An Examination of Information Technology and its Perceived Quality Issues in Single System Hospitals in the United States

by

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Abstract

The safety and quality of healthcare is of great concern in the United States. The positive effects of information technology reported in past research, especially case studies, has encouraged expectations that information technology may increase the quality of healthcare while reducing costs of healthcare. The goals of this study was to examine the relationship between levels of information technology, chief nursing officers perceptions of the quality of information for clinical decision making, and hospital performance with three measures: 1) the perceived quality of healthcare, 2) healthcare quality metrics, and 3) cost of healthcare in hospitals.

The study utilized primary data (questionnaire) and secondary data obtained from the HIMSSAnalytics database and the American Hospital Directory. This study involved three phases: 1) questionnaire development, 2) implementation of the questionnaire and 3) merging the primary data (questionnaires) with secondary data from the American Hospital Directory and the HIMSSAnalytics database. Data were collected from a key informant, Chief Nursing Officer, of single system independent hospitals in the United States. One thousand surveys were mailed via the United States Postal Service. This mailing was followed by two e-mails. The overall response rate was 21.4%.

The findings from the study give some support for the value of information technology (IT) in hospitals. Directly or indirectly IT was related to many of the factors in the study, but not

all. The significance of quality of information in increasing the quality of healthcare and decreasing the cost of healthcare was determined.

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"No matter what accomplishments you make, somebody helped you."
Althea Gibson, 1927–2003.

I have had the help of many people to be able to write this page. Though I have been blessed, there have been tears shed as well as joyful times. I have, however, held on to the things I treasure most- my faith in God, my family and the pursuit of scholarly inquiry.

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Chapter 1. Introduction

Overview of the Study

This dissertation primarily investigates three distinct relationships. First, the study investigates the relationship between the level of clinical information technology (IT) implementation and the chief nursing officers' (CNO) perceptions of the quality of information for clinical decision making in hospitals. Second, the study investigates the association between the CNOs' perceptions of the quality of information for clinical decision making and hospital performance. Last, the study examines the relationship between the level of clinical IT implementation and hospital performance.

History of the Issue

The safety and quality of healthcare is of great concern in the United States. Hospital administrators, healthcare providers, and healthcare delivery systems all strive to provide safe and quality care for patients in complex environments. However, it has been reported that hospitalized patients are frequently harmed by the very care that is intended to facilitate their well-being (1964). Institute of Medicine (IOM) reports, *To Err is Human* (Briere, 2001; Kohn et al., 2000a) and *Crossing the Quality Chasm* (Briere, 2001), deduced that each year many Americans are harmed as a result of adverse events that occur during hospitalizations. Specifically, the IOM reports that 44,000 to 98,000 deaths occur each year because of medical errors. These medical errors are the eighth leading cause of death in the U.S. It is estimated that the annual cost of medical errors is 17 to 29 billion dollars annually (Kohn et al., 2000).

While medical errors may occur for many different reasons, some possible causes of these adverse events are work demands (Griffith & Jordan, 2003), improper monitoring of patients (Jordan et al., 2002; Kohn et al., 2000; Koppel et al., 2005), and prescribing errors (Bates et al., 1999; Koppel et al., 2005b; Overhage et al., 1997). Prescribing errors are the most common adverse medical events, and researchers have indicated that they may cause 32 to 64% of medical errors (Eslami et al., 2007; Griffith & Jordan, 2003; Rainu Kausal *et al.*, 2003).

The healthcare industry today is information-intensive (Amarasingham *et al.*, 2007; Ash et al., 2007; Kossman & Scheidenhelm, 2008). The patient medical record (PMR) is a document and repository of pertinent information for management and care of the patient. The PMR also includes documentation of clinical treatment, plans, and observations (Embi et al., 2004). The PMR is frequently updated with treatment history and clinical experiences to provide information for the course of treatments and decision support for clinicians in caring for medical patients (Tsai & Bond, 2008).

Paper-Based Patient Medical Record

The conventional paper-based PMR has been in existence for several centuries (Reiser, 1991). The paper-based PMR began as a personal clinical notebook containing pertinent details to remind healthcare providers of the care experiences of individual patients. These notebooks would frequently be used for dialogue with colleagues and were free from government and regulatory agencies' authority over what information was required in the record (Nightingale, 1860; Shortliffe, 1999).

Today, paper-based PMRs are used in more than 85% of healthcare organizations (Ilie et al., 2007; Kuo et al., 2007; Meinert, 2005; Versel, 2002). This data-rich document is a major source of information for daily healthcare delivery. It includes healthcare providers' handwritten information about patients' diagnoses, assessments, therapeutic strategies, and treatment histories (Kuo et al., 2007; Meinert, 2005). Advantages of the paper-based PMR are that it is portable to the bedside, it does not crash as computers do, and it allows the provider the freedom to record data in his or her own words.

On the other hand, the paper-based PMR also has many limitations. These PMRs are frequently wrought with inefficiencies, such as illegible handwriting and missing information, as well as contain unorganized and inaccessible documentation, which may cause difficulty in assuring quality of care (Bates & Gawande, 2003; Embi et al., 2004; Shortliffe, 1999; Tange, 1995; Tsai & Bond, 2008). These records frequently become bulky or expand into multiple volumes over time, which may cause important information to be overlooked (Roukema et al., 2006). These barriers could encumber quality of care.

Paper-based PMRs do not facilitate communication and coordination between the various departments of a hospital. Patient care in a hospital setting relies on several different departments each handling their particular specialty on behalf of patients. For example, patients need laboratory tests, such as blood tests; radiology tests, such as x-rays; special foods provided by food services, and medications from the pharmacy. For the patient to obtain the best care and for the hospital to prevent medical errors, the various departments (Ilie et al., 2007) need to have timely, reliable, and accurate information from the doctors, the nurses, and other clinical personnel on the patient wards. Clinical personnel also need timely, reliable, and accurate information from other clinicians such as consulting surgeons and other specialists, as well as from ancillary services, such as laboratory, radiology and pharmacy (AHRQ, 2008; Tierney, 2001). This patient information, which comes primarily from the PMR, is used by all of these various departments and clinicians in providing care for patients (Ilie et al., 2007; Kossman & Scheidenhelm, 2008; Reiser, 1991).

The problems associated with paper-based PMRs have led practitioners and researchers to investigate converting these paper-based records to computer-based records (Ball et al., 2003; Bates et al., 2001; Davidson & Heineke, 2007; Ilie et al., 2007; Kossman & Scheidenhelm, 2008; Tsai & Bond, 2008). In many other industries, information technology (IT) has been associated with positive outcomes in many organizations (Barua & Mukhopadhyay, 2000; Bates et al., 2001; E. Brynjolfsson, 1996; Tanriverdi, 2006). In industries outside of healthcare, IT has been associated with greater efficiency and lower costs (Byrd et al., 2006), more timely outcomes and greater quality (Banker et al., 2006), greater productivity (Brandyberry et al., 1999; Erik Brynjolfsson & Hitt, 1996), better decision making (Mukhopadhyay & Cooper, 1992), and better coordination and communication (Rai et al., 2006). The positive effects of IT in other industries have bolstered expectations that IT may also have some of these effects in the healthcare industry (Roukema et al., 2006; Stead & Lorenzi, 1999; Tsai & Bond, 2008).

However, the implementation of clinical IT in the healthcare industry has lagged behind other industries (Menachemi et al., 2007). Therefore, the positive effects of IT found in other industries may not have materialized yet in the healthcare industry. To date, the majority of studies reported have been case studies, typically in academic hospital settings (Bates et al., 2001; Bates et al., 1999; Embi et al., 2004; R. Kausal et al., 2006). There are problems with generalizing these case study results to the general hospital population. For example, the settings of the studies have mainly been academic hospitals whose IT systems were developed in-house; therefore, the results of the studies cannot be applied across the board to other types of hospitals.

Most hospitals in the U.S. are non-academic hospitals. They use commercial IT systems, not systems developed in-house.

Case studies have, however, produced information about some potential advantages and disadvantages of clinical IT. These findings need to be further investigated to increase generalizability. One documented advantage of clinical IT is the elimination of handwritten records that are difficult to read. Other advantages include easier access to patient information and other data from other departments (laboratory, pharmacy, radiology, consultations, etc.), easier access to information needed for clinical decision support (Kossman & Scheidenhelm, 2008; Kuo et al., 2007), and frequently, the ability to interface and integrate among clinical technology applications (Ash et al., 2007; Ash et al., 2004; Bates et al., 2001). These advantages may lead to enhanced patient safety and quality of care.

Clinical IT may also have some disadvantages, according to these case studies. One of the barriers to the effective implementation of clinical IT is the technology resistance of healthcare providers accustomed to paper-based PMRs. Other drawbacks to clinical IT are the time requirements for healthcare providers to enter data, the lack of champions to support the technology, a lack of expertise with technology implementation and use, delays in treatment (even with alert systems), entries into wrong charts, and wrong orders. Different clinical IT applications may be incompatible and difficult to integrate for effective communication among departments. Clinical IT applications may also give false alarms or may crash (Ash et al., 2004; Bates et al., 2001; Berger, 2002; Koppel et al., 2005; Roukema et al., 2006).

There are few quantitative empirical studies examining the association of IT with firm performance measures. The two that have been reported seem to support the notion that clinical IT does have favorable relationships with some performance variables, like cost and return on investment (Kossman & Scheidenhelm, 2008; Menachemi et al., 2007). Quantitative studies in this area examine the relationships between IT and hospital performance variables in a large number of hospitals. These studies allow for the findings to be more applicable to hospital settings in general. More quantitative studies are needed to validate the propositions from the case studies about the effects of clinical IT. This dissertation used large-scale analysis to investigate the relationships between perceptions of IT and quality variables in a number of hospitals.

Electronic Medical Records and Electronic Medical Administration Records

The most popular emerging clinical IT in the healthcare industry is the electronic medical record (EMR), an electronic and expanded version of the paper-based PMR. Another similar application, the Electronic Medical Administration Record (eMAR), also replaces some of the functions of the paper-based PMR. These electronic systems, in one form or another, have been in existence for more than twenty years (Ilie et al., 2007; Markus & Tanis, 1999; Shortliffe, 1999). EMRs and eMARs are computer systems in the category of enterprise systems; these include enterprise resource planning (ERP) systems, customer relationship management (CRM) systems, and supply chain management (SCM) systems that typically span more than one department or even several organizations. At the highest level, an enterprise system like an EMR electronically integrates most of the departments of an organization and may stretch out to encompass other organizations (Markus & Tanis, 1999). Personnel in these various departments share a common, centralized database where the primary data to be shared are stored. In an EMR and eMAR, the information that is shared across departments consists primarily of information about the patients and their medical care in the healthcare organization. Table 1 is a compilation of software applications that may be included in EMR and eMAR systems.

Table 1

Software Applications Found in Electronic Medical Records/Electronic Medication Administration Records

Clinical Data Repository (CDR)	A centralized database that allows organizations to collect, store, access, and report on clinical, administrative, and financial information collected from various applications within or across the healthcare organization that provides healthcare organizations an open environment for accessing/ viewing, managing, and reporting enterprise information.
Clinical Decision Support Systems (CDSS)	An application that uses pre-established rules and guidelines, that can be created and edited by the healthcare organization, and integrates clinical data from several sources to generate alerts and treatment suggestions. Example: All patients who have potassium below 2.5mg% should not have a cardiac glycoside. The physician would enter into the system the prescription for a cardiac glycoside and the system would pop up an alert to the fact that the patient should not be given this medicine due to the low level of potassium in their blood.
Computerized Practitioner Order Entry (CPOE)	An order entry application specifically designed to assist clinical practitioners in creating and managing medical orders for inpatient acute care services or medications. This application has special electronic signature, workflow, and rules engine functions that reduce or eliminate medical errors associated with practitioner ordering processes. A computer application that accepts the provider's orders for diagnostic and treatment services electronically instead of the clinician recording them on an orders sheet or prescription pad.
Laboratory Information Systems (LIS)	An application to streamline the process management of the laboratory for basic services such as hematology and chemistry. This application may provide general functional support for microbiology reporting, but does not generally support blood bank functions. Provides an automatic interface to laboratory analytical instruments to transfer verified results to nurse stations, chart carts, and remote physician offices. The module allows the user to receive orders from any designated location, process the order and report results, and maintain technical, statistical, and account information. It eliminates tedious paperwork, calculations, and written documentation while allowing for easy retrieval of data and statistics.
Nursing Documentation (ND)	This software documents nursing notes that describe the care or service to that client. Health records may be paper documents or electronic documents, such as electronic medical records, faxes, emails, audio or video tapes and images. Through documentation, nurses communicate their observations, decisions, actions, and outcomes of these actions for clients. Documentation software tracks what occurred and when it occurred.

Table 1 (continued)

Order Entry (OE) (Includes Order Communications)	A legacy HIS application that allows for entry of orders from multiple sites including nursing stations, selected ancillary departments, and other service areas; allows viewing of single and composite results for each patient order. The function creates billing records as a by-product of the order entry function.
Pharmacy Management System (PMS)	An application that provides complete support for the Pharmacy department from an operational, clinical, and management perspective, helping to optimize patient safety, streamline workflow, and reduce operational costs. It also allows the pharmacist to enter and fill physician orders and, as a byproduct, performs all of the related functions of patient charging, General Ledger updating, re-supply scheduling and inventory reduction/statistics maintenance. During order entry, the module automatically checks for Drug-Drug and Food-Drug Interactions and monitors for allergy contraindications. Maintenance of an on-line patient medication profile allows easy access by the pharmacist and may be viewed by nursing stations, ancillary departments, and physicians.
Physician Documentation (PD)	The use of structured template documentation by physicians [providers] to capture any of their patient findings that are part of the electronic medical record (e.g., history and physicals, diagnostic findings, discharge notes, etc). The structured template documentation captures discreet data that is used for interaction with the clinical decision support system relative to evidence based medicine guidelines and/or protocols. Dictation and transcription applications do not qualify as a physician documentation application for the purpose of this study.
Radiology Information System (RIS)	An automated RIS system manages the operations and services of the radiology department. This functionality includes scheduling, patient and image tracking and the rapid retrieval of diagnostic reports. The RIS can be integrated with the hospital information system and a PACS to provide an efficient environment for users to collect, process and manage data.

From the HIMSS Analytic Database Definitions, 2009

The healthcare industry has not embraced EMRs as fully as other industries have embraced enterprise systems like ERPs. As of 2007, fully functional integrated EMR has been used in only 4 to 15% of hospitals in the U.S. (Ilie et al., 2007; Kausal et al., 2006; Koppel et al., 2005b). Technology systems in hospitals have been used more in handling billing and administrative issues than in clinical support (Bates et al., 1999; Ilie et al., 2007; Meinert, 2005; Shortliffe, 1999). However, this has started to change. Although fully functional integrated EMRs are used in less than 15% of hospitals, many others have implemented EMRs with limited features across a limited number of departments, or sometimes just one department. This dissertation uses EMRs and associated clinical IT as the primary focus for IT implementation.

Quality of Information

The importance of the quality of information has grown significantly in almost every industry (Nelson et al., 2005). However, in the healthcare industry, the quality of information is particularly critical because it can mean the difference between life and death to many patients. The quality of information is determined by characteristics like accuracy, reliability and timeliness (Fisher & Kingma, 2001; Lee et al., 2002; Parasuraman, et al, 1985; Wand & Wang, 1996). In virtually all organizations, the operational, tactical, and strategic performances of the organizations can be linked tightly with their quality of information (Gattiker & Goodhue, 2005; Nelson et al., 2005).

Quality of Healthcare

Quality healthcare is the right of all hospitalized patients. Healthcare personnel have been challenged to measure and improve the quality of healthcare. Quality of healthcare has become multifaceted. One definition of quality healthcare is “doing the right thing, at the right time, in the right way, for the right person and having the best possible results” (Agency for Healthcare Research and Quality, 2003; Kohn et al., 2000a). This definition is consistent with Donabedian’s conceptualization of quality healthcare. Considered a seminal leader in the field of quality healthcare (Luce, 2004), his view involves a patient receiving a given intervention (process) in a setting (structure) that produces a change in disease (outcome) (Bowers & Kiefe, 2002; Donabedian, 1966).

A primary goal of governmental agencies, consumer groups, and healthcare organizations is to build a safer healthcare system (AHRQ, 2008; Bush, 2004). Though radical transformation is needed (Angst & Agarwal, 2009), attempts to reduce medical errors and other miscues have become paramount to increasing the quality of healthcare and increasing the satisfaction of healthcare patients. Trying to discover ways to increase the quality of healthcare has been the primary focus of healthcare literature and research for years.

Cost of Healthcare

One of the most significant challenges facing the U.S. healthcare system has been increasing the quality of healthcare in a cost-efficient way. Unfortunately, the cost of healthcare in the U.S. has been accelerating in recent years (Menachemi et al., 2007). In fact, the cost of healthcare is becoming so onerous that it leaves an increasing number of patients exposed to financial devastation because of inadequate or no insurance coverage (Cucciare & O'Donohue, 2002). Practitioners and researchers are searching for ways to reduce the growth of healthcare costs. Clinical IT has been cited as one of the methods that might help reduce overall healthcare costs (Chaudhry et al., 2006; Office, 2008).

Purpose of the Study

The purpose of this study is to examine the relationship between the level of IT, perceptions of the quality of information for clinical decision making, and hospital performance with these three measures: the perceived quality of healthcare, healthcare quality metrics, and cost of healthcare in hospitals.

The level of IT in this study was measured by the number of clinical IT applications in hospitals. These data were collected from the Healthcare and Information Systems Society Analytics (HIMMS Analytics) database which has up-to-date information on IT implementation in more than 5,000 hospitals. According to the HIMMS Analytics Web site (2009), the database "contains healthcare provider software, hardware and infrastructure portfolios as well as information for 140,000+ 'C-Suite' decision makers within healthcare organizations …" (HIMSS Analytics, 2009).

The data for the perceived quality of healthcare and perceived quality of information were collected from chief nursing officers (CNO). The CNO is the highest ranking administrative nurse in the hospital. Most CNO have spent several years at the clinical bedside. Many have advanced academic degrees and training in business practice, nursing administration and other related fields. The position of CNO requires responsibility for many hospital departments as well as an extensive knowledge of the day to day operations and routines in the hospital. Among other responsibilities, the CNO's chief primary responsibility is the delivery and evaluation of the quality of healthcare in the clinical setting of the organization. As a member of the executive team, the CNO has perceptions of the quality of healthcare given and the quality of information nurses use in the hospital (Cathcart, 2008; Grohar-Murray & DiCroce, 2003; Zalon, 2006).

The data for the healthcare quality metrics are taken for the American Hospital Directory (AHD) database. According to the Web page, the AHD provides data for more than 6,000 hospitals that is collected from both private and public sources(AHD, 2009; Directory, 2009). The AHD acquire quality of healthcare metrics that are reported to the Health and Human Services Department through Medicare and Medicaid Programs. These measures include responses to acute medical conditions that are commonly treated in hospitals. The measures are: heart attack, heart failure, pneumonia, surgical care improvement/preventing blood clots, surgical care improvement/preventing infection (American Hospital Directory, 2009).

The cost measures were also taken from the AHD. One cost metric is the overall cost to the hospital. The other cost metric is the average cost of the major medical services in these hospitals. These medical services are in the Statistics by Medical Service Description of the database. For example the average charges at a sample hospital for heart failure and shock was $13,551 (AHD, 2009).

Research Questions

The value of IT has been shown to have positive effects in other industries (reference). However, as mentioned earlier, IT for clinical care has not been widely implemented in hospitals. Therefore, questions remain about the value of IT in hospitals. Consequently, the research questions for this dissertation are:

(1) What is the relationship between the level of IT and end-user (CNO) perceptions of the quality of information for clinical decision making in hospitals?

(2) What is the relationship between CNO perceptions of quality of information for clinical decision making and quality of healthcare?

(3) What is the relationship between the level of clinical IT and quality of healthcare?

(4) Are there statistically significant differences in perceptions of quality based across CNO demographic and practice characteristics?

(5) What is the relationship between clinical IT and hospital cost?

(6) What is the relationship between CNO perceptions of quality of information and hospital cost?

The research to address these research questions is grounded in the IT value literature. The effects of IT on the perceived quality of information of CNOs, the perceived quality of information of CNOs, the quality of healthcare metrics, and the cost of operations were investigated. In this research, an important variable, perceived information quality, was examined as a partial mediator between the level of clinical IT implementation and performance variables, such as the quality of healthcare and cost of operations. One survey instrument with two primary variables, one to measure perceived quality of information for clinical decision making and another to measure perceived quality of healthcare outcomes, was deplored to collect data and tested for validity and reliability.

Conceptual Research Model

The conceptual research model in Figure 1 suggests that the level of IT has a relationship with quality of information (e.g. accuracy, reliability, and timeliness of information). Accuracy is the degree to which information is correct, unambiguous, meaningful, believable, valid and consistent (Lee, et al, 2002; Nelson, et al., 2005; Wand & Wang, 1996). Reliability is the ability to perform dependably and completely (Jun, et al., 1998; Lee, et al., 2002; Parasuraman, et al., 1985; Wand & Wang, 1996). Timeliness is appropriate and up to date at the time of intended use (Fisher & Kingma, 2001; Lee, et al., 2002). The model also suggests that the quality of information (fitness for use) (Fisher & Kingma, 2001) affects firm performance (e.g. quality of healthcare and overall relative costs). The controls for this conceptual model were size of hospital, profit versus nonprofit hospitals, and service population. These were proposed to hold conditions of this study uniform and to avoid possible imposition of bias on the dependent variables.

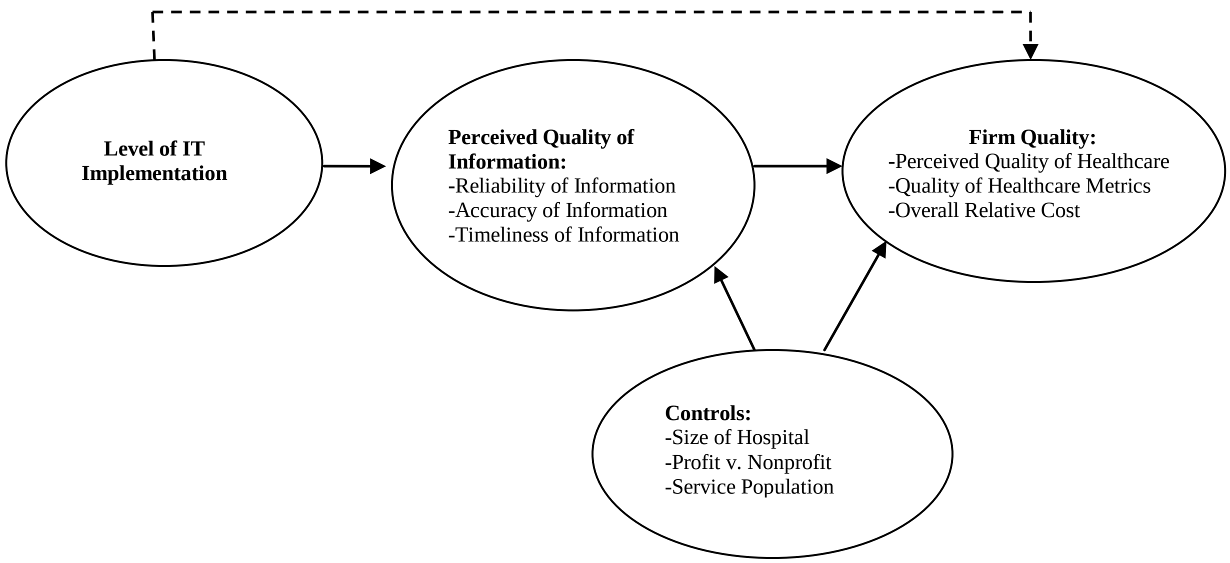

Figure 1. Conceptual Research Model

Data were collected from three different sources to reduce common method bias. The Healthcare Information and Management Systems Society (HIMSS) Analytics database was used to determine level of IT implementation. A questionnaire was distributed to obtain data on CNOs' perceptions of quality of information for clinical decision making and the quality of healthcare in hospitals. As administrative officials, CNOs are positioned to know their hospitals as a whole, with expert knowledge about the quality of information used by nurses as well as the quality of healthcare delivered by nurses in their hospitals. The CNO in the hospital organization was key to providing important opinions relevant to this study. The third data source on quality of healthcare and healthcare cost for the hospitals in the survey were taken from the American Hospital Directory. The model used in the study was analyzed by partial least squares (PLS) equation, a robust statistical method that can analyze multiple relationships in a path model simultaneously. PLS is a structural equation modeling (SEM) statistical method that can simultaneously test measurements of different paths and relationships between multiple response variables and multiple explanatory variables (Chin, et al., 2003; Gil-Garcia, 2008; Pirouz, 2006).

How Can IT Help

IT investment, touted as a potential answer to quality of healthcare issues and cost, has been shown to have a general overall positive effect (Barua & Mukhopadhyay, 2000; Kohli et al., 1999; Menon et al., 2000). It has been suggested that IT can simplify processes, help procedures become more efficient and accurate, and reduce many human error risks (AHRQ, 2008; Banker & Kemerer, 1992) However, there are still many questions about the role of IT in the healthcare setting and its effects on performance variables like quality of healthcare and cost (Chaudhry et al., 2006).

Supporters who believe that IT can increase the quality of healthcare and reduce costs include many national organizations such as The Leap Frog Group, Joint Commission on Accreditation of Healthcare Organizations (JCAHO), Agency for Healthcare Research and Quality (AHRQ), The President's IT Advisory Committee, Institute of Medicine (IOM), Medicare/Medicaid, and healthcare insurance companies (AHRQ, 2008; Koppel et al., 2005; Menachemi et al., 2007; Ortiz, 2003). Former President George W. Bush, during his 2004 State of the Union Address, asserted that by utilizing IT, "We can avoid dangerous mistakes, reduce cost, and improve quality of healthcare." Senator Hillary Clinton and former Speaker of the House Newt Gingrich have also promoted IT as a way to improve safety and quality of healthcare (Bush, 2004, 2006; Clinton, 2005; Gingrich, 2003). President Barack Obama has proposed that Americans invest in healthcare technology to standardize health records, improve quality of healthcare, and decrease healthcare-related costs (Goldman, 2009; Obama, 2009).

Over the past couple of decades, the use of IT has grown in all types of organizations. This study is one of very few that has used large-scale techniques to examine IT and its relationship with other resources in a hospital setting. For instance, this study combined three research streams: 1) the value of IT in organizations, 2) quality of information, and 3) firm performance.

Expected Contributions

This dissertation contributes to the literature on the quality of information by investigating some of the antecedent and consequent variables, based on end-user perceptions. This study may also suggest organizational resources that could be related to the quality of healthcare and cost in hospitals.

The results of this study could provide a resource to hospital administrators as they make decisions about the implementation of IT in their hospitals. If IT is shown to be associated with positive benefits in a large number of hospitals, then hospital administrators may be more likely to move forward with their own investments in IT. Furthermore, this study seeks to give these administrators more guidance in their IT investments by examining the relationship between IT and perceptions of the quality of information. The study attempted to link IT investment level with an organizational resource, the quality of information where IT's effect may be more closely tied. A positive relationship between IT and information quality will help hospital administrators to focus on their IT investment, instead of just trying to reduce overall costs, and to improve overall quality of healthcare. A negative relationship between IT and information quality could help administrators avoid making costly acquisition decisions. The results of this study may provide hospital administrators with information about end-user (CNO) perceptions before they invest in IT, which is very expensive. Finally, this research adds evidence about the nature of the relationship between IT and other resources, such as quality of healthcare and relative costs in hospitals.

Organization of the Dissertation

This dissertation is presented in five chapters. Chapter I describes provides a description of the problem and discusses the significance of the study and its implications. Additionally, the research model is presented and the research questions are posed. In Chapter II, the theoretical foundation and background for this research study are provided as a review of pertinent literature. Theoretical support for the proposed hypothesis is examined. A review of published literature is used to develop constructs in the conceptual model and to develop the related hypothesis. Chapter III discusses the methodology to conduct this research and the formal research hypotheses. Additionally, the sample population is described, as is the process that was used for data collection. Chapter IV describes the empirical results that were analyzed from the data and the testing of hypotheses. A summary of the descriptive statistics and test results are discussed. Chapter V concludes with a summary of the findings, a discussion of the results, and implications for future study. Major contributions to the body of knowledge and limitations of the study are also reviewed.

Chapter 2. Literature Review

Information Technology Performance

The value of IT to organizations has been a continuous topic of discussion since computers were introduced into organizations (Bharadwaj, 2000; Melville et al., 2004; Santhanam & Hariono, 2003). There have been reports about the positive impact of IT in public and private organizations in both scholarly and practitioner literature. These publications have reported that IT can enable new ways of planning and organizing processes to reduce costs and increase productivity (Sabherwal & Chan, 2001); to grow profits and market share (Byrd & Turner, 2001; Weill, 1992); to exploit business strategies and organizational structures (Chan et al., 1997); to increase product and service quality (Mukhopadhyay et al., 1997b); to integrate business processes and operations (Luftman et al., 1993); and to achieve, ultimately, a competitive advantage over its nearest competitors (Bharadwaj, 2000; Byrd & Turner, 2001; Melville et al., 2004). Despite the claims and evidence that have been presented in these reports, there are still major knowledge gaps in the understanding of the true value of IT to organizations and of how value, if any, is created and effectively utilized.

The research literature in IT quality is divided into two major streams (Barua & Mukhopadhyay, 2000). The first stream has used production economics to study the relationship between IT and firm performance (Brynjolfsson & Hitt, 1996; Loveman, 1994; Roach, 1987). This stream makes use of econometrics in its analyses of the value of IT to organizations. The second stream has been labeled the process-oriented model of IT (Banker et al., 2006; Bhatt &

Grover, 2005; Byrd & Turner, 2001; Harris & Katz, 1991; Rai et al., 2006; Tanriverdi, 2006; Weill, 1992). These studies use path models to investigate possible intermediate variables that might mediate or moderate the relationship between IT and firm performance (Barua et al., 1995). The general findings along both paths have followed similar trajectories with early studies in both streams finding no relationship between IT and firm performance.

The results were especially dismal in the production economics literature. For example, Loveman (1994) found that the contribution from IT capital in 60 strategic business units (SBUs) was negative instead of positive. Strassman (1990), another researcher who used econometrics techniques, found no relationship between IT and firm performance. Other researchers who followed the production economics tradition during this period also came up with findings that indicated very little value in the use of IT by public and private organizations (Berndt & Morrison, 1995; Osterman, 1986).

During this same period of time, IT business value studies using the process-oriented model also started to appear, and most results suggested negative or inconsistent impact (Bender, 1986; Cron & Sobol, 1983). For example, Bender discovered that firms with high or low IT expenditures were getting very little value from their investments in IT. Cron and Sobol found that the type of company using IT made a difference in the value they reported. They determined that firms with substantial investments in IT either had very high firm performance or very weak firm performance. They reported that firms that were not substantial users of IT had average or low firm performance. These findings gave no support for a direct relationship between IT and firm performance.

Also yielding inconsistent results were studies by Weill (1992) and Venkatraman and Zaheer (1990). Weill used six years of data from 33 small and medium-sized companies and found that IT that had been invested for strategic purposes had a negative relationship with firm performance. Findings also suggested that IT that was used mainly to provide information for knowledge workers had little or no effect either way. The only type of IT to show a positive relationship with firm performance in Weill's study was IT devoted to transaction processing. As can be seen from these production economics and process-oriented studies, IT did not add value to most of the organizations in the studies. This prompted research by Roach (1988), who coined the term "productivity paradox" to depict the failure of IT to contribute any value to organizations at that time. He noted that although many organizations had invested in IT, this investment had actually produced negative results for these firms.

More recent studies in both the production economics and process-oriented literature have shown more positive results in the relationship between IT and firm performance. In a landmark study, Brynjolfsson (1996) used data for a five-year period from 380 large Fortune 1000-sized firms. Their findings suggested that the IT contribution to productivity was significantly robust and that the heavier investors in IT were seeing substantial value from their investments. In line with Brynjolfsson and Hitt's results, during the late 1990s, additional researchers who used IT production economics to study the value of IT reported similar positive results. Barua and Lee (1997) found that IT had more impact on firm productivity than any other type of firm investment, including non-IT capital and labor. Brynjolfsson and Hitt (1996) showed that IT both contributes to firm productivity and provides substantial benefits in lower prices and better customer service for the customers of these companies. In a study in the healthcare field, Menon, Lee, and Eldenburg (2000) gave an account of a longitudinal investigation using more than 18 years' worth of hospital data that showed that IT contributed positively to productivity in the sample hospitals.

Similar results were reported in more recent process-oriented studies. Studies conducted by Barua, Kriebel, and Mukhopadyay (1995), Bharadwaj, Bharadwaj, and Konsynski (1999), Bharadwaj (2000), and Rai, Patnayakuni and Seth (2006) all provided evidence that IT capabilities in organizations had positive effects on organizational performance measures. Barua, Kriebel, and Mukhopadhyay demonstrated that IT investment had a positive effect on intermediate-level performance variables such as reducing inventory levels and increasing inventory turnover. Bharadwaj, Bharadwaj, and Konsynski related the level of IT investment in organizations with a stock market indicator, Tobin's q. Bharadwaj used a set of companies that had been identified as the most effective users of IT by an industry trade journal. She matched each company in the set with a company that was from the same industry and had similar characteristics such as size and budget. This resulted in two sets of companies —one set that had been identified as effective users of IT (Banker et al., 2006) and one set without this distinction. Bharadwaj compared the two sets of companies on various dimensions and found that the most effective IT users were superior in almost all measures of financial performance, such as return on investment (ROI), return on sales (ROS), operating income (OI), and operating expense (OE). Rai, Patnayakuni, and Seth (2006) used a process model to show that IT affected supply chain integration, which, in turn, affected firm performance as measured by operational excellence and revenue growth.

Other recent studies have shown similar results (Banker et al., 2006; Byrd, 2001; Mukhopadhyay et al., 1997a). Because of this trend of favorable results, Barua and Mukhopadhyay (2000) noted that the "productivity paradox," proposed by Roach earlier, might now be a myth of the past.

In their review article, Wade and Hulland (2004) summarized findings from previous studies examining the effect of IT on firm performance. They concluded that IT has a favorable effect on firm performance both directly and with other IT or non-IT organizational resources. An overwhelming number of studies in the review demonstrated a positive relationship between IT and firm performance, either directly or through interactions with other organizational variables, compared to the number of studies showing no effect or negative effect between IT and firm performance.

This evidence supports the overall positive contribution of IT to organizations. However, the specific nature of that contribution remains a mystery in most organizational contexts. While the very large question of whether IT provides value to the organization seems to have been answered, the many small questions of *how* IT adds value remains open to debate. Additionally, these questions of how IT adds value may be becoming industry-specific questions. More frequently, IT is being embedded and integrated into the organizational strategies and structures of today's firms (Melville et al., 2004; Piccoli & Ives, 2005). Because of this integration, it is likely that the means of identifying how IT is adding value to organizations will be to examine its relationship within individual business processes in a specific industry.

Business processes, strategies, and structures often vary considerably across industry boundaries. With variations in businesses' characteristics, it could be expected that the use of IT would also vary among firms in different industries. These variations are one rational for moving the investigation of the value of IT from analysis across different industries in a single study to only considering organizations from a specific industry within a study. In this way, the value of IT can be more closely tied to the specific business processes, strategies, and structures it is integrated with in that industry. Removing cross-industry variability may produce more significant knowledge about how IT adds value in a certain type of organization.

This dissertation explores the value of IT in the healthcare industry. The healthcare industry lags behind most industries in its applications of IT. However, this is rapidly changing as more and more healthcare organizations invest in IT. The Health Insurance Portability and Accountability Act (HIPAA) and other federal mandates are forcing healthcare organizations to rapidly acquire and implement IT to increase patient safety and to lower overall healthcare costs.

Information Technology Quality in the Healthcare Industry

Two major types of studies dominate the research examining IT in the healthcare industry. One is the case study approach, where some information systems, such as computerized practitioner order entry (CPOE), are implemented in a hospital and evaluated across some limited spectrum of quality variables. The other type of study is the large-scale survey exploring the relationship between IT and, typically, firm-level quality variables. Research on the relationships between IT and the quality variables for both case studies and surveys is limited. This is especially true in hospitals, which comprise the domain of this dissertation. Although this dissertation uses a survey of end-user perceptions to examine IT quality, the literature for the case study area and the survey research streams will both be reviewed here to thoroughly cover research that could explain this study’s research outcomes.

Information Technology Quality in Case Study Research in Hospitals

The literature covered in this section focuses exclusively on IT in hospitals because this is the relevant domain of the proposed study. The research articles selected for the literature review in this section met certain criteria. Studies included in this review centered on clinical IT, not administrative IT. The IT in these studies had multifunctional systems that included some integrated capabilities such as health information, information storage, documentation, or order entry capabilities. The quality variables in these studies tended to include direct outcomes from the implementation of IT applications.

Bates and his colleagues (1999) studied the implementation of a CPOE application at the Brigham and Women's Hospital in Boston. The researchers used a time series analysis to study all patients admitted to three medical units by comparing three different post-implementation time periods with a pre-implementation baseline time period. The time periods lasted from seven to ten weeks. Their main dependent variable was medication errors (with the exclusion of missed dose errors). In their study, the number of medication errors that occurred was substantially reduced after the implementation of the CPOE. This included all types of medications errors—dose errors, frequency errors, route errors, substitution errors, and drug allergies. For instance, drug allergy errors were reduced from ten in the pre-implementation time period to only two in all three of the post-implementation time periods combined. Another significant outcome from the study is that the number of errors in the post-implementation time periods was reduced in each subsequent time period. This could indicate that as the staff learned how to make better use of the CPOE over time, they provided better quality of care in the medical units.

A number of the studies in the literature have been conducted at teaching hospitals or at hospitals associated with universities. Embi and colleagues (2004) investigated the impact of a computerized physician documentation system at a Veterans Affairs Medical Center (VAMC) teaching hospital. They used semi-structured interviews with ten physician faculty members and ten medical residents who had used the system, asking them to elaborate on the system's impact on hospital operations. The researchers concluded from these interviews that the computerized system had both positive and negative effects on operations at the hospital. On the positive side, the physicians noted that the documentation from the computerized system was more accessible and legible than with the paper-based format. They could now get information when and where they needed it. Additionally, the information was presented with improved readability and enhanced data quality. However, on the negative side, the physicians also reported some redundancy in the information presented and the perpetuation of data errors in the system. Some physicians would simply “cut and paste” previous report information from other physicians back into the system as their own new reports. Therefore, any erroneous data that had been entered before was simply repeated over and over again as the reports were cut and pasted. Even with these problems, when the physicians were asked if they would like to keep the computerized system or move back to a paper-based system, the almost unanimous answer was to stay with the computerized system.

Kaushal and his colleagues (2006)assessed the ROI of a CPOE at Brigham and Women’s Hospital over a ten-year time period. In an early study reported in this dissertation, the researchers had found that this CPOE application did contribute to a reduction in medication errors (Bates et al., 1999). However, the question of whether these improvements at the intermediate level translated into more organization-wide benefits were not addressed in that study. In Kaushal’s study, the authors reported that the Brigham and Women’s Hospital spent about 12 million dollars on the CPOE system for design, development, implementation, and maintenance between 1993 and 2002. Over this nine-year period, the authors estimated that the computer system had saved the hospital about 28.5 million dollars, for a net savings of more than 16 million dollars. These savings came from operational improvements in nursing time utilization, specific drug guidance, and adverse drug event prevention, among others. The authors concluded that other hospitals could also achieve the same or similar benefits by investing in CPOE systems.

A study by Amarasingham and his colleagues (2007)examined the improvements in catheter-related blood stream infections (CRBSI) from clinical information systems in the intensive care units (ICUs) of 19 Michigan hospitals. The authors used a new measurement instrument that assessed the automation and usability of an ICU's clinical information system. The automation measure "represents the degree to which clinical information processes in the intensive care unit are fully computerized" (p. 289). The usability measure "represents the degree to which the information system is effective, easy to use, and well supported" (p. 289). The authors found that as the scores on both automation and usability increased, CRBSI in the bloodstream generally decreased. The finding here indicates that within certain ranges, as they become more sophisticated, clinical information systems are able to help in improving medical care in ICUs.

Mekhjian and his colleagues (2002)evaluated the benefits of a CPOE application and an electronic medication administration record (eMAR) in the Ohio State University Medical Center. These researchers used a pre-implementation and post-implementation methodology to compare specific quality outcomes. The quality outcomes examined in the study were laboratory orders, timeliness of countersignature of verbal orders, volume of nursing transcription errors, length of stay, and total cost in the hospital departments of pharmacy, radiology and the laboratory. Benchmark data were collected for four months before the CPOE was implemented. The timeframe after the implementation was six months for the CPOE alone, and the CPOE and the eMAR systems were used together for an additional two months. The researchers found that the CPOE system improved medication turnaround times by 64%, radiology procedure completion times by 43%, laboratory results reporting times by 25%, and order countersignature by physician times by 43%. One of the most remarkable results was that the combination of CPOE and eMAR virtually eliminated transcription errors by physicians and nurses. The authors concluded that the IT applications implemented at this hospital certainly resulted in a good ROI.

Another study at the Brigham and Women's Hospital by Kuperman and colleagues (1999) investigated an automatic alerting system and the time it took before laboratory tests were ordered for patients in critical medical situations. The study period was two months. The study compared patients who were associated with computerized alerting with a control group of patients with whom no automatic notification was used. The results showed that the intervention group of patients, those associated with the automatic alert system, had a 38% shorter median wait time before appropriate laboratory tests were ordered, for 192 alerting situations (94 intervention group, 98 control group). In this study, the automatic alerting system increased the quality of healthcare for the intervention group. The implication is that such systems can improve the timeliness of laboratory testing for critical care in other hospitals.

Overhage and colleagues (1997) studied the effects of automated reminders from an IT application on physicians' inclinations to order tests and treatments. The study was conducted over six months. The researchers used 48 physicians as an intervention group and had them use a computerized system that offered corollary orders for their patients. They also placed 41 physicians in a control group that had no computerized support. The intervention ordered the corollary tests and treatments in about 46% of the instances when offered a reminder. The control group only ordered the tests and treatments in 21% of the cases without the reminders. This suggests that errors of omission can be reduced with the aid of computerized reminders in a healthcare setting.

Wong and his colleagues ((2003) examined how much time nurses spent on documentation and other tasks before and after the introduction of an intensive care unit (ICU) third-generation information system. The setting for the study was a ten-bed surgical ICU at a Veterans Hospital. The researchers observed ten ICU nurses in a real-time time-motion analysis in four-hour increments before and after the information system was implemented. The observer for the study recorded on a laptop computer all the tasks as they occurred, along with a time stamp noting the time of the work activity. The intervention of the information system reduced the time for documentation by 30% while the time devoted to patient care increased by 25%. Therefore, with the help of the information system, the nurses were able to shift their time at work from documentation to actually spending time in direct contact with their patients.

Devaraj and Kohli (2000) studied three years' worth of data in monthly reports from eight hospitals that are members of a health system. Each hospital is an independent entity with its own financial reports and management. The health system is fairly large, with more than 20,000 employees and an operating revenue of 1.5 billion dollars. The eight hospitals collectively offer a vast range of services from acute care to extended care to care for the disabled. This study considered the effects of the overall IT investment on profitability and quality. The findings showed that the investments in IT in these hospitals were significantly related to both profitability and quality measures. This is one of the few small-scale studies that looked at the overall effects of IT on hospital quality.

Not all studies reported the positive effects of IT in hospitals. A few studies reported the negative side of IT implementation in hospitals. Koppel and his colleagues (2005) reported that they found that a CPOE system actually contributed to an increase in the number of medical errors in a hospital. In the study of a CPOE system at a tertiary-care teaching hospital from 2002 to 2004, researchers surveyed 241 staff members, held five focus groups, and conducted 32 intensive one-on-one interviews with stakeholders (e.g., IT leaders, physicians, nurses, and pharmacists). They also observed how nurses, hospital leaders, and physicians used the CPOE application. Their major finding was that the CPOE facilitated 22 different medication errors. These included wrong medication selection, failure to provide medications after surgery, allergy information delay, loss of data, time, and focus when CPOE application was nonfunctional, sending medication to the wrong room when the system is down, late-in-day orders lost for twenty-four hours, and conflicting or duplicative medications. The authors in this study did not try to balance these negative outcomes with any positive benefits of the CPOE application, so it was not possible to appraise the overall net effect of the application. The authors warned that hospital personnel who are implementing CPOE applications need to consider establishing ways to address the errors that are introduced by the CPOE systems as well the errors that these applications prevent.

Another study that looked at the adverse effects of the implementation of clinical information systems was conducted by Ash and colleagues (2007). These researchers completed a qualitative study in five hospitals, searching for unexpected consequences of CPOE implementation. Using telephone interviews, they asked physicians and nurses in 176 hospitals that had implemented CPOE about their perceptions of the extent and importance of CPOE-related negative consequences. The researchers found that these hospitals experienced eight different unintended negative consequences from the implementation of CPOE applications. The consequences were related to new work or more work, workflow mismatches, never-ending demands for new hardware and maintenance, the persistence of paper even though the CPOE was supposed to reduce the amount of paper, communication problems between personnel in different functions, intense negative emotions in users, new types of errors, readjustments for changes in the power structure as the power of physicians was reduced, and overdependence on technology being exposed when the systems failed. According to Ash and her colleagues, these adverse conditions are widespread and must be aggressively addressed to wring the greatest benefits from CPOE applications.

In critiquing the case study literature that examined the impact of IT in healthcare organizations, a number of deficiencies are apparent. The dependent variables in the studies tend to be associated with primary or secondary preventive care. The studies used immediate outcomes such as reduction of medication errors in the area of the experiment or a decrease in documentation burden by hospital personnel. Although these effects are important, there is no evidence that these benefits can be maintained as these systems are rolled out to an increasing number of employees in the hospitals. Most of these studies were conducted in a very limited context and are not necessarily representative of the operations of a typical hospital setting. In fact, many of these used academic or teaching hospitals for experimental settings and were championed by academics at the universities housing the hospitals. In most hospitals, these conditions could not be duplicated.

Another problem with many of the studies in this literature is that most of the CPOE systems were homegrown and developed in-house. This is probably not a reasonable option for most hospitals, which do not have strong champions or internal expertise to lead the design, development, and implementation of in-house systems. Most hospitals will have to opt for commercially developed clinical information systems because they lack the expertise and leadership to develop and build these systems in-house (Chaudhry et al., 2006). The fact that these systems were built in-house over a long period of time probably played a role in their success. In fact, the nurses and physicians in these hospitals likely participated to a large extent in the development and implementation of the information systems reported on in most of these studies. As has been shown in the IT research for a long time, user participation in the development process is a primary key to the success of an information system (Franz & Robey, 1986). These studies presented very little evidence on the viability and success of commercially available clinical information systems and how they will impact operations and overall quality in hospitals.

An especially troublesome fact in these studies is that many of the results come from a very limited number of hospitals. These include Regenstrief Institute, Brigham and Women’s Hospital, and the Department of Veterans Affairs Hospitals. Very few studies were found outside of these academically connected hospitals. There is a need for high quality research, outside of these few hospitals, using commercially developed clinical information systems because these types of systems are likely to be the norm in most hospitals.

In view of these limitations, a major overall problem with this literature is its lack of generalizability. One of the reasons for conducting research is to be able to use the lessons learned in similar environments or situations. If the lessons learned from a specific study are not generalizable, those lessons are not very valuable beyond the immediate environment or situation. Therefore, an implication of this literature review is the need for more generalizable research using hospitals that are not associated with a university and that are using commercially available software.

Quantitative Research of Information Technology Quality in Healthcare

There is a dearth of quantitative studies investigating the relationship between IT and firm quality in the healthcare industry. Quantitative studies are typically characterized by medium to large sample sizes and the use of statistical techniques such as ANOVA, regression, and structural equation modeling to draw conclusions about the relationships between two or more constructs. One reason is because the healthcare industry has lagged behind most other industries in implementing IT into their clinical operations (Ball et al., 2003; Li & Benton, 2006). The implementation of clinical IT systems, such as CPOE, clinical decision support systems (CDSS), and EMR, that are actually used in the day-to-day operations of healthcare organizations has only become popular in the last five to ten years. Therefore, the opportunity to study these types of systems in healthcare organizations simply has not been available. More recently, the popularity of clinical IT in the healthcare industry has been growing very rapidly and thus is having much more of an impact on the organizations in this industry (Davidson & Heineke, 2007; McCormick et al., 2007). Some researchers have suggested that the impact might not be positive but negative (Davidson & Heineke, 2007). However, there is little empirical evidence from large-scale studies to accurately gauge the present impact of clinical IT on operations and firm quality. Evidence from empirical research, using large-scale study design, is needed to answer the question of what value the recent implementation of clinical IT has brought to hospitals.

In the review of the literature five large-scale studies researching IT value in the healthcare industry were discovered, which are reviewed below. Menon, Lee, and Eldenburg (2000)used a production function to study the impact of IT in the healthcare industry using a longitudinal sample of hospital data from 1976 to 1994. The authors used regulatory data reported to the Washington State Department of Health from hospitals operating in the state. The hospitals in the state are required to report many different organizational outcomes, including IT expense. The sample consisted of 50 or so general medical and surgical hospitals each year for the years 1976 to 1994, for an overall total of 1064 observations in the study. IT-related variables were broken down into IT capital and IT labor. IT capital included data processing and telecommunications expenses in the hospitals. IT labor was the amount of capital used for IT personnel serving the hospitals. Because of the time period of the study, most of the IT in the study was focused on administrative tasks, such as billing, general ledger activities, and automation of clinical records. The amount of IT expense that was associated with clinical IT as opposed to the amount related to business related expense was very low in Menon, Lee, and Eldenburg's study. Therefore, the IT measures in this study applied primarily to business related IT expense and not to clinical IT applications. The results of the study showed that both IT capital and IT labor had a positive influence on revenue contribution for the hospitals in the sample.

Culler and his colleagues (2007) used 66 hospitals in the state of Georgia to investigate the associations between the overall availability of IT applications in the hospitals and the risk-adjusted incidence of 15 Patient Safety Indicators (PSIs). Data on IT applications in the study were obtained using an instrument called the "Computerized Physician Order Entry and IT Infrastructure Survey" (CPOEITIS) with the stated purpose of determining the IT sophistication in hospitals. CPOEITIS asks about the availability of 97 IT applications, including 56 functional applications (processes or activities involving the use of computer-based applications) and 41 technological hardware devices. The PSIs, developed by the Agency for Healthcare Research and Quality (AHRQ), are measures of healthcare quality. The measures include risk incidences such as "complications of anesthesia," "foreign body left during procedure," "infection due to medical care," "postoperative respiratory failure," and "accidental puncture or laceration." Multivariate regression was used to assess whether the number of IT applications was statistically related to risk-adjusted PSI outcomes after controlling for some variables (location, size, affiliation with multi-hospital system). The results of the study showed that the number of IT applications did not reduce the number of incidents in the Georgia hospitals. The authors noted in their discussion that other studies have shown that the mere presence of IT does not always lead to more positive outcomes in organizations. They concluded that other organizational factors are necessary for positive quality outcomes in hospitals and that IT alone does not determine hospital quality.

Pare and Sicotte (2001) developed an instrument to measure IT sophistication in healthcare using 116 hospitals in Canada. They broke the measurement instrument down into three components. These were (1) functional sophistication, (2) technological sophistication, and (3) integration sophistication. Functional sophistication “represents 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” (p. 208). Technological sophistication is the total number of hardware devices used in the hospitals (e.g., bar coding, data warehousing, wireless LANs, and medical imaging). Integration sophistication refers to “the degree to which computer-based applications are integrated both internally via common database and externally via electronic communications links” (p. 208). The primary finding of this study was that a high to moderate level of functional sophistication, a somewhat low level of technological sophistication, and an extremely low level of integration sophistication existed in the Canadian hospitals. The authors suggested that integration sophistication be improved in the hospitals. This is especially important to this study considering that the authors suggest that integration sophistication is the most valuable of the three and may contribute most to the overall value of hospital quality.

Another large-scale IT study in the healthcare industry the authors studied 98 hospitals that were members of the Florida Hospital Association. They used a survey in the hospitals in to explore the relationship between different types of IT and their relationships with such performance variables as higher level of revenues, income, and cash flow (Menachemi et al., 2006). The IT variables were divided into three types using cluster analysis, a statistical technique that is able to group entities (in this case, IT applications) using their characteristics: administrative IT applications, clinical IT applications, and strategic IT applications. Administrative IT applications included patient billing, payroll, scheduling, accounts payable, and similar software programs. Clinical IT applications included electronic health records, critical care bedside applications, clinical decision support systems, and pharmacy information systems. Finally, strategic IT applications included executive information systems, enterprise resource planning systems (ERPs), and business intelligence software applications. The authors found that collective IT and each of the types of IT—administrative, clinical, and strategic—had positive impacts on the quality variables in the study: higher levels of revenues and income. However, IT applications were also associated with high costs in the hospitals. The authors explained that these higher costs probably reflected the expense associated with the acquisition and ongoing management of the implemented IT applications.

Finally, Li and Benson (2006) conducted the study that is possibly most relevant to the focus of this dissertation. The study examined hospital technology and its relationships with nurse staffing management decisions, cost, and quality of care. Hospital technology included measures for individual IT applications, such as laboratory technology, pharmacy technology, dietary technology, automated drug dispensing systems, and automated batch analyzer. Even though the referenced paper was published in 2006, the actual data were collected in the early to mid-1990s. During that time, most of the clinical IT applications that are being used increasingly by hospitals today were not available. Nursing management decisions included nurse staff training, nurse competence, and job enlargement. Items in the questionnaire measured cost (e.g., holding down patient costs, attaining high labor productivity) and quality of care (e.g., clinical quality, customer satisfaction).

Li and Benson mailed out 492 surveys to a sample of hospitals in Ohio, Oregon, and Florida and received 165 back from hospital administrators or chief operating managers. About 75% of the responding hospitals were nonprofit hospitals. A significant feature of this study is that the authors used a path model to assess the relationships among the variables. Specifically, Li and Benson examined the relationships between hospital technology and nursing management decisions. They also studied the relationships between hospital technology and two quality variables: cost and quality of care. Finally, they investigated the relationships between nursing management decisions and the quality variables.

Li and Benson found significant relationships between hospital technology and nursing management decisions, hospital technology and cost, and nursing management decisions and cost. They did not find significant relationships between hospital technology and quality of care or between nursing management decisions and quality of care. This lack of significance ($p > 0.05$) may be attributed to the earliness of the study. It might also be because the hospital technology variable measured the investment associated with several different applications (technological sophistication) but not the integration among these applications (integration sophistication). The IT integration sophistication is likely to have the most profound effect on organizational quality variables, as previously reported.

An important feature of Li and Benson's study is that it gives one answer to *how* IT affects costs—through its effect on nursing management decisions. In other words, nursing management decisions are a partial mediator between the relationship between IT and hospital cost, according to the finding. This study also gives at least one answer to the question of *how* IT affects organizational quality. As explained earlier in this chapter, research has established a link between IT and overall hospital quality. The question now is how IT affects performance: Is it through mediation with intermediate variables (Barua et al., 1995)? Is it by reducing cost, as in the study by Li and Benson? Is it by increasing revenue? Is it by affecting the quality of organizational processes or overall quality? These, and others like them, are the questions that need to be answered to assemble a more comprehensive view of the value of IT in the healthcare delivery in hospitals.

The findings and limitations from these large-scale studies demonstrate the need for additional research to fill the gaps in the literature. First, the number of studies reported in the literature that used large-scale surveys to investigate the relationship between IT and healthcare quality variables is very few. All of these studies, except Li and Benson, consider only the relationship between IT and overall organizational quality variables, following the example of most of the studies among organizations in other industries. Only one study (Li and Benson) actually addresses how IT may affect organizational quality. Even in that study, the type of technology analysis that was considered is not the type most likely to yield positive relationships with intermediate and organizational quality variables. This type is IT integration sophistication, which has been touted as the most likely to yield the most value to organizations (Pare & Sicotte, 2001).

This dissertation study proposes analysis of IT integration and also uses perceptions of information quality for decision making as the intermediate variable because it is one of the variables in the healthcare setting most likely to be associated with IT, as reported previously. This study also uses a comprehensive measure of the quality of healthcare that has been developed through an extensive review of the relevant healthcare literature. Additionally, this research uses both this subjective measure of quality of care and information and objective measures of quality of care and information. Therefore, this dissertation attempts to answer the call to examine IT along with other variables through mediation or moderation to assess its value in today's healthcare organizations (Melville et al., 2004). Next, the concept of information quality is discussed.

Information Quality

The concept of information quality is becoming more important as information becomes the very lifeblood of organizations today. The operational, tactical, and strategic performance of organizations is tied directly to the quality of their information (Gattiker & Goodhue, 2005; Nelson et al., 2005; Redman, 1998). Poor information quality can wreak havoc in organizations by resulting in customer dissatisfaction, increased costs, reduced levels in the effectiveness of decision making, and a diminished ability to plan, implement, and execute organizational strategies (Redman, 1998). For example, poor information quality may result in customers getting charged for products or services that they did not purchase. Products might be shipped to the wrong addresses. Human resources departments could spend enormous amounts of time correcting errors in the personnel files of their companies' employees. Poor information quality may be the single biggest obstacle to developing sound business strategies (Redman, 1998). In an industry like healthcare, poor information quality can literally be the difference between life and death. It has been reported that medical errors result in 44,000 to 98,000 deaths per year, and in untold human suffering (Anderson et al., 2006).

The consensus among researchers is that information quality is a multidimensional concept (Fisher & Kingma, 2001; Lee et al., 2002; Nelson et al., 2005; Pipino et al., 2002; Redman, 1998; Wang & Strong, 1996). Wang and Strong used a two-stage survey and a two-phase sorting procedure to reduce a large number of information quality attributes down into four dimensions that are important to information consumers. Wang and Strong also set up initial guidelines for any resulting framework. They proposed that any framework must include the following aspects: 1) the information must be accessible, 2) the information must be interpretable, 3) the information must be relevant, and 4) the information must be accurate. The result after the survey and sorting procedures was four dimensions. These four dimensions were labeled as *intrinsic* information quality, *contextual* information quality, *representational* information quality, and *accessibility* information quality.

Intrinsic information quality includes related objective attributes, such as accuracy, reputation, and believability, independent of any specific context. This aspect of information quality denotes the fact that information has quality in its own right and not just in a particular context or tied to a specific information system (Wang & Strong, 1996). The inclusion of reputation and believability in this dimension in the study is a little surprising, indicating that information users look beyond just accuracy and objectivity of data to the source of the information. They want to know who produced the information and if the source is credible.

Contextual information quality “highlights the requirement that information quality must be considered within the context of the task at hand; that is, information (data) must be relevant, timely, complete, and appropriate in terms of amount so as to add value” (Wang & Strong, 1996). For example, in an organizational environment such as a healthcare setting, information has a limited useful life and must be available in a timely fashion to have any value at all. If information that a patient is allergic to certain medications arrives after a patient has been given one or more of the allergens, the information may be useless if the patient has died from a reaction to the drugs. Likewise, if information about such an allergy has been omitted in a patient's medical chart, resulting in incomplete information, the outcome may be the same.

The representational information quality dimension includes both the format of the information and the meaning of the data. The information quality attributes for this dimension included interpretability, ease of understanding, representational consistency, and concise representation. In the study by Wang and Strong (1996), this dimension is tied to the output of a computer system. The two previous dimensions of information quality, intrinsic and contextual, are independent of computer systems and could have resulted from any source.

The last dimension in the typology, accessibility information quality, is related to how accessible the information is to find or to discover in a computer system, given its security features. Before the widespread use of computer systems, researchers did not consider accessibility as an aspect of information quality because information was disseminated in hard-copy format; thus, getting to the data was not a problem. However, with the use of computers, Wang and Strong pinpointed accessibility as a major concern. This issue is also related to the ownership of information and how information gatekeepers manage and disseminate that information to others in the organization (Redman, 1998). This user-friendly information is also based upon the capture of the information in a digital format that is accessible to those who need it in an comprehensive format (Angst & Agarwal, 2009).

Table 2, which is adapted from Lee and colleagues (2002), gives an academic view of information quality. The references with the asterisks were added to the table specifically for inclusion in this dissertation. The table presents a fairly comprehensive review of studies that have helped define the information quality construct.

Table 2

Information Quality

Reference	***Intrinsic IQ***	***Contextual IQ***	***Representational IQ***	***Accessibility IQ***
*Bailey and Pearson (1983)	Accuracy, precision	Currency, timeliness, completeness, relevance	Format, conciseness	
Ballou and Pazer (1985)	Accuracy, consistency	Completeness, timeliness		
Delone and McLean (1992)	Accuracy, precision, reliability, freedom from bias	Importance, relevance, usefulness, informativeness, content, sufficiency, completeness, currency, timeliness	Understandability, readability, clarity, format, appearance, conciseness, uniqueness, comparability	Usableness, quantitativeness, convenience of access
*Fisher and Kingma (2001)	Accuracy	Timeliness, completeness, data relevance, completeness	Fitness for use	
Goodhue (1995)	Accuracy, reliability	Currency, level of detail	Compatibility, meaning, presentation, lack of confusion	Accessibility, assistance, ease of use, locatability
Jarke and Vassiliou (1997)	Believability, accuracy, credibility, consistency, completeness	Relevance, usage, timeliness, source currency, data warehouse currency, non-volatility	Interpretability, syntax, version control, semantics, aliases, origin	Accessibility, system availability, transaction availability, privileges

(table continues)

Table 2 (continued)

Reference	***Intrinsic IQ***	***Contextual IQ***	***Representational IQ***	***Accessibility IQ***
*King and Epstein (1983)	Freedom from bias, quantitativeness	Currency, relevance to decisions, comparability, reliability, sufficiency	Understandability	
* Levitin and Redman (1998)	Accuracy	Timeliness, consistent,	Format – too much or too little information	Access, privileges, security, privacy
* Nelson et al. (2005)	Accuracy, believable, unambiguous, objective	Completeness, currency,	Format, interpretable to the user, understandable	Accessibility
* Pipino et al. (2002)	Free of error, believability	Completeness, consistency, timeliness, appropriate amount of data		Accessibility
* Redman (1998)	Accuracy, consistency	Timeliness, currency, completeness	Appropriateness of format, ease of interpretation	Privacy, security, ownership
Wand and Wang (1996)	Correctness, unambiguous	Completeness	Meaningfulness	
Wang and Strong (1996)	Accuracy, believability, reputation, objectivity	Value-added, relevance, timeliness, appropriate amount	Understandability, Interpretability, Concise representation, consistent representation	Accessibility, ease of operations, security
Zmud (1978)	Accurate, factual	Quantity, reliable, timely	Arrangement, readable, reasonable	

Source: (Lee et al., 2002). This data has been amended from Lee and colleagues. The studies with the asterisks have been added for this dissertation.

All four of these dimensions are important to healthcare organizations, and any problems connected with them should be explored extensively through empirical research. However, examining all of these issues in one study would be a monumental task and not practical in a single study. An initial study investigating information quality in the healthcare industry should examine the dimensions that are most frequently associated with this quality construct. These dimensions are the intrinsic view and the contextual view (Fisher & Kingma, 2001; Wang & Strong, 1996). The information attributes of these dimensions — accuracy, timeliness, completeness, and relevancy — are at the core of information quality in any organization. For example, if the information that is received for decision making is not accurate, the format or ease of interpretation is not important in that case. If the information is no longer needed, if it is not timely, privacy or security issues will likely not be a major concern.

Additionally, this dissertation examines information quality perceptions independent of the presence or absence of computer systems in the hospitals surveyed. The information quality in these hospitals is related to all the information that nurses receive to do their jobs, whether the information is paper-based or computer-based. The representational dimension and the accessibility dimension of information quality, as defined in the research literature, are mostly associated with information from computer-based systems. Because this study is more general and looks at information from both paper-based media and computer-based systems, the more general concepts of information quality are appropriate.

Healthcare Quality and Nurses' Perceptions

Building a safer system with quality healthcare is the goal of healthcare organizations and has become paramount in almost every hospital in the U.S. within the past two decades. Governmental agencies such as the IOM, consumer groups such as The Leapfrog Group, and healthcare groups such as the Joint Commission on Healthcare Organizations (JCAHO) have become very involved in the pursuit of quality healthcare (Chao, 2007; Joint-Commission, 2007; Leapfrog, 2007). With increased awareness of the need for quality healthcare, it is important for healthcare providers to manage a plethora of information and knowledge in order to provide safe, quality healthcare.

The demand for evaluating and improving the quality of healthcare is not new. According to Marquis and Huston (2006), evaluating patient outcomes for quality care was used by Florence Nightingale, founder of modern nursing. For instance, Nightingale used statistical analysis to collect and generate consistent data on quality of care during the Crimean War through the use of mortality and morbidity rates and exposed the poor quality of care being delivered at that time (1860). Quality of care continues to be a primary focus in the healthcare research and literature, and increasingly, nurses' perceptions are being explored.

In the U.S., registered nurses comprise the largest profession in healthcare with more than 2.5 million jobs. Fifty-nine percent of registered nurses work in hospitals, delivering more than 70% of actual service delivery in hospitals (Statstics, 2007). As providers of the greater part of healthcare services in a variety of settings, nurses are in a position to appreciate the quality of care that patients receive. Exploring the perceptions of quality of care in this population is key to understanding how the quality of information impacts quality of healthcare in hospitals.

Historically, nurses have been committed to evaluating clinical practices and identifying ways to improve quality of care. Quality of care is evaluated in hospitals by nurses, especially by CNOs, in a review process against quality indicators (Zalon, 2007). According to Finkelman (2006) and Grohar-Murray and DiCroce (2003), although CNO job duties vary from hospital to hospital, it is the CNO who is responsible for upholding the standards of quality care and health outcomes at all levels, in addition to being responsible for governing financial resources and staff development.

Brewer (2007) reported that CNOs are the drivers of quality of healthcare. JCAHO requires CNOs to collect data and perform proactive annual failure mode and analysis to decrease the risk of errors, increase patient safety, and improve overall quality of care. In this dissertation, CNOs are identified and surveyed. Due to the very nature of the job, the CNO is in a position to observe and identify matters related to quality of healthcare from several aspects including information, timeliness, accuracy, and reliability. Table 3 is the definition of a CNO from the HIMSS Analytics Database ((2009).

Table 3

Definition of Chief Nursing Officer

Chief Nursing Officer	Responsible for the coordination and representation of the system's (facility) nursing staff. Licensed as a registered nurse. Other common titles include: Chief Nursing Head, VP/Director of Nursing, and VP/Director of Patient Care Services.

Adapted from HimssAnalytics Database, 2009

Defining Quality of Healthcare

Defining quality can be difficult because it is often viewed as a multifaceted concept (Jacoby & Haddock, 1973; Takeuchi & Quelch, 1983). A broad definition of quality, according to Webster's New World College Dictionary is "excellence, superiority." This definition is nebulous and inadequate, however, in providing a comprehensive view of quality in healthcare. In fact, quality of healthcare must be defined in many ways from many different perspectives (Brook, 1973; Jun et al., 1998b; Nau, 2007). Table 4 notes a few definitions for quality of care.

Lohr's (1990) definition of quality of care, which was created when she directed a quality assurance initiative regarding Medicare, has been accepted by many researchers.

Table 4

Definitions of Quality of Health Care

Source	Definition of Quality of Healthcare
Nash (1995)	The process of intervention, significant measured improvement in the condition of the patient, alleviation of pain or other desired outcomes while providing real value
Dennis 2007	Care that meets professional standards, practice guidelines, standards issued by societies, professional associations, and other consensus groups and those dictated by statute or regulation
Zineldin (2006)	The art of doing the right thing at the right time, in the right way, for the right person, and having the best possible results
Lohr (1990)	The degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge

There is no best definition of quality of care because there are different situations for applicability of the term, and it cannot be generalized to each circumstance. The definitions for quality of care all have strengths and weakness.

Concepts of Quality of Healthcare

Donabedian, a seminal leader and founder of the modern field of quality of care (Luce, 2004), reported that the definition of quality of healthcare should be based on conceptual and operational definitions (Donabedian, 1966). He postulated that quality of care can be evaluated by examining relationships between structure, process, and outcomes. The structure is associated with the physical/organizational attributes of the setting where care is delivered. The process is whether or not good medical practices are followed. The outcomes denote the impact on healthcare. Donabedian also conceptualized and posed seven attributes in a framework to define quality of care. He described the attributes of quality of care as efficacy, effectiveness, efficiency, equity, acceptability, optimality, and legitimacy (Donabedian, 1980).

Measuring Quality in Healthcare

Other researchers have adapted frameworks similar to Donabedian's. Three of these studies — Parasuraman et al. (1985), Bowers et al. (1994), and Jun et al. (1998) — used empirical techniques to generate a similar set of dimensions with some adaptations of the studies for quality in healthcare. The service quality measures (SERVQUAL) are based on the conceptual model with a theoretical foundation by Parasuraman and colleagues (1985). This model was developed as a general purpose measure for quality in industry and has also been used in healthcare. The instrument discriminates between different dimensions of service quality, as noted in Table 4. SERVQUAL is feasible for large-scale studies. Bowers and Kiefe (1994b) found that five of the dimensions identified were common across service businesses and healthcare (reliability, responsiveness, assurance, empathy, and tangibles).

Limitations of SERVQUAL are that this instrument was not developed exclusively for healthcare. Instead, the instrument was cultivated as a general purpose measure of quality in service industries. Additionally, the instrument usually has been applied to commercial services.

Bowers and colleagues (1994) conducted focus groups to determine attributes to measure healthcare quality, as noted in Table 4. They found some measures that agreed with SERVQUAL and some that did not. Bowers and colleagues did not find tangibles and assurance, two measure dimensions from SERVQUAL, significant. They did find caring and communication, two other measure dimensions, significant and suggested they be added to the overall measure of healthcare quality.

The benefit of the Bowers and colleagues' research was that their study was developed specifically to measure quality of healthcare by combining patient perceptions with quality measures derived from sources, such as medical record reviews, to achieve a more comprehensive measure of overall quality. In the Bowers study, the quality of healthcare measure was operationalized using several different stakeholders: patient, healthcare provider, and administrator. The dimensions in the Bowers study were not, however, validated in a large-scale study.

Jun and colleagues (1998) identified 11 attributes of the quality of healthcare and patient satisfaction, as shown in Table 4. The authors employed focus group interviews to collect detailed patient, administrator, and physician feedback about their feelings, attitudes, and perceptions on service quality. They also examined differences between the findings of previous research on healthcare quality dimensions and those from the three focus groups in their study. Additionally, they made recommendations to improve healthcare quality.

Several dimensions of the quality of healthcare seem to be common across multiple studies (Bowers et al., 1994; Jun et al., 1998; Parasuraman et al., 1985). Because these studies have an almost identical set of dimensions for quality of healthcare, they were used to establish an initial set of dimensions to compare other measuring tools found in other studies for quality of healthcare. This initial set was used to help consolidate dimensions from other studies measuring quality of healthcare. The result of this consolidation is shown in Table 4. The goal of consolidation was to establish a definitive set of dimensions found in the literature review that measured quality of healthcare (Bowers et al., 1994; Hulka et al., 1970; Jun et al., 1998; Meterko et al., 1990; Parasuraman et al., 1985; Ware & Snyder, 1975; Zineldin, 2006).

Zineldin (2006) developed a conceptual model with behavior dimensions of patient-physician relationships and patient satisfaction — the 5Q's model. This research took place in three hospitals in Egypt and Jordan. Forty-eight items were identified within five quality dimensions. Benefits of the 5Q's model are that 1) the model is based on a theoretical foundation; 2) the model is more comprehensive and incorporates multidimensional attributes that are missing in other models; 3) the model evaluates healthcare in hospitals; and 4) use of the model is feasible in large populations. However, the model is new, which could be a limitation.

The Patient Satisfaction Questionnaire (PSQ) was developed by Ware and Synder (1975) to assist in planning, administrating, and evaluating healthcare services. The questionnaire began with more than 900 items administered by interview. The instrument was field-tested over four years, and a new version containing 55 items was derived. Benefits of the PSQ are that it contains subscales representing several aspects of quality of care from the patient's perspective (QCPP). The Cronbach's alpha reliability test results for the measures in the model ranged from 0.60 to 0.90. The questionnaire has been used in at least eight studies as a questionnaire and in five studies as a source for developing a questionnaire (Pascoe et al., 1983). This questionnaire is also feasible for large populations and has been used among samples of 232 to 640. A limitation of this questionnaire is that it is not based on any theory of patient satisfaction and, therefore, the content validity of the instrument is not specifically supported.

In 1970, Hulka and colleagues developed the Satisfaction with Physician and Primary Care Scale (SPPCS). Further work was done with this scale by Merenstein and Hirsch (1989) in multi-specialty primary care. This scale is used in assessing patient satisfaction attitudes toward medical care in three areas: professional competence, personal qualities, and cost/convenience. Benefits of SPPCS are that Cronbach's alpha test results on its measures ranged from 0.63 to 0.75. This scale is feasible with large sample sizes and has been used in several studies, including patients of outpatient clinics, ambulatory clinics, and multi-specialty primary care centers. The limitations of SPPCS are that it is not based explicitly on theories of patient satisfaction, and the scale does not discriminate between well-defined aspects of patient satisfaction and broader quality of healthcare. Also, this scale has been questioned by external reviewers (van Campen et al., 1995).

The final measure of quality of healthcare in this literature review is Patient Judgment of Hospital Quality. Meterko and colleagues (1990)reported on the instrument in an eight-article supplement on the Hospital Satisfaction Project using this instrument. They found that the measure of quality of care was not restricted to the concept of patient satisfaction. Written comments from three focus groups were analyzed by Meterko and colleagues, resulting in a 106-item questionnaire with 46 key items. This instrument is beneficial in that it discriminates between several aspects of hospital care, as reported in the eight articles. The subscales are internally consistent with Cronbach's alpha greater than 0.70 and inter-scale range of 0.44 to 0.76. The correlation of the items from different scales is lower than the internal consistency of the items within the scales. This instrument is also feasible for large sample sizes, with strong reliability and validity. The limitation of this scale is that it is not based explicitly on a theory of patient judgments.

Table 5 is a comparison of the five scales/models discussed in this dissertation by six criteria identified in the studies cited. For this dissertation only, dimensions that relate to information and information quality are denoted by *.

Table 5

Quality Dimensions of Healthcare Service

Quality Dimensions of Healthcare Service Jun 1998 Parasuraman1988 Bowers 1994	**SERVQUAL (Revised)** Parasuraman 1988	**5 Q's** Zineldin 2000	**PSQ** Ware and Synder 1975; 1983
Tangibles* Appearance Process Cleanliness	**Tangibles***		
		Quality of Atmosphere	
			Personal Qualities
			Interpersonal Manner
Courtesy Attitude Privacy Professionalism	**Courtesy**		**Finances/Cost**
Reliability Assurance Consistency (equal treatment) Billing Accuracy	**Reliability** Assurance		**Continuity**
Communication* Technical complexity explained Interaction Time spent	**Communication***	**Quality of Interaction*** (Communication)	
		Quality of Object	
		Quality of Infrastructure	
Competence Education Expected Continued Improvement Measurable Empowerment	**Competence**		**Competence**

(table continued)

Table 5 (continued)

Quality Dimensions of Healthcare Service Jun 1998 Parasuraman1988 Bowers 1994	**SERVQUAL (Revised)** Parasuraman 1988	**5 Q's** Zineldin 2000	**PSQ** Ware and Synder 1975; 1983
Understanding Customer Patient Physician	**Understanding or Knowing Customer**		
Access Visibility Convenience	**Access**		**Accessibility/convenience** **Availability**
Responsiveness*	**Responsiveness***		**Responsiveness***
Caring	**Caring**	**Quality of the Treatment Process** (Caring)	
Patient Outcomes			
Collaboration* Teamwork Synergistic Package Internal and External To Hospital			
Security*	**Security***		

Table 6 compares the five survey scales/models to five criteria determined to measure quality of care based on their theoretical and methodological attributes.

Table 6

Evaluation of Five Measuring Instruments by Five Criteria

Instrument	5Qs	SERVQUAL	PSQ	SPPCS	PJHQ
Theory	+	+	-	-	-
Subscales of QCPP	+	-	+	-	+
Reliability	+	+	+	+	+
Validity	+	+	-	-	+
Large Population	+	-	+	+	-

Adapted from van Campen, 1995

Operational Definitions of Study Variables

In light of the discussion in this Chapter to this point, the following operational definitions are given in Table 6. These variables will be used to test the hypotheses that are given in the next section.

Table 7

Operational Definitions

Study Variable	**Operational Definitions**
Level of IT Implementation	The number of clinical IT applications associated with electronic medical records and electronic medication administration records. These clinical IT applications are shown and defined in Table 1. The level of IT implementation is associated with the sophistication and the integration of IT in hospitals. The reasoning is that the greater the number of clinical IT that are present and a part of the overall repository of IT resources of the hospitals, the more likely these resources are integrated into systems with more capabilities. This is a continuous variable not a categorical variable.
Perceived Quality of Information	The perceived Quality of Information variable consists of and is defined by three factors: accuracy, reliability, and timeliness. These are defined below.
• Accuracy	The degree to which information for decision making is correct, unambiguous, meaningful, believable, valid, free of errors and consistent. Lee, et al, 2002; Nelson et al, 2005; Wand & Wang; 1996
• Reliability	The degree to which the information for decision making allows nurses to act dependably and completely in caring for patients or communicating with other healthcare professionals.
• Timeliness	The degree to which the information is opportune, appropriate, and up-to-date at the time the information is needed for decision making. Fisher & Kingma, 2001; Lee et al ,2002
Perceived Quality of Healthcare	The perceived Quality of Healthcare variable consists and is defined by six factors: assurance, responsiveness, understanding, tangible, collaboration, and safety. These are defined below.
• Assurance	The degree to which nurses are knowledgeable, dependable, and reliable in delivering healthcare services to patients. Parasuraman et al. 1988
• Responsiveness	The degree to which the nurses provide prompt service and respond quickly to the needs of the patients. Parasuraman et al. 1988; Ware and Synder 1975, 1983
• Understanding	The degree to which nurses can empathize, know, and identify with the needs of the patients. Parasuraman et al. 1988

(table continues)

Table 7 (continued)

Study Variable	Operational Definitions
• Tangible	The degree to which nurses can easily find needed equipment and devices and present a professional image to patients. Parasuraman et al. 1988
• Collaboration	The degree to which the nurses are able to communicate with other healthcare workers and work in a cohesive team to deliver healthcare. Parasuraman 1988; Zineldin 2000.
• Safety	The degree to which nurse provide an accident and error free environment in providing healthcare to patients. Parasuraman 1988
Cost of Operations	Total expense reported by the hospitals divided by the size of the hospital.
Average Cost of Service	The average cost of the top twenty medical procedures in hospitals as reported in the AHD
Quality of Healthcare Metrics	Quality measurements that report how often a hospital provides recommended care to get the best results for most patients for four major medical conditions.
• Heart Attack on Arrival	Proper response to patients suffering from a heart attack on arrival to the hospital.
• Heart Attack at Discharge	Proper response to patients that suffered a heart attack on discharge.
• Heart Failure	Proper response to patients suffering from heart failure.
• Pneumonia Care	Appropriate response to patients that have symptoms of pneumonia.
• Surgical Care	Preventing blood clots in and after surgery.
• Surgical Care	Preventing infection in surgery in and after surgery.

Hypotheses

This study examines the relationship of levels of IT implementation and information quality in hospitals from the perceptions of CNOs and perceptions of quality from end-users. Though there have been studies that examine IT from many perspectives, this dissertation is distinctive because it is a large-scale study that considers other factors, such as independent hospitals, multiple levels of IT implementation in those hospitals, and quality of information and care. As discussed in the literature review, much of the past research has been from case studies in hospitals and from the business sector.

The first relationship in the research model will examine the link between the level of IT implementation and perceptions of information quality. There are several reasons to explore how the level of IT implementation may be associated with perceptions of information quality. First, there is previous evidence that the implementation of information systems leads to better overall information quality in many organizations (DeLone & McLean, 1992).

Second, the measurement of the level of IT implementation in the proposed study is the number of clinical IT applications associated with EMR and eMAR systems that are live and operational in the hospitals. This means that the IT application is being used in live operations to support clinical workflow. These IT applications were shown in Table 1. Both EMR and eMAR systems span two or more functions in hospitals and can even span the entire hospital. Thus, they are designated “enterprise” systems. Enterprise systems like EMR and eMAR promise standardization of processes, integration of clinical processes, and access to integrated data across the hospitals. The standardization and integration of processes were found to be associated with such positive organizational traits such as communication, consensus, coordination, and measurability (Wullenweber et al., 2008). These are organizational traits that have been found to increase the quality of information in all types of organizations (Fisher & Kingma, 2001; Low & Mohr, 2001). Typically, the greater the number of clinical IT applications in a hospital, the higher the level of IT implementation (see Table 1).

Finally, there is evidence from case studies in the healthcare industry that IT can improve information quality. Embi and his colleagues (2004) found improved availability of information in the implementation of a computerized physician documentation system. They measured quality of information by the availability of documentation, improved legibility and accuracy, and better accessibility. Mekhjian and his colleagues (2002) found that a CPOE had substantial impact on the quality of information in an academic medical center. The CPOE combined with eMAR virtually eliminated all physician and nursing transcription errors. The quality of information was measured in this study by Mekhjian and his colleagues by timeliness and reduction of medical errors. These studies, along with the previous evidence, point strongly to a relationship between the level of IT implementation and information quality in hospitals. Therefore, the first hypothesis is:

H1: The level of IT implementation is related to perceptions of information quality in hospitals.

Possibly the strongest link between IT implementation and any organizational benefit is its relationship with the cost of operations. Empirical studies in non-hospital industries have shown an exceedingly strong tie between IT implementation and reduction in the overall cost in organizations. Brynjolfsson and Hitt’s study (1996) used firm-level data to examine the impact of IT spending in 367 large firms in a five-year period. They specifically tested the relationship between IT spending and productivity in these firms. Productivity was measured as overall output divided by input. When the output is increased, or the input is reduced with the same output, the cost per manufactured item or service is reduced. They found that IT spending does have positive association with firm productivity, thus linking IT strongly with cost.

Many other studies have demonstrated a significant relationship between IT and cost in organizations. Hitt(1996) found that IT is associated with decreases in both internal and external coordination costs. Banker and his colleagues(1990) studied an IT implementation in the

Hardee's Corporation and found that the implementation was associated with some impressive efficiency gains in its restaurants. Other studies have shown similar results — that IT is closely related to an increase in efficiency and a reduction in cost in the organizations they considered (Bharadwaj, 2000; Byrd et al., 2006; Miller & Doyle, 1987; Shao & Lin, 2002).

Large-scale IT systems have been shown to streamline business transactions and, therefore, to increase efficiency in internal operations. Increasing the level of IT implementation can enhance internal and external coordination by strengthening the IT infrastructure and through more robust IT applications. Better integration and communication facilities resulting from a more effective IT infrastructure should help reduce cost through interaction of hospital workers with patients and others outside the hospitals. For example, better communication between pharmacy and hospital floors can increase the efficiency of moving drugs to the right place, thus reducing the cost. Such a match reduces cost by helping to reduce inventory, optimize work schedules, and deliver drugs and services on time and in the proper quantity (Brandyberry et al., 1999). This evidence leads to the next hypotheses:

H2a: There is a relationship between the level of IT implementation and cost of operations in hospitals.

H2b: There is a relationship between the level of IT implementation and the average cost of service in hospitals.

There is not as much evidence in the IT value research literature linking IT with increases in products or service quality as there is with cost. However, some studies have indicated that a positive association between IT and quality is likely. The results from a study by Banker and colleagues (1990) indicate such a link. The researchers stated that IT worked through other intermediate variables to significantly affect plant quality in their study of manufacturing plants.

In a study mentioned above, Barua and colleagues (1995) ascertained that IT implementation was a significant factor in improving product quality in manufacturing firms. Through mathematical modeling, Thatcher and Oliver (2001) demonstrated that IT investments and product quality are related if the emphasis is placed on improving quality instead of lowering cost or increasing productivity. In a study in the healthcare industry, Devaraj and Kohli (2000) examined eight hospitals that had implemented decision support systems and found that the hospitals improved their product quality and service quality over time.

As mentioned earlier in this chapter, several case studies in the healthcare area have indicated that IT may indeed improve quality in hospitals. Case studies by Embi and colleagues (2004), Mekhjian and colleagues (2002), Bates and colleagues (1999), and Amarasingham and colleagues (2007) all indicate that IT applications are positively related to at least some quality factors in hospitals. This evidence, combined with the evidence from studies above from the IT value literature, gave support for the following hypotheses:

H3a: There is a relationship between the level of IT implementation and end-user (CNO) perceptions of the quality of healthcare in hospitals.

H3b: There is a relationship between the level of IT implementation and quality of healthcare metrics in hospitals.

Healthcare organizations like hospitals are susceptible to poor information quality because information on patients comes from many different sources, including physicians, laboratories, pharmacies, nurses, diagnostic centers, and the patients themselves. The quality of this information can certainly have an effect on the corresponding cost and quality of healthcare in hospitals (Wand & Wang, 1996). One problem with information is that it is often abstract, and its quality cannot be determined directly through techniques like personal measurement or observation. When information is missing, inaccessible, or inaccurate, it is typically very expensive to find or access the information or to correct it (Levitin & Redman, 1998). For example, to correct inaccurate information, it is often necessary to seek out the real-life counterpart that the information represents (Levitin & Redman, 1998). When trying to correct this information for patients, an attending caregiver, such as a nurse, may have to call physicians, laboratories, pharmacies, other floors of the hospitals, admissions, or the discharge office. Even then, the accuracy of the information may be difficult to correct because of conflicting or confusing information from these outside information sources.

Even worse, poor quality information is like a virus (Levitin & Redman, 1998). It can easily spread throughout a hospital, wreaking havoc wherever it goes. There is really no way to determine where bad information may turn up in the hospital and what effect it may have on operations. In addition, faulty information typically builds on itself as one error exponentially grows into many more through its use in patient care and other processes. For example, an error written into the physician's orders can be propagated through several other functions and departments such as pharmacy, laboratory, surgery, and diagnostic testing. Fairly predictably, when incorrect information is used in the hospital, overall costs will increase because of the need to correct so many different processes and areas later (Levitin & Redman, 1998).

Thomas Redman (1998) provides an anecdote about the cost of poor information quality. He noted that he once worked for an organization whose one task was to discover the errors in the information received from its largest suppliers. The budget for that organization, he said, amounted to tens of millions of dollars per year. Not only that, but every other department in that organization had similar excessive costs resulting from poor information quality. The human resources department spent time correcting information on employees, the shipping department spent time correcting information on products and customers, and so on, with the other departments in the company. Redman estimated that 40 to 60% of the expenses of service organizations like hospitals might be due to poor information quality. Another study by Tucker (2004) suggested that a 204-bed hospital with 75% occupancy could lose a minimum of 51,000 dollars and a maximum of 27 million dollars per year from operational failures, including problems from defective information quality. From this information, the next hypotheses are posited:

H4a: There is a relationship between end-user (CNO) perceptions of information quality and the hospital performance indicator cost of operations in hospitals.

H4b: There is a relationship between end-user (CNO) perceptions of information quality and the average cost of service in hospitals.

Poor information quality is likely related to poor task execution in work processes like patient care (Redman, 1998). Flawed information quality in hospitals can lead to all types of errors in patient care. Patients may be given the wrong medications or the wrong dosage of the right medications, may be switched with other patients in the hospitals, or may receive the wrong operations, among other things, when the information quality is poor.

The problems resulting from faulty information quality have been proliferated with the recent changes in healthcare. In the past, the primary physician was at the top of the medical pyramid, and most medical decisions were made through that physician. In today's medical environment, medical care is mainly dispensed by multidisciplinary teams of clinicians and non-clinicians who must provide comprehensive and coordinated care to their patients (Tierney, 2001). In such an environment, the caregivers must depend on information they have on hand about the patients to accurately and quickly deliver their respective treatment. When the quality of the information is poor, the caregivers are likely to wrongly diagnose the complaint and to deliver an improper treatment to a patient. It has been reported that nearly half of serious medication errors are a direct result of medical caregivers not having sufficient quality of information (Bates & Gawande, 2003). Of course, on the other hand, the better the data quality, the more likely the problem is diagnosed accurately and the proper treatment is administered (Tierney, 2001).

Tucker (2004) completed one study examining the impact of operational failures on healthcare quality. Operational failures in her study included disruptions or errors in the supply of necessary materials and errors in information available to employees. She found that the operational failures in her study contributed to delays in patient care and other difficulties in the overall quality of care. One of the most serious problems encountered was patients being subjected to unnecessary medical procedures. This study, along with other evidence presented here, leads to the following hypotheses:

H5a: There is a relationship between end-user (CNO) perceptions of quality of information and end-user (CNO) perceptions of quality of healthcare in hospitals.

H5b: There is a relationship between end-user (CNO) perceptions of quality of information and quality of healthcare metrics in hospitals.

In connection to the hypotheses to test the main research questions in this study, a questionnaire is developed to establish measures for the perceived quality of information and the perceived quality of healthcare. Part of the validation process for the questionnaire is to include nomological validity for the instrument. This procedure involves making sure that the questionnaire does not vary significantly on variables irrelevant to the study. In this study, a single respondent, a CNO, reports on organizational level variables through the questionnaire.

The demographic and practice characteristics of the CNOs are collected on the questionnaire along with the main variables, the quality variables, of interest. If the instrument is valid and does not significantly vary across these demographic and practice characteristics, there is likely other reasons for any variation found in the responses, notably the level of IT implementation in this study. There is no reason to believe that the perceive quality of information and the perceived quality of healthcare should be related to these demographic and practice characteristics. Most CNOs are at least forty years old and have many years of experience in hospitals and, therefore, are not likely to vary in their perceptions on these variables. Consequently, the following hypotheses are given:

H6a: There are no significant differences in perceptions of quality of information across demographic and practice characteristics of respondent CNOs.

H6a: There are no significant differences in perceptions of quality of information across demographic and practice characteristics of respondent CNOs.

Table 8

Summary of Study Hypotheses

H1:	The level of IT implementation is related to end-user perceptions of information quality in hospitals.
H2a:	There is a relationship between the level of IT implementation and cost of operations in hospitals.
H2b:	There is a relationship between the level of IT implementation and the average cost of service in hospitals.

(table continues)

Table 8 (continued)

H3a:	There is a relationship between the level of IT implementation and end-user (CNO) perceptions of the quality of healthcare in hospitals.
H3b:	There is a relationship between the level of IT implementation and quality of healthcare metrics in hospitals.
H4a:	There is a relationship between end-user (CNO) perceptions of information quality and the hospital performance indicator cost of operations in hospitals.
H4b:	There is a relationship between end-user (CNO) perceptions of information quality and the average cost of service in hospitals.
H5a:	There is a relationship between end-user (CNO) perceptions of quality of information and end-user (CNO) perceptions of quality of healthcare in hospitals.
H5b:	There is a relationship between end-user (CNO) perceptions of quality of information and quality of healthcare metrics in hospitals.
H6a:	There are no significant differences in perceptions of quality of information across demographic and practice characteristics of respondent CNOs.
H6a:	There are no significant differences in perceptions of quality of information across demographic and practice characteristics of respondent CNOs.

In this chapter, research related to Quality, healthcare quality, and the components of the research model were discussed. Based on the review of the literature, relationships between the components of the research models were hypothesized. Table 8 contains the list of study hypotheses. Chapter 3 provides the details of the methodology and the measures that were used to assess the constructs and the hypotheses for the proposed study.

Chapter 3. Research Methodology

The goal of this research was to assess relationships between the level of IT implementation with 1) the perceived quality of information for clinical decision making, 2) the perceived quality of healthcare delivered, 3) an objective measure of the quality of healthcare, and 4) the overall cost of healthcare in single independent hospitals. Additionally, the study examined the relationships between the perceived quality of information for clinical decision making with 1) the perceived quality of healthcare, 2) an objective measure of the quality of healthcare, and 3) the overall cost of healthcare in single independent hospitals. To investigate these relationships, data from two secondary data sources were combined with primary data collected through a cross-sectional field survey involving CNOs in the single independent hospitals that constitute the sample for this study. The secondary data sources are the HimssAnalytics Database and the American Hospital Directory. Both of these are discussed in some detail later in the chapter.

Specifically, this study made an effort to examine the impact of IT in providing quality information for nurses making clinical decisions in independent single hospitals. Barua and colleagues (1995) argue that understanding the value of IT in organizations requires analyses of its use at lower levels in the organization, at so-called “intermediate levels” (p. 6) (the use of the term ‘levels’ here refers to the levels in an organization, such as operational, tactical, and strategic levels, and not to the level of IT which has more to do with the sophistication and integration of IT). These authors reason that the closer IT is to the variables it allegedly affects, the more likely the relationships between IT and these consequent variables can be detected. Barua and colleagues further state that IT is “expected to have its first-order effects on operational level variables” (p. 7) such as the quality of information variable used in this study. These intermediate variables can then be related to overall quality variables to complete what Barua and colleagues call a “web of intermediate level contributions” (p. 6). In this way, a value-added analysis of IT can be done, and its value can be seen through a more transparent empirical lens.

Barua and colleagues also suggest that IT be analyzed in lower responsibility units that are free of corporate or other ownership influences. Using such organizations helps to eliminate confounding factors that are very difficult to control or measure in wholly owned strategic business units (SBUs), such as hospitals that are part of a chain. Therefore, single independent hospitals were chosen as the focus of this study. The choice of single independent hospitals follows Barua’s suggestion to choose responsibility units that are free of corporate influence and ownership influences that might confound the relationships between IT and performance indicators in the hospitals. Although this slightly decreases the generalizability of the study, it virtually eliminates the possibility that superior quality in a hospital is primarily due to the management of some corporate entity and not the operations of the targeted hospital.

The survey instrument was mailed to the chief nursing officer (CNO). Because the variables associated with information quality and quality of healthcare are focused on the nursing staff in the hospitals, the chief nursing officer was the candidate likely to know the most about these issues. The names and addresses for the CNOs in the targeted hospitals were obtained from the HIMSS Analytics database. Next, a section giving an overview of the questionnaire development, questionnaire implementation, and the merging of primary data with secondary data is presented. After this overview, the details of each of these processes are discussed.

Overview of the Study Design

This study design proceeded in three phases. First, the questionnaire was developed to collect data from CNOs. The questionnaire was developed in a way consistent with the suggestions of Lewis, Templeton, and Byrd (2005). The first step according to Lewis and his colleagues is to develop an initial set of questions from the existing literature. This suggestion was followed. Next, a pretest of the set of questions was done by nurses and nursing professors to review the questionnaire items for understandability and clarity. After the pretest, a pilot study was done. The pilot test consisted of having nurses and nursing manager fill out the questionnaire and to also make suggestions on how it might be improved. Some of these (Segars & Grover, 1999)respondents were also interviewed after they filled out the questionnaire. Finally, principal component analysis was run on the results from the pilot study to determine the validity and reliability of the questionnaire.

The second phase was to implement the questionnaire and send it to CNOs at 1000 hospitals in single systems. This study used the “key informant” methodology. Segars and Grovers said about key informant, “Such informants are not chosen at random; rather, they are chosen because they possess special qualification such as status, experience, or specialized knowledge. In survey research, targeted respondents assume the role of a key informant and provide information on an aggregated unit of analysis by reporting on group or organizational properties rather than personal attitudes and behaviors” (p. 147). CNOs are chosen for this study because of their experience and specialized knowledge about the quality of information and the quality of healthcare in their respective hospitals. They are asked to provide information on these measures that refer to an aggregated organizational level of analysis.

A disadvantage to using a CNO as a key informant is the possibility of bias by the CNO toward his or her own hospital. The CNO may tend to look at his or her hospital in a more or less favorable light than is warranted by the actual situation. One way to reduce this bias is to offer a report to the CNO that compares the perceptions of information quality and healthcare quality of each CNO's hospital against an aggregate of perceptions of the CNOs of all the other hospitals. The report would show the perceptual view of each hospital's rank against all other hospitals in the sample. This tends to reduce the bias and increase the chance of getting more truthful data because the CNO would likely want as accurate a picture of how his or her hospital compares to other hospitals as he or she can get. The information could be used to improve areas that may have been evaluated as relatively low in the survey results.

A paper questionnaire was sent to 1000 CNOs. The sampling for the hospitals was 1000 single system hospitals, one third with no EMR or eMAR systems, one third with either EMR or eMAR systems, and one third with both EMR and eMAR systems. This was done to try to have a representative sampling of the level of IT implementation. A letter accompanying the questionnaire asked the CNOs to fill out and return the questionnaire or informed them that they could also complete the questionnaire on the Internet. Two follow-up email contacts was also done, one about three weeks after the mailing of the questionnaire, and the next about two weeks after the first email. The study used a unique identifier to track each hospital's response.

In the third phase of the study secondary data from two sources, the American Hospital Directory and the HIMSSAnalytics database, were merged with the primary data of the questionnaire. The number of IT applications in EMR and eMAR systems that were in each hospital was collected using the HIMSS Analytics database. The database gives information on which clinical IT applications are live and operational in which hospitals. These data were combined in an Excel spreadsheet file with the quality of healthcare and relative costs from the AHD using the same unique identifiers that were used in the questionnaire survey to identify the hospitals. In the same way, once the data from the questionnaire survey were obtained, they were combined with this secondary data file to create the file used to test the hypotheses.

Questionnaire Development

As noted, this study collected primary data using a questionnaire from a key informant (CNO) in the sample of single system independent hospitals. The questionnaire has three major sections, one to collect data on the quality of information, and one to collect data on the quality of healthcare and one to collect data on demographic and practice characteristics. Each section of the questionnaire had instructions for filling out that portion of the survey to help minimize misunderstandings and misinterpretations.

In addition to the data on the two constructs of research interest, perceived quality of information and perceived quality of healthcare, demographic and practice characteristics on the CNO were requested. The information included length of tenure at the hospital, years of experience, highest degree, gender, age range, job level, and name of position. The practice characteristics helped to assure that the key informant was indeed knowledgeable and able to answer the questionnaire with accuracy. These data were collected to control for concerns that the level of management might be an overriding factor in determining the quality of information and the quality of healthcare in the hospitals. It also allowed for testing of significant differences among demographic characteristics across study variables.

The two variables that the data represent include perceived quality of information and perceived quality of healthcare. Items for these two constructs are taken from past research studies (Bowers, 1994; Jun et al., 1998; Nelson et al., 2005; Parasuraman 1988; Wand & Wang 1996). The questionnaire included items using a 5-point Likert scale. Each proposed factor for the perceived quality of information and the perceived quality of healthcare was measured by at least three items. Reliability theory states that the higher the number of items that compose a factor, the more reliable the factor and the more accurate any analyses that use the factor (Carmines & Zeller, 1979). However, in practical situations, the number of items for any factor used in a survey must be balanced against the response rate of that survey. The number of items cannot be so large as to dramatically decrease the response rate, even though more items may be desirable for reliability and analysis. Too many items measuring a factor can also quickly become redundant and bore the respondent. A rule of thumb for the number of items for structural equation modeling techniques like PLS is a minimum of three indicators for each factor (Bollen, 1989; Chin et al., 2003). Any fewer than three indicators for a factor can seriously jeopardize the reliability and validity of the factor and the subsequent analyses that use that factor (Bollen, 1989; Carmines & Zeller, 1979; Chin et al., 2003). To balance these concerns, three items were included for each factor so that reliability and validity problems were reduced without severely affecting response rate.

The perceived quality of information measure was developed through a literature review, as detailed in Chapter 2. The resulting multidimensional concept of information quality consisted of intrinsic information quality, contextual information quality, and representational information quality (Wang et al., 1997), as discussed previously. Intrinsic information quality is related to object attributes, such as accuracy, reputation, and believability, independent of any specific context. Contextual information quality highlights the requirement that information quality must be considered within the context of the task at hand, that is, information must be relevant, timely, complete, and of an appropriate amount so as to add value. Representational information quality includes attributes such as interpretability, ease of understanding, representational consistency, and conciseness. The potential factors for the perceived quality of information that resulted from these categories for this study are 1) accuracy of information: the quality or state of being free from mistakes and errors, 2) reliability of information: the quality of trustworthiness, and 3) timeliness of information: decreased delay in time required to receive the information for decision making (Byrd & Hauser, 1991). The initial items for these three factors are taken from both Wang and Strong (1996) and Gattiker and Goodhue (2005).

The perceived quality of healthcare factor consisted of six potential factors. These are 1) responsiveness: prompt service to the patients and their requests, 2) assurance: instill confidence by being knowledgeable and reliable, 3) understanding: insight and compassion about the patients and their concerns, 4) tangible: following protocols and the processes of patient care, 5) collaboration: the level of cooperation and teamwork with physicians, pharmacists, and other medical personnel, and 6) safety: creating an environment that is safe and free of accidents and medical errors (Hulka et al., 1970; Meterko et al., 1990; Parasuraman et al., 1988). The initial items were primarily taken from Hulka and colleagues (1970), Meterko and colleagues (1990), and Parasuraman and colleagues (1988). These items were modified to fit the current study examining the quality of healthcare supported by the nurses in the sample hospitals.

Questionnaire Pretest

Two pretest procedures were done to begin validation of the questionnaire. First, two registered nurses involved in hospital information systems and four academicians well-informed about IT reviewed the items for understandability and clarity in the questions, and consistency in the terminology used in the questions and in healthcare settings. After several iterations, the questions were judged to be unambiguous and comprehensible by the six experts. The terminology used in the questions was deemed to be the same as the terminology used in the healthcare industry.

Next, the revised questionnaire was administered to faculty members of the School of Nursing at Auburn University. They were asked to complete the survey and to review both its appearance and its content. The instrument was also administered to five members of a nursing sorority that includes some nursing supervisors and managers. They also were asked to fill out the questionnaire and to comment on its appearance and content. The comments were reviewed, and the instrument was revised based on feedback from the nursing professors and the members of the nursing sorority. After being evaluated by two sets of experts in healthcare and IT and being revised from the comments from each set as stated, the questionnaire was now deemed ready for pilot testing.

Questionnaire Pilot Test

A pilot test was conducted to evaluate the revised questionnaire. A pilot study is defined as a small-scale version of the proposed research. It is used to develop and refine the research process, often including the data collection survey (Burns & Grove, 2001; Polit & Beck, 2010), especially when a new instrument has been developed for use with people whose characteristics are unlike those for whom the original instrument was developed (Neiswiadomy, 2002). The pilot study is conducted with people whose characteristics are similar to those of the proposed sample population (Hinds & Gattuso, 1991; Neiswiadomy, 2002). The purpose of this pilot study was to determine the reliability and validity of the questionnaire. The questionnaire was pilot-tested at a nursing sorority conference, whose members are all registered nurses (RNs). Using the conference's attendees provided a convenient, small pilot sample at a relatively low cost (Jairath et al., 2000). Approximately 200 members attended the meeting. Only female members were in attendance for this conference. Other demographics such as age and education were not elicited.

Most members of the sorority are full-time nurses. Many work as nursing supervisors, nursing staff, nurse practitioners, educators, and managers in healthcare organizations. Two hundred questionnaires were distributed by staff members (pages) to the members of the sorority at one of the business meetings during the conference that involved all the members (The demographics portion of the survey was not piloted). The members were instructed by the researcher to fill out the questionnaire, to note the amount of time it took to fill out the questionnaire in minutes in the upper right corner of the first page, and to return it to a designated location at the back of the meeting hall. Fifty-seven (29%) pilot study surveys were returned.

The pilot study provided the researcher an opportunity to talk with some of the nurses who returned the questionnaire to get their impressions of the items and the overall questionnaire. One concern noted by the pilot test nurses regarded items that were included in the survey for reverse scoring. For example, one of the items for timeliness was "The information that nurses received for clinical decision-making is not sufficiently timely to provide the high quality healthcare." One of the other items for timeliness stated, "The information nurses used for clinical decisions is sufficiently up-to-date to offer high quality patient care." It should be clear that these two statements are the same information but in opposing ways. One is asking if information is NOT timely and the other is asking if information is timely. This is referred to a reverse scoring when you used for questionnaire items.

Two participants reported they had to read the items carefully to provide a truthful opinion. A nurse researcher reported that she detected reversed items that required close attention while responding. Reasons to use reverse-scored items in opinion/perception surveys is to prevent participants from determining the intent of the survey and to encourage the participant to read the items closely (Burns & Grove, 2001; DeVellis, 1991; Kerlinger, 1986). The concerns of the participants indicated that reverse scoring was achieving its purpose.

The questionnaire had twenty-eight questions for this research project, nineteen for the quality of healthcare measure and nine for the quality of information measure. An exploratory factor analysis was completed separately for each construct. For a pilot test, a 3 to 1 ratio of respondent to item is adequate to give an initial assessment of the validity of a measure. Therefore, a target of at least 57 respondents (that is, 3 times 19) was adequate for the pilot test. Cronbach's alpha was also assessed for each resulting factor.

Questionnaire Implementation

The revised instrument was used to collect data from the CNO in each hospital. The data collection process used the key informant method. The key informant method targets one individual who is knowledgeable about the area of interest as the source of data collection. A questionnaire was sent to each CNO in 1000 single system hospitals. A cover letter accompanied the questionnaire. The cover letter introduced the researcher and the parameters of the study itself. It also contained a statement assuring the informants that all responses will be kept in the strictest confidence and that no individual responses, names of participants, or names of associated hospitals will be shared with anyone other than the researcher of the study and that all published information will only be in de-identified summary form. The cover letter asked the informants if they wished to receive a copy of the survey results as an executive summary, which will compare their hospital against an aggregate of all other hospitals that responded. If the informants desired the executive summary, they were asked to send the researcher their preferred email address. (See Appendix 1 for a copy of the cover letter.) The mail packet also contained a self-addressed and prepaid return envelope to mail back the questionnaire.

In addition to returning the paper questionnaire in the prepaid envelope, the informant had the option of completing the survey online rather than on paper. The Web-based questionnaire was hosted on the Auburn's College of Business survey site. It was developed by a technical expert that was employed at the Network and Media Services (NAMS) in the College of Business. The site was thoroughly tested by the expert and the researcher by entering sample data for each question and examining the output. The Web-based questionnaire was created to be convenient and user-friendly, and it relayed the same information and collected the same data as the paper-based questionnaire.

The Website information for the online questionnaire was provided in each of the cover letters and in the instructions provided on the front of the questionnaires. The unique identifier assigned to each hospital served as a password for the online questionnaire if the informant chose to use that option instead of the paper-based questionnaire. A record for these log-in identifiers was stored, along with the data from the online questionnaire, so that each respondent was authorized to complete the survey and then have their data matched to the secondary data. The researcher was able to use the log-in identifiers to make sure that if the nursing officers did complete both the paper-based and online versions of the questionnaire only one survey was included in the study results. The online questionnaire also allowed the researcher to download the results directly into a spreadsheet file that can be used for analysis. This reduced the possibility of transfer errors that can occur when transferring data from a paper form to electronic form.

Sample Hospitals

The sample of hospitals had to be carefully planned. A sample of 1,000 hospitals was targeted because 1) this number of hospitals in the sample should yield an adequate number for analysis, and 2) resources available for questionnaire mail out were limited. Studies using high-level administrators as informants commonly have response rates from 10 to 20% (Byrd & Turner, 2000; Segars & Grover, 1998).

The goal was to make sure that some of the hospitals with a high level of IT implementation were included in this sample. In fact, the goal was to have one-third of the 1,000 hospitals with a high level of IT implementation, one-third at a moderate level of IT implementation and one-third at a low level of IT implementation. The presence or absence of EMR and eMAR helped the researcher make these determinations.

The implementation of high levels of IT, such as EMRs and eMARs, are at the beginning stages, and there are a limited number of hospitals that have both, according to the HIMSS Analytics database. Of the 2,200 single independent hospitals, about 300 hospitals have both high-level EMR and eMARs. Because the total sample for the study was set at 1,000 hospitals, all 300 of these hospitals were included in the study so that potentially one-third of the hospitals for analysis would be at the top end. To get the second level, 350 hospitals that have either an EMR or an eMAR, but not both, were included in the sample. Lastly, 350 hospitals without EMR or eMAR were randomly selected. In this way, a well-rounded sample of 1,000 hospitals was assembled and used in this study.

Data collection for this study began in the latter part of April 2009 with the recruitment of potential participants who were identified in the HIMSS Analytics Database as CNOs. The questionnaires were sent to 1000 CNOs after they were identified. Two follow-up emails were also sent to the CNO email addresses. The first email was sent three weeks after the mailing of the paper questionnaire packets. This timeframe was selected to allow time for delivery by the U.S. Postal Service and inter-hospital mail systems. The second email was sent two weeks after the first email as a reminder to complete the questionnaire either on paper or online. A second paper mailing was not necessary because the first mailing and the two emails produced an adequate sample size. Copies of the letters, questionnaire, and emails are included in Appendix 2.

HIMSS Analytics Data and the American Hospital Directory Analyses

Secondary data was used from the HIMSS Analytics database and the AHD database and was merged into the self-reported questionnaire data. According to the HIMSS Analytics website, the company "collects and analyzes healthcare organization data relating to IT processes and environments, products, IS department composition and costs, IS department management metrics, healthcare delivery trends, and purchasing-related decisions." HIMSS Analytics makes available to members of its graduate school program a database that stores a vast amount of IT data on more than 6,000 hospitals.

Of primary interest for this study are the IT applications associated with each hospital. The level of IT implementation was primarily determined by the number of clinical applications associated with EMR and eMAR. The applications of these two enterprise systems were chosen because they represent the most sophisticated and integrated applications for hospitals, according to the definitions from HIMSS Analytics. HIMSSAnalytics (2009) defines EMR as

> … an application environment that is composed of the clinical data repository, clinical decision support, controlled medical vocabulary, order entry, computerized practitioner order entry, and clinical documentation applications. This environment supports the patient's electronic medical records across inpatient and outpatient environments, and is used by healthcare practitioners to document, monitor, and manage healthcare delivery.

HIMSS Analytics (2009) defines eMAR as

> "an electronic recordkeeping system that documents every drug taken by a patient during a hospital stay. This application supports the five rights of medication administration (right patient, right medication, right dose, right time, and the right route of administration) by utilizing bar coding functionality with pharmacy medication dispensing and nursing medication administration services. This functionality is implemented to reduce medication errors. This functionality requires tightly coupled data flows between CPOE, pharmacy, automated dispensing machines, robotic devices, and nursing administration applications."

The sampling strategy has already been detailed above, with a third of the hospitals having both EMR and eMAR, a third having either EMR or eMAR, but not both, and a third of the hospitals not having either EMR or eMAR. The sampling strategy should give a good variation in the number of clinical software applications associated with these systems in the 1,000 hospitals that were surveyed.

The AHD is a database containing information on quality information reported to Medicare and Medicaid Services, and financial reports for more than 6,000 hospitals in the United States. The database has exhibited reliability because of its sources at Medicare and Medicaid Services and through audited financial reports. The data include quality of healthcare information, like comparisons of care of individual hospitals against national averages for four conditions: heart attack, heart failure, pneumonia, and surgical infection prevention. It also has survey data of hospital patient experiences. Additionally, the AHD includes financial data on each hospital in its database. The financial statement for each hospital in AHD includes an overall cost measure and an average cost of service that are used in this study.

Data Analysis

The data for this study were collected through a questionnaire containing thirteen demographic items and forty Likert items, based on a five-point scale of "strongly disagree" to "strongly agree." The Likert items were used directly in the Partial Least Squares (PLS) statistical package for analysis. The items are not summated or averaged outside of the PLS analysis.

The analysis for this dissertation began by assembling all the data from the various sources into one data file. An electronic data file allowed for initial screening to make sure all the data seemed reasonable and within the boundaries of their respective limits. Basic descriptive statistics (i.e., means, standard deviations, maximum and minimum ranges) and frequency distributions were examined and presented. The data were also checked for missing observations, outliers, and normality through the values of indexes of univariate skew and kurtosis. All of these investigations helped to identify any data that might be out of bound or improperly coded through input error, omissions by informants, or other causes. Correlation analysis and scatterplots were performed. These analyses were inspected for problems areas like multicollinearity. Multicollinearity occurs when two or more variables are highly correlated and are used in multiple regression. This problem can cause abnormalities in the results in response to small changes in the variables or other conditions. Therefore, it is a common practice in such cases to test for and reduce multicollinearity in any statistical analysis. If any problems were detected in any of these areas, the proper steps to correct them were implemented before the validity, reliability, and relationship analyses were conducted.

Non-Response Bias Check

Non-response analysis was needed to make sure that the hospitals of the responding informants did not differ significantly from the hospitals in the population that did not respond. Early respondents were compared with late respondents on the questionnaire items to make sure that there was no significant difference between the two groups (Lewis et al., 2005). The sample was divided into three groups by the dates they were received: early group, middle group, and late group. The early group was compared to the late group using t-tests to see if there were any differences in the two groups on the factors in the survey. If there are no significant differences on these factors, it indicates a low possibility of response bias in the sample. Additionally, non-response bias was assessed using the data in the HIMSS Analytics database. The responding and non-responding hospitals can be compared using t-tests on a number of measurement items in the HIMSS Analytics database, such as number of beds, number of employees, cost of operations, and revenues. Again, if no significant differences are found between the responding sample and the non-respondents on these various parameters, response bias is determined to be statistically insignificant.

Convergent and Discriminant Validity

Convergent and discriminant validity for the survey items were assessed using five different methods to increase confidence in the sample. Convergent validity is used to test if the items reflect the true dimensions of the factor that they are purported to measure (Cronbach & Meehl, 1955). Convergent validity is the extent to which the indicators accurately measure what they are supposed to measure (Hair et al., 1994). Discriminant validity assures that the factors of the questionnaire are truly independent of each other and not measuring the same concept. Kerlinger (1986) suggests factor analysis is a legitimate method for testing for validity. Hair and colleagues (1994) also suggest that validity can be analyzed using the average variance extracted (AVE). The AVE "reflects the overall amount of variance in the indicators accounted for by the latent constructs (the factor)" (p. 642). The higher the AVE, the more likely the items are truly representative of the underlying factor. Recommended value for AVE is typically 0.50 or higher (Hair et al. 1994).

The first test used principal component analysis to make sure that all items load on their own factors and do not cross-load on other factors. If the items load on their own factors, it is a sign of convergent validity. If the items do not load on any other factors, it indicates the presence of discriminant validity in the sample data. Second, the study used the confirmatory factor analysis in PLS to test that the loadings on the items are consistent with the expected underlying factors and that no or very little cross-loading is present in the data. Third, the AVE was calculated and inspected for each factor to make sure that each of the values is above the cutoff of 0.50. The fourth test for validity also uses the AVE. With the test, the AVE of the factors is compared to the cross-correlations for all cross-correlations of the factors. If the AVE is higher than the cross-correlations, it is another source of support for validity of the measures in this sample. Finally, the correlation between any two factors should be less than 0.90, which denotes that the factors are independent of each other.

Reliability

Reliability for each factor is determined in two different ways. Reliability is a measure of the internal consistency of the factors, depicting the degree to which they indicate the unobserved factor (Hair et al., 1994). First, Cronbach's alpha was assessed for each factor. The second reliability measure is composite reliability, which is determined using PLS. Typically, the two results are similar. The most commonly used threshold for reliability measures is 0.70 (Hair et al., 1994). Therefore, the results from the analyses were inspected for all relevant measures to assess whether they were above this threshold.

Relationship Analyses

The relationship model was analyzed using PLS. PLS allows for analysis within a smaller sample size than covariance-based structural equation models (SEMs), like AMOS and LISREL (Chin, 1998). PLS also handles non-normal data better than the covariance-based SEMs; therefore, the underlying data distribution is not as important (Chin, 1998). The advantage of PLS over regular regression is that it is able to analyze multiple dependent variables and also allow a factor to be an independent and dependent variable in the same analysis (Chin, 1998).

The intent of this study was to examine the relationship between the level of IT and the quality of healthcare and level of IT and the cost of healthcare. The literature review reveals that the quality of information was a likely mediator between the relationship between IT and the quality of healthcare and the between the relationship between IT and the cost of healthcare. There are two different measures of the quality of healthcare used in the study, one is the perceived quality of healthcare with data collected from the CNOs and the quality of healthcare data that is reported to Health and Human Services for the Medicare and Medicaid programs. Thus, there are three sets of variables for this study, two for the quality of healthcare and one for cost. Therefore, three different model runs, each featuring one of the set of quality variables or the set of cost variables, are performed in PLS.

Power Analysis

The main role of power analysis is to determine sample size (Pedhazur & Schmelkin, 1991). Establishing the appropriate sample size for a study is dependent upon power, level of significance, and effect size. Conventionally, effect size is estimated from previous research in the field of study. Because the proposed study is novel and the effect size cannot be estimated from previous research, it will be set at .80, which is usually considered adequate (Munro, 2005). The effect size is a sample-based estimate of the strength of the relationship between two factors in statistics. According to Cohen (1988)), effect size is designated ‘r’ and is defined as small effect size = 0.1, moderate = 0.3, and large = 0.5 (small effect size ‘r’ has a 10% difference between two groups, and large effect size ‘r’ is 50% difference). The standard is to use the moderate effect size of 0.3 if little or no research on the topic is available. The level of significance is commonly set at 0.01 or 0.05 (Cohen, 1988; Munro, 2005).

With the parameters of power, level of significance, and effect size established, the sample size can be determined. Cohen provides suitable sample size using power, level of significance, and effect size in tables in his book (Cohen, 1988). Using conservative estimation, a moderate effect size (0.30) with a power of 0.80 and significance level of 0.05, the required sample size from one of Cohen’s tables was determined to be 84 (Cohen, 1988). This sample size should also satisfy any ANOVA or simple regression performed to test Hypotheses 6 since PLS is a multiple regression statistical technique with a higher sample size requirement than ANOVA or simple regression. Therefore, the sample size of 84 should be adequate for these statistical procedures as well.

Chapter 4. Analysis and Results

Chapter 3 identified and explained the methodology used in the analysis stage of this dissertation. In this chapter, the data collection results, the analyses of the data, and the final results from those analyses are reported. Part of this dissertation's research was administering a survey to collect primary data. Because instruments that had been used in previous studies were modified for use in this questionnaire, a pilot study to examine the questionnaire items was performed. The details and results of that pilot study are reported first. Next, the primary data collection collected from CNOs is described more fully and the data analyzed for validity and reliability. The results of these data analyses are presented in text and tables. Finally, the hypotheses of the study are evaluated using PLS, and the results of the evaluation process are reported. These results will be fully discussed in Chapter 5.

Pilot Study

The pretest for the pilot was reported in the previous chapter. The pretest resulted in a questionnaire with nineteen items to measure the factors for quality of healthcare and nine items to measure the factors for quality of information. As described earlier, the questionnaire was administered to nurses at a nursing sorority meeting. Fifty-seven participants completed and returned the survey. Principal component analysis was used to analyze the results from the pilot subjects to investigate how well the questionnaire items fit within the factors, as they were used in previous studies. The principal component analysis used varimax rotation on the factor analysis runs.

The initial draft of the questionnaire for the quality of healthcare proposed six factors from the literature, including measures used in previous studies, as detailed in Chapter 3. These factors were 1) Assurance, 2) Responsiveness, 3) Understanding, 4) Tangibles, 5) Collaboration, and 6) Safety. One way to determine the number of factors in a set of data is to use eigenvalues. The number of components with eigenvalues above or equal to 1.0 equates to the number of factors that the data represent. However, eigenvalues should also be used with reason and experimentation to determine the best factor solution for a given set of data. The eigenvalues in this analysis revealed that the number of factors in the quality of healthcare data was five. The eigenvalues are given in Table 9 for the perceptions of quality of healthcare principal component analysis. The scree plot for this measure also indicates that a five-factor solution is probably the best one. The number of points above 1.0 in the plot (1.0 is at the "elbow" of the graph) translates into the recommended number of factors in the data being analyzed. The scree plot for this analysis is shown in Figure 2. Some experimentation with the data (trying other numbers of factors) revealed that this five-factor solution was indeed the best for the pilot data.

Table 9

Quality of Healthcare Factor Extraction - Eigenvalues

Factor	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	10.336	46.980	46.980
2	1.691	7.685	54.665
3	1.455	6.615	61.280
4	1.265	5.750	67.030
5	1.046	4.756	71.786
6	0.929	4.221	76.008
7	0.737	3.352	79.360
8	0.644	2.925	82.152
9	0.631	2.867	85.152
10	0.494	1.953	87.398

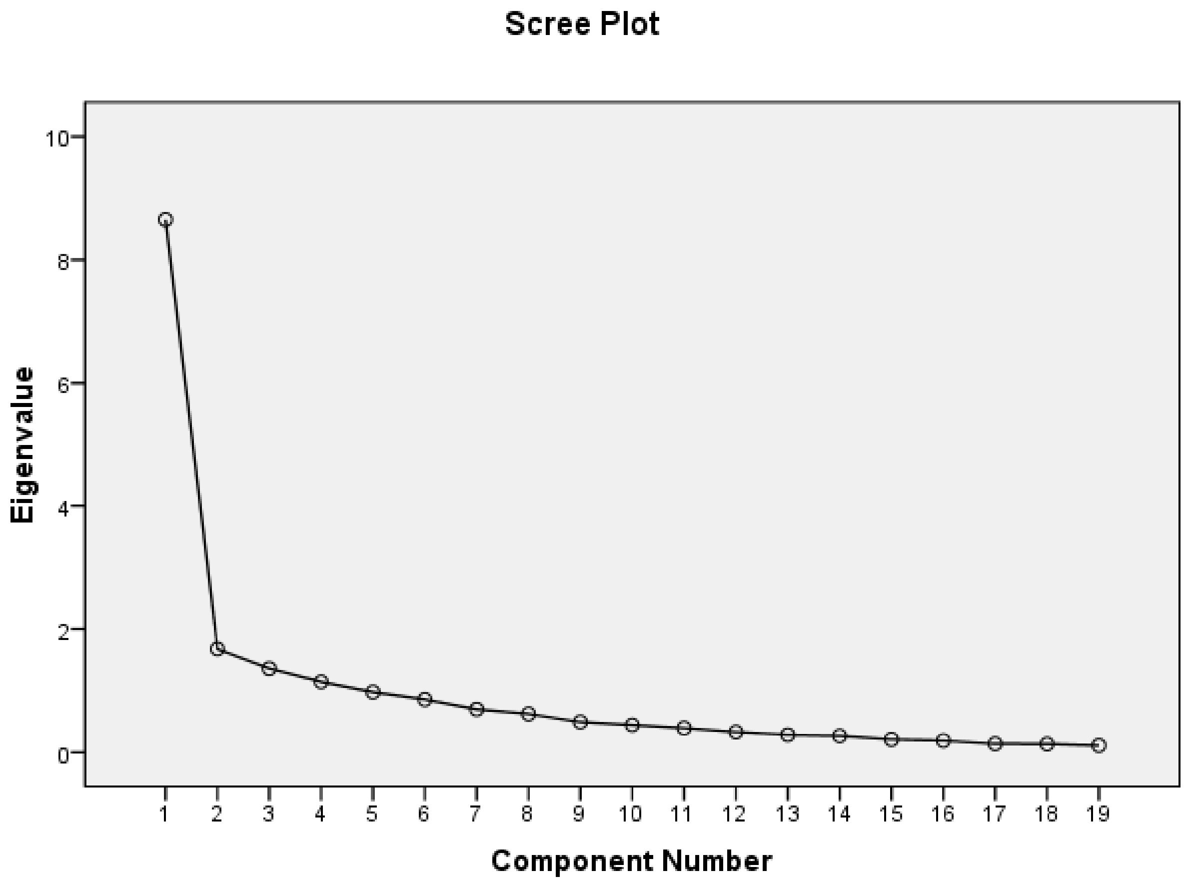

Figure 2. Quality of Healthcare Scree Plot

Table 10 shows the loadings of the items for the factors from the principal component analysis for the perceptions of quality of healthcare measure. Because this is a pilot study, 0.40 was used as the cutoff point for the loadings to be included in a factor. If there were situations where loadings for the same items were above 0.40, the highest loading was used to determine where an item fits best. The loading items are shown in bold and are underlined.

Table 10

Results of Factor Analysis for Pilot Data for Quality of Healthcare

Rotated Factor Matrix (Varimax Rotation)

Items	**Factor**				
	1	**2**	**3**	**4**	**5**
A1: Our nursing service is one of the best at providing reliable healthcare.	.388	**.647**	.035	.306	.328
A2: Our nurses are known for performing services right the first time.	.038	**.746**	.400	-.074	-.070
A3: The nursing staff is dependable in handling patient needs.	.213	**.622**	-.095	.481	-.161
A4: The nurses at this hospital maintain error-free charts on patients.	.201	**.760**	.154	.169	.076
R1: The nurses keep patients informed about when their services will be performed while here in our hospital.	.322	**.780**	-.085	.129	.143
R2: Our nurses provide prompt services to patients.	.258	**.810**	.163	.165	.015
R3: The nursing staff is known for responding quickly to patients' requests.	.258	**.773**	.235	.168	.132
U1: Our nurses understand the needs of the patients and their healthcare needs.	**.622**	.073	.231	.207	-.051
U2: The nursing staff knows the patients on a personal level.	.265	.073	**.798**	.127	.072
U3: Nurses at the hospital can identify with the patients and their healthcare needs.	.170	.284	**.744**	.145	-.142

(table continues)

Table 10 (continued)

Items	Factor				
	1	2	3	4	5
T1: Nurses can easily find the equipment or devices they need for patient care.	.333	.284	.372	**.624**	.105
T2: The nursing areas in the hospital are not cluttered but are neat and organized.	.187	.007	.171	**.832**	.198
T3: The nursing station has everything in its proper place.	-.109	.108	-.021	**.871**	.091
C1: The nurses in the hospitals can collaborate with other departments such as pharmacy and laboratory.	.170	.205	.374	.202	**.658**
C2: Our nurses communicate with the pharmacists and laboratory personnel.	.114	.207	.500	-.039	**.692**
C3: The nursing staff communicate with physicians on the status of patients	-.202	.300	.273	.282	**.613**
S1: Our nursing staff has created a safe environment for patients.	**.546**	.409	.369	.194	.273
S2: Medical errors from nurses are rare compared to other hospitals of this size.	**.756**	.082	.033	.193	-.014
S3: The nurses at this hospital are vigilant about preventing accidents among patients.	**.850**	.278	.097	.045	-.106

Note. A1-4: Assurance; R1-R3: Responsiveness; U1-3: Understanding; T1-3: Tangibles; C1-3: Collaboration; Safety: S1-3.

The reason for reducing the number of factors from six to five was the loading of the proposed Assurance factor and proposed Responsiveness factor into one factor by the analysis. After careful evaluation of the items, it was determined that the two sets of items were indeed different factors, and they were not changed for the survey for the CNOs. A decision was made to leave all of the items in the questionnaire for the survey of the CNOs. The data for these two factors would again be evaluated to make sure that they are indeed separate factors. One of the items for Understanding loaded with the items of the Safety factor. Again, the items were compared and appeared to measure different concepts. This item was left in the questionnaire since the cross-loading into another factor seemed to be an anomaly.

Table 11 shows the eigenvalues for the quality of information measure. The number of eigenvalues above one for the quality of information items was three. The scree plot also indicates that a three-factor measure is the best. The scree plot is shown in Figure 3.

Table 11

Quality of Information Factor Extraction - Eigenvalues

Factor	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	10.273	57.070	57.070
2	1.429	7.940	65.010
3	1.213	6.738	71.749
4	0.927	5.152	76.900
5	0.683	3.792	80.693
6	0.561	3.114	83.807
7	0.515	2.864	86.671
8	0.392	2.177	88.848

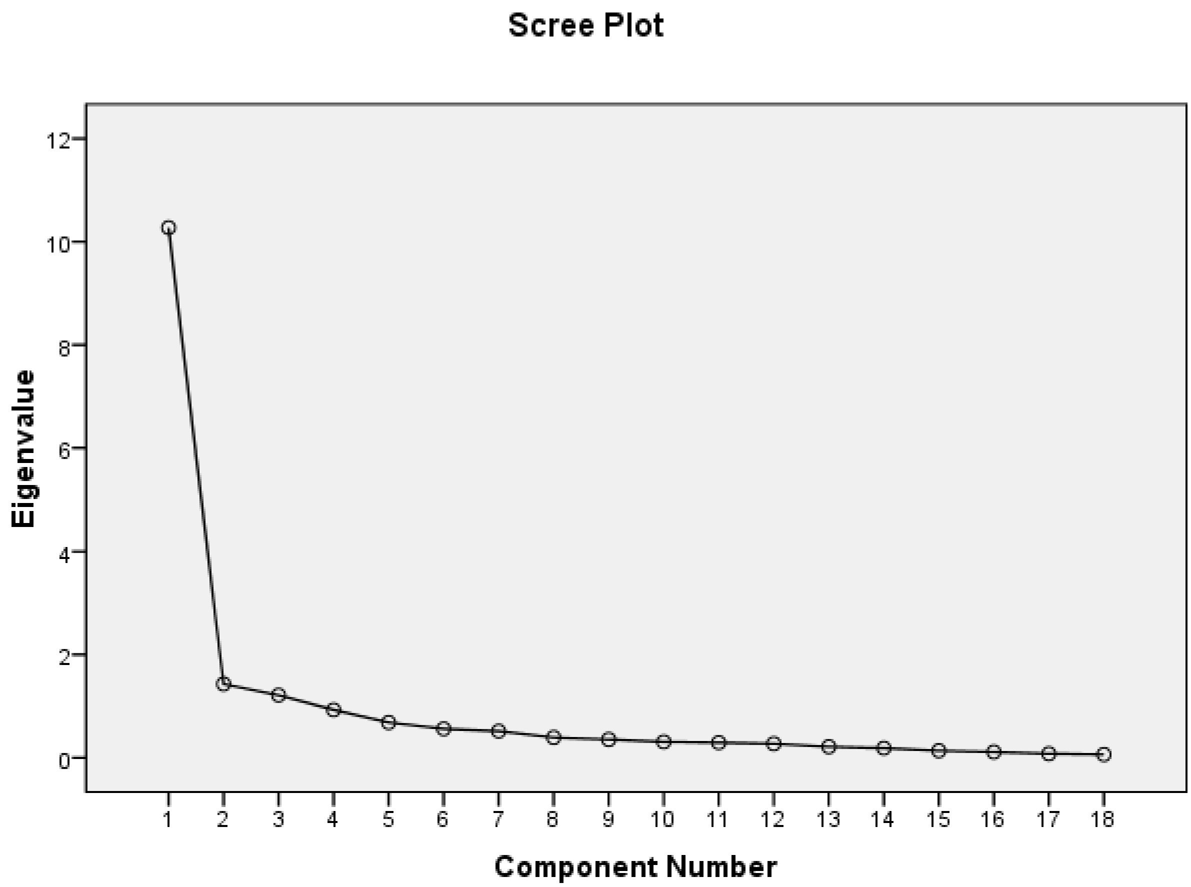

Figure 3. Quality of Information Scree Plot

The loadings for the items for accuracy, reliability, and timeliness are shown in Table 12. The loading for this measure fits the proposed factors very well. No changes were made to the items for the survey. As in the previous measure, the loading items are shown in bold and are underlined.

Table 12

Results of Factor Analysis for Pilot Data for Quality of Information

Rotated Factor Matrix (Varimax Rotation)

Items	Factor		
	1	2	3
AC1: The information used for clinical decision making has numerous accuracy problems that make it difficult for nurses to care for patients.	-.045	**-.858**	-.190
AC2: The information used for clinical decision making that is provided to nurses is accurate.	.405	**.698**	.174
AC3: The information that is used for clinical decision making is correct and adequate to provide excellent patient care.	.213	**.622**	-.095
RL1: The information that nurses need for patient care includes all necessary values.	**.786**	.218	.084
RL2: Clinical information for nurses received is sufficiently complete to provide high quality patient care.	**.763**	.305	.215
RL3: The information that nurses received for patient care has sufficient breadth and depth.	**.774**	.290	.215
TL1: The information that nurses received for clinical decision making is not sufficiently timely to provide the high quality healthcare.	-.071	-.90	**-.902**
TL2: The information used for clinical decision making is not sufficiently timely to provide the high quality healthcare.	-.196	-.095	**-.867**
TL3: The information nurses used for clinical decisions is sufficiently up-to-date to offer high quality patient care.	.416	.469	**.480**

Note. AC1-3: Accuracy; RL1-3: Reliability; TL1-3: Timeliness

After the analyses for the two measures were completed, the questionnaire items were ready for the survey of the CNOs. Items to collect demographics were added to the front of the questionnaire. The demographic items were job-related information, such job title, number of years in the hospital, and job experience; educational degrees; personal information, such as age and race; and technology skills preferred in new hires, such as basic Microsoft skills, personal digital assistant skills, and Internet search skills. These demographics are shown in the questionnaire in the appendix.

Results from Phase 2 Questionnaire Implementation

One thousand single hospital health systems were targeted for the survey, as described in Chapter 3. All of the hospitals were in the United States. The targets of the survey were the CNOs of the hospitals or executive nursing managers with comparable titles. A paper-based survey was sent, and respondents also had the option to take the survey over the Internet. The paper-based survey mailing was followed by two emails reminding the CNOs to respond to the survey request. By using the unique identifier on each survey, the researcher detected that one survey respondent completed both the online and paper survey. Because the responses to each of the items were the same on both surveys, the paper one was disregarded; the electronic survey was formatted for analysis. One hundred and forty-eight respondents used the paper-based questionnaire, and 66 used the online questionnaire, for a total of 214 respondents. Therefore, the response rate for the survey was 21.4%, based on the actual set of survey responses used in the analyses. After the first three weeks, 92 questionnaires were completed. After the initial email, 62 more were completed and returned over the next two weeks. Finally, after a second email to the CNOs, 60 more completed questionnaires were returned. One packet was returned from the paper mailing. Thirty emails were returned from the first email request and 10 emails were returned on the second email request.

Most of the hospitals with responding CNOs were nonprofit healthcare organizations. Of the 214 hospitals, only seven were “for profit” organizations, leaving 207 nonprofit hospitals in the sample.

Descriptive Analysis

Table 13 provides the general characteristics of the survey respondents. The job titles varied but stayed within the scope and definition of a CNO. For example, some of the job titles were CNO, Vice President of Nursing Services, Director of Nursing and Patient Care Services, Chief Clinical Officer, Vice President of Patient Care Services, and Chief Nursing Executive.

Table 13

Age Range of Respondents

Age Range	Frequency	Percent
30-39	8	3.70
40-49	54	25.20
50-59	124	57.90
60-65	23	10.70

There were 193 female respondents, 16 male respondents, and five respondents who did not give their gender. There were 205 Caucasian respondents, 4 Hispanic/Spanish respondents, 3 African-American respondents, and 1 Asian-American respondent. One respondent did not give her race. All but one of the respondents noted that they were registered nurses (see Table 14).

Table 14

Years as Registered Nurse and Chief Nursing Officer

	N	Range	Minimum	Maximum	Standard Deviation
RN	188	41	4	45	7.24
CNO	209	38	0	38	1078.

The correlation matrix for the latent variables is shown in Table 15. The means, standard deviations (SD), and average variance explained (AVE) are also shown in the table. The AVEs in Table 15 are greater than the correlations on the horizontal axis and the vertical axis indicating that the latent variables are distinct and that multicollinearity is likely not a problem in these data. The correlations in Table 15 are also much lower than .75 which indicates that multicollinearity is not likely to be a problem with the data. Typically, variables with correlations greater than .75 may have a problem with multicollnearity. The correlation of .75 is a fairly conservative number (Hair et al., 1995).

Table 15

Correlation Matrix and Descriptive Statistics for Latent Variables

Factors	Mean (SD)	1	2	3	4	5	6	7	8	9
1. Assurance	4.03 (.49)	**.54**								
2. Responsiveness	4.13 (.54)	.46*	**.70**							
3. Understanding	4.30 (.53)	.51*	.53*	**.60**						
4. Tangibles	3.63 (.72)	.34*	.42*	.32*	**.65**					
5. Collaboration	4.38 (.55)	.35*	.39*	.46*	.46*	**.78**				
6. Safety	4.08 (.57)	.50*	.47*	.48*	.49*	.47*	**.63**			
7. Accuracy	3.91 (.72)	.44*	.23*	.24*	.41*	.48*	.47*	**.78**		
8. Reliability	3.91 (.69)	.39*	.20*	.20*	.43*	.45*	.45*	.68*	**.79**	
9. Timeliness	3.85 (.81)	.38*	.24*	.29*	.36*	.35*	.39*	.66*	.61*	**.81**

* significant at .05 level

SD: Standard Deviation

Average Variance Explained (AVE) is bold on the diagonal

Convergent and Discriminant Validity

Confirmatory factor analysis (CFA) was used to examine the convergent validity of both the proposed quality of healthcare factors and quality of information factors. Both measures had gone through a pretest, as described in Chapter 3, and a pilot test, as described earlier in this chapter using principal component analysis. Confirmatory factor analysis was done as part of the PLS analysis to examine the fit of each set of questionnaire items with its respective factor (Lewis et al., 2005). Table 16 gives the loadings for items for the factors. This study used a cutoff of 0.50. As can be seen from Table 16, all of the loadings of the items are 0.50 or greater.

In fact, except for two items, the loadings are greater than 0.70. This indicates that the items fit their respective factors very well.

Table 16

Factor Loadings from PLS Confirmatory Factor Analysis

Factor	Questionnaire Item	Loading
Assurance (AVE = 0.54)		
	A1	.823
	A2	.788
	A3	.678
	A4	.592
Responsiveness (AVE = 0.70)		
	R1	.679
	R2	.889
	R3	.910
Understanding (AVE = 0.60)		
	U1	.858
	U2	.670
	U3	.768
Tangibles (AVE = 0.65)		
	T1	.745
	T2	.824
	T3	.835
Collaboration (AVE = 0.78)		
	C1	.898
	C2	.914
	C3	.828
Safety (AVE = 0.63)		
	S1	.847
	S2	.702
	S3	.825
Accuracy (AVE = 0.78)		
	AC1	.922
	AC2	.932
	AC3	.778
Reliability (AVE = 0.79)		
	RL1	.852
	RL2	.915
	RL3	.900

(table continues)

Table 16 (continued)

Factor	Questionnaire Item	Loading
Timeliness (AVE = 0.81)		
	TL1	.934
	TL2	.924
	TL3	.826

Additionally, the AVEs for the factors are all greater than 0.50. As explained in Chapter 3, the higher the AVE, the more likely the items are truly representative of the underlying factor. In this data, not only are the AVEs for the factors over the threshold of 0.50, many exceed 0.70, which indicates a very strong fit of the data to the factor. The loadings and the AVEs show that the latent variables have adequate convergent validity.

Discriminant validity was evaluated using the test from Fornell and Larcker (1981). The test compares the square root of the AVE in Table 16 to check if it exceeds every correlation on the same row and column. A more stringent test checks to see if the AVE itself exceeds every correlation on the same row and column. For example, the AVE for Accuracy is 0.78. This value would be compared to every value in the row beside it and every value below it. As shown in Table 15, in every case following this example, the AVE is always greater than any of its corresponding correlations. This test shows that the latent variables exhibit excellent discriminant validity.

Reliability

To evaluate the reliability (internal consistency) of each latent variable, both Cronbach's alpha and the composite reliability were calculated. Composite reliability is a value of the internal consistency of the items that are given using the PLS graph. The results of both sets of calculations are shown in Table 17.

Table 17

Reliability Results from Cronbach's Alpha and Composite Reliability Analyses

Factor	Cronbach's Alpha	Composite Reliability
Assurance	.702	.815
Responsiveness	.785	.870
Understanding	.681	.811
Tangibles	.715	.844
Collaboration	.854	.912
Safety	.708	.826
Accuracy	.839	.911
Reliability	.871	.919
Timeliness	.877	.924

Reliability indicates the consistency of the items of a given factor. Table 17 shows the results of two calculations of reliability. A conservative threshold is for the reliability to be 0.70 or above for each factor. A more liberal standard is 0.60 or above. The only measure below 0.70 on any of the statistics is the Understanding factor, which has a Cronbach's alpha of .681. However, the composite reliability for the measure is well above that conservative threshold. Therefore, the reliability for each of the measures is adequate, and the measures are ready to be used for hypothesis testing.

Non-Response Bias

Non-response bias was evaluated in two ways. First, the characteristics of the hospitals with responding CNOs were compared to the characteristics of a similar number of hospitals whose CNOs did not respond. For both sets of hospitals, the characteristics were taken from the

HIMSSAnalytics database. These characteristics included operational costs, net revenue, full-time employees, staffed beds, licensed beds, and the population served by the hospital. The t-test compared the two groups for each of these hospital characteristics. Second, non-response bias was evaluated by comparing the early respondents with the late respondents, using the factors in the survey. The t-test compared the group means for any differences in the early respondents and late respondents.

The number of responding CNOs was 214. To evaluate non-response bias using the characteristics of the hospitals of responding CNOs against the hospitals of the non-responding CNOs, three random samples of the non-responding CNOs' hospitals were generated. Typically, in using t-test analysis, best results are derived when the two groups are approximately the same size. Using three random samples increase the possibility that all of the remaining hospitals are used in the analyses. A SAS procedure called "proc surveyselect" was used to create the three random samples. It is a straightforward SAS procedure that can be used to draw a small sample from a larger data set. SAS 9.1 was used to create the samples. While 214 hospitals responded to the survey, 786 hospitals did not. These 786 hospitals were used as the data set to draw three random samples of 225 hospitals to use in the non-response analyses. The results of the t-tests comparing the hospital characteristics using these three random sets of hospitals and the responding hospitals are shown in Table 18.

Table 18

Results of Non-Response Bias Using Hospital Characteristics

Hospital Characteristic	Sample 1		Sample 2		Sample 3	
	t	sig	t	sig.	t	sig.
Operational Costs	-.685	.494	-1.393	.185	-0.774	.439
Net Revenue	-.636	.525	-1.495	.139	-0.666	.506
Full-Time Employees	-.285	.776	-1.421	.156	-0.706	.481
Number of Staffed Beds	-.815	.415	-0.520	.604	-1.646	.100
Number of Licensed Beds	-.991	.322	-0.665	.506	-0.525	.607
Service Population	-.872	.384	-0.867	.386	0.902	.368

Each sample of 225 non-respondents is compared against the sample of the 214 respondents to the survey questionnaire.

As shown by the results in Table 18 that compare respondents against three random samples of non-respondents, there were no significant differences in any of the characteristics. This is a strong indication that the responding and the non-responding hospitals were very alike overall. Indeed, the results here give evidence that the responding hospital group was representative of the original group of hospitals selected for analysis.

To further check for non-response bias, early responding hospitals were compared to late responding hospitals. Table 19 gives the results of the t-test analyses for these two groups, comparing the latent variables in the study.

Table 19

Results of T-tests on Factors of Early Respondents and Late Respondents

Factor	t	Significance
Assurance	0.325	.745
Responsiveness	1.595	.112
Understanding	0.424	.672
Tangibles	1.197	.233
Collaboration	0.241	.810
Safety	0.148	.883
Accuracy	0.162	.315
Reliability	0.228	.820
Timeliness	0.425	.671

Again, the t-tests in Table 19 show that there is no difference between early respondents and late respondents in the data that was collected. The results show that the responding group and the non-responding group were statistically similar on key demographic and study variables. Overall findings suggest that non-response bias is not a factor in this study.

Hypothesis Testing

Partial least squares (PLS) regression, using PLS-Graph, was used on the hypotheses previously presented in this study. These hypotheses explore the relationship between the level of IT implementation, the quality of information, the quality of healthcare, and operational cost in single-owned hospitals in the United States. PLS is a statistical technique that allows for evaluation of models where variables can be both endogenous (dependent) and exogenous (independent) simultaneously. The first model will relate level of IT implementation, the quality of information, and the perceived quality of healthcare. The model is shown in Figure 4.

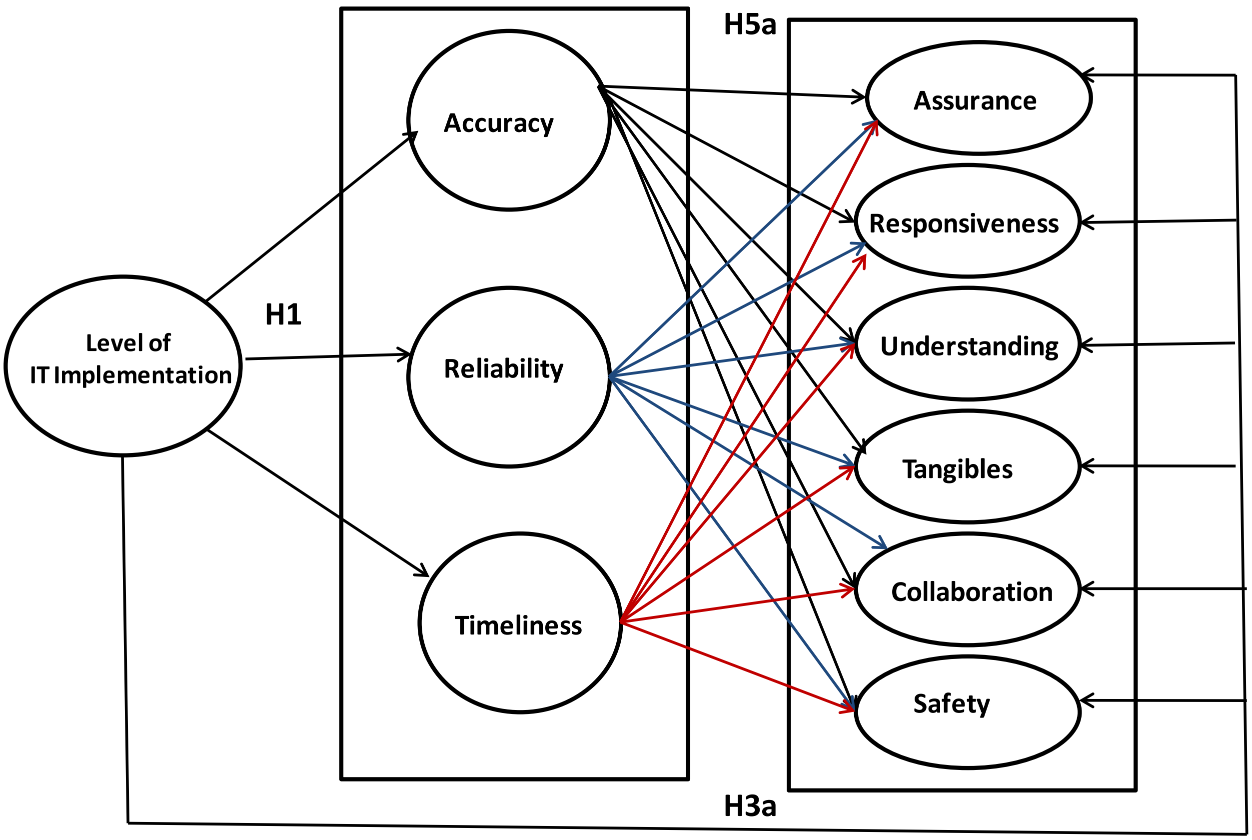

Figure 4. Model for Hypotheses 1, 3a, and 5a in the Study

Controls for Model: Size by Beds, Service Population

This model tests Hypothesis 1, Hypothesis 3a, and Hypothesis 5a. Hypothesis 1 (H1 in Figure 4) examines the relationship between the level of IT implementation and the perceptions of information quality. Hypothesis 3a (H3a in Figure 4) looks at the relationship between the level of IT implementation and the perceptions of the quality of healthcare in hospitals. Hypothesis 5a (H5a in Figure 4) inspects the relationship between the perceptions of information quality and the perceptions of the quality of healthcare in hospitals. The results are shown in Figure 5 and Table 20.

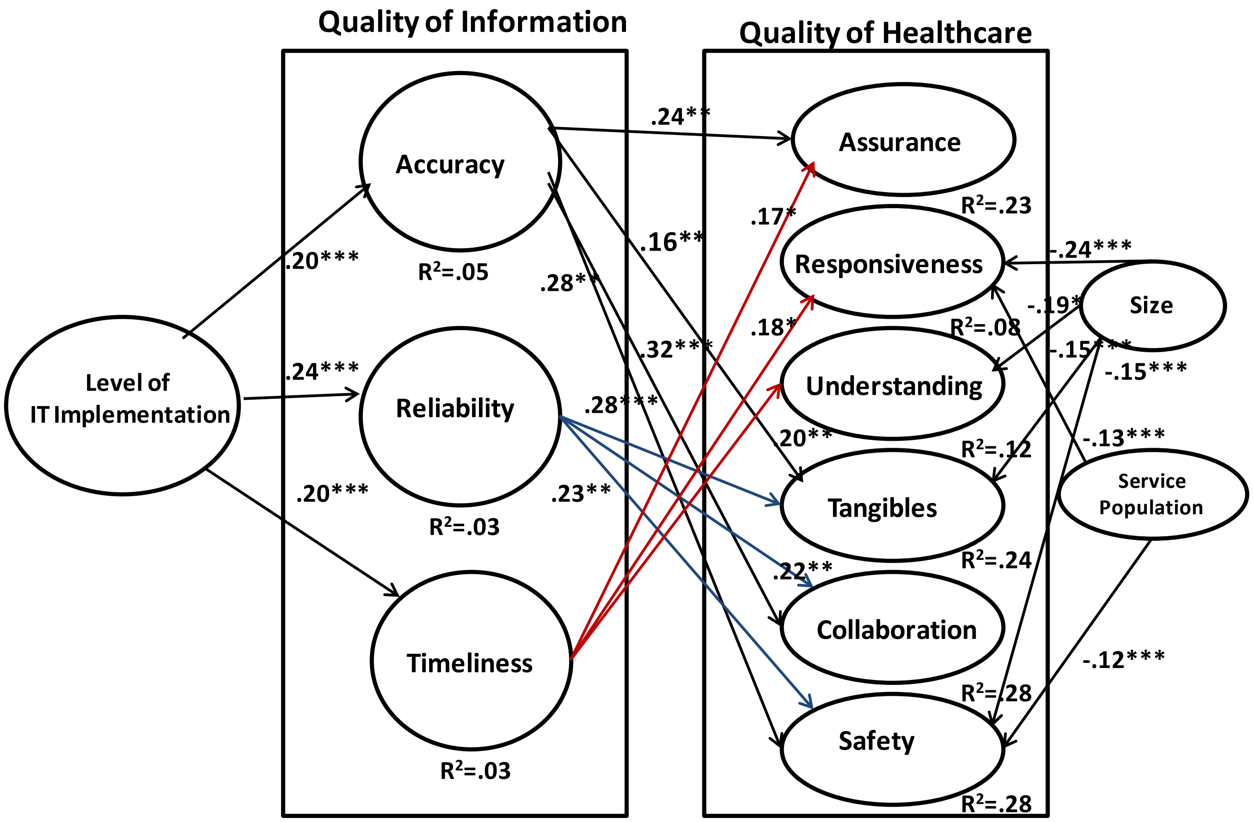

Figure 5. Results of PLS Analysis for Hypotheses 1, 3, and 5

Significance Key for Figure 5: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 20 gives another view of the significant relationships in the model.

Table 20

Significant Relationships among Factors for Hypotheses 1, 3, and 5

Relationship	Beta Coefficient	T-Statistic
Level of IT Implementation → Accuracy	.20	3.02
Level of IT Implementation → Reliability	.24	3.44
Level of IT Implementation → Timeliness	.20	2.60
Accuracy → Assurance	.24	2.43
Accuracy → Tangibles	.16	2.10
Accuracy → Collaboration	.32	3.34
Accuracy → Safety	.28	3.04
Reliability → Tangibles	.28	2.91
Reliability → Collaboration	.22	2.38
Reliability → Safety	.23	2.45
Timeliness → Assurance	.17	1.68
Timeliness → Responsiveness	.18	1.70
Timeliness → Understanding	.20	1.97
Size → Responsiveness	-.24	4.03
Size → Understanding	-.19	1.74
Size → Tangibles	-.15	2.65
Size → Safety	-.15	2.89
Service Population → Responsiveness	-.13	2.71
Service Population → Safety	-.12	3.25

The second model relates the level of IT implementation, the quality of information, and the cost of healthcare. The model uses two different measures for cost of healthcare. To standardize the measure across hospitals, one is the hospital operations cost divided by the number of beds. This measure includes all costs associated with running the hospitals. The second measure is the average cost of twenty of the most common hospital services. This is a measure that indicates the cost of the clinical services in the hospitals. The model, shown in Figure 6, examines Hypotheses 2 (H2) and 4 (H4).

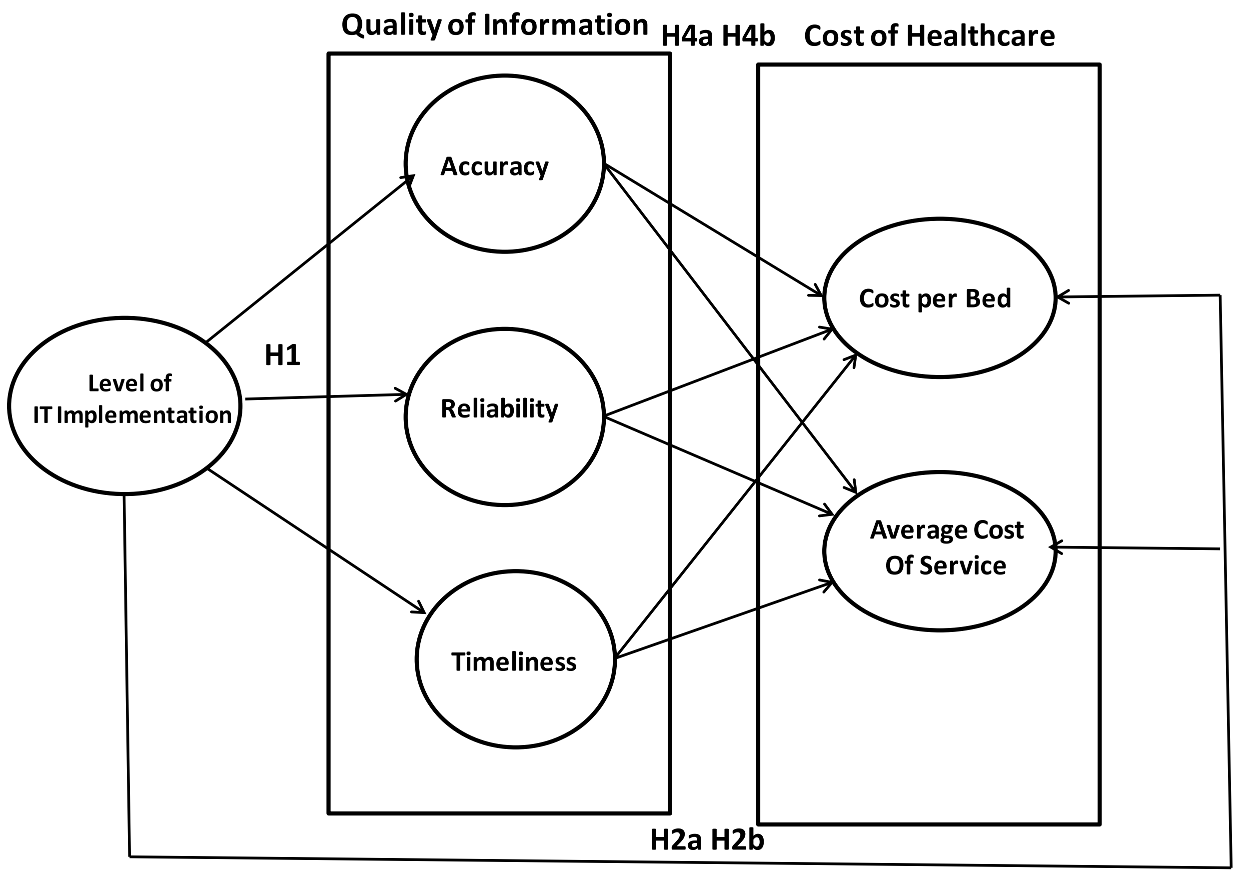

Figure 6. Model for Hypotheses 2a, 2b, 4a and 4b

Controls for Model: Service Population

This model tests Hypotheses 2a, 2b, 4a and 4b (Hypothesis 1 is the same as before). Hypotheses 2a and 2b (H2a and H2b in Figure 6) look at the relationship between the level of IT implementation and the cost of healthcare in hospitals. Hypotheses 4a and 4b (H4a and H4b in

Figure 6) inspect the relationship between the perceptions of information quality and the cost of healthcare in hospitals. The results are shown in Figure 7 and Table 21.

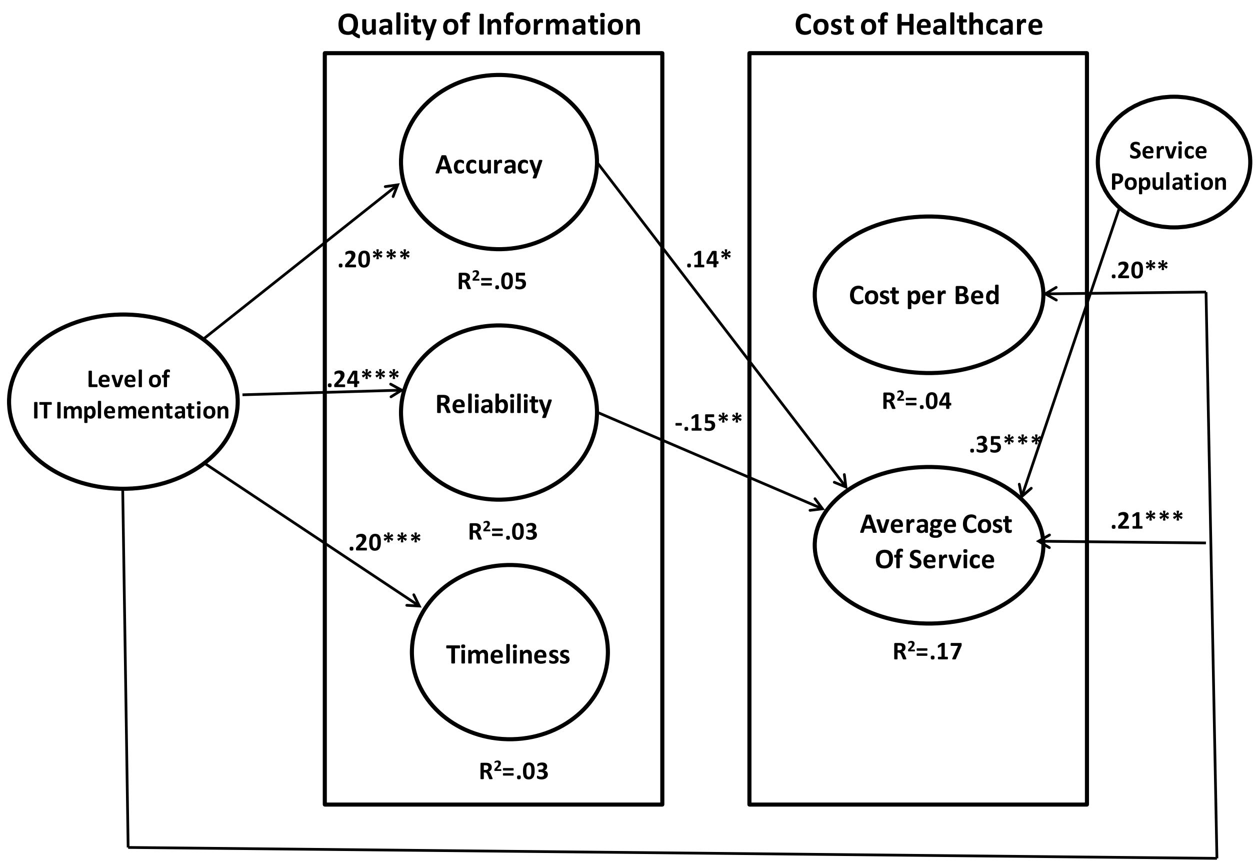

Figure 7. Results of PLS Analysis for Hypotheses 2a, 2b, 4a and 4b

Significance Key for Figure 7: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 21 gives another view of the significant relationships in the model.

Table 21

Significant Relationships for Hypotheses 2a, 2b, 4a and 4b

Relationship	Beta Coefficient	T-Statistic
Level of IT Implementation → Cost per Bed	.20	2.32
Level of IT Implementation → Average Cost of Service	.21	3.31
Accuracy → Average Cost of Service	.14	1.70
Reliability → Average Cost of Service	-.15	2.23
Service Population → Average Cost of Service	.35	2.50

The third model relates the level of IT implementation, the quality of information, and the quality of healthcare. However, the measures for the quality of healthcare are not the perceived quality of healthcare factors from the survey of CNOs. These quality of healthcare measures are taken from the American Hospital Directory (AHD). The AHD obtains the measures from the Health and Human Services Department of the United States government and makes them available in individual hospital reports. The measures are scores associated with basic medical services related to treatments for four acute conditions: heart attack, heart failure, pneumonia, and surgical care. Thus, this model reexamines Hypotheses 3b and 5b using different quality of healthcare measures. The model for this run is shown in Figure 8.

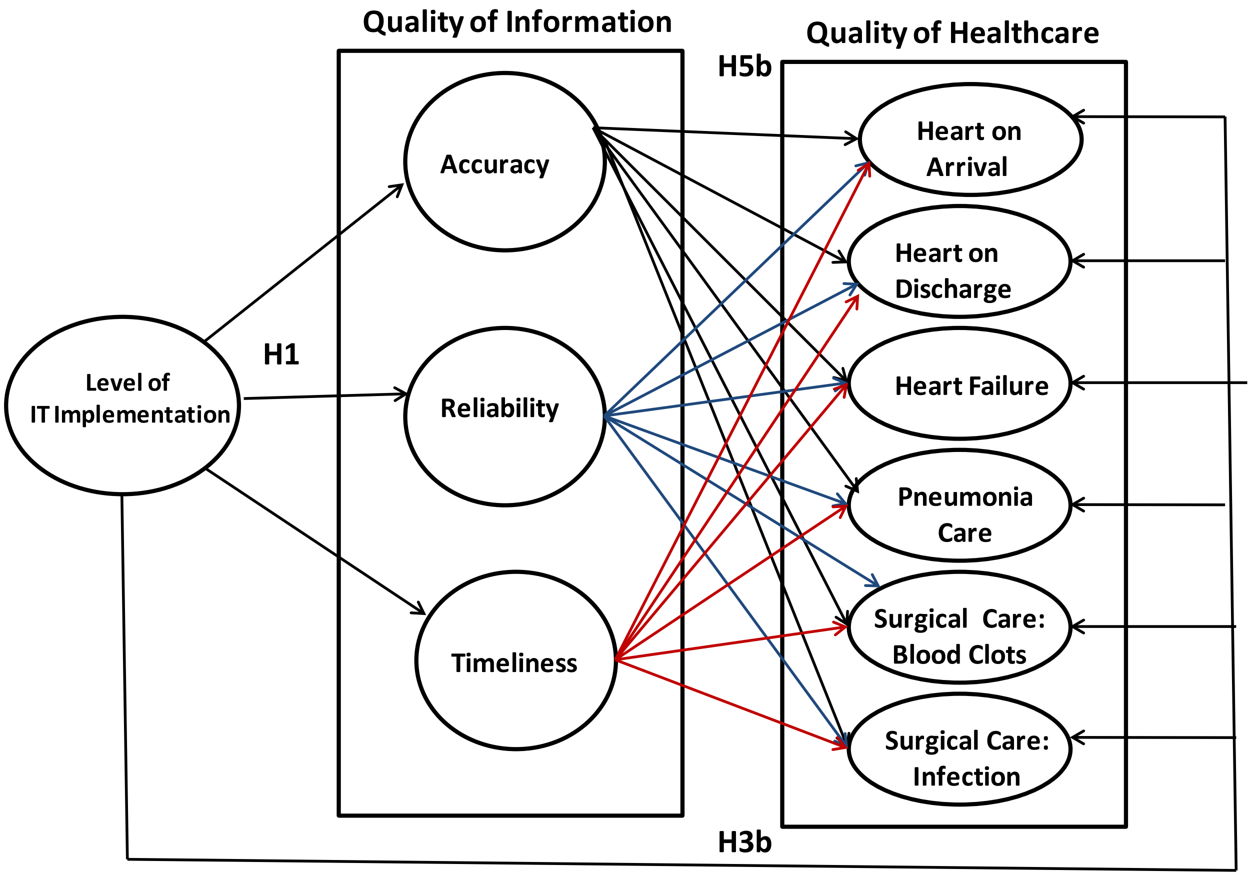

Figure 8. Model for Examination of Hypotheses 3b and 5b

Controls for Model: Size by Beds, Service Population

This model tests Hypotheses 3b and 5b (Hypothesis 1 is the same as before) again using different quality of healthcare measures, as explained above. Hypothesis 3b (H3b in Figure 8) looks at the relationship between the level of IT implementation and the quality of healthcare using the AHD measures. Hypothesis 5b (H5b in Figure 8) inspects the relationship between the perceptions of information quality and the quality of healthcare measures from the AHD. The results are shown in Figure 9 and Table 22.

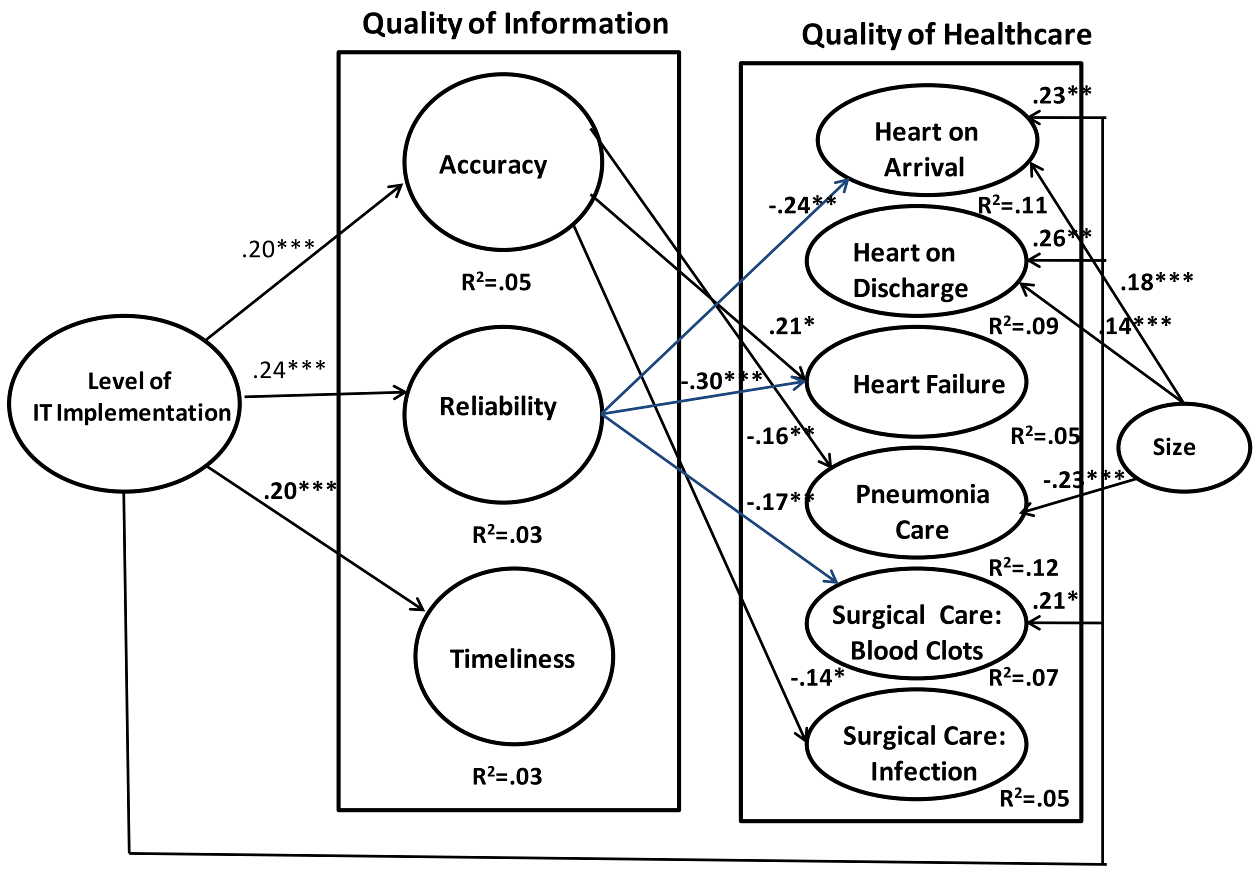

Figure 9. Results of PLS Analysis for Reexamination of Hypotheses 3b and 5b

Significance Key for Figure 9: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 22

Significant Relationships for Reexamination of Hypotheses 3 and 5

Relationship	Beta Coefficient	T-Statistic
Level of IT Implementation → Heart on Arrival	.23	2.50
Level of IT Implementation → Heart on Discharge	.26	2.60
Level of IT Implementation → Surgical Care: Start	.21	1.71
Accuracy → Heart Failure	.21	1.75
Accuracy → Pneumonia Care	-.16	2.12
Accuracy → Surgical Care: End	-.14	1.73
Reliability → Heart on Arrival	-.24	2.10
Reliability → Heart Failure	-.30	2.60
Reliability → Surgical Care: Start	-.17	1.86

The next two of hypotheses, 6a and 6b, are added to test against bias in the research instrument. If the questionnaire is to be used to be a general purpose tool, there should be no differences in the responses in the demographic and practice characteristics of the respondents. The demographic and practice characteristics used to test these hypotheses were Gender, Race, Age, Years of Practice, Years in Hospital, and Years in Current Job. The data for Age, Gender, and Race were collected by having the respondents choose a category from a list. The data for Years of Practice, Years in Hospital, and Years in Current Job were collected as continual data and not in categories or groups. A bivariate analysis using Analysis of Variance (ANOVA) was done for responses to each item in the survey instrument against each of these demographic and practice characteristics. First, Table 22 shows the means and standard deviations for all of the responses to the items in the survey instrument. The results of the bivariate analyses for the demographic and practice characteristics against the respondents to the items are in Table 23 through Table 28. The mean and standard deviation for each of the demographic or practice characteristics (continuous variables) are given in these tables as well, respectively.

Table 22

Mean and Standard Deviation for Responses to the Items in Survey Instrument

Variable	N	Mean	Std. Deviation
A1	211	4.38	.584
A2	211	4.12	.620
A3	211	3.22	.867
A4	209	4.42	.623
R1	212	4.05	.655
R2	211	4.21	.589
R3	211	4.14	.694
U1	210	4.29	.590
U2	211	4.35	.756
U3	212	4.26	.665
T1	212	3.99	.800
T2	212	3.52	.987
T3	212	3.39	.924
C1	211	4.34	.667
C2	212	4.44	.593
C3	211	4.36	.595
S1	212	4.32	.550
S2	212	3.81	.861
S3	211	4.10	.727
AC1	211	2.27	1.032
AC2	211	4.02	.693
AC3	211	3.98	.727
RL1	210	3.96	.731
RL2	211	3.94	.803
RL3	211	3.82	.794
TL1	211	3.91	1.753
TL2	210	3.80	.951
TL3	211	3.94	.785

Table 23

ANOVA Analysis for Gender Against Responses to Items in the Survey Instrument

Gender Analysis				
Analysis of Variance (ANOVA)	**Levene's Test for Equality of Variances**		**t-test for Equality of Means**	
	F	Significance	t	p-value
Gender x A1	1.444	.231	.013	.990
Gender x A2	.935	.335	.004	.997
Gender x A3	.001	.980	-.987	.325
Gender x A4	8.259	.004	1.097	.274
Gender x R1	2.285	.132	-.60	.952
Gender x R2	3.751	.054	.211	.833
Gender x R3	3.743	.054	-.311	.756
Gender x U1	.247	.620	-.621	.535
Gender x U2	3.739	.055	.540	.590
Gender x U3	.881	.349	-.752	.453
Gender x T1	.854	.357	-.723	.470
Gender x T2	6.529	.011	-1.225`	.222
Gender x T3	.006	.940	-1.098	.273
Gender x C1	.059	.808	-.955	.341
Gender x C2	1.000	.318	-.403	.688
Gender x C3	.228	.634	-1.007	.315
Gender x S1	.976	.324	-.434	.665
Gender x S2	.373	.542	-1.762	.080
Gender x S3	.084	.772	-.873	.384
Gender x AC1	.591	.443	.530	.597
Gender x AC2	.008	.928	-1.704	.090
Gender x AC3	.260	.610	-1.512	.132
Gender x RL1	1.262	.263	-1.281	.202
Gender x RL2	1.670	.198	-1.588	.114
Gender x RL3	8.194	.005	-1.586	.114
Gender x TL1	.178	.674	-.647	.518
Gender x TL2	008	.929	-1.142	.255
Gender x TL3	2.444	.120	-1.324	.187

Table 24

ANOVA Analysis for Race Against Responses to Items in the Survey Instrument

Race Analysis				
Analysis of Variance (ANOVA)	**Levene's Test for Equality of Variances**		**t-test for Equality of Means**	
	F	Significance	t	p-value
Race x A1	3.87	.050	.630	.529
Race x A2	.124	.725	-.605	.546
Race x A3	.889	.347	-.512	.609
Race x A4	2.049	.154	.756	.451
Race x R1	.075	.785	1.358	.176
Race x R2	2.997	.085	1.027	.306
Race x R3	.223	.638	.037	.970
Race x U1	.012	.912	.690	.491
Race x U2	.411	.522	-1.049	.295
Race x U3	.442	.507	-.472	.637
Race x T1	7.346	.007	2.672	.008
Race x T2	.153	.696	-.937	.350
Race x T3	.260	.611	.033	.974
Race x C1	3.343	.069	-.098	.922
Race x C2	11.225	.001	.365	.722
Race x C3	.108	.743	.515	.605
Race x S1	1.415	.236	.336	.737
Race x S2	2.446	.119	.631	.528
Race x S3	.000	.993	.379	.705
Race x AC1	.678	.411	-1.345	.180
Race x AC2	.010	.919	-.400	.690
Race x AC3	.000	.994	-.571	.569
Race x RL1	.088	.766	-.151	.880
Race x RL2	.013	.908	-.188	.851
Race x RL3	3.721	.055	-1.101	.272
Race x TL1	.308	.580	-.755	.451
Race x TL2	1.371	.243	-1.724	.086
Race x TL3	.453	.502	-1.148	.252

Table 25

ANOVA Analysis for Race Against Responses to Items in the Survey Instrument

Age Range				
Analysis of Variance	**Levene's Test for Equality of Variances**		**t-test for Equality of Means**	
	F	Significance	t	p-value
Age x A1	.000	.997	.223	.824
Age x A2	.629	.429	.460	.646
Age x A3	.076	.783	-.061	.952
Age x A4	.118	.731	.374	.709
Age x R1	.028	.866	-.286	.775
Age x R2	6.470	.012	-1.296	.196
Age x R3	1.125	.291	-.877	.381
Age x U1	.628	.429	-.920	.359
Age x U2	1.032	.311	2.147	.033
Age x U3	.461	.498	.924	.356
Age x T1	1.467	.227	1.308	.192
Age x T2	.299	.585	.497	.620
Age x T3	.434	.511	-.753	.452
Age x C1	.002	.968	-.576	.565
Age x C2	6.542	.011	-1.135	.258
Age x C3	3.178	.076	-.036	.971
Age x S1	1.642	.201	-.133	.894
Age x S2	5.074	.025	-.508	.612
Age x S3	.698	.404	-.341	.733
Age x AC1	.420	.518	-.159	.874
Age x AC2	.131.	.718	.329	.742
Age x AC3	970	.326	.930	.354
Age x RL1	4.362	.038	-.127	.899
Age x RL2	10.718	.001	.667	.505
Age x RL3	7.058	.009	-.138	.890
Age x TL1	.424.	.516	2.001	.047
Age x TL2	5.694	.018	.987	.325
Age x TL3	11.074	.001	.743	.458

Table 26

ANOVA Analysis for Years of Practice Against Responses to Items in the Survey Instrument

Years of Practice		
Mean (Std Dev)	29.2(7.2)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Years of Practice x A1	1.603	.204
Years of Practice x A2	.632	.595
Years of Practice x A3	.682	.605
Years of Practice x A4	1.354	.258
Years of Practice x R1	.053	.984
Years of Practice x R2	1.324	.268
Years of Practice x R3	1.086	.356
Years of Practice x U1	1.172	.312
Years of Practice x U2	.806	.492
Years of Practice x U3	.693	.557
Years of Practice x T1	3.161	.026
Years of Practice x T2	1.336	.259
Years of Practice x T3	1.442	.211
Years of Practice x C1	1.347	.261
Years of Practice x C2	2.689	.071
Years of Practice x C3	.164	.920
Years of Practice x S1	1.388	.248
Years of Practice x S2	1.503	.203
Years of Practice x S3	.789	.501
Years of Practice x AC1	.031	.998
Years of Practice x AC2	1.211	.308
Years of Practice x AC3	1.101	.358
Years of Practice x RL1	1.530	.208
Years of Practice x RL2	1.433	.235
Years of Practice x RL3	2.975	.033
Years of Practice x TL1	.752	.586
Years of Practice x TL2	1.074	.371
Years of Practice x TL3	.595	.619

Table 27

ANOVA Analysis for Years in Hospital Against Responses to Items in the Survey Instrument

Years in Hospital		
Mean (Std Dev.)	13.6 (10.8)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Years in Hospital x A1	4.190	.016
Years in Hospital x A2	.909	.438
Years in Hospital x A3	1.255	.289
Years in Hospital x A4	1.396	.245
Years in Hospital x R1	2.844	.039
Years in Hospital x R2	1.826	.144
Years in Hospital x R3	1.511	.213
Years in Hospital x U1	2.521	.059
Years in Hospital x U2	3.382	.019
Years in Hospital x U3	1.195	.313
Years in Hospital x T1	.412	.744
Years in Hospital x T2	1.696	.152
Years in Hospital x T3	1.279	.274
Years in Hospital x C1	4.721	.003
Years in Hospital x C2	7.512	.001
Years in Hospital x C3	1.675	.174
Years in Hospital x S1	1.180	.318
Years in Hospital x S2	1.328	.261
Years in Hospital x S3	1.105	.348
Years in Hospital x AC1	.366	.833
Years in Hospital x AC2	1.537	.193
Years in Hospital x AC3	1.987	.098
Years in Hospital x RL1	1.611	.188
Years in Hospital x RL2	.848	.469
Years in Hospital x RL3	2.552	.057
Years in Hospital x TL1	.732	.600
Years in Hospital x TL2	.930	.447
Years in Hospital x TL3	.771	.512

Table 28

ANOVA Analysis for Years in Current Job Against Responses to Items in the Survey Instrument

Years in Current Job		
Mean (Std Dev.)	9.1 (7.8)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Years in Current Job x A1	1.037	.357
Years in Current Job x A2	.858	.464
Years in Current Job x A3	1.239	.296
Years in Current Job x A4	.373	.773
Years in Current Job x R1	2.506	.061
Years in Current Job x R2	2.702	.047
Years in Current Job x R3	3.372	.020
Years in Current Job x U1	2.118	.123
Years in Current Job x U2	1.112	.346
Years in Current Job x U3	2.739	.045
Years in Current Job x T1	.254	.858
Years in Current Job x T2	.875	.480
Years in Current Job x T3	3.417	.010
Years in Current Job x C1	3.470	.017
Years in Current Job x C2	3.625	.029
Years in Current Job x C3	1.114	.345
Years in Current Job x S1	2.823	.040
Years in Current Job x S2	1.977	.100
Years in Current Job x S3	.872	.457
Years in Current Job x AC1	1.589	.179
Years in Current Job x AC2	.361	.836
Years in Current Job x AC3	.711	.585
Years in Current Job x RL1	.447	.720
Years in Current Job x RL2	.725	.538
Years in Current Job x RL3	1.707	.167
Years in Current Job x TL1	.904	.480
Years in Current Job x TL2	.830	.508
Years in Current Job x TL3	1.235	.298

Additionally, a bivariate analysis was also done for responses to each item against hospital characteristics. The hospital characteristics were Service Population, Number of Licensed Beds, Number of Staffed Beds, Full Time Employees, Net Revenue, Operational Expense, Average Cost of Service and whether the hospitals had no EMR or eMAR, either EMR or eMAR, or both EMR and eMAR. The results from the bivariate analyses are shown in Table 29 through Table 35. The mean and standard deviation for each hospital characteristic are given in their respective table.

Table 29

ANOVA Analysis for Service Population Against Responses to Items in the Survey Instrument

Service Population		
Mean (Std Dev.)	1843834.3 (1.4E7)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Service Population x A1	.353	.703
Service Population x A2	2.551	.057
Service Population x A3	.399	.809
Service Population x A4	.390	.760
Service Population x R1	1.451	.229
Service Population x R2	1.358	.257
Service Population x R3	.160	.923
Service Population x U1	.346	.792
Service Population x U2	2.386	.070
Service Population x U3	2.903	.036
Service Population x T1	1.085	.357
Service Population x T2	.427	.789
Service Population x T3	.189	.967
Service Population x C1	.448	.719
Service Population x C2	.428	.652
Service Population x C3	.634	.594
Service Population x S1	.249	.862
Service Population x S2	.805	.523
Service Population x S3	2.361	.073
Service Population x AC1	1.403	.234
Service Population x AC2	.128	.972
Service Population x AC3	.179	.949
Service Population x RL1	1.757	.157
Service Population x RL2	1.353	.258
Service Population x RL3	2.094	.102
Service Population x TL1	.213	.957
Service Population x TL2	.276	.893
Service Population x TL3	.183	.908

Table 30

ANOVA Analysis for Number of Licensed Beds Against Responses to Items in the Survey Instrument

Number of Licensed Beds		
Mean (Std Dev.)	212.1 (201.2)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Licensed Beds x A1	1.188	.307
Licensed Beds x A2	.178	.911
Licensed Beds x A3	.857	.490
Licensed Beds x A4	.304	.823
Licensed Beds x R1	1.732	.161
Licensed Beds x R2	1.441	.232
Licensed Beds x R3	.492	.688
Licensed Beds x U1	.530	.662
Licensed Beds x U2	1.897	.131
Licensed Beds x U3	.527	.664
Licensed Beds x T1	.167	.919
Licensed Beds x T2	.825	.511
Licensed Beds x T3	.504	.773
Licensed Beds x C1	.211	.889
Licensed Beds x C2	.800	.451
Licensed Beds x C3	.912	.436
Licensed Beds x S1	1.216	.305
Licensed Beds x S2	1.437	.223
Licensed Beds x S3	.894	.445
Licensed Beds x AC1	1.250	.291
Licensed Beds x AC2	.173	.952
Licensed Beds x AC3	.169	.954
Licensed Beds x RL1	.639	.591
Licensed Beds x RL2	.172	.915
Licensed Beds x RL3	.470	.704
Licensed Beds x TL1	1.185	.318
Licensed Beds x TL2	.473	.756
Licensed Beds x TL3	.154	.927

Table 31

ANOVA Analysis for Number of Staffed Beds Against Responses to Items in the Survey Instrument

Number of Staffed Beds		
Mean (Std Dev.)	190.3 (185.2)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Staffed Beds x A1	.997	.371
Staffed Beds x A2	.375	.771
Staffed Beds x A3	1.040	.387
Staffed Beds x A4	.263	.852
Staffed Beds x R1	2.072	.105
Staffed Beds x R2	1.136	.335
Staffed Beds x R3	.419	.740
Staffed Beds x U1	.662	.576
Staffed Beds x U2	1.886	.133
Staffed Beds x U3	.691	.558
Staffed Beds x T1	.290	.832
Staffed Beds x T2	.874	.481
Staffed Beds x T3	.571	.722
Staffed Beds x C1	.171	.916
Staffed Beds x C2	1.209	.301
Staffed Beds x C3	.632	.595
Staffed Beds x S1	1.236	.297
Staffed Beds x S2	1.383	.241
Staffed Beds x S3	.771	.511
Staffed Beds x AC1	1.399	.236
Staffed Beds x AC2	.100	.982
Staffed Beds x AC3	.235	.918
Staffed Beds x RL1	.570	.636
Staffed Beds x RL2	.116	.950
Staffed Beds x RL3	.441	.724
Staffed Beds x TL1	1.140	.341
Staffed Beds x TL2	.541	.706
Staffed Beds x TL3	.106	.956

Table 32

ANOVA Analysis for Full Time Employees Against Responses to Items in the Survey Instrument

Full Time Employees		
Mean (Std Dev.)	940.9 (1188.0)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
F/T Employees x A1	1.871	.157
F/T Employees x A2	.246	.864
F/T Employees x A3	.239	.916
F/T Employees x A4	.080	.923
F/T Employees x R1	2.168	.093
F/T Employees x R2	.672	.570
F/T Employees x R3	1.629	.184
F/T Employees x U1	2.242	.085
F/T Employees x U2	.393	.758
F/T Employees x U3	.972	.407
F/T Employees x T1	.208	.891
F/T Employees x T2	1.226	.301
F/T Employees x T3	.271	.929
F/T Employees x C1	.272	.846
F/T Employees x C2	1.209	.301
F/T Employees x C3	.028	.972
F/T Employees x S1	7.287	.000
F/T Employees x S2	1.964	.102
F/T Employees x S3	.818	.485
F/T Employees x AC1	.942	.441
F/T Employees x AC2	1.337	.258
F/T Employees x AC3	.425	.791
F/T Employees x RL1	.352	.787
F/T Employees x RL2	.569	.636
F/T Employees x RL3	.376	.770
F/T Employees x TL1	1.533	.182
F/T Employees x TL2	2.566	.040
F/T Employees x TL3	.446	.721

Table 33

ANOVA Analysis for Net Revenue Against Responses to Items in the Survey Instrument

Net Revenue		
Mean (Std Dev.)	1.54E8 (2.4E8)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Net Revenue x A1	2.404	.094
Net Revenue x A2	.308	.820
Net Revenue x A3	.254	.907
Net Revenue x A4	.587	.557
Net Revenue x R1	.924	.431
Net Revenue x R2	.233	.873
Net Revenue x R3	.580	.629
Net Revenue x U1	1.425	.238
Net Revenue x U2	.917	.434
Net Revenue x U3	1.121	.342
Net Revenue x T1	.266	.850
Net Revenue x T2	1.699	.153
Net Revenue x T3	.689	.633
Net Revenue x C1	.237	.871
Net Revenue x C2	1.240	.292
Net Revenue x C3	.025	.994
Net Revenue x S1	3.608	.015
Net Revenue x S2	1.983	.100
Net Revenue x S3	.841	.473
Net Revenue x AC1	.997	.411
Net Revenue x AC2	1.923	.128
Net Revenue x AC3	.303	.823
Net Revenue x RL1	.763	.517
Net Revenue x RL2	.072	.975
Net Revenue x RL3	.109	.955
Net Revenue x TL1	1.282	.280
Net Revenue x TL2	1.395	.238
Net Revenue x TL3	.062	.980

Table 34

ANOVA Analysis for Operational Expense Against Responses to Items in the Survey Instrument

Operational Expense		
Mean (Std Dev.)	1.5E8 (2.3E8)	
Analysis of Variance	**F-Statistic**	
	F	p-value
Operational Expense x A1	2.081	.128
Operational Expense x A2	.301	.824
Operational Expense x A3	.270	.897
Operational Expense x A4	.662	.518
Operational Expense x R1	.932	.427
Operational Expense x R2	.267	.849
Operational Expense x R3	.588	.624
Operational Expense x U1	1.608	.190
Operational Expense x U2	.901	.442
Operational Expense x U3	1.100	.351
Operational Expense x T1	.248	.862
Operational Expense x T2	1.574	.184
Operational Expense x T3	.636	.673
Operational Expense x C1	.263	.852
Operational Expense x C2	1.240	.292
Operational Expense x C3	.032	.992
Operational Expense x S1	3.450	.018
Operational Expense x S2	2.209	.071
Operational Expense x S3	.698	.555
Operational Expense x AC1	.982	.419
Operational Expense x AC2	2.015	.114
Operational Expense x AC3	.499	.683
Operational Expense x RL1	.652	.583
Operational Expense x RL2	.100	.960
Operational Expense x RL3	.136	.939
Operational Expense x TL1	1.275	.282
Operational Expense x TL2	1.475	.213
Operational Expense x TL3	.065	.978

Table 35

ANOVA Analysis for Average Cost of Service Against Responses to Items in the Survey Instrument

Average Cost of Service		
Mean (Std. Dev.)	8829.9 (5206.9)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Average Cost of Service x A1	1.135	.324
Average Cost of Service x A2	1.716	.165
Average Cost of Service x A3	1.618	.171
Average Cost of Service x A4	.327	.806
Average Cost of Service x R1	.567	.638
Average Cost of Service x R2	1.408	.242
Average Cost of Service x R3	.667	.573
Average Cost of Service x U1	.198	.898
Average Cost of Service x U2	1.853	.139
Average Cost of Service x U3	1.145	.332
Average Cost of Service x T1	1.077	.360
Average Cost of Service x T2	.485	.747
Average Cost of Service x T3	.314	.904
Average Cost of Service x C1	.114	.952
Average Cost of Service x C2	2.328	.100
Average Cost of Service x C3	.130	.942
Average Cost of Service x S1	.468	.705
Average Cost of Service x S2	1.565	.185
Average Cost of Service x S3	.265	.850
Average Cost of Service x AC1	1.877	.116
Average Cost of Service x AC2	1.782	.134
Average Cost of Service x AC3	.743	.564
Average Cost of Service x RL1	2.398	.069
Average Cost of Service x RL2	2.769	.043
Average Cost of Service x RL3	1.612	.188
Average Cost of Service x TL1	.394	.852
Average Cost of Service x TL2	.972	.424
Average Cost of Service x TL3	.432	.730

Table 36

ANOVA Analysis for EMR/eMAR Categories Against Responses to Items in the Survey Instrument

EMR/eMAR Categories		
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
EMR/eMAR x A1	.295	.745
EMR/eMAR x A2	.073	.930
EMR/eMAR x A3	1.183	.308
EMR/eMAR x A4	.993	.372
EMR/eMAR x R1	.203	.816
EMR/eMAR x R2	.128	.880
EMR/eMAR x R3	.274	.760
EMR/eMAR x U1	1.299	.275
EMR/eMAR x U2	2.631	.074
EMR/eMAR x U3	.500	.607
EMR/eMAR x T1	1.138	.322
EMR/eMAR x T2	.260	.771
EMR/eMAR x T3	.853	.428
EMR/eMAR x C1	1.277	.281
EMR/eMAR x C2	.422	.644
EMR/eMAR x C3	.718	.489
EMR/eMAR x S1	.390	.678
EMR/eMAR x S2	.144	.866
EMR/eMAR x S3	.292	.747
EMR/eMAR x AC1	.307	.736
EMR/eMAR x AC2	.351	.705
EMR/eMAR x AC3	.138	.871
EMR/eMAR x RL1	.828	.438
EMR/eMAR x RL2	.499	.608
EMR/eMAR x RL3	1.165	.314
EMR/eMAR x TL1	1.402	.249
EMR/eMAR x TL2	.138	.871
EMR/eMAR x TL3	.038	.963

Finally, a bivariate analysis was done for responses to each item against each of the quality of healthcare metrics from the AHD. The quality of healthcare metrics from the AHD were Heart Attack Treatment on Arrival, Heart Attack Treatment on Discharge, Pneumonia Care, Surgical Care: Treatment at Start, and Surgical Care: Treatment at End. The results of the bivariate ANOVA analysis of these variables with the responses to the items of the survey instrument are given in Tables 37 to 42.

Table 37

ANOVA Analysis for Heart Attack Treatment on Arrival Against Responses to Items in the Survey Instrument

Heart Attack Treatment on Arrival		
Mean (Std Dev.)	.88 (.16)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Heart:Arrival x A1	.364	.696
Heart:Arrival x A2	.820	.484
Heart:Arrival x A3	.733	.571
Heart:Arrival x A4	.167	.919
Heart:Arrival x R1	.907	.439
Heart:Arrival x R2	.830	.479
Heart:Arrival x R3	.996	.396
Heart:Arrival x U1	.382	.766
Heart:Arrival x U2	.389	.761
Heart:Arrival x U3	5.261	.002
Heart:Arrival x T1	.728	.537
Heart:Arrival x T2	1.100	.359
Heart:Arrival x T3	.426	.830
Heart:Arrival x C1	.933	.426
Heart:Arrival x C2	1.325	.269
Heart:Arrival x C3	.326	.807
Heart:Arrival x S1	.523	.667
Heart:Arrival x S2	.415	.743
Heart:Arrival x S3	1.466	.226
Heart:Arrival x AC1	.975	.406
Heart:Arrival x AC2	.298	.827
Heart:Arrival x AC3	.262	.853
Heart:Arrival x RL1	1.539	.207
Heart:Arrival x RL2	.422	.737
Heart:Arrival x RL3	.431	.731
Heart:Arrival x TL1	.257	.936
Heart:Arrival x TL2	.339	.852
Heart:Arrival x TL3	.084	.969

Table 38

ANOVA Analysis for Heart Attack Treatment at Discharge Against Responses to Items in the Survey Instrument

Heart Attack Treatment at Discharge		
Mean (Std Dev.)	.90 (.14)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Heart:Discharge x A1	.104	.901
Heart:Discharge x A2	1.405	.243
Heart:Discharge x A3	1.134	.342
Heart:Discharge x A4	.507	.678
Heart:Discharge x R1	1.348	.261
Heart:Discharge x R2	2.510	.061
Heart:Discharge x R3	.271	.846
Heart:Discharge x U1	.685	.563
Heart:Discharge x U2	.628	.598
Heart:Discharge x U3	2.906	.036
Heart:Discharge x T1	.345	.793
Heart:Discharge x T2	.264	.900
Heart:Discharge x T3	.433	.825
Heart:Discharge x C1	.253	.859
Heart:Discharge x C2	.128	.880
Heart:Discharge x C3	.130	.942
Heart:Discharge x S1	2.285	.081
Heart:Discharge x S2	1.401	.244
Heart:Discharge x S3	.844	.472
Heart:Discharge x AC1	.091	.965
Heart:Discharge x AC2	.409	.747
Heart:Discharge x AC3	.147	.931
Heart:Discharge x RL1	1.137	.336
Heart:Discharge x RL2	.364	.779
Heart:Discharge x RL3	.083	.969
Heart:Discharge x TL1	.384	.859
Heart:Discharge x TL2	.779	.540
Heart:Discharge x TL3	.853	.467

Table 39

ANOVA Analysis for Heart Failure Treatment Against Responses to Items in the Survey Instrument

Heart Failure Treatment		
Mean (Std Dev.)	.84 (.15)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Heart Failure x A1	.579	.562
Heart Failure x A2	.677	.568
Heart Failure x A3	1.640	.167
Heart Failure x A4	1.372	.253
Heart Failure x R1	.224	.880
Heart Failure x R2	2.540	.058
Heart Failure x R3	.157	.925
Heart Failure x U1	1.053	.371
Heart Failure x U2	1.474	.224
Heart Failure x U3	3.675	.013
Heart Failure x T1	.240	.868
Heart Failure x T2	.229	.922
Heart Failure x T3	.094	.993
Heart Failure x C1	.237	.871
Heart Failure x C2	.473	.624
Heart Failure x C3	.282	.838
Heart Failure x S1	1.152	.330
Heart Failure x S2	.796	.498
Heart Failure x S3	.277	.842
Heart Failure x AC1	.502	.734
Heart Failure x AC2	.256	.857
Heart Failure x AC3	.143	.934
Heart Failure x RL1	2.158	.095
Heart Failure x RL2	1.690	.171
Heart Failure x RL3	.419	.739
Heart Failure x TL1	.347	.884
Heart Failure x TL2	.587	.672
Heart Failure x TL3	.266	.850

Table 40

ANOVA Analysis for Pneumonia Care Against Responses to Items in the Survey Instrument

Pneumonia Care		
Mean (Std. Dev.)	.84 (.15)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Pneumonia Care x A1	.364	.695
Pneumonia Care x A2	.161	.923
Pneumonia Care x A3	.437	.781
Pneumonia Care x A4	.657	.579
Pneumonia Care x R1	.985	.401
Pneumonia Care x R2	.625	.600
Pneumonia Care x R3	1.520	.211
Pneumonia Care x U1	2.303	.079
Pneumonia Care x U2	.693	.558
Pneumonia Care x U3	.371	.774
Pneumonia Care x T1	.073	.975
Pneumonia Care x T2	1.126	.346
Pneumonia Care x T3	.371	.868
Pneumonia Care x C1	.226	.878
Pneumonia Care x C2	.243	.784
Pneumonia Care x C3	.584	.626
Pneumonia Care x S1	1.670	.175
Pneumonia Care x S2	1.097	.352
Pneumonia Care x S3	.149	.930
Pneumonia Care x AC1	.651	.627
Pneumonia Care x AC2	.638	.591
Pneumonia Care x AC3	2.772	.043
Pneumonia Care x RL1	1.923	.128
Pneumonia Care x RL2	.045	.987
Pneumonia Care x RL3	.225	.879
Pneumonia Care x TL1	2.015	.079
Pneumonia Care x TL2	1.673	.158
Pneumonia Care x TL3	.888	.449

Table 41

ANOVA Analysis for Surgical Care: Treatment at Start Against Responses to Items in the Survey Instrument

Surgical Care: Treatment at Start		
Mean (Std Dev.)	.89 (.09)	
Analysis of Variance	**F-Statistic**	
	F	p-value
Surgical Care:Start x A1	.994	.372
Surgical Care:Start x A2	.210	.889
Surgical Care:Start x A3	.212	.931
Surgical Care:Start x A4	.250	.861
Surgical Care:Start x R1	3.776	.012
Surgical Care:Start x R2	.461	.710
Surgical Care:Start x R3	.639	.591
Surgical Care:Start x U1	.384	.765
Surgical Care:Start x U2	1.381	.250
Surgical Care:Start x U3	.026	.994
Surgical Care:Start x T1	.385	.764
Surgical Care:Start x T2	2.210	.070
Surgical Care:Start x T3	.249	.935
Surgical Care:Start x C1	1.219	.304
Surgical Care:Start x C2	1.331	.267
Surgical Care:Start x C3	.183	.908
Surgical Care:Start x S1	.175	.913
Surgical Care:Start x S2	.629	.597
Surgical Care:Start x S3	.168	.918
Surgical Care:Start x AC1	1.390	.239
Surgical Care:Start x AC2	.836	.476
Surgical Care:Start x AC3	1.395	.246
Surgical Care:Start x RL1	.490	.690
Surgical Care:Start x RL2	.412	.745
Surgical Care:Start x RL3	2.367	.073
Surgical Care:Start x TL1	.385	.858
Surgical Care:Start x TL2	.787	.535
Surgical Care:Start x TL3	.768	.548

Table 42

ANOVA Analysis for Surgical Care: Treatment at End Against Responses to Items in the Survey Instrument

Surgical Care: Treatment at End		
Mean (Std Dev.)	.81 (.19)	
Analysis of Variance (ANOVA)	**F-Statistic**	
	F	p-value
Surgical Care:End x A1	.981	.377
Surgical Care:End x A2	.265	.850
Surgical Care:End x A3	.261	.902
Surgical Care:End x A4	2.345	.075
Surgical Care:End x R1	.742	.529
Surgical Care:End x R2	3.561	.016
Surgical Care:End x R3	1.409	.242
Surgical Care:End x U1	3.760	.012
Surgical Care:End x U2	.785	.504
Surgical Care:End x U3	.376	.771
Surgical Care:End x T1	.177	.912
Surgical Care:End x T2	.319	.865
Surgical Care:End x T3	.642	.668
Surgical Care:End x C1	.303	.823
Surgical Care:End x C2	.060	.942
Surgical Care:End x C3	.982	.403
Surgical Care:End x S1	.329	.805
Surgical Care:End x S2	1.148	.332
Surgical Care:End x S3	.508	.678
Surgical Care:End x AC1	1.480	.222
Surgical Care:End x AC2	.106	.957
Surgical Care:End x AC3	.540	.655
Surgical Care:End x RL1	1.340	.264
Surgical Care:End x RL2	.187	.905
Surgical Care:End x RL3	1.928	.127
Surgical Care:End x TL1	.802	.550
Surgical Care:End x TL2	.768	.548
Surgical Care:End x TL3	.888	.449

Examining Table 23 through Table 42 reveals that very few of the ANOVA bivariate results show p-values less than .05 and are significant at that level of analysis. Therefore, hypotheses 6a and 6b are supported and there are no differences across these demographic, practice, or even hospital characteristics in the study.

Summary of Hypotheses

The hypotheses in this study were tested with three PLS runs. The results indicated that Hypothesis 1 was supported, as the level of IT implementation was positively and significantly related to all three quality of information measures: Accuracy, Reliability, and Timeliness. Hypothesis 2a examined the relationship between the level of IT implementation and the cost of healthcare. This hypothesis, too, was supported, as the level of IT implementation was related to the cost of operations. Hypothesis 2b examined the relationship between IT and average cost of service. This hypothesis was supported. The next hypothesis, 3a, proposed a relationship between the level of IT implementation and the perceived quality of healthcare. This hypothesis was not supported. Hypothesis 3b examined the relationship between IT and the quality of healthcare metrics, the measures taken from AHD. This hypothesis was partially supported as IT was significantly related to three of the six quality of healthcare metrics.

The next two hypotheses, 4a and 4b, involved the relationships of the perceived quality of information with the two cost measures, the cost of operations and the average cost of service, respectively. The relationship between the perceived quality of information and the cost of operations was not supported. The relationship between the perceived quality of information and the average cost of service was partially supported as Accuracy and Reliability were significantly related to the average cost of service.

Hypotheses 5a and 5b suggested that the perceived quality of information was related to the perceived quality of healthcare and the quality of healthcare metrics, respectively. Hypothesis 5a was supported. All of the factors of the perceived quality of information were significantly related to at least three of the six measures of perceived quality of healthcare. For Hypothesis 5a, two of the quality of information measures, Accuracy and Reliability, had significant relationships with three of the six quality of healthcare metrics from the AHD. Therefore, 5b was partially supported.

Hypotheses 6a and 6b explore the relationships between demographic and practice characteristics and the responses to the items in the survey instrument. There were virtually no differences in the responses across any of these characteristics. Therefore, Hypotheses 6a and 6b are supported.

Table 43 summarizes the statistical procedures used in this study to test the hypotheses as described above.

Table 43

Summary of the Results of the Hypotheses

H1: The level of IT implementation is related to end-user perceptions of information quality in hospitals.	Supported
H2a: There is a relationship between the level of IT implementation and cost of operations in hospitals.	Supported
H2b: There is a relationship between the level of IT implementation and the average cost of service in hospitals.	Supported
H3a: There is a relationship between the level of IT implementation and end-user (CNO) perceptions of the quality of healthcare in hospitals.	Not Supported
H3b: There is a relationship between the level of IT implementation and quality of healthcare metrics in hospitals.	Partially Supported
H4a: There is a relationship between end-user (CNO) perceptions of information quality and the cost of operations in hospitals.	Not Supported
H4b: There is a relationship between end-user (CNO) perceptions of information quality and the average cost of service in hospitals.	Partially Supported
H5a: There is a relationship between end-user (CNO) perceptions of quality of information and end-user (CNO) perceptions of quality of healthcare in hospitals.	Supported
H5b: There is a relationship between end-user (CNO) perceptions of quality of information and quality of healthcare metrics in hospitals.	Partially Supported
H6a: There are no significant differences in perceptions of quality of information across demographic and practice characteristics of respondent CNOs.	Supported
H6b: There are no significant differences in perceptions of quality of healthcare across demographic and practice characteristics of respondent CNOs.	Supported

Table 44 gives the statistical procedures used for each hypothesis tests.

Table 44

Statistical Procedures for the Testing of Hypothesis

Hypothesis	Statistical Analysis
H1: The level of IT implementation is related to end-user perceptions of information quality in hospitals.	PLS
H2a: There is a relationship between the level of IT implementation and cost of operations in hospitals.	PLS
H2b: There is a relationship between the level of IT implementation and the hospital performance indicator quality of care.	PLS
H3a: There is a relationship between the level of IT implementation and end-user (CNO) perceptions of the quality of healthcare in hospitals.	PLS
H3b: There is a relationship between the level if IT implementation and quality of healthcare metrics in hospitals.	PLS
H4a: There is a relationship between end-user (CNO) perceptions of information quality and the hospital performance indicator cost of operations.	PLS
H4b: There is a relationship between end-user (CNO) perceptions of information quality and the average cost of service.	PLS
H5: There is a relationship between end-user (CNO) perceptions quality of information and end-user (CNO) perceptions of quality of healthcare in hospitals.	PLS
H5b: There is a relationship between end-user (CNO) perceptions of quality of information and quality of healthcare metrics in hospitals	PLS
H6a: There are no significant differences in perception of quality of information across demographic characteristics of respondent CNOs.	ANOVA
H6b: There are no significant differences in perceptions of quality of information across demographic and practice characteristics of respondent CNOs.	

Chapter 5 discusses these findings and their implications. It also examines the limitations of this study and looks ahead at future research that might be undertaken, considering the findings. Finally, Chapter 5 concludes with the importance of this study.

Chapter 5. Discussion and Implications

The safety, quality, and cost of healthcare are among the most pressing concerns of healthcare administrators, healthcare providers, patients, businesspeople, and politicians. Many of these stakeholders have expressed concern that the high cost of healthcare may not correspond with a high level of healthcare quality. In considering a role that IT may play in that concern and/or solution, this study has examined the relationships among the level of IT implementation, the perceived quality of information, the perceived quality of healthcare, and overall costs in hospitals. IT has been shown to improve quality and reduce cost in other industries such as manufacturing, banking, insurance, and retail, and is expected to perform similarly in the healthcare industry (e.g., Barua et al., 1995). This chapter will discuss the findings from the investigation of the relationships among the variables mentioned above.

This study examined three research questions pertaining to the relationships between IT, quality of information, and quality of healthcare. Specifically, these three research questions were:

(1) What is the relationship between the level of IT and end-user (CNO) perceptions of the quality of information for clinical decision making in hospitals?

(2) What is the relationship between the level of clinical IT and hospital performance as measured by healthcare quality and cost?

(3) What is the relationship between perceptions of quality of information for clinical decision making and hospital performance as measured by the healthcare quality and cost?

These questions were considered using two secondary data sources, the American Hospital Directory and HIMSSAnalytics database, and a questionnaire methodology. One thousand CNOs in single independent hospitals were surveyed to gather information on 1) their perceptions about the quality of information used for clinical decision making among the nurses in their hospitals, and 2) perceptions about the quality of healthcare delivered in those hospitals. These data were matched with data from the HIMSSAnalytics database, which contains information pertaining to IT on thousands of hospitals in the United States. Matching hospital data on healthcare quality were also obtained from the American Hospital Directory (AHD), which contains financial and quality of care information on most of the hospitals in the United States. All of these data were combined to help provide some answers to the research questions posed in the study.

The findings from the study give some support for the growing importance of IT in hospitals. IT was related directly or indirectly to many of the other factors in the study but not to all of them. Details of these findings are discussed later in this chapter.

Questionnaire Development

The measures in the questionnaire for this study were tested for validity and reliability. Construct validity and discriminant validity were evaluated using results from correlation analysis and PLS and both met established guidelines. The reliability of the instrument was evaluated using both Cronbach's alpha and the composite reliability number that is obtained from PLS. Again, both sets of numbers for the factors were well above the cutoff point recommended for good reliability. The study also used bivariate ANOVA analyses to test if there were no differences in demographic and practice characteristics of the respondents across the responses to the items in the survey questionnaire. Additionally, bivariate ANOVA analyses were used to test the hospital characteristics as well. Generally, the ANOVA analyses found virtually no differences in the study items in the questionnaire across all of these characteristics. Therefore, the researcher concluded that there was little bias recognized in the study items relative to the demographic and practice characteristics of the respondents and the hospital characteristics. All of these results suggest that the survey instrument provided adequate validity for the data set used collected in this study.

Information Technology in the Healthcare Industry

The value of IT in many other industries has been shown in past studies (Bharadwaj, 2000; Byrd & Turner, 2001; Chan et al., 1997; Melville et al., 2004; Weill, 1992). However, there have been very few large-scale quantitative studies to present evidence that IT will have a similar impact in the healthcare industry and, more specifically, in hospitals. This study is important because it is one of the first quantitative studies to investigate the value of IT in this industry. The first hypothesis purports the relationship between the level of IT implementation and the perceived quality of information for clinical decision making in hospital care units. The level of IT implementation was measured using the number of clinical IT applications for hospitals as reported in the HIMSSAnalytics database. The perceived quality of information data was collected from the 214 responding CNOs from the sample of 1,000 hospitals that were contacted for the study. The perceived quality of information construct was measured using three factors: accuracy, reliability, and timeliness. PLS was used to examine the relationship between the level of IT and each of these factors. In each case, the level of IT implementation was positively and significantly related to the variables. However, in all three cases, the amount of variance explained, as measured by R^2, was low.

Accuracy: The level of IT implementation was positively related to the accuracy of the information used for clinical decision making. Accuracy is an extremely important aspect of clinical decision making. Every year, thousands of patients die because of errors in the medical data (Briere, 2001). Anything that can help reduce this number should be welcomed into the industry. If IT does indeed increase the accuracy of information for clinical decision making as indicated from the findings in this study, healthcare organizations need to consider the implementation of IT for this reason alone. Of course, opportunity costs (trade-offs) that something else might be better have to be weighed, but IT should certainly be considered in its relationship with accuracy, according to the results of this study.

Problems with accuracy of information in hospitals can lead to many different negative outcomes, including dose error (e.g. overdose, under-dose, missed dose), frequency errors (e.g. too many or too few medical interventions), drug interactions, illegible orders, known allergy to drug not being disclosed, preparation error, and delays in treatment (Bates et al., 1999). If clinical information given to healthcare providers is inaccurate, these and other similar problems are much more likely to occur. In this study, evidence indicates that the level of IT was directly related to the perceived accuracy of information for decision making. If the perceptions of the CNOs about the accuracy of information for decision making are correct, this suggests that IT may also contribute to reducing the number of these types of problems and making hospitals safer for patients.

Reliability

IT was also positively and significantly related to reliability in this study. The notion of reliable information is also associated with trust in the information that is acquired (Wang & Strong, 1996). It seems that when IT is involved, the clinical information for decision making as perceived by CNOs is more believable, and thus, more reliable. Much more information can be stored about the patient and delivered through IT applications than by paper charts. The information in IT applications evidently can carry more breadth and depth than with paper charts. For example, information about drug interactions **can** be obtained with the appropriate IT applications. Such information can help make any prescribed medications more believable and trustworthy and, therefore, more reliable. Physicians would be able to add much more documentation in an IT application if the technology has been properly designed to facilitate and augment a physician's notes. For example, a physician documentation system called i-Round Clinical Physician Documentation Solution notes in its promotional material that its standardized notes help streamline the data process by capturing patient data with the ability to share information electronically allowing more explanation into the medical record than would be possible with paper notes (Teges, 2009).

Timeliness

Finally, for the information quality factors, IT seemingly can help increase the timeliness of the information for clinical decision making. More and more technology communication and integration standards have been developed and used in many different industries (Shaver, 2007). The healthcare industry has also started to develop its own communication and integration standards, such as Health Level 7 (HL7), to allow integration across departments and functions. Such integration allows information to move quickly from one department to another and, in many cases where integrated IT applications are available, provide on-demand response for healthcare providers throughout the hospital. The CNOs in this study linked positively in relation to timeliness. Perhaps they perceive an advantage of IT applications in delivering timely information for patient care from physicians, laboratories, pharmacies, or other patient ward units. This timely information can mean the difference between life and death in some situations.

Although IT was positively and significantly related to all three information quality factors the amount of variance explained by the presence of IT was low, which reflects the limited use of IT for clinical decision making currently in hospitals. Hospitals have just started to implement IT, lagging behind almost every other industry in adoption of IT for decision making. According to the HIMSSAnalytics website, only thirteen hospitals out of more than 5,000 are at a level where their clinical operations are essentially paperless (HIMSSAnalytics, 2009). This is in stark contrast to many other information industries, such as insurance and banking, which are almost entirely paperless. Early studies in these other industries when IT was first introduced showed a similar pattern of positive results but with low variance (Barua & Mukhopadhyay, 2000; Mata, 1995; Weill 1992). As the use of IT increased in these industries, the studies of IT implementation in these industries begin to show the positive impact (Bhatt & Grover, 2005; Rai, Ratnayakuni, & Seth, 2006). The same positive impact is expected from IT implementation in hospitals. The positive relationships that IT had with the information quality factors in this study give some support to this expectation.

Information Technology and Cost of Healthcare

The data for cost per bed and average cost of care were taken from the AHD. The level of IT implementation had a positive and significant relationship with the cost of healthcare in this study. This means that as hospitals added IT, the cost of operations actually went up as measured by the cost per bed and average cost of service. Although these cost measures are limited and do not capture the entire costs of the hospitals, the results here still may seem to be somewhat at odds to recent findings in studies examining IT relationships with other cost measures (Banker et al., 2006; Barua & Lee, 1997; Brynjolfsson & Hitt, 1996; Byrd & Turner, 2001). For example, Banker and colleagues (2006) found that more effective users of IT reduced operating expense more than companies identified as not being effective users of IT. Brynjolfsson and Hitt (1996) found that IT substantially reduced operational cost in firms from manufacturing and service industries.

One way that the findings in this study and those found in other study may be different is that IT for clinical decision making is relatively new in hospitals. This technology has just been implemented in these healthcare organizations. The results are similar to the results in other industries in the early days of IT implementation. As mentioned in Chapter 2, early investments in IT during the 1980s did not reduce operational costs (Roach 1988). Roach even labeled the lack of a positive effect on operational costs the “productivity paradox.” However, over time, studies such as those by Brynjolfsson and Hitt (1996) and Banker and colleagues (2006) showed that IT did increase efficiency and lower cost in organizations. In fact, Brynjolfsson and colleagues (1994) found evidence that there was a lag between the implementation of IT and any benefits that accrued.

In the recent healthcare debate in the Congress and the White House, President Obama has consistently argued that the United States must put forth an investment for implementing IT in healthcare to later see reduction in costs from these investments (Obama, 2009). This also seems to be a prevailing pattern in other industries. Hospitals are just starting to step up and implement IT for clinical decision making. Most hospitals are still at a low level in the implementation and integration of IT applications (HIMSSAnalytics, 2009). It will likely take some time before IT begins to lower operational costs in hospitals. As hospital personnel become more familiar with using the technology and as the technology interfaces improve, cost savings should follow. This is the pattern seen in other industries as IT diffused and infused into the companies in these industries and it should be expected that this will hold for healthcare as well. Future research studies should address that question.

Comparing the strength of the relationships between IT and cost per bed with IT and the average cost of service yields an interesting observation. The relationship between IT and the average cost of service seem to be closer, as shown by the significant level and by the R^2. The IT in this study is applications that are used for clinical decision making, that is, in the delivery of medical services to patients in the hospitals. Logically, it would seem that these IT applications would be closer from a relationship standpoint than to the average cost of service measure than the more general cost measure of cost per bed which might include cost for many other factors not directly related to the actual delivery of healthcare service. A future study could use the average cost of service measure when considering IT for clinical services and cost in hospitals; the findings here should provide some guidance for future researchers in this area.

There were no relationships between the level of IT and any of the perceived quality of healthcare factors in the study. The only relationship between IT and these variables were indirectly through the quality of information variables. Because the quality of healthcare factors here were the perceptions of the CNOs in the hospitals, these measures are likely to be associated more with the nursing function than with a general view of healthcare quality. If so, it is reasonable that any contribution from IT to the quality of healthcare variables could come through the quality of information variables. After all, the quality of information given to the nurses should partially account for how well they care for their patients, as will be discussed later in this chapter. As the presence of IT for clinical decision making in hospitals increases, these relationships will need to be revisited by future researchers.

Information Technology Implementation and Quality

This study investigated the relationships between the level of IT implementation and several quality indicators from the American Hospital Directory database. Hospitals report these quality measures to the United States Department of Health and Human Services (DHHS). These measures indicate the hospital scores on certain medical services associated with four different conditions, and they reflect the use of recommended care shown to reduce complications associated with these conditions. The conditions include heart attack, heart failure, pneumonia, and surgical care/bloodclots/infection. Relationships were found between IT and three of the six quality indicators in the study. The three were related to measures for “medication on arrival for a heart attack,” “medication for heart on discharge,” and “medication for blood clots after surgery.” The three non-related to the measures were “heart failure,””pneumonia” and “surgical care/preventing infection.

The results here suggest IT can be useful in the administration of standardized care. This evidence points to the possibility that standardized procedures like these can be easily stored in IT applications and easily retrieved when they are needed to help care for patients. Healthcare providers can follow a checklist in such cases to make sure that all standard protocols are followed. The discovery of the relationships between IT and its possible usefulness in administering standardized care is important since many other medical conditions have recommended solutions that may be stored and retrieved by healthcare workers. If this is true, IT could have a major impact on hospital practice simply by facilitating administration of correct standard procedures and practices for patient care in an accurate, reliable, and timely manner.

The use of IT could reduce the number of medical errors, at least those that are committed by not following proper protocol. This doesn’t mean that healthcare providers do not know these procedures and protocols. However, because of the limitations of human information processing, as reported by Galbraith (1974) healthcare providers can easily miss or wrongly substitute a procedure or protocol when administering to patients. IT can help reduce this possibility by providing standard information in a timely fashion. Additionally, as procedures are modified and deleted and as new procedures become available, the changes can be made quickly to a database and made immediately available to healthcare practitioners in a hospital. There will be no need to deliver this information through a memo or a training class; it will be available as needed through the IT applications connected to a central database repository.

Quality of Information and Perceived Quality of Healthcare

As expected, many of the links between the factors for perceived quality of information and the factors for the perceived quality of healthcare were positively and significantly related. The accuracy factor was related to assurance, tangibles, collaboration, and safety, but not to responsiveness and understanding. Evidently, having accurate information helps nurses deliver safer care with more confidence. According to the data, having accurate information helps nurses perform healthcare services correctly the first time with little need to repeat this care. According to the CNOs, it makes the nursing staff more dependable in handling patient needs. A competent nursing staff that performs healthcare services correctly is a valuable asset to any hospital. Accurate information also helps nurses deliver safer healthcare than when information contains errors. Although the finding is certainly intuitive, this might be the first study to empirically provide evidence of the relationship. Whether intuitive or not, this finding is certainly very important to healthcare practitioners. A major concern of patients in hospital settings is the safety of the healthcare that they are receiving. As mentioned earlier, the Institute of Medicine reported that many Americans suffered because of errors in the delivery of their medical care (Kohn et al., 2000).

Accurate information helps nurses communicate and collaborate with other departments and physicians. The evidence in the study indicates that the more accurate the information nurses receive, the more willing they are to collaborate and communicate about patient care with other caregivers such as pharmacists, laboratory personnel, and physicians. Other caregivers could also have more confidence in accepting information from nurses if the nurses have more accurate information. When physicians make their rounds in the hospitals, they must be able to depend on the status information they receive from nurses to make decisions about medical care. It would seem that the more accurate the information, the more physicians would trust and seek out information from nurses. Finally, accurate information seems to also have a role in keeping the nursing station neat and orderly. Retrieving accurate information through the conduits of IT allows the nurses to forego other information sources such as reference books and manuals. Such books and manuals can clutter a work space and make it difficult to find medical information when needed.

The reliability of information is associated with safety, collaboration, and tangibles, three of the same quality of healthcare factors that the accuracy of information was related. This is reasonable since the accuracy and reliability of information are closely related themselves. Again, we would expect that more reliable information would make for a safer clinical environment. However, the difference between accuracy and reliability in this study is that reliability implies that all information that is needed to make an informed clinical decision is available. There is sufficient breadth and depth to the information used for clinical decision-making. Accuracy is primarily about the concern that the information that is obtained is free of errors. Among other possible scenarios, threats to accuracy may indicate the possibility of an error of omission of data that could have helped make better clinical decisions. Reliable information should have sufficient breadth and depth to make good medical decisions.

More reliable information should also increase the safety of patients by making more complete information available to the nurses providing care. Problems with the safety of patients can possibly occur even when the information that is used is accurate if it is not complete. For example, omission that a patient is allergic to a certain medication jeopardizes the safety of that patient even if all the information about his illness is accurate. More reliable information would include the allergy and would imply that a different course of treatment would be appropriate.

More reliable information also is likely to include information that is important to other functional areas such as pharmacy and the laboratory because of its breadth and depth. Such information makes it more likely for nurses to communicate and collaborate with other departments since they have something of value to share. The communication and collaboration among departments have been shown to be a positive factor in better overall healthcare (Davidson & Chismar, 2007). The same could be said about physicians. More reliable information is also likely to facilitate the collaboration between nurses and physicians making for a richer exchange of information. The result in this study shows a positive relationship between reliability and collaboration and, thus, supports the findings of past research.

Finally, receiving more reliable information can help with keeping an orderly nursing area for reasons similar to the accuracy of information. If the information that nurses receive is more reliable, and, thus, more complete, there is less reason for the nurses to look elsewhere for the information. Less information searching can eliminate the need for supplemental resources that would otherwise be needed to get additional information needed for decision making.

The last quality of information variable, timeliness, is significantly related to responsiveness, assurance, and understanding. The link of timeliness to responsiveness is understandable. When information is delivered on time or ahead of schedule, the nurses are able respond very quickly to the need of the patients. Prompt service to patients' needs increases patient satisfaction. Patient satisfaction has certainly become more important in today's competitive environment. Patients who have bad experiences or do not receive the level of care that they think is adequate are likely to move their healthcare needs to other facilities in the future when possible. Hospitals are not immune to the rising intensity of customer demands. Making timely information available to nurses is apparently one way to help increase patient satisfaction and, thus, help make a hospital more competitive in its marketplace.

The relationship between timeliness and understanding is not so apparent. Understanding in this study is centered on nurses being able to identify and understand patients. The link between these two factors may be explained by Hojat's (2009) suggestion that that access to more information about patients increase empathy and, thus, understanding. Therefore, nurses caring for patients without adequate clinical information can result in a deterrent to this clinical bond.

In addition, timeliness is positively associated with information assurance. Assurance in this study is providing reliable, dependable healthcare by nurses the first time or at least early in the encounter with patients. This study shows that timely information is important in making first time experiences by patients satisfying ones. There is a saying that a first impression is a lasting impression. If a mistake happened early in a clinical encounter between healthcare providers and patients, there is a distinct possibility that the early encounter will cloud the rest of the patient care in that hospital. Timely information can help reduce such mistakes and help clinical providers with the right information to provide quality care early in the encounter with a patient.

Overall, using the results of this study, the perceived quality of information for decision making by nurses is positively associated with the perceived quality of healthcare by the CNOs in the hospitals of this sample. If these hospitals are typical to other single hospitals, the evidence here may point to the possibility that the quality of information for decision making could be a critical factor in the quality of healthcare delivered by nurses as hypothesized.

One interesting aspect of the findings in this study is that different factors of the perceived quality of information were associated with different factors of the perceived quality of healthcare. This can be valuable in delivering high quality healthcare in every way from reducing errors to improving patient satisfaction. For example, according to the results of the study, accurate information does not affect all factors of the perceived quality of healthcare. It is not related to responsiveness, for instance. If responsiveness is one of the qualities that is most important in a hospital, having accurate information is not enough according to the results of this study. If responsiveness is important, the evidence from this study says that the information has to be timely. Without timely information, responsiveness might not be difficult. Accurate information that is not timely may cause problems because nurses will not be able to respond with all the facts needed to provide the best available care. On the other hand, timely information that is not accurate can also cause problems by possibly prompting medical errors.

The relationships between the factors of perceived quality of information and perceived quality of healthcare also suggest an indirect relationship between the level of IT implementation and the perceived quality of healthcare. This is important since there was no direct relationship between the two variables. Indirect relationships are important to practice as are direct relationships. For example, increasing clinical IT applications could affect the perceived quality of healthcare by nurses in hospitals. The quality of information could act as a mediator between these two variables. Path models that reveal mediated paths between two sets of important organizational variables help us better understand the dynamics of just how organizational resources might affect performance variables. Such models help get inside the "black box" of the effects of IT to see <u>how</u> IT is affecting organizational outcomes instead of just examining <u>if</u> IT is affecting organizational outcomes (Bhardwaj 2000).

Quality of Information and Cost

None of the perceived quality of information factors was related to the measure for operational costs which was the cost per bed. This was unexpected; it was speculated that as the perceived quality of information increased, it would have an effect on operational cost. Apparently, the effects of perceived quality of information for decision making are too far removed from overall operational cost for any effect to be easily detected. There are so many other factors in a hospital that can affect the operational costs. There are many expensive types of diagnostic equipment that can very quickly increase the cost of performing healthcare for hospitals.

The average cost of service proved to be a better cost measure in relationships with quality of information. Two of the three quality of information measures, accuracy and reliability, were significantly related to the average cost of service. However, the relationships were in opposite directions. The relationship between accuracy and average cost of service was positive while the relationship between reliability and average cost of service was negative. It seems that accurate information does cost more by increasing the cost of service. Increasing the quality of information will cost more money. However, expectations are that better quality/accuracy will eventually pay off in decreased errors, quicker diagnoses, more accurate diagnoses, and similar positive clinical outcomes. More accurate information can help decrease cost by reducing preventable complications that can quickly drive up cost. So, eventually, better information quality like accuracy of information would actually lower service cost because of these more positive outcomes. In the sample of hospitals of this study, higher accuracy of information has not resulted in lower service cost but instead it has increased the cost. The relationship in this study was not strong but it was significant. This result implies that the cost of service curve has not yet been reduced. Of course, this could change in the future as the cost of providing more accurate information decrease in the future. One way to reduce this cost may be through IT as it matures and become less costly to a hospital.

On the other hand, reliable information was negatively related to average cost of service in this study. That means the more reliable the information, the lower the cost of the average cost of service. The argument is similar to the one in the previous paragraph except this time the additional cost of providing reliable information is not as great as the reduction in the cost of service. It is certainly more expensive to provide more depth and breadth to the information provided for clinical decision making and to make to increase the completeness of that information. Yet, it seems that this extra expense is paying off with a reduction in the cost of services. This is the first positive sign that IT, which is positively related to reliability, does also decrease the cost of doing business in hospitals. This is indeed a hopeful sign for those that see IT as a way to reduce cost in hospitals. It likely is only a matter of time before the effects of IT on cost reduction in hospitals might be seen indirectly in other mediators such as the accuracy of information or more directly with its relationships with these and other hospital cost variables.

Quality of Information and DHHS Quality of Healthcare Measures

Again, only two of the three perceived quality of information factors, accuracy and reliability, were significantly related to at least some of the objective quality of healthcare measures. These are the quality of healthcare measures that are reported to the Centers for Medicare and Medicaid Services (CMS), an agency of the U.S. Department of Health and Human Services (DHHS) along with the Hospital Quality Alliance (HQA). The findings in this study showed a negative relationship between the perceived quality of information variables, accuracy and reliability, and these reported quality of healthcare measures except in the case of the treatments associated with heart failure. Accuracy has a positive relationship with the heart failure treatments. This relationship notwithstanding, it does seem odd that the perceived quality of information variables would be negatively related to treatments associated with four common medical problems. One explanation might be seen in the R^2 values in the significant relationships between the perceived quality of information variables and the quality of healthcare variables. The R^2 values are fairly low which indicates that the perceived quality of information variables are not having much of an impact on the quality of healthcare variables even though the relationships are significant in some cases. The low R^2 values make some sense considering that perceived quality of information variables in this study are quality of information used by nurses in their clinical decision-making. Most of the treatments for the conditions are typically ordered or even administered by a physician and would not be the direct responsible of nurses. Increasing the accuracy and reliability of clinical information for nurses could likely have no direct effect at all on these variables. The relationships seen here might because of both of these sets of variables are related to a third variable, for example, the size of the hospital.

The size of the hospital is used in this study as a control variable. In the two sets of model runs where the perceived quality of healthcare measures from the CNOs and the DHHS quality of healthcare measures were used, size was negatively related to several of the measures of the two sets of quality of healthcare measures. This indicates as the size of the hospital goes up, the perceived quality of healthcare and the DHHS quality of healthcare measures go down. On the other hand, a check on the correlation between the perceived quality of information variables, accuracy, and reliability, revealed positive relationships between these variables and size. Therefore, it could be that the negative relationships that are seen in the relationship between the perceived quality of information and the DHHS quality of healthcare are really a function of their relationships with the size of the hospitals in the sample.

Perhaps to determine if the perceived quality of information would have positive effects on the DHHS quality of healthcare variable would require a broader measure of the perceived quality of information than the one used in this study. Such a measure would likely include information that are used by physicians and other care givers such as pharmacists and laboratory personnel in the hospitals and not just information for nurses. Data for this broader measure of the perceived quality of information might come from someone in the hospital like the chief operating officer (COO), an executive management officer with a broader viewpoint than CNOs.

Study Limitations

Limitations to the current study are acknowledged and addressed. First, the proposed methodology for survey sampling the population for this study was not adhered to. There were to be four mailings to the potential participants, a U. S. Postal Service (USPS) mailing followed by two email reminders and a final USPS mailing. When the response rate of 214 exceeded the power analysis of 84 surveys that was determined to be sufficient for this study and financial resources were limited, it was decided to omit the final USPS mail-out. However, the returned surveys were examined for representativeness of the population by analyzing the data for non-response bias and by comparing early responders to late responders. Both of these examinations indicated there were no differences on a number of criteria between the sample respondents and the larger population. Even though the response rate was adequate, the methodology chosen for this study, PLS, supports smaller sample sizes while examining relationships between variables (Chin et al., 2003).

The second limitation has to do with the using the chief nursing officer (CNO) of each hospital as the key informant in this study. Ultimately, it is the CNO who is responsible for the quality of care given and the information received and used by the nurses in the hospital. However, other managers in the hierarchy of leadership of hospitals have opinions that would affect interpretations of quality of care and quality of information, but were not contacted for this study. For instance, nurse managers or unit managers work more closely with staff nurses. These managers would likely have more knowledge in the day-to-day delivery of the quality of care and use of information of the nurse. On the other hand, the chief financial officer (CFO) would likely have more knowledge of actual costs related to patient care.

In addition, perceptions of the CNOs were collected. The CNOs may have overstated the magnitudes of some of the variables in the study to make their hospitals look superior to others in the report. They may have also given opinions on some variables that they are not currently exposed to as CNOs in management positions and not directly involved in patient care. The use of CNOs perceptions is in itself a limitation. CNO perceptions are being used as proxy variables and no direct claims can be made about the relationship between quality of information and quality of healthcare and other target variables.

A third limitation of this study is generalizability. The CNOs for this study are based at single system hospitals that were mostly non-profit (three were for profit). Using this type of hospital permitted the researcher to limit some variables that may affect hospital cost and quality of healthcare, for instance, being a part of a multi-systems hospital group. However, this restricts the generalizabilty to other types of hospitals such as multi-systems hospitals, teaching hospitals and for profit hospitals. Future studies should examine these other types of hospitals and compare the results with those in this study.

Shortcomings of secondary data are the fourth limitation. The use of secondary data saves time, money and resources; however, there are potential problems that a researcher must be aware. First, the researcher has no control of how the data were collected. Second, there may be biases that the researcher is unaware of in the data. There is also potential for coding and data entry errors. Finally, the data may not fit the hypothesis and or research questions as closely as primary data might. Yet, the secondary data for this study was obtained from the HIMSS Analytics Database and the AHD, reliable sources of secondary data on hospitals. Therefore, this limitation is probably not as severe as it might be with data from less reputable or reliable resources.

The HIMSS Analytics Database provides on-line information for more than 5,000 healthcare facilities in the U.S. The HIMSS Analytics Database site offers assurance on their Website that their data collectors are expert at gathering data from hospitals and healthcare facilities throughout the U.S. Not only does each facility in the database have their information completed by chief staff in that facility, HIMSS Analytics staff follow-up to ensure that all information is correct. Additionally, the information in the database is frequently updated, so that the data are current.

The American Hospital Directory Database also maintains a repository of proprietary data for more than 6,000 U. S. hospitals. The information in the data base is from private and public sources including Medicare claims data and services and hospitals reports of cost and quality information. The database is continually updated.

Another limitation to note is that the cost variables used in this study were proxies and were not optimal to use in examining the impact of IT. Ideally, a cost measure that more closely could be tied to the design, development, implementation, and use of IT would be better. However, data that precisely measure the cost of these IT processes are very difficult to obtain. Direct costs and indirect costs of all the IT processes might not even be available in many hospitals. Even if the data are available, such information is generally not released or reported outside the organization. Therefore, proxies such as cost of operation and cost of service are typically the only cost variables readily available.

The effects of social desirability-the tendency of the sample respondents to answer a questionnaire in a way that is acceptable by others-was not considered. Researchers need to be sensitive to the potential of the tendency of individuals to lean toward socially desirable traits (Randall & Fernandes, 1991). The lack of testing for social desirability response bias in this study may be a limitation if the chief nursing officers responded to the questionnaire by presenting positive or inaccurate responses thereby distorting the information gained from their perceptions (Fisher, 1993). Any future study should consider social desirability bias impacts. The use of social desirability measures such as the Marlowe-Crowne short form to assess for bias should be incorporated into the future questionnaire.

Future Research

One of the primary purposes of this research was to gauge the relationships of IT with the quality of healthcare and with hospital cost. The study used two measures of the quality of healthcare, one a perceived measure on the quality of healthcare by nurses and collected from CNOs and the other measure a broader one of the quality of healthcare for key services that is reported to the DHHS. IT does seem to be related to the quality of healthcare either directly or indirectly although the impact does not seem to be high at this point in its diffusion into the healthcare sector. However, this is very likely to change as more IT applications are implemented in more and more hospitals. The results here suggest that IT may improve the quality of healthcare either through some mediated variables like quality of information or directly. As more hospitals adopt clinical IT and gain experience in its use, more studies need to be completed to see if this potential for improving the quality of healthcare through IT is being fulfilled. Experimental study design will be needed to fully assess the potential for this outcome.

The relationship between IT and hospital cost was positive. This means as hospitals are implementing IT, the cost of operations and the cost of services are going up. This is not a reason for alarm, however, at least not yet. Similar patterns have been documented in other industries as IT was introduced into those industries and then started to have an impact. Roach (1988) described this phenomenon as the "productivity paradox." There is general a lag between the implementation of IT and improvements in efficiency and cost. This has happened in other industries and it seems to be happening in hospitals and probably all of the healthcare industry. Again, as IT is diffused more densely into hospitals, these costs will go down if they follow the pattern of other industries. Of course, only future studies can check and see if these benefits are truly realized in hospitals as they have materialized in other industries.

Another area of future research concerns the discovery in this study that different quality of information factors affect different quality of healthcare factors. When discussing the quality of healthcare it is often common to use the term without considering that several different factors are included. Those different factors may be impacted by different antecedents and, in turn, impact different consequent variables. These differences should be acknowledged and utilized in future studies exploring the quality of healthcare in healthcare institutions. The various factors of quality of healthcare are likely to have different implications to healthcare institutions. For example, in some organizations, the issue of responsiveness might be the primary issue that needs to be addressed. In others, collaboration might be a major problem and may have different solutions than the issue of responsiveness. In both cases there might be a problem with the quality of care but the solutions might be difference. Scholars of future studies using the quality of information factors or the quality of healthcare factors need to acknowledge these possibilities and model their studies accordingly.

One limitation that detracts from IT studies in hospitals is the relatively low level of sophistication and diffusion of IT in most hospitals. Out of the 5125 hospitals in the HIMSS Analytics database, a recent report revealed that only 353 have complete closed loop medication administration. This means that only 353 hospitals have IT applications that completely integrate the clinical operations of the hospitals, that is, completely integrate the patient wards with the pharmacy, laboratories, food service, radiology, operating room, intensive care units, and other functions. This is only about seven percent of the total hospitals in the country.

Yet, future researchers might be able to use this recent report and the hospitals listed. These hospitals are on the leading edge in implementing and utilizing IT in their clinical operations. Future research could focus on these advanced IT hospitals to investigate the impact that IT is having there. The results might be able to open a window into the future of the other 93% of hospitals in the country in their use of IT. These hospitals could be matched with a sample of hospitals that have very little IT implemented and could be compared on relevant performance variables to explore the degrees of differences between the two groups. Other studies might consider the relationships between operational variables such as quality of information, quality of healthcare, and other variables to comprehend how workflow in these advanced IT hospitals operates.

This study has looked specifically at IT and the perceived quality of information for decision making by nurses as antecedents to hospital costs and to the quality of healthcare. There are likely many other mediators, like the quality of information variable that was used in this study, that could be analyzed in future studies using path models. Variables measuring the perceptions of information quality from physicians, pharmacists, or other healthcare providers might be introduced in future studies to compare to the results in this study that was focusing on nurses. Variables like coordination or cooperation between healthcare providers could act as mediators in path models relating IT and performance variables like hospital and the quality of healthcare.

Another avenue for investigation for future studies is to use different measures of the level of IT. This study used the number of clinical applications as a proxy for the level of IT in hospitals. Other measures such as the presence or absence of an IT steering committee, the level of the chief information officer (CIO) in the organization, the presence or absence of an IT strategic plan, IT governance, the alignment of IT with clinical operations, and the use of IT for external relationships, among others, could be used in future studies. These studies could use the variables similar to the ones in this study or some of the variables suggested in the previous paragraph. The combinations are almost endless, since we know so little about the impact of IT in hospitals and the healthcare sector.

There are other performance measures that could be investigated in the context of the research questions of this study. There are also other quality of healthcare variables that could be used. For example, patient satisfaction is becoming more important in evaluating the performance of hospitals. Recently, the AHD has added a measure of patient satisfaction to its Website. This secondary data could be used in future studies or a researcher might choose to collect his or her own primary data on this very important performance measure. Future research could use both primary and secondary patient satisfaction data to assess different viewpoints. There are multiple other quality of healthcare measures and cost measures that future researchers could employ. It is important to insure that performance variables used within the study are appropriate for other target variables used within the path models.

Conclusions

This quantitative study began with an investigation of relationships between the level of clinical information technology implementation and chief nursing officers (CNO) perceptions of the quality of information for clinical decision making in hospitals. The study also investigated the CNO perceptions of the quality of information for clinical decision making and hospital performance as well as the relationship between the level of clinical IT implementation and hospital performance. This attempt identified many associations of IT’s impact on quality of information, care and cost for the CNO perspective. However these contributions are but the tip of an iceberg. Future research looking directly at impact is needed as the level of IT use in hospitals increase.

References

Agency for Healthcare Research and Quality. (2003). Your guide to choosing quality healthcare. In U. S. Department of Health and Human Services (Ed.): AHRQ Information Resource Center. Retrieved September 18, 2008, from http:www.ahrq.gov/consumer/qnt/qntlook.htm.

AHD. (2009). American hospital directory. Retrieved January 9, 2007-November 20, 2009, from http://www.ahd.com/.

AHRQ, Agency for Healthcare Research and Quality (2008). Quality and patient safety. Retrieved May 22, 2008, from http://www.ahrq.gov

Amarasingham, R., Pronovost, P. J., Diener-west, M., Goeschel, C., Dorman, T., Thiemann, D. R., et al. (2007). Measuring clinical information technology in the ICU setting: Application in a quality improvement collaborative. *Journal of the American Medical Informatics Association, 14*(3), 288–294.

Anderson, J. G., Ramanujam, R., Hensel, D., Anderson, M. M., & Sirio, C. A. (2006). The need for organizational change in patient safety initiatives. *International Journal of Medical Informatics*, *75*(12), 809–817.

Angst, C. M., & Agarwal, R. (2009). Adoption of electronic health records in the presence of privacy concerns: The elaboration likelihood model and individual persuasion. *MIS Quarterly*, *33*(2), 339–370.

Ash, J., Sittig, D. F., Poon, E. G., Guappone, K., Campbell, E., & Dystra, R. H. (2007). The extent and importance of unintended consequences related to computerized provider order entry. *Journal of American Medical Informatics Association, 14*(4), 415–423.

Ash, J. S., Berg, M., & Coiera, E. (2004). Some unintended consequence of information technology in health care: The nature of patient care information system-related errors. *Journal of the American Medical Informatics Association, 11*(2), 104–112.

Bailey, J. E., & Pearson, S. W. (1983). Development of a tool measuring and analyzing computer user satisfaction. *Management Science, 29*(5), 530–545.

Ball, M. J., Weaver, C., & Abbortt, P. A. (2003). Enabling technologies promise to revitalize the role of nursing in an era of patient safety. *International Journal of Medical Informatics, 69*(1), 29–38.

Ballou, D. P., & Pazer, H. L. (1985). Modeling data and process quality in multi-input, multi-output information systems. *Management Science, 31*(2), 150–162.

Banker, R. D., Bardham, I. R., Chang, H., & Lin, S. (2006). Plant information systems, manufacturing capabilities, and plant performance. *MIS Quarterly, 30*(2), 315–337.

Banker, R. D., Kauffman, R. J., & Morey, R. C. (1990). Measuring gains in operational efficiency from information technology: A study of the positran deployment at Hardee's inc. *Journal of Management Information Systems, 7*(2), 29–54.

Banker, R. D., & Kemerer, C. F. (1992). Performance evaluation metrics for information systems development: A principle-agent model. *Information Systems Research, 3*(4), 377–400.

Barua, A., Kriebel, C. H., & Mukhopadhyay, T. (1995). Information technologies and business value — An analytic and empirical-investigation. *Information Systems Research, 6*(1), 3–23.

Barua, A., & Lee, B. (1997). The information technology productivity paradox revisited: A theoretical and empirical investigation in the manufacturing sector. *International Journal of Flexible Manufacturing Systems, 9*(2), 145–166.

Barua, A., & Mukhopadhyay, T. (2000). Information technology and business performance: Past, present, and future. In R. W. Zmud (Ed.), *Framing the domains of IT management: Projecting the future through the past* (pp. 65–84). Cincinnati, OH: Pinnaflex Educational Resources, Inc.

Bates, D. W., Cohen, M., Leape, L., Overhage, J. M., Shabot, M., & Sheridan, T. (2001). Reducing the frequency of errors in medicine using information technology. *Journal of American Medical Informatics Association, 8*(4), 100–103.

Bates, D. W., & Gawande, A. A. (2003). Improving safety with information technology. *New England Journal of Medicine, 348*(25), 2526–2534.

Bates, D. W., Teich, J. M., Lee, J., Seger, D., Kuperman, G. J., Ma'Luf, N., et al. (1999). The impact of computerized physician order entry on medication error prevention. *Journal of the American Medical Informatics Association, 6*(4), 313–321.

Bender, D. H. (1986). Financial impact of information processing. *Journal of Management Information Systems, 3*(2), 22–32.

Berger, R. G. K., J. P. (2002). Computerized physician order entry: Helpful or harmful. *Journal of American the Medical Informatics Association, 11*(2), 136–144.

Berndt, E. R., & Morrison, C. J. (1995). High-tech capital formation and economic performance in U.S. manufacturing industries: An exploratory analysis. *Journal of Econometrics, 65*, 9–43.

Bharadwaj, A. S. (2000). A resource-based perspective on information technology capability and firm performance: An empirical investigation. *MIS Quarterly, 24*(1), 169–196.

Bharadwaj, A. S., Bharadwaj, S. G., & Konsynski, B. R. (1999). Information technology effects on firm performance as measured by tobin's q. *Management Science*, *45*(7), 1008–1024.

Bhatt, G. D., & Grover, V. (2005). Type of information technology capabilities and their role in competitive advantage: An empirical study. *Journal of Management Information Systems*, *22*(2), 253–277.

Bollen, K. A. (1989). *Structural equation with latent variable*. New York, NY: Wiley.

Bowers, M., & Kiefe, C. (2002). Measuring health care quality: Comparing and contrasting the medical and the marketing approaches. *American Journal of Medical Quality, 17*(4), 136–144.

Bowers, M. R., Swan, J. E., & Koehler, W. F. (1994). What attributes determine quality and satisfaction in health care delivery. *Health Care Management Review*, *19*(4), 49–55.

Brandyberry, A., Rai, A., & White, G. P. (1999). Intermediate performance impacts of advanced manufacturing technology systems: An empirical investigation. *Decision Sciences, 30*(4), 993–1020.

Brewer, B. B. (2007). Managing quality and patient safety. In R. A. P. Jones (Ed.), *Nursing leadership and management: Theories, processes and practice* (pp. 452). Philadelphia, PA: F. A. Davis Company.

Briere, R. (Ed.). (2001). *Crossing the quality chasm. A new health system for the 21st century*. Washington, DC: National Academy Press.

Brook, R. H. (1973). Medical audit of quality of care. *Journal of Medical Education, 48*(48), 1973.

Brynjolfsson, E. (1996). The contribution of information technology to consumer welfare. *Information Systems Research*, *7*(3), 281–300.

Brynjolfsson, E., & Hitt, L. (1996). Paradox lost? Firm-level evidence on the returns to information systems spending. *Management Science*, *42*(4), 541–558.

Burns, N., & Grove, S. K. (2001). *The practice of nursing research conduct, critique & utilization* (4th ed.). New York: W. B. Saunders Co.

Bush, G. W. (2004). The 2004 state of the union. Retrieved May 15, 2006, from www.whitehouse.gov/stateoftheunion/2004/01/20040120-7html

Bush, G. W. (2006). State of the union address. Retrieved March 9, 2008, from www.whitehouse.gov/stateoftheunion/2006/

Byrd, T. A. (2001). Information technology, core competencies, and sustained competitive advantage. *Information Resources Management Journal*, *14*(2), 27–36.

Byrd, T. A., & Hauser, R. D. (1991). Expert systems in production and operations management: Research directions in assessing overall impact. *International Journal of Production Research*, *29*(12), 2471–2482.

Byrd, T. A., Thrasher, E. H., Lang, T., & Davidson, N. W. (2006). A process-oriented perspective of is success: Examining the impact of is on operational cost. *Omega*, *34*(6), 448–460.

Byrd, T. A., & Turner, D. E. (2000). Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct. *Journal of Management Information Systems*, *17*(1), 167–208.

Byrd, T. A., & Turner, D. E. (2001). An exploratory analysis of the value of the skills of IT personnel: Their relationship to is infrastructure and competitive advantage. *Decision Sciences, 32*(1), 21–54.

Carmines, E. G., & Zeller, R. A. (1979). *Reliability and validity assessment*. Beverly Hills, CA: Sage Publications.

Chan, Y. E., Huff, S. L., Copeland, D. G., & Barclay, D. W. (1997). Business strategic orientation, information systems strategic orientation and strategic alignment. *Information Systems Research, 8*(2), 125–150.

Chao, S. (2007). *Advancing quality improvement research: Challenges and opportunities - workshop summary*. Washington, DC: Institute of Medicine.

Chaudhry, B., Wang, J., Wu, S., Maglione, M., Mojica, W., Roth, E., et al. (2006). Systematic review: Impact of health information technology on quality, efficiency, and costs of medical care. *Annals of Internal Medicine, 144*(10), 12–22.

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. In G. A. Marcoulides (Ed.), *Modern methods for business research* (pp. 295–336). London: Lawrence Erlbaum.

Chin, W. W., Marcolin, B. L., & Newsted, P. R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: Results form a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research, 14*(2), 189–217.

Clinton, H. R. (2005). Senator Hillary Clinton press release. Retrieved March 11, 2008, from http://clinton.senate.gov/news/statements/details.cfm?id=239875

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Cron, W. L., & Sobol, M. G. (1983). The relationship between computerization and performance: A strategy for maximizing the economic benefits of computerization. *Information & Management, 6*, 171–181.

Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological Bulletin, 52*(4), 281–302.

Cucciare, M. A., & O'Donohue, W. (2002). Predicting future healthcare costs: How well does risk-adjustment? *Journal of Health Organization and Management, 20*(2), 150–162.

Culler, S. D., Hawley, J. N., Naylor, V., & Rask, K. J. (2007). Is th availability of hospital IT applications associated with a hospital's risk adjusted incidence rate for patient safety indicators: Results from 66 Georgia hospitals. *Journal of Medical Systems, 31*, 319–327.

Davidson, S. M., & Heineke, J. (2007). Toward an effective strategy for the diffusion and use of clinical information systems. *Journal of the American Medical Informatics Association, 14*(3), 361–367.

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research, 3*(1), 60–95.

Devaraj, S., & Kohli, R. (2000). IT payoff in the healthcare industry: A longitudinal study. *Journal of Management Information Systems, 16*(4), 41–68.

DeVellis, R. F. (1991). *Scale development- theory and applications* (Vol. 26). Newbury Pa, CA: SAGE Publications.

Directory, American Hospital (2009). American hospital directory Retrieved January 9, 2007-November 30, 2009, from http://www.ahd.com/.

Donabedian, A. (1966). Evaluating the quality of medical care. *The Milbank Memorial Fund Quarterly, 44*(3), 514–539.

Donabedian, A. (1980). *The definition of quality and approaches to its assessment*. Ann Arbor, MI: Health Administration Press.

Embi, P. J., Yackel, T. R., Logan, J. R., Bowen, J. L., Cooney, T. G., & Gorman, P. N. (2004). Impacts of computerized physician documentation in a teaching hospital: Perceptions of faculty and resident physicians. *Journal of the American Medical Informatics Association, 11*(4), 300–309.

Eslami, S., Ameen, A.-H., & De Keizer, N. (2007). Evaluation of outpatient computerized physician medication order entry systems. *Journal of the American Medical Informatics Association*, *14*(4), 400–406.

Finkelman, A. A. (2006). *Leadership and management in nursing*. Upper Saddle River, NJ: Pearson Prentice Hall.

Fisher, C. W., & Kingma, B. R. (2001). Criticality of data quality as exemplified in two disasters. *Information & Management, 39*(2), 109–116.

Fisher, R. J. (1993). Social desirability and the validity of indirect questioning. *Journal of Consumer Research, 20*, 303–315.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50.

Franz, C. R., & Robey, D. (1986). Organizational context, user involvement, and the usefulness of information systems. *Decision Sciences, 17*(3), 329–356.

Gattiker, T. F., & Goodhue, D. L. (2005). What happens after erp implementation: Understanding the impact of interdependence and differentiation on plant-level outcomes. *MIS Quarterly, 29*(3), 559–585.

Gingrich, N. (2003). Newt Gingrich on technology for the health care industry. *CIO*. Retrieved March 11, 2008, from http://www.cio.com/article/print/29801.

Goldman, D. (2009). Obama's health care challenge. *CNNMoney.com*. Retrieved May 11, 2009, from http://money.cnn.com/2009/01/12/technology/stimulusheatlh/.

Goodhue, D. L. (1995). Understanding user evaluations of information systems. *Management Science, 41*(2), 1827–1844.

Griffith, R., & Jordan, S. (2003). Administration of medicines part1: The law and nursing. *Nursing Standard, 18*(2), 47–55.

Grohar-Murray, M. E., & DiCroce, H. R. (2003). *Leadership and management in nursing* (3rd ed.). Upper Saddle City, NJ: Prentice Hall.

Hair, J. F., Anderson, J. C., Tatham, R. L., & Black, W. C. (1994). *Multivariate data analysis* (4th Edition ed.). Upper Saddle River, NJ: Prentice Hall.

Harris, S. E., & Katz, J. L. (1991). Organizational performance and IT investment intensity in the insurance. *Organization Science, 2*(3), 263–295.

HIMSS Analytics. (2009). HimssAnalytics Database. Retrieved May 5, 2007-November 15, 2009, from http://www.himssanalytics.org/hcproider/emradoption.asp.

Hinds, P. S., & Gattuso, J. S. (1991). From pilot work to a major study in cancer nursing research. *Cancer Nursing, 14*(3), 132–135.

Hitt, L. M., & Brynjolfsson, E. (1996). Productivity, business profitability, and consumer surplus: Three different measures of information technology value. *MIS Quarterly, 20*(2), 121–142.

Hojat, M. (2009). Ten approaches for enhancing empathy in health and human services cultures. *Journal of Health and Human Services Administration, 31*(4), 412–450.

Hulka, B. S., Zyzanski, S. J., Cassell, J. C., & Thompson, S. J. (1970). Scale for the measurement of attitudes towards physicians and primary medical care. *Medical Care, 8*(5), 429–436.

Ilie, V., Courtney, J. F., & Van Slyke, C. (2007). *Paper versus electronic: Challenges associated with physician's usage of electronic medical records.* Paper presented at the 40th Hawaii International Conference on System Sciences.

Jacoby, J., & Haddock, R. A. (1973). Price, brand name and product composition characteristics as determinants of perceived quality. *Journal of Applied Psychology, 55*(6), 570–579.

Jairath, N., Hogerney, M., & Parsons, C. (2000). The role of the pilot study: A case illustration from cardiac nursing. *Applied Nursing Research, 13*(2), 92–96.

Jarke, M., & Vassiliou, Y. (1997). *Data warehouse quality: A review of the DWQ project.* Paper presented at the Proceedings of the Conference on Information Quality, Cambridge, MA.

Joint-Commission. (2007). *The joint commission annual report on quality and safety 2007* (PDF). Oakbrook Terrance, IL: The Joint Commission.

Jordan, S., Tunnicliffe, C., & Sykes, A. (2002). Minimizing side-effects: The clinical impact of nurse-administered 'side-effect' checklists. *Journal of Advanced Nursing, 37*(2), 155–165.

Jun, M., Peterson, R. T., & Zsidisin, G. A. (1998). The identification and measurement of quality dimensions in health care: Focus group interview results. *Health Care*

Kausal, R., Jha, A. K., Franz, C., Glaser, J., Shetty, K. D., Jaggi, T., et al. (2006). Return on investment for a computerized physician order entry system. *Journal of the American Medical Informatics Association, 13*(3), 261–266.

Kausal, R., Kaveh, S., & Bates, D. W. (2003). Effects of computerized physician order entry and clinical decision support systems on medication safety: A systematic review. *Archives of Internal Medicine, 163*(12), 1409–1416.

Kerlinger, F. N. (1986). *Foundations of behavioral research* (3rd Edition ed.). New York, NY: Harcourt Brace Jovanovich.

King, W. R., & Epstein, B. J. (1983). Assessing information system value. *Decision Sciences, 14*(1), 34–45.

Kohli, R., Tan, J. K., Piontek, F. A., Ziege, D. E., & Groot, H. (1999). Integrating cost information with health management support system: An enhanced methodology to assess health care quality drivers. *Top Health Inf Manage, 20*(1), 80–95.

Kohn, L. T., Corrigan, J., & Donaldson, M. S. (Eds.). (2000). *To err is human: Building a safer health system*. Washington, DC: National Academy Press.

Koppel, R., Metlay, J. P., Cohen, A., Abaluck, B., Kimmel, A. R., Lacalio, S. E., et al. (2005). Role of computerized physician order entry systems in facilitating medication errors. *Journal of the American Medical Informatics Association, 293*(10), 1197–1203.

Kossman, S. P., & Scheidenhelm, S. L. (2008). Nurses' perceptions of the impact of electronic health records on work and patient outcomes. *Computers, Informatics, Nursing, 26*(2), 69–77.

Kuo, G. M., Mullen, P. D., McQueen, A., Swank, P. R., & Rogers, J., C. (2007). Cross-sectional comparison of electronic and paper medical records on medication counseling in primary care clinics: A southern primary-care urban research network (spur_net) study. *Journal of the American Board of Family Medicine, 20*(2), 164–173.

Kuperman, G. J., Teich, J. M., Tanasijevic, M., Ma'Luf, N., Rittenberg, E., Jha, A. K., et al. (1999). Improving response to critical laboratory results with automation: Results form a randomized controlled trial. *Journal of the American Medical Informatics Association, 6*(6), 512–522.

Leapfrog. (2007). *The leapfrog group fact sheet*. Washington, DC: The Leapfrog Group.

Lee, Y. W., Strong, D. M., Kahn, B. K., & Wang, R. Y. (2002). Aimq: A methodology for information quality assessment. *Information & Management, 40*(2), 133–146.

Levitin, A. V., & Redman, T. C. (1998). Data as a resource: Properties, implications, and prescription. *Sloan Management Review, 40*(1), 89–101.

Lewis, B. R., Templeton, G. F., & Byrd, T. A. (2005). A methodology for construct development in MIS research. *European Journal of Information Systems, 14*(4), 388–400.

Li, L., & Benton, W. C. (2006). Hospital technology and nurse staffing management decisions. *Journal of Operations Management, 24*(5), 676–691.

Lohr, K. N. (1990). *Medicare: A strategy for quality assurance*. Washington, DC: National Academy Press.

Loveman, G. W. (Ed.). (1994). *An assessment of the productivity impact of the information technologies*. New York: Oxford University Press.

Low, G. S., & Mohr, J. J. (2001). Factors affecting the use of information in the evaluation of marketing communications productivity. *Academy of Marketing Science, 29*(1), 70–88.

Luce, B. R. (2004). Ispor avedis donabedian outcomes research lifetime achievement awards (Lohr's acceptance speech). *International Society for Pharmacoeconomics and Outcomes Research*.

Luftman, J. N., Lewis, P. R., & Oldach, S. H. (1993). Transforming the enterprise: The alignment of business and technology strategies. *IBM Systems Journal*, *10*(1), 97–122.

Markus, M. L., & Tanis, C. (1999). The enterprise systems experience — from adoption to success. In R. W. Zmud (Ed.), *Framing the domains of IT research: Glimpsing the future through the past*. Cincinnati, OH: Pinnaflex Educational Resources.

Marquis, B. L., & Huston, C. J. (2006). *Leadership roles and management functions in nursing: Theory and application* (5th ed.). Philadelphia, PA: Lippincott, Williams and Wilkins.

McCormick, K. A., Deleney, C. J., Brennan, P. F., Effken, J. A., Kendrick, K., Murphy, J., et al. (2007). Guideposts to the future — an agenda for nursing information. *Journal of the American Medical Informatics Association*, *14*(1), 19–24.

Meinert, D. B. (2005). Resistance to electronic medical records (emrs): A barrier to improved quality of care. *Informing Science and Information Technology, 2*, 493–504.

Mekhjian, H. S., Kumar, R. R., Kuehn, L., Thomas, A., Payne, B., & Ahmad, A. (2002). Immediate benefits realized following implementation of physician order entry at an academic medical center. *Journal of American Medical Informatics Association*, *9*(5), 2002.

Melville, N., Kraemer, K., & Gurbaxani, V. (2004). Information technology and organizational performance: An integrative model of IT business value. *MIS Quarterly, 28*(2), 283–321.

Menachemi, N., Burkhardt, J., Shewchuck, R., Burke, D., & Brooks, R. G. (2006). Hospital information technology and positive financial performance: A different approach to finding an roi. *Journal of Healthcare Management, 51*(1), 40–59.

Menachemi, N., Saunders, C., Chukmaitov, A., Matthews, M. C., & Brooks, R. G. (2007). Hospital adoption of information technologies and improved patient safety: A study of 98 hospitals in florida. *Journal of Healthcare Management, 52*(6), 398–409.

Menon, N. M., Lee, B., & Eldenburg, L. (2000). Productivity of information systems in the healthcare industry. *Information Systems Research, Forthcoming*.

Merenstein, J. H., & Hirsch, R. F. (1989). Non-returning patients: A survey of inactive patients in surburan practice. *Family Practice, 21*(3), 206–210.

Meterko, M. N., Field, D., & Deckard, G. (1990). Patients' judgments of hospital quality: Report of pilot study. *Medical Care, 32*(7), 745–754.

Miller, J., & Doyle, B. A. (1987). Measuring effectiveness of computer based information systems in the financial services sector. *MIS Quarterly, 11*(4), 107–124.

Mukhopadhyay, T., & Cooper, R. B. (1992). Impact of management-information-systems on decisions. *Omega-International Journal of Management Science, 20*(1), 37–49.

Mukhopadhyay, T., Lerch, F. J., & Mangal, V. (1997a). Assessing the impact of information technology on labor productivity: A field study. *Decision Support Systems, 19*(2), 109–122.

Mukhopadhyay, T., Rajiv, S., & Srinivasan, K. (1997b). Information technology impact on process output and quality. *Management Science, 43*(12), 1645–1659.

Munro, B. H. (2005). *Statistical methods for health care research* (5th ed.). Philadelphia, PA: Lippincott, Williams & Wilkins.

Nash, D. B. (1995). Accountability for hospital quality: The role of clinical practice guidelines. In N. Goldfield & D. B. Nash (Eds.), *Providing quality care* (pp. 205). Ann Arbor, Michigan: Health Administration Press.

Nau, D. P. (2007). Performance measurement of medication-use system. In MacKinnon (Ed.), *Safe and effective: The eight essential elements of an optimal medication-use system* (pp. 417-433). Ottawa, Canada: Canadian Pharmacists Association.

Neiswiadomy, R. M. (2002). *Foundations of nursing research*. Upper Saddle River, NJ: Prentice Hall.

Nelson, R. R., Todd, P. A., & Wixon, B. H. (2005). Antecedents of information and system quality: An empirical examination within the context of data warehousing. *Journal of Management Information Systems, 21*(4), 199–235.

Nightingale, F. (1860). *Notes on nursing: What it is and what it is not*. London, England: Harrison and Sons.

Obama, B. (2009). Organizing for America. Digital millennium copyright. Retrieved May 3, 2009, from http://www.barackobama.com/issues.

Office, Congressional Budget. (2008). Evidence on the cost and benefits of health information technology. Accessed September 13, 2009. from http://www.cbo.gov/ftpdocs/alxx/doc9168/05-20-HealthIT.pdf.

Ortiz, E. (2003). Federal initiatives in information technology to improve patient safety and quality of care. *Studies in Health Technology and Informatics, 92*, 59–71.

Osterman, P. (1986). The impact of computers on the employment of clerks and managers. *Industrial and Labor Relations Review, 39*(2), 175–186.

Overhage, J. M., Tierney, W. M., Zhou, X.-H., & McDonald, C. J. (1997). A randomized trial of "corollary orders" to prevent errors of omission. *Journal of the American Medical Informatics Association, 4*(5), 364–375.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985). A conceptual model of service and its implications for future research. *Journal of Marketing, 49*(4), 41–50.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). Serqual: A multiple scale for measuring consumer perceptions of service quality. *Journal of Retailing, 64*(1), 12–40.

Pare, G., & Sicotte, C. (2001). Information technology sophistication in health care: An instrument validation study among Canadian hospitals. *International Journal of Medical Informatics, 63*(3), 205–223.

Pascoe, G. C., Attkisson, C. C., & Roberts, R. E. (1983). Comparison of indirect and direct approaches to measuring patient satisfaction. *Evaluation and Program Planning, 6*(3-4), 359–371.

Pedhazur, E. J., & Schmelkin, L. P. (1991). *Measurement, design, and analysis: An integrated approach*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Piccoli, G., & Ives, B. (2005). Review: IT-dependent strategic initiatives and sustained competitive advantage: A review and synthesis of the literature. *MIS Quarterly, 29*(4), 747–776.

Pipino, L. L., Lee, Y. W., & Wang, R. Y. (2002). Data quality assessment. *Communications of the ACM, 45*(4), 211–218.

Polit, D. F., & Beck, C. T. (2010). *Essentials of nursing research- appraising evidence for nursing practice* (7th ed.). New York: Wolters Kluwer/Lippincott Williams & Wilkins.

Rai, A., Robinson, J. M., Patnayakuni, R., & Seth, N. (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS Quarterly*, *30*(2), 225–246.

Randall, D. M., & Fernandes, M. F. (1991). The socail desirability response bias in ethics research. *Journal of Business Ethics, 10*, 805–817.

Redman, T. C. (1998). The impact of poor data quality on the typical enterprise. *Communications of the ACM, 41*(2), 79–82.

Reiser, S. J. (1991). The clinical record in medicine; part 1: Learning from cases. *American College of Physicians*, *114*(10), 902–907.

Roach, S. (1987). *America's technology dilemma: A profile of the information economy* (Special Economic Study): Morgan Stanley.

Roach, S. (1988). Technology and the service sector: The hidden competitive challenge. *Technological Forecasting and Social Change, 34*(4), 387–403.

Roukema, J., Los, R. L., Bleeker, S. E., van Ginneken, A. M., van der Lei, J., & Moll, H. (2006). Paper versus computer: Feasibility of an electronic medical record in general practice. *American Academy of Pediatrics, 117*(1), 15–22.

Sabherwal, R., & Chan, Y. E. (2001). Alignment between business and is strategies: A study of prospectors, analyzers, and defenders. *Information Systems Research, 12*(1), 11–33.

Santhanam, R., & Hariono, E. (2003). Issues liking information technology capability to firm performance. *MIS Quarterly, 27*(1), 125–143.

Schimmel, E. M. (1964). The hazards of hospitalization. *Annals of Internal Medicine, 60*(1), 100–110.

Segars, A. H., & Grover, V. (1998). Strategic information systems planning success: An investigation of the construct and its measurement. *MIS Quarterly*, *22*(2), 139–163.

Segars, A. H., & Grover, V. (1999). Profiles of strategic information systems planning. *Information Systems Research, 10*(3), 199–232.

Shao, B. B. M., & Lin, W. T. (2002). Technical efficiency analysis of information technology investments: A two-stage empirical investigation. *Information & Management, 39*(5), 391–401.

Shaver, D. (2007). Hl7 101: A beginners guide. *For the Record, 19*(1), 22–25.

Shortliffe, E. H. (1999). The evolution of electronic medical records. *Academic Medicine, 74*(4), 414–419.

Statstics, Burea of Labor (2007). Registered nurses. Retrieved January 9, 2008, from http://www.bls.gov/oco/ocos083.htm

Stead, W. W., & Lorenzi, N. M. (1999). Health informatics: Linking investment to value. *Journal of the American Medical Informatics Association, 6*(5), 341–348.

Takeuchi, H., & Quelch, J. A. (1983). Quality is more than making a good product. *Harvard Business Review*(July/August), 139–145.

Tange, H. J. (1995). The paper-based patient record: Is it really so bad? *Computer Methods and Programs in Biomedicine, 48*, 127–131.

Tanriverdi, H. (2006). Performance effects of information technology synergies in multibusiness firms. *MIS Quarterly, 30*(1), 57–77.

Teges. (2009). Integrated data. Informed data.

Thatcher, M. E., & Oliver, J. R. (2001). The impact of technology investments on a firm's production efficiency, product quality, and productivity. *Journal of Management Information Systems, 18*(2), 17–42.

Tierney, W. M. (2001). Improving clinical decisions and outcomes with information: A review. *International Journal of Medical Informatics, 62*(1), 1–9.

Tsai, J., & Bond, G. (2008). A comparison of electronic records to paper records in mental health centers. *International Journal for Quality in Health Care, 20*(2), 136–143.

Tucker, A. L. (2004). The impact of operational failures on hospital nurses and their patients. *Journal of Operations Management, 22*(2), 151–169.

van Campen, C. S., Sixma, H., Friele, R. D., Kerssens, J. J., & Peters, L. (1995). Quality of care and patient satisfaction: A review of measuring instruments. *Medical Care and Patient Satisfaction, 52*(1), 109–133.

Venkatraman, N., & Zaheer, A. (1990). Electronic integration and strategic advantage: A quasi-experimental study in the insurance industry. *Information Systems Research, 1*(4), 377–393.

Versel, N. (2002). Stalking the elusive ‘killer app’: Hacking through the EMR jungle to find the ultimate beast could take as long as a decade, experts say. *Modern Physician, 6*(5), 21–22.

Wade, M., & Hulland, J. (2004). The resource-based view and information systems research: Review, extension, and suggestions for future research. *MIS Quarterly, 28*(1), 107–142.

Wand, Y., & Wang, R. Y. (1996). Anchoring data quality dimensions in ontological foundations. *Communications of the ACM, 39*(11), 86–95.

Wang, C. H., Gopal, R. D., & Zionts, S. (1997). Use of data envelopment analysis in assessing information technology impact on firm performance. *Annals of Operations Research, 73*, 191–213.

Wang, R. Y., & Strong, D. M. (1996). Beyond accuracy: What data quality means to data consumers. *Journal of Management Information Systems*, *12*(4), 5–34.

Ware, J. E., & Snyder, M. K. (1975). Dimensions of patient attitudes regarding doctors and medical care services. *Medical Care, 13*(8), 669–682.

Ware, J. E., & Synder, M. K. (1975). Dimensions of patient attitudes regarding doctors and medical care services. *Medical Care, 13*(8), 669–682.

Weill, P. (1992). The relationship between investment in information technology and firm performance: A study of the valve manufacturing sector. *Information Systems Research, 3*(4), 307–333.

Wong, D. H., Gallegos, Y., Weinger, M. B., Clack, S., Slagle, J., & Anderson, C. T. (2003). Changes in intensive care unit nurse task activity after installation of a third-generation intensive care unit information system. *Critical Care Medicine, 31*(10), 2488–2494.

Wullenweber, K., Beimborn, D., Weitzel, T., & Konig, W. (2008). The impact of process standardization on business process outsourcing success. *Information Systems Frontiers, 10*, 211–224.

Zalon, M. L. (2007). Consumer relationships. In P. S. Yoder-Wise (Ed.), *Leading and managing in nursing* (pp. 435–458). Lubbock, TX: Mosby Elsevier.

Zineldin, M. (2006). The quality of health care and patient satisfaction. *International Journal of Health Care Assurance, 19*(1), 60–92.

Zmud, R. W. (1978). Concepts, theories, and techniques: An empirical investigation of the dimensionality of the concept of information. *Decision Sciences, 9*(2), 187–195.

Appendix 1

Information Letter

DEPARTMENT
OF PHARMACY
CARE SYSTEMS

AUBURN UNIVERSITY

HARRISON SCHOOL
OF PHARMACY

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT)

INFORMATION LETTER

For a Research Study entitled
An Examination of Information Technology and its Perceived Quality Issues in Hospitals

You are invited to participate in a research study to gain a better understanding of chief nursing officers (CNO) perception of the quality of information in their hospitals. Your assistance is critical in helping me gain an understanding about CNO perceptions of information nurses need to provide quality care. The study is being conducted by Linda Byrd, PhD Candidate, under the direction of Dr. Jan Kavookjian in the Auburn University Department of Pharmacy Care systems. You were selected as a possible participant because you are a chief nursing officer and are age 19 or older.

What will be involved if you participate? If you decide to participate in this research study, you will be asked to complete a survey either paper format or an electronic version on-line. You will be asked to complete a series of questions regarding the quality of care and the quality of information within your hospital. The survey will take approximately 10 minutes to complete. When you complete the survey, you may mail the paper copy in the self-addressed, stamped envelope. If you prefer to complete an electronic online survey, you may access the survey at this email address: https://business.auburn.edu/surveys/byrdlin. **You will need to use this unique code to access the electronic survey__________.**

Are there any risks or discomforts? You will not be asked to provide your name or hospital name on the survey instrument. Each survey has a unique number or password. This number will allow me to match the survey response for your hospital with additional financial and quality information available in the HimssAnalytics Database and the American Hospital Directory.

Are there benefits to yourself or others? Your participation is essential to my research. Information gained from this research may help you and other chief nursing officers understand information nurses need to provide quality care. These results may also aid you as you make continuing decisions regarding additional investments in IT or changes in your current organizational structure.

Will you receive compensation for participation? I will offer to you and any CNO a summary of the results of this research as a way of saying "Thank You". The summary will include the group aggregates for all participating chief nursing officers. To request the executive summary, simply e-mail me your preferred e-mail address to: byrdlin@auburn.edu.

Are there any cost? There are no costs for you to participate in this study.

If you change your mind about participating you may choose not to participate at any time, however, after you provide information, it will become anonymous and you will not be able to withdraw your data since there will be no way to identify individual information. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, The School of Pharmacy or the Department of Pharmacy Care Systems.

Any data obtained in connection with this study will remain anonymous. Information collected through your participation may be used to fulfill a dissertation requirement for the degree of Ph.D. of Pharmacy Care Systems at Auburn University, published in a professional journal, and/or presented at a professional meeting.

If you have questions about this study, I invite you to ask them now by e-mailing me at byrdlin@auburn.edu. If you have questions later, I can be reached at (334)844-6757 or e-mailed at byrdlin@auburn.edu or you may contact my research advisor, Dr. Jan Kavookjian at (334)844-8301. We will be more than happy to answer any questions you may have regarding this study or the information provided in the survey instrument.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

Linda Byrd
Investigator signature
Linda Byrd
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The Auburn University Institutional Review Board has approved this document for use from 2/10/09 to 2/9/10. Protocol # 09-020 EP 0902

Appendix 2

Survey

Please answer all questions unless specified otherwise.

Are you a registered nurse? __Yes __No. If you are a registered nurse how long? _______ years.

What is your job title____.

How long have you been with this hospital _______ years.

Your years experience in your current job _________ years.

Gender: __Male __Female.

What educational degrees do you have? (Check and/or specify all others that apply to you)
Associate degree nursing_____ Bachelors degree Nursing____
Master of Science Nursing___ PhD Nursing__
Other Bachelors degree________________ Other Masters Degree______________
Other PhD____________________
Other(s)____.

Age range: __18-22 years __23-29 years __30-39 years
__40-49 years __50-59 years __60-65 years __more than 65 years.

Race: __White/Caucasian __Black/African American __American Indian __Asian
__Native Hawaiian/Pacific Islander __Spanish/Latino/Hispanic ___Other

Do you require your new hire registered nurses to have the following skills? (Check all that apply)
Typing/Keyboarding__ Word processing__ Power-point__ PDA(Personal Digital Assistant)__
Email(send and receive)__ Library search on the Internet__ Other_____________________.

Do you offer your current registered nurses classes to acquire the following skills? (Check all that apply)
Typing/Keyboarding__ Word processing__ Power-point__ PDA(Personal Digital Assistant)__
Email(send and receive)__ Library search on the Internet__ Other_____________________.

What technology skills do you think should be included in a school of nursing curriculum? (Check all that apply)
None_____
Typing/Keyboarding__ Word processing__ Power-point__ PDA(Personal Digital Assistant)__
Email(send and receive)__ Library search on the Internet__ Other_____________________.

Would you like to receive a summary report ? Yes___ No___. If yes, please email your preferred email address to: byrdlin@auburn.edu

Comments or suggestions____
____

Please Go to Next Page

The following questions measure the quality of your overall nursing service. Please answer each question to the best of your knowledge. Please use the key to the right:	**<u>SD</u> means that you <u>strongly disagree</u> with the statement** **<u>D</u> means that you <u>disagree</u> with the statement** **<u>N</u> means that you are <u>neutral</u> with the statement** **<u>A</u> means that you <u>agree</u> with the statement** **<u>SA</u> means that you <u>strongly agree</u> with the statement**

	SD	**D**	**N**	**A**	**SA**
1. Our nursing service is one of the best at providing reliable healthcare.					
2. Our nurses are known for performing services right the first time.					
3. The nurses at this hospital maintain error-free charts on patients.					
4. The nursing staff is dependable in handling patient needs.					
5. The nurses keep patients informed about when their services will be performed while here in our hospital.					
6. Our nurses provide *prompt* services to patients.					
7. The nursing staff is known for *responding quickly* to patients' requests.					
8. Our nurses *understand* the needs of the patients and their healthcare needs.					
9. The nursing staff *knows* the patients on a personal level.					
10. Nurses at the hospital *can identify* with the patients and their healthcare needs.					
11. Nurses can easily find the equipment or devices they need for patient care.					
12. The nursing areas in the hospital are <u>*not*</u> cluttered but are neat and organized.					
13. The nursing station has everything in its proper place.					
14. The nurses in the hospital can *collaborate* with other departments such as the pharmacy and the laboratory.					
15. Our nurses *communicate* with the pharmacists and laboratory personnel.					
16. The nursing staff *communicates* with physicians on the status of patients.					
17. Our nursing staff has created a safe environment for patients.					
18. Medical errors from nurses are rare compared to other hospitals of this size.					
19. The nurses at this hospital are vigilant about preventing accidents among patients.					

Please Continue On the Back

This survey is to investigate the quality of information used by the majority of nurses for clinical decision making in hospitals. Answer each question to the best of your knowledge. Please use the key at your right:	**SD means that you strongly disagree with the statement** **D means that you disagree with the statement** **N means that you are neutral with the statement** **A means that you agree with the statement** **SA means that you strongly agree with the statement**

The information for the following questions can come from either paper-based, computer based or a combination of paper-based, computer based chart systems. The information may be found in patient orders, medication administration records (MARs), history and physical reports, laboratory reports, and radiology reports or other parts of the patient's chart.					
	SD	**D**	**N**	**A**	**SA**
1. The information used for clinical decision-making has numerous accuracy problems that make it difficult to care for patients.					
2. The information used for clinical decision-making that is provided to nurses is accurate.					
3. The information that is used for clinical decision-making is correct and adequate to provide excellent patient care.					
4. The information that nurses need for patient care includes all necessary values.					
5. Clinical information for nurses is sufficiently complete to provide high quality patient care.					
6. The information that nurses receive for patient care has sufficient breadth and depth.					
7. The information that nurses receive for clinical decision-making is not sufficiently timely to provide high quality healthcare.					
8. The information used for clinical decision-making is not sufficiently timely to provide high quality healthcare.					
9. The information nurses used for clinical decisions is sufficiently up-to-date to offer high quality patient care.					

You have completed answering all questions

Appendix 3

Follow-up Emails

First Follow-up e-mail

Dear

This email is a follow-up to a survey that was sent a few weeks ago by U. S. Postal Service and the email that was sent a couple of weeks ago.. You were asked to complete a survey about chief nursing officers (CNO) perceptions of the quality of information in their hospitals. This study is being conducted by Linda Byrd, a registered nurse, researcher and Ph.D. candidate, under the direction of Dr. Jan Kavookjian in the Department of Pharmacy Care Systems, College of Pharmacy at Auburn University. Your responses are of great, critical value in identifying the challenges of CNOs as they address the need for nurses to provide quality care in their hospitals. If you have already completed the survey, I would like to thank you for your contribution to this study. If you have not yet reviewed the information about the study or completed the survey, please take a few minutes to find out more about the study by clicking on the link below. I encourage you to add your input to those of your colleagues. If for any reason you are having trouble accessing the link in the previous announcement, it is included at the bottom of this message.

The results of this study may aid CNOs in decisions regarding investments in information technology and changes to their current organizational structure. It is hoped that these decisions may result in improved quality of care, improved safety and decreased cost in hospitals.
Time is critical so please complete the survey within seven days if your schedule permits. Your time and cooperation are truly appreciated. A summary report of the results of the study will be provided to all CNO who send their preferred email address to: byrdlin@auburn.edu. The summary report will only make use of aggregate data from all participants, therefore your responses and organization name will remain strictly confidential.
Please take a few moments to complete the survey for this study by clicking this link: https://business.auburn.edu/surveys/byrdlin. If you prefer, you may participate in the study by completing the paper survey that was mailed to you. Simply complete the survey and return it in the pre-paid postage envelope. The survey will only take about ten minutes of your time.
Use this unique code to gain access to the survey_______.
Thank you for your support of this research project. If you have any questions you may contact me at (334)844-6758 or email at byrdlin@auburn.edu.

Sincerely,
Linda Byrd, RN, MSN
Ph.D Candidate
(334)8446758
byrdlin@auburn.edu

Dr. Jan Kavookjian
Co-investigator and Chair
(334)844-8301
kavooja@auburn.edu

Second Follow-up email

Dear:

A few weeks ago I sent you a letter and information packet followed by an e-mail requesting your participation in my study of chief nursing officers (CNO) opinions on the quality of care in their hospitals. Unfortunately, I have not received the completed survey from your hospital. I ask that you please complete the survey.

If you have already completed and returned the questionnaire, please accept my sincere thank you! If not, please do so today. Information that you and other CNO provide will be used to gain an understanding about CNO perceptions of information nurse need for quality care and patient safety.

You may respond: (1) on paper [use the survey that I mailed to you], or (2) online (type the following Web address in your Web browser, then enter the __digit password/code to access the questionnaire) https://business.auburn.edu/surveys/byrdlin

Again, thank you for your support in this research project.

Sincerely,
Linda W. Byrd, RN, MSN
Ph.D Candidate
byrdlin@auburn.edu
(334)844-6758

Dr. Jan Kavookjian
Co-investigator and Chair
(334)844-8301
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