. Any bureaucratic barriers, especially those instituted by the Office of the Civil Service Commission (as some respondents have mentioned) that prevent recruitment and retention of qualified IT specialists, need to be tackled. Ongoing efforts to train the country's informatics workforce need to be promoted, which reinforces a recommendation by national experts.[193]

### 6.6.2 Implications for Health Informatics Communities

The conceptual framework evaluated in this study provides a useful theoretical guide for researchers and health IT implementers. The associations between facilitating organizational IT management and other aspects of IT adoption suggest that organizations should not only focus on the technical and functional aspects when implementing a technology but also on the associated sociocultural and managerial aspect. As any health informatics expert would testify, it is not enough to have a great technology but it is also important to pay attention to how the IT implementation project and the changes it introduces are envisioned, planned, managed, and communicated. The needs to involve users, consider workflow implications, provide adequate training, and learn from past experience cannot be overstated. In addition to implementers, future health IT adoption researchers should keep this important aspect of IT adoption in mind when studying IT adoption.

The interesting findings related to the relationships, or the lack thereof, between hospital characteristics and IT adoption have important implications for other countries and IT adoption researchers. At the very least, it presents new contrasting evidence against the effect of hospital size and for-profit status. This could be merely an aberrant finding from just one locale, but it might also create a new line of studies to test the arguments that better explain the observation. For policymakers in other countries, individual contexts will dictate the facilitators and barriers of IT adoption, but findings from this study may suggest ways to overcome the “adoption chasm” by optimally shaping the local market conditions. For instance, appropriate funding and systematic promotion of open-source or low-cost well-designed health IT products that meet the needs of many target hospitals might spur the adoption. Encouraging collaboration, constructive dialogue, and sharing of lessons learned among peer hospitals would also create a momentum and social influence that may accelerate adoption toward "the tipping point." More studies should attempt to study the local health IT markets in Thailand and draw lessons for other developing countries. It would also be interesting to see how Gladwell's concepts in "The Tipping Point"[251] could be applied to study Thailand's health IT adoption.

### 6.7 Study Significance

This study is among the first quantitative studies of organizational health IT adoption to specifically include organizational cultures and management practices in the analysis and consider them a crucial part of the IT adoption process. While extensive qualitative studies and expert opinions have documented the importance of these sociocultural and managerial factors, this study provides quantitative evidence that supports their importance. It is also one of the rare health IT adoption studies at the organizational level that are heavily rooted in a theoretical framework.[28] The application of Paré and Sicotte's IT sophistication model[29] provides a useful multi-faceted conceptualization of IT adoption, with its breakdown of IT adoption into technologies, functions, and information sharing. With the added "managerial" aspect, this study further refines the model and argues that this "soft" component of organizational IT is as important as other more identifiable components. The necessary split of information sharing into internal and external dimensions, as indicated by the data, also suggest that these two properties behave quite differently and should be treated as such. Although in the end the factor analysis findings indicated a poor fit between this conceptualization of IT adoption and the data, they gave rise to a new plausible theoretical model. This new model still somewhat resembles Paré and Sicotte's IT sophistication framework[29] but was able to fit the data reasonably better and logically explain the interrelationships among the constructs, while also highlighting the roles of facilitating organizational IT management on various aspects of hospital IT adoption.

In addition to simple univariate and multivariate analyses common to most health IT adoption studies, this study also employed more advanced path analysis techniques to move the science and theory of health IT adoption forward. The use of path analysis or even more sophisticated structural equation modeling and similar methods, is not new in fields like psychology, sociology, organizational behaviors, or information science. It is not new either in studies of health IT adoption and use at the individual level. But this study ranks among the few organizational-level IT adoption studies in the health care setting that use these techniques.

The atypical observations regarding the relationships between hospital characteristics and IT adoption also offer an uncommon opportunity for future researchers to investigate how these hospital characteristics relate to health IT adoption. Different causal mechanisms may be offered that contrast to existing propositions and move us toward better understanding of how the social contexts influence organizational behaviors.

This study also exemplifies how a cross-study and cross-country comparison of health IT adoption could be done. While remaining definitional and methodological issues prevented the definitive conclusions to be drawn, this study attempted to use definitions that were as close as possible to that of recent prior studies.[21,97] It also shows that a breakdown of IT adoption into several dimensions does not preclude us from conducting comparative analysis with other studies.

Finally, this study is the first scientific study that offers high-quality estimates of health IT adoption in Thai hospitals. The survey was done nationwide with a high response rate. While a previous study already exists,[200] that study suffered from much lower response rate and measurement issues that prevent reliable adoption estimates to be derived. It was also conducted six years before this study, and as evident in this study's findings, a lot has changed since then. Another study has focused on IT adoption among Thailand's community health centers.[196-198] This study provides information about Thai hospitals' IT adoption that was a large missing piece in Thailand's health IT adoption puzzle.

### 6.8 Study Limitations

While this study contributes to the knowledge body on health IT adoption, it also has some important limitations. First, it is a cross-sectional observational study, which prevents it from establishing causation. Associations between factors in the conceptual framework do not necessarily suggest that these factors actually cause successful IT adoption, although it is believed that use of path analysis in this study is a step forward in providing plausible mechanisms. In his seminal book, Bollen[226] extensively discussed the issue of causation in structural equation modeling. Three important components are required before causality can be concluded—isolation, association, and direction of causation. Isolation refers to the separation of an explanatory variable's effect on a dependent variable from effects of other variables. In this study, some degree of isolation was achieved through adjustment of likely confounding effects, such as the use of hospital bed size, teaching, and public status together in the analyses. However, it is still possible that unmeasured confounders, such as accreditation status, may contribute to the observed effects. Association refers to the observed association "net of other influences."[226] The use of path analysis in this study allows significant associations controlling for other factors to be observed. Lastly, direction of causation is determined through either temporal priority or "causal priority."[226] The latter notion stipulates that if a variable (such as the respondent's age) cannot be affected by another variable it is associated with (such as attitudes or emotions), the direction of causality from the second variable to the first variable is impossible. In this study, hospital characteristics very likely have causal priority over IT adoption constructs because any non-negligible causal effect from adopting IT to changes in the hospital's size, public status, or teaching status is not easily imaginable.

The observed associations between two IT adoption constructs in the model (the extent of adoption of infrastructural technologies and the level of IT-supported clinical EHR workflows, for instance) do not necessarily suggest that one occurs before, and thus is the cause of, the other. In this study and its resulting models, causation is not implied.

This limitation on causation is echoed in the notion of equivalent path models.[209] These equivalent models, common in path models, behave in a statistically similar manner to this study's model but with directional differences in some effects. The models cannot be distinguished statistically, and can only be eliminated if they are not causally plausible. In this study's models, reversal of the effect direction of certain IT sophistication constructs on others (such as between clinical EHR workflows supported by IT and infrastructural technologies adoption) produces an equivalent model. Given the complexity of the model in this study, there are likely several equivalent models, none of which could be distinguished statistically. The resulting model in this study, therefore, needs to be interpreted with caution. However, this study does not stress as much on the direction of causal effects among the six IT adoption constructs as their conceptualized associations and their relationships with hospital characteristics. In other words, we would expect that several of these constructs in the model (e.g., adoption of infrastructural technologies, the level of IT-supported clinical EHR workflows, the level of IT-supported inpatient clinical documentation) would occur together when a hospital decides to adopt and use health IT. Whether one comes before and thus causes another is not as important as the notion that, given that they are associated with one another, we should look at these aspects together in a balanced way when implementing health IT. Therefore, with proper caution against causal interpretation, the model should still be useful for IT implementation and future research.

The model analyzed used findings from exploratory factor analysis to inform the proper model specification and underwent steps of respecification that repeatedly fitted the model on the same data. While this technique is acceptable and sometimes necessary in early theory development, it capitalizes on chance.[209] The model that is fitted again and again over the same data set would certainly improve. Therefore, the final model with satisfactory fit statistics may merely reflect the overfitting rather than the true model in the population. It is important that the model be cross-validated in independent samples to assess if it is externally valid. Nevertheless, given this study's large sample size and only a few steps of respecifications, the chance capitalization should not be too great.

Like other surveys, this study is susceptible to certain kinds of errors that could influence the results. While several strategies led to a satisfactory response rate, nonresponse bias was present. The tendency of respondents to be public hospitals, somewhat larger in size, and with some geographic variations, when considered together with the observed findings, suggest that this study may overestimate the level of IT adoption and IT sophistication. Respondents of different roles might tend to have different perspectives that confounded the findings. It is also possible that the respondents would not provide truthful and accurate answers to the survey questions. This study allowed respondents to complete the questionnaire anonymously, which should alleviate some concerns about their truthfulness. The tendency of subjects to respond in a socially-desirable manner is always possible, but the clearly low average scores on external information sharing compared to other aspects of IT adoption, together with the fact that the identities of individual respondents and hospitals will not be revealed to the public, should reduce the concern of this phenomenon.

The poor interrater reliability observed in the pilot study is worrisome, although various logical improvements have been made based on the results of the pilot study. The acceptable internal consistency reliability for most of the factors nevertheless provides some confidence for the measurement properties of the instrument. Although one aspect of IT adoption (the extent of adoption of basic infrastructural technologies) had relatively low internal consistency reliability, incorporating these reliability measures to account for measurement errors in path analysis did not change most of the significant associations observed, providing an even stronger case for this study's findings.

Lastly, the findings and the models were evaluated in one population. The social contexts and other uncaptured phenomena may explain the observed findings in this study but these relationships may not be reproducible in other settings. Until reasonable evidence is provided through cross-validation, the resulting model reflects only findings of this sample and should be interpreted cautiously when generalized to other settings.

### 6.9 Areas for Future Research

This study opens a wide array of opportunities for future research. Although the study itself is cross-sectional in nature, it allows for subsequent studies to track the progress of IT adoption in Thai hospitals over time and make longitudinal comparisons. It would also be interesting to compare the state of IT adoption in Thai hospitals and the country's other settings, such as the ambulatory physician's offices that have not been studied at all. As previously discussed, studies should also investigate the local environments that could explain high adoption in some geographic regions, especially the rural areas. The unique social context and health IT markets in Thailand that give rise to the interesting observations between hospital characteristics and IT adoption should be critically analyzed to identify lessons that other developing countries can learn from Thailand. Additionally, measuring the level of IT adoption enables the evaluation of health IT impacts on clinical outcomes and organizational performance in Thai hospitals. The data can also be used to conduct evaluation studies of certain strategies designed to encourage widespread adoption.

Researchers who are interested in the theoretical side of the study can also try to replicate the findings by evaluating the final model, or its variations, in other samples, or in other types of organizations within and outside health care. Cross-validation would provide more information about the model's validity. Studies could also focus on refining or modifying the model, for instance by investigating how the effects of organizational factors differ between samples, identifying additional factors that are associated with IT adoption, or discovering relationships not postulated in this study. One particular potential improvement is to investigate how hospital IT budget and size of IT workforce play a role in the model of hospital IT adoption, an endeavor that this study was unable to fulfill due to data quality issues. These efforts will help improve the model's explanatory power, its generalizability, and our theoretical knowledge. Qualitative studies to confirm, investigate, or disprove findings or arguments in this study are also encouraged. These include studies on IT adoption decision-making, the roles of facilitating management practices on aspects of IT adoption, and the nature of information sharing within and outside the hospitals.

The instrument development aspect of this study could also be improved. For instance, researchers might wish to test how the instrument performs in other samples or find ways to improve the item wording or the list of items. The items for the extent of adoption of basic infrastructural technologies, with relatively low internal consistency reliability, may particularly benefit from efforts to improve them. Finally, the underlying factor patterns using a different sample could be compared with those of this study.

With the multitude of research opportunities it offers, this study serves as an influential starting point for streams of IT adoption research in years to come.

## 6.10 Conclusion

With the influential roles of health IT on quality and efficiency of care, it is important for health IT adoption research to capture the state of health IT adoption as well as providing theoretical understanding that would be helpful to practitioners, policymakers, and researchers. This study tackles both the practical and scientific fronts by conducting a nationwide survey of Thai hospitals' adoption of information technology. Given the lack of knowledge about the baseline level of IT adoption in Thai hospitals, this study captures and compares the country's state of adoption so that appropriate policies can be made. Together with a previous study investigating IT adoption in Thailand's community health centers,[196-198] this study provides a more complete picture by offering the much needed insights on IT adoption in Thailand's hospital setting. It suggests that IT adoption in Thai hospitals appears encouraging, and there are unique characteristics of Thailand's local social contexts that are responsible for relatively high adoption, including the presence of open-source and low-cost solutions and the social influence among peer hospitals.

This study also provides significant scientific contributions to the field of biomedical and health informatics. By incorporating the managerial aspect into the conceptual framework, this study highlights the role of organizational IT management on successful adoption, an important component that is often missing in previous IT adoption studies. In addition, this study is among the few to investigate the structural relationships between various organizational factors and hospital IT adoption together in one theoretical model. Such a move is believed to be important to the field because it provides a scientific, theoretical explanation on how different organizational factors lead to different aspects of IT adoption, building upon knowledge from previous studies. Findings reaffirm the importance of the organizational IT management aspect and the utility of Paré and Sicotte's IT sophistication framework,[29] although this framework did not fit well with the data and ultimately gave rise to a new theoretical model of hospital IT adoption. The theoretical understanding gained from this study not only serves as foundations for future research but also as helpful guides for policymakers and practitioners to successfully tackle the adoption problem.

To honor the respondents who participated in this study and the country from which this study benefited, the final model after taking measurement errors into account (with the significant paths in Figure 5.19) is named the "Theory of Hospital Adoption of Information Systems (THAIS)" by the researcher. The model is not necessarily considered complete or valid, and more work is needed to determine the applicability and usefulness of the model. Naming of this model is intended only to encourage its clear and unambiguous reference for future studies. It is the researcher's hope that the resulting model from this study's analyses serves as the input for further validation, refinements, or disconfirmation in future studies.

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# Appendix A

Pilot Survey Instrument and

Other Documents for the Pilot Study

## Cover Letter for Pilot Survey (English)

คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
๒๗๐ ถนนพระราม ๖ แขวงทุ่งพญาไท เขตราชเทวี กทม. ๑๐๔๐๐
โทร. ๐-๒๓๕๔-๗๒๗๕, ๐-๒๒๐๑-๑๒๙๖ โทรสาร ๐-๒๓๕๔-๗๒๓๓

**Faculty of Medicine Ramathibodi Hospital, Mahidol University**
270 Rama VI Road, Ratchathewi, Bangkok 10400, Thailand
Tel. (+66) 2354-7275, (+66) 2201-1296 Fax (+66) 2354-7233

No. /2010

Medical Informatics Division
Office of the Dean
Faculty of Medicine Ramathibodi Hospital

July 20, 2010

Re: Asking for participation in a pilot study to evaluate the adoption of information technology in Thai hospitals

To:

In today's environment, hospitals have employed Information technology (IT) to support the work of health care practitioners. However, the picture about the extent to which hospitals in Thailand utilize IT is still largely unclear, making policy planning and creating strategies to facilitate hospital use of IT difficult. Use of IT in hospitals is therefore unintegrated and facilitation from government agencies is lacking. Hospitals also lack information about the situation of IT adoption in other hospitals and factors that will facilitate better ouse of IT, which will be very useful for planning, decision making, and management of hospital information systems. Moreover, patients also lose the opportunity to receive more convenient, timelier, safer, and higher quality care through the use of technology. It is therefore necessary to conduct more studies to produce knowledge very valuable to policymakers as well as hospital administrators and IT workers. This will ultimately offer values to the patients and hospitals in the long term.

My name is Dr. Nawanan Theera-Ampornpunt. I currently work in the Medical Informatics Division, Faculty of Medicine Ramathibodi Hospital, Mahidol University, and I am also currently a Ph.D. student in Health Informatics at the University of Minnesota in the United States. I'm working on a dissertation research study called the Thai Hospitals' Adoption of Information Technology Survey (THAIS), by sending questionnaires to all hospitals to assess the level of hospital IT adoption. Research findings will be useful for planning and policymaking in our country's public health.

I would like to assess the appropriateness of the questionnaire in a pilot study before sending the questionnaires to all hospitals nationwide. For this reason, your hospital has been selected as a suitable candidate for participation in this pilot study. I therefore would like to ask you to forward the ten questionnaires I attached to three groups of workers in your hospital and ask them to complete the questionnaire: 1) IT executives or other IT staff members responsible for administering, developing, or maintaining the information systems, B) health care professionals who are users of the hospitals' information systems, C) you and/or other hospital executives. Please include all three groups of workers among the respondents (one questionnaire for each individual) and return them individually to me using the attached stamped envelopes **by August 16, 2010**. The choice and number of respondents in each group are upon your discretion.

This study has been approved by the Committee on Human Rights to Researches Involving Human Subjects of the Faculty of Medicine Ramathibodi Hospital, Mahidol University. You can find more information about the study in the attached Participant Information Sheet. When the study is completed, I would be happy to send the study results to your hospital for comparison with other hospitals and for your hospital's strategic planning. In addition, respondents who complete and return the questionnaire will receive a small token of appreciation for their time in the amount of 150 baht per person if they provide their name and contact information at the end of the questionnaire.

I therefore ask for your assistance in this regard and thank you and your hospital's employees very much for spending time to complete the questionnaires. If you have a question, please don't hesitate to contact me directly at 0-2201-2992, 087-111-3853.

Best regards,

Nawanan Theera-Ampornpunt, M.D.
Principal Investigator

## Informed Consent Documents for Pilot Survey (English)

### Participant Information Sheet

Thank you very much for your interest in this study about how hospitals in Thailand adopt and use information technology. You have been selected as part of the target sample in this pilot study because you work in a hospital that participates in this pilot. The purpose of this pilot study is to assess the appropriateness of the questionnaire before conducting a nationwide survey. We ask that you spend time reading the following information and asking any questions you may have before completing the questionnaire.

| | |
|---|---|
| **Study** | Thai Hospitals' Adoption of Information Technology Survey (THAIS) |
| **Researcher** | Dr. Nawanan Theera-Ampornpunt<br>Medical Informatics Division, Faculty of Medicine Ramathibodi Hospital, Mahidol University<br>Ph.D. student in health informatics at the University of Minnesota, USA, under the supervision of Prof. Stuart M. Speedie as the academic advisor |
| **Location** | Medical Informatics Division, Faculty of Medicine Ramathibodi Hospital, Mahidol University, 270 Rama VI Road, Ratchathewi, Bangkok 10400 |
| **Sponsor** | Faculty of Medicine Ramathibodi Hospital, Mahidol University |

**Background Information**

Information technology (IT) has the potential to support the work of health care practitioners in a hospital to improve quality and efficiency. However, the picture about the extent to which hospitals in Thailand utilize IT is still largely unclear, making policy planning and creating strategies to facilitate hospital use of IT difficult. Moreover, patients also lose the opportunity to receive more convenient, timelier, safer, and higher quality care through the use of technology. It is therefore necessary to conduct more studies to produce knowledge very valuable to policymakers. Hospitals such as yours would also benefit from the use of such knowledge in IT planning within the hospitals, ultimately offering values to the patients and hospitals in the long term.

This pilot study aims to evaluate the appropriateness of the questionnaire, using your responses along with comments and issues identified during the completion to improve the questionnaire for accuracy of findings in the nationwide survey. The researcher will send 10 questionnaires to each participating hospital, which is asked to forward them to hospital workers, including IT executives, IT specialists, health care professionals, and hospital executives, as appropriate.

**Objectives** This study is a dissertation research study of the researcher, aimed at conducting a survey on the extent of IT adoption and use in hospitals nationwide and identifying facilitating factors that will lead to more IT adoption and use and improved patient care and hospital performance.

**Procedures to be Conducted to Participants** If you agree to be in the study, we will ask you to fill out the attached questionnaire and return it to the researcher. A stamped envelope is provided for your convenience. It should take you about 30 minutes to complete the questionnaire.

**Risks and Benefits of Being in the Study**

There is no risk associated with participating in this study.

There is no direct benefit to you for participating in this study. However, your participation would greatly yield societal benefits by helping policymakers better understand the state of health IT adoption in our country. This knowledge could lead to more effective strategies to facilitate IT use in hospitals, which could benefit your hospital among others, as well as patients and the general population, in the long term. In addition, if specified at the end of the questionnaire, the researcher would provide results of the analysis that will allow the comparison of your hospital's situation with other hospitals nationwide once the study has completed. However, we also understand that answering the questionnaire requires time and inconvenience on your part, and therefore we will give you 150 baht as a token of appreciation once we receive your completed questionnaire, if your information is provided at the end of the questionnaire. While the amount may not be so significant, it serves as a big "thank you" for participating in this study and for your contribution in pushing our nation's health informatics agenda forward to support our entire health care system.

**Confidentiality**

At the end of the questionnaire, there is a space where you can provide your name and contact information if you choose to receive the 150-baht token and/or the study results. Providing your information is entirely optional and the information will not be used to link you and your answers in any analysis. We also use a tracking number that identifies the hospitals we send out the questionnaire to, which is used to help us track which hospitals have responded and to allow us to analyze the responses by hospital characteristics. All questionnaire responses as well as identities and contact information of you and your hospital will be kept private with no one outside the research team having access. If we publish the results publicly, we will only report aggregate findings and will not include any information that will reveal the identity of you or your hospital.

**Voluntary Nature of the Study**

Participation in this study is completely voluntary. Your decision whether or not to participate will not affect your or your hospital's current or future relationship with the Faculty of Medicine Ramathibodi Hospital, Mahidol University, or the University of Minnesota. If you decide to participate, you are free to withdraw at any time without affecting these relationships. You are also free to skip any questions that you do not wish to answer for whatever reason.

**Contact Information for Questions and Issues Related to This Study**

Dr. Nawanan Theera-Ampornpunt
PO Box 125, Pns. Samsen Nai, Phaya Thai, Bangkok 10400
Or Medical Informatics Division, Faculty of Medicine Ramathibodi Hospital
270 Rama VI Road, Ratchathewi, Bangkok 10400
Tel. 0-2201-2992, 087-111-3853 or e-mail: ranta@mahidol.ac.th
Or contact the researcher's academic advisor (Prof. Stuart Speedie) at e-mail: speed002@umn.edu

## Statement of Informed Consent

I have read and understood the information about this study as well as the risks and benefits of being in the study from the researchers, and I agree to participate in this study. I understand that I can ask the researchers should I have further questions or issues, and I can refuse to participate at any time without affecting the relationships and services I'm entitled to. In addition, the researchers will keep information about the identities of myself and my hospital private, which can be disclosed publicly only in an aggregate format. When I complete and return the questionnaire, I have implied my consent to participate in this study in lieu of a signed consent statement.

You may keep this document for your record.

If you have any questions or concerns regarding the research conduct of this study and would like to talk to someone other than the researchers, you are encouraged to contact:
1) Committee on Human Rights Related to Researches Involving Human Subjects, Faculty of Medicine Ramathibodi Hospital at the Ethics in Researches Involving Human Subjects Unit, 3rd Floor, Research Centre, Research and Personnel Benefits Building.
Tel. 0-2201-1544 (regular office hours), or
2) Research Subjects' Advocate Line, University of Minnesota, D528 Mayo, 420 Delaware St SE, Minneapolis, MN 55455 USA. Tel. +1 612-625-1650

**Survey Instrument for Pilot Survey (English)**

**Note:** There are 18 pages in English but 16 pages in Thai. Each page's contents may not exactly match between the two versions.

# Thai Hospitals' Adoption of Information Technology Survey (THAIS)

**Conducted By**

Nawanan Theera-Ampornpunt, M.D.
Medical Informatics Division
Faculty of Medicine Ramathibodi Hospital
Ph.D. Student in Health Informatics
University of Minnesota, USA

**Supported By**

Faculty of Medicine Ramathibodi Hospital
Mahidol University

**2010**

Thank you for your interest in this study. You have been chosen to complete this questionnaire because you work in a hospital that participates in this pilot study. The purpose of this pilot study is to assess the appropriateness of the questionnaire, which will be used in a nationwide survey of hospital IT adoption. Your responses, therefore, would be very helpful to improvement of the questionnaire for the nationwide study. We very much hope that you could spend part of your time completing it, and if you have any comment about the questionnaire, you can provide your thoughts inside the questionnaire or at the end.

If you are not sure about certain questions, please feel free to ask one of your colleagues who may know better or refer to other data sources. If that is not possible, please provide the most appropriate answer to the best of your ability. To express our appreciation, those who respond and send the questionnaire back will receive a 150-baht token if their name and address are provided on the back.

At the end, we will also ask you the approximate time it takes you to complete the questionnaire. Therefore, before you begin, please notice the time for the purpose of your estimation.

## Section 1: Hospital Profile

1. How many inpatient beds does your hospital currently have?

   |________| Beds

2. Which of the following best fits the type of your hospital?

   1 □ A public hospital (including state enterprises, autonomous public hospitals, and public organizations)

   2 □ A non-profit private hospital

   3 □ A for-profit private hospital

Page 2

3. Does your hospital routinely teach medical students?

1 □ Yes. We are a teaching hospital or part of a medical school.

2 □ Yes. We are an external affiliate of a medical school and routinely teach its medical students.

3 □ No. We don't routinely teach medical students.

4. What is your hospital's current number of IT personnel (including IT executives, IT managers, IT administrators, systems analysts, programmers, other technical staffs and other hospital staffs with important roles in IT works)?

1 □ None

2 □ 1-5 persons

3 □ 6-20 persons

4 □ 21-50 persons

5 □ 51 persons or more

5. Which of the following best describes your hospital's accreditation (HA) status?

1 □ Is currently not accredited and has no plan in place toward accreditation.

2 □ Is currently not accredited, has a plan in place, but has not made significant progress toward accreditation.

3 □ Is currently not accredited but has made significant progress toward accreditation.

4 □ Is currently accredited.



6. What was your hospital's total budget during the fiscal year 2009?

|________________| Baht (Approximate figure is fine.)

□ I don't know.

7. During the fiscal year 2009, how much did your hospital spend on IT, including IT hardware, software, personnel, consulting, and outsourcing?

|________________| Baht (Approximate figure is fine.)

□ I don't know.

8. If you did not know the answer to Q6 or Q7 above, please estimate what percentage of your hospital's total budget your hospital spends on IT approximately.

1 □ Less than 1%

2 □ 1-4%

3 □ 5-8%

4 □ More than 8%

9. To what extent do you agree or disagree with each of the following statements? "N/A" represents a statement not applicable to your hospital.

| Statement | Strongly Disagree | | | | Strongly Agree | |
|---|---|---|---|---|---|---|
| a. Our hospital is open to new ways of conducting operations. | 1 | 2 | 3 | 4 | 5 | N/A |

| Statement | Strongly Disagree | | | | Strongly Agree | |
|---|---|---|---|---|---|---|
| b. Our hospital sets clear visions and goals on what we wish to achieve with IT projects. | 1 | 2 | 3 | 4 | 5 | N/A |
| c. When a new technology is introduced, we clearly communicate the goals, plans, and progress to key stakeholders. | 1 | 2 | 3 | 4 | 5 | N/A |
| d. Those who will use the information systems are fully involved early in our IT projects. | 1 | 2 | 3 | 4 | 5 | N/A |
| e. Our top-level management fully supports the use of IT. | 1 | 2 | 3 | 4 | 5 | N/A |
| f. We have a multi-disciplinary team of users involved in our IT projects. | 1 | 2 | 3 | 4 | 5 | N/A |
| g. Before new IT is implemented in our hospital, the workflow changes required are carefully considered. | 1 | 2 | 3 | 4 | 5 | N/A |
| h. The majority of hospital employees are committed to achieving the envisioned organizational goals. | 1 | 2 | 3 | 4 | 5 | N/A |



| Statement | Strongly Disagree | | | | Strongly Agree | |
|---|---|---|---|---|---|---|
| i. Before a new system is introduced, we adequately provide training to those who will use the system. | 1 | 2 | 3 | 4 | 5 | N/A |
| j. When our hospital is conducting an IT project, we have a process in place to track its progress and manage it. | 1 | 2 | 3 | 4 | 5 | N/A |
| k. Our hospital learns from the past experience to improve its operations. | 1 | 2 | 3 | 4 | 5 | N/A |

## Section 2: IT Adoption and Use Profile

10. Overall, what is the extent of your hospital's adoption of information technology to support its operations?

1 □ Very high

2 □ High

3 □ Moderate

4 □ Low

5 □ Very low

11. How many personal computers (including desktops and notebooks/laptops) does your hospital have in use?

|_______| Personal Computers (Approximate figure is fine.)

12. What is the primary hospital information system in your hospital, if any?

1 □ Our hospital doesn't have a hospital information system.

2 □ HOSxP

3 □ Hospital OS

4 □ A custom system developed by our hospital or a contractor

5 □ Other. Please specify |______________________|

13. Since what year has your hospital been using the hospital information system you specified in Q12? If you don't know the exact year, please provide an approximate one.

Year |______| □ I don't know.

14. For each of the following activities, how much is the activity supported by computerized information systems in your hospital? If it varies across departments in your hospital, please indicate the average level in the entire hospital. "N/A" is not applicable (no such activity in the hospital).

| ACTIVITY | NOT SUPPORTED AT ALL BY COMPUTERS | | | | FULLY SUPPORTED BY COMPUTERS | |
|---|---|---|---|---|---|---|
| Patient Management | | | | | | |
| Patient registration | 1 | 2 | 3 | 4 | 5 | N/A |
| Insurance eligibility verification | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient appointment scheduling | 1 | 2 | 3 | 4 | 5 | N/A |



| ACTIVITY | NOT SUPPORTED AT ALL BY COMPUTERS | | | | FULLY SUPPORTED BY COMPUTERS | |
|---|---|---|---|---|---|---|
| Patient management within outpatient clinics | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient admissions | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient discharges | 1 | 2 | 3 | 4 | 5 | N/A |
| Patient referral to another facility | 1 | 2 | 3 | 4 | 5 | N/A |
| Bed occupancy and availability check | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient Care | | | | | | |
| Inpatient medication order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient lab order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient imaging order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient lab results reporting | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient imaging results reporting | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient clinical notes | 1 | 2 | 3 | 4 | 5 | N/A |
| Discharge summary documentation | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient Care | | | | | | |
| Outpatient medication order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient lab order entry | 1 | 2 | 3 | 4 | 5 | N/A |

| Activity | Not Supported At All By Computers | | | | Fully Supported By Computers | |
|---|---|---|---|---|---|---|
| Outpatient imaging order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient lab results reporting | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient imaging results reporting | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient clinical notes | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>Nursing</u> | | | | | | |
| Care planning | 1 | 2 | 3 | 4 | 5 | N/A |
| Order review and processing | 1 | 2 | 3 | 4 | 5 | N/A |
| Medication administration and documentation | 1 | 2 | 3 | 4 | 5 | N/A |
| Documentation of nursing assessment | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>Surgery/Operating Room (OR)</u> | | | | | | |
| Surgery appointments and scheduling | 1 | 2 | 3 | 4 | 5 | N/A |
| Patient management within operating rooms | 1 | 2 | 3 | 4 | 5 | N/A |
| Operative note documentation | 1 | 2 | 3 | 4 | 5 | N/A |
| Anesthetic note documentation | 1 | 2 | 3 | 4 | 5 | N/A |
| Case service charging | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>Laboratory</u> | | | | | | |
| Specimen handling | 1 | 2 | 3 | 4 | 5 | N/A |



| Activity | Not Supported At All By Computers | | | | Fully Supported By Computers | |
|---|---|---|---|---|---|---|
| Results capture from automated equipments | 1 | 2 | 3 | 4 | 5 | N/A |
| Results entry for non-automated tests | 1 | 2 | 3 | 4 | 5 | N/A |
| Results validation and confirmation | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>Radiology and Imaging</u> | | | | | | |
| Imaging appointments and scheduling | 1 | 2 | 3 | 4 | 5 | N/A |
| Image capture from imaging devices | 1 | 2 | 3 | 4 | 5 | N/A |
| Imaging reports entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Image viewing by radiologists | 1 | 2 | 3 | 4 | 5 | N/A |
| Image viewing by attending physicians | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>Pharmacy</u> | | | | | | |
| Pharmacist's review of medication orders | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient medication dispensing | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient pharmacy inventory control | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient medication dispensing | 1 | 2 | 3 | 4 | 5 | N/A |

| Activity | Not Supported At All By Computers | | | | Fully Supported By Computers | |
|---|---|---|---|---|---|---|
| Inpatient pharmacy inventory control | 1 | 2 | 3 | 4 | 5 | N/A |
| Finance | | | | | | |
| Billing, claims, and reimbursement | 1 | 2 | 3 | 4 | 5 | N/A |
| Accounting | 1 | 2 | 3 | 4 | 5 | N/A |
| Human Resource Management | | | | | | |
| Personnel records | 1 | 2 | 3 | 4 | 5 | N/A |
| Staff workload management | 1 | 2 | 3 | 4 | 5 | N/A |
| Materials Management | | | | | | |
| Inventory management | 1 | 2 | 3 | 4 | 5 | N/A |
| Administration/Miscellaneous | | | | | | |
| Internal communications | 1 | 2 | 3 | 4 | 5 | N/A |
| Public relations and external communications | 1 | 2 | 3 | 4 | 5 | N/A |



15. For each of the following technologies, to what extent is it made available in your hospital? If it varies across departments in your hospital, please indicate the average level among the applicable departments. "N/A" is not applicable (no activity exists that can be supported by the technology).

| Technology | Not At All Available | | | | Extensively Available | |
|---|---|---|---|---|---|---|
| a. Internet access | 1 | 2 | 3 | 4 | 5 | N/A |
| b. Hospital Web site | 1 | 2 | 3 | 4 | 5 | N/A |
| c. Hospital intranet (internal Web site) | 1 | 2 | 3 | 4 | 5 | N/A |
| d. Hospital e-mail system | 1 | 2 | 3 | 4 | 5 | N/A |
| e. Local area network (LAN) | 1 | 2 | 3 | 4 | 5 | N/A |
| f. Wireless networks | 1 | 2 | 3 | 4 | 5 | N/A |
| g. Data warehouse | 1 | 2 | 3 | 4 | 5 | N/A |
| h. Computerized order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| i. Electronic medical record/electronic documentation of clinical care | 1 | 2 | 3 | 4 | 5 | N/A |
| j. Disease management systems | 1 | 2 | 3 | 4 | 5 | N/A |
| k. Laboratory information system | 1 | 2 | 3 | 4 | 5 | N/A |
| l. Pharmacy information system | 1 | 2 | 3 | 4 | 5 | N/A |

| Technology | Not At All Available | | | | Extensively Available | |
|---|---|---|---|---|---|---|
| m. Electronic medication administration records | 1 | 2 | 3 | 4 | 5 | N/A |
| n. Picture archiving and communication system (PACS) | 1 | 2 | 3 | 4 | 5 | N/A |
| o. Radiology information system | 1 | 2 | 3 | 4 | 5 | N/A |
| p. Telemedicine (remote provision of medical services or consultation through IT) | 1 | 2 | 3 | 4 | 5 | N/A |
| q. Teleconferencing | 1 | 2 | 3 | 4 | 5 | N/A |
| r. Barcoding | 1 | 2 | 3 | 4 | 5 | N/A |
| s. Enterprise resource planning (ERP) system to manage finance, human resources, and materials of the organization | 1 | 2 | 3 | 4 | 5 | N/A |



16. An information system is sometimes linked (integrated) with other information systems, with data being shared or transferred between them. In other cases, an information system may be stand-alone and does not share or transfer data with other systems. For each of the following functions or settings, to what extent do its information systems share data with other systems within your hospital overall? "N/A" is not applicable (no such function/setting).

Data-Sharing **Within** Hospital

| Function/Setting | Not Sharing Data At All | | | | Extensively Sharing Data | |
|---|---|---|---|---|---|---|
| a. ER | 1 | 2 | 3 | 4 | 5 | N/A |
| b. Patient registration, admissions, discharges, and transfers | 1 | 2 | 3 | 4 | 5 | N/A |
| c. Inpatient | 1 | 2 | 3 | 4 | 5 | N/A |
| d. Outpatient clinics | 1 | 2 | 3 | 4 | 5 | N/A |
| e. Nursing | 1 | 2 | 3 | 4 | 5 | N/A |
| f. Surgery/OR | 1 | 2 | 3 | 4 | 5 | N/A |
| g. Laboratory | 1 | 2 | 3 | 4 | 5 | N/A |
| h. Radiology | 1 | 2 | 3 | 4 | 5 | N/A |
| i. Pharmacy | 1 | 2 | 3 | 4 | 5 | N/A |
| j. Finance | 1 | 2 | 3 | 4 | 5 | N/A |
| k. Human resource management | 1 | 2 | 3 | 4 | 5 | N/A |
| l. Others | 1 | 2 | 3 | 4 | 5 | N/A |

17. For each of the following functions or settings, to what extent do its information systems share data with other systems outside your hospital overall (including linkages to government agencies and other hospitals)? "N/A" is not applicable (no such function/setting).

| FUNCTION/SETTING | DATA-SHARING OUTSIDE HOSPITAL: NOT SHARING DATA AT ALL | | | | EXTENSIVELY SHARING DATA | |
|---|---|---|---|---|---|---|
| a. ER | 1 | 2 | 3 | 4 | 5 | N/A |
| b. Patient registration, admissions, discharges, and transfers | 1 | 2 | 3 | 4 | 5 | N/A |
| c. Inpatient | 1 | 2 | 3 | 4 | 5 | N/A |
| d. Outpatient clinics | 1 | 2 | 3 | 4 | 5 | N/A |
| e. Nursing | 1 | 2 | 3 | 4 | 5 | N/A |
| f. Surgery/OR | 1 | 2 | 3 | 4 | 5 | N/A |
| g. Laboratory | 1 | 2 | 3 | 4 | 5 | N/A |
| h. Radiology | 1 | 2 | 3 | 4 | 5 | N/A |
| i. Pharmacy | 1 | 2 | 3 | 4 | 5 | N/A |
| j. Finance | 1 | 2 | 3 | 4 | 5 | N/A |
| k. Human resource management | 1 | 2 | 3 | 4 | 5 | N/A |
| l. Others | 1 | 2 | 3 | 4 | 5 | N/A |



## Section 3: Respondent's Information

18. What is your gender?

1 □ Male

2 □ Female

19. What is your current age?

|______| Years

20. What is your highest level of education completed?

1 □ Lower than bachelor's degree

2 □ Bachelor's degree

3 □ Master's degree or higher

21. Which of the following best describes your formal IT training?

1 □ I had no formal training in an IT-related area.

2 □ I had a non-degree training in an IT-related area.

3 □ I received an academic degree in an IT-related field.

22. Which of the following best describes your formal clinical training? (clinical training includes training in medicine, dentistry, nursing, pharmacy, medical technology, physical therapy, radiological technology, etc.)

1 □ I had no formal training in a clinical field.

2 □ I had a non-degree training in a clinical field.

3 □ I received an academic degree in a clinical field.

23. Which of the following best describes your formal business administration (BA)/management training?

1 □ I had no formal training in BA/management.

2 □ I had a non-degree training in BA/management.

3 □ I received an academic degree in BA/management.

24. How many years have you worked in <u>any IT-related</u> position at all past and current workplaces combined?

|______| Years

25. Which of the following best describes your role in the hospital? If you hold multiple roles, please check all that apply?

1 □ The director or senior executive of the hospital

2 □ A hospital executive who directly supervises hospital IT

3 □ An IT manager or head of the hospital's IT department

4 □ An IT specialist, system administrator, system analyst, programmer, or computer technician within the hospital but not an executive or department head

5 □ A hospital worker with an important role in IT projects without an executive or technical role

6 □ A hospital worker without an important role in IT projects and without an executive or technical role

7 □ Other. Please specify |_____________________________|

For the purpose of survey improvement, we ask that you tell us that it took you______minutes answering the questionnaire.



Thank you very much for your participation in this study. Your responses are very important to future improvement of our country's health informatics works and facilitation of IT implementation in Thai hospitals. If you have additional comments, please use the space below.

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

If you would like to receive a copy of the study results and/or the 150-baht token of appreciation, please include your name and address below. This information will be kept strictly confidential and will be used only to deliver the token and the results. It will not be linked to your responses in the questionnaire.

(Please specify your name and address)________________________

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

If you have any questions about this questionnaire, please contact Dr. Nawanan Theera-Ampornpunt at 0-2201-2992, 087-111-3853 or e-mail to ranta@mahidol.ac.th.

Please return the completed questionnaire in the provided stamped return envelope, or if the envelope has been misplaced, please return the questionnaire to: Dr. Nawanan Theera-Ampornpunt
PO Box 125, Pns. Samsen Nai, Phaya Thai, Bangkok 10400 or
Medical Informatics Division, Faculty of Medicine Ramathibodi Hospital
270 Rama VI Road, Ratchathewi, Bangkok 10400

## Cover Letter for Pilot Survey (Thai)

**คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล**
๒๗๐ ถนนพระราม ๖ แขวงทุ่งพญาไท เขตราชเทวี กทม. ๑๐๔๐๐
โทร. ๐-๒๓๕๔-๗๒๗๕, ๐-๒๒๐๑-๑๒๙๖ โทรสาร ๐-๒๓๕๔-๗๒๓๓

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ที่ /๒๕๕๓

งานเวชสารสนเทศ สำนักงานคณบดี
คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

วันที่ ๒๐ กรกฎาคม ๒๕๕๓

เรื่อง ขอความอนุเคราะห์เข้าร่วมโครงการวิจัยนำร่องเพื่อสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย

เรียน

ในปัจจุบัน โรงพยาบาลต่างๆ มีการนำเทคโนโลยีสารสนเทศมาใช้งานเพื่อสนับสนุนการให้บริการทางการแพทย์มากยิ่งขึ้น แต่ความเข้าใจในภาพรวมเกี่ยวกับการนำเทคโนโลยีสารสนเทศมาใช้งานในโรงพยาบาลต่างๆ ในประเทศไทยยังมีอยู่อย่างจำกัดมาก ทำให้ขาดข้อมูลที่จะเป็นประโยชน์ในการวางแผนและสร้างกลไกเพื่อสนับสนุนการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลมากยิ่งขึ้น การนำเทคโนโลยีสารสนเทศมาใช้งานในโรงพยาบาลต่างๆ จึงขาดการบูรณาการและการสนับสนุนส่งเสริมอย่างจริงจังจากหน่วยงานที่เกี่ยวข้อง ทางโรงพยาบาลต่างๆ ก็ขาดข้อมูลเกี่ยวกับสถานการณ์การใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลอื่นๆ และปัจจัยเกื้อหนุนที่เกี่ยวข้อง ซึ่งจะเป็นประโยชน์อย่างมากในการวางแผน ตัดสินใจ และบริหารจัดการระบบสารสนเทศภายในโรงพยาบาล นอกจากนี้ ยังทำให้ผู้ป่วยที่มารับบริการสูญเสียโอกาสที่จะได้รับบริการที่อาจได้รับความสะดวก รวดเร็ว ปลอดภัย และมีคุณภาพมากยิ่งขึ้นจากการนำเทคโนโลยีสารสนเทศมาใช้งาน จึงจำเป็นจะต้องมีการศึกษาวิจัยเพิ่มเติม เพื่อเป็นข้อมูลอันมีค่ายิ่งทั้งต่อผู้กำหนดนโยบายของระบบสุขภาพ และผู้บริหารและผู้ปฏิบัติงานด้านเทคโนโลยีสารสนเทศในโรงพยาบาล อันจะส่งผลดีต่อโรงพยาบาลต่างๆ และผู้ป่วยที่มารับบริการโดยรวม

ด้วย ข้าพเจ้า นายแพทย์นวนรรน ธีระอัมพรพันธุ์ ปฏิบัติงานอยู่ ณ งานเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล ในฐานะนักศึกษาปริญญาเอกสาขาเวชสารสนเทศ มหาวิทยาลัยมินนิโซต้า ประเทศสหรัฐอเมริกา อยู่ในระหว่างดำเนินงานโครงการวิจัยวิทยานิพนธ์ ในโครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย (Thai Hospitals' Adoption of Information Technology Survey: THAIS) โดยการส่งแบบสอบถามไปยังโรงพยาบาลทั่วประเทศ เพื่อสำรวจระดับการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาล โดยผลการวิจัยที่ได้จะเป็นข้อมูลที่เป็นประโยชน์ต่อการวางแผนและกำหนดนโยบายด้านสาธารณสุขของประเทศ

ผู้วิจัย มีความประสงค์จะทดสอบความเหมาะสมของแบบสอบถาม ในโครงการนำร่อง ก่อนการส่งแบบสอบถามไปยังโรงพยาบาลทั่วประเทศเพื่อการสำรวจจริง เพื่อการนี้ โรงพยาบาลของท่านได้รับคัดเลือกให้เป็นโรงพยาบาลที่มีความเหมาะสมที่จะเป็นโรงพยาบาลในโครงการนำร่องนี้ ผู้วิจัย จึงใคร่ขอความอนุเคราะห์จากท่าน โดยขอให้ส่งแบบสอบถามที่แนบมานี้ จำนวน ๑๐ ชุด มอบให้กับบุคลากร ๓ กลุ่มในโรงพยาบาลของท่าน ได้แก่ ๑) ผู้บริหารและบุคลากรที่มีบทบาทโดยตรงในการบริหารจัดการ พัฒนา หรือดูแลรักษาระบบสารสนเทศ ๒) บุคลากรทางการแพทย์ที่ใช้งานระบบสารสนเทศในโรงพยาบาล และ ๓) ท่าน และ/หรือผู้บริหารท่านอื่นของโรงพยาบาล เป็นผู้ตอบ โดยขอให้มีบุคลากรทั้ง ๓ กลุ่มเป็นผู้ตอบแบบสอบถามรวม ๑๐ ชุดนี้ (๑ ท่าน ต่อ ๑ ชุด) แล้วส่งคืนมายังผู้วิจัยเป็นรายบุคคลโดยใช้ซองติดแสตมป์ที่แนบมาพร้อมนี้ **ภายในวันที่ ๑๖ สิงหาคม ๒๕๕๓** ทั้งนี้ บุคลากรที่เหมาะสมที่จะเป็นผู้ตอบแบบสอบถาม และจำนวนบุคลากรในแต่ละกลุ่ม เป็นไปตามดุลพินิจของท่าน

โครงการนี้ ได้ผ่านความเห็นชอบจากคณะกรรมการจริยธรรมการวิจัยในคน ของคณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดลแล้ว และมีรายละเอียดเพิ่มเติมของโครงการวิจัยในเอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้เข้าร่วมการวิจัย (Participant Information Sheet) ที่แนบมาพร้อมนี้ ทั้งนี้ เมื่อโครงการวิจัยเสร็จสิ้น ผู้วิจัย ยินดีส่งผลการวิจัยให้กับโรงพยาบาลของท่าน เพื่อเป็นข้อมูลในการเปรียบเทียบกับโรงพยาบาลอื่นๆ ทั่วประเทศ และการวางแผนการตัดสินใจภายในโรงพยาบาลของท่านต่อไป นอกจากนี้ ผู้ตอบแบบสอบถามและส่งคืนผู้วิจัยแต่ละท่าน จะได้รับค่าตอบแทนเล็กๆ น้อยๆ เพื่อเป็นการชดเชยเวลาที่สละให้กับการวิจัยนี้ เป็นเงิน ๑๕๐ บาท ต่อท่าน หากผู้ตอบได้ระบุชื่อและที่อยู่ท้ายแบบสอบถาม

จึงเรียนมาเพื่อขอความอนุเคราะห์จากท่าน และขอขอบพระคุณท่านและบุคลากรในโรงพยาบาลเป็นอย่างสูง ที่กรุณาสละเวลาตอบแบบสอบถามมา ณ โอกาสนี้ ทั้งนี้ หากมีข้อสงสัย สามารถติดต่อผู้วิจัยโดยตรงได้ที่ ๐-๒๒๐๑-๒๖๖๒, ๐๘๗-๑๑๑-๓๘๕๓

ขอแสดงความนับถือ

(นายแพทย์นวนรรน ธีระอัมพรพันธุ์)

หัวหน้าโครงการวิจัย

## Informed Consent Documents for Pilot Survey (Thai)

### เอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้เข้าร่วมการวิจัย (Participant Information Sheet)

ผู้วิจัยขอขอบพระคุณเป็นอย่างสูงสำหรับความสนใจของท่านต่อโครงการวิจัยนี้ ซึ่งเป็นการวิจัยเพื่อศึกษาการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศไทย ท่านได้รับเลือกให้เป็นกลุ่มตัวอย่างเป้าหมายในโครงการนำร่องของการวิจัยนี้ เนื่องจากท่านปฏิบัติงานอยู่ในโรงพยาบาลที่เข้าร่วมในโครงการนำร่องนี้ ซึ่งมีวัตถุประสงค์หลักเพื่อการทดสอบความเหมาะสมของแบบสอบถามก่อนทำการสำรวจจริงในโรงพยาบาลทั่วประเทศ ผู้วิจัยขอความกรุณาท่านสละเวลาอันมีค่าเพื่ออ่านรายละเอียดของการวิจัยนี้ และสอบถามประเด็นที่ท่านอาจมีข้อสงสัยก่อนเริ่มตอบแบบสอบถาม

| | |
|---|---|
| **ชื่อโครงการ** | โครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย<br>(Thai Hospitals' Adoption of Information Technology Survey: THAIS) |
| **ชื่อผู้วิจัย** | นพ.นวนรรน ธีระอัมพรพันธุ์<br>งานเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล<br>นักศึกษาปริญญาเอกสาขาเวชสารสนเทศ มหาวิทยาลัยมินนิโซต้า ประเทศสหรัฐอเมริกา<br>โดยมี Prof. Stuart M. Speedie เป็นอาจารย์ที่ปรึกษา |
| **สถานที่วิจัย** | งานเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล<br>270 ถนนพระราม 6 เขตราชเทวี กทม. 10400 |

**ผู้สนับสนุนการวิจัย** คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

**<u>ความเป็นมาของโครงการ</u>**

เทคโนโลยีสารสนเทศ มีศักยภาพในการสนับสนุนการปฏิบัติงานของบุคลากรทางการแพทย์ในโรงพยาบาล เพื่อให้การปฏิบัติงานมีคุณภาพและประสิทธิภาพมากยิ่งขึ้น แต่ความเข้าใจในภาพรวมเกี่ยวกับการนำเทคโนโลยีสารสนเทศมาใช้งานในโรงพยาบาลต่างๆ ในประเทศไทย ยังมีอยู่อย่างจำกัดมาก ทำให้ขาดข้อมูลที่จะเป็นประโยชน์ในการวางแผนและสร้างกลไก เพื่อสนับสนุนการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลมากยิ่งขึ้น ทั้งยังทำให้ผู้ป่วยที่มารับบริการสูญเสียโอกาสที่จะได้รับการบริการที่อาจได้รับความสะดวก รวดเร็ว ปลอดภัย และมีคุณภาพมากยิ่งขึ้นจากการนำเทคโนโลยีสารสนเทศมาใช้งาน จึงจำเป็นจะต้องมีการศึกษาวิจัยเพิ่มเติม เพื่อเป็นข้อมูลอันมีค่ายิ่งสำหรับผู้กำหนดนโยบายของระบบสุขภาพในอนาคต ทั้งยังจะให้ข้อมูลที่เป็นประโยชน์ต่อโรงพยาบาลของท่านในการวางแผนการพัฒนางานด้านเทคโนโลยีสารสนเทศ อันจะสร้างประโยชน์ต่อโรงพยาบาลของท่านและผู้ป่วยที่มารับบริการในระยะยาว

ในส่วนของโครงการนำร่องนี้ เป็นการทดสอบความเหมาะสมของแบบสอบถาม เพื่อนำคำตอบที่ได้รับมาประมวลกับความเห็นและปัญหาที่พบในการตอบแบบสอบถาม อันจะนำไปสู่การปรับปรุงแบบสอบถามเพื่อการสำรวจจริงทั่วประเทศที่ถูกต้อง แม่นยำ มากยิ่งขึ้น โดยผู้วิจัยจะส่งแบบสอบถามไปยังโรงพยาบาลในโครงการนำร่องนี้ เพื่อส่งต่อให้กับบุคลากรในโรงพยาบาล ประมาณแห่งละ 10 ท่าน ซึ่งรวมถึงผู้บริหารงานเทคโนโลยีสารสนเทศ (ถ้ามี) ผู้ปฏิบัติงานด้านเทคโนโลยีสารสนเทศ บุคลากรทางการแพทย์ และผู้บริหารของโรงพยาบาล ตามที่โรงพยาบาลเห็นเหมาะสม

**<u>วัตถุประสงค์</u>**

โครงการนี้เป็นโครงการวิจัยวิทยานิพนธ์ของผู้วิจัย เพื่อสำรวจระดับการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศ และวิเคราะห์หาปัจจัยเกื้อหนุน เพื่อส่งเสริมให้มีการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลมากยิ่งขึ้น และส่งผลดีต่อการให้บริการผู้ป่วยและการดำเนินงานของโรงพยาบาลต่อไป

**<u>รายละเอียดที่จะปฏิบัติต่อผู้เข้าร่วมการวิจัย</u>**

หากท่านยินยอมเข้าร่วมการวิจัยนี้ ผู้วิจัยจะขอให้ท่านตอบแบบสอบถามที่แนบมาพร้อมนี้ และส่งกลับคืนมายังผู้วิจัยโดยใช้ซองไปรษณีย์ที่ติดแสตมป์ไว้ล่วงหน้าที่ได้แนบมาด้วย แบบสอบถามนี้ใช้เวลาประมาณ 30 นาทีในการตอบ

**<u>ประโยชน์และผลข้างเคียงที่อาจเกิดแก่ผู้เข้าร่วมการวิจัย</u>**

การวิจัยนี้ไม่มีผลข้างเคียงที่อาจเกิดต่อผู้เข้าร่วมการวิจัย และไม่มีประโยชน์โดยตรงต่อท่าน แต่การเข้าร่วมวิจัยของท่านจะส่งประโยชน์ต่อสังคมเป็นอย่างมาก โดยช่วยให้ผู้กำหนดนโยบายด้านระบบสุขภาพของประเทศเข้าใจสภาพการใช้งานเทคโนโลยีสารสนเทศในประเทศไทยมากยิ่งขึ้น ความรู้นี้จะช่วยให้มีการพัฒนาโครงการที่สนับสนุนการใช้เทคโนโลยีสารสนเทศในโรงพยาบาลไทยมากยิ่งขึ้น ซึ่งอาจส่งผลดีต่อโรงพยาบาลของท่านและโรงพยาบาลอื่นๆ รวมไปถึงผู้ป่วยและประชาชนทั่วไปในระยะยาว นอกจากนี้ ผู้วิจัยยินดีส่งผลการวิจัยให้กับโรงพยาบาลของท่านเมื่อการวิจัยเสร็จสิ้น ซึ่งจะช่วยให้ท่านสามารถเปรียบเทียบระดับการใช้งานของโรงพยาบาลของท่านกับโรงพยาบาลอื่นๆ ทั่วประเทศได้ อย่างไรก็ตาม ผู้วิจัยตระหนักว่าการตอบแบบสอบถามในการวิจัยนี้ จะเป็นการรบกวนเวลาของท่าน ผู้วิจัยจึงยินดีให้ค่าตอบแทนเพื่อชดเชยกับเวลาอันมีค่าของท่าน เป็นเงิน 150 บาท หลังจากที่ท่านส่งแบบสอบถามคืนกลับมาแล้ว และได้ระบุชื่อผู้ประสงค์จะรับค่าตอบแทนไว้ท้ายแบบสอบถาม ซึ่งค่าตอบแทนดังกล่าว แม้อาจเป็นจำนวนเพียงเล็กน้อยเมื่อเทียบกับเวลาที่ท่านสละให้กับการวิจัย แต่ก็เป็นการแสดงความขอบคุณที่ท่านเข้าร่วมการวิจัย และต้องการเห็นการพัฒนางานด้านเวชสารสนเทศเพื่อรองรับระบบบริการสุขภาพของประเทศยิ่งๆ ขึ้นไป

**<u>การรักษาความลับของข้อมูล</u>**

แบบสอบถามนี้ มีช่องว่างท้ายแบบสอบถาม เพื่อให้ท่านกรอกชื่อและที่อยู่ของท่านหากท่านประสงค์จะรับค่าตอบแทน การให้ชื่อและที่อยู่ดังกล่าว ขึ้นอยู่กับความสมัครใจของท่าน และจะไม่มีการเชื่อมโยงตัวตนของท่านกับคำตอบที่ท่านให้ไว้ในแบบสอบถามในการวิเคราะห์ใดๆ ทั้งสิ้น นอกจากนี้ การวิจัยนี้ มีการใช้เลขรหัสเพื่อระบุโรงพยาบาลที่ตอบแบบสอบถาม ซึ่งจะช่วยให้ผู้วิจัยสามารถติดตามได้ว่าโรงพยาบาลใดได้ตอบแบบสอบถามแล้ว และสามารถวิเคราะห์ข้อมูลของโรงพยาบาลแต่ละแห่งและแต่ละประเภทได้ คำตอบที่ท่านให้ไว้ รวมถึงข้อมูลเกี่ยวกับตัวตนของท่านและโรงพยาบาลของท่าน จะถูกเก็บไว้เป็นความลับและเข้าถึงได้เฉพาะทีมผู้วิจัยเท่านั้น หากผู้วิจัยจะเผยแพร่ผลงานวิจัยนี้ต่อสาธารณะ ผู้วิจัยจะนำเสนอเฉพาะข้อมูลในภาพรวม และไม่เปิดเผยข้อมูลที่ระบุตัวตนของท่านหรือโรงพยาบาลของท่านแต่อย่างใด

**<u>ความสมัครใจในการเข้าร่วมการวิจัย</u>**

การตัดสินใจเข้าร่วมการวิจัยนี้ เป็นไปด้วยความสมัครใจของท่าน การตัดสินใจของท่าน จะไม่มีผลต่อความสัมพันธ์ในปัจจุบันหรืออนาคตระหว่างท่านหรือโรงพยาบาลของท่าน กับคณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล หรือมหาวิทยาลัยมินนิโซต้า หากท่านตัดสินใจที่จะเข้าร่วมการวิจัย ท่านมีสิทธิที่จะถอนตัวจากการวิจัยนี้เมื่อใดก็ได้โดยไม่มีผลต่อความสัมพันธ์เหล่านี้ นอกจากนี้ หากท่านไม่ต้องการตอบคำถามในข้อหนึ่งข้อใดไม่ว่าด้วยเหตุใดก็ตาม ท่านสามารถข้ามคำถามข้อนั้นได้

**<u>บุคคลและวิธีการติดต่อเมื่อมีปัญหาหรือข้อสงสัยที่เกี่ยวข้องกับการวิจัย</u>**

นพ.นวนรรน ธีระอัมพรพันธุ์ ตู้ ปณ. 125 ปณศ.สามเสนใน เขตพญาไท กทม. 10400

หรือ งานเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี 270 ถ.พระราม 6 เขตราชเทวี กทม. 10400

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## คำยินยอมโดยได้รับการบอกกล่าวและเต็มใจ (Informed Consent)

ข้าพเจ้าได้ทราบรายละเอียดของโครงการวิจัย ตลอดจนประโยชน์และความเสี่ยงที่อาจเกิดขึ้นต่อข้าพเจ้าจากผู้วิจัยแล้วอย่างชัดเจน ไม่มีสิ่งใดปิดบังซ่อนเร้น และยินยอมให้ทำการวิจัยในโครงการที่มีชื่อข้างต้น และข้าพเจ้าทราบว่าถ้ามีปัญหาหรือข้อสงสัยเกิดขึ้น ข้าพเจ้าสามารถสอบถามผู้วิจัยได้ และข้าพเจ้าสามารถปฏิเสธไม่เข้าร่วมโครงการวิจัยนี้เมื่อใดก็ได้ โดยไม่มีผลกระทบต่อความสัมพันธ์และการบริการที่ข้าพเจ้าพึงได้รับ นอกจากนี้ ผู้วิจัยจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าและโรงพยาบาลของข้าพเจ้าเป็นความลับ และจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัยเท่านั้น ทั้งนี้ ให้ถือว่าการตอบแบบสอบถามที่แนบมานี้และส่งคืนให้กับผู้วิจัย เป็นการแสดงเจตนายินยอมเข้าร่วมการวิจัยนี้ของข้าพเจ้า แทนการลงนามให้คำยินยอม

ท่านสามารถเก็บเอกสารฉบับนี้ไว้เป็นบันทึกของท่านได้

ถ้าท่านมีข้อข้องใจหรือมีความกังวลใจเกี่ยวกับวิธีดำเนินการวิจัยของโครงการวิจัยนี้
และประสงค์จะพูดคุยกับบุคคลอื่นนอกเหนือจากผู้วิจัย ท่านสามารถติดต่อได้ที่:
1) ประธานกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี ที่หน่วยจริยธรรมการวิจัยในคน ชั้น 3 สำนักงานวิจัยคณะฯ อาคารวิจัยและสวัสดิการ โทร. 02-201-1544 ในเวลาราชการ หรือ
2) สายด่วนคุ้มครองผู้เข้าร่วมการวิจัย (Research Subjects' Advocate Line) ของมหาวิทยาลัยมินนิโซต้า (University of Minnesota) ที่อยู่ D528 Mayo, 420 Delaware St SE, Minneapolis, MN 55455 USA
โทร. +1 612-625-1650

**Survey Instrument for Pilot Survey (Thai)**

**Note:** There are 18 pages in English but 16 pages in Thai. Each page's contents may not exactly match between the two versions.

# การสำรวจการใช้งานเทคโนโลยี
# สารสนเทศ
# ของโรงพยาบาลไทย
# Thai Hospitals' Adoption of Information Technology

**ดำเนินการวิจัยโดย**


นพ.นวนรรน ธีระอัมพรพันธุ์

งานเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

นักศึกษาระดับปริญญาเอก สาขาเวชสารสนเทศ

มหาวิทยาลัยมินนิโซต้า ประเทศสหรัฐอเมริกา



**สนับสนุนโดย**

คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

มหาวิทยาลัยมหิดล

**2553**


ผู้วิจัยขอขอบคุณท่านสำหรับความสนใจในงานวิจัยนี้ ท่านได้รับคัดเลือกให้เป็นผู้ตอบแบบสอบถามนี้ เนื่องจากท่านปฏิบัติหน้าที่อยู่ในโรงพยาบาลในโครงการนำร่องของโครงการวิจัยนี้ วัตถุประสงค์ของโครงการนำร่องนี้คือเพื่อทดสอบความเหมาะสมของแบบสอบถามนี้ ในการนำไปใช้จริงในการสำรวจการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศ คำตอบและข้อคิดเห็นของท่าน จึงเป็นประโยชน์อย่างมากต่อการปรับปรุงแบบสอบถาม เพื่อการสำรวจระดับประเทศ ทางผู้วิจัยจึงหวังเป็นอย่างยิ่งว่าท่านจะกรุณาสละเวลาตอบแบบสอบถามนี้ และหากมีความเห็นประการใดเกี่ยวกับตัวแบบสอบถาม ท่านสามารถแสดงความเห็นของท่านได้ในตัวแบบสอบถาม หรือท้ายแบบสอบถาม

หากท่านไม่แน่ใจคำตอบของคำถามข้อใด ท่านสามารถสอบถามบุคลากรที่เกี่ยวข้องในโรงพยาบาลของท่านได้ หรือหากท่านไม่สามารถค้นหาข้อมูลในส่วนใดได้ โปรดพิจารณาให้คำตอบตามที่ท่านเห็นว่าเหมาะสมที่สุดเท่าที่ท่านจะทำได้ เพื่อเป็นการขอบคุณในความร่วมมือ ผู้ที่ตอบแบบสอบถามและส่งคืนผู้วิจัยจะได้รับค่าตอบแทนเป็นเงิน 150 บาท หากท่านระบุชื่อ ที่อยู่ ด้านหลังแบบสอบถาม

ท้ายแบบสอบถาม จะมีการสอบถามระยะเวลาโดยประมาณที่ท่านใช้ในการตอบ ดังนั้น ก่อนเริ่มตอบแบบสอบถาม กรุณาสังเกตเวลาที่ท่านเริ่มตอบแบบสอบถาม เพื่อประโยชน์ในการประมาณระยะเวลา

## ส่วนที่ 1: ข้อมูลทั่วไปของโรงพยาบาล

1. ปัจจุบันโรงพยาบาลของท่านมีเตียงรับผู้ป่วยในจำนวนกี่เตียง?

   |________| เตียง

2. โรงพยาบาลของท่านเป็นโรงพยาบาลประเภทใด?

   1 □ โรงพยาบาลของรัฐ (รวมถึงรัฐวิสาหกิจ โรงพยาบาลในกำกับของรัฐ และองค์การมหาชน)
   2 □ โรงพยาบาลเอกชนที่ไม่มุ่งหวังผลกำไร (non-profit private hospital)
   3 □ โรงพยาบาลเอกชนที่มุ่งหวังผลกำไร (for-profit private hospital)

3. โรงพยาบาลของท่าน มีการเรียนการสอนนักศึกษาแพทย์เป็นประจำหรือไม่?

   1 □ ใช่ เป็นโรงพยาบาลโรงเรียนแพทย์ หรือส่วนหนึ่งของคณะแพทยศาสตร์
   2 □ ใช่ เป็นสถาบันสมทบที่มีการเรียนการสอนนักศึกษาแพทย์ของคณะแพทยศาสตร์
   3 □ ไม่มีการเรียนการสอนนักศึกษาแพทย์เป็นประจำ

4. ปัจจุบันโรงพยาบาลของท่านมีบุคลากร<u>ด้านเทคโนโลยีสารสนเทศ</u> (รวมถึงผู้บริหารงานสารสนเทศ ผู้ดูแลระบบ นักวิเคราะห์ระบบ โปรแกรมเมอร์ บุคลากรทางเทคนิคอื่นๆ และบุคลากรอื่นของโรงพยาบาลที่มีบทบาทสำคัญในงานด้านสารสนเทศ) จำนวนกี่คน?

1 ☐ ไม่มี
2 ☐ 1-5 คน
3 ☐ 6-20 คน
4 ☐ 21-50 คน
5 ☐ 51 คนขึ้นไป

5. ข้อใดต่อไปนี้ตรงกับสถานภาพการรับรองคุณภาพโรงพยาบาล (hospital accreditation หรือ HA) ของโรงพยาบาลของท่านในปัจจุบันมากที่สุด?

1 ☐ ยังไม่ได้รับการรับรอง และยังไม่มีแผนที่จะรับการตรวจรับรอง
2 ☐ ยังไม่ได้รับการรับรอง มีแผนที่จะขอรับการตรวจรับรอง แต่ยังไม่มีความคืบหน้าที่ชัดเจน
3 ☐ ยังไม่ได้รับการรับรอง แต่มีความคืบหน้าที่ชัดเจนในการเตรียมรับการตรวจรับรอง
4 ☐ ปัจจุบันผ่านการรับรองแล้ว

6. ในปีงบประมาณ 2552 โรงพยาบาลของท่านมีงบประมาณทั้งสิ้นเท่าใด?

|________________| บาท (อาจตอบเป็นตัวเลขโดยประมาณ) ☐ ไม่ทราบข้อมูล

7. ในปีงบประมาณ 2552 โรงพยาบาลของท่าน ใช้งบประมาณด้านเทคโนโลยีสารสนเทศ ซึ่งรวมถึงการจัดซื้อ/จัดจ้างฮาร์ดแวร์ ซอฟต์แวร์ ค่าตอบแทนบุคลากร ที่ปรึกษา และการจ้างงาน (outsourcing) ด้านเทคโนโลยีสารสนเทศ เป็นจำนวนทั้งสิ้นเท่าใด?

|________________| บาท (อาจตอบเป็นตัวเลขโดยประมาณ) ☐ ไม่ทราบข้อมูล

8. หากท่านไม่ทราบข้อมูลข้อ 6 หรือ 7 กรุณาคาดคะเนว่า งบประมาณด้านเทคโนโลยีสารสนเทศคิดเป็นประมาณร้อยละเท่าใดของงบประมาณทั้งโรงพยาบาล?

1 ☐ น้อยกว่าร้อยละ 1
2 ☐ ร้อยละ 1 ถึงร้อยละ 4
3 ☐ ร้อยละ 5 ถึงร้อยละ 8
4 ☐ มากกว่าร้อยละ 8



9. ท่านเห็นด้วยหรือไม่เห็นด้วยกับข้อความแต่ละข้อต่อไปนี้มากน้อยเพียงใด?
หากข้อความใดไม่เกี่ยวข้องกับโรงพยาบาลของท่าน กรุณาเลือก "N/A" (Not Applicable)

| ข้อความ | ไม่เห็นด้วยอย่างยิ่ง | | | | เห็นด้วยอย่างยิ่ง | |
|---|---|---|---|---|---|---|
| ก. โรงพยาบาลของเราเปิดกว้างสำหรับแนวทางใหม่ๆ ในการปฏิบัติงาน | 1 | 2 | 3 | 4 | 5 | N/A |
| ข. โรงพยาบาลของเรามีการกำหนดวิสัยทัศน์และเป้าหมายที่ชัดเจนที่เราหวังจะไปให้ถึงด้วยโครงการต่างๆ ด้านสารสนเทศ | 1 | 2 | 3 | 4 | 5 | N/A |
| ค. เมื่อเรานำเทคโนโลยีใหม่ๆ เข้ามาในโรงพยาบาล เรามีการสื่อสารเป้าหมาย แผนงาน และความคืบหน้าของโครงการไปยังผู้เกี่ยวข้องอย่างชัดเจน | 1 | 2 | 3 | 4 | 5 | N/A |
| ง. ผู้ที่จะใช้ระบบสารสนเทศในโรงพยาบาลของเรามีส่วนร่วมในโครงการด้านสารสนเทศอย่างเต็มที่ตั้งแต่เนิ่นๆ | 1 | 2 | 3 | 4 | 5 | N/A |
| จ. ผู้บริหารระดับสูงของเราสนับสนุนการใช้เทคโนโลยีสารสนเทศอย่างเต็มที่ | 1 | 2 | 3 | 4 | 5 | N/A |
| ฉ. เรามีทีมผู้ใช้งานจากหลากหลายสาขาที่มีส่วนร่วมในโครงการด้านสารสนเทศของเรา | 1 | 2 | 3 | 4 | 5 | N/A |
| ช. ก่อนที่โรงพยาบาลของเราจะนำเทคโนโลยีสารสนเทศใหม่ๆ มาใช้ การเปลี่ยนแปลงของกระบวนการทำงาน (workflow) ได้รับการพิจารณาอย่างรอบคอบ | 1 | 2 | 3 | 4 | 5 | N/A |
| ซ. บุคลากรส่วนใหญ่ของโรงพยาบาลมีความมุ่งมั่นที่จะให้โรงพยาบาลประสบความสำเร็จตามเป้าหมายขององค์กรที่วางไว้ | 1 | 2 | 3 | 4 | 5 | N/A |

| ข้อความ | ไม่เห็นด้วยอย่างยิ่ง | | | | เห็นด้วยอย่างยิ่ง | |
|---|---|---|---|---|---|---|
| ฌ. ก่อนที่ระบบจะถูกนำมาใช้ โรงพยาบาลของเรามีการจัดการอบรมผู้ที่จะใช้งานระบบสารสนเทศใหม่อย่างเพียงพอ | 1 | 2 | 3 | 4 | 5 | N/A |
| ญ. เมื่อเราดำเนินโครงการด้านสารสนเทศ โรงพยาบาลของเรามีกระบวนการติดตามความคืบหน้าและบริหารจัดการโครงการ | 1 | 2 | 3 | 4 | 5 | N/A |
| ฎ. โรงพยาบาลของเราเรียนรู้จากประสบการณ์ในอดีตเพื่อปรับปรุงการปฏิบัติงาน | 1 | 2 | 3 | 4 | 5 | N/A |

## ส่วนที่ 2: การใช้งานเทคโนโลยีสารสนเทศ

10. โรงพยาบาลของท่านมีการนำเทคโนโลยีสารสนเทศมาใช้งานโดยรวมเพื่อสนับสนุนภารกิจของโรงพยาบาลมากน้อยเพียงใด?

1 ☐ มาก
2 ☐ ค่อนข้างมาก
3 ☐ ปานกลาง
4 ☐ ค่อนข้างน้อย
5 ☐ น้อยมาก

11. โรงพยาบาลของท่านมีเครื่องคอมพิวเตอร์ส่วนบุคคล (รวมถึง desktops, notebooks และ laptops) สำหรับใช้งานจำนวนกี่เครื่อง?

|________| เครื่อง (อาจตอบเป็นตัวเลขโดยประมาณ)



12. โรงพยาบาลของท่านใช้ระบบสารสนเทศโรงพยาบาล (Hospital Information System) ระบบใดเป็นระบบหลัก?

1 ☐ โรงพยาบาลของเราไม่มีระบบสารสนเทศโรงพยาบาล
2 ☐ HOSxP
3 ☐ Hospital OS
4 ☐ ระบบที่โรงพยาบาลของเราพัฒนาขึ้นเองหรือจ้างพัฒนาเป็นพิเศษ
5 ☐ อื่นๆ โปรดระบุ |________________________________|

13. โรงพยาบาลของท่านเริ่มใช้ระบบสารสนเทศที่ท่านระบุในข้อ 12 ตั้งแต่ปี พ.ศ. ใด? หากท่านไม่ทราบปี พ.ศ. ที่แน่นอน โปรดระบุปี พ.ศ. โดยประมาณ

พ.ศ. |________| ☐ ไม่ทราบข้อมูล

14. กิจกรรมแต่ละข้อต่อไปนี้ ได้รับการสนับสนุนด้วยระบบสารสนเทศทางคอมพิวเตอร์มากน้อยเพียงใด? หากระดับการสนับสนุนแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับโดยเฉลี่ยทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมใดเลย กรุณาเลือก "N/A" (Not Applicable)

| กิจกรรม | ไม่มีการสนับสนุนด้วยคอมพิวเตอร์เลย | | | | มีการสนับสนุนด้วยคอมพิวเตอร์อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| การจัดการผู้ป่วย (Patient Management) | | | | | | |
| การลงทะเบียนผู้ป่วย | 1 | 2 | 3 | 4 | 5 | N/A |
| การตรวจสอบสิทธิค่ารักษาพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการตารางนัดหมายผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการรายชื่อและคิวผู้ป่วย (patient management) ในแผนกผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การรับผู้ป่วยไว้รักษาในโรงพยาบาล (admission) | 1 | 2 | 3 | 4 | 5 | N/A |
| การจำหน่ายผู้ป่วยในออกจากโรงพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| การส่งต่อผู้ป่วยไปยังสถานพยาบาลอื่น | 1 | 2 | 3 | 4 | 5 | N/A |

| กิจกรรม | ไม่มีการสนับสนุน ด้วยคอมพิวเตอร์เลย | | | | มีการสนับสนุนด้วย คอมพิวเตอร์อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| การตรวจสอบการครองเตียงและจำนวนเตียงที่ว่าง | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>การดูแลผู้ป่วยใน</u> | | | | | | |
| การสั่งยาผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานผลการตรวจทางห้องปฏิบัติการของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานผลการตรวจทางรังสีวิทยาของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกประวัติการรักษาพยาบาลของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การสรุปประวัติผู้ป่วยจำหน่าย (discharge summary) | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>การดูแลผู้ป่วยนอก</u> | | | | | | |
| การสั่งยาผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานผลการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานผลการตรวจทางรังสีวิทยาของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |



| กิจกรรม | ไม่มีการสนับสนุน ด้วยคอมพิวเตอร์เลย | | | | มีการสนับสนุนด้วย คอมพิวเตอร์อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| การบันทึกประวัติการรักษาพยาบาลของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>การพยาบาล</u> | | | | | | |
| การวางแผนทางการพยาบาล (care planning) | 1 | 2 | 3 | 4 | 5 | N/A |
| การทบทวนและดำเนินการตามการสั่งการรักษา (order) ของแพทย์ | 1 | 2 | 3 | 4 | 5 | N/A |
| การให้ยาและบันทึกการให้ยาผู้ป่วย (medication administration) | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกการประเมินทางการพยาบาล (nursing assessment) | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>ห้องผ่าตัด (OR)</u> | | | | | | |
| การจัดตารางนัดและการนัดผ่าตัด | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการรายชื่อและคิวผู้ป่วย (patient management) ในห้องผ่าตัด | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกรายงานการผ่าตัด (operative note) | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกรายงานการดมยา (anesthetic note) | 1 | 2 | 3 | 4 | 5 | N/A |
| การคิดราคาค่าผ่าตัด | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>ห้องปฏิบัติการ</u> | | | | | | |
| การจัดการสิ่งส่งตรวจ (specimen) | 1 | 2 | 3 | 4 | 5 | N/A |
| การรับผลการตรวจทางห้องปฏิบัติการจากเครื่องตรวจอัตโนมัติ | 1 | 2 | 3 | 4 | 5 | N/A |
| การป้อนผลการตรวจทางห้องปฏิบัติการสำหรับการตรวจที่ไม่ได้ใช้เครื่องตรวจอัตโนมัติ | 1 | 2 | 3 | 4 | 5 | N/A |

| กิจกรรม | ไม่มีการสนับสนุนด้วยคอมพิวเตอร์เลย | | | | มีการสนับสนุนด้วยคอมพิวเตอร์อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| การตรวจสอบและยืนยันผลการตรวจทางห้องปฏิบัติการ | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>รังสีวิทยา</u> | | | | | | |
| การจัดตารางนัดและการนัดผู้ป่วยรังสี | 1 | 2 | 3 | 4 | 5 | N/A |
| การรับภาพทางรังสีวิทยาโดยตรงจากเครื่องเอกซเรย์เข้าระบบคอมพิวเตอร์ (แทนที่จะใช้ฟิล์มเอกซเรย์) | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกรายงานผลการตรวจทางรังสีวิทยา | 1 | 2 | 3 | 4 | 5 | N/A |
| การเรียกดูภาพทางรังสีวิทยาโดยรังสีแพทย์ผ่านระบบคอมพิวเตอร์ | 1 | 2 | 3 | 4 | 5 | N/A |
| การเรียกดูภาพทางรังสีวิทยาโดยแพทย์ผู้รักษาผ่านระบบคอมพิวเตอร์ | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>งานเภสัชกรรม</u> | | | | | | |
| การทบทวนการสั่งยาโดยเภสัชกร | 1 | 2 | 3 | 4 | 5 | N/A |
| การจ่ายยาผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการคลังยาและเวชภัณฑ์ผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การจ่ายยาผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการคลังยาและเวชภัณฑ์ผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>งานการเงินการคลัง</u> | | | | | | |
| การเงินและการเบิกจ่ายค่ารักษาพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| การบัญชี | 1 | 2 | 3 | 4 | 5 | N/A |



| กิจกรรม | ไม่มีการสนับสนุนด้วยคอมพิวเตอร์เลย | | | | มีการสนับสนุนด้วยคอมพิวเตอร์อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| <u>งานบริหารทรัพยากรบุคคล</u> | | | | | | |
| ทะเบียนประวัติบุคลากร | 1 | 2 | 3 | 4 | 5 | N/A |
| การบริหารจัดการภาระงาน (workload) | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>งานพัสดุ</u> | | | | | | |
| การจัดการคลังพัสดุ | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>งานบริหาร/ทั่วไป</u> | | | | | | |
| การสื่อสารภายในโรงพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| การประชาสัมพันธ์และสื่อสารกับภายนอก | 1 | 2 | 3 | 4 | 5 | N/A |

15. โรงพยาบาลของท่านมีเทคโนโลยีแต่ละอย่างต่อไปนี้ติดตั้งอยู่ในโรงพยาบาลเพื่อให้ใช้งาน (available) มากน้อยเพียงใด? หากแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับโดยเฉลี่ยของหน่วยงานทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมที่สามารถนำเทคโนโลยีใดมาสนับสนุนการทำงานได้ กรุณาเลือก "N/A" (Not Applicable)

| เทคโนโลยี | ไม่มีเทคโนโลยีนี้อยู่ในโรงพยาบาล | | | | มีเทคโนโลยีนี้อยู่ในโรงพยาบาลอย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| ก. การเข้าถึงอินเทอร์เน็ต | 1 | 2 | 3 | 4 | 5 | N/A |
| ข. เว็บไซต์ของโรงพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| ค. อินทราเน็ต (เว็บไซต์ภายใน) ของโรงพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| ง. ระบบ e-mail ขององค์กร | 1 | 2 | 3 | 4 | 5 | N/A |
| จ. ระบบเครือข่ายภายในโรงพยาบาล (local area network/LAN) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฉ. เครือข่ายไร้สาย (wireless networks) | 1 | 2 | 3 | 4 | 5 | N/A |

| เทคโนโลยี | ไม่มีเทคโนโลยีนี้อยู่ในโรงพยาบาล | | | | มีเทคโนโลยีนี้อยู่ในโรงพยาบาลอย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| ช. ระบบคลังข้อมูล (data warehouse) | 1 | 2 | 3 | 4 | 5 | N/A |
| ซ. ระบบสั่งการรักษาผ่านคอมพิวเตอร์ (computerized order entry) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฌ. ระบบบันทึกประวัติการรักษาพยาบาลในรูปแบบอิเล็กทรอนิกส์ (electronic medical record/documentation of clinical care) | 1 | 2 | 3 | 4 | 5 | N/A |
| ญ. ระบบสารสนเทศรักษาผู้ป่วยเฉพาะโรค (disease management systems) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฎ. ระบบสารสนเทศห้องปฏิบัติการ (laboratory information system) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฏ. ระบบสารสนเทศทางเภสัชกรรม (pharmacy information system) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฐ. ระบบสารสนเทศบันทึกการให้ยาผู้ป่วย (electronic medication administration records) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฑ. ระบบภาพทางรังสีวิทยา (Picture archiving and communication system/PACS) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฒ. ระบบสารสนเทศทางรังสีวิทยา (radiology information system) | 1 | 2 | 3 | 4 | 5 | N/A |
| ณ. การให้บริการหรือคำปรึกษาทางการแพทย์ทางไกลโดยใช้เทคโนโลยีสารสนเทศ (telemedicine) | 1 | 2 | 3 | 4 | 5 | N/A |
| ด. การประชุมทางไกล (teleconference) | 1 | 2 | 3 | 4 | 5 | N/A |
| ต. บาร์โค้ด (barcoding) | 1 | 2 | 3 | 4 | 5 | N/A |
| ถ. ระบบบริหารทรัพยากร (งานคลัง ทรัพยากรบุคคล และพัสดุ) ขององค์กร (Enterprise resource planning/ERP) | 1 | 2 | 3 | 4 | 5 | N/A |



16. ในบางครั้ง ระบบสารสนเทศหนึ่งจะมีการเชื่อมต่อกับระบบสารสนเทศอื่นๆ และมีการแลกเปลี่ยนหรือส่งผ่านข้อมูลระหว่างกัน แต่ในบางกรณี ระบบสารสนเทศหนึ่งอาจไม่ได้แลกเปลี่ยนหรือส่งต่อข้อมูลกับระบบอื่น (stand-alone) ระบบสารสนเทศในภาพรวมของแต่ละระบบงานต่อไปนี้ มีการแลกเปลี่ยนข้อมูลกับระบบสารสนเทศอื่นภายในโรงพยาบาลมากน้อยเพียงใด? หากโรงพยาบาลของท่านไม่มีระบบงานใด กรุณาเลือก "N/A" (Not Applicable)

| | การแลกเปลี่ยนข้อมูล **ภายใน** โรงพยาบาล | | | | | |
|---|---|---|---|---|---|---|
| ระบบงาน | ไม่มีการแลกเปลี่ยนข้อมูล | | | | มีการแลกเปลี่ยนข้อมูลอย่างเต็มที่ | |
| ก. ห้องฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| ข. การลงทะเบียนผู้ป่วย การรับผู้ป่วยไว้ในโรงพยาบาล การจำหน่าย และการส่งต่อผู้ป่วย | 1 | 2 | 3 | 4 | 5 | N/A |
| ค. ผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| ง. ผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| จ. งานการพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| ฉ. ห้องผ่าตัด (OR) | 1 | 2 | 3 | 4 | 5 | N/A |
| ช. ห้องปฏิบัติการ | 1 | 2 | 3 | 4 | 5 | N/A |
| ซ. งานรังสีวิทยา | 1 | 2 | 3 | 4 | 5 | N/A |
| ฌ. งานเภสัชกรรม | 1 | 2 | 3 | 4 | 5 | N/A |
| ญ. งานการเงินการคลัง | 1 | 2 | 3 | 4 | 5 | N/A |
| ฎ. งานการเจ้าหน้าที่และทรัพยากรบุคคล | 1 | 2 | 3 | 4 | 5 | N/A |
| ฏ. ระบบงานอื่นๆ | 1 | 2 | 3 | 4 | 5 | N/A |

17. ระบบสารสนเทศในภาพรวมของแต่ละระบบงานต่อไปนี้ มีการแลกเปลี่ยนข้อมูลกับระบบสารสนเทศอื่นภายนอกโรงพยาบาล (รวมถึงการเชื่อมต่อกับระบบสารสนเทศของส่วนราชการและสถานพยาบาลอื่น) มากน้อยเพียงใด? หากโรงพยาบาลของท่านไม่มีระบบงานใด กรุณาเลือก "N/A" (Not Applicable)

| ระบบงาน | การแลกเปลี่ยนข้อมูล **ภายนอก** โรงพยาบาล<br>**ไม่มีการแลกเปลี่ยนข้อมูล** | | | | **มีการแลกเปลี่ยนข้อมูลอย่างเต็มที่** | |
|---|---|---|---|---|---|---|
| ก. ห้องฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| ข. การลงทะเบียนผู้ป่วย การรับผู้ป่วยไว้ในโรงพยาบาล การจำหน่าย และการส่งต่อผู้ป่วย | 1 | 2 | 3 | 4 | 5 | N/A |
| ค. ผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| ง. ผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| จ. งานการพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| ฉ. ห้องผ่าตัด (OR) | 1 | 2 | 3 | 4 | 5 | N/A |
| ช. ห้องปฏิบัติการ | 1 | 2 | 3 | 4 | 5 | N/A |
| ซ. งานรังสีวิทยา | 1 | 2 | 3 | 4 | 5 | N/A |
| ฌ. งานเภสัชกรรม | 1 | 2 | 3 | 4 | 5 | N/A |
| ญ. งานการเงินการคลัง | 1 | 2 | 3 | 4 | 5 | N/A |
| ฎ. งานการเจ้าหน้าที่และทรัพยากรบุคคล | 1 | 2 | 3 | 4 | 5 | N/A |
| ฏ. ระบบงานอื่นๆ | 1 | 2 | 3 | 4 | 5 | N/A |



## ส่วนที่ 3: ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม

18. โปรดระบุเพศของท่าน

1 □ ชาย
2 □ หญิง

19. ท่านมีอายุเท่าใด

|______| ปี

20. ท่านจบการศึกษาขั้นสูงสุดระดับใด?

1 □ ต่ำกว่าปริญญาตรี
2 □ ปริญญาตรี
3 □ ปริญญาโทหรือสูงกว่า

21. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้านเทคโนโลยีสารสนเทศของท่านมากที่สุด?

1 □ ไม่เคยได้รับการศึกษาอบรมในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศเลย
2 □ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ
3 □ เคยได้รับปริญญาตรี/โท/เอกในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ

22. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมในสาขาวิชาชีพทางคลินิกของท่านมากที่สุด? (สาขาวิชาชีพทางคลินิก หมายรวมถึงสาขาวิชาทางแพทยศาสตร์ ทันตแพทยศาสตร์ พยาบาลศาสตร์ เภสัชศาสตร์ เทคนิคการแพทย์ กายภาพบำบัด รังสีเทคนิค เป็นต้น)

1 □ ไม่เคยได้รับการศึกษาอบรมในสาขาวิชาชีพทางคลินิก
2 □ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาวิชาชีพทางคลินิก
3 □ เคยได้รับปริญญาตรี/โท/เอกในสาขาวิชาชีพทางคลินิก

23. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้านบริหารธุรกิจหรือการจัดการ (business administration/management) ของท่านมากที่สุด?

1 □ ไม่เคยได้รับการศึกษาอบรมด้านการบริหารธุรกิจหรือการบริหารจัดการ
2 □ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาด้านการบริหารธุรกิจหรือการบริหารจัดการ
3 □ เคยได้รับปริญญาตรี/โท/เอกด้านการบริหารธุรกิจหรือการบริหารจัดการ

24. ท่านปฏิบัติงานในบทบาทที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ ไม่ว่าในตำแหน่งใด ณ สถานที่ทำงานใดในอดีตและปัจจุบัน มาแล้วรวมทั้งหมดเป็นเวลากี่ปี?

|______| ปี

25. ข้อใดต่อไปนี้ตรงกับบทบาทของท่านในโรงพยาบาล? หากท่านมีหลายบทบาท กรุณาเลือกทุกบทบาทที่ตรงกับท่าน

1 □ ผู้อำนวยการหรือผู้บริหารระดับสูงของโรงพยาบาล
2 □ ผู้บริหารโรงพยาบาลที่กำกับดูแลงานด้านสารสนเทศของโรงพยาบาลโดยตรง
3 □ หัวหน้าหน่วยงานด้านเทคโนโลยีสารสนเทศของโรงพยาบาล
4 □ ผู้เชี่ยวชาญด้านเทคโนโลยีสารสนเทศ ผู้ดูแลระบบ นักวิเคราะห์ระบบ โปรแกรมเมอร์ นักวิชาการคอมพิวเตอร์ หรือบุคลากรทางเทคนิคในโรงพยาบาล แต่ไม่ใช่ผู้บริหารหรือหัวหน้าหน่วยงาน
5 □ บุคลากรในโรงพยาบาลที่มีบทบาทสำคัญในโครงการทางเทคโนโลยีสารสนเทศแต่ไม่ได้มีบทบาททางบริหารหรือทางเทคนิค
6 □ บุคลากรในโรงพยาบาลที่ไม่ได้มีบทบาทสำคัญในโครงการทางเทคโนโลยีสารสนเทศ และไม่ได้มีบทบาททางบริหารหรือทางเทคนิค
7 □ อื่นๆ โปรดระบุ |________________________________|

เพื่อประโยชน์ในการปรับปรุงแบบสอบถาม ผู้วิจัยขอความกรุณาท่านช่วยให้ข้อมูลเพิ่มเติมว่า ท่านใช้เวลาในการตอบแบบสอบถามนี้ทั้งสิ้นประมาณ____________นาที



ผู้วิจัยขอขอบพระคุณท่านเป็นอย่างสูงที่ได้กรุณาสละเวลาในการตอบแบบสอบถามนี้ คำตอบของท่านมีคุณค่าและสำคัญอย่างยิ่งต่อการพัฒนางานด้านเวชสารสนเทศของประเทศในอนาคต และการสนับสนุนการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลของประเทศ หากท่านมีความเห็นเพิ่มเติมเกี่ยวกับแบบสอบถามนี้ หรือในเรื่องอื่นใด ท่านสามารถแสดงความเห็นดังกล่าวได้ในช่องว่างข้างล่างนี้

หากท่านประสงค์จะได้รับ ค่าตอบแทนเป็นเงิน 150 บาท สำหรับการตอบแบบสอบถามนี้ กรุณาระบุชื่อ และที่อยู่ของท่านในช่องว่างข้างล่างนี้ ข้อมูลนี้จะถูกเก็บรักษาไว้เป็นความลับ และจะถูกนำมาใช้เพื่อส่งค่าตอบแทนเท่านั้น จะไม่มีการเชื่อมโยงกับคำตอบของท่านในแบบสอบถามแต่อย่างใด

(โปรดระบุชื่อที่อยู่ผู้รับ)________________________________

หากท่านมีข้อสงสัยเกี่ยวกับแบบสอบถามนี้ ท่านสามารถติดต่อ นพ.นวนรรน ธีระอัมพรพันธุ์ ได้ที่หมายเลขโทรศัพท์ 0-2201-2992, 087-111-3853 หรือทาง e-mail ที่ ranta@mahidol.ac.th

กรุณาส่งแบบสอบถามที่ตอบเสร็จแล้วในซองที่ผนึกตราไปรษณียากรแล้วซึ่งทางผู้วิจัยได้แนบมาพร้อมกับแบบสอบถามนี้ หรือหากซองดังกล่าวสูญหาย โปรดส่งไปที่:
นพ.นวนรรน ธีระอัมพรพันธุ์ ตู้ ปณ. 125 ปณค. สามเสนใน เขตพญาไท กทม. 10400
หรือ งานเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี
270 ถนนพระราม 6 เขตราชเทวี กทม. 10400

# Appendix B

Final Survey Instrument and

Other Documents for the Nationwide Study

## Prenotice Letter for Nationwide Survey (English)


**คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล**
๒๗๐ ถนนพระราม ๖ แขวงทุ่งพญาไท เขตราชเทวี กทม. ๑๐๔๐๐
โทร. ๐-๒๓๕๔-๗๒๗๕, ๐-๒๒๐๑-๑๒๙๖ โทรสาร ๐-๒๓๕๔-๗๒๓๓

**Faculty of Medicine Ramathibodi Hospital, Mahidol University**
270 Rama VI Road, Ratchathewi, Bangkok 10400, Thailand
Tel. (+66) 2354-7275, (+66) 2201-1296 Fax (+66) 2354-7233


No. 186/2011


Medical Informatics Division
Faculty of Medicine Ramathibodi Hospital
Tel. 0-2201-2992 Fax. 0-2201-1113


November 25, 2010

Re: Asking for participation in a study evaluating the adoption of information technology in Thai hospitals

To:

In about a week from now, you will receive a letter asking for your hospital's response in a questionnaire on an important research study conducted by the Faculty of Medicine Ramathibodi Hospital.

The study is related to adoption and use of information technology (IT) in Thai hospitals, and factors that facilitate IT adoption in Thailand's context. Your hospital has been selected as one of the suitable candidates for this study. The target respondent for this study is **your hospital's IT executive directly responsible for managing the information systems, or the chief of your hospital's IT department. If your hospital does not have such a person, the hospital director is the target respondent.**

As the study's principal investigator, I therefore would like to inform you in advance so that you will have enough time to assign and coordinate with the appropriate person to complete the questionnaire, before it arrives in about a week from now. Your hospital's response will be very important because it will help us see the overall picture of IT adoption in Thai hospitals nationwide, which will be useful in the formulation of policy to facilitate use of IT in hospitals at all levels in both public and private sectors.

I thank you for your time in consideration to participate in this study. This study will be successful and provide maximum values to our country's health care only with kind assistance from hospitals like yours.

Best regards,

Nawanan Theera-Ampornpunt, M.D.
Principal Investigator

## Cover Letter for Nationwide Survey (English)


**คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล**
๒๗๐ ถนนพระราม ๖ แขวงทุ่งพญาไท เขตราชเทวี กทม. ๑๐๔๐๐
โทร. ๐-๒๓๕๔-๗๒๗๕, ๐-๒๒๐๑-๑๒๕๖ โทรสาร ๐-๒๓๕๔-๗๒๓๓

**Faculty of Medicine Ramathibodi Hospital, Mahidol University**
270 Rama VI Road, Ratchathewi, Bangkok 10400, Thailand
Tel. (+66) 2354-7275, (+66) 2201-1296 Fax (+66) 2354-7233


No. 200/2011


Medical Informatics Division
Faculty of Medicine Ramathibodi Hospital
Tel. 0-2201-2992 Fax. 0-2201-1113


December 2, 2010

Re: Asking for participation in a study evaluating the adoption of information technology in Thai hospitals

To:

Information technology (IT) has played an important role in supporting operations of hospitals to provide health care services, where workload and expectations have increased steadily. However, the picture about the extent to which hospitals in Thailand utilize IT is still largely unclear, both in the public and private sectors, making policy planning and creating strategies to facilitate hospital use of IT difficult. Development of information systems in hospitals is therefore fragmented and poses a challenge to health informatics development of the country as a whole.

My name is Dr. Nawanan Theera-Ampornpunt. I currently work in the Medical Informatics Division, Faculty of Medicine Ramathibodi Hospital, Mahidol University, and I am also currently a Ph.D. student in Health Informatics at the University of Minnesota in the United States. With these issues in mind, I am working on a dissertation research study called the Thai Hospitals' Adoption of Information Technology Survey (THAIS), which aims to assess the level of hospital IT adoption in hospitals nationwide and identify factors that facilitate better use of IT. Research findings will be useful for planning and policymaking in our country's public health.

For this reason, your hospital has been selected as a suitable candidate for participation in this study. I therefore would like to ask you to forward the attached questionnaire to **your hospital's IT executive directly responsible for managing the information systems, or the chief of your hospital's IT department for completion. If your hospital does not have**

**such a person, I hope the hospital director could spend some time completing it** and return it to me using the attached stamped envelopes **by December 31, 2010**.

This study has been approved by the Committee on Human Rights to Researches Involving Human Subjects of the Faculty of Medicine Ramathibodi Hospital, Mahidol University. You can find more information about the study in the attached Participant Information Sheet. When the study is completed, I would be happy to send the study results to your hospital for comparison with other hospitals and for your hospital's strategic planning. In addition, the respondent who complete and return the questionnaire will receive a small token of appreciation in the amount of 150 baht if he or she provides the name and contact information at the end of the questionnaire.

I therefore ask for your assistance in this regard and thank you and your hospital's respondent very much for spending time to complete the questionnaire.

Best regards,

Nawanan Theera-Ampornpunt, M.D.
Principal Investigator

## Endorsement Letter for Nationwide Survey (English)

To: Deans of Medical Schools and Hospital Directors

In today's environment, hospitals in Thailand have increasingly employed Information technology (IT) to support the work of health care practitioners but knowledge about the overall picture of IT adoption in the hospitals and what factors facilitate IT adoption is still largely lacking This makes policy planning and creation of strategies to facilitate hospital use of IT difficult. Use of IT in hospitals is therefore unintegrated and facilitation from government agencies is lacking. This makes it challenging to drive the national public health policy forward and increase the capability of the hospitals in providing health care services to the people in the long term.

I am therefore delighted to know that the Faculty of Medicine Ramathibodi Hospital, Mahidol University, by Dr. Nawanan Theera-Ampornpunt, has taken the initiative to study the extent of IT adoption and use in Thai hospitals in a study called the Thai Hospitals' Adoption of Information Technology Survey (THAIS). Results of this study will be very useful to planning and policy-making at the national level to facilitate health IT development in Thai hospitals nationwide, in both public and private sectors.

As someone working in the health informatics area, I therefore sincerely hope that your hospital could be kind enough to spend some time participating in this study, so that our country will have a clearer picture of hospitals nationwide, which will subsequently provide benefits to the public health as a whole as well as your hospital.

I hereby ask you for your consideration.

Best regards,

Narong Kasitipradith, M.D.
Director of Cluster for Health Information Development
Bureau of Policy and Strategy
Ministry of Public Health

President of Thai Medical Informatics Association (TMI)

## Informed Consent Documents for Nationwide Survey (English)

### Participant Information Sheet

Thank you very much for your interest in this study about how hospitals in Thailand adopt and use information technology. You have been selected as part of the target sample because you work in a Thai hospital with the responsibility in managing, developing, and maintaining information systems in your hospital. We ask that you spend time reading the following information and asking any questions you may have before completing the questionnaire.

| | |
|---|---|
| **Study** | Thai Hospitals' Adoption of Information Technology Survey: THAIS |
| **Researcher** | Dr. Nawanan Theera-Ampornpunt, a Ph.D. student in health informatics at the University of Minnesota, USA, under the supervision of Prof. Stuart M. Speedie as the academic advisor |
| **Location** | Medical Informatics Division, Faculty of Medicine Ramathibodi Hospital, Mahidol University, 270 Rama VI Road, Ratchathewi, Bangkok 10400 |
| **Sponsor** | Faculty of Medicine Ramathibodi Hospital, Mahidol University |

**Background Information**

Information technology (IT) has the potential to support the work of health care practitioners in a hospital to improve quality and efficiency. However, the picture about the extent to which hospitals in Thailand utilize IT is still largely unclear, making policy planning and creating strategies to facilitate hospital use of IT difficult. Moreover, patients also lose the opportunity to receive more convenient, timelier, safer, and higher quality care through the use of technology. It is therefore necessary to conduct more studies to produce knowledge very valuable to policymakers. Hospitals such as yours would also benefit from the use of such knowledge in IT planning within the hospitals, ultimately offering values to the patients and hospitals in the long term.

**Objectives** This study is a dissertation research study of the researcher, aimed at conducting a survey on the extent of IT adoption and use in hospitals nationwide and identifying facilitating factors that will lead to more IT adoption and use and improved patient care.

**Procedures to be Conducted to Participants** If you agree to be in the study, we will ask you to fill out the attached questionnaire and return it to the researcher. A stamped envelope is provided for your convenience. It should take you about 20 minutes to complete the questionnaire.

**Risks and Benefits of Being in the Study**

There is no risk associated with participating in this study.

There is no direct benefit to you for participating in this study. However, your participation would greatly yield societal benefits by helping policymakers better understand the state of health IT adoption in our country. This knowledge could lead to more effective strategies to facilitate IT use in hospitals, which could benefit your hospital among others, as well as patients and the general population, in the long term. In addition, if specified at the end of the questionnaire, the researcher would provide results of the analysis that will allow the comparison of your hospital's situation with other hospitals nationwide once the study has completed. However, we also understand that answering the questionnaire requires time and inconvenience on your part, and therefore we will give you 150 baht as a token of appreciation once we receive your completed questionnaire, if your information is provided at the end of the questionnaire. While the amount may not be so significant, it serves as a big "thank you" for participating in this study and for your contribution in pushing our nation's health informatics agenda forward to support our entire health care system.

**Confidentiality**

At the end of the questionnaire, there is a space where you can provide your name and contact information if you choose to receive the 150-baht token and/or the study results. Providing your information is entirely optional and the information will not be used to link you and your answers in any analysis. We also use a tracking number that identifies the hospitals we send out the questionnaire to, which is used to help us track which hospitals have responded and to allow us to analyze the responses by hospital characteristics. All questionnaire responses as well as identities and contact information of you and your hospital will be kept private with no one outside the research team having access. If we publish the results publicly, we will not include any information that will reveal the identity of you or your hospital.

**Voluntary Nature of the Study**

Participation in this study is completely voluntary. Your decision whether or not to participate will not affect your or your hospital's current or future relationship with the Faculty of Medicine Ramathibodi Hospital, Mahidol University, or the University of Minnesota. If you decide to participate, you are free to withdraw at any time without affecting these relationships. You are also free to skip any questions that you do not wish to answer for whatever reason.

**Contact Information for Questions and Issues Related to This Study**

Dr. Nawanan Theera-Ampornpunt
PO Box 125, Pns. Samsen Nai, Phaya Thai, Bangkok 10400
Or Medical Informatics Division, Faculty of Medicine Ramathibodi Hospital
270 Rama VI Road, Ratchathewi, Bangkok 10400
Tel. 0-2201-2992, 087-111-3853 or e-mail: ranta@mahidol.ac.th
Or contact the researcher's academic advisor (Prof. Stuart Speedie) at e-mail: speed002@umn.edu

## Statement of Informed Consent

I have read and understood the information about this study as well as the risks and benefits of being in the study from the researchers, and I agree to participate in this study. I understand that I can ask the researchers should I have further questions or issues, and I can refuse to participate at any time without affecting the relationships and services I'm entitled to. In addition, the researchers will keep information about the identities of myself and my hospital private, which can be disclosed publicly only in an aggregate format. When I complete and return the questionnaire, I have implied my consent to participate in this study in lieu of a signed consent statement.

You may keep this document for your record.

If you have any questions or concerns regarding the research conduct of this study and would like to talk to someone other than the researchers, you are encouraged to contact:
1) Committee on Human Rights Related to Researches Involving Human Subjects, Faculty of Medicine Ramathibodi Hospital at the Ethics in Researches Involving Human Subjects Unit, 3rd Floor, Research Centre, Research and Personnel Benefits Building.
Tel. 0-2201-1544 (regular office hours), or
2) Research Subjects' Advocate Line, University of Minnesota, D528 Mayo, 420 Delaware St SE, Minneapolis, MN 55455 USA. Tel. +1 612-625-1650

## Survey Instrument for Nationwide Survey (English)

**Note:** There are 18 pages in English but 16 pages in Thai. Each page's contents may not exactly match between the two versions.

# Thai Hospitals' Adoption of Information Technology Survey (THAIS)

**Conducted By**

Nawanan Theera-Ampornpunt, M.D.
Medical Informatics Division
Faculty of Medicine Ramathibodi Hospital
Ph.D. Student in Health Informatics
University of Minnesota, USA

**Supported By**

Faculty of Medicine Ramathibodi Hospital
Mahidol University

**2010**

Thank you for your interest in this study. This questionnaire is designed for the person who is responsible for managing information systems in your hospital, such as the chief information officer or someone in an equivalent position. If there is no such person in your hospital, we ask that an IT manager or administrator in your hospital could spend some time answering the questionnaire. If there is nobody in one of these roles, we hope that the hospital director or another senior executive could devote some time in providing answers.

If you are not sure about certain questions, please feel free to ask one of your colleagues who may know better. If you could not obtain an answer for any question, please provide the most appropriate answer to the best of your ability. To express our appreciation, those who respond and send the questionnaire back will receive a 150-baht token if their name and address are provided on the back.

### Section 1: Hospital Profile

1. Which of the following best fits the type of your hospital?

   1 □ A public hospital (including state enterprises, autonomous public hospitals, and public organizations)
   2 □ A private hospital

2. Does your hospital routinely teach medical students?

   1 □ Yes
   2 □ No

3. What is your hospital's current number of <u>total</u> personnel?

   |________________| Persons (Approximate figure is fine.)

4. What is your hospital's current number of <u>IT</u> personnel?

   |________________| Persons (Approximate figure is fine.)

Page 2

5. What was your hospital's <u>total</u> budget during the fiscal year 2010?

|________________| Baht (Approximate figure is fine.)

□ I don't know.

6. During the fiscal year 2010, how much did your hospital spend <u>on IT</u>, including IT hardware, software, personnel, consulting, and outsourcing?

|________________| Baht (Approximate figure is fine.)

□ I don't know.

7. If you did not know the answer to Q5 or Q6 above, please estimate what percentage of your hospital's total budget your hospital spends approximately on IT during the fiscal year 2010.

1 □ Less than 1%

2 □ 1-4%

3 □ 5-8%

4 □ More than 8%

8. To what extent do you agree or disagree with each of the following statements?

| Statement | Strongly Disagree | | | | Strongly Agree |
|---|---|---|---|---|---|
| a. Our hospital is open to new ways of conducting operations. | 1 | 2 | 3 | 4 | 5 |
| b. Our top-level management fully supports the use of IT. | 1 | 2 | 3 | 4 | 5 |
| c. Our hospital sets clear vision, goals, and plans on IT works. | 1 | 2 | 3 | 4 | 5 |
| d. Our hospital communicates goals, plans and progress on IT works to stakeholders clearly. | 1 | 2 | 3 | 4 | 5 |
| e. Those who will use the information systems are fully involved in hospital IT development. | 1 | 2 | 3 | 4 | 5 |
| f. The team of users involved in our IT development comes from several disciplines. | 1 | 2 | 3 | 4 | 5 |
| g. The majority of hospital employees are committed to achieving the envisioned organizational goals. | 1 | 2 | 3 | 4 | 5 |
| h. In our hospital's IT development, the workflow changes are carefully considered. | 1 | 2 | 3 | 4 | 5 |
| i. Our hospital provides training to those who will use the system adequately. | 1 | 2 | 3 | 4 | 5 |
| j. Our hospital has a process in place to track work progress and manage IT works appropriately. | 1 | 2 | 3 | 4 | 5 |
| k. Our hospital uses our past experience as lessons driving our current works. | 1 | 2 | 3 | 4 | 5 |



## Section 2: IT Adoption and Use Profile

9. Overall, what is the extent of your hospital's utilization of information technology to support its operations?

1 □ Very high

2 □ High

3 □ Moderate

4 □ Low

5 □ Very low

10. How many personal computers (including desktops and notebooks/laptops) does your hospital have in use?

|_______| Personal Computers (Approximate figure is fine.)

11. What is the primary hospital information system in your hospital, if any?

1 □ Our hospital doesn't have a hospital information system.

2 □ HOSxP

3 □ Hospital OS

4 □ A custom system developed by our hospital or a contractor

5 □ Other. Please specify |_______________________________|

12. Since what year has your hospital been using the hospital information system you specified in Q11? If you don't know the exact year, please provide an approximate one.

Year |_______| □ I don't know.

13. For each of the following activities, how much is the activity supported by computerized information systems in your hospital? If it varies across departments in your hospital, please indicate the average level in the entire hospital. If your hospital doesn't have a particular activity (Not Applicable), please leave that item blank.

| ACTIVITY | NOT SUPPORTED AT ALL BY COMPUTERS | | | | FULLY SUPPORTED BY COMPUTERS |
|---|---|---|---|---|---|
| Patient Management | | | | | |
| Patient registration and recording of patient's demographic information | 1 | 2 | 3 | 4 | 5 |
| Outpatient appointment scheduling | 1 | 2 | 3 | 4 | 5 |
| Viewing the list of hospitalized patients | 1 | 2 | 3 | 4 | 5 |



| ACTIVITY | NOT SUPPORTED AT ALL BY COMPUTERS | | | | FULLY SUPPORTED BY COMPUTERS |
|---|---|---|---|---|---|
| Outpatient Care | | | | | |
| Outpatient medication order entry | 1 | 2 | 3 | 4 | 5 |
| Outpatient lab order entry | 1 | 2 | 3 | 4 | 5 |
| Outpatient lab results viewing | 1 | 2 | 3 | 4 | 5 |
| Outpatient imaging order entry | 1 | 2 | 3 | 4 | 5 |
| Electronic image viewing (instead of using films) for outpatients | 1 | 2 | 3 | 4 | 5 |
| Documentation of history & physical examination of outpatients | 1 | 2 | 3 | 4 | 5 |
| Inpatient Care | | | | | |
| Inpatient medication order entry | 1 | 2 | 3 | 4 | 5 |
| Inpatient lab order entry | 1 | 2 | 3 | 4 | 5 |
| Inpatient lab results viewing | 1 | 2 | 3 | 4 | 5 |
| Inpatient imaging order entry | 1 | 2 | 3 | 4 | 5 |
| Electronic image viewing (instead of using films) for inpatients | 1 | 2 | 3 | 4 | 5 |
| Documentation of history, physical examination & progress note of inpatients | 1 | 2 | 3 | 4 | 5 |
| Discharge summary documentation | 1 | 2 | 3 | 4 | 5 |
| Nursing | | | | | |
| Documentation of medication administration to patients | 1 | 2 | 3 | 4 | 5 |
| Nursing documentation | 1 | 2 | 3 | 4 | 5 |
| Pharmacy | | | | | |
| Outpatient medication dispensing | 1 | 2 | 3 | 4 | 5 |
| Inpatient medication dispensing | 1 | 2 | 3 | 4 | 5 |

| Activity | Not Supported At All By Computers | | | | Fully Supported By Computers |
|---|---|---|---|---|---|
| Pharmacy inventory control | 1 | 2 | 3 | 4 | 5 |
| Automatic drug allergy checking | 1 | 2 | 3 | 4 | 5 |
| Automatic drug interaction checking | 1 | 2 | 3 | 4 | 5 |
| Finance | | | | | |
| Patient billing | 1 | 2 | 3 | 4 | 5 |
| Reimbursement claims | 1 | 2 | 3 | 4 | 5 |

14. For each of the following technologies, to what extent is it made available in your hospital? If it varies across departments in your hospital, please indicate the average level among the applicable departments. If a technology is not applicable to any activities in your hospital, please leave that item blank.

| Technology | Not At All Available | | | | Extensively Available |
|---|---|---|---|---|---|
| a. Internet access | 1 | 2 | 3 | 4 | 5 |
| b. Hospital Web site | 1 | 2 | 3 | 4 | 5 |
| c. Local area network (LAN) | 1 | 2 | 3 | 4 | 5 |
| d. Master Patient Index | 1 | 2 | 3 | 4 | 5 |
| e. Computerized physician order entry | 1 | 2 | 3 | 4 | 5 |
| f. Electronic medication administration records | 1 | 2 | 3 | 4 | 5 |
| g. Electronic medical records that documents clinical care in the system | 1 | 2 | 3 | 4 | 5 |
| h. Laboratory information system | 1 | 2 | 3 | 4 | 5 |
| i. Picture archiving and communication system (PACS) for electronic storage of medical images instead of films | 1 | 2 | 3 | 4 | 5 |
| j. Barcode use in patient care | 1 | 2 | 3 | 4 | 5 |

15. Sometimes, information is shared or transmitted among the information systems. In other cases, information may not be shared or transferred between the systems at all.

For each of the following types of information, to what extent is the information shared or transmitted among the information systems within your hospital?

Data-Sharing **Within** Hospital

| Type of Information | Not Shared At All | | | | Extensively Shared |
|---|---|---|---|---|---|
| a. Patient's demographic information | 1 | 2 | 3 | 4 | 5 |
| b. Outpatient's history and medical documentation | 1 | 2 | 3 | 4 | 5 |
| c. Outpatient's diagnoses | 1 | 2 | 3 | 4 | 5 |
| d. Outpatient's medication orders | 1 | 2 | 3 | 4 | 5 |
| e. Inpatient's history and medical documentation | 1 | 2 | 3 | 4 | 5 |
| f. Inpatient's diagnoses | 1 | 2 | 3 | 4 | 5 |
| g. Inpatient's medication orders | 1 | 2 | 3 | 4 | 5 |
| h. Surgical operations and procedures | 1 | 2 | 3 | 4 | 5 |
| i. Laboratory results | 1 | 2 | 3 | 4 | 5 |
| j. Medical images and results | 1 | 2 | 3 | 4 | 5 |

16. For each of the following types of information, to what extent is the information shared or transmitted between your hospital's information systems and other information systems outside your hospital (such as information systems of government agencies or other hospitals), including outbound and inbound transmissions?

| Type of Information | Data-Sharing **Outside** Hospital: Not Shared At All | | | | Extensively Shared |
|---|---|---|---|---|---|
| a. Patient's demographic information | 1 | 2 | 3 | 4 | 5 |
| b. Outpatient's history and medical documentation | 1 | 2 | 3 | 4 | 5 |
| c. Outpatient's diagnoses | 1 | 2 | 3 | 4 | 5 |
| d. Outpatient's medication orders | 1 | 2 | 3 | 4 | 5 |
| e. Inpatient's history and medical documentation | 1 | 2 | 3 | 4 | 5 |
| f. Inpatient's diagnoses | 1 | 2 | 3 | 4 | 5 |
| g. Inpatient's medication orders | 1 | 2 | 3 | 4 | 5 |
| h. Surgical operations and procedures | 1 | 2 | 3 | 4 | 5 |
| i. Laboratory results | 1 | 2 | 3 | 4 | 5 |
| j. Medical images and results | 1 | 2 | 3 | 4 | 5 |

## Section 3: Respondent's Information

17. What is your gender?

1 □ Male　　2 □ Female

18. What is your current age?

|______| Years



19. What is your highest level of education completed?

1 □ Lower than bachelor's degree
2 □ Bachelor's degree (including M.D.)
3 □ Master's degree or higher (including specialist physicians)

20. Which of the following best describes your formal IT training?

1 □ I had no formal training in an IT-related area.
2 □ I had a non-degree training in an IT-related area.
3 □ I received a bachelor's/master's/doctoral degree in an IT-related field.

21. Which of the following best describes your formal training in health science? (health science training includes training in medicine, dentistry, nursing, pharmacy, medical technology, physical therapy, radiological technology, public health)

1 □ I had no formal training in health science.
2 □ I had a non-degree training in health science.
3 □ I received a bachelor's/master's/doctoral degree in health science.

22. Which of the following best describes your formal business administration (BA)/management training?

1 □ I had no formal training in BA/management.
2 □ I had a non-degree training in BA/management.
3 □ I received a bachelor's/master's/doctoral degree in BA/management.

23. How many years have you worked in any IT-related position at all past and current workplaces combined?

|______| Years

24. Which of the following best describes your role in the hospital? If you hold multiple roles, please check all that apply.

1 □ The director or a senior executive of the hospital

2 □ A hospital executive who directly supervises hospital IT responsibilities

3 □ An IT manager or head of the hospital's IT unit or department, but not a hospital executive

4 □ An IT specialist such as a system administrator, a system analyst, a programmer, a health information management specialist or a computer technician within the hospital but not an executive or department head

5 □ A hospital worker with a past or present important role in IT development, but not a hospital executive or a computer technician

6 □ A hospital worker without an important role in IT development and not a hospital executive or a computer technician

7 □ Other. Please specify |______________________________|



Thank you very much for your participation in this study. Your responses are very important to future improvement of health informatics works in our country's hospitals. If you have additional comments, please use the space below.

___________________________________________

___________________________________________

If you would like to receive a copy of the study results and/or the 150-baht token of appreciation, please include your name and address below. This information will be kept strictly confidential and will be used only to deliver the token and the results. It will not be linked to your responses in the questionnaire.

I would like to receive □ only study results □ only 150-baht token □ both
(Please provide your name and address, and if you wish to receive study results via e-mail, please provide your e-mail address)

___________________________________________

___________________________________________

___________________________________________

___________________________________________

Please return the completed questionnaire in the provided stamped return envelope, or return the questionnaire to: Dr. Nawanan Theera-Ampornpunt
PO Box 125, Pns. Samsen Nai, Phaya Thai, Bangkok 10400

□□□□□

## Reminder Letter for Nationwide Survey (English)


คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
๒๗๐ ถนนพระราม ๖ แขวงทุ่งพญาไท เขตราชเทวี กทม. ๑๐๔๐๐
โทร. ๐-๒๓๕๔-๗๒๗๕, ๐-๒๒๐๑-๑๒๙๖ โทรสาร ๐-๒๓๕๔-๗๒๓๓

**Faculty of Medicine Ramathibodi Hospital, Mahidol University**
270 Rama VI Road, Ratchathewi, Bangkok 10400, Thailand
Tel. (+66) 2354-7275, (+66) 2201-1296 Fax (+66) 2354-7233


No. 315/2011


Medical Informatics Division
Faculty of Medicine Ramathibodi Hospital
Tel 0-2201-2992, 0-2201-2227 Fax 0-2201-1113


January 24, 2011

Re: Asking for participation in a study evaluating the adoption of information technology in Thai hospitals

To:

About a month ago, the Faculty of Medicine Ramathibodi Hospital sent a letter to your hospital asking for your help on participating in a study called Thai Hospitals' Adoption of Information Technology Survey (THAIS), which aims to assess the level of hospital IT adoption in hospitals nationwide and identify factors that facilitate better use of IT. Research findings will be useful for policymaking in our country's public health. In the package, a questionnaire was attached. However, the study has not received a completed questionnaire back from your hospital.

The research project has received overwhelming responses from other hospitals, including public and private hospitals, which have provided valuable insights for the assessment of the state of IT adoption in our country's hospitals. We have also received a number of feedbacks about challenges in managing information systems that proved to be helpful.

On behalf of the study and as the study's principal investigator, I would like to ask for your assistance again, because information from your hospital would help make our study's findings more accurate. Even though we have received numerous responses from other hospitals, the study findings will be accurate only when most hospitals in the sample participate.

Your hospital's responses will be kept strictly confidential, with no disclosure of individual hospitals' data. In addition, if you specify at the end of the questionnaire, we will be happy to send the study findings to your hospital for comparison with other hospitals and for your hospital's strategic planning.

We therefore hope you could forward the attached questionnaire to **your hospital's IT executive directly responsible for managing the information systems, or the chief of your hospital's IT department for completion. If your hospital does not have such a person, I hope the hospital director could spend some time completing it** and return it to me using the attached stamped envelopes **by February 21, 2011**.

I therefore ask for your assistance in this regard and thank you and your hospital's respondent very much and would like to offer sincere apologies if you have returned the questionnaire before receiving this letter.

Best regards,

Nawanan Theera-Ampornpunt, M.D.
Principal Investigator

## Prenotice Letter for Nationwide Survey (Thai)

**คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล**
๒๗๐ ถนนพระราม ๖ แขวงทุ่งพญาไท เขตราชเทวี กทม. ๑๐๔๐๐
โทร. ๐-๒๓๕๔-๗๒๗๕, ๐-๒๒๐๑-๑๒๙๖ โทรสาร ๐-๒๓๕๔-๗๒๓๓

**Faculty of Medicine Ramathibodi Hospital, Mahidol University**
270 Rama VI Road, Ratchathewi, Bangkok 10400, Thailand
Tel. (+66) 2354-7275, (+66) 2201-1296 Fax (+66) 2354-7233

ฝ่ายเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี
โทร ๐-๒๒๐๑-๒๙๙๒ โทรสาร ๐-๒๒๐๑-๑๑๑๓

ที่ ๑๘๖/๒๕๕๔

วันที่ ๒๕ พฤศจิกายน ๒๕๕๓

เรื่อง ขอความอนุเคราะห์เข้าร่วมโครงการวิจัยเพื่อสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย

เรียน

อีกประมาณ ๑ สัปดาห์จากนี้ ท่านจะได้รับเอกสารทางไปรษณีย์ ขอความอนุเคราะห์จากท่านในการตอบแบบสอบถามเกี่ยวกับโครงการวิจัยที่สำคัญโครงการหนึ่ง ซึ่งดำเนินการวิจัยโดยคณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

โครงการวิจัยดังกล่าว เกี่ยวข้องกับการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลในประเทศไทย และปัจจัยเกื้อหนุนการใช้งานเทคโนโลยีสารสนเทศเหล่านี้ในบริบทของไทย ซึ่งโรงพยาบาลของท่าน ได้รับคัดเลือกให้เป็นโรงพยาบาลหนึ่งที่มีความเหมาะสมสำหรับโครงการวิจัยนี้ **โดยกลุ่มเป้าหมายของโครงการวิจัยนี้คือผู้บริหารที่กำกับดูแลงานด้านเทคโนโลยีสารสนเทศของโรงพยาบาลโดยตรง หรือหัวหน้าผู้รับผิดชอบงานด้านเทคโนโลยีสารสนเทศ หรือท่านผู้อำนวยการโรงพยาบาล ในกรณีที่โรงพยาบาลของท่านไม่มีบุคคลดังกล่าวข้างต้น**

กระผม ในฐานะหัวหน้าโครงการวิจัย จึงขอเรียนให้ท่านทราบเกี่ยวกับโครงการวิจัยดังกล่าวล่วงหน้า เพื่อให้ท่านมีเวลาสักเล็กน้อยในการพิจารณามอบหมาย และประสานงานกับผู้ที่จะตอบแบบสอบถาม ก่อนที่แบบสอบถามจะส่งมาถึงท่านในอีก ๑ สัปดาห์ คำตอบของโรงพยาบาลของท่านในโครงการวิจัยนี้ มีความสำคัญยิ่ง เนื่องจากจะช่วยให้ผู้วิจัยเห็นข้อมูลภาพรวมเกี่ยวกับการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศ อันจะเป็นประโยชน์ในการวางแผนเพื่อส่งเสริมการนำเทคโนโลยีสารสนเทศ มาสนับสนุนการดำเนินงานของโรงพยาบาลต่างๆ ทุกระดับ ทั้งภาครัฐและภาคเอกชน ต่อไป

กระผมขอขอบพระคุณท่านที่ได้กรุณาสละเวลาเพื่อพิจารณาให้การสนับสนุนโครงการวิจัยนี้ โครงการวิจัยนี้จะประสบความสำเร็จและก่อประโยชน์สูงสุดให้กับงานด้านการแพทย์และสาธารณสุขของประเทศของเราได้ ก็ด้วยความอนุเคราะห์อย่างดียิ่งจากโรงพยาบาลต่างๆ เช่นโรงพยาบาลของท่าน

ขอแสดงความนับถือ

(นายแพทย์นวนรรน ธีระอัมพรพันธุ์)

หัวหน้าโครงการวิจัย

## Cover Letter for Nationwide Survey (Thai)

**คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล**
๒๗๐ ถนนพระราม ๖ แขวงทุ่งพญาไท เขตราชเทวี กทม. ๑๐๔๐๐
โทร. ๐-๒๓๕๔-๗๒๗๕, ๐-๒๒๐๑-๑๒๙๖ โทรสาร ๐-๒๓๕๔-๗๒๓๓

**Faculty of Medicine Ramathibodi Hospital, Mahidol University**
270 Rama VI Road, Ratchathewi, Bangkok 10400, Thailand
Tel. (+66) 2354-7275, (+66) 2201-1296 Fax (+66) 2354-7233

ฝ่ายเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี
โทร ๐-๒๒๐๑-๒๙๙๒ โทรสาร ๐-๒๒๐๑-๑๑๑๓

ที่ ๒๐๐/๒๕๕๔
วันที่ ๒ ธันวาคม ๒๕๕๓
เรื่อง ขอความอนุเคราะห์เข้าร่วมโครงการวิจัยเพื่อสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย
เรียน

เทคโนโลยีสารสนเทศ ได้เข้ามามีบทบาทสำคัญในการดำเนินงานของโรงพยาบาลต่างๆ เพื่อสนับสนุนการให้บริการของโรงพยาบาล ซึ่งนับวันจะมีภาระงานและความคาดหวังของผู้รับบริการมากยิ่งขึ้น อย่างไรก็ตาม ประเทศของเรายังไม่มีข้อมูลภาพรวมเกี่ยวกับสถานการณ์การใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศ ทั้งภาครัฐและเอกชน ทำให้ขาดนโยบายที่ชัดเจนในการสนับสนุนการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาล การพัฒนาระบบสารสนเทศในโรงพยาบาลต่างๆ จึงขาดความเป็นเอกภาพ และเป็นอุปสรรคต่องานด้านเวชสารสนเทศของประเทศโดยรวม

ด้วยเหตุนี้ กระผม นายแพทย์นวนรรน ธีระอัมพรพันธุ์ ปฏิบัติงานอยู่ ณ ฝ่ายเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล ในฐานะนักศึกษาปริญญาเอกสาขาเวชสารสนเทศ มหาวิทยาลัยมินนิโซตา ประเทศสหรัฐอเมริกา จึงได้ดำเนินงานวิจัยวิทยานิพนธ์ ในโครงการ Thai Hospitals' Adoption of Information Technology Survey (THAIS) โดยมีวัตถุประสงค์เพื่อสำรวจระดับการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศ และวิเคราะห์หาปัจจัยเกื้อหนุนที่เกี่ยวข้อง ซึ่งจะเป็นประโยชน์ต่อการกำหนดนโยบายด้านสาธารณสุขของประเทศต่อไป

เพื่อการนี้ โรงพยาบาลของท่านได้รับคัดเลือกให้เป็นโรงพยาบาลที่มีความเหมาะสมที่จะเข้าร่วมโครงการวิจัยนี้ ผู้วิจัย จึงใคร่ขอความอนุเคราะห์จากท่าน โดยขอให้ส่งแบบสอบถามที่แนบมานี้ ให้กับ**ผู้บริหารที่มีบทบาทโดยตรงในการบริหารจัดการระบบสารสนเทศ หรือหัวหน้าผู้รับผิดชอบงานด้านสารสนเทศในโรงพยาบาลของท่าน เป็นผู้ตอบ หรือหากโรงพยาบาลของท่านไม่มีบุคลากรด้านสารสนเทศโดยตรง ขอความอนุเคราะห์ท่านผู้อำนวยการ สละเวลาเป็นผู้ตอบแบบสอบถามดังกล่าว** แล้วส่งคืนมายังผู้วิจัยโดยใช้ซองติดแสตมป์ที่แนบมาพร้อมนี้ **ภายในวันที่ ๓๑ ธันวาคม ๒๕๕๓**

โครงการนี้ ได้ผ่านความเห็นชอบจากคณะกรรมการจริยธรรมการวิจัยในคน ของคณะแพทยศาสตร์โรงพยาบาลรามาธิบดีแล้ว และมีรายละเอียดเพิ่มเติมของโครงการวิจัยในเอกสารที่แนบมาพร้อมนี้ ทั้งนี้ เมื่อโครงการวิจัยเสร็จสิ้น ผู้วิจัยยินดีส่งผลการวิจัยให้กับโรงพยาบาลของท่าน เพื่อเป็นข้อมูลในการเปรียบเทียบกับสถานการณ์ในภาพรวมทั่วประเทศ และการวางแผนการตัดสินใจภายในโรงพยาบาลของท่านต่อไป นอกจากนี้ ผู้ตอบแบบสอบถามและส่งคืนผู้วิจัย จะได้รับค่าตอบแทนเล็กๆ น้อยๆ เพื่อชดเชยเวลาที่สละให้กับการวิจัยนี้ เป็นเงิน ๑๕๐ บาท หากได้ระบุชื่อและที่อยู่ท้ายแบบสอบถาม

จึงเรียนมาเพื่อขอความอนุเคราะห์จากท่าน และขอขอบพระคุณท่านและบุคลากรในโรงพยาบาลเป็นอย่างสูงที่กรุณาสละเวลาตอบแบบสอบถามมา ณ โอกาสนี้

ขอแสดงความนับถือ

(นายแพทย์นวนรรน ธีระอัมพรพันธุ์)
หัวหน้าโครงการวิจัย

## Endorsement Letter for Nationwide Survey (Thai)

เรียน ท่านคณบดีคณะแพทยศาสตร์และท่านผู้อำนวยการโรงพยาบาลทุกท่าน

ในปัจจุบัน โรงพยาบาลต่างๆ ในประเทศไทยมีการนำเทคโนโลยีสารสนเทศมาใช้งานเพื่อสนับสนุนการให้บริการทางการแพทย์มากยิ่งขึ้น แต่ความเข้าใจในภาพรวมเกี่ยวกับสถานการณ์การนำเทคโนโลยีสารสนเทศมาใช้งานในโรงพยาบาลต่างๆ รวมถึงปัจจัยแวดล้อมที่มีผลสนับสนุนต่อการใช้งานเทคโนโลยีสารสนเทศ ยังมีอยู่อย่างจำกัดมาก ทำให้ขาดข้อมูลที่จะเป็นประโยชน์ในการวางแผน และสร้างกลไกเพื่อสนับสนุนให้มีการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลมากยิ่งขึ้น การนำเทคโนโลยีสารสนเทศมาใช้งานในโรงพยาบาลต่างๆ จึงขาดการบูรณาการและการสนับสนุนส่งเสริมอย่างจริงจังจากหน่วยงานที่เกี่ยวข้อง ซึ่งกลายเป็นอุปสรรคต่อการขับเคลื่อนนโยบายทางสาธารณสุขของประเทศในภาพรวม และการพัฒนาขีดความสามารถของโรงพยาบาลในการให้บริการประชาชนในระยะยาว

เป็นที่น่ายินดีว่า คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล โดย นพ.นวนรรน ธีระอัมพรพันธุ์ ได้มีความคิดที่จะทำการศึกษาวิจัยเพื่อสำรวจการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลของประเทศไทย ในโครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย (Thai Hospitals' Adoption of Information Technology Survey: THAIS) ซึ่งผลการวิจัยดังกล่าวจะเป็นประโยชน์อย่างมากต่อการวางแผนและกำหนดนโยบายระดับชาติเพื่อสนับสนุนการพัฒนางานด้านเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศไทย ทั้งภาครัฐและเอกชน

ในฐานะผู้ที่ปฏิบัติงานด้านเวชสารสนเทศคนหนึ่ง ผมจึงหวังเป็นอย่างยิ่งว่าโรงพยาบาลของท่าน จะสามารถสละเวลาสักเล็กน้อย ให้เกียรติเข้าร่วมโครงการวิจัยนี้ เพื่อให้ประเทศของเรามีข้อมูลภาพรวมของโรงพยาบาลทั่วประเทศ ซึ่งจะส่งผลดีทั้งต่อระบบสาธารณสุขโดยรวม และโรงพยาบาลของท่านต่อไป

จึงเรียนมาเพื่อโปรดพิจารณา จักเป็นพระคุณยิ่ง

ขอแสดงความนับถือ

(นพ.ณรงค์ กษิติประดิษฐ์)
ผู้อำนวยการกลุ่มภารกิจด้านข้อมูลข่าวสารและสารสนเทศสุขภาพ
สำนักนโยบายและยุทธศาสตร์
กระทรวงสาธารณสุข
นายกสมาคมเวชสารสนเทศไทย (TMI)

## Informed Consent Documents for Nationwide Survey (Thai)

### เอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้เข้าร่วมการวิจัย (Participant Information Sheet)

ผู้วิจัยขอขอบพระคุณเป็นอย่างสูงสำหรับความสนใจของท่านต่อโครงการวิจัยนี้ ซึ่งเป็นการวิจัยเพื่อศึกษาการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศไทย ท่านได้รับเลือกให้เป็นกลุ่มตัวอย่างเป้าหมายของการวิจัยนี้เนื่องจากท่านปฏิบัติงานอยู่ในโรงพยาบาลในประเทศ โดยมีบทบาทในการบริหารจัดการ พัฒนา หรือดูแลระบบสารสนเทศในโรงพยาบาลของท่าน ผู้วิจัยขอความกรุณาท่านสละเวลาอันมีค่าเพื่ออ่านรายละเอียดของการวิจัยนี้ และสอบถามประเด็นที่ท่านอาจมีข้อสงสัยก่อนเริ่มตอบแบบสอบถาม

**ชื่อโครงการ** โครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย
(Thai Hospitals' Adoption of Information Technology Survey: THAIS)

**ชื่อผู้วิจัย** นพ.นวนรรน ธีระอัมพรพันธุ์
ฝ่ายเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
นักศึกษาปริญญาเอกสาขาเวชสารสนเทศ มหาวิทยาลัยมินนิโซตา ประเทศสหรัฐอเมริกา
โดยมี Prof. Stuart M. Speedie เป็นอาจารย์ที่ปรึกษา

**สถานที่วิจัย** ฝ่ายเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
270 ถนนพระราม 6 เขตราชเทวี กทม. 10400

**ผู้สนับสนุนการวิจัย** คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

**ความเป็นมาของโครงการ**

เทคโนโลยีสารสนเทศ มีศักยภาพในการสนับสนุนการปฏิบัติงานของบุคลากรทางการแพทย์ในโรงพยาบาล เพื่อให้การปฏิบัติงานมีคุณภาพและประสิทธิภาพมากยิ่งขึ้น แต่ความเข้าใจในภาพรวมเกี่ยวกับการนำเทคโนโลยีสารสนเทศมาใช้งานในโรงพยาบาลต่างๆ ในประเทศไทย ยังมีอยู่อย่างจำกัดมาก ทำให้ขาดข้อมูลที่จะเป็นประโยชน์ในการวางแผนและสร้างกลไกเพื่อสนับสนุนการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลมากยิ่งขึ้น ทั้งยังทำให้ผู้ป่วยที่มารับบริการสูญเสียโอกาสที่จะได้รับการบริการที่อาจได้รับความสะดวก รวดเร็ว ปลอดภัย และมีคุณภาพมากยิ่งขึ้นจากการนำเทคโนโลยีสารสนเทศมาใช้งาน จึงจำเป็นจะต้องมีการศึกษาวิจัยเพิ่มเติมเพื่อเป็นข้อมูลอันมีค่ายิ่งสำหรับผู้กำหนดนโยบายของระบบสุขภาพในอนาคต ทั้งยังจะให้ข้อมูลที่เป็นประโยชน์ต่อโรงพยาบาลของท่านในการวางแผนการพัฒนางานด้านเทคโนโลยีสารสนเทศ อันจะสร้างประโยชน์สูงสุดต่อโรงพยาบาลของท่านและผู้ป่วยที่มารับบริการในระยะยาว

**วัตถุประสงค์**

โครงการนี้เป็นโครงการวิจัยวิทยานิพนธ์ของผู้วิจัย เพื่อสำรวจระดับการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศ และวิเคราะห์หาปัจจัยเกื้อหนุน เพื่อส่งเสริมให้มีการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลมากยิ่งขึ้น และส่งผลดีต่อการให้บริการผู้ป่วยและการดำเนินงานของโรงพยาบาลต่อไป

**รายละเอียดที่จะปฏิบัติต่อผู้เข้าร่วมการวิจัย**

หากท่านยินยอมเข้าร่วมการวิจัยนี้ ผู้วิจัยจะขอให้ท่านตอบแบบสอบถามที่แนบมาพร้อมนี้ และส่งกลับคืนมายังผู้วิจัยโดยใช้ซองไปรษณีย์ที่ติดแสตมป์ไว้ล่วงหน้าที่ได้แนบมาด้วย แบบสอบถามนี้ใช้เวลาประมาณ 20 นาทีในการตอบ

**ประโยชน์และผลข้างเคียงที่อาจเกิดแก่ผู้เข้าร่วมการวิจัย**

การวิจัยนี้ไม่มีผลข้างเคียงที่อาจเกิดต่อผู้เข้าร่วมการวิจัย และไม่มีประโยชน์โดยตรงต่อท่าน แต่การเข้าร่วมวิจัยของท่านจะส่งประโยชน์ต่อสังคมเป็นอย่างมาก โดยช่วยให้ผู้กำหนดนโยบายด้านระบบสุขภาพของประเทศเข้าใจสภาพการใช้งานเทคโนโลยีสารสนเทศในประเทศไทยมากยิ่งขึ้น ความรู้นี้จะช่วยให้มีการพัฒนาโครงการที่สนับสนุนการใช้เทคโนโลยีสารสนเทศในโรงพยาบาลไทยมากยิ่งขึ้น ซึ่งอาจส่งผลดีต่อโรงพยาบาลของท่านและโรงพยาบาลอื่นๆ รวมไปถึงผู้ป่วยและประชาชนทั่วไปในระยะยาว นอกจากนี้ ผู้วิจัยยินดีส่งผลการวิจัยให้กับท่านเมื่อการวิจัยเสร็จสิ้น หากท่านระบุความประสงค์ดังกล่าวท้ายแบบสอบถาม ซึ่งจะช่วยให้ท่านสามารถเปรียบเทียบระดับการใช้งานของโรงพยาบาลของท่านกับโรงพยาบาลอื่นๆ ทั่วประเทศได้ อย่างไรก็ตาม ผู้วิจัยตระหนักว่าการตอบแบบสอบถามในการวิจัยนี้ จะเป็นการรบกวนเวลาของท่าน ผู้วิจัยจึงยินดีให้ค่าตอบแทนเพื่อชดเชยกับเวลาอันมีค่าของท่าน เป็นเงิน 150 บาท หลังจากที่ท่านส่งแบบสอบถามคืนกลับมาแล้ว และได้ระบุชื่อผู้ประสงค์จะรับค่าตอบแทนไว้ท้ายแบบสอบถาม ซึ่งค่าตอบแทนดังกล่าว แม้อาจเป็นจำนวนเพียงเล็กน้อยเมื่อเทียบกับเวลาที่ท่านสละให้กับการวิจัย แต่ก็เป็นการแสดงความขอบคุณที่ท่านเข้าร่วมการวิจัย และต้องการเห็นการพัฒนางานด้านเวชสารสนเทศเพื่อรองรับระบบบริการสุขภาพของประเทศยิ่งๆ ขึ้นไป

**การรักษาความลับของข้อมูล**

แบบสอบถามนี้ มีช่องว่างท้ายแบบสอบถาม เพื่อให้ท่านกรอกชื่อและที่อยู่ของท่านหากท่านประสงค์จะรับค่าตอบแทนและ/หรือผลการวิจัย การให้ชื่อและที่อยู่ดังกล่าว ขึ้นอยู่กับความสมัครใจของท่าน และจะไม่มีการเชื่อมโยงตัวตนของท่านกับคำตอบที่ท่านให้ไว้ในแบบสอบถามในการวิเคราะห์ใดๆ ทั้งสิ้น นอกจากนี้ การวิจัยนี้ มีการใช้เลขรหัสเพื่อระบุโรงพยาบาลที่ตอบแบบสอบถาม ซึ่งจะช่วยให้ผู้วิจัยสามารถติดตามได้ว่าโรงพยาบาลใดได้ตอบแบบสอบถามแล้ว และสามารถวิเคราะห์ข้อมูลของโรงพยาบาลแต่ละแห่งและแต่ละประเภทได้ คำตอบที่ท่านให้ไว้ รวมถึงข้อมูลเกี่ยวกับตัวตนของท่านและโรงพยาบาลของท่าน จะถูกเก็บไว้เป็นความลับและเข้าถึงได้เฉพาะทีมผู้วิจัยเท่านั้น หากผู้วิจัยจะเผยแพร่ผลงานวิจัยนี้ต่อสาธารณะ ผู้วิจัยจะนำเสนอเฉพาะข้อมูลในภาพรวม และไม่เปิดเผยข้อมูลที่ระบุตัวตนของท่านหรือโรงพยาบาลของท่านแต่อย่างใด

**ความสมัครใจในการเข้าร่วมการวิจัย**

การตัดสินใจเข้าร่วมการวิจัยนี้ เป็นไปด้วยความสมัครใจของท่าน การตัดสินใจของท่าน จะไม่มีผลต่อความสัมพันธ์ในปัจจุบันหรืออนาคตระหว่างท่านหรือโรงพยาบาลของท่าน กับคณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดลหรือมหาวิทยาลัยมินนิโซตา หากท่านตัดสินใจที่จะเข้าร่วมการวิจัย ท่านมีสิทธิที่จะถอนตัวจากการวิจัยนี้เมื่อใดก็ได้โดยไม่มีผลต่อความสัมพันธ์เหล่านี้ นอกจากนี้ หากท่านไม่ต้องการตอบคำถามในข้อหนึ่งข้อใดไม่ว่าด้วยเหตุใดก็ตาม ท่านสามารถข้ามคำถามข้อนั้นได้

**บุคคลและวิธีการติดต่อเมื่อมีปัญหาหรือข้อสงสัยที่เกี่ยวข้องกับการวิจัย**

นพ.นวนรรน ธีระอัมพรพันธุ์ ตู้ ปณ. 125 ปณศ.สามเสนใน เขตพญาไท กทม. 10400

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## คำยินยอมโดยได้รับการบอกกล่าวและเต็มใจ (Informed Consent)

ข้าพเจ้าได้ทราบรายละเอียดของโครงการวิจัย ตลอดจนประโยชน์และความเสี่ยงที่อาจเกิดขึ้นต่อข้าพเจ้าจากผู้วิจัยแล้วอย่างชัดเจน ไม่มีสิ่งใดปิดบังซ่อนเร้น และยินยอมให้ทำการวิจัยในโครงการที่มีชื่อข้างต้น และข้าพเจ้าทราบว่าถ้ามีปัญหาหรือข้อสงสัยเกิดขึ้น ข้าพเจ้าสามารถสอบถามผู้วิจัยได้ และข้าพเจ้าสามารถปฏิเสธไม่เข้าร่วมโครงการวิจัยนี้เมื่อใดก็ได้ โดยไม่มีผลกระทบต่อความสัมพันธ์และการบริการที่ข้าพเจ้าพึงได้รับ นอกจากนี้ ผู้วิจัยจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าและโรงพยาบาลของข้าพเจ้าเป็นความลับ และจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัยเท่านั้น ทั้งนี้ ให้ถือว่าการตอบแบบสอบถามที่แนบมานี้และส่งคืนให้กับผู้วิจัย เป็นการแสดงเจตนายินยอมเข้าร่วมการวิจัยนี้ของข้าพเจ้า แทนการลงนามให้คำยินยอม

ท่านสามารถเก็บเอกสารฉบับนี้ไว้เป็นบันทึกของท่านได้

ถ้าท่านมีข้อข้องใจหรือมีความกังวลใจเกี่ยวกับวิธีดำเนินการวิจัยของโครงการวิจัยนี้
และประสงค์จะพูดคุยกับบุคคลอื่นนอกเหนือจากผู้วิจัย ท่านสามารถติดต่อได้ที่:
1) ประธานกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี ที่หน่วยจริยธรรมการวิจัยในคน ชั้น 3 สำนักงานวิจัยคณะฯ อาคารวิจัยและสวัสดิการ โทร. 0-2201-1544 ในเวลาราชการ หรือ
2) สายด่วนคุ้มครองผู้เข้าร่วมการวิจัย (Research Subjects' Advocate Line) ของมหาวิทยาลัยมินนิโซตา (University of Minnesota) ที่อยู่ D528 Mayo, 420 Delaware St SE, Minneapolis, MN 55455 USA
โทร. +1 612-625-1650

## Survey Instrument for Nationwide Survey (Thai)

**Note:** There are 18 pages in English but 16 pages in Thai. Each page's contents may not exactly match between the two versions.

# การสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย

# Thai Hospitals' Adoption of Information Technology

**ดำเนินการวิจัยโดย**


นพ.นวนรรน ธีระอัมพรพันธุ์

ฝ่ายเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

นักศึกษาระดับปริญญาเอก สาขาเวชสารสนเทศ

มหาวิทยาลัยมินนิโซตา ประเทศสหรัฐอเมริกา


**สนับสนุนโดย**


คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

มหาวิทยาลัยมหิดล


**2553**

ผู้วิจัยขอขอบคุณท่านสำหรับความสนใจในงานวิจัยนี้ แบบสอบถามฉบับนี้ ได้รับการออกแบบเพื่อให้ผู้ที่มีหน้าที่บริหารจัดการระบบสารสนเทศของโรงพยาบาลของท่าน ซึ่งอาจเป็นผู้บริหารโรงพยาบาลที่มีหน้าที่ดูแลงานด้านสารสนเทศโดยตรง หรือหากไม่มีบุคคลดังกล่าว ทางผู้วิจัย ขอความกรุณาท่านหัวหน้าผู้รับผิดชอบงานด้านเทคโนโลยีสารสนเทศ หรือผู้ดูแลระบบสารสนเทศในโรงพยาบาล สละเวลาเป็นผู้ตอบแบบสอบถาม ในกรณีที่ไม่มีผู้ที่มีบทบาทนี้ในโรงพยาบาลของท่าน ผู้ดำเนินการวิจัยหวังเป็นอย่างยิ่ง ว่าผู้อำนวยการโรงพยาบาลของท่าน หรือผู้บริหารระดับสูงท่านอื่น จะสามารถสละเวลาในการตอบแบบสอบถามนี้ได้

หากท่านไม่แน่ใจคำตอบของคำถามข้อใด ท่านสามารถสอบถามบุคลากรที่เกี่ยวข้องในโรงพยาบาลของท่านได้ หรือหากท่านไม่สามารถค้นหาข้อมูลในส่วนใดได้ โปรดพิจารณาให้คำตอบตามที่ท่านเห็นว่าเหมาะสมที่สุดเท่าที่ท่านจะทำได้ เพื่อเป็นการขอบคุณในความร่วมมือ ผู้ที่ตอบแบบสอบถามและส่งคืนผู้วิจัยจะได้รับค่าตอบแทนเป็นเงิน 150 บาท หากท่านระบุชื่อ ที่อยู่ ด้านหลังแบบสอบถาม

## ส่วนที่ 1: ข้อมูลทั่วไปของโรงพยาบาล

1. โรงพยาบาลของท่านเป็นโรงพยาบาลประเภทใด

   1 ☐ โรงพยาบาลของรัฐ (รวมถึงรัฐวิสาหกิจ โรงพยาบาลในกำกับของรัฐ และองค์การมหาชน)
   2 ☐ โรงพยาบาลเอกชน

2. โรงพยาบาลของท่าน มีการเรียนการสอนนักศึกษาแพทย์เป็นประจำหรือไม่

   1 ☐ ใช่
   2 ☐ ไม่ใช่

3. ปัจจุบันโรงพยาบาลของท่านมีบุคลากร<u>ทั้งสิ้น</u> จำนวนกี่คน

   |________________| คน (อาจตอบเป็นตัวเลขโดยประมาณ)

4. ปัจจุบันโรงพยาบาลของท่านมีบุคลากร<u>ด้านเทคโนโลยีสารสนเทศ</u> จำนวนกี่คน

   |________________| คน (อาจตอบเป็นตัวเลขโดยประมาณ)

5. ในปีงบประมาณ 2553 โรงพยาบาลของท่านมีงบประมาณ<u>ทั้งสิ้น</u>เท่าใด

|_______________| บาท (อาจตอบเป็นตัวเลขโดยประมาณ) ☐ไม่ทราบข้อมูล

6. ในปีงบประมาณ 2553 โรงพยาบาลของท่าน ใช้งบประมาณ<u>ด้านเทคโนโลยีสารสนเทศ</u> ซึ่งรวมถึงการจัดซื้อ/จัดจ้างฮาร์ดแวร์ ซอฟต์แวร์ ค่าตอบแทนบุคลากร ที่ปรึกษา และการจ้างงาน (outsourcing) ด้านเทคโนโลยีสารสนเทศ เป็นจำนวนทั้งสิ้นเท่าใด

|_______________| บาท (อาจตอบเป็นตัวเลขโดยประมาณ) ☐ไม่ทราบข้อมูล

7. หากท่านไม่ทราบข้อมูลข้อ 5 หรือ 6 กรุณาคาดคะเนว่า งบประมาณด้านเทคโนโลยีสารสนเทศในปีงบประมาณ 2553 คิดเป็นประมาณร้อยละเท่าใดของงบประมาณทั้งโรงพยาบาล

1 ☐น้อยกว่าร้อยละ 1
2 ☐ร้อยละ 1 ถึงร้อยละ 4
3 ☐ร้อยละ 5 ถึงร้อยละ 8
4 ☐มากกว่าร้อยละ 8

8. ท่านเห็นด้วยหรือไม่เห็นด้วยกับข้อความแต่ละข้อต่อไปนี้มากน้อยเพียงใด

| ข้อความ | ไม่เห็นด้วยอย่างยิ่ง | | | | เห็นด้วยอย่างยิ่ง |
|---|---|---|---|---|---|
| ก. โรงพยาบาลของเราเปิดกว้างสำหรับแนวทางใหม่ๆ ในการดำเนินงาน | 1 | 2 | 3 | 4 | 5 |
| ข. ผู้บริหารระดับสูงของเราสนับสนุนการใช้เทคโนโลยีสารสนเทศอย่างเต็มที่ | 1 | 2 | 3 | 4 | 5 |
| ค. โรงพยาบาลของเรามีการกำหนดวิสัยทัศน์ เป้าหมาย และแผนงานด้านสารสนเทศที่ชัดเจน | 1 | 2 | 3 | 4 | 5 |
| ง. โรงพยาบาลของเรามีการสื่อสารเป้าหมาย แผนงาน และความคืบหน้าของงานด้านสารสนเทศไปยังผู้เกี่ยวข้องอย่างชัดเจน | 1 | 2 | 3 | 4 | 5 |



| ข้อความ | ไม่เห็นด้วยอย่างยิ่ง | | | | เห็นด้วยอย่างยิ่ง |
|---|---|---|---|---|---|
| จ. ผู้ที่จะใช้ระบบสารสนเทศในโรงพยาบาลของเรามีส่วนร่วมในการพัฒนาระบบสารสนเทศของโรงพยาบาลอย่างเต็มที่ | 1 | 2 | 3 | 4 | 5 |
| ฉ. ทีมผู้ใช้งานที่มีส่วนร่วมในการพัฒนาระบบสารสนเทศของเรา มาจากหลากหลายสาขา | 1 | 2 | 3 | 4 | 5 |
| ช. บุคลากรส่วนใหญ่ของโรงพยาบาล มีความมุ่งมั่นที่จะให้โรงพยาบาลประสบความสำเร็จตามเป้าหมายขององค์กรที่วางไว้ | 1 | 2 | 3 | 4 | 5 |
| ซ. ในการพัฒนาระบบสารสนเทศของโรงพยาบาลของเรา การเปลี่ยนแปลงของขั้นตอนการทำงาน (workflow) ได้รับการพิจารณาอย่างรอบคอบ | 1 | 2 | 3 | 4 | 5 |
| ฌ. โรงพยาบาลของเรามีการอบรมผู้ที่จะใช้งานระบบสารสนเทศอย่างเพียงพอ | 1 | 2 | 3 | 4 | 5 |
| ญ. โรงพยาบาลของเรามีกระบวนการติดตามความคืบหน้าและการจัดการงานด้านสารสนเทศอย่างเหมาะสม | 1 | 2 | 3 | 4 | 5 |
| ฎ. โรงพยาบาลของเรานำประสบการณ์การทำงานในอดีตมาเป็นบทเรียนเพื่อขับเคลื่อนการทำงานในปัจจุบัน | 1 | 2 | 3 | 4 | 5 |

## ส่วนที่ 2: การใช้งานเทคโนโลยีสารสนเทศ

9. โรงพยาบาลของท่านมีการนำเทคโนโลยีสารสนเทศมาใช้งานโดยรวมเพื่อสนับสนุนภารกิจของโรงพยาบาลมากน้อยเพียงใด

1 ☐มาก
2 ☐ค่อนข้างมาก
3 ☐ปานกลาง
4 ☐ค่อนข้างน้อย
5 ☐น้อยมาก

10. โรงพยาบาลของท่านมีเครื่องคอมพิวเตอร์ส่วนบุคคล (รวมถึง desktops, notebooks และ laptops) สำหรับใช้งานจำนวนกี่เครื่อง

|________| เครื่อง (อาจตอบเป็นตัวเลขโดยประมาณ)

11. โรงพยาบาลของท่านใช้ระบบสารสนเทศโรงพยาบาล (Hospital Information System) ระบบใดเป็นระบบหลัก

1 ☐โรงพยาบาลของเราไม่มีระบบสารสนเทศโรงพยาบาล
2 ☐HOSxP
3 ☐Hospital OS
4 ☐ระบบที่โรงพยาบาลของเราพัฒนาขึ้นเองหรือจ้างพัฒนาเป็นพิเศษ
5 ☐อื่นๆ โปรดระบุ |________________________________|

12. โรงพยาบาลของท่านเริ่มใช้ระบบสารสนเทศที่ท่านระบุในข้อ 11 ตั้งแต่ปี พ.ศ. ใด หากท่านไม่ทราบปี พ.ศ. ที่แน่นอน โปรดระบุปี พ.ศ. โดยประมาณ

พ.ศ. |________| ☐ไม่ทราบข้อมูล



13. กิจกรรมแต่ละข้อต่อไปนี้ ได้รับการสนับสนุนด้วยระบบสารสนเทศทางคอมพิวเตอร์มากน้อยเพียงใด หากระดับการสนับสนุนแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับโดยเฉลี่ยทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมใดเลย (Not Applicable) กรุณาเว้นคำตอบของข้อนั้นไว้

| กิจกรรม | ไม่มีการสนับสนุนด้วยคอมพิวเตอร์เลย | | | | มีการสนับสนุนด้วยคอมพิวเตอร์อย่างเต็มที่ |
|---|---|---|---|---|---|
| <u>การจัดการผู้ป่วย (Patient Management)</u> | | | | | |
| การลงทะเบียนและบันทึกข้อมูลทั่วไปของผู้ป่วย | 1 | 2 | 3 | 4 | 5 |
| การจัดการตารางนัดหมายผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| การเรียกดูรายชื่อผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| <u>การดูแลผู้ป่วยนอก</u> | | | | | |
| การสั่งยาผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| การเรียกดูผลการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| การเรียกดูภาพทางรังสีวิทยาผ่านคอมพิวเตอร์ (แทนฟิล์มเอกซเรย์) สำหรับผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| การบันทึกประวัติและการตรวจร่างกายของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| <u>การดูแลผู้ป่วยใน</u> | | | | | |
| การสั่งยาผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |

| กิจกรรม | ไม่มีการสนับสนุนด้วยคอมพิวเตอร์เลย | | | | มีการสนับสนุนด้วยคอมพิวเตอร์อย่างเต็มที่ |
|---|---|---|---|---|---|
| การเรียกดูผลการตรวจทางห้องปฏิบัติการของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| การเรียกดูภาพทางรังสีวิทยาผ่านคอมพิวเตอร์ (แทนฟิล์มเอกซเรย์) สำหรับผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| การบันทึกประวัติ การตรวจร่างกาย และ Progress Note ของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| การสรุปประวัติผู้ป่วยจำหน่าย (discharge summary) | 1 | 2 | 3 | 4 | 5 |
| <u>การพยาบาล</u> | | | | | |
| การบันทึกการให้ยาผู้ป่วย | 1 | 2 | 3 | 4 | 5 |
| การบันทึกทางการพยาบาล | 1 | 2 | 3 | 4 | 5 |
| <u>งานเภสัชกรรม</u> | | | | | |
| การจ่ายยาผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| การจ่ายยาผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| การจัดการคลังยาและเวชภัณฑ์ | 1 | 2 | 3 | 4 | 5 |
| การตรวจสอบการสั่งยาที่ผู้ป่วยมีประวัติแพ้ด้วยระบบคอมพิวเตอร์ | 1 | 2 | 3 | 4 | 5 |
| การตรวจสอบการสั่งยาที่มีปฏิกิริยาต่อกัน (drug interactions) | 1 | 2 | 3 | 4 | 5 |
| <u>การเงิน</u> | | | | | |
| การเรียกเก็บเงินจากผู้ป่วย | 1 | 2 | 3 | 4 | 5 |
| การเบิกจ่ายค่ารักษาพยาบาล | 1 | 2 | 3 | 4 | 5 |



**14.** โรงพยาบาลของท่านมีเทคโนโลยีแต่ละอย่างต่อไปนี้ติดตั้งอยู่ในโรงพยาบาล (available) มากน้อยเพียงใด หากแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับโดยเฉลี่ยของหน่วยงานทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมที่สามารถนำเทคโนโลยีใดมาสนับสนุนการทำงานได้ (Not Applicable) กรุณาเว้นคำตอบของข้อนั้นไว้

| เทคโนโลยี | ไม่มีเทคโนโลยีนี้อยู่ในโรงพยาบาล | | | | มีเทคโนโลยีนี้อยู่ในโรงพยาบาลอย่างเต็มที่ |
|---|---|---|---|---|---|
| ก. การเข้าถึงอินเทอร์เน็ต | 1 | 2 | 3 | 4 | 5 |
| ข. เว็บไซต์ของโรงพยาบาล | 1 | 2 | 3 | 4 | 5 |
| ค. ระบบเครือข่ายภายในโรงพยาบาล (LAN) | 1 | 2 | 3 | 4 | 5 |
| ง. ระบบทะเบียนผู้ป่วย (Master Patient Index) | 1 | 2 | 3 | 4 | 5 |
| จ. ระบบที่ให้แพทย์สั่งการรักษาด้วยคอมพิวเตอร์ | 1 | 2 | 3 | 4 | 5 |
| ฉ. ระบบบันทึกการให้ยาผู้ป่วยด้วยคอมพิวเตอร์ (electronic medication administration records) | 1 | 2 | 3 | 4 | 5 |
| ช. ระบบเวชระเบียนอิเล็กทรอนิกส์ (electronic medical records) ซึ่งบันทึกประวัติการรักษาพยาบาลในคอมพิวเตอร์ | 1 | 2 | 3 | 4 | 5 |
| ซ. ระบบสารสนเทศห้องปฏิบัติการ (laboratory information system - LIS) | 1 | 2 | 3 | 4 | 5 |
| ฌ. ระบบจัดเก็บและเรียกดูภาพทางรังสีวิทยาด้วยคอมพิวเตอร์แทนฟิล์มเอกซเรย์ (PACS) | 1 | 2 | 3 | 4 | 5 |
| ญ. การใช้บาร์โค้ดในการดูแลรักษาผู้ป่วย | 1 | 2 | 3 | 4 | 5 |

15. ในบางครั้ง ข้อมูลสารสนเทศจะมีการแลกเปลี่ยนหรือส่งต่อกันทางอิเล็กทรอนิกส์ระหว่างระบบสารสนเทศต่างๆ แต่ในบางกรณี ข้อมูลสารสนเทศอาจไม่ได้มีการแลกเปลี่ยนหรือส่งต่อกันระหว่างระบบสารสนเทศเลย

ข้อมูลสารสนเทศแต่ละประเภทต่อไปนี้ มีการแลกเปลี่ยนหรือส่งต่อกันระหว่างระบบสารสนเทศต่างๆ ภายในโรงพยาบาลมากน้อยเพียงใด

การแลกเปลี่ยนข้อมูล **ภายใน** โรงพยาบาล

| **ประเภทของข้อมูล** | **ไม่มีการแลกเปลี่ยนข้อมูล** | | | | **มีการแลกเปลี่ยนข้อมูลอย่างเต็มที่** |
|---|---|---|---|---|---|
| ก. ข้อมูลทั่วไปของผู้ป่วย | 1 | 2 | 3 | 4 | 5 |
| ข. ประวัติการเจ็บป่วยและบันทึกทางการแพทย์ในแผนกผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| ค. การวินิจฉัยโรคของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| ง. ยาที่แพทย์สั่งให้ผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| จ. ประวัติการเจ็บป่วยและบันทึกทางการแพทย์ในแผนกผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| ฉ. การวินิจฉัยโรคของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| ช. ยาที่แพทย์สั่งให้ผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| ซ. รายการผ่าตัดและการทำหัตถการ | 1 | 2 | 3 | 4 | 5 |
| ฌ. ผลการตรวจทางห้องปฏิบัติการ | 1 | 2 | 3 | 4 | 5 |
| ญ. ภาพและผลการตรวจทางรังสีวิทยา | 1 | 2 | 3 | 4 | 5 |



16. ข้อมูลสารสนเทศแต่ละประเภทต่อไปนี้ มีการแลกเปลี่ยนหรือส่งต่อกันระหว่างระบบสารสนเทศของโรงพยาบาล กับระบบสารสนเทศอื่นภายนอกโรงพยาบาล (เช่น ระบบสารสนเทศของส่วนราชการหรือสถานพยาบาลอื่น) ทั้งการส่งข้อมูลให้กับระบบภายนอก และการรับข้อมูลจากระบบภายนอก มากน้อยเพียงใด

การแลกเปลี่ยนข้อมูล **ภายนอก** โรงพยาบาล

| **ประเภทของข้อมูล** | **ไม่มีการแลกเปลี่ยนข้อมูล** | | | | **มีการแลกเปลี่ยนข้อมูลอย่างเต็มที่** |
|---|---|---|---|---|---|
| ก. ข้อมูลทั่วไปของผู้ป่วย | 1 | 2 | 3 | 4 | 5 |
| ข. ประวัติการเจ็บป่วยและบันทึกทางการแพทย์ในแผนกผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| ค. การวินิจฉัยโรคของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| ง. ยาที่แพทย์สั่งให้ผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 |
| จ. ประวัติการเจ็บป่วยและบันทึกทางการแพทย์ในแผนกผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| ฉ. การวินิจฉัยโรคของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| ช. ยาที่แพทย์สั่งให้ผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 |
| ซ. รายการผ่าตัดและการทำหัตถการ | 1 | 2 | 3 | 4 | 5 |
| ฌ. ผลการตรวจทางห้องปฏิบัติการ | 1 | 2 | 3 | 4 | 5 |
| ญ. ภาพและผลการตรวจทางรังสีวิทยา | 1 | 2 | 3 | 4 | 5 |

## ส่วนที่ 3: ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม

17. โปรดระบุเพศของท่าน

1 ☐ชาย 2 ☐หญิง

18. ท่านมีอายุเท่าใด

|______| ปี

19. ท่านจบการศึกษาขั้นสูงสุดระดับใด

1 ☐ต่ำกว่าปริญญาตรี
2 ☐ปริญญาตรี (รวมถึงปริญญาแพทยศาสตรบัณฑิต)
3 ☐ปริญญาโทหรือสูงกว่า (รวมถึงแพทย์ที่จบสาขาเฉพาะทาง)

20. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้าน<u>เทคโนโลยีสารสนเทศ</u>ของท่านมากที่สุด

1 ☐ไม่เคยได้รับการศึกษาอบรมในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศเลย
2 ☐เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ
3 ☐เคยได้รับปริญญาตรี/โท/เอกในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ

21. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมใน<u>สาขาวิชาชีพทางสุขภาพ</u>ของท่านมากที่สุด (สาขาวิชาชีพทางสุขภาพ เช่น สาขาวิชาทางแพทยศาสตร์ ทันตแพทยศาสตร์ พยาบาลศาสตร์ เภสัชศาสตร์ เทคนิคการแพทย์ กายภาพบำบัด รังสีเทคนิค สาธารณสุขศาสตร์)

1 ☐ไม่เคยได้รับการศึกษาอบรมในสาขาวิชาชีพทางสุขภาพ
2 ☐เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาวิชาชีพทางสุขภาพ
3 ☐เคยได้รับปริญญาตรี/โท/เอกในสาขาวิชาชีพทางสุขภาพ

22. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้าน<u>บริหารธุรกิจหรือการบริหารจัดการ</u> (business administration/management) ของท่านมากที่สุด

1 ☐ไม่เคยได้รับการศึกษาอบรมด้านการบริหารธุรกิจหรือการบริหารจัดการ
2 ☐เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาด้านการบริหารธุรกิจหรือการบริหารจัดการ
3 ☐เคยได้รับปริญญาตรี/โท/เอกด้านการบริหารธุรกิจหรือการบริหารจัดการ

23. ท่านปฏิบัติงานในบทบาทที่เกี่ยวข้องกับ<u>เทคโนโลยีสารสนเทศ</u> <u>ไม่ว่าในตำแหน่งใด</u> ณ สถานที่ทำงานใดในอดีตและปัจจุบัน มาแล้วรวมทั้งหมดเป็นเวลากี่ปี

|______| ปี



24. ข้อใดต่อไปนี้ตรงกับบทบาทของท่านในโรงพยาบาล หากท่านมีหลายบทบาท กรุณาเลือกทุกบทบาทที่ตรงกับท่าน

1 ☐ผู้อำนวยการหรือผู้บริหารระดับสูงของโรงพยาบาล
2 ☐ผู้บริหารโรงพยาบาลที่กำกับดูแลงานด้านสารสนเทศโดยตรง
3 ☐หัวหน้าหน่วยงานด้านสารสนเทศที่ไม่ใช่ผู้บริหารโรงพยาบาล
4 ☐ผู้เชี่ยวชาญด้านสารสนเทศ เช่น ผู้ดูแลระบบ นักวิเคราะห์ระบบ โปรแกรมเมอร์ นักวิชาการคอมพิวเตอร์ นักเวชสถิติ หรือบุคลากรทางเทคนิคในโรงพยาบาล ที่ไม่ใช่ผู้บริหารหรือหัวหน้าหน่วยงาน
5 ☐บุคลากรในโรงพยาบาลที่มีหรือเคยมีบทบาทสำคัญในการพัฒนางานด้านเทคโนโลยีสารสนเทศ แต่ไม่ใช่ผู้บริหารโรงพยาบาลหรือบุคลากรทางเทคนิค
6 ☐บุคลากรในโรงพยาบาลที่ไม่ได้มีบทบาทสำคัญในการพัฒนางานด้านเทคโนโลยีสารสนเทศ และไม่ใช่ผู้บริหารโรงพยาบาลหรือบุคลากรทางเทคนิค
7 ☐อื่นๆ โปรดระบุ |______________________________|

ผู้วิจัยขอขอบพระคุณท่านเป็นอย่างสูงที่ได้กรุณาสละเวลาในการตอบแบบสอบถามนี้ คำตอบของท่านมีคุณค่ายิ่งต่อการพัฒนางานด้านเวชสารสนเทศของโรงพยาบาลในประเทศไทย หากท่านมีความเห็นเพิ่มเติมในเรื่องใด ท่านสามารถแสดงความเห็นดังกล่าวได้ในช่องว่างข้างล่างนี้

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หากท่านประสงค์จะได้รับผลการวิจัย และ/หรือ ค่าตอบแทนเป็นเงิน 150 บาท กรุณาระบุชื่อและที่อยู่ของท่านในช่องว่างข้างล่างนี้ ข้อมูลนี้จะถูกเก็บรักษาไว้เป็นความลับ และจะถูกนำมาใช้เพื่อส่งค่าตอบแทนและผลการวิจัยเท่านั้น จะไม่มีการเชื่อมโยงกับคำตอบของท่านแต่อย่างใด

ประสงค์จะรับ ☐เฉพาะผลการวิจัย ☐เฉพาะค่าตอบแทน ☐ทั้งผลการวิจัยและค่าตอบแทน
(โปรดระบุชื่อที่อยู่ผู้รับ และหากประสงค์จะรับผลการวิจัยทาง e-mail โปรดระบุ e-mail address)

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กรุณาส่งแบบสอบถามที่ตอบเสร็จแล้วในซองติดแสตมป์ที่ได้แนบมาพร้อมนี้ หรือส่งไปที่:
นพ.นวนรรน ธีระอัมพรพันธุ์ ตู้ ปณ. 125 ปณฝ. สามเสนใน เขตพญาไท กทม. 10400

☐☐☐☐☐

## Reminder Letter for Nationwide Survey (Thai)

**คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล**
๒๗๐ ถนนพระราม ๖ แขวงทุ่งพญาไท เขตราชเทวี กทม. ๑๐๔๐๐
โทร. ๐-๒๓๕๔-๗๒๗๕, ๐-๒๒๐๑-๑๒๙๖ โทรสาร ๐-๒๓๕๔-๗๒๓๓

**Faculty of Medicine Ramathibodi Hospital, Mahidol University**
270 Rama VI Road, Ratchathewi, Bangkok 10400, Thailand
Tel. (+66) 2354-7275, (+66) 2201-1296 Fax (+66) 2354-7233

ฝ่ายเวชสารสนเทศ คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี
โทร ๐-๒๒๐๑-๒๙๙๒, ๐-๒๒๐๑-๒๒๒๗ โทรสาร ๐-๒๒๐๑-๑๑๑๓

ที่ ๓๑๕/๒๕๕๔
วันที่ ๒๔ มกราคม ๒๕๕๔
เรื่อง ขอความอนุเคราะห์เข้าร่วมโครงการวิจัยเพื่อสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย
เรียน

เมื่อประมาณ ๑ เดือนก่อน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี ได้ส่งหนังสือมายังสถานพยาบาลของท่าน ขอความอนุเคราะห์เข้าร่วมโครงการวิจัยเพื่อสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย (Thai Hospitals' Adoption of Information Technology Survey) หรือโครงการ THAIS ซึ่งมีวัตถุประสงค์เพื่อสำรวจระดับการใช้งานเทคโนโลยีสารสนเทศในโรงพยาบาลทั่วประเทศ และวิเคราะห์หาปัจจัยเกื้อหนุนที่เกี่ยวข้อง เพื่อประโยชน์ในการกำหนดนโยบายด้านสาธารณสุขของประเทศ และได้แนบแบบสอบถามมา ๑ ฉบับ เพื่อขอให้ท่านตอบและส่งคืนผู้วิจัย อย่างไรก็ตาม ทางโครงการวิจัยยังมิได้รับแบบสอบถามจากสถานพยาบาลของท่านแต่อย่างใด

ทางโครงการวิจัย ได้รับแบบสอบถามคืนจากสถานพยาบาลอื่นอย่างกว้างขวาง ทั้งสถานพยาบาลภาครัฐและภาคเอกชน ซึ่งได้ให้ข้อมูลที่มีค่ายิ่งต่อการวิเคราะห์สถานการณ์การใช้เทคโนโลยีสารสนเทศของสถานพยาบาลในประเทศ ทั้งยังได้รับความเห็นเกี่ยวกับปัญหาอุปสรรคในการดำเนินงานด้านเทคโนโลยีสารสนเทศที่เป็นประโยชน์อย่างมาก

กระผม ในฐานะหัวหน้าโครงการวิจัย จึงใคร่ขอความอนุเคราะห์จากสถานพยาบาลของท่านอีกครั้งหนึ่ง เนื่องจากข้อมูลของสถานพยาบาลของท่าน จะช่วยให้งานวิจัยนี้ได้ข้อมูลที่ถูกต้องมากยิ่งขึ้น แม้ว่าผู้วิจัยจะได้รับแบบสอบถามคืนจากสถานพยาบาลอื่นๆ แล้วก็ตาม แต่ผลการวิจัยจะถูกต้องแม่นยำก็ต่อเมื่อได้รับข้อมูลจากสถานพยาบาลส่วนใหญ่ในกลุ่มตัวอย่าง

คำตอบของสถานพยาบาลของท่าน จะถูกปิดไว้เป็นความลับ โดยจะไม่มีการรายงานผลเป็นรายสถานพยาบาลแต่อย่างใด นอกจากนี้ หากท่านระบุรายละเอียดท้ายแบบสอบถาม ทางผู้วิจัยยินดีส่งผลการวิจัยให้กับสถานพยาบาลของท่านเพื่อการเปรียบเทียบกับสถานการณ์ในภาพรวมทั่วประเทศ และการวางแผนตัดสินใจภายในโรงพยาบาลของท่านต่อไป

ทางโครงการวิจัย จึงใคร่ขอความอนุเคราะห์จากท่านในการตอบแบบสอบถาม ซึ่งได้แนบมาอีกครั้งพร้อมหนังสือฉบับนี้ โดยขอให้ท่านส่งแบบสอบถามที่แนบมานี้ ให้กับ**ผู้บริหารที่มีบทบาทโดยตรงในการบริหารจัดการระบบสารสนเทศหรือหัวหน้าผู้รับผิดชอบงานด้านสารสนเทศในโรงพยาบาลของท่าน เป็นผู้ตอบ หรือหากโรงพยาบาลของท่านไม่มีบุคลากรด้านสารสนเทศโดยตรง ขอความอนุเคราะห์ท่านผู้อำนวยการ สละเวลาเป็นผู้ตอบแบบสอบถามดังกล่าว** แล้วส่งคืนมายังโครงการวิจัยโดยใช้ซองติดแสตมป์ที่แนบมาพร้อมนี้ **ภายในวันที่ ๒๑ กุมภาพันธ์ ๒๕๕๔**

จึงเรียนมาเพื่อโปรดพิจารณา และขอขอบพระคุณสถานพยาบาลของท่านสำหรับความอนุเคราะห์มา ณ โอกาสนี้ ทั้งนี้ ทางโครงการวิจัยกราบขออภัยหากหนังสือฉบับนี้สวนทางกับแบบสอบถามที่สถานพยาบาลของท่านได้ส่งคืนกลับมาแล้ว

ขอแสดงความนับถือ

(นายแพทย์นวนรรน ธีระอัมพรพันธุ์)
หัวหน้าโครงการวิจัย THAIS

# Appendix C

Letters of Ethical Approval

## Grant of Exemption Status by the University of Minnesota's Institutional Review Board

**From: irb@umn.edu**
**Subject: 1005E82796 - PI Theera-Ampornpunt - IRB - Exempt Study Notification**
**Date: Wed, 2 Jun 2010**
**To: speed002@umn.edu, theer002@umn.edu,**

The IRB: Human Subjects Committee determined that the referenced study is exempt from review under federal guidelines 45 CFR Part 46.101(b) category #2 SURVEYS/INTERVIEWS; STANDARDIZED EDUCATIONAL TESTS; OBSERVATION OF PUBLIC BEHAVIOR.

Study Number: 1005E82796

Principal Investigator: Nawanan Theera-Ampornpunt

Title(s):
Thai Hospitals' Adoption of Information Technology Survey (THAIS)

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This e-mail confirmation is your official University of Minnesota RSPP notification of exemption from full committee review. You will not receive a hard copy or letter.
This secure electronic notification between password protected authentications has been deemed by the University of Minnesota to constitute a legal signature.

The study number above is assigned to your research. That number and the title of your study must be used in all communication with the IRB office.

Research that involves observation can be approved under this category without obtaining consent.

SURVEY OR INTERVIEW RESEARCH APPROVED AS EXEMPT UNDER THIS CATEGORY IS LIMITED TO ADULT SUBJECTS.

This exemption is valid for five years from the date of this correspondence and will be filed inactive at that time. You will receive a notification prior to inactivation. If this research will extend beyond five years, you must submit a new application to the IRB before the study?s expiration date.

Upon receipt of this email, you may begin your research. If you have questions, please call the IRB office at (612) 626-5654.

You may go to the View Completed section of eResearch Central at http://eresearch.umn.edu/ to view further details on your study.

The IRB wishes you success with this research.

We have created a short survey that will only take a couple of minutes to complete. The questions are basic, but will give us guidance on what areas are showing improvement and what areas we need to focus on:

https://umsurvey.umn.edu/index.php?sid=36122&lang=um

**From: Marsha Williams <willi173@umn.edu>**
**Subject: IRB Exempt Proposal #1005E82796**
**Date: Wed, 2 Jun 2010**
**To: theer002@umn.edu,**
**CC: speed002@umn.edu**

The IRB received your application entitled "Thai Hospitals' Adoption of Information Technology Survey (THAIS)." The exemption is granted but following information is needed:

* Copy of the Committee on Human Rights Related to Researches Involving Human Subjects of the Faculty of Medicine Ramathibody Hospital, Mahidol University approval - once received
* Confirm you will follow U of MN OIT standards for storing any data containing identifying information - see OIT website at http://www.oit.umn.edu/index.php
* Confirm you will add your advisors contact information to the consent information sheet
* Confirm you will add the IRB's contact information to the consent sheet - see below for details

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

Please provide this information to this e-mail address at your earliest convenience. If you have any questions, feel free to send me an e-mail or call me directly at 612-625-9186. Thank you.

*PLEASE DO NOT SUBMIT A REVISED APPLICATION*

Sincerely,

Marsha Williams
Exempt Review Administrator
Institutional Review Board (IRB) - Exempt

MMC 820
420 Delaware Street SE
Minneapolis, MN 55455

612-625-9186 (direct)
612-626-6061 (fax)

willi173@umn.edu
http://www.research.umn.edu/subjects/index.cfm

## Confirmation of Satisfactory Actions for Exempt Study as instructed by the University of Minnesota's Institutional Review Board

**From: Marsha Williams <willi173@umn.edu>**
**Subject: RE: IRB Exempt Proposal #1005E82796**
**Date: Mon, 7 Jun 2010**
**To: theer002@umn.edu,**
**CC: speed002@umn.edu**

Dr. Theera-Ampornpunt,

Thank you for the confirmations. I've added the information to your file. Please note it is not necessary to provide a revised consent or application form. Your confirmation to make the requested changes is sufficient. The IRB will wait to receive a copy of the Committee on Human Rights Related to Researches Involving Human Subjects of the Faciulty of Medicine Ramathibodi Hospital approval.

Sincerely,

Marsha Williams
Exempt Review Administrator
Institutional Review Board (IRB) - Exempt

From: Nawanan Theera-Ampornpunt [mailto:theer002@umn.edu]
Sent: Wednesday, June 02, 2010 2:10 PM
To: Marsha Williams
Cc: speed002@umn.edu
Subject: Re: IRB Exempt Proposal #1005E82796

Dear Ms. Marsha Williams,

Thank you for the information on my IRB exempt application #1005E82796. Once received, I will submit a copy of the approval of the Committee on Human Rights Related to Researches Involving Human Subjects of the Faculty of Medicine Ramathibodi Hospital, Mahidol University.

I also confirm that
- I will follow the University's OIT standards for storing any data containing identifying information;
- I will add my advisor's contact information to the consent information sheet
- I will add the IRB's contact information to the consent sheet as told by the IRB in the message below.

I will provide the IRB office with the updated documents once I have a chance to revise them per the recommendations.

I sincerely thank you and the IRB for the consideration. If you need any further information from me, apart from the pending ethics committee approval from Thailand, please don't hesitate to let me know.

Sincerely,

Nawanan Theera-Ampornpunt

**From: Marsha Williams <willi173@umn.edu>**
**Subject: RE: IRB Exempt Proposal #1005E82796**
**Date: Wed, 9 Jun 2010**
**To: theer002@umn.edu,**
**CC: speed002@umn.edu**

Dr. Theera-Ampornpunt,

Thank you for the copy of the approval. I will add this document to your file. Everything is in order, your study is exempt and the IRB wishes you the best with your project.

Feel free to contact the IRB if you have any questions.

Sincerely,

Marsha Williams
Exempt Review Administrator
Institutional Review Board (IRB) - Exempt
MMC 820
420 Delaware Street SE
Minneapolis, MN 55455

612-625-9186 (direct)
612-626-6061 (fax)

willi173@umn.edu
http://www.research.umn.edu/subjects/index.cfm

-----Original Message-----
From: theer002@umn.edu [mailto:theer002@umn.edu]
Sent: Tuesday, June 08, 2010 3:06 AM
To: Marsha Williams
Cc: speed002@umn.edu
Subject: RE: IRB Exempt Proposal #1005E82796

Ms. Williams,

I see. Attached I have received the approval document from the Committee on Human Rights Related to Researches Involving Human Subjects of the Faculty of Medicine Ramathibodi Hospital, Mahidol University. Together with the confirmation of certain changes, this completes the requirements made by the University's IRB on my study. If there is additional information necessary, please don't hesitate to contact me.

I would appreciate it if you could confirm with me upon the satisfactory receipt and review of this document.

Thank you,

Nawanan Theera-Ampornpunt

## Acknowledgement of Change in Protocol Request for Exempt Study By the University of Minnesota's Institutional Review Board

**From: irb@umn.edu**
**Subject: IRB Change in Protocol for Study 1005E82796**
**Date: Tue, 9 Nov 2010**
**To: theer002@umn.edu**

**Study:** 1005E82796
**PI:** Theera-Ampornpunt, Nawanan
**Status:** Active
**Title:** Thai Hospitals' Adoption of Information Technology Survey (THAIS)

The IRB reviewed and acknowledged the change in protocol detailed in your letter dated November 4, 2010.

The IRB has acknowledged your request to ask follow-up questions of subjects based on what they write in their journal entries as well as the consent form received November 4, 2010.

The IRB: Human Subjects Committee determined that the referenced study continues to be exempt from review under federal guidelines 45 CFR Part 46.101(b) category #2 SURVEYS/INTERVIEWS; STANDARDIZED EDUCATIONAL TESTS; OBSERVATION OF PUBLIC BEHAVIOR.

Please do not hesitate to contact the IRB office at 612-626-5654 if you have any questions.

**Ethical Approval by Faculty of Medicine Ramathibodi Hospital's Committee on Human Rights Related to Researches Involving Human Subjects (English)**

คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
ถนนพระราม 6 กทม. 10400
โทร. (662) 354-7275, 201-1296 โทรสาร (662) 354-7233

Faculty of Medicine, Ramathibodi Hospital, Mahidol University
Rama VI Road, Bangkok 10400, Thailand
Tel. (662) 354-7275, 201-1296 Fax (662) 354-7233

**Documentary Proof of Ethical Clearance Committee on Human Rights Related to Researches Involving Human Subjects Faculty of Medicine, Ramathibodi Hospital, Mahidol University**

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**MURA2010/203**

| | |
|---|---|
| **Title of Project** | Thai Hospitals' Adoption of Information Technology Survey ( THAIS ) |
| **Protocol Number** | ID 05-53-05 |
| **Principal Investigator** | Nawanan Theera-ampornpunt, M.D. |
| **Official Address** | Medical Informatics Division<br>Faculty of Medicine, Ramathibodi Hospital<br>Mahidol University |

***The aforementioned project has been reviewed and approved by Committee on Human Rights Related to Researches Involving Human Subjects, based on the Declaration of Helsinki.***

| | |
|---|---|
| **Signature of Secretary**<br>**Committee on Human Rights Related to**<br>**Researches Involving Human Subjects** | ...........................................<br>Prof. Duangrurdee Wattanasirichaigoon, M.D. |
| **Signature of Chairman**<br>**Committee on Human Rights Related to**<br>**Researches Involving Human Subjects** | ...........................................<br>Prof. Boonsong Ongphiphadhanakul, M.D. |
| **Date of Approval** | May 14, 2010 |

**Ethical Approval by Faculty of Medicine Ramathibodi Hospital's Committee on Human Rights Related to Researches Involving Human Subjects (Thai)**

คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
ถนนพระราม 6 กทม. 10400
โทร. (662) 354-7275, 201-1296 โทรสาร (662) 354-7233

Faculty of Medicine, Ramathibodi Hospital, Mahidol University
Rama VI Road, Bangkok 10400, Thailand
Tel. (662) 354-7275, 201-1296 Fax (662) 354-7233

ที่ จวค ๑๐๓๐/๒๕๕๓ คณะกรรมการจริยธรรมการวิจัยในคน

วันที่ ๑ มิถุนายน ๒๕๕๓

เรื่อง แจ้งผลการพิจารณาของคณะกรรมการจริยธรรมการวิจัยในคน

เรียน นายแพทย์นวนรรน ธีระอัมพรพันธุ์

อ้างถึงโครงการวิจัยเรื่อง โครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย

หมายเลขโครงการวิจัย ID ๐๕-๕๓-๐๕ ย

ในนามของคณะกรรมการจริยธรรมการวิจัยในคน ผมขอแสดงความยินดีที่โครงการวิจัยดังกล่าวข้างต้นของท่านได้ผ่านความเห็นชอบจากคณะกรรมการฯแล้ว

เพื่อให้สอดคล้องกับระเบียบปฏิบัติคณะแพทยศาสตร์โรงพยาบาลรามาธิบดี ว่าด้วยการศึกษาวิจัยและการทดลองในมนุษย์ พ.ศ. ๒๕๔๔ คณะกรรมการฯ ขอให้ท่านถือปฏิบัติโดยเป็นไปตามข้อแนะนำดังต่อไปนี้

๑. การดำเนินการวิจัยจะต้องเป็นไปตามโครงร่างวิจัยล่าสุดที่ผ่านการพิจารณาจากคณะกรรมการจริยธรรมการวิจัยในคนแล้ว
๒. การดำเนินการวิจัยจะต้องไม่เบี่ยงเบนไปจากโครงร่างวิจัยหรือมีการเปลี่ยนโครงร่างการวิจัยก่อนที่การแก้ไขเพิ่มเติมโครงร่างวิจัยนั้นจะได้รับการอนุมัติและเห็นชอบจากคณะกรรมการจริยธรรมการวิจัยในคนก่อน ยกเว้นในกรณีจำเป็นที่จะต้องกระทำไปก่อนเพื่อขจัดอันตรายเฉพาะหน้าที่เกิดขึ้นกับผู้ยินยอมตนให้ทำวิจัย
๓. ในกรณีที่มีการเปลี่ยนแปลงชื่อโครงการจากชื่อเดิมที่เสนอไว้ ต่อคณะกรรมการฯ ต้องแจ้งชื่อมายังคณะกรรมการฯ เพื่อออกหนังสือรับรองให้เสมอ
๔. ผู้ยินยอมตนให้ทำวิจัยจะต้องได้รับเอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้ยินยอมตนให้ทำวิจัย (Patient/Participant Information Sheet) และลงนามในหนังสือยินยอมโดยได้รับการบอกกล่าวและเต็มใจ (Informed Consent Form) ก่อนเริ่มดำเนินการวิจัย
๕. ในเอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้ยินยอมตนให้ทำวิจัย (Patient's Information Sheet) จะต้องพิมพ์ข้อความดังต่อไปนี้ไว้ด้วยทุกครั้ง

" ถ้าท่านมีข้อข้องใจหรือมีความกังวลใจเกี่ยวกับวิธีดำเนินการวิจัยของโครงการวิจัยนี้ ท่านสามารถติดต่อได้ที่ ประธานกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดีหน่วยจริยธรรมการวิจัยในคนชั้น ๓ สำนักงานวิจัยคณะฯ อาคารวิจัยและสวัสดิการ โทรศัพท์ ๐๒-๒๐๑ ๑๕๔๔ ในเวลาราชการ "

๖. ความลับของผู้ยินยอมตนให้ทำวิจัย จะต้องถูกปกปิดไว้ตลอดเวลา ยกเว้นถ้าเป็นคำสั่งตามกฎหมาย

สุดท้ายนี้ ขอให้โครงการวิจัยของท่านประสบผลสำเร็จตามความมุ่งหมายอันจะนำมาซึ่งความเจริญก้าวหน้าทางวิชาการ และเพื่อประโยชน์ของมนุษยชาติสืบต่อไป

ขอแสดงความนับถือ

(ศาสตราจารย์บุญส่ง องค์พิพัฒนกุล)
ประธานกรรมการจริยธรรมการวิจัยในคน

คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล
ถนนพระราม 6 กทม. 10400
โทร. (662) 354-7275, 201-1296 โทรสาร (662) 354-7233
Faculty of Medicine, Ramathibodi Hospital, Mahidol University
Rama VI Road, Bangkok 10400, Thailand
Tel. (662) 354-7275, 201-1296 Fax (662) 354-7233

**เอกสารรับรองโดยคณะกรรมการจริยธรรมการวิจัยในคน**
**คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี**
**มหาวิทยาลัยมหิดล**

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**เลขที่** ๒๕๕๓/๒๐๓

**ชื่อโครงการ** โครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย

**เลขที่โครงการ/รหัส** ID ๐๕-๕๓-๐๕ ย

**ชื่อหัวหน้าโครงการ** นายแพทย์นวนรรน ธีระอัมพรพันธุ์

**ที่ทำงาน** งานเวชสารสนเทศ สำนักงานคณบดี
คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี
มหาวิทยาลัยมหิดล

***ขอรับรองว่าโครงการดังกล่าวข้างต้นได้ผ่านการพิจารณาเห็นชอบโดยสอดคล้องกับแนวปฏิญญา เฮลซิงกิ จากคณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี***

**ลงนาม** ______________________

**กรรมการและเลขานุการจริยธรรมการวิจัยในคน** (ศาสตราจารย์ แพทย์หญิงดวงฤดี วัฒนศิริชัยกุล)

**ลงนาม** ______________________

**ประธานกรรมการจริยธรรมการวิจัยในคน** (ศาสตราจารย์ นายแพทย์บุญส่ง องค์พิพัฒนกุล)

**วันที่รับรอง** ๑๔ พฤษภาคม ๒๕๕๓

**Approval of the Document Revision (For Pilot Study)**
**by Faculty of Medicine Ramathibodi Hospital's Committee on Human Rights**
**Related to Researches Involving Human Subjects (Thai)**

คณะกรรมการจริยธรรมการวิจัยในคน
โทรศัพท์ 1544 โทรสาร 2772

ที่ จวค 1497/2553

วันที่ 2 สิงหาคม 2553

เรื่อง อนุญาตให้เปลี่ยนแปลงเอกสารในโครงการวิจัย

เรียน นายแพทย์นวนรรน ธีระอัมพรพันธุ์

อ้างถึง ที่ 484/25523 ลงวันที่ 9 กรกฎาคม 2553 คณะกรรมการจริยธรรมการวิจัยในคนได้พิจารณาโครงการวิจัยเรื่อง โครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย (Thai Hospitals' Adoption of Information Technology Survey (THAIS) (ID 05-53-05 ย)
ของ นายแพทย์นวนรรน ธีระอัมพรพันธุ์ งานเวชสารสนเทศ สำนักงานคณบดี หัวหน้าโครงการได้ส่งเอกสารขอเปลี่ยนแปลงโครงร่างการวิจัยดังนี้

- ปรับปรุงรูปแบบและถ้อยคำในเอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้เข้าร่วมการวิจัย และแบบสอบถาม

คณะกรรมการจริยธรรมการวิจัยในคนรับทราบและอนุมัติตามข้อความดังกล่าว

(ศาสตราจารย์บุญส่ง องค์พิพัฒนกุล)
ประธานกรรมการจริยธรรมการวิจัยในคน

**Approval of the Document Revision (For Nationwide Study)**
**by Faculty of Medicine Ramathibodi Hospital's Committee on Human Rights**
**Related to Researches Involving Human Subjects**
**(Thai)**

คณะกรรมการจริยธรรมการวิจัยในคน
โทรศัพท์ 1544 โทรสาร 2772

ที่ จวค 2273/2553
วันที่ 30 พฤศจิกายน 2553
เรื่อง อนุญาตให้เปลี่ยนแปลงเอกสารในโครงการวิจัย

เรียน นายแพทย์นวนรรน ธีระอัมพรพันธุ์

อ้างถึง ที่ 93/2554 ลงวันที่ 2 กรกฎาคม 2553 คณะกรรมการจริยธรรมการวิจัยในคนได้พิจารณาโครงการวิจัยเรื่อง โครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย
(Thai Hospitals' Adoption of Information Technology Survey (THAIS) (ID 05-53-05 ย)
ของ นายแพทย์นวนรรน ธีระอัมพรพันธุ์ งานเวชสารสนเทศ สำนักงานคณบดี หัวหน้าโครงการได้ส่งเอกสารขอเปลี่ยนแปลงโครงร่างการวิจัยนำร่อง ซึ่งได้รับการอนุมัติเอกสารตามที่เสนอคณะกรรมการ วันที่ 5 พฤศจิกายน 2553 โดยมีการเปลี่ยนแปลงและแก้ไขเอกสารดังนี้

- ปรับปรุงรูปแบบและถ้อยคำในเอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้เข้าร่วมการวิจัย และแบบสอบถาม

คณะกรรมการจริยธรรมการวิจัยในคนรับทราบและอนุมัติตามข้อความดังกล่าว

(ศาสตราจารย์บุญส่ง องค์พิพัฒนกุล)
ประธานกรรมการจริยธรรมการวิจัยในคน

**Ethical Approval by Prasat Neurological Institute's**
**Institutional Review Board/Independent Ethics Committee (English)**

Document No. 54024

**Institutional Review Board/Independent Ethics Committee**

**Prasat Neurological Institute, Department of Medical Services, Ministry of Public Health, Thailand**

| | |
|---|---|
| **Name of project** | Thai hospitals' adoption of information technology servey : THAIS (Project No.54024) |
| **Principal investigator** | Nawanan Theera-Ampornpunt MD. |
| **Trial site** | Prasat Neurological Institute |
| **Approved documents** | 1. Thai Protocal (Version date 9 December 2010)<br>2. Patient/Participant Information Sheet and Data release consent form (Version date 9 December 2010)<br>3. Case report form (Version date 9 December 2010) |
| **Date of approval** | 13 December 2010 |

We also confirm that we are an ethics committee constituted in agreement and in accordance with the ICH GCP.

The Institutional Review Board/Independent Ethics Committee Prasat Neurological Institute, Department of Medical Services, Ministry of Public Health, Thailand had reviewed Thai and/or English protocol. In ethical concern, the committee has reviewed and approved for implementation of the research study as above mention, therefore the Thai protocol will be mainly conduct.

S. Hanchaiphiboolkul Chairman

(Mr. Suchat Hanchaiphiboolkul)

P. Pimchanok Secretary

(Ms. Pimchanok Puthkhao)

**Ethical Approval by Prasat Neurological Institute's**
**Institutional Review Board/Independent Ethics Committee (Thai)**

ที่ สธ 0310/ ๒๒๑๘๖

สถาบันประสาทวิทยา กรมการแพทย์
เลขที่ 312 ถนนราชวิถี แขวงทุ่งพญาไท
เขตราชเทวี กรุงเทพฯ 10400

๑๕ ธันวาคม 2553

เรื่อง แจ้งการอนุมัติให้ดำเนินโครงการวิจัยในสถาบันประสาทวิทยา

เรียน นพ. นวนรรน ธีระอัมพรพันธุ์

สิ่งที่ส่งมาด้วย เอกสารอนุมัติให้ดำเนินการวิจัยในสถาบันประสาทวิทยา

ตามที่ท่านได้เสนอขออนุมัติดำเนินการวิจัยในสถาบันประสาทวิทยา ต่อคณะกรรมการวิจัยสถาบันประสาทวิทยา ซึ่งเป็นคณะกรรมการวิจัยประจำสถาบัน ที่มีการดำเนินงานตามแนวทางการวิจัยทางคลินิกที่ดี และขณะนี้คณะกรรมการฯ ได้ดำเนินการพิจารณาและอนุมัติให้ดำเนินโครงการวิจัยดังกล่าวเรียบร้อยแล้ว

ในการนี้ สถาบันประสาทวิทยา จึงขอแจ้งการอนุมัติให้ดำเนินโครงการวิจัยดังกล่าวในสถาบันประสาทวิทยา ตามเอกสารของคณะกรรมการฯ ดังแนบ

จึงเรียนมาเพื่อโปรดทราบ

ขอแสดงความนับถือ

(นายมัยธัช สามเสน)
ผู้อำนวยการสถาบันประสาทวิทยา

ที่ สธ 0310 (12500)/2.206

คณะกรรมการวิจัยสถาบันประสาทวิทยา
สถาบันประสาทวิทยา เลขที่ 312 ถนนราชวิถี
แขวงทุ่งพญาไท เขตราชเทวี กรุงเทพฯ 10400

14 ธันวาคม 2553

เรื่อง อนุมัติให้ดำเนินการวิจัยได้

เรียน นพ. นวนรรน ธีระอัมพรพันธุ์

ตามที่ท่านซึ่งเป็น หัวหน้าโครงการวิจัยตามรายละเอียดข้างท้าย ได้เสนอ โครงการวิจัยดังกล่าวต่อคณะกรรมการวิจัยสถาบันประสาทวิทยา

เลขที่โครงการ 54024
ชื่อโครงการ โครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย

ในการนี้ คณะกรรมการวิจัยสถาบันประสาทวิทยา ซึ่งเป็นคณะกรรมการวิจัยสถาบัน (Institutional Review Board : IRB) ที่มีการดำเนินงานตามแนวทางการวิจัยทางคลินิกที่ดี (ICH GCP) ได้พิจารณา และมีมติอนุมัติให้ดำเนินการ โครงการวิจัยดังกล่าวในสถาบันประสาทวิทยาได้ โดยผู้วิจัยจะต้องมีหน้าที่และความรับผิดชอบภายหลังได้รับการอนุมัติ คือ ต้องปฏิบัติตามพระราชบัญญัติสุขภาพแห่งชาติ พ.ศ. 2550 มาตรา 7 "ข้อมูลสุขภาพของบุคคล เป็นความลับส่วนบุคคล ผู้ใดจะนำไปเปิดเผยในประการที่น่าจะทำให้บุคคลนั้นเสียหายไม่ได้ เว้นแต่การเปิดเผยนั้นเป็นไปตามความประสงค์ของบุคคลนั้นโดยตรง" โดยเคร่งครัด และจะต้องรายงานความก้าวหน้าของโครงการวิจัยเมื่อมีการร้องขอและ/หรือเมื่อเกิดเหตุการณ์ต่อไปนี้ ทุกครั้ง ได้แก่

1. เมื่อโครงการวิจัยยุติลง ซึ่งอาจจะเป็นการดำเนินการวิจัยเสร็จสิ้นสมบูรณ์ หรืออาจจะไม่สามารถดำเนินการวิจัยต่อไปได้ พร้อมทั้งแจ้งสาเหตุของการยุติโครงการวิจัยให้ทราบด้วย
2. เมื่อมีการเปลี่ยนแปลงในโครงการวิจัยต้องระบุให้ชัดเจนว่า มีการเปลี่ยนแปลงอะไร อย่างไร พร้อมเหตุผลที่ต้องเปลี่ยนแปลง
3. เมื่อมีการเปลี่ยนแปลงหัวหน้าโครงการวิจัยหรือเพิ่มเติมคณะผู้วิจัย ต้องส่งประวัติของคนที่เปลี่ยนแปลงพร้อมเหตุผลให้คณะกรรมการฯ ทราบด้วย
4. เมื่อมีอาการไม่พึงประสงค์เกิดขึ้นในโครงการวิจัย ขอให้ผู้วิจัยวิเคราะห์สถานการณ์การเกิดอาการไม่พึงประสงค์ที่ relate, possible/likely, probably related, fatal กับโครงการวิจัยที่ท่านรับผิดชอบอย่างไร รวมทั้งขอทราบมาตรการในการดูแลป้องกันอาสาสมัครในประเทศไทยด้วย
5. จัดส่งรายงานการศึกษาวิจัย จำนวน 1 ชุด ให้แก่สำนักงานคณะกรรมการวิจัยสถาบันประสาทวิทยาเมื่อสิ้นสุดการดำเนินงาน

จึงเรียนมาเพื่อโปรดทราบ

ขอแสดงความนับถือ

(นายสุชาติ หาญไชยพิบูลย์กุล)
ประธานคณะกรรมการวิจัยสถาบันประสาทวิทยา

สำนักงานคณะกรรมการวิจัยสถาบันประสาทวิทยา
ศูนย์วิจัยสถาบันประสาทวิทยา
โทร. 02-3547076 ต่อ 2402 โทรสาร 02-3545357

**คณะกรรมการวิจัยสถาบันประสาทวิทยา**
**สถาบันประสาทวิทยา กรมการแพทย์ กระทรวงสาธารณสุข**

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**โครงการวิจัย** โครงการสำรวจการใช้งานเทคโนโลยีสารสนเทศของโรงพยาบาลไทย (เลขที่โครงการ 54024)

**ผู้วิจัยหลัก** นพ. นวนรรน ธีระอัมพรพันธุ์

**สถานที่ดำเนินการวิจัย** สถาบันประสาทวิทยา

**เอกสารที่พิจารณา**
1. แบบเสนอโครงการวิจัย ฉบับวันที่ 9 ธันวาคม 2553
2. เอกสารชี้แจงข้อมูล/คำแนะนำแก่ผู้เข้าร่วมการวิจัย ฉบับวันที่ 9 ธันวาคม 2553
3. คำยินยอมโดยได้รับการบอกกล่าวและเต็มใจ ฉบับวันที่ 9 ธันวาคม 2553
4. แบบเก็บรวบรวมข้อมูล ฉบับวันที่ 9 ธันวาคม 2553

**วันที่พิจารณาอนุมัติ** 13 ธันวาคม 2553

คณะกรรมการวิจัยสถาบันประสาทวิทยา ได้พิจารณาโครงการฉบับภาษาไทยและ/หรือฉบับภาษาอังกฤษแล้ว คณะกรรมการฯ พิจารณาอนุมัติในแง่จริยธรรมและให้ดำเนินการวิจัยข้างต้นภายในสถาบันประสาทวิทยาได้ ทั้งนี้โดยยึดตามเอกสารฉบับภาษาไทยเป็นหลัก

ประธานคณะกรรมการ
(นายสุชาติ หาญไชยพิบูลย์กุล)

กรรมการและเลขานุการ
(นางสาวพิมพ์ชนก พุฒขาว)

# Appendix D

Details of Changes in Survey Items

## Item Changes from Pilot Survey Instrument to Nationwide Survey Instrument (English)

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| 1. How many inpatient beds does your hospital currently have? | | Somewhat unreliable especially in large hospitals | Dropped | Respondent not reliable source. Authoritative source available. |
| 2. Which of the following best fits the type of your hospital?<br>❑ A public hospital (including state enterprises, autonomous public hospitals, and public organizations)<br>❑ A non-profit private hospital<br>❑ A for-profit private hospital | 1. Which of the following best fits the type of your hospital?<br>❑ A public hospital (including state enterprises, autonomous public hospitals, and public organizations)<br>❑ A private hospital | Reliable | Revised response categories for simplification | |
| 3. Does your hospital routinely teach medical students?<br>❑ Yes. We are a teaching hospital or part of a medical school.<br>❑ Yes. We are an external affiliate of a medical school and routinely teach its medical students.<br>❑ No. We don't routinely teach medical students. | 2. Does your hospital routinely teach medical students?<br>❑ Yes<br>❑ No | Different responses in some hospitals | Revised response categories for better clarity by grouping two categories together and revised wording | To reduce possibility of misinterpretation |
| | 3. What is your hospital's current number of <u>total</u> personnel?<br>\|__________________\| Persons<br>(Approximate figure is fine.) | Not in pilot survey | Added. | A proxy of hospital size |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| 4. What is your hospital's current number of IT personnel (including IT executives, IT managers, IT administrators, systems analysts, programmers, other technical staffs and other hospital staffs with important roles in IT works)?<br>❑ None<br>❑ 1-5 persons<br>❑ 6-20 persons<br>❑ 21-50 persons<br>❑ 51 persons or more | 4. What is your hospital's current number of IT personnel?<br>\|________________\| Persons<br>(Approximate figure is fine.) | Different responses in some hospitals | Revised wording and response format. Changed from categorical to numeric. | No external reliable source. |
| 5. Which of the following best describes your hospital's accreditation (HA) status?<br>❑ Is currently not accredited and has no plan in place toward accreditation.<br>❑ Is currently not accredited, has a plan in place, but has not made significant progress toward accreditation.<br>❑ Is currently not accredited but has made significant progress toward accreditation.<br>❑ Is currently accredited. | | Different responses in some hospitals | Dropped | Not very reliable. Authoritative source not accessible to this study. Dropped because not central to study. Could be incorporated in future research. |
| 6. What was your hospital's total budget during the fiscal year 2009?<br>\|________________\| Baht<br>(Approximate figure is fine.)<br>❑ I don't know. | 5. What was your hospital's total budget during the fiscal year 2010?<br>\|________________\| Baht<br>(Approximate figure is fine.)<br>❑ I don't know. | Highly unreliable | Revised fiscal year for nationwide survey | Highly unreliable but no external source available. May need to drop this variable from analytic model. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| 7. During the fiscal year 2009, how much did your hospital spend on IT, including IT hardware, software, personnel, consulting, and outsourcing?<br>|_________________| Baht<br>(Approximate figure is fine.)<br>❑ I don't know. | 6. During the fiscal year 2010, how much did your hospital spend <u>on IT</u>, including IT hardware, software, personnel, consulting, and outsourcing?<br>|_________________| Baht<br>(Approximate figure is fine.)<br>❑ I don't know. | Highly unreliable. | Revised fiscal year. | Highly unreliable but no external source available. May need to drop this variable from analytic model. |
| 8. If you did not know the answer to Q6 or Q7 above, please estimate what percentage of your hospital's total budget your hospital spends on IT approximately.<br>❑ Less than 1%<br>❑ 1-4%<br>❑ 5-8%<br>❑ More than 8% | 7. If you did not know the answer to Q5 or Q6 above, please estimate what percentage of your hospital's total budget your hospital spends approximately on IT during the fiscal year 2010.<br>❑ Less than 1%<br>❑ 1-4%<br>❑ 5-8%<br>❑ More than 8% | Highly unreliable. | Retained with slight rewording. | Highly unreliable but no external source available. May need to drop this variable from analytic model. |
| 9. To what extent do you agree or disagree with each of the following statements? "N/A" represents a statement not applicable to your hospital. | 8. To what extent do you agree or disagree with each of the following statements? | Acceptable reliability. | Revised wording. Individual items were also revised and reordered. | "N/A" tended to confuse people (sometimes they chose "N/A" even though they meant the lowest choice in the Likert-type scale). |
| a. Our hospital is open to new ways of conducting operations. | a. Our hospital is open to new ways of conducting operations. | High item-total correlation. | Retained. | |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| b. Our hospital sets clear visions and goals on what we wish to achieve with IT projects. | c. Our hospital sets clear vision, goals, and plans on IT works. | Low item-total correlation and isolated from other items in factor pattern. | Revised wording. | Likely due to misinterpretation as hospital's overall vision and mission. |
| c. When a new technology is introduced, we clearly communicate the goals, plans, and progress to key stakeholders. | d. Our hospital communicates goals, plans and progress on IT works to stakeholders clearly. | High item-total correlation. | Revised wording. | To increase coherence and reflect changes in item b of pilot. |
| d. Those who will use the information systems are fully involved early in our IT projects. | e. Those who will use the information systems are fully involved in hospital IT development. | High item-total correlation. | Revised wording. | To increase clarity and avoid double-barreled statements. |
| e. Our top-level management fully supports the use of IT. | b. Our top-level management fully supports the use of IT. | High item-total correlation. | Retained. | |
| f. We have a multi-disciplinary team of users involved in our IT projects. | f. The team of users involved in our IT development comes from several disciplines. | High item-total correlation. | Revised wording. | To increase clarity. |
| g. Before new IT is implemented in our hospital, the workflow changes required are carefully considered. | h. In our hospital's IT development, the workflow changes are carefully considered. | High item-total correlation. | Revised wording. | To increase clarity. |
| h. The majority of hospital employees are committed to achieving the envisioned organizational goals. | g. The majority of hospital employees are committed to achieving the envisioned organizational goals. | High item-total correlation. | Retained. | |
| i. Before a new system is introduced, we adequately provide training to those who will use the system. | i. Our hospital provides training to those who will use the system adequately. | High item-total correlation. | Revised wording. | To increase clarity. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| j. When our hospital is conducting an IT project, we have a process in place to track its progress and manage it. | j. Our hospital has a process in place to track work progress and manage IT works appropriately. | High item-total correlation. | Revised wording. | To increase clarity. |
| k. Our hospital learns from the past experience to improve its operations. | k. Our hospital uses our past experience as lessons driving our current works. | High item-total correlation. | Revised wording. | To increase clarity. |
| 10. Overall, what is the extent of your hospital's adoption of information technology to support its operations?<br>❑ Very high<br>❑ High<br>❑ Moderate<br>❑ Low<br>❑ Very low | 9. Overall, what is the extent of your hospital's utilization of information technology to support its operations?<br>❑ Very high<br>❑ High<br>❑ Moderate<br>❑ Low<br>❑ Very low | Not large variation. | Retained (English wording revised but Thai wording unchanged). | |
| 11. How many personal computers (including desktops and notebooks/laptops) does your hospital have in use?<br>\|_______\| Personal Computers<br>(Approximate figure is fine.) | 10. How many personal computers (including desktops and notebooks/laptops) does your hospital have in use?<br>\|_______\| Personal Computers<br>(Approximate figure is fine.) | Large variations in medium to large hospitals. | Retained. | No external data source available. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| 12. What is the primary hospital information system in your hospital, if any?<br>❑ Our hospital doesn't have a hospital information system.<br>❑ HOSxP<br>❑ Hospital OS<br>❑ A custom system developed by our hospital or a contractor<br>❑ Other. Please specify<br>\|________________________________\| | 11. What is the primary hospital information system in your hospital, if any?<br>❑ Our hospital doesn't have a hospital information system.<br>❑ HOSxP<br>❑ Hospital OS<br>❑ A custom system developed by our hospital or a contractor<br>❑ Other. Please specify<br>\|________________________________\| | Responses were similar within the same hospitals. | Retained. | |
| 13. Since what year has your hospital been using the hospital information system you specified in Q12? If you don't know the exact year, please provide an approximate one.<br>Year \|_______\|<br>❑ I don't know. | 12. Since what year has your hospital been using the hospital information system you specified in Q11? If you don't know the exact year, please provide an approximate one.<br>Year \|_______\|<br>❑ I don't know. | Similar responses within the same hospitals. | Retained. | |
| 14. For each of the following activities, how much is the activity supported by computerized information systems in your hospital? If it varies across departments in your hospital, please indicate the average level in the entire hospital. "N/A" is not applicable (no such activity in the hospital). | 13. For each of the following activities, how much is the activity supported by computerized information systems in your hospital? If it varies across departments in your hospital, please indicate the average level in the entire hospital. If your hospital doesn't have a particular activity (Not Applicable), please leave that item blank. | Responses were somewhat different among respondents of the same hospitals, but internal consistency was satisfactory. The total items (51) were too many and overly burdened the respondents. | Revised wording. Some individual items were revised and reorganized, and some were dropped to reduce the overall numbers. Two new items were added to represent clinical decision support features. | "N/A" tended to confuse people (sometimes they chose "N/A" even though they meant the lowest choice in the Likert-type scale). |
| - Patient registration | - Patient registration and recording of patient's demographic information | High item-total correlation. | Revised wording. | To increase clarity. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| - Insurance eligibility verification | | High item-total correlation. | Dropped. | Not substantively important. |
| - Outpatient appointment scheduling | - Outpatient appointment scheduling | Low item-total correlation. | Retained. | Substantively important. |
| - Patient management within outpatient clinics | | Moderate item-total correlation. | Dropped. | Not substantively important. |
| - Inpatient admissions | | High item-total correlation. | Dropped. | Not substantively important. |
| - Inpatient discharges | | High item-total correlation. | Dropped. | Not substantively important. |
| - Patient referral to another facility | | High item-total correlation. | Dropped. | Not substantively important. |
| - Bed occupancy and availability check | - Viewing the list of hospitalized patients | High item-total correlation. | Revised wording. | To group similar items and increase clarity. |
| - Inpatient medication order entry | - Inpatient medication order entry | Moderate item-total correlation. | Retained. | Substantively important. |
| - Inpatient lab order entry | - Inpatient lab order entry | Moderate-to-high item-total correlation. | Retained. | Substantively important. |
| - Inpatient imaging order entry | - Inpatient imaging order entry | High item-total correlation. | Retained. | Substantively important. |
| - Inpatient lab results reporting | - Inpatient lab results viewing | Moderate-to-high item-total correlation. | Revised wording. | Substantively important. Revised to increase clarity. |
| - Inpatient imaging results reporting | | Moderate item-total correlation. | Dropped. | Many hospitals do not have radiologists to provide imaging reports and hence this item would not be applicable. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| - Inpatient clinical notes | - Documentation of history, physical examination & progress note of inpatients | Moderate-to-high item-total correlation. | Revised wording. | Substantively important. Revised to increase clarity. |
| - Discharge summary documentation | - Discharge summary documentation | High item-total correlation. | Retained. | Substantively important. |
| - Outpatient medication order entry | - Outpatient medication order entry | Moderate item-total correlation. | Retained. | Substantively important. |
| - Outpatient lab order entry | - Outpatient lab order entry | High item-total correlation. | Retained. | Substantively important. |
| - Outpatient imaging order entry | - Outpatient imaging order entry | High item-total correlation. | Retained. | Substantively important. |
| - Outpatient lab results reporting | - Outpatient lab results viewing | High item-total correlation. | Revised wording. | To increase clarity. |
| - Outpatient imaging results reporting | | High item-total correlation. | Dropped. | Many hospitals do not have radiologists to provide imaging reports and hence this item would not be applicable. |
| - Outpatient clinical notes | - Documentation of history & physical examination of outpatients | Moderate-to-high item-total correlation. | Revised wording. | Substantively important. Revised to increase clarity. |
| - Care planning | | Moderate item-total correlation. | Dropped. | Likely to be misinterpreted, and could be grouped with other items. |
| - Order review and processing | | Moderate item-total correlation. | Dropped. | Responses likely to vary by local workflow needs. Function could be reasonably assumed if order entry functions exist. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| - Medication administration and documentation | - Documentation of medication administration to patients | Low item-total correlation. | Revised wording. | Substantively important. Revised to increase clarity. |
| - Documentation of nursing assessment | - Nursing documentation | Moderate item-total correlation. | Revised wording. | Substantively important. Revised to group nursing documentation activities together (except medication administration). |
| - Surgery appointments and scheduling | | Moderate-to-high item-total correlation. | Dropped. | Substantively not important. |
| - Patient management within operating rooms | | High item-total correlation. | Dropped. | Substantively not important. |
| - Operative note documentation | | Moderate item-total correlation. | Dropped. | Substantively not important. |
| - Anesthetic note documentation | | Moderate item-total correlation. | Dropped. | Substantively not important. |
| - Case service charging | | High item-total correlation. | Dropped. | Substantively not important. |
| - Specimen handling | | High item-total correlation. | Dropped. | Substantively not important. |
| - Results capture from automated equipments | | High item-total correlation. | Dropped. | Substantively not important. |
| - Results entry for non-automated tests | | High item-total correlation. | Dropped. | Substantively not important. |
| - Results validation and confirmation | | High item-total correlation. | Dropped. | Substantively not important. |
| - Imaging appointments and scheduling | | High item-total correlation. | Dropped. | Substantively not important. |
| - Image capture from imaging devices | | Low item-total correlation. | Dropped. | Could be grouped with another item. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| - Imaging reports entry | | Moderate-to-high item-total correlation. | Dropped. | Substantively not important. |
| - Image viewing by radiologists | | Low item-total correlation. | Dropped. | Substantively not important. |
| - Image viewing by attending physicians | - Electronic image viewing (instead of using films) for inpatients<br>- Electronic image viewing (instead of using films) for outpatients | Low item-total correlation. | Split into inpatient and outpatient items and revised wording. | Substantively important. Revised to increase clarity. |
| - Pharmacist's review of medication orders | | Moderate item-total correlation. | Dropped. | Responses likely to vary by local workflow needs. |
| - Outpatient medication dispensing | - Outpatient medication dispensing | Moderate item-total correlation. | Retained. | Substantively important. |
| - Outpatient pharmacy inventory control | - Pharmacy inventory control | Moderate-to-high item-total correlation. | Revised wording. | Revised to group outpatient and inpatient items. |
| - Inpatient medication dispensing | - Inpatient medication dispensing | High item-total correlation. | Retained. | Substantively important. |
| - Inpatient pharmacy inventory control | | Moderate item-total correlation. | Dropped. | Grouped with another item above. |
| | - Automatic drug allergy checking | | Added. | Added the item for an important clinical decision support feature. |
| | - Automatic drug interaction checking | | Added. | Added the item for an important clinical decision support feature. |
| - Billing, claims, and reimbursement | - Patient billing<br>- Reimbursement claims | Low item-total correlation. | Split and revised wording. | Substantively important. Split to two functions. Revised to increase clarity. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| - Accounting | | Low item-total correlation. | Dropped. | Substantively not important. |
| - Personnel records | | Moderate-to-high item-total correlation. | Dropped. | Substantively not important. |
| - Staff workload management | | High item-total correlation. | Dropped. | Substantively not important. Responses likely to vary by interpretation. |
| - Inventory management | | Low item-total correlation. | Dropped. | Substantively not important. |
| - Internal communications | | Moderate item-total correlation. | Dropped. | Substantively not important. |
| - Public relations and external communications | | Moderate item-total correlation. | Dropped. | Substantively not important. |
| 15. For each of the following technologies, to what extent is it made available in your hospital? If it varies across departments in your hospital, please indicate the average level among the applicable departments. "N/A" is not applicable (no activity exists that can be supported by the technology). | 14. For each of the following technologies, to what extent is it made available in your hospital? If it varies across departments in your hospital, please indicate the average level among the applicable departments. If a technology is not applicable to any activities in your hospital, please leave that item blank. | Responses were different among respondents of the same hospitals, possibly suggesting varying interpretation, but internal consistency was acceptable. | Revised wording. The total number of items was also reduced to shorten the questionnaire. | "N/A" tended to confuse people (sometimes they chose "N/A" even though they meant the lowest choice in the Likert-type scale). |
| a. Internet access | a. Internet access | Low-to-moderate item-total correlation. | Retained. | Substantively important. |
| b. Hospital Web site | b. Hospital Web site | Moderate item-total correlation. | Retained. | Substantively important. |
| c. Hospital intranet (internal Web site) | | Moderate item-total correlation. | Dropped. | Substantively not important. |
| d. Hospital e-mail system | | Low item-total correlation. | Dropped. | Substantively not important. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| e. Local area network (LAN) | c. Local area network (LAN) | Low item-total correlation. | Retained. | Substantively important. Low item-total correlation in small pilot sample probably because most hospitals would have this technology regardless of their adoption of others. |
| f. Wireless networks | | Low item-total correlation. | Dropped. | Substantively not important. |
| g. Data warehouse | | Low item-total correlation. | Dropped. | Likely to cause misinterpretation, and substantively not very important. |
| | d. Master Patient Index | | Added. | Missing item that is substantively important. |
| h. Computerized order entry | e. Computerized physician order entry | Low item-total correlation. | Revised wording. Thai wording revised to increase interpretability. | Substantively important. Revised to increase clarity. |
| i. Electronic medical record/electronic documentation of clinical care | g. Electronic medical records that documents clinical care in the system | Low item-total correlation. | Revised wording. | Substantively important. Revised to increase clarity. |
| j. Disease management systems | | Moderate-to-high item-total correlation. | Dropped. | Misinterpretation very likely and difficult to improve item clarity. |
| k. Laboratory information system | h. Laboratory information system | Moderate item-total correlation. | Retained. | Substantively important. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| l. Pharmacy information system | | Moderate item-total correlation. | Dropped. | Misinterpretation likely and difficult to improve item clarity. Another item on pharmacy informatics-related technologies already exists. |
| m. Electronic medication administration records | f. Electronic medication administration records | Moderate item-total correlation. | Revised wording in Thai (English wording retained). | Substantively important. Revised to increase clarity. |
| n. Picture archiving and communication system (PACS) | i. Picture archiving and communication system (PACS) for electronic storage of medical images instead of films | High item-total correlation. | Revised wording. | Substantively important. Revised to increase clarity. |
| o. Radiology information system | | High item-total correlation. | Dropped. | Likely to create misinterpretation. Substantively not very important. |
| p. Telemedicine (remote provision of medical services or consultation through IT) | | High item-total correlation. | Dropped. | Might create misinterpretation. Substantively not very important. |
| q. Teleconferencing | | Moderate item-total correlation. | Dropped. | Substantively not important. |
| r. Barcoding | j. Barcode use in patient care | Moderate item-total correlation. | Revised wording. | Revised to increase clarity. |
| s. Enterprise resource planning (ERP) system to manage finance, human resources, and materials of the organization | | High item-total correlation. | Dropped. | Interpretation likely to vary due to many hospitals' unfamiliarity with ERP systems. Substantively not important. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| 16. An information system is sometimes linked (integrated) with other information systems, with data being shared or transferred between them. In other cases, an information system may be stand-alone and does not share or transfer data with other systems. For each of the following functions or settings, to what extent do its information systems share data with other systems within your hospital overall? "N/A" is not applicable (no such function/setting). | 15. Sometimes, information is shared or transmitted among the information systems. In other cases, information may not be shared or transferred between the systems at all.<br><br>For each of the following types of information, to what extent is the information shared or transmitted among the information systems within your hospital? | Responses were different among respondents of the same hospitals, possibly suggesting varying interpretation, but internal consistency was satisfactory. | Revised wording and structure of item categories. | To focus on sharing of various types of information rather than departmental systems (due to high subjectivity, lack of conceptual clarity, and dependence on local IT configurations). |
| a. ER | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| b. Patient registration, admissions, discharges, and transfers | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| c. Inpatient | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| d. Outpatient clinics | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| e. Nursing | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| f. Surgery/OR | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| g. Laboratory | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| h. Radiology | | Moderate item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| i. Pharmacy | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| j. Finance | | Moderate item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| k. Human resource management | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| l. Others | | High item-total correlation. | Dropped. | Highly subject to individual's interpretation. Item dropped to restructure entire item list. |
| | a. Patient's demographic information | | Added. | Conceptually more appropriate. |
| | b. Outpatient's history and medical documentation | | Added. | Conceptually more appropriate. |
| | c. Outpatient's diagnoses | | Added. | Conceptually more appropriate. |
| | d. Outpatient's medication orders | | Added. | Conceptually more appropriate. |
| | e. Inpatient's history and medical documentation | | Added. | Conceptually more appropriate. |
| | f. Inpatient's diagnoses | | Added. | Conceptually more appropriate. |
| | g. Inpatient's medication orders | | Added. | Conceptually more appropriate. |
| | h. Surgical operations and procedures | | Added. | Conceptually more appropriate. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| | i. Laboratory results | | Added. | Conceptually more appropriate. |
| | j. Medical images and results | | Added. | Conceptually more appropriate. |
| 17. For each of the following functions or settings, to what extent do its information systems share data with other systems outside your hospital overall (including linkages to government agencies and other hospitals)? "N/A" is not applicable (no such function/setting). | 16. For each of the following types of information, to what extent is the information shared or transmitted between your hospital's information systems and other information systems outside your hospital (such as information systems of government agencies or other hospitals), including outbound and inbound transmissions? | Responses were very similar among the respondents, likely because most hospitals had low level of external information sharing. Internal consistency was satisfactory. | Revised wording. | To focus on sharing of various types of information rather than departmental systems (due to high subjectivity, lack of conceptual clarity, and dependence on local IT configurations). |
| a. ER | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| b. Patient registration, admissions, discharges, and transfers | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| c. Inpatient | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| d. Outpatient clinics | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| e. Nursing | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| f. Surgery/OR | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| g. Laboratory | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| h. Radiology | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| i. Pharmacy | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| j. Finance | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| k. Human resource management | | High item-total correlation. | Dropped. | Item dropped to restructure entire item list. |
| l. Others | | High item-total correlation. | Dropped. | Highly subject to individual's interpretation. Item dropped to restructure entire item list. |
| | a. Patient's demographic information | | Added. | Conceptually more appropriate. |
| | b. Outpatient's history and medical documentation | | Added. | Conceptually more appropriate. |
| | c. Outpatient's diagnoses | | Added. | Conceptually more appropriate. |
| | d. Outpatient's medication orders | | Added. | Conceptually more appropriate. |
| | e. Inpatient's history and medical documentation | | Added. | Conceptually more appropriate. |
| | f. Inpatient's diagnoses | | Added. | Conceptually more appropriate. |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| | g. Inpatient's medication orders | | Added. | Conceptually more appropriate. |
| | h. Surgical operations and procedures | | Added. | Conceptually more appropriate. |
| | i. Laboratory results | | Added. | Conceptually more appropriate. |
| | j. Medical images and results | | Added. | Conceptually more appropriate. |
| 18. What is your gender?<br>❑ Male<br>❑ Female | 17. What is your gender?<br>❑ Male<br>❑ Female | | Retained. | |
| 19. What is your current age?<br>\|______\| Years | 18. What is your current age?<br>\|______\| Years | | Retained. | |
| 20. What is your highest level of education completed?<br>❑ Lower than bachelor's degree<br>❑ Bachelor's degree<br>❑ Master's degree or higher | 19. What is your highest level of education completed?<br>❑ Lower than bachelor's degree<br>❑ Bachelor's degree (including M.D.)<br>❑ Master's degree or higher (including specialist physicians) | | Revised wording **Note:** in Thailand, M.D. is considered a bachelor's degree (6 years of college study) because there are no pre-medical years. This item would need a revision for use elsewhere. | Response categories revised to increase clarity. |
| 21. Which of the following best describes your formal IT training?<br>❑ I had no formal training in an IT-related area.<br>❑ I had a non-degree training in an IT-related area.<br>❑ I received an academic degree in an IT-related field. | 20. Which of the following best describes your formal IT training?<br>❑ I had no formal training in an IT-related area.<br>❑ I had a non-degree training in an IT-related area.<br>❑ I received a bachelor's/master's/ doctoral degree in an IT-related field. | | Retained (English wording revised). | |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| 22. Which of the following best describes your formal clinical training? (clinical training includes training in medicine, dentistry, nursing, pharmacy, medical technology, physical therapy, radiological technology, etc.)<br>❑ I had no formal training in a clinical field.<br>❑ I had a non-degree training in a clinical field.<br>❑ I received an academic degree in a clinical field. | 21. Which of the following best describes your formal training in health science? (health science training includes training in medicine, dentistry, nursing, pharmacy, medical technology, physical therapy, radiological technology, public health)<br>❑ I had no formal training in health science.<br>❑ I had a non-degree training in health science.<br>❑ I received a bachelor's/master's/ doctoral degree in health science. | | Revised wording. | Revised to increase clarity, with clinical training also changed to health science training. |
| 23. Which of the following best describes your formal business administration (BA)/management training?<br>❑ I had no formal training in BA/management.<br>❑ I had a non-degree training in BA/management.<br>❑ I received an academic degree in BA/management. | 22. Which of the following best describes your formal business administration (BA)/management training?<br>❑ I had no formal training in BA/management.<br>❑ I had a non-degree training in BA/management.<br>❑ I received a bachelor's/master's/ doctoral degree in BA/management. | | Revised wording. | Slightly revised to increase clarity. |
| 24. How many years have you worked in <u>any IT-related</u> position at all past and current workplaces combined?<br>\|______\| Years | 23. How many years have you worked in <u>any IT-related</u> position at all past and current workplaces combined?<br>\|______\| Years | | Retained. | |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey | Pilot Assessment | Decision | Rationale |
|---|---|---|---|---|
| 25. Which of the following best describes your role in the hospital? If you hold multiple roles, please check all that apply?<br>❑ The director or senior executive of the hospital<br>❑ A hospital executive who directly supervises hospital IT responsibilities<br>❑ An IT manager or head of the hospital's IT unit or department<br>❑ An IT specialist, system administrator, system analyst, programmer, or computer technician within the hospital but not an executive or department head<br>❑ A hospital worker with an important role in IT projects without an executive or technical role<br>❑ A hospital worker without an important role in IT projects and without an executive or technical role<br>❑ Other. Please specify \|______________________\| | 24. Which of the following best describes your role in the hospital? If you hold multiple roles, please check all that apply.<br>❑ The director or a senior executive of the hospital<br>❑ A hospital executive who directly supervises hospital IT responsibilities<br>❑ An IT manager or head of the hospital's IT unit or department, but not a hospital executive<br>❑ An IT specialist such as a system administrator, a system analyst, a programmer, a health information management specialist or a computer technician within the hospital but not an executive or department head<br>❑ A hospital worker with a past or present important role in IT development, but not a hospital executive or a computer technician<br>❑ A hospital worker without an important role in IT development and not a hospital executive or a computer technician<br>❑ Other. Please specify \|______________________\| | | Revised wording | Revised to increase clarity. |
| For the purpose of improving this questionnaire, may we inquire how long it took you to answer this questionnaire?<br>\|________\| minutes | | | Dropped | Intended for pilot study only, to gauge respondent's burden. |

## Item Changes from Pilot Survey Instrument to Nationwide Survey Instrument (Thai)

(Please refer to the English version for details of the changes and rationale.)

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| 1. ปัจจุบันโรงพยาบาลของท่านมีเตียงรับผู้ป่วยในจำนวนกี่เตียง?<br>\|_________\| เตียง | (Dropped from nationwide survey.) |
| 2. โรงพยาบาลของท่านเป็นโรงพยาบาลประเภทใด?<br>❑ โรงพยาบาลของรัฐ (รวมถึงรัฐวิสาหกิจ โรงพยาบาลในกำกับของรัฐ และองค์การมหาชน)<br>❑ โรงพยาบาลเอกชนที่ไม่มุ่งหวังผลกำไร (non-profit private hospital)<br>❑ โรงพยาบาลเอกชนที่มุ่งหวังผลกำไร (for-profit private hospital) | 1. โรงพยาบาลของท่านเป็นโรงพยาบาลประเภทใด<br>❑ โรงพยาบาลของรัฐ (รวมถึงรัฐวิสาหกิจ โรงพยาบาลในกำกับของรัฐ และองค์การมหาชน)<br>❑ โรงพยาบาลเอกชนที่มุ่งหวังผลกำไร (for-profit private hospital) |
| 3. โรงพยาบาลของท่าน มีการเรียนการสอนนักศึกษาแพทย์เป็นประจำหรือไม่?<br>❑ ใช่ เป็นโรงพยาบาลโรงเรียนแพทย์ หรือส่วนหนึ่งของคณะแพทยศาสตร์<br>❑ ใช่ เป็นสถาบันสมทบที่มีการเรียนการสอนนักศึกษาแพทย์ของคณะแพทยศาสตร์<br>❑ ไม่มีการเรียนการสอนนักศึกษาแพทย์เป็นประจำ | 2. โรงพยาบาลของท่าน มีการเรียนการสอนนักศึกษาแพทย์เป็นประจำหรือไม่<br>❑ ใช่<br>❑ ไม่ใช่ |
| (Not present in pilot survey.) | 3. ปัจจุบันโรงพยาบาลของท่านมีบุคลากร<u>ทั้งสิ้น</u> จำนวนกี่คน<br>\|________________\| คน (อาจตอบเป็นตัวเลขโดยประมาณ) |
| 4. ปัจจุบันโรงพยาบาลของท่านมีบุคลากร<u>ด้านเทคโนโลยีสารสนเทศ</u> (รวมถึงผู้บริหารงานสารสนเทศ ผู้ดูแลระบบ นักวิเคราะห์ระบบ โปรแกรมเมอร์ บุคลากรทางเทคนิคอื่นๆ และบุคลากรอื่นของโรงพยาบาลที่มีบทบาทสำคัญในงานด้านสารสนเทศ) จำนวนกี่คน?<br>❑ ไม่มี<br>❑ 1-5 คน<br>❑ 6-20 คน<br>❑ 21-50 คน<br>❑ 51 คนขึ้นไป | 4. ปัจจุบันโรงพยาบาลของท่านมีบุคลากร<u>ด้านเทคโนโลยีสารสนเทศ</u> จำนวนกี่คน<br>\|________________\| คน (อาจตอบเป็นตัวเลขโดยประมาณ) |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| 5. ข้อใดต่อไปนี้ตรงกับสถานภาพการรับรองคุณภาพโรงพยาบาล (hospital accreditation หรือ HA) ของโรงพยาบาลของท่านในปัจจุบันมากที่สุด?<br>❑ ยังไม่ได้รับการรับรอง และยังไม่มีแผนที่จะรับการตรวจรับรอง<br>❑ ยังไม่ได้รับการรับรอง มีแผนที่จะขอรับการตรวจรับรอง แต่ยังไม่มีความคืบหน้าที่ชัดเจน<br>❑ ยังไม่ได้รับการรับรอง แต่มีความคืบหน้าที่ชัดเจนในการเตรียมรับการตรวจรับรอง<br>❑ ปัจจุบันผ่านการรับรองแล้ว | (Dropped from nationwide survey.) |
| 6. ในปีงบประมาณ 2552 โรงพยาบาลของท่านมีงบประมาณทั้งสิ้นเท่าใด?<br>\|________________\| บาท (อาจตอบเป็นตัวเลขโดยประมาณ)<br>❑ ไม่ทราบข้อมูล | 5. ในปีงบประมาณ 2553 โรงพยาบาลของท่านมีงบประมาณ<u>ทั้งสิ้น</u>เท่าใด<br>\|________________\| บาท (อาจตอบเป็นตัวเลขโดยประมาณ)<br>❑ ไม่ทราบข้อมูล |
| 7. ในปีงบประมาณ 2552 โรงพยาบาลของท่าน ใช้งบประมาณด้านเทคโนโลยีสารสนเทศ ซึ่งรวมถึงการจัดซื้อ/จัดจ้างฮาร์ดแวร์ ซอฟต์แวร์ ค่าตอบแทนบุคลากร ที่ปรึกษา และการจ้างงาน (outsourcing) ด้านเทคโนโลยีสารสนเทศ เป็นจำนวนทั้งสิ้นเท่าใด?<br>\|________________\| บาท (อาจตอบเป็นตัวเลขโดยประมาณ)<br>❑ ไม่ทราบข้อมูล | 6. ในปีงบประมาณ 2553 โรงพยาบาลของท่าน ใช้งบประมาณ<u>ด้านเทคโนโลยีสารสนเทศ</u> ซึ่งรวมถึงการจัดซื้อ/จัดจ้างฮาร์ดแวร์ ซอฟต์แวร์ ค่าตอบแทนบุคลากร ที่ปรึกษา และการจ้างงาน (outsourcing) ด้านเทคโนโลยีสารสนเทศ เป็นจำนวนทั้งสิ้นเท่าใด<br>\|________________\| บาท (อาจตอบเป็นตัวเลขโดยประมาณ)<br>❑ ไม่ทราบข้อมูล |
| 8. หากท่านไม่ทราบข้อมูลข้อ 6 หรือ 7 กรุณาคาดคะเนว่า งบประมาณด้านเทคโนโลยีสารสนเทศ คิดเป็นประมาณร้อยละเท่าใดของงบประมาณทั้งโรงพยาบาล?<br>❑ น้อยกว่าร้อยละ 1<br>❑ ร้อยละ 1 ถึงร้อยละ 4<br>❑ ร้อยละ 5 ถึงร้อยละ 8<br>❑ มากกว่าร้อยละ 8 | 7. หากท่านไม่ทราบข้อมูลข้อ 5 หรือ 6 กรุณาคาดคะเนว่า งบประมาณด้านเทคโนโลยีสารสนเทศในปีงบประมาณ 2553 คิดเป็นประมาณร้อยละเท่าใดของงบประมาณทั้งโรงพยาบาล<br>❑ น้อยกว่าร้อยละ 1<br>❑ ร้อยละ 1 ถึงร้อยละ 4<br>❑ ร้อยละ 5 ถึงร้อยละ 8<br>❑ มากกว่าร้อยละ 8 |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| 9. ท่านเห็นด้วยหรือไม่เห็นด้วยกับข้อความแต่ละข้อต่อไปนี้มากน้อยเพียงใด? หากข้อความใดไม่เกี่ยวข้องกับโรงพยาบาลของท่าน กรุณาเลือก “N/A” (Not Applicable) | 8. ท่านเห็นด้วยหรือไม่เห็นด้วยกับข้อความแต่ละข้อต่อไปนี้มากน้อยเพียงใด |
| ก. โรงพยาบาลของเราเปิดกว้างสำหรับแนวทางใหม่ๆ ในการปฏิบัติงาน | ก. โรงพยาบาลของเราเปิดกว้างสำหรับแนวทางใหม่ๆ ในการดำเนินงาน |
| ข. โรงพยาบาลของเรามีการกำหนดวิสัยทัศน์และเป้าหมายที่ชัดเจนที่เราหวังจะไปให้ถึงด้วยโครงการต่างๆ ด้านสารสนเทศ | ข. โรงพยาบาลของเรามีการกำหนดวิสัยทัศน์ เป้าหมาย และแผนงานด้านสารสนเทศที่ชัดเจน |
| ค. เมื่อเรานำเทคโนโลยีใหม่ๆ เข้ามาในโรงพยาบาล เรามีการสื่อสารเป้าหมาย แผนงาน และความคืบหน้าของโครงการไปยังผู้เกี่ยวข้องอย่างชัดเจน | ค. โรงพยาบาลของเรามีการสื่อสารเป้าหมาย แผนงาน และความคืบหน้าของงานด้านสารสนเทศไปยังผู้เกี่ยวข้องอย่างชัดเจน |
| ง. ผู้ที่จะใช้ระบบสารสนเทศในโรงพยาบาลของเรามีส่วนร่วมในโครงการด้านสารสนเทศอย่างเต็มที่ตั้งแต่เนิ่นๆ | ง. ผู้ที่จะใช้ระบบสารสนเทศในโรงพยาบาลของเรามีส่วนร่วมในการพัฒนาระบบสารสนเทศของโรงพยาบาลอย่างเต็มที่ |
| จ. ผู้บริหารระดับสูงของเราสนับสนุนการใช้เทคโนโลยีสารสนเทศอย่างเต็มที่ | จ. ผู้บริหารระดับสูงของเราสนับสนุนการใช้เทคโนโลยีสารสนเทศอย่างเต็มที่ |
| ฉ. เรามีทีมผู้ใช้งานจากหลากหลายสาขาที่มีส่วนร่วมในโครงการด้านสารสนเทศของเรา | ฉ. ทีมผู้ใช้งานที่มีส่วนร่วมในการพัฒนาระบบสารสนเทศของเรา มาจากหลากหลายสาขา |
| ช. ก่อนที่โรงพยาบาลของเราจะนำเทคโนโลยีสารสนเทศใหม่ๆ มาใช้ การเปลี่ยนแปลงของกระบวนการทำงาน (workflow) ได้รับการพิจารณาอย่างรอบคอบ | ช. ในการพัฒนาระบบสารสนเทศของโรงพยาบาลของเรา การเปลี่ยนแปลงของขั้นตอนการทำงาน (workflow) ได้รับการพิจารณาอย่างรอบคอบ |
| ซ. บุคลากรส่วนใหญ่ของโรงพยาบาล มีความมุ่งมั่นที่จะให้โรงพยาบาลประสบความสำเร็จตามเป้าหมายขององค์กรที่วางไว้ | ซ. บุคลากรส่วนใหญ่ของโรงพยาบาล มีความมุ่งมั่นที่จะให้โรงพยาบาลประสบความสำเร็จตามเป้าหมายขององค์กรที่วางไว้ |
| ฌ. ก่อนที่ระบบจะถูกนำมาใช้ โรงพยาบาลของเรามีการจัดการอบรมผู้ที่จะใช้งานระบบสารสนเทศใหม่อย่างเพียงพอ | ฌ. โรงพยาบาลของเรามีการอบรมผู้ที่จะใช้งานระบบสารสนเทศอย่างเพียงพอ |
| ญ. เมื่อเราดำเนินโครงการด้านสารสนเทศโรงพยาบาลของเรามีกระบวนการติดตามความคืบหน้าและบริหารจัดการโครงการ | ญ. โรงพยาบาลของเรามีกระบวนการติดตามความคืบหน้าและการจัดการงานด้านสารสนเทศอย่างเหมาะสม |
| ฎ. โรงพยาบาลของเราเรียนรู้จากประสบการณ์ในอดีตเพื่อปรับปรุงการปฏิบัติงาน | ฎ. โรงพยาบาลของเรานำประสบการณ์การทำงานในอดีตมาเป็นบทเรียนเพื่อขับเคลื่อนการทำงานในปัจจุบัน |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| 10. โรงพยาบาลของท่านมีการนำเทคโนโลยีสารสนเทศมาใช้งานโดยรวมเพื่อสนับสนุนภารกิจของโรงพยาบาลมากน้อยเพียงใด?<br>❑ มาก<br>❑ ค่อนข้างมาก<br>❑ ปานกลาง<br>❑ ค่อนข้างน้อย<br>❑ น้อยมาก | 9. โรงพยาบาลของท่านมีการนำเทคโนโลยีสารสนเทศมาใช้งานโดยรวมเพื่อสนับสนุนภารกิจของโรงพยาบาลมากน้อยเพียงใด<br>❑ มาก<br>❑ ค่อนข้างมาก<br>❑ ปานกลาง<br>❑ ค่อนข้างน้อย<br>❑ น้อยมาก |
| 11. โรงพยาบาลของท่านมีเครื่องคอมพิวเตอร์ส่วนบุคคล (รวมถึง desktops, notebooks และ laptops) สำหรับใช้งานจำนวนกี่เครื่อง?<br>\|________\| เครื่อง (อาจตอบเป็นตัวเลขโดยประมาณ) | 10. โรงพยาบาลของท่านมีเครื่องคอมพิวเตอร์ส่วนบุคคล (รวมถึง desktops, notebooks และ laptops) สำหรับใช้งานจำนวนกี่เครื่อง<br>\|________\| เครื่อง (อาจตอบเป็นตัวเลขโดยประมาณ) |
| 12. โรงพยาบาลของท่านใช้ระบบสารสนเทศโรงพยาบาล (Hospital Information System) ระบบใดเป็นระบบหลัก?<br>❑ โรงพยาบาลของเราไม่มีระบบสารสนเทศโรงพยาบาล<br>❑ HOSxP<br>❑ Hospital OS<br>❑ ระบบที่โรงพยาบาลของเราพัฒนาขึ้นเองหรือจ้างพัฒนาเป็นพิเศษ<br>❑ อื่นๆ โปรดระบุ \|________________________________\| | 11. โรงพยาบาลของท่านใช้ระบบสารสนเทศโรงพยาบาล (Hospital Information System) ระบบใดเป็นระบบหลัก<br>❑ โรงพยาบาลของเราไม่มีระบบสารสนเทศโรงพยาบาล<br>❑ HOSxP<br>❑ Hospital OS<br>❑ ระบบที่โรงพยาบาลของเราพัฒนาขึ้นเองหรือจ้างพัฒนาเป็นพิเศษ<br>❑ อื่นๆ โปรดระบุ \|________________________________\| |
| 13. โรงพยาบาลของท่านเริ่มใช้ระบบสารสนเทศที่ท่านระบุในข้อ 12 ตั้งแต่ปี พ.ศ. ใด? หากท่านไม่ทราบปี พ.ศ. ที่แน่นอน โปรดระบุปี พ.ศ. โดยประมาณ<br>พ.ศ. \|________\|<br>❑ ไม่ทราบข้อมูล | 12. โรงพยาบาลของท่านเริ่มใช้ระบบสารสนเทศที่ท่านระบุในข้อ 11 ตั้งแต่ปี พ.ศ. ใด หากท่านไม่ทราบปี พ.ศ. ที่แน่นอน โปรดระบุปี พ.ศ. โดยประมาณ<br>พ.ศ. \|________\|<br>❑ ไม่ทราบข้อมูล |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| 14. กิจกรรมแต่ละข้อต่อไปนี้ ได้รับการสนับสนุนด้วยระบบสารสนเทศทางคอมพิวเตอร์มากน้อยเพียงใด? หากระดับการสนับสนุนแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับโดยเฉลี่ยทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมใดเลย กรุณาเลือก "N/A" (Not Applicable) | 13. กิจกรรมแต่ละข้อต่อไปนี้ ได้รับการสนับสนุนด้วยระบบสารสนเทศทางคอมพิวเตอร์มากน้อยเพียงใด หากระดับการสนับสนุนแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับโดยเฉลี่ยทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมใดเลย (Not Applicable) กรุณาเว้นคำตอบของข้อนั้นไว้ |
| - การลงทะเบียนผู้ป่วย | - การลงทะเบียนและบันทึกข้อมูลทั่วไปของผู้ป่วย |
| - การตรวจสอบสิทธิค่ารักษาพยาบาล | (Dropped from nationwide survey.) |
| - การจัดการตารางนัดหมายผู้ป่วยนอก | - การจัดการตารางนัดหมายผู้ป่วยนอก |
| - การจัดการรายชื่อและคิวผู้ป่วย (patient management) ในแผนกผู้ป่วยนอก | (Dropped from nationwide survey.) |
| - การรับผู้ป่วยไว้รักษาในโรงพยาบาล (admission) | (Dropped from nationwide survey.) |
| - การจำหน่ายผู้ป่วยในออกจากโรงพยาบาล | (Dropped from nationwide survey.) |
| - การส่งต่อผู้ป่วยไปยังสถานพยาบาลอื่น | (Dropped from nationwide survey.) |
| - การตรวจสอบการครองเตียงและจำนวนเตียงที่ว่าง | - การเรียกดูรายชื่อผู้ป่วยใน |
| - การสั่งยาผู้ป่วยใน | - การสั่งยาผู้ป่วยใน |
| - การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยใน | - การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยใน |
| - การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยใน | - การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยใน |
| - การรายงานผลการตรวจทางห้องปฏิบัติการของผู้ป่วยใน | - การเรียกดูผลการตรวจทางห้องปฏิบัติการของผู้ป่วยใน |
| - การรายงานผลการตรวจทางรังสีวิทยาของผู้ป่วยใน | (Dropped from nationwide survey.) |
| - การบันทึกประวัติการรักษาพยาบาลของผู้ป่วยใน | - การบันทึกประวัติ การตรวจร่างกาย และ Progress Note ของผู้ป่วยใน |
| - การสรุปประวัติผู้ป่วยจำหน่าย (discharge summary) | - การสรุปประวัติผู้ป่วยจำหน่าย (discharge summary) |
| - การสั่งยาผู้ป่วยนอก | - การสั่งยาผู้ป่วยนอก |
| - การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก | - การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก |
| - การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยนอก | - การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยนอก |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
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| - การรายงานผลการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก | - การเรียกดูผลการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก |
| - การรายงานผลการตรวจทางรังสีวิทยาของผู้ป่วยนอก | (Dropped from nationwide survey.) |
| - การบันทึกประวัติการรักษาพยาบาลของผู้ป่วยนอก | - การบันทึกประวัติและการตรวจร่างกายของผู้ป่วยนอก |
| - การวางแผนทางการพยาบาล (care planning) | (Dropped from nationwide survey.) |
| - การทบทวนและดำเนินการตามการสั่งการรักษา (order) ของแพทย์ | (Dropped from nationwide survey.) |
| - การให้ยาและบันทึกการให้ยาผู้ป่วย (medication administration) | - การบันทึกการให้ยาผู้ป่วย |
| - การบันทึกการประเมินทางการพยาบาล (nursing assessment) | - การบันทึกทางการพยาบาล |
| - การจัดตารางนัดและการนัดผ่าตัด | (Dropped from nationwide survey.) |
| - การจัดการรายชื่อและคิวผู้ป่วย (patient management) ในห้องผ่าตัด | (Dropped from nationwide survey.) |
| - การบันทึกรายงานการผ่าตัด (operative note) | (Dropped from nationwide survey.) |
| - การบันทึกรายงานการดมยา (anesthetic note) | (Dropped from nationwide survey.) |
| - การคิดราคาค่าผ่าตัด | (Dropped from nationwide survey.) |
| - การจัดการสิ่งส่งตรวจ (specimen) | (Dropped from nationwide survey.) |
| - การรับผลการตรวจทางห้องปฏิบัติการจากเครื่องตรวจอัตโนมัติ | (Dropped from nationwide survey.) |
| - การป้อนผลการตรวจทางห้องปฏิบัติการสำหรับการตรวจที่ไม่ได้ใช้เครื่องตรวจอัตโนมัติ | (Dropped from nationwide survey.) |
| - การตรวจสอบและยืนยันผลการตรวจทางห้องปฏิบัติการ | (Dropped from nationwide survey.) |
| - การจัดตารางนัดและการนัดผู้ป่วยรังสี | (Dropped from nationwide survey.) |
| - การรับภาพทางรังสีวิทยาโดยตรงจากเครื่องเอกซเรย์เข้าระบบคอมพิวเตอร์ (แทนที่จะใช้ฟิล์มเอกซเรย์) | (Dropped from nationwide survey.) |
| - การบันทึกรายงานผลการตรวจทางรังสีวิทยา | (Dropped from nationwide survey.) |
| - การเรียกดูภาพทางรังสีวิทยาโดยรังสีแพทย์ผ่านระบบคอมพิวเตอร์ | (Dropped from nationwide survey.) |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
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| - การเรียกดูภาพทางรังสีวิทยาโดยแพทย์ผู้รักษาผ่านระบบคอมพิวเตอร์ | - การเรียกดูภาพทางรังสีวิทยาผ่านคอมพิวเตอร์ (แทนฟิล์มเอกซเรย์) สำหรับผู้ป่วยใน<br>- การเรียกดูภาพทางรังสีวิทยาผ่านคอมพิวเตอร์ (แทนฟิล์มเอกซเรย์) สำหรับผู้ป่วยนอก |
| - การทบทวนการสั่งยาโดยเภสัชกร | (Dropped from nationwide survey.) |
| - การตรวจสอบการสั่งยาที่ผู้ป่วยมีประวัติแพ้ด้วยระบบคอมพิวเตอร์ | - การตรวจสอบการสั่งยาที่ผู้ป่วยมีประวัติแพ้ด้วยระบบคอมพิวเตอร์ |
| - การตรวจสอบการสั่งยาที่มีปฏิกิริยาต่อกัน (drug interactions) | - การตรวจสอบการสั่งยาที่มีปฏิกิริยาต่อกัน (drug interactions) |
| - การจ่ายยาผู้ป่วยนอก | - การจ่ายยาผู้ป่วยนอก |
| - การจัดการคลังยาและเวชภัณฑ์ผู้ป่วยนอก | - การจัดการคลังยาและเวชภัณฑ์ |
| - การจ่ายยาผู้ป่วยใน | - การจ่ายยาผู้ป่วยใน |
| - การจัดการคลังยาและเวชภัณฑ์ผู้ป่วยใน | (Dropped from nationwide survey.) |
| - การเงินและการเบิกจ่ายค่ารักษาพยาบาล | - การเรียกเก็บเงินจากผู้ป่วย<br>- การเบิกจ่ายค่ารักษาพยาบาล |
| - การบัญชี | (Dropped from nationwide survey.) |
| - ทะเบียนประวัติบุคลากร | (Dropped from nationwide survey.) |
| - การบริหารจัดการภาระงาน (workload) | (Dropped from nationwide survey.) |
| - การจัดการคลังพัสดุ | (Dropped from nationwide survey.) |
| - การสื่อสารภายในโรงพยาบาล | (Dropped from nationwide survey.) |
| - การประชาสัมพันธ์และสื่อสารกับภายนอก | (Dropped from nationwide survey.) |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| 15. โรงพยาบาลของท่านมีเทคโนโลยีแต่ละอย่างต่อไปนี้ติดตั้งอยู่ในโรงพยาบาลเพื่อให้ใช้งาน (available) มากน้อยเพียงใด? หากแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับโดยเฉลี่ยของหน่วยงานทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมที่สามารถนำเทคโนโลยีใดมาสนับสนุนการทำงานได้ กรุณาเลือก “N/A” (Not Applicable) | 14. โรงพยาบาลของท่านมีเทคโนโลยีแต่ละอย่างต่อไปนี้ติดตั้งอยู่ในโรงพยาบาล (available) มากน้อยเพียงใด หากแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับโดยเฉลี่ยของหน่วยงานทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมที่สามารถนำเทคโนโลยีใดมาสนับสนุนการทำงานได้ (Not Applicable) กรุณาเว้นคำตอบของข้อนั้นไว้ |
| - การเข้าถึงอินเทอร์เน็ต | - การเข้าถึงอินเทอร์เน็ต |
| - เว็บไซต์ของโรงพยาบาล | - เว็บไซต์ของโรงพยาบาล |
| - อินทราเน็ต (เว็บไซต์ภายใน) ของโรงพยาบาล | (Dropped from nationwide survey.) |
| - ระบบ e-mail ขององค์กร | (Dropped from nationwide survey.) |
| - ระบบเครือข่ายภายในโรงพยาบาล (local area network/LAN) | - ระบบเครือข่ายภายในโรงพยาบาล (LAN) |
| - เครือข่ายไร้สาย (wireless networks) | (Dropped from nationwide survey.) |
| - ระบบคลังข้อมูล (data warehouse) | (Dropped from nationwide survey.) |
| - ระบบทะเบียนผู้ป่วย (Master Patient Index) | - ระบบทะเบียนผู้ป่วย (Master Patient Index) |
| - ระบบสั่งการรักษาผ่านคอมพิวเตอร์ (computerized order entry) | - ระบบที่ให้แพทย์สั่งการรักษาด้วยคอมพิวเตอร์ |
| - ระบบบันทึกประวัติการรักษาพยาบาลในรูปแบบอิเล็กทรอนิกส์ (electronic medical record/documentation of clinical care) | - ระบบเวชระเบียนอิเล็กทรอนิกส์ (electronic medical records) ซึ่งบันทึกประวัติการรักษาพยาบาลในคอมพิวเตอร์ |
| - ระบบสารสนเทศรักษาผู้ป่วยเฉพาะโรค (disease management systems) | (Dropped from nationwide survey.) |
| - ระบบสารสนเทศห้องปฏิบัติการ (laboratory information system) | - ระบบสารสนเทศห้องปฏิบัติการ (laboratory information system) |
| - ระบบสารสนเทศทางเภสัชกรรม (pharmacy information system) | (Dropped from nationwide survey.) |
| - ระบบสารสนเทศบันทึกการให้ยาผู้ป่วย (electronic medication administration records) | - ระบบบันทึกการให้ยาผู้ป่วยด้วยคอมพิวเตอร์ (electronic medication administration records) |
| - ระบบภาพทางรังสีวิทยา (Picture archiving and communication system/PACS) | - ระบบจัดเก็บและเรียกดูภาพทางรังสีวิทยาด้วยคอมพิวเตอร์แทนฟิล์มเอกซเรย์ (PACS) |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| - ระบบสารสนเทศทางรังสีวิทยา (radiology information system) | (Dropped from nationwide survey.) |
| - การให้บริการหรือคำปรึกษาทางการแพทย์ทางไกลโดยใช้เทคโนโลยีสารสนเทศ (telemedicine) | (Dropped from nationwide survey.) |
| - การประชุมทางไกล (teleconference) | (Dropped from nationwide survey.) |
| - บาร์โค้ด (barcoding) | - การใช้บาร์โค้ดในการดูแลรักษาผู้ป่วย |
| - ระบบบริหารทรัพยากร (งานคลัง ทรัพยากรบุคคล และพัสดุ) ขององค์กร (Enterprise resource planning/ERP) | (Dropped from nationwide survey.) |
| 16. ในบางครั้ง ระบบสารสนเทศหนึ่งจะมีการเชื่อมต่อกับระบบสารสนเทศอื่นๆ และมีการแลกเปลี่ยนหรือส่งผ่านข้อมูลระหว่างกัน แต่ในบางกรณี ระบบสารสนเทศหนึ่งอาจไม่ได้แลกเปลี่ยนหรือส่งต่อข้อมูลกับระบบอื่น (stand-alone) ระบบสารสนเทศในภาพรวมของแต่ละระบบงานต่อไปนี้ มีการแลกเปลี่ยนข้อมูลกับระบบสารสนเทศอื่นภายในโรงพยาบาลมากน้อยเพียงใด? หากโรงพยาบาลของท่านไม่มีระบบงานใด กรุณาเลือก “N/A” (Not Applicable) | 15. ในบางครั้ง ข้อมูลสารสนเทศจะมีการแลกเปลี่ยนหรือส่งต่อกันทางอิเล็กทรอนิกส์ระหว่างระบบสารสนเทศต่างๆ แต่ในบางกรณี ข้อมูลสารสนเทศอาจไม่ได้มีการแลกเปลี่ยนหรือส่งต่อกันระหว่างระบบสารสนเทศเลย<br><br>ข้อมูลสารสนเทศแต่ละประเภทต่อไปนี้ มีการแลกเปลี่ยนหรือส่งต่อกันระหว่างระบบสารสนเทศต่างๆ ภายในโรงพยาบาลมากน้อยเพียงใด |
| - ห้องฉุกเฉิน | (Dropped from nationwide survey.) |
| - การลงทะเบียนผู้ป่วย การรับผู้ป่วยไว้ในโรงพยาบาล การจำหน่าย และการส่งต่อผู้ป่วย | (Dropped from nationwide survey.) |
| - ผู้ป่วยใน | (Dropped from nationwide survey.) |
| - ผู้ป่วยนอก | (Dropped from nationwide survey.) |
| - งานการพยาบาล | (Dropped from nationwide survey.) |
| - ห้องผ่าตัด (OR) | (Dropped from nationwide survey.) |
| - ห้องปฏิบัติการ | (Dropped from nationwide survey.) |
| - งานรังสีวิทยา | (Dropped from nationwide survey.) |
| - งานเภสัชกรรม | (Dropped from nationwide survey.) |
| - งานการเงินการคลัง | (Dropped from nationwide survey.) |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| - งานการเจ้าหน้าที่และทรัพยากรบุคคล | (Dropped from nationwide survey.) |
| - ระบบงานอื่นๆ | (Dropped from nationwide survey.) |
| (Not present in pilot survey.) | - ข้อมูลทั่วไปของผู้ป่วย |
| (Not present in pilot survey.) | - ประวัติการเจ็บป่วยและบันทึกทางการแพทย์ในแผนกผู้ป่วยนอก |
| (Not present in pilot survey.) | - ประวัติการเจ็บป่วยและบันทึกทางการแพทย์ในแผนกผู้ป่วยใน |
| (Not present in pilot survey.) | - การวินิจฉัยโรคของผู้ป่วยนอก |
| (Not present in pilot survey.) | - การวินิจฉัยโรคของผู้ป่วยใน |
| (Not present in pilot survey.) | - ยาที่แพทย์สั่งให้ผู้ป่วยนอก |
| (Not present in pilot survey.) | - ยาที่แพทย์สั่งให้ผู้ป่วยใน |
| (Not present in pilot survey.) | - รายการผ่าตัดและการทำหัตถการ |
| (Not present in pilot survey.) | - ผลการตรวจทางห้องปฏิบัติการ |
| (Not present in pilot survey.) | - ภาพและผลการตรวจทางรังสีวิทยา |
| 17. ระบบสารสนเทศในภาพรวมของแต่ละระบบงานต่อไปนี้ มีการแลกเปลี่ยนข้อมูลกับระบบสารสนเทศอื่นภายนอกโรงพยาบาล (รวมถึงการเชื่อมต่อกับระบบสารสนเทศของส่วนราชการและสถานพยาบาลอื่น) มากน้อยเพียงใด? หากโรงพยาบาลของท่านไม่มีระบบงานใด กรุณาเลือก “N/A” (Not Applicable) | 16. ข้อมูลสารสนเทศแต่ละประเภทต่อไปนี้ มีการแลกเปลี่ยนหรือส่งต่อกันระหว่างระบบสารสนเทศของโรงพยาบาล กับระบบสารสนเทศอื่นภายนอกโรงพยาบาล (เช่น ระบบสารสนเทศของส่วนราชการหรือสถานพยาบาลอื่น) ทั้งการส่งข้อมูลให้กับระบบภายนอกและการรับข้อมูลจากระบบภายนอก มากน้อยเพียงใด |
| - ห้องฉุกเฉิน | (Dropped from nationwide survey.) |
| - การลงทะเบียนผู้ป่วย การรับผู้ป่วยไว้ในโรงพยาบาล การจำหน่าย และการส่งต่อผู้ป่วย | (Dropped from nationwide survey.) |
| - ผู้ป่วยใน | (Dropped from nationwide survey.) |
| - ผู้ป่วยนอก | (Dropped from nationwide survey.) |
| - งานการพยาบาล | (Dropped from nationwide survey.) |
| - ห้องผ่าตัด (OR) | (Dropped from nationwide survey.) |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| - ห้องปฏิบัติการ | (Dropped from nationwide survey.) |
| - งานรังสีวิทยา | (Dropped from nationwide survey.) |
| - งานเภสัชกรรม | (Dropped from nationwide survey.) |
| - งานการเงินการคลัง | (Dropped from nationwide survey.) |
| - งานการเจ้าหน้าที่และทรัพยากรบุคคล | (Dropped from nationwide survey.) |
| - ระบบงานอื่นๆ | (Dropped from nationwide survey.) |
| (Not present in pilot survey.) | - ข้อมูลทั่วไปของผู้ป่วย |
| (Not present in pilot survey.) | - ประวัติการเจ็บป่วยและบันทึกทางการแพทย์ในแผนกผู้ป่วยนอก |
| (Not present in pilot survey.) | - ประวัติการเจ็บป่วยและบันทึกทางการแพทย์ในแผนกผู้ป่วยใน |
| (Not present in pilot survey.) | - การวินิจฉัยโรคของผู้ป่วยนอก |
| (Not present in pilot survey.) | - การวินิจฉัยโรคของผู้ป่วยใน |
| (Not present in pilot survey.) | - ยาที่แพทย์สั่งให้ผู้ป่วยนอก |
| (Not present in pilot survey.) | - ยาที่แพทย์สั่งให้ผู้ป่วยใน |
| (Not present in pilot survey.) | - รายการผ่าตัดและการทำหัตถการ |
| (Not present in pilot survey.) | - ผลการตรวจทางห้องปฏิบัติการ |
| (Not present in pilot survey.) | - ภาพและผลการตรวจทางรังสีวิทยา |
| 18. โปรดระบุเพศของท่าน<br>❑ ชาย<br>❑ หญิง | 17. โปรดระบุเพศของท่าน<br>❑ ชาย<br>❑ หญิง |
| 19. ท่านมีอายุเท่าใด<br>\|______\| ปี | 18. ท่านมีอายุเท่าใด<br>\|______\| ปี |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| 20. ท่านจบการศึกษาขั้นสูงสุดระดับใด?<br>❑ ต่ำกว่าปริญญาตรี<br>❑ ปริญญาตรี<br>❑ ปริญญาโทหรือสูงกว่า | 19. ท่านจบการศึกษาขั้นสูงสุดระดับใด<br>❑ ต่ำกว่าปริญญาตรี<br>❑ ปริญญาตรี (รวมถึงปริญญาแพทยศาสตรบัณฑิต)<br>❑ ปริญญาโทหรือสูงกว่า (รวมถึงแพทย์ที่จบสาขาเฉพาะทาง) |
| 21. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้านเทคโนโลยีสารสนเทศของท่านมากที่สุด?<br>❑ ไม่เคยได้รับการศึกษาอบรมในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศเลย<br>❑ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ<br>❑ เคยได้รับปริญญาตรี/โท/เอกในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ | 20. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้าน<u>เทคโนโลยีสารสนเทศ</u>ของท่านมากที่สุด<br>❑ ไม่เคยได้รับการศึกษาอบรมในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศเลย<br>❑ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ<br>❑ เคยได้รับปริญญาตรี/โท/เอกในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ |
| 22. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมในสาขาวิชาชีพทางคลินิกของท่านมากที่สุด? (สาขาวิชาชีพทางคลินิก หมายรวมถึงสาขาวิชาทางแพทยศาสตร์ ทันตแพทยศาสตร์ พยาบาลศาสตร์ เภสัชศาสตร์ เทคนิคการแพทย์ กายภาพบำบัด รังสีเทคนิค เป็นต้น)<br>❑ ไม่เคยได้รับการศึกษาอบรมในสาขาวิชาชีพทางคลินิก<br>❑ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาวิชาชีพทางคลินิก<br>❑ เคยได้รับปริญญาตรี/โท/เอกในสาขาวิชาชีพทางคลินิก | 21. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมใน<u>สาขาวิชาชีพทางสุขภาพ</u>ของท่านมากที่สุด (สาขาวิชาชีพทางสุขภาพ เช่น สาขาวิชาทางแพทยศาสตร์ ทันตแพทยศาสตร์ พยาบาลศาสตร์ เภสัชศาสตร์ เทคนิคการแพทย์ กายภาพบำบัด รังสีเทคนิค สาธารณสุขศาสตร์)<br>❑ ไม่เคยได้รับการศึกษาอบรมในสาขาวิชาชีพทางสุขภาพ<br>❑ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาวิชาชีพทางสุขภาพ<br>❑ เคยได้รับปริญญาตรี/โท/เอกในสาขาวิชาชีพทางสุขภาพ |
| 23. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้านบริหารธุรกิจหรือการจัดการ (business administration/management) ของท่านมากที่สุด?<br>❑ ไม่เคยได้รับการศึกษาอบรมด้านการบริหารธุรกิจหรือการบริหารจัดการ<br>❑ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาด้านการบริหารธุรกิจหรือการบริหารจัดการ<br>❑ เคยได้รับปริญญาตรี/โท/เอกด้านการบริหารธุรกิจหรือการบริหารจัดการ | 22. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้าน<u>บริหารธุรกิจหรือการบริหารจัดการ</u> (business administration/management) ของท่านมากที่สุด<br>❑ ไม่เคยได้รับการศึกษาอบรมด้านการบริหารธุรกิจหรือการบริหารจัดการ<br>❑ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาด้านการบริหารธุรกิจหรือการบริหารจัดการ<br>❑ เคยได้รับปริญญาตรี/โท/เอกด้านการบริหารธุรกิจหรือการบริหารจัดการ |
| 24. ท่านปฏิบัติงานในบทบาท<u>ที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ ไม่ว่าในตำแหน่งใด</u> ณ สถานที่ทำงานใดในอดีตและปัจจุบัน มาแล้วรวมทั้งหมดเป็นเวลากี่ปี?<br>\|______\| ปี | 23. ท่านปฏิบัติงานในบทบาทที่เกี่ยวข้องกับ<u>เทคโนโลยีสารสนเทศ ไม่ว่าในตำแหน่งใด</u> ณ สถานที่ทำงานใดในอดีตและปัจจุบัน มาแล้วรวมทั้งหมดเป็นเวลากี่ปี<br>\|______\| ปี |

| Item Wording in Pilot Survey | Item Wording in Nationwide Survey |
|---|---|
| 25. ข้อใดต่อไปนี้ตรงกับบทบาทของท่านในโรงพยาบาล? หากท่านมีหลายบทบาท กรุณาเลือกทุกบทบาทที่ตรงกับท่าน<br>❑ ผู้อำนวยการหรือผู้บริหารระดับสูงของโรงพยาบาล<br>❑ ผู้บริหารโรงพยาบาลที่กำกับดูแลงานด้านสารสนเทศของโรงพยาบาลโดยตรง<br>❑ หัวหน้าหน่วยงานด้านเทคโนโลยีสารสนเทศของโรงพยาบาล<br>❑ ผู้เชี่ยวชาญด้านเทคโนโลยีสารสนเทศ ผู้ดูแลระบบ นักวิเคราะห์ระบบ โปรแกรมเมอร์ นักวิชาการคอมพิวเตอร์ หรือบุคลากรทางเทคนิคในโรงพยาบาล แต่ไม่ใช่ผู้บริหารหรือหัวหน้าหน่วยงาน<br>❑ บุคลากรในโรงพยาบาลที่มีบทบาทสำคัญในโครงการทางเทคโนโลยีสารสนเทศแต่ไม่ได้มีบทบาททางบริหารหรือทางเทคนิค<br>❑ บุคลากรในโรงพยาบาลที่ไม่ได้มีบทบาทสำคัญในโครงการทางเทคโนโลยีสารสนเทศ และไม่ได้มีบทบาททางบริหารหรือทางเทคนิค<br>❑ อื่นๆ โปรดระบุ \|________________________________\| | 24. ข้อใดต่อไปนี้ตรงกับบทบาทของท่านในโรงพยาบาล หากท่านมีหลายบทบาท กรุณาเลือกทุกบทบาทที่ตรงกับท่าน<br>❑ ผู้อำนวยการหรือผู้บริหารระดับสูงของโรงพยาบาล<br>❑ ผู้บริหารโรงพยาบาลที่กำกับดูแลงานด้านสารสนเทศโดยตรง<br>❑ หัวหน้าหน่วยงานด้านสารสนเทศที่ไม่ใช่ผู้บริหารโรงพยาบาล<br>❑ ผู้เชี่ยวชาญด้านสารสนเทศ เช่น ผู้ดูแลระบบ นักวิเคราะห์ระบบ โปรแกรมเมอร์ นักวิชาการคอมพิวเตอร์ นักเวชสถิติ หรือบุคลากรทางเทคนิคในโรงพยาบาล ที่ไม่ใช่ผู้บริหารหรือหัวหน้าหน่วยงาน<br>❑ บุคลากรในโรงพยาบาลที่มีหรือเคยมีบทบาทสำคัญในการพัฒนางานด้านเทคโนโลยีสารสนเทศ แต่ไม่ใช่ผู้บริหารโรงพยาบาลหรือบุคลากรทางเทคนิค<br>❑ บุคลากรในโรงพยาบาลที่ไม่ได้มีบทบาทสำคัญในการพัฒนางานด้านเทคโนโลยีสารสนเทศและไม่ใช่ผู้บริหารโรงพยาบาลหรือบุคลากรทางเทคนิค<br>❑ อื่นๆ โปรดระบุ \|________________________________\| |
| เพื่อประโยชน์ในการปรับปรุงแบบสอบถาม ผู้วิจัยขอความกรุณาท่านช่วยให้ข้อมูลเพิ่มเติมว่าท่านใช้เวลาในการตอบแบบสอบถามนี้ทั้งสิ้นประมาณ_________นาที | Dropped because intended only for pilot study to gauge respondent's burden. |

# Appendix E

Descriptive Statistics of Individual IT Sophistication

Items in the Nationwide Study

| Item | Value |
|---|---|
| **Managerial Sophistication** | |
| a. Our hospital is open to new ways of conducting operations. (N=904) | 4.08 ± 0.87 |
| b. Our top-level management fully supports the use of IT. (N=903) | 4.24 ± 0.85 |
| c. Our hospital sets clear vision, goals, and plans on IT works. (N=906) | 3.74 ± 0.96 |
| d. Our hospital communicates goals, plans and progress on IT works to stakeholders clearly. (N=905) | 3.50 ± 0.90 |
| e. Those who will use the information systems are fully involved in hospital IT development. (N=904) | 3.40 ± 0.95 |
| f. The team of users involved in our IT development comes from several disciplines. (N=904) | 3.53 ± 1.03 |
| g. The majority of hospital employees are committed to achieving the envisioned organizational goals. (N=905) | 3.92 ± 0.85 |
| h. In our hospital's IT development, the workflow changes are carefully considered. (N=905) | 3.70 ± 0.87 |
| i. Our hospital provides training to those who will use the system adequately. (N=905) | 3.29 ± 0.95 |
| j. Our hospital has a process in place to track work progress and manage IT works appropriately. (N=905) | 3.33 ± 0.86 |
| k. Our hospital uses our past experience as lessons driving our current works. (N=905) | 3.84 ± 0.86 |
| **Average Overall Score for Managerial Sophistication** (N=907) | 3.69 ± 0.64 |
| **Technological Sophistication** | |
| a. Internet access (N=903) | 4.49 ± 0.77 |
| b. Hospital Web site (N=904) | 3.66 ± 1.46 |
| c. Local area network (LAN) (N=902) | 4.65 ± 0.70 |
| d. Master Patient Index (N=876) | 4.45 ± 0.92 |
| e. Computerized physician order entry (N=886) | 3.88 ± 1.43 |
| f. Electronic medication administration records (N=894) | 3.84 ± 1.46 |
| g. Electronic medical records that documents clinical care in the system (N=899) | 3.93 ± 1.34 |
| h. Laboratory information system (N=893) | 3.58 ± 1.56 |
| i. Picture archiving and communication system (PACS) for electronic storage of medical images instead of films (N=889) | 1.79 ± 1.42 |
| j. Barcode use in patient care (N=895) | 1.63 ± 1.13 |
| **Average Overall Score for Technological Sophistication** (N=906) | 3.59 ± 0.69 |
| **Functional Sophistication** | |
| Patient Management | |
| 1. Patient registration and recording of patient's demographic information (N=906) | 4.75 ± 0.57 |
| 2. Outpatient appointment scheduling (N=905) | 4.20 ± 1.13 |
| 3. Viewing the list of hospitalized patients (N=901) | 4.59 ± 0.84 |
| Outpatient Care | |
| 4. Outpatient medication order entry (N=904) | 4.54 ± 0.96 |
| 5. Outpatient lab order entry (N=898) | 4.37 ± 1.12 |
| 6. Outpatient lab results viewing (N=900) | 4.29 ± 1.19 |
| 7. Outpatient imaging order entry (N=894) | 4.16 ± 1.27 |
| 8. Electronic image viewing (instead of using films) for outpatients (N=893) | 1.97 ± 1.51 |
| 9. Documentation of history & physical examination of outpatients (N=902) | 3.95 ± 1.32 |
| Inpatient Care | |
| 10. Inpatient medication order entry (N=896) | 4.18 ± 1.27 |
| 11. Inpatient lab order entry (N=894) | 4.15 ± 1.28 |
| 12. Inpatient lab results viewing (N=894) | 4.00 ± 1.37 |

| Item | Value |
|---|---|
| 13. Inpatient imaging order entry (N=883) | 3.82 ± 1.48 |
| 14. Electronic image viewing (instead of using films) for inpatients (N=885) | 1.88 ± 1.46 |
| 15. Documentation of history, physical examination & progress note of inpatients (N=895) | 2.68 ± 1.58 |
| 16. Discharge summary documentation (N=895) | 3.59 ± 1.48 |
| Nursing | |
| 17. Documentation of medication administration to patients (N=901) | 3.18 ± 1.68 |
| 18. Nursing documentation (N=899) | 2.74 ± 1.63 |
| Pharmacy | |
| 19. Outpatient medication dispensing (N=905) | 4.64 ± 0.78 |
| 20. Inpatient medication dispensing (N=897) | 4.48 ± 0.97 |
| 21. Pharmacy inventory control (N=900) | 3.92 ± 1.32 |
| 22. Automatic drug allergy checking (N=904) | 4.32 ± 1.09 |
| 23. Automatic drug interaction checking (N=900) | 3.74 ± 1.44 |
| Finance | |
| 24. Patient billing (N=902) | 4.34 ± 1.09 |
| 25. Reimbursement claims (N=902) | 4.31 ± 1.04 |
| **Average Overall Score for Functional Sophistication** (N=906) | 3.87 ± 0.77 |
| **Internal Integration Sophistication** | |
| a. Patient's demographic information (N=899) | 4.09 ± 1.14 |
| b. Outpatient's history and medical documentation (N=900) | 3.80 ± 1.32 |
| c. Outpatient's diagnoses (N=897) | 4.00 ± 1.21 |
| d. Outpatient's medication orders (N=897) | 4.11 ± 1.18 |
| e. Inpatient's history and medical documentation (N=898) | 3.38 ± 1.44 |
| f. Inpatient's diagnoses (N=896) | 3.81 ± 1.28 |
| g. Inpatient's medication orders (N=894) | 3.81 ± 1.31 |
| h. Surgical operations and procedures (N=890) | 3.46 ± 1.42 |
| i. Laboratory results (N=897) | 3.83 ± 1.34 |
| j. Medical images and results (N=890) | 2.29 ± 1.53 |
| **Average Overall Score for Internal Integration Sophistication** (N=902) | 3.66 ± 1.02 |
| **External Integration Sophistication** | |
| a. Patient's demographic information (N=895) | 2.49 ± 1.41 |
| b. Outpatient's history and medical documentation (N=896) | 2.32 ± 1.36 |
| c. Outpatient's diagnoses (N=896) | 2.53 ± 1.43 |
| d. Outpatient's medication orders (N=894) | 2.38 ± 1.39 |
| e. Inpatient's history and medical documentation (N=887) | 2.20 ± 1.32 |
| f. Inpatient's diagnoses (N=893) | 2.44 ± 1.43 |
| g. Inpatient's medication orders (N=890) | 2.25 ± 1.37 |
| h. Surgical operations and procedures (N=890) | 2.25 ± 1.36 |
| i. Laboratory results (N=896) | 2.20 ± 1.35 |
| j. Medical images and results (N=887) | 1.69 ± 1.12 |
| **Average Overall Score for External Integration Sophistication** (N=897) | 2.28 ± 1.19 |
| **Average Total IT Sophistication Score (All Dimensions Combined)** (N=907) | 3.53 ± 0.59 |

Data are mean ± SD.