A STUDY OF THE IMPACT OF HEALTH INFORMATION QUALITY ON CARE DELIVERY QUALITY AND SATISFACTION FROM THE CARE PROVIDER'S PERSPECTIVE

by

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Abstract

A STUDY OF THE IMPACT OF HEALTH INFORMATION QUALITY ON CARE DELIVERY QUALITY AND SATISFACTION FROM THE CARE PROVIDER'S PERSPECTIVE

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The US healthcare system is rapidly adopting health information technologies (IT) in its quest to improve patient safety and deliver high quality care at a lower cost. As healthcare providers increasingly rely on health IT in caring for their patients, there is a corresponding increase in the impact of health IT on the outcome of care delivery. Unfortunately, there is a dearth of empirical studies on how health IT quality influences healthcare outcome. Using a comprehensive framework based on Work Systems Theory, a research model was developed to study the impact of health information quality on care delivery outcome and satisfaction from the use of healthcare information systems from the perspective of the nursing staff in a hospital setting. A unique aspect of the research model is the conceptualization of information quality as pushed and pulled information quality. As pushed information, in the form of alerts and notifications, plays an increasingly important role in care delivery in a hospital setting, it is imperative to understand its impact on care delivery quality. Data collected through a survey of

162 nurses was analyzed using the partial least square (PLS) method of structural equation modeling. The results provide strong support for most hypothesized relationships. A key finding of the study is that both pushed and pulled information quality influence care delivery quality, however only pulled information quality has an impact on satisfaction from the use of the information system. Leadership endorsement of quality was found to directly influence care quality while also having a moderating effect on the influence of pulled information quality on care delivery. The implications of the findings for research and practice are discussed, and directions for future research are outlined.

Table of Contents

List of Illustrations

Figure | Page

List of Tables

Table | Page

Chapter 1

Introduction and Motivation

Quality has different meanings in different contexts. In consumer products, quality may refer to lasting durability, aesthetic value or reliable performance. In the services industry, quality relates to expectation fulfillment such as in judging timeframe in which goods undergo repair, replacement or recovery. In the domain of information systems, quality covers a wide range of concepts and measures surrounding the structure, business processes, products, services and outcome. The structure and the process aspect relates to IT operational elements such as infrastructure system performance, delivery quality of IT functions, and performance of IT support. The products and services aspect includes the quality of information the consumers see while outcome refers to the quality of information products and services in meeting the needs of the consumer and their overall satisfaction. Healthcare researchers have extensively utilized the structure-process-outcome (SPO) framework laid out by Donabedian (1978) to study the quality of care.

In almost every information system, the gap between the physical entity and the corresponding digital entity is pervasive (English, 1999, 2009). In fact, quality expert Feigenbaum recognizes quality as “the single most important force leading to the economic growth of companies in international markets” (Feigenbaum, 1982). Since this study is situated in healthcare, the quality issues encountered in the healthcare IT setup will be the focus. Although the Institute of Medicine defines healthcare quality as “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (IOM, 2001), its implications in the context of information systems entails the efficacy of healthcare information system (HIS) in the delivery of care by the healthcare providers. Therefore, while healthcare quality focuses generally on achieving fewer errors, lower mortality, lower cost, and patient satisfaction (Kleinman and Dougherty, 2013), the role of an information system in achieving these goals can be aided by assessing how well the healthcare providers are equipped with patient-related information in delivering care.

High quality information is an enabler for better outcomes for organizations and helps in areas such as customer gains, reducing churns, and higher patient satisfaction. With the explosion of data modern organizations deal with, quality takes center stage. The gap that exists in the delivery of information from information systems from its real world exact value to the value stored in the information system is the most fundamental issue of information quality. This results in the misidentification of data entities which may cause analysis paralysis, making bad decisions, making late decisions, or making no decisions at all. The gap widens further when elements of IS malfunction or when supposedly connected information systems work independently of each other or work in silos. As a result of this, healthcare providers do not possess the complete picture of the patient they are serving. This results in providers erroneously prescribing medications, procedures, and billings repeatedly when the patient moves from one provider to another. The poor quality of information and its sub-optimal delivery puts decision makers and those who are subjected to those decisions at much higher risk depending on the criticality of the situation.

Healthcare reform is underway to integrate the silos which enable the healthcare system to become patient centric rather than provider centric and make information available to all its providers irrespective of space and time variance (Stephen, 2014, Chan et al., 2008). One of the administrative provisions of the Health Insurance Portability and Accountability Act (HIPAA) originally mandates the implementation of a unique identifier to facilitate the availability of patient records from anywhere and anytime with the help of universal identifier. Electronic healthcare records are experiencing a massive structural reform to become a patient-centric repository reducing cost while improving care at the same time. This requires sharing of health information by different providers. Thus, information exchange amongst care providers and systems is essential for care quality improvement and cost reduction to avoid medication, procedure, and billing repetitions. Health Information Exchanges (HIE) were created with the specific intent to facilitate information sharing among health care providers. However, a recent report by the Agency for Healthcare Research and Quality (AHRQ) indicates that HIE was used by 38% of office-based physicians, and 1% of long-term care providers in 2012 (AHRQ report, 2015). These statistics about lack of HIE use show that in a non-patient-centric system the possibility of repeating the same process or medication is very high due to disconnects among providers raising healthcare cost. Uniquely identifying a patient will increase her/his chance of better care by not being victimized by treatment repeats, by not undergoing through the same procedure unnecessarily, and by not paying repeatedly. Having a 360-degree picture of all the information is not only necessary but vital for maintaining the integrity of patient data, delivering safe care, and avoiding elusiveness of information.

High quality information not only helps the providers, but also enables patients to make better choices and to reach optimal cost solutions. Data quality affects organizational competitiveness as well because it directly relates to customer service and customer. However, delivering high quality output is costly and requires clear and bold strategies to bring about integration of silos and systems to achieve a conformance of data and metadata to establish a single version of truth and completeness of information (Isson and Harriot, 2012). According to a published result, losses reported by one hundred major multinational companies exceeded well over a trillion dollars by 2009 which is attributed to poor data quality (English, 2009). As more organizations rapidly become more data driven, the cost associated with low quality data is only going to exceed previous estimates of losses.

As care crosses geographical boundaries, healthcare is gaining more complexity from a technological standpoint. Cyber processing and system integration allow organizations to present themselves globally, cutting through several time zones and several cultural and linguistic borders to serve a multitude of populations. This presents both a challenge and an opportunity. The challenge lies in the integration and interchange of widespread data while the opportunity exists in serving customers and patients globally and reducing costs due to reasons mentioned earlier. Another challenge comes with handling the large volume, high velocity, and variety of data. While data are on an aggressive path of exponential increase, the expectation on data quality is never depressed, in fact, as non-information system-based data such as paper-based information is vanishing, the expectation keeps growing on true value and the veracity of data hosted within the information system. Data used to be only a structured entity with foundation in relational algebra but now data has escaped the boundary of relational database management systems. This brings up a technological challenge of dealing with nonstructured data. Data exists now in semi-structured, unstructured, and binary formats such as images, geospatial, graphs, XML, JSON, and freeform data such as encounter notes and notifications, follow-ups, alerts, and provider's comments. While major technological changes are ongoing in regards to data management, the goal of information delivery remains unchanged to see high quality information from information systems regardless of massive growth in volume (quantity), velocity (speed), and variety (type) of data.

Modern information systems, in general, and healthcare information systems in particular are growing more complex each day. This complexity poses challenges in every step of data management and creates several quality issues. On one hand, IS can face frequent operational jeopardies on a day-to-day basis owing to complexity of structural configurations that are responsible for organizational data creation (i.e. infrastructure and application software), while, on the other hand lower quality of information exposed by the IS delivery (processes) can cause analysis paralysis resulting in unsatisfactory care (outcome) delivered by the providers. Yet we have not come across a research in IS that incorporates structure, process and outcome in one single model. A lot of IS research includes information and system quality as listed out in Appendix A. Emphasis on information delivery (information quality) alone ignoring the underlying structure and the business processes will not be able to provide a prescriptive model for research. This stream of research in information/data quality has not given emphasis on the sources, namely, the applications and the underlying systems that create the data and induce quality issues in the delivery. When the quality is not assessed or corrected at the source of its creation or insertion into the system, the problem continues in the decision support systems which gets nothing better than what the operational source system feeds in. This has been well said with the pithy maxim known in computer science as “Garbage in garbage out.”

Focus on the consumer side of quality (the delivery end of the information flow pipeline) makes it appear to be the symptomatic side of the disease, and thereby limits the dimensions of quality to focus only on the manifestation of the problem. As the symptom of a disease is different from its cause, the cause of manifestation of bad quality delivery may actually lie in the manufacturing, organizing, and processing of data. Therefore, there is a need to look at the quality of information delivery from the process that feeds and creates data, structures that manage and retain the data, and the IT functions that transform and expose the data to its users. Although, healthcare researchers have used the Donabedian model to study clinical processes and outcomes of care, the framework fails to include interactions and interdependencies among system components. That is, it lacks the organismic whole view of the work system and therefore, it fails to be prescriptive which a good IS model strives for.

There is a recent study that suggests that medical error is now the third leading cause of deaths in the U.S. (McMains and Nelson, 2016). While the quality of care continues to be a depressing issue as the numbers tell, (98,000 deaths were reported by medication errors alone in the year 2000 (IOM, 2000), which reached 250,000 in the year 2016), there is a dearth of empirical work and construct consolidation to facilitate studies to causally relate the constructs to become predictive model for care delivery. Therefore, this research looks at the issues of IT-Mediated functions delivery, system performance, IT support performance, communicated information quality, and retrieved information quality in an integrated way and offers a framework that applies to quality issues in information systems from end to end in the delivery of care. This study includes only the information system-related factors that may influence healthcare outcome and does not include other aspects such as a doctor's intellectual or subject matter expertise to provide care to the patient.

There is another challenge in dealing with information in general. IS research is silent on what constitutes a complete set of information required by information consumers. In the context of information systems, information can be considered as an output (Ballou et al., 1998) of information manufacturing engine. The output from the manufacturing process can be exposed in two possible modes. The first mode is synchronous mode initiated by user interaction when the user is in full control of the system, i.e. by "pulling" required information from the information system. The second mode is asynchronous delivery. In this mode, the information is delivered either to a general audience (through broadcasting) or to a specific user by "pushing" the information which is triggered based on certain conditions designed within the information system. In healthcare, the information output is delivered in both the modes, but the pushed information makes the majority of information that care providers deal with (Angst et al., 2012). Until now, to the best of our knowledge, information system research has used "information quality" as a single construct and does not differentiate between pulled and pushed information. This research uses both pulled and pushed information to measure complete information quality.

1.1 Research Question

The central idea of this research is to develop a healthcare information system quality framework in which organizational aspects (leadership endorsement, and work environment), operational aspects (system performance, IT support performance, and IT-Mediated function delivery) and information products (pushed information and pulled information) are integrated so that quality as seen through the eyes of the quality experts is institutionalized. Since dealing with quality issues necessitate assessment and intervention, this framework extends prior research by including the antecedents (IT-Mediated functions and system performance) of the endogenous constructs (pulled information quality and pushed information quality) so that managerial and engineering interventions can be designed in areas where quality issues begin to arise. In summary, the research questions are:

1. What is a complete set of information that information quality as a construct should measure?
2. How do different modes of information (pushed and pulled) impact providers' care delivery quality and satisfaction?
3. How do the elements of IT infrastructure (system performance and IT-Mediated function delivery) impact different modes of information delivery?
4. What impact IT Support has on the health of IT infrastructural elements?
5. Do organizational variables (quality endorsement of the leadership) have an impact on care delivery and provider satisfaction from the use of HIS?
6. Does the environment (occupational stress) have any impact on care delivery and satisfaction of care providers?

1.2 Importance of Research

We have moved from an industrial era to a digital era with the explosion of data and by the ability to use them digitally. We are resolved in converting every physical form of information into electronic data and in doing so, human and machine missteps are pervasive and result in many concerns surrounding electronic data. This is truly a data tsunami that the modern age is facing. Losses reported by major U.S. industries have piled up constantly (Batini et al., 2009; Chengular-Smith et al., 1999; Eckerson, 2006; English 2009) due to random, occasional, procedural, organizational, and systemic issues in the process of creating, using, communicating, converting, and reusing electronic data. The issue of quality in relation to information systems is becoming more intricate with the explosion of information system technological innovations in addition to data deluge. As a result of fast-paced innovations, not only is the amount of data growing but the mode of data delivery is also changing. However, IS researchers have not taken into account the complete set of information collected through different modes in the study of information quality. This is a major gap in IS research. This research is an effort to fill that gap.

With all the unprecedented growth in information technology, academic research especially in healthcare, still suffers from the lack of an integrative framework that researchers can use. The purpose of this research is to establish an integrative framework surrounding care quality and provide a variance model which will may also help design engineering and managerial interventions around the potential occurrences of information quality issues situated in healthcare to reach optimal care delivery.

1.3 Overview of the Dissertation

Chapter 2 provides a review and introduces existing literature on quality, its measurement, and frameworks. Chapter 3 introduces the frameworks related to the healthcare information system and care delivery. Chapter 4 introduces the proposed research model, constructs and hypotheses developed utilizing the work system framework. The model uses constructs related to software development life cycle (IT-Mediated functions), information products, care delivery, and satisfaction. Chapter 5 presents a study design to validate the proposed model. Chapter 6 provides the results of a cross-sectional survey of nurses applied to our framework. Chapter 7 presents a general discussion of the study's findings and implications for both theory and practice. Finally, limitations of this study have been listed along with possible enhancements and guidance to practitioners.

Chapter 2

Literature Review

Quality is a much-entangled concept when it relates to information systems. It has been conceptualized in many ways which varies from discipline to discipline. The complexity is due to a few reasons surrounding the words “information” and “system.” First, information and data are used interchangeably for measurement, yet “information systems” instead of “data systems” has been the lingo. Data remained an existential entity by the virtue of its mere existence and data systems convey the aspect of technology responsible for storing and managing data (DeLone and McLean, 1992). Second, “system” is a very generic term and includes pretty much everything under the information system umbrella. Third, an added complexity comes from the fact that an information system is an open system that is on a continuous evolutionary path, making it very difficult to treat it as a final product for studying quality under the realm of “product quality.” The quality of a product is ascertained at the point of sale since a snapshot of the product is the time it is purchased. Treating an information system as a product is unrealistic since it goes through a life cycle from the moment of adoption to the point of discontinuance. So, this study begins with a definitional clarity of the elements of information system entities that directly or indirectly affect the outcome from the use of an information system throughout its life cycle.

2.1 Definitions of Data, Big Data, Information and Communication

Communication theory (Shannon and Weaver, 1949; Mason, 1978) defines information on three levels: semantic, technical and influential. The technical level deals with the amount of data/information transmitted in a given time; the semantic the level measures the success of information (meaning in the data), the effectiveness of which is realized at an influential level. The technical level measures the precision of data records while success and influence measures are realizable at the incidence of retrieving or deriving value from stored data records. These definitions face challenge when the views on information expand from merely communication flow perspective as described in the communication theory to archiving of data in the information system. Redman (1992, 2001) expressed concerns that the definition of data as the raw material of information misses the structure embedded in data. Therefore, Redman conceptualizes data as a triplet composed of <e, a, v> where the value ‘v’ is from a set of attributes ‘a’ of an entity ‘e’. Redman (2001) defines “data records” as distinct from data per se, which is physical realizations of data stored in papers or in information systems. Therefore, data are facts, numbers or text without any context. When data is processed, organized, structured, or presented in a given context so in order to make it useful, it becomes information to its consumer. Redman (1992) pointed out that what is perceived as data by one person may be viewed as information by another. This boundary problem between data and information can be substantially overcome if one views data as flowing into the information system for the purpose of being stored while information can be viewed as flowing out of the data elements from the information system demanded by the user. This view also helps in understanding the difference between “data system” (or even “big data system") and "information system". Data system deals with the data storage while information system deals with turning the data into information.

Healthcare has been dramatically impacted both by technological and regulatory changes, such as use of big data technologies, regulations related to healthcare information interchange and privacy. Big data is a relatively recent introduction in healthcare, however, its use has grown explosively in a very short time period (Raghupathi and Raghupathi, 2014; Becker et al., 2013). A report delivered to the U.S. Congress in August 2012 defines big data as "large volumes of high velocity, complex, and variable data that require advanced techniques and technologies to enable the capture, storage, distribution, management and analysis of the information" (IHTT, 2013). Big data consists of structured, semi-structured (i.e., XML and JSON) and unstructured data (graphs, binaries, free-form textual, and document oriented). Big data tools enable the ingestion of structured, semi-structured and unstructured data formats into Data Lake repositories. The big in the term "big data" is due to the contemporary limitations of information systems, that means, what is big now may not continue to be viewed as big data after some time in the future (Franks, 2012).

The digitization of medical records, wearable technologies, mobile technologies, and the "Internet of Things" are some examples of big data use-cases in the domain of healthcare. Big data poses technological challenges in its processing, however, continued innovations in technology are making it possible to transform this data into meaningful and actionable insights to enhance delivery outcomes such as patient care, user experience, and reduced cost. Big data types also contribute to the complexity of data processing. Prior to the rise of big data, the most used data types were smallint, int, char, varchar, decimal, and float. The culmination of last millennium's technologies created new and complex data types, such as, IMAGE, BLOB, CLOB, TEXT, GEO, SPATIAL, XML, and JSON, some of which have found widespread use in the healthcare domain.

2.2 Quality Concepts within the Information System Realm

Several quality concepts related to the information system have been studied extensively. The entire spectrum of quality related to information systems is very wide covering several aspects of information systems. It begins with the fundamental input entity, data, and the output entity – the information. Therefore, data source quality, information quality, data quality, data definition quality, data content quality, data warehouse quality, contextual data quality, intrinsic data quality, information quality, information architecture and design quality, maintenance quality, processing quality, product quality, representational data quality, information retrieval quality, and data storage quality have been discussed in data quality literature (Wang and Strong,1996; Eppler and Muenzenmaver, 2002; Zhu and Gauch, 2000; English 1999; Jarke et al., 1999). In addition to the above quality concepts specific to information product, IS researches have also operationalized concepts related to the business and customer service processes such as system quality and service quality (Wixom and Todd, 2005; Kahn et al., 2002; Rai et al., 2002; Forker, 1991; Parasuraman et al., 1985; Garvin, 1984).

2.2.1 Product Quality

The debate about whether information should be treated as raw material or as a product remains open. Wherever information has been viewed as a final product (Wang et al., 1996; English, 1999), literature on product quality offers some insight in the study of information quality. Since information in this study is undertaken in the context of delivery of care, this study treats information as a product which is consumed by the care providers and, therefore, this study benefits from the discussions on product quality. Although, the literature on product quality wrestles with identifying quality as a subjective and in some cases as an objective concept and does not concur on one unifying thought, a conceptual framework on product quality was initially presented by Garvin (1984) and later enhanced by Forker (1991). Table 2-1 presents five definitions of product quality proposed by Garvin (1984).

Table 2-1 Conceptual Framework of Quality, Garvin (1984)

Quality Perspective and Underlying Discipline	Quality Definitions
Transcendental (Philosophy)	Quality is synonymous with innate excellence. Thus quality is an abstract or a philosophical concept.
Product-Oriented (Economics)	Quality is precisely measurable. Difference in quality reflects difference in quantity which is measurable. This creates gap between true and actual quality of desired attributes.
User-Based (Economics, Marketing and Operations Management)	This is demand side of quality; that is, quality lies in the eyes of who demands it.
Manufacturing-Based (Operations Management)	This is the supply side of the manufacturing process or what it supplies to the consumer. Therefore, quality is measurable in the context of conforming to design specifications.
Value-Based (Operations Management)	This measures quality in terms of benefits and costs.

In addition to the above five perspectives of product quality, Taguchi (1987) added a societal perspective and defined quality as a social loss. From IS perspective, this loss may result from the variability in production processes or from undesired side effects of management of IS. From the five perspectives mentioned in Garvin's framework, the user-based approach considers quality from the eye of the beholder and matches closely with the demand side (quality demanded by the consumer of data) of data quality. Demand side of information quality in information quality literature has been known as information's "fitness for use" (Strong et al., 1997; Wang and Strong, 1996). On the other hand, the supply side view embodies the manufacturing-based approach (i.e., what the manufacturing process supplies to the consumer of data) which largely depends on the engineering and manufacturing practices of data management. In this regard, information quality is viewed as the quality of information that "conforms to requirements."

2.2.2 Data and Information Quality

Most existing research in data quality has been conducted from three broad angles: first, data quality as a general concept; second, data quality in information systems for data consumers; and third, data quality in accounting and auditing (Wang and Strong, 1996). The assessment methods of data and information that have been employed in the research are mixed and both the objective and the subjective evaluation have been used. The problem in choosing an objective versus subjective assessment lies in the fact that data is purely an objective entity due to its mere existence (such as amount of data) while quality can be measured either objectively or subjectively. Objective measurement relates to the conformance to the requirements i.e. the deviation measured between the requirement specification and what was delivered. Subjective measurement is based on the degree to which the consumer views data to be fit for use (Eppler, 2003). Even though data is generally objectively measured, information can be assessed both objectively and subjectively, nevertheless, in most of the studies information quality and data quality has generally been used interchangeably in the literature (Madnick et al., 2009).

The early studies treat data as an intrinsic entity (Brodie, 1980; Wang and Strong, 1996) by measuring it objectively in relation to a pre-specified benchmark as opposed to measuring it against a particular use by a specific user and in a specific context. Intrinsic view can be considered as matching with the manufacturing based view under Garvin's framework. The intrinsic view focuses on the content of the data alone irrespective of the several formatting and delivery modes and therefore, this view facilitates the generalization of dimensions across multiple applications and systems. The advantage of intrinsic dimensions is the possibility of an unbiased comparison of more than one application in the same way and against the same quality benchmarks. The disadvantage of intrinsic measures is its limited scope because measure such as amount of data (e.g., completeness of data such as a table that maintains information of each of the states of the USA must have 50 rows of data to represent 50 states) does not tell much about other dimensions such as accuracy (whether the content of those rows in the table are correct or not e.g. a row corresponding to the state of Texas inaccurately may show acronym for Texas as TS instead of TX). As opposed to an intrinsic view, an extrinsic view is based on the usage and the value judgment of the data consumer. This extrinsic view brings in different facets of measurement. Contextual data quality, representational data quality, and accessibility data quality have been proposed to address the different facets in addition to intrinsic attributes. Figure 2-1 shows the diagrammatic representation of data quality dimensions as illustrated by Wang and Strong (1996).

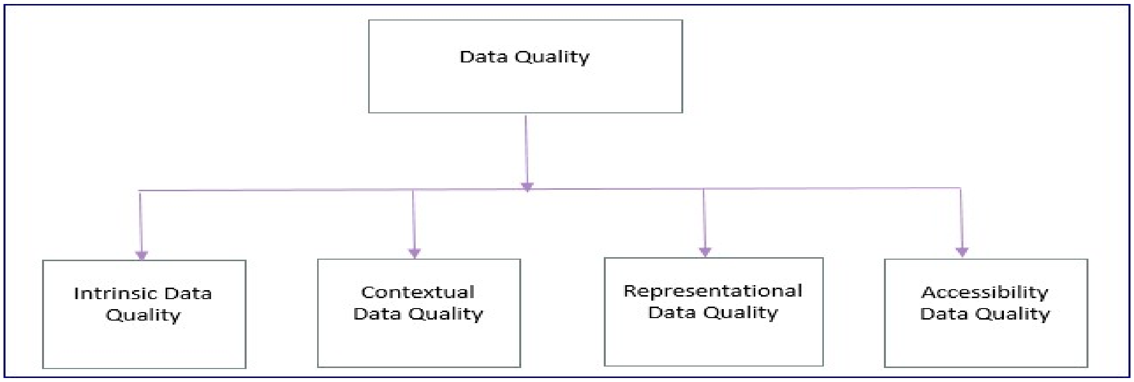

Figure 2-1 Data quality dimensions (Wang and Strong, 1996).

The second stream of research is based on user-based view of data quality as treated in information system success studies and user satisfaction literature. These studies have defined data quality from the perspectives of the data consumers. This is the demand side of the data that a user demands from the information system. Therefore, conformity to design is not the focus here; instead the focus on quality is on the fitness for use of the data, depending on the context of the task. Dimensions such as information timeliness, reliability, and accuracy have been employed in measuring the quality of data (Kriebel, 1979; Ahituv, 1980; Ives et al., 1983; Munro and Davis, 1977; Gallagher, 1974) in this scenario. These dimensions are subsumed in the Wang and Strong (1996) data quality framework.

The third stream is related to accounting and auditing involving accounting information system (AIS). The quality in this area is measured by noticing a presence or absence of target error classes in accounts such as existence (E), completeness (C), rights and obligations (R), valuation and allocation (VA), presentation and disclosure (P), and compliance with legal restriction (CLR) (Kaplan et al., 1998). In this stream, the dimensions of AIS data quality include accessibility, accuracy, availability, comparability, compliance, completeness, confidentiality, effectiveness, efficiency, integrity, relevance, reliability, security, and understandability (Wongsim and Gao, 2011).

2.2.3 System Performance

"System" is a very generic word and is used indistinctively (Alter, 2000, 2006, 2013; Lee, 2010; Markus and Mao, 2004), it remains unclear in IS studies related to system quality whether it implies the quality of a component of the information system or of the entire deployed information system. Murray was right in pointing out almost 60 years ago that the word "system" is a much cathected term (Murray, 1959) and it should be used with care. It is important to have a definitional clarity in the use of the word "system." Therefore, for this study, "system" is considered as the information system's backbone (infrastructure) such as the network, the storage, and the plethora of software running on the hardware for the IT applications to deliver IT functions. In other words, we will separate system performance and the performance of IT functions of target IS that an organization develops for serving its customers. Thus, system performance is the quality of the elements of IT infrastructure (sometime called as host systems) on which organizationally-focused (target application is hosted on) information systems are deployed. Modern information system infrastructure are comprised of varieties of software such as utility software (e.g. Winzip, SCP, and Anti-virus), operating system software (e.g. Windows, Mac, and Linux), database management software (e.g. SQL Server, Oracle and MySQL), and application platform software (e.g. java and .NET). Besides these software, a variety of hardware components (e.g. servers, EMC drives, and SSD drives) and the network components (e.g. Cisco switches and T1 cables) make up the information system footprint. Any aspect of infrastructure malfunctioning can impact the output and the performance (and quality) of target information systems. The delivery performance of infrastructure is often challenged by peak-hour loads, applications of patches and hotfixes, component upgrades, and accidental loss of computing resources resulting in unwanted performance issues. A performance gap between the expected and what is delivered results in the failure to meet SLAs related to quality. Studies have found that organizational decision making and information quality vastly depend on integration and interoperability of multiple data sources (Wetherbe, 1991) which require uninterrupted network connectivity. The performance parameters of an information system such as responsiveness, reliability, fault tolerance, scalability in dealing with load fluctuations, flexibility (Gray and Watson, 1998; Wybo and Goodhue, 1995), interoperability with other systems (Belardo et al., 1982; Conklin et al., 1982; Bailey and Pearson, 1983; Sakaguchi and Frolick, 1997) and accessibility (Srinivasan, 1985) have been studied extensively in IS success-related researches.

2.2.4. Leadership endorsement of Quality

Quality is an organizational objective and enforcing quality goals requires time and resources. At times, this requires re-scheduling deadlines, prioritizing deployment releases, and allocating budgets to meet goals related to quality. An employee who does not have the responsibility in the decision-making process would not have the power to extend the deadline or incur additional costs to deliver a higher quality product. Information system quality goals are best attained when leadership and top management promote quality improvements in the design processes to achieve higher information quality (Ravichandran and Rai, 2000).

In a large IT setup, one of the ways to ensure higher quality is by incorporating advanced tools and technologies that can help locate quality issues through stress testing, regression testing, user-acceptance testing, statistical analysis, and knowledge discovery. Managers employing advanced automated testing tools can get a much faster and accurate assessment of the factors behind falling quality in a fast-changing dynamic data domain (Nambisan, 2003; Dermusoglua and Barczak, 2011). However, those high-end tools are very expensive and require support from leadership in its procurement and mandating its use. By effectively endorsing quality and procuring better tools, bugs can be eliminated and minimized before deploying new releases into production environment which can help ensure high quality output from IS.

2.2.5 Summary of Quality

No one definition of quality works best in all situations. Each definition has strengths and weaknesses in terms of organizational usefulness in its measurement and assessment in guiding practitioners. Internally focused definitions of quality as a value, or quality as excellence or quality as conforming to design specifications can lead to increased organizational efficiency without having to depend on customer feedback for making corrective managerial interventions. Externally focused definitions of quality such as meeting and/or exceeding customer expectation allows managers to design interventions to match the customer's growing expectations (Reeves and Bednar, 1994). Garvin's (1983) product-based and manufacturing-based definitions being internally focused are objectively measurable. On the other hand, Garvin's user-based classification aligns with perceived quality and, therefore, is subjectively assessed as the term "fitness for use" suggests.

The selection between objective and subjective methods depends on the goals of assessment. To achieve higher quality of industrial and corporate performance, it requires a numeric measure to quantify the level of quality at any point in time. To achieve higher quality for consumer's goods, it requires quantifying mechanistic features and objective value. In marketing literature, measures of quality includes quantification of the gap scores as in the case of measuring service quality as the difference between perceived service quality and expected service quality (Parasuraman et al., 1988). For the purpose of psychometric measure, the academic researchers conceptualize quality as subjective perception of objects (Holbrook and Corfman, 1985). This research uses the subjective measure of quality (perceived quality) as derived from eliciting consumer perception of an object's overall performance (Zeithmal, 1988).

2.3 Management of Quality–Continued Quality SLAs

We have discussed many different types of quality concepts as it relates to information systems but we have not yet detailed how to maintain good quality SLAs. Maintaining a quality level rests on the management of quality issues. Quality management is aimed at maintaining a desired level of performance for an organization. This includes quality planning, assessment, control, improvement and assurance. A framework that captures all these stages is called total quality management (TQM). In TQM literature, Deming had proposed the iterative cyclical steps (P-D-C-A) of Plan, Do, Check and Act (Deming, 1986) and has been widely used in quality improvement programs toward continued quality assurance.

2.3.1 Data Quality Management

When the quality management principle is applied to ensure the desired level of quality in data, it is termed "data quality management". Total Data Quality Management (TDQM) is an iterative process rather than a one-time implementation to achieve and maintain the desired data quality. TDQM generally consists of the data quality definition (D), DQ measurement (M), DQ assessment (A) and DQ improvement (I) in a cyclical process D-M-A-I (Wang and Strong, 1998; Shankarnarayanan et al., 2003).

2.3.2 Data Quality Assessment

In the above paragraphs, we discussed the definitions and dimensions of DQ for measurement purposes. The next step after measuring the data dimensions is DQ assessment and DQ improvement. The definitions and dimensions provide the first step in quality assessment and improvement. Measurement of the quality of data is the process of mapping the attribute-level values to real world entities. Assessment is the process of comparing the variance or deviation of the measured value from the real entity value (Stivilia et al., 2007). The data quality assessment includes the analyzing requirements, identifying critical areas, understanding processes, and measuring data quality. The gap between the measured and the actual true value provides an assessment as to how far the entity is from the quality goals.

2.3.3 Data Quality Improvement (DQI)

The next stage of data quality management includes employing continuous improvement techniques and strategies to correct data errors. DQI strategies generally include the cost evaluation of fixing data issues, assignment of responsibilities, and identification of causes of errors, design of improvement methods, process redesign, and monitoring. These strategies are either data driven or process driven. Data driven strategies require the fixing of data records in data repositories by using one or more techniques such as data normalization, schema integration, data cleansing, data profiling, and record linkage. However, data driven techniques are provisional and run the risk of being overwritten with bad data again if the same process that initially caused the issue remains in place (Maydanchik, 2007). Therefore, a more thorough improvement programs which can fix the organizational data creation process requires process redesign to eliminate the systemic issues seeded in a continuous software development life cycle (SDLC) by adhering to the principles of effective requirement gathering, design, coding, testing and implementation (Batini et al., 2009, Goodhue et al., 1988).

2.4 Care Quality in Healthcare and Its Measures

The core functionalities of Healthcare Information Technology (HIT) include results management, order entry, decision support reporting, supporting functionalities for electronic communication and connectivity, patient support, administrative support and population health management (Blumenthal and Glaser, 2007; Chaudhry et al., 2006). These different functionalities are offered by different types of health information systems each serving a specific purpose in the process of care delivery. The U.S. Congressional Budget Office report (2008) identifies seven different types of health information systems, namely,

- electronic medical record (EMR) – the electronic equivalent of a patient's paper record
- electronic health record (EHR) – a more complete record that includes all of a patient's information across multiple healthcare organizations (this term is becoming the general term for all forms of electronic patient records)
- personal health record (PHR) – a variation of EMR/EHR being considered to be maintained and controlled by the patient rather than a healthcare organization
- payer-based health record – this is the electronic patient information maintained by the payers (e.g., insurance companies) and primarily includes procedure, cost, and payment information
- computerized physician order entry (CPOE) – information systems that allow physicians to order procedures

- clinical decision support system (CDSS) – based on guidelines and research, these systems can suggest possible diagnoses and treatments that the physician can consider
- e-prescribing or electronic pharmacy systems (EPS) – systems that allow physicians to electronically enter prescriptions, which can then be checked for drug interactions

According to a published report (FamilyUSA, 2014), the purpose of quality measurement is to improve health care delivery by: 1) preventing the overuse, underuse, and misuse of health care services and ensuring patient safety; 2) identifying what works in health care and what does not to drive improvement; 3) holding health insurance plans and health care providers accountable for providing high-quality care; 4) measuring and addressing disparities in how care is delivered and in health outcomes; and 5) helping consumers make informed choices about their care. It is evident that healthcare involves many stakeholders, myriads of complexities and vastly fragmented system which is expected to deliver care that is 100% accurate since failure of such systems can potentially cause financial harm or even put people's lives at risk. It is not easy to summarize this complexity without limiting the focus to a specific aspect of care delivery such as patient safety or reducing costs. In studying patient safety, healthcare researchers have used SPO framework proposed by Donabedian (1978) in the past. This framework requires assessment of quality measures as listed in Table 2-2.

Structure assesses the characteristics of a care setting, including facilities, personnel, infrastructure, and/or policies related to care delivery. Process determines if the services provided to patients are consistent with routine clinical care leading to satisfactory outcomes such as patient health improvement as a result of care.

Table 2-2 Types of Healthcare Quality Measures

Quality Measures	Description	Uses and Examples
Structure	Assesses the characteristics of a care setting, including facilities, personnel, and/or policies related to care delivery.	Measures of structure are often used by insurance companies and regulators to determine whether a provider has the required capacities needed to deliver high quality care, such as whether a hospital has a system in place to order prescription drugs electronically. These measures are also commonly used in the certification or accreditation of health plans and providers.
Process	Determines if the services provided to patients are consistent with routine clinical care.	Measures of process are used to determine the extent to which providers consistently give patients specific services that are consistent with recommended guidelines for care. These measures are generally linked to procedures or treatments that are known to improve health status or prevent future complications or health conditions.
Outcome	Evaluates patient health as a result of the care received.	Measures of outcome evaluate patients' health as a result of the care they have received. More specifically, these measures look at the effects, either intended or unintended, that care has had on patients' health, health status, and function. Outcome measures frequently include traditional measures of survival (mortality), incidence of disease (morbidity), and health-related quality of life issues.
Patient Experience	Provides feedback on patients' experiences of care to keep improving health care quality incrementally.	Measures of patient experience provide feedback on patients' experiences of their care, including the interpersonal aspects of care. Examples of patient experience measures include: How long did patients have to wait before being seen? Did a physician give easy-to-understand information to her patients that addressed their health questions or concerns? Did someone from the provider's office follow up regarding the results of a blood test, X-ray, or other lab work?

2.5 Satisfaction and Its Measures

Satisfaction has been one of the ways IS literature has assessed the success of IS since satisfaction is the post-use evaluation of the product (Seddon 1997, DeLone and McLean, 1992; Baroudi and Orlikowski, 1988; Doll and Torkzadeh, 1988; Bailey and Pearson 1983) formed by the overall attitude toward the product. Wixom and Todd (2005) incorporated information satisfaction and system satisfaction in their model and empirically supported that object based beliefs (information quality and service quality) shape user's satisfaction.

Healthcare information systems have been shown to have a direct impact on the clinical performance of healthcare providers (McCullough et al., 2010; Hillestad et al., 2005). Use of electronic patient record (EPR) health information system has been linked to nurses' satisfaction in a study of unified theory of acceptance and use of EPR technology (Maillet et al., 2014).

The measure of success has been an issue that IS scholars have raised and some studies have argued that in case of voluntary use of IS, system usage can be used as a surrogate measure of success (Ives et al., 1983). In case of mandatory use of IS, perceptual measure of satisfaction have been touted to be more appropriate measure of IS success (Baroudi et al., 1986).

Chapter 3

Proposed Framework

"What cannot be measured cannot be improved" was a famous remark by management thinker Peter Drucker. The essence of measurement is to quantify claims and, therefore, the focus of the quality measurement in this study is to measure those elements that contribute to the delivery of information leading to the delivery of care and realization of satisfaction from the IS.

The body of research in the area of total information quality management is not comprehensive in the sense that either the existing work is not bringing together all the necessary elements of quality related to the use of information system or the framework is not specific enough (such as related to healthcare), or, the framework creates confusion between the process and variance model. DeLone and McLean's (1992, 2003) model, which is extensively referenced in the IS researches, suffers in its specificity and has been criticized for creating confusion between process and variance model (Seddon, 1997). Wixom and Todd's (2005) framework, later extended by Xu's et al. (2013) framework focuses more on efficiency, lacks in measuring the effectiveness of IS. IS scholars have expressed concerns from time to time about the inadequacy of IS espoused theories and frameworks. Some of those are listed here to make a point.

- McLean (1973) expressed concern that IS research should move focus away from efficiency (doing it right) to effectiveness (doing the right thing).
- Myers et al. (1997) criticized that system quality is inadequate in measuring effectiveness of IS.

- Goodhue (2007) expressed that IS models such as TAM and Task-Technology Fit are static models. He states "…perhaps the proper larger question for IS academic field now is how to design and redesign… how to design the entire work system."
- Gable et al. (2008) expressed that many success measures overlap in studies.
- McKinney and Yoos (2010) stated that IS researches have traditionally routed more energy on technology adoption so much that "The IS field has been largely unreflective about the persistent difficulties in defining information, choosing to focus on the "T" rather than the "I" in IT. IS "flees forward" to study new advances in technology in order to escape foundational problems about information."
- Angst et al. (2012) and Coiera (2006) mentioned that the bulk of the information in healthcare is communication (communicated information).

Therefore, this study tries to redress long standing grievance of IS scholars as outlined above by developing a holistic framework that incorporates effectiveness (care delivery quality) to measure IS success. Our framework also addresses the issue that Angst et al. (2012) raised about communicated information. We developed a variance model by integrating the participants (IT support groups), the users (nurses) , the business processes (IT-Mediated functions), the technologies and the infrastructure (system performance), the organizational strategy (leadership endorsement of quality), the organizational environment (work stress), the complete set of information product (pulled information and pushed information), and the effectiveness of IS by measuring care delivery quality and satisfaction from the use of IS in a specific context (healthcare). The above elements organically cover a complete work system as espoused by work system theory (Alter, 2006). This research makes a specific contribution to the field of healthcare by examining responses from nurses in major hospitals where the use of HIS is mandatory. We begin the development of our framework by looking at various system approaches.

3.1 System Theories

The study of thinking in a unified way is not new. System theory uses the notion of organic thinking. General Systems Theory (GST) was developed by biologist Ludwig von Bertalanffy (1972). Bertalanffy's objective was to bring together the organismic science he had observed in his work under one heading. His desire was to use the word “system” for principles that are common to systems in general. In GST, he writes:

> “... there exist models, principles, and laws that apply to generalized systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relationships or "forces" between them. It seems legitimate to ask for a theory, not of systems of a more or less special kind, but of universal principles applying to systems in general.,”

Healthcare ecosystems consist of many individual elements that link one another to establish the organismic whole and can be regarded as special case of the general system. This is analogous to an object which can be a specific instantiation of a general class in an object oriented methodology. Healthcare employs a variety of technologies, participants, products and services with many purveyors (Kohli and Tan, 2016), which can be integrated for an overarching goal to achieve better and safer patient care.

Towards this goal, a work system model involving participants, tools/technologies, and an environment was developed by Carayon et al. (2003). In addition, the Systems Engineering Initiative for Patient Safety (SEIPS) model of work system and patient safety was proposed by Carayon et al. (2006). While both of these models are a good work flow type of model neither models can be easily used in a research design that can provide guidance to IS researchers.

This research uses the Work System Theory (Alter, 2000, 2006, 2013) which is based on the concept of a work system. Work system is a sociotechnical entity that recognizes the interaction between people and technology in workplaces. The work system acknowledges IS within the system thinking perspective. In an organizational setting, a work system can be realized with the help of Work System Framework (Alter 2006, 2008a, 2008b) which includes participants, information, processes, technologies, and activities to produce products to be utilized by the customers. This research restructures a healthcare based work system framework consisting of healthcare customer, healthcare work system participants, healthcare processes, healthcare technologies, and healthcare information products as one would encounter in a healthcare setup.

3.2 System Performance: Deep Dive into the Word “System”

Even though the use of the word “system” has become almost second nature, one of the difficulties of IS research is the many possible definitions of the word “system” (Lee, 2010). System and information system cannot and should not mean the same thing.

This is an over simplification of an overly complex entity and unfortunately this has become a plague in IS research. An example such as "Microsoft Office is not performing well on my older laptop" can clarify this point. In this example, "system" is clearly referring to the hardware, while the information system is the Microsoft Office software (assuming the exact same version of MS Office installed on both laptops and there is no other software installed on either of the laptops). Assuming the older laptop to have the low end hardware and the newer laptop equipped with high end hardware, the poor performance of the exact same MS Office software on older laptop insinuates the difference in hardware between the two laptops. Another example is booking a flight ticket on a slow network versus using a high speed internet connection insinuates the difference of network infrastructure. The above examples serve to clarify the construct "system performance" at an individual level.

In an organizational setup, system refers to the infrastructure on which the organization's customer applications are deployed. This definition pertains to the overall system capabilities (information system backbone) to address the organizational information system needs. Many studies have cited "system" specifically as a technical artifact as highlighted by DeLone and McLean (1992). Many other studies (Nelson et al., 2005; Wixom and Watson, 2005; Wixom and Todd, 2005; DeLone and McLean, 1992) have not clearly distinguished the target IS in question from the information system backbone. The result of the lack of clarity in properly identifying the target information system is that the system quality in most studies is defined in a way that is impossible to figure out whether the quality being discussed is that of a customer facing application (the target IS of the study) or that of the infrastructure system (backbone or the tools/technologies) on which the target application software has been developed and deployed. This mingling can be found in several studies where system quality and information quality have been placed at the same level in the variance model without regard to the impact of health of infrastructure on delivering information. The other possible explanation behind such variance models are the assumption that stored data will be available as information from the information system without IS functions doing any manipulations. Gable et al. (2008) through extensive review of IS success literature has pointed out that there is much overlap in quality constructs that have been used to measure IS success. Some studies have used system quality while some have used information quality to report IS success. Therefore, it is imperative to properly identify what system quality must refer to and what impact it will have on the product (information) of IS. Since a bad infrastructure system is expected to generate bad information quality, in that regard system quality is an upstream construct (independent variable) and information quality (dependent variable) will be downstream construct of system quality. It is important to note that a bad information quality on the other hand cannot have any impact on the infrastructure quality (hardware, network, storage) which demands that system quality and information quality must not be placed at the same level in any staged model.

In deviation from many previous studies, system quality has been shown to impact the information quality (Xu et al., 2013), underscoring the point that quality of the infrastructure (Xu et al. define system as the structural element of IS) impacts quality of information. Dimensions such as reliability, timeliness, and responsiveness speak for the underlying infrastructure even though end users can elicit their perception about those dimensional items based on how the target application responds. This has been clarified with the earlier example of an older laptop showing slowness in using Microsoft Office. The user would perceive the difference between the older low end laptop and a powerful newer laptop not by the touch and feel of the laptop but only when he tries to make use of it (e.g. by using Microsoft Office).

Although many studies failed to distinguish system quality from target application quality, the distinction between system quality and customer facing application quality becomes visibly prominent in the perspective of cloud computing (Benlian et al., 2012). Cloud services provide infrastructure as a service (IaaS) or platform as a service (PaaS). In those service models, IT organizations can lease infrastructure (hardware, storage, network, and backup solutions) and platform (operating system, ERP, DBMS, and browsers) and, therefore, a client-facing IT organization (such as a consulting company) can solely focus on developing their target applications to serve their clients. The following few examples further highlights the need to separate the system from the information system.

System and target information system both go through operational breakdowns. Operational outages in its scope of disruption resulting from system breakdown are different from those of application breakdown. Infrastructure troubles might result in total disruption due to the unavailability of the network, due to loss of database or due to failure in storage, while target application troubles may at times only break down certain functionalities and may not be fully broken.

Another distinction appears in diagnostic error logs that come from infrastructure system and the target information system. Error logs such as “Network not available”, “Loading …Please wait”, and “Server is down” help in identifying the component of infrastructure that may be experiencing trouble. On the other hand, error logs such as “run time error”, “divide by zero error”, “the content cannot be displayed in the frame”, and “invalid value passed to the function” provide diagnostic help in identifying target application issues.

When it comes to resolving issues related to infrastructure, it is external vendors and not the IT application development team who take the responsibility of resolving the issue. Storage issues are generally resolved by storage vendors; network issues are resolved by network support engineers; and vendor software issues are resolved through support and indemnification offered by the software vendors. In the cloud architecture, it will be cloud providers (providing IaaS) who will own the responsibility of resolving issues with infrastructure. Therefore, with all the clarifications done as above, we define system performance as the quality of the infrastructural elements.

3.3 Information System IT-Mediated Function Delivery

Infrastructure is a relatively static element as it is procured based on capacity-planning for an estimated growth. However, business needs keep changing requiring changes in IS applications to enhance IT functions to meet new business needs without having to change anything in the infrastructure. Application code changes continue to occur to make enhancement and add new features to the target IS which may not require any change in infrastructure. Change management process exists either to facilitate quality assurance or to enhance current functionalities (Ward et al., 2007).

A detailed study conducted by Microsoft on the extent of problems reported by their own trouble ticket system quantified that 21% of the errors are caused by faulty hardware (system failures such as storage loss, network failures, CPU, or memory issues), 36.2 % due to system side faults (such as database crashes, OS corruption, utility libraries malfunctions) and 37.1% due to customer IS failures (Zhou et al., 2013). This suggests that approximately four out of ten outages (37%) can be attributed to target application and six out of ten (57.2%) to system performance.

It is important to understand what “IT-Mediated function delivery” stands for. To understand this, let us begin with a business function (also called service content). Business functions help organizations deal with serving its customers. When the business functions can be delivered through the use of IS programs, we call them IT-Mediated functions. Thus, ordering, billing, paying, repair, and return are business functions (service contents) that can also be accomplished with the help of information technology. However, in order to generically measure the delivery of different types of business functions (instead of focusing on specific business function or service content delivery such as ordering), IS researchers are interested in generic dimensions that can speak for all the different types of service contents. We call this IT-Mediated functions delivery. IT-Mediated functions delivery involves the user-experience (UX) aspect of system design. Factors such as accessibility, navigability, interactivity, interoperability, adaptability, and security in delivering the information have been used as a measure of IT-Mediated functions delivery (Tan et al., 2013; Fassnacht and Koess, 2006; Surjadjaja et al., 2003; Barnes and Vidgen, 2001; Childers et al., 2001).

When the IT-Mediated functions are not architected well (designed and developed), a perfectly accurate information presented or delivered in a manner not expected by its recipients may result in misrepresentation and misuse of the information. The information quality not only depends on good content (data) but also on how appropriately the delivery functions facilitate the use of IS to its users. A well performing delivery interface will ease navigation across a complex site content, promote interactivity, allow a "single sign on" (SSO) for ease of accessibility, demonstrate interoperability, and adapt to the changing screen content without cluttering or freezing.

3.4 Healthcare Information Quality

Information depends on data and information quality depends on the data quality as discussed in the literature review (Shannon and Weaver, 1949; Mason 1978; DeLone and McLean, 1992; Langefors, 1966). Information is a derivative process and is drawn in the context of the task at hand from the raw data. Healthcare information quality depends on the information obtained from the information system in regard to patient care. Wang and Strong (1996) classified information quality (IQ) in terms of four dimensions (intrinsic, contextual, representational, and accessibility). When the user pulls information from the HIS, he or she can form perception about dimensions of information quality such as format (representational), completeness (intrinsic), timeliness, and accuracy (contextual). This study calls this category of information as "pulled information". In pulling the information for providing care, the user of the HIS is in control to invoke the IT-Mediated function of the HIS and is aware of his expectation about the information that will be displayed synchronously to him. Figure 3-1 shows dimensions of pulled information quality.

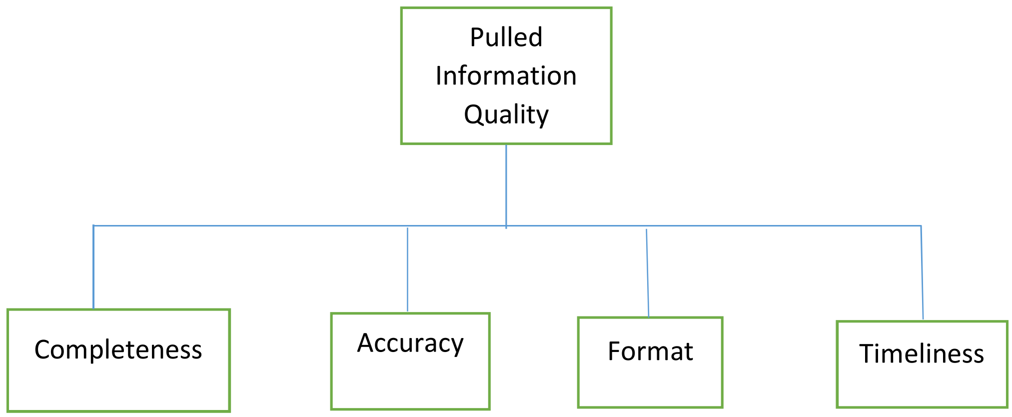

Figure 3-1 Dimensions of Pulled Information Quality

3.5 Healthcare Recipient Communication Quality (Notifications and Alerts)

Earlier studies have not made any distinction between information that is synchronously delivered to the user during the active use of HIS from information that may be asynchronously communicated when the user is not interacting with the HIS. There are many types of communication that occur amongst providers for care delivery. The communication space accounts for the bulk of information transactions in healthcare (Angst et al., 2012; Coiera, 2000). With the use of computer mediated communication (CMC), it has been possible to connect to the recipient with patient-related information on their mobile devices even when the recipient is not using the HIS. CMC facilitates notifications and alerts pushed to the recipients automatically when a certain event is triggered.

Several studies have explored the complexity of possible communication pathways that are required for clinical tests for a patient (Coiera, 2006; Lang and Dickie, 1978). More efforts to allow seamless communication between information systems, such as between clinical laboratory information systems (LIS) and the electronic health record (EHR) are consistently underway (Coiera, 2006, 2003). Given the tremendous amount of communications involved in the healthcare delivery process, it is important that communication devices and the means of communication function reliably. No lapse should be detected when it comes to alerts and notifications either between patients and providers or among providers themselves. Failure of communication can result in delay of care, increased wait time, missed treatments, incorrect treatments, and many other discomforts which can potentially lead to fatal outcomes for patients and possible legal hazards for providers (Bates et al., 2000, 1999).

The communicated information such as communication related to treatment adherence and follow-ups on treatments are very important aspects of healthcare delivery. One study reported that 85% of errors across all industries could be attributed to communication failures (Pronovost et al., 2003). Another study, looking specifically at care delivery, reported that approximately one-half of all serious medication errors resulted from insufficient information communication (Bates and Gawande, 2003). In another study, poor communication between case managers and primary care providers was reported as one of the major barriers in the quality of care delivery (Hirschhorn et al., 2009). The post face-to-face patient-provider interaction information needs to be communicated to the provider for continued care delivery. Our study measures separately the synchronously pulled information and the asynchronously pushed information.

However, both the pulled and the pushed information fundamentally are information entities and therefore, we used the same identical dimensions for measuring pushed information. These dimensions are accuracy, completeness, currency, and format.

3.6 IT-Support Performance

IT support is a customer service given to IS users. In a work system, IT operations require continuous monitoring to meet the service level agreements (SLAs). Support services have been found to influence adoption, post-adoption and use (Au et al., 2008; Benlian et al., 2012, Setia et al 2013; Luo et al., 2012). There are other reasons behind the increased importance of IT support in the age of virtualized infrastructure. In the cloud computing virtualized environment, the user has the flexibility to scale up or scale down the computing resources depending on business needs. This brings in a new type of variability on the stability of computing resources. The variability due to auto-scaling of virtualized infrastructure was non-existent when organizations owned fixed computing resources in their on-premise data centers. We argue that handling variability in system would require more participation from IT support groups. Past studies have shown that strong IT-technical support has been measured as an important driver in evaluating adequacy of web portals up-time (Yang et al, 2004). An important driver of how IT is used and supported in the customer service process is a key IT capability that affects IT service process performance (Ray et al, 2005).

3.7 Healthcare Care Delivery Quality

Studies have shown that information quality impacts the delivery of care (Marshall, 1998; Tierney et al., 1988). The care delivery quality is either judged by the care provider (Marshal, 1998) or by the quality criteria defined by the care receiver (Hirschhorn, 2009). Providers may be able to judge the effectiveness of HIS in delivering care by the quality of data delivered to them. The providers can also realize their level of satisfaction based on the information they retrieve or information they receive to advance care delivery. These outcomes from care delivery, however, may vary from a high stress to a low stress work environment. Furthermore, high quality care delivery is also an organizational goal which may be achieved through support from organizational leadership and their endorsement of quality initiatives and policies.

Patients can also judge the care they receive from the care providers. Often patients register their satisfaction on the care they received by completing the patient satisfaction survey forms. This is generally collected and evaluated by third-party independent agencies. Since it is the providers and not the patients who use the healthcare information system, their measure of fulfillment in using HIS can only be determined by the user (nurses and doctors) of the HIS. This study measures the perception of the providers about their use of the information system in delivering care and not the perception of the patient on the quality of care received.

The effect of HIS use (such as EMR, EHR, and CPOE) on healthcare delivery quality has been extensively studied in the past. Most studies have concluded that EMR systems have positive impact on delivering care (Marshall, 1998; Tierney et al., 1987; McDonald and Tierney, 1992). Reduction in transcription errors, promotion of adherence to standard care, quicker order entry, reduction in delays due to incomplete orders are notable benefits of using HIS (Sittig and Stead, 1994). Hunt et al. (1998) have systematically reviewed controlled clinical trials assessing the effects of computer-based clinical decision support systems (CDSSs) and found positive impact on physician performance and patient outcomes. Several other studies (see Table 3-1) have measured the benefit of using HIS in adherence to protocol, adherence to recommendations, frequency of hospitalizations, errors in test ordering, rate of redundant laboratory testing, follow-up intervals, reminders, drug costs, rate of unnecessary admissions, length of hospital stay, time to completion of required tasks, and patient care costs. Providers have used specific measures to express their perceptions as to how far or how close they feel from achieving the satisfactory outcome by using the healthcare information system. Table 3-1 briefly presents the measures that physicians have used to assess the benefits of computer systems in care delivery.

3.8 Satisfaction from the Use of HIS

In IS literature, satisfaction has been recognized as an outcome measure from the use of IS. User satisfaction from using the IS has been defined as the "sum of one's positive and negative reactions to a set of factors" (Bailey and Pearson, 1983). Doll and Torkzadeh (1983) describe it as ‘‘the affective attitude toward a specific computer application by someone who interacts with the application directly”. The attitude-behavior literature (Wixom and Todd, 2005, Tan et al., 2013, Xu et al., 2013) has stated that beliefs about objects (in this case, pulled information quality, and pushed information

Table 3-1 Brief Summary of Study on Effect of HIS on Physician Outcome

Outcome Category	Physician Outcomes	Study
Disease Management and Prevention	Adherence to protocol, compliance	Bates et al. (2003); Tierney et al. (2003); Brownbridge et al. (1986);Litzelman et al. 1993
Management of Health Conditions	Adherence to recommendations (such as drug dosing and prescribing)	McDonald (1994); McDonald et al. (1992); Lobach et al. (1994); Mazzuca et al. (1999); Nilasena et al. (1995); Overhage et al. (1996)
	Test ordering	Tierney et al. (1988)
	Errors in test ordering	Bates et al. (1999); Young (1981)
	Rate of redundant laboratory testing	Bates et al. (1999, 1995)
	Rate of advance directive discussions and form completion	Dexter et al. (1998)
	Follow-up intervals, reminders	Fihn et al. (1994); Turner et al. (1989); Chambers et al. (1991); Ornstein et al.(1991), Dexter (2001); McDonald et al. (1992, 1994); Holt et al. (2010)
	Quality of Care	McCullough et al. 2010
	Time to completion of required tasks	Safran et al. (1995)
	Alerts	Kucher et al., (2005), Frank et al., (2004), Krall et al. (2004)
	Prevention of adverse drug effect	Gurwitz et al. (2008), Bates et al. (1997)
Healthcare utilization	Rate of unnecessary admissions	Hales et al. (1995)
Healthcare cost	Adherence to recommendations (such as drug dosing and Prescribing)	Bates et al. (1999)
	Adherence to recommendations (such as drug dosing and Prescribing)	Tierney et al. (1993)

Table 3-2 Work System Framework Construct

Constructs of WSF	**Explanations and Operationalization**
Infrastructure	Robustness of underlying IT layers consisting of the hardware, storage, and network
Technology	This is embedded in SDLC. These are use of core technologies on which IT-Mediated functions are developed, such as use of Java, Oracle, and Web Sphere etc. We are not operationalizing it as a separate construct.
Customers	The Healthcare providers, namely, doctors and nurses who are users of HIS
Information (stored)	Stored data This is embedded in SDLC, such as availability of reference data and patient data that is created by the use of IT-Mediated functions. For a freshly deployed HIS into production, information will comprise of reference data alone. As patients are enrolled in HIS, patient related data starts accumulating. This created data (possibly stored in a database or file systems) about the patient and the non-patient related reference data are the ones that becomes the subject of perception when they are retrieved or when they are received with the help of IT-Mediated functions.
Participants	IT support groups that participate in successful operation of deployed HIS
Products/Services	Pushed and pulled Information that is consumed for providing care This refers to the “information as a product” since processes and activities (IT-Mediated functions) transform the stored information (data) to become useful product to the end user. In the same manner, the process of pushing the information (such as pagers, emails, texts, and auto-pops), being computer mediated, requires that IT-Mediated functions initiate those communications as and when they are needed. This serves as “information as a service”.
Strategy	Endorsement of quality initiative undertaken by upper management
Environment	The environment under which healthcare providers such as doctors and nurses work
Process and Activities	The IT-Mediated functions delivery that facilitates the activities in a care delivery process

quality) are linked to attitudes towards those objects (in this case, satisfaction from the use of HIS). Therefore, for this study, we recognize satisfaction as object-based overall attitude towards the use of HIS by nurses.

3.9 Work Stress

The environment of care providers is different from other professional environments. Stress resulting from the management of trauma, pain, diseases, and death on a daily basis is unique to healthcare (Price and Bergen, 1977; Schulz and Aderman, 1976; Hay and Oken, 1972; Kornfeld, 1971). Studies have determined that high levels of stress adversely affect patient care (Meyer, 1962; Meyer and Mendelson, 1961; Revans, 1959) delivered by nurses.

3.10 Summary of Work System Constructs

Work system framework as proposed by Alter (2006) has nine constructs. The definition of all the constructs have been mentioned in Table 3-2. We are not measuring the information construct at the lowest level of WSF as we believe that the lowest level information construct represents the information creation that happens before information is assessed as a product of IS. We consider information construct to represent "stored patient data" or "stored reference data" that is created before or during the patient encounter. The pulled and the pushed information quality represents the perception or the evaluation of those stored data sets.

Chapter 4

Constructs, Hypotheses and Research Models

4.1 Constructs and Hypotheses

The target IS does not function independently, the output from the target information system is dependent on the performance of other interacting components of a work system. Therefore, quality issues can emerge from the enactment of every element of work system framework. The main enablers of the work system are the information system infrastructure, technologies, participants who maintain and support the system, the embedded data, the IT-Mediated functions delivery, the pulled information, the pushed information (communicated information), and the healthcare customers (the users of the HIS). Work system (the shaded part in Figure 4-1) is established around the environment, the infrastructure and the strategies under which it is supposed to function as depicted in work system framework (Alter, 2006) in Figure 4-1.

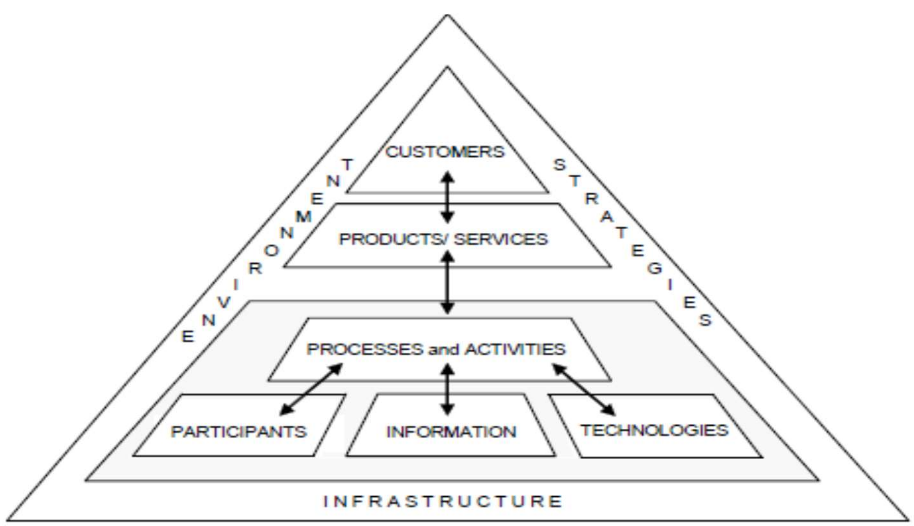

Figure 4-1 Work System Framework (Alter, 2006)

Healthcare researchers have traditionally employed Donabedian (1978) and Glickman (2007) - a Structure, Process and Outcome (SPO) framework to understand the phenomenon surrounding healthcare delivery. An enhancement to the SPO framework was proposed by Chaudhury et al. (2006) to add granularity to the structure, process and outcome framework by introducing socio-technical elements such as technological, organizational, project management factors, electronic communications, connectivity amongst providers and patients, participants, organizational process changes, and management. Another important framework is the Baldrige criteria for achieving care excellence. However, these frameworks are descriptive and do not offer any prescription for the improvement of the quality of healthcare delivery. Therefore, a gap exists in the healthcare literature related to the healthcare information system that this research aims to fill in by introducing a prescriptive framework for understanding care delivery quality.

From the ground up, infrastructural elements, participants, processes and activities, information (stored data), and technologies are the foundational elements of a work system. This make up of work system is based on the results obtained from many experiments on work system that was conducted by Alter himself year after year starting from the year 2000 (Alter, 2013). We will start with the information construct of the work system framework. Although work system calls it "information", it implies stored organizational data. The "information" construct of the work system is a context-free stored raw data. A healthcare work system hosts varieties of digital elements such as data records, images, and audios generated during the patient care. Another set of data that HIS hosts are non-patient data. Information such as physician certification, physician location, pharmacy location, hospital location, state, and city are examples of non-patient data without which the target application cannot function.

Work system framework includes participants as one of the construct. The participants of the work system are those who are entrusted with the smooth operations of the HIS. IT support is essential for maintaining trouble-free business operations because IT operations deal with day-to-day anomalies due to fluctuating loads, system faults, and business process changes to address changing business needs. For example, in a flu season hospitals might witness more patient admissions and can cause unpredictable loads on HIS. The varying load on infrastructure may affect application’s throughput. IT support is crucial in any crisis management to help resolve the troubles with the systems.

Another construct of work system is infrastructure system (or sometime called as system infrastructure) which makes up the backbone of the information technology. System performance has been found to impact information quality (Chuanga and Lin, 2013; Xu et al, 2013; Melville et al., 2004). Infrastructure related troubles can cause unreliable performance, and interoperability issues during data interchange across systems and across multiple makes of devices. Lack of flexible adjustments amongst different components can also cause a dent in the information quality. Therefore, improvements made to the IT infrastructure can help enhance the quality of information.

Work system also includes processes and activities. Processes and activities can be accomplished through the IT-Mediated functions which enable providers to serve patients. An example of this is the use of EPIC system that allows providers to do activities such as pull a patient’s EMR, or enter patient-related orders, or view lab results. Processes may also facilitate time-based automated events of care or any sort of computer mediated communication to notify providers for the patient care. As discussed earlier, a troubled IT-Mediated delivery mechanisms can significantly impede a nurse's ability to serve patients even though infrastructure systems (hardware, network, and operating system) may be completely healthy. An example of bad IS delivery and poor design of IT-Mediated function is one when a user of IS has to navigate through several pages before it actually lets the user login to the site. Another example of troubled delivery mechanism is requiring a user to login several times for the same authenticated user to access related sets of IT functions. This lack of seamless interoperability for an application poses a challenge to the ease of use in the IT delivery process.

One of the major theoretical enrichments of the work system framework is that it considers products of a work system as the outcome of processes and activities. This means that when the information quality is at the center of investigation, information can be regarded as the IS products. Under this configuration, IS-Mediated delivery functions themselves become the processes and activities of work system. This is analogous to the idea that products are an end result of the manufacturing process. We regard information as the end result of IT transformations and as a product of IS which is consumed by the customers of IS. Information as product is different from context-free data stored in the databases (the stored information construct of WSF) discussed earlier because information required for serving a consumer is a context-specific and the stored data goes through transformations by the IT-Mediated functions. In healthcare, IT delivers information product in two modes, pulled information and pushed information.

By integrating all the constructs of work system mentioned in the WSF, we propose an information system based research framework to study the care delivery quality in healthcare. We restructured the generic WSF specific to fully deployed and operational healthcare IT with its constructs as defined in Table 3-2. Figure 4-2 shows the Healthcare Work System Framework dervied (HWSF) from the generic work system framework proposed by Alter (2006).

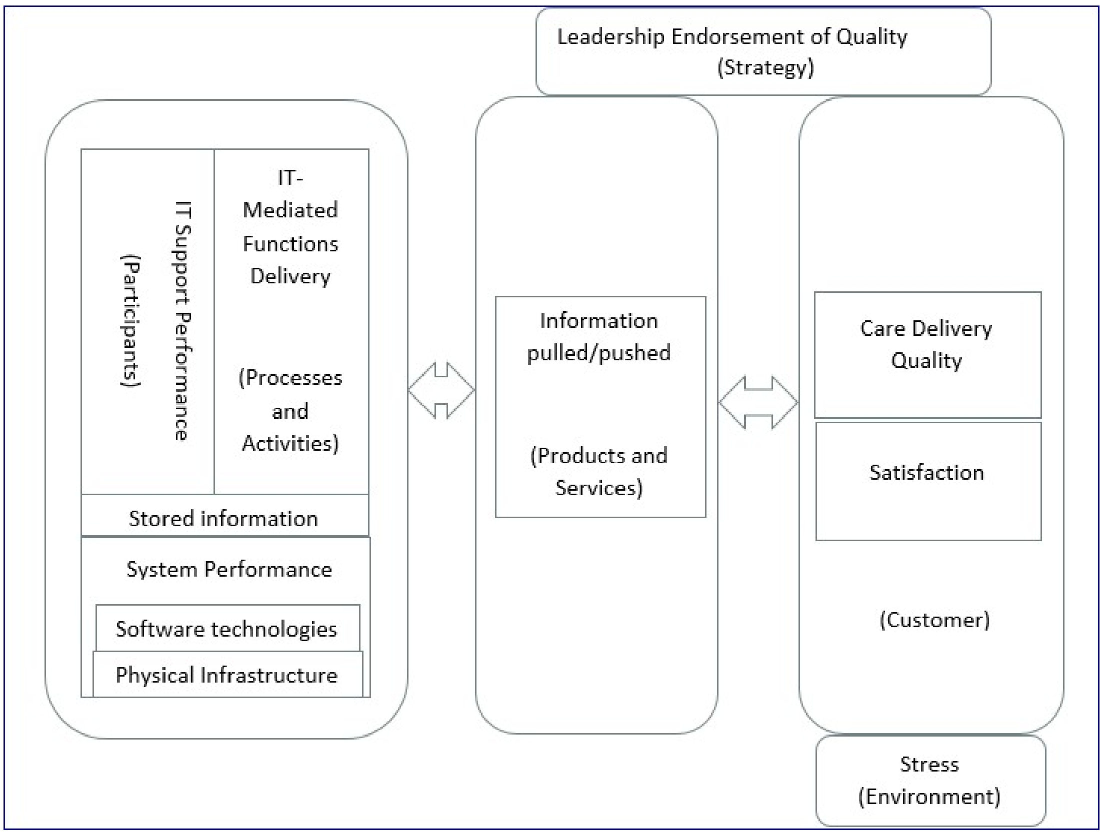

Figure 4-2 Proposed Healthcare Work Information System Framework

4.1.1 Healthcare Care Outcome

Care delivery quality (CRDELQ) and satisfaction (WRKSAT) derived from the use of HIS by the health care providers are dependent variables in this study. For this study, care delivery quality and satisfaction are based on the perception of nurses who are the primary users of HIS. Physicians and nurses know the extent to which HIS enables them in their routine work to do things such as admissions, retrieving patient records, updating care plans, documentations, treatments, diagnoses, follow-ups, reminders, discharges, and taking corrective actions such as detecting dosage error, and wrong medications. In order to measure the effectiveness of HIS in the process of care delivery, a hospital information system instrument called HIS- monitor was developed by Ammenwerth et al. (2007). By using the HIS-monitor it has been shown that the quality of the information processing in nursing strongly increased after the introduction of HIS (Bardhan and Thouin, 2013; Ammenwerth et al., 2007; Marshall, 1998). This implies that the use of HIS increases satisfaction in delivering care. Another study conducted by Maillet et al. (2014) has related HIS use to satisfaction from HIS.

The HIS-monitor assesses the degree to which information system supports patient care by providing the information that care providers need. Information such as ccomputer-based patient record (CPR) or electronic patient record (EPR), demographics, financials, and other medical information from health related services such as registration, billing, lab, radiology, pathology, pharmacy, and transcription allows clinicians to improve care delivery. The impact of using EMR systems on patient care has been extensively studied from the perspective of physicians and nurses who are the primary users of the HIS in any patient care (Menachemi et al., 2008; Ammenwerth et al., 2007; Marshall, 1998). This study uses the measures of care delivery as proposed by Marshall (1998).

User satisfaction is the most frequently used construct to measure the success of an information system. Satisfaction represents an affective response of an individual to the overall task (Fishbein, 1967). Several researches have recognized that good quality service leads to satisfaction (Cronin et al., 2000; Spreng and Mackoy, 1996; Kettinger and Lee, 1994). Several other researches have recognized that perceived usefulness (net benefits) leads to satisfaction (Hsieh and Wang, 2007; Rai et al., 2002; Seddon and Kiew, 1996). Studies situated in healthcare have shown that benefits derived from the use of HIT and EMR system in delivering care promotes satisfaction (Likourezos et al., 2004; Sittig et al., 2009; Ammenwerth, 2007) amongst nurses and physicians. Therefore, we extend the argument that when expectations of care givers are fulfilled by the use of HIS in serving the patient, the users are satisfied with the system. In order to measure the satisfaction, this study has adapted measures from Bhattacherjee (2001) and the survey includes the question, "How do you feel about your overall experience of working with the HIS?" The questionnaires use Likert scales ranging from very dissatisfied to (1) very satisfied (7), very displeased to (1) very pleased (7), very frustrated (1) to very contented (7), and absolutely terrible (1) to absolutely delighted (7). We hypothesize:

H1: Care Delivery Quality positively impacts satisfaction from the HIS.

4.1.2 Pulled Information Quality (PULLIQ)

Several studies where IS success (benefits derived from using IS) and IS satisfaction are the dependent variables, information quality has been recognized to impact the benefits and satisfaction from the IS. (Xu et al., 2013; Nelson et al., 2005; Wixom and Todd, 2005; Wixom and Watson, 2001; DeLone and McLean, 1999). When a patient-provider encounter occurs, the products for the providers are the information needed to serve the patients. These information sets include patient's record and other data sets such as regulatory data, insurance data, pharmaceutical data, staffing data, facility and provider's data, all of which need to be available so that providers get those information whenever they need them. Information quality has been found to impact the information satisfaction (Wixom and Todd, 2005, Xu et al., 2013) and the delivery of care (Lobach et al., 2012; Marshall, 1998; Tierney et al., 1988). Information quality has also been found to relate to the benefits from the IS (Gable et al., 2008, Bharati and Chaudhury, 2006; Rai et al., 2002; Lynch and Ariely, 2000; DeLone and McLean, 1992; Lucas, 1988; Baroudi et al, 1986; Bailey and Pearson, 1983). Information quality has been found to impact decision making efficiency (Gatian, 1994), work performance improvement (D'Ambra and Rice, 2001; Shih, 2004; Wixom and Watson, 2001), and decision making satisfaction (Bharati and Chaudhury, 2006). We extend the argument based on above findings that good information can help in making appropriate decisions for patient care. Therefore, we hypothesize:

H2:Pulled information quality has a positive relationship with care delivery quality.

H3: Pulled information quality has a positive relationship with satisfaction from the HIS.

4.1.3 Pushed Information Quality (PUSHIQ)

The HIS (such as EHR/EMR/EPR) like any other enterprise system is not a standalone entity, instead, it interfaces with many other systems such as physician order entry system, electronic communication systems, laboratory information systems, and the clinical workstations. These interoperable systems supplement information to the providers through notifications/alerts to help with care delivery (Bates and Gawande, 2003; Bingham, 1998; Davis, 1993). The multitude of information systems within the healthcare network exchanges data to provide continuity to the patient care. Since the patients are not tied to providers all the time, it requires some way to communicate to the provider as and when a new information about patients becomes available. From the provider's (nurses/doctor) perspective, they are not actively pulling this information from the HIS; instead, there is a computer mediated communication delivery process that auto-delivers the information to the care providers if they needed to be alerted about any patient. Examples of these alerts can be things such as next immunization for a patient, or an alert from the pharmacist to the nurses about a dosage that was incorrectly prescribed.

To understand the importance of information related to alerts, notifications, or any other communicated information, our study included several questions about the quality of notifications care providers receive related to patients. Notifications and alerts are type of information just like the information that providers pull from HIS. However, there are unique nuances to the asynchronous push delivery. This delivery is sometimes disseminated to a wider audience as a broadcast message in which the recipients do not have control of what messages they receive. Therefore, the survey includes questionnaires related to the accuracy of communicated information. Some notifications can be very time sensitive and must be communicated to the provider immediately to ensure safety of care. An unexpectedly delayed communication can jeopardize the care delivery and can lower the expectations of the providers. However, when notifications and alerts are communicated right, it can enhance the satisfaction of the care providers by offering timely care to the patients. Since pushed and pulled information are like two sides of a coin, we extend the argument of pulled information quality to pushed information quality. Therefore, we hypothesize:

H4:Pushed information quality has a positive relationship with care delivery quality.

H5: Pushed information quality has a positive relationship with satisfaction from the HIS.

4.1.4 IT-Mediated Function Delivery (ITFUNC)

McLean (1973) has called for separating IT functions from the measures of system performance. Effective IS function is concerned with the impact of information provided in helping users do their jobs (Myers et al., 1997). IT-Mediated functions involve user interfaces through which users of an information system accomplish their tasks. Several studies on user interfaces have been done in the past to identify appropriate design attributes that relate to the application and software quality. McCall et al. (1977) looks at software quality in the light of product operation, product revision and product transition. Boehm et al. (1978) looks at hierarchical characteristics of software quality based on user’s needs. Grady and Caswell (1987) proposed a FURPS model based on functionality, usability, reliability, performance (efficiency) and supportability (maintainability). ISO 9126 defined software product quality in terms of functionality, usability, reliability, supportability, portability and efficiency.

Functionality generally represents the functional adequacy and the product features of a software. Usability is concerned with characteristics such as aesthetics and consistency in the user interface. Reliability is concerned with characteristics such as availability (the amount of system "up time"), accuracy of system calculations, and the system's ability to recover from failure. Performance is associated with characteristics such as throughput, response time, recovery time, start-up time, and shutdown time. Supportability deals with characteristics such as testability, adaptability, maintainability, compatibility, configurability, instability, scalability, and localizability.

Studies have shown that functional design attributes have an impact on information quality (Eppler, 2003; Tate and Alexander, 1999). In the “what and how” lingo, if the content takes the role of “what”, the delivery would be assumed to take the role of “how well.” This suggests that data content, however complete it may be (as stored in databases), is not automatically delivered in the desired way without good design attributes of the IT functions. For this reason data as a content has been recognized as merely a precondition for its delivery (Cenfetelli et al., 2008; Carter and Belanger, 2005). Thus IT-Mediated function delivery is the user enablement of delivering service content through enhancement of application design attributes. Service delivery is a multidimensional concept and this study has used the dimensions proposed by Tan et al. (2013) to measure IT-Mediated function delivery. These dimensions are accessibility, navigability, interactivity, interoperability, adaptability, and security which is defined as below (see Table 4-1). Since the end goal of any information system is to make data available to its authenticated users from the databases, the main objective of IT-Mediated function is to help achieve those business goals.

Therefore, we hypothesize

H6: IT-Mediated function delivery has a positive relationship with pulled information quality.

H7: IT-Mediated function delivery has a positive relationship with pushed information quality.

Table 4-1 IT-Mediated Function Delivery Dimensions (Adapted from Tan et al. 2013)

Dimensions	**Explanation**
Accessibility	Extent to which information content is accessible across different information outlets irrespective of technological differences, such as viewing the information on different browsers or viewing it on different mobile devices
Navigability	Extent to which navigation between related information interfaces remains connectible
Interactivity	Extent to which HIS proactively engages the providers during patient care
Interoperability	1. Extent to which HIS-related system operates in unison, such as moving from computer to hand-held devices for patient care or vice versa (such as nurses' use of small hand-held device to scan bar code from patient's arm) 2. Extent to which HIS facilitates the computer mediated communication when an alert or notification system pushes information to HIS or HIS sends alert to nurse's devices
Adaptability	Extent to which information delivery process is flexible to fluctuations (such as increased information delivery during a flu seasons) and remain functional
Security	Extent to which information content is delivered securely to its authenticated users only

4.1.5 System Performance (SYSPERF)

Infrastructure determines structural characteristics of an information system across organizational footprint and it represents the quality of IT backbone on which target application is deployed. However, due to variability of the parameters of IT infrastructure, such as increased load or hardware upgrade or software patching, the outcome from the IT backbone can vary. IT applications are designed based on the estimation of user traffic load and based on forecasted growth. When the performance of any IT-Mediated functions degrade without any change done to target application or any change to traffic patterns, infrastructure becomes the clobbering target.

Well planned and well implemented infrastructure can improve a firm's ability to manage a large amount of data and yet deliver timely, up-to-date, correct, accurate, complete, and relevant information to the users of IS (Jayachandran et al., 2005; Coltman, 2007; Mithas et al. 2005). High availability of IT resources, responsiveness of the network, reliability of the hardware and storage, and flexibility to adjust to high loads are crucial to smooth operations of the IS and the quality of information it delivers (Xu et al 2013; Yang et al., 2005). A latency observed in the response time, an accessibility interruption causing the system to become unreliable at times, or lack of flexibility in handling unplanned loads can cause operational disruptions. Therefore, studies that measure system performance incorporate dimensions such as the flexibility, the reliability and the responsiveness of IS. (Xu et al., 2013; Tan et al., 2013; Wixom and Todd, 2005; DeLone and Mclean, 1999). Underperforming system is likely to be unable to provide good quality of information while being pulled from the information system. In the same way, an underperforming system will delay the pushed information such as notifications and alerts to its users. Therefore, we hypothesize:

H8: System performance is positively related to pulled information quality.

H9: System performance is positively related to pushed information quality.

4.1.6 IT-Support Performance (ITSUPP)

All IT operations face disruptions. Disruptions and outages can be caused by any of the components of IT infrastructure such as hardware, storage, and network. Disruptions can breakdown the main target application as well. IT support group is committed to restoring normal operations when unexpected and disruptive events bring discontinuity. They stay on top of monitoring IT infrastructure and information systems. IT support has long been recognized as a competitive weapon in elevating a firm's performance (El-Ansary, 1992; Kopicki et al., 1993; Porter and Millar, 1985). Adequacy of technical support during and after IS implementation has been recognized as a critical factor for IS implementation and its success (Thong et al., 1994; Lucas et al. 1988). Failure to bring a system out of an outage can keep IT-Mediated functions delivery or one or more computing resources grounded. A good IT support team can help remove temporary or long lasting disruptions in a timely fashion and restore normal business operations by bringing the system back to the point of acceptable performance. Therefore, we hypothesize:

H10: IT support is positively related to IT-Mediated function delivery.

H11: IT support is positively related to system performance.

4.1.7 Influence of Leadership Endorsement of Quality (LE)

Quality evangelists such as Crosby, Deming, and Juran unanimously consider leadership commitment to quality as a top priority (Waldman, 1994). Leadership endorsement of quality initiative is the “strategies” element of the work system framework. In this study, leadership endorsement of quality refers to the rules, incentives and the policies set by the leadership of the organization to enforce the importance of quality in delivering care. In order to continuously meet and exceed customer’s needs fulfillment, quality measures should include information products, service quality, users’ productivity, user satisfaction (Ang et al., 2000; Oakland, 1993; Woodruþ, 1995). Some empirical studies have found positive effect of top management support on IS implementation and IS performance (Raghu-Nathan et al., 2004; Sharma and Yetton, 2003; Swink, 2000). Leadership endorsement of quality requires allocating resources for higher quality, such as offering incentives to staffs who strive to rank higher in patient satisfaction, or hiring more nurses in case of increased workloads. Prior research has suggested that top management uses rewards and incentives to enhance information product quality for IS success and better system usage (Lin, 2010; Wixom and Watson, 2005, Ang et al., 2000; Ravichandran and Rai, 2000). An example of this strategy is, when rewards and penalties are known to employees for fulfilling or omitting certain actions, they start paying more attention in using the information system. Strong endorsement of quality will encourage IS users to carefully fill in the information as required and avoid taking short cuts such as filling a mandatory field with junk values. Strong endorsement of quality will also encourage IS users to carefully read and interpret the information even when there is a rush.

Studies have suggested that nurses work in a high stress environment. Fatigue follows them throughout. Under duress they may fail to properly utilize the information about patients when they are pulling information from the system. In certain cases when they get alerts they may fail to respond to those alerts. However, we argue that with proper rewards and incentives enforced by leadership for maintaining quality, the care delivery can be maintained at higher level. Therefore, we hypothesize:

H12: Leadership endorsement of quality moderates the relationship between pulled information quality and care delivery quality such that this effect will be stronger when leadership endorsement is strong than when it is weak.

H13: Leadership endorsement of quality moderates the relationship between pushed information quality and care delivery quality such that this effect will be stronger when leadership endorsement is strong than when it is weak.

H14: Leadership endorsement of quality has a positive relationship with care delivery quality.

4.2. Research Model

The above hypotheses collectively represents an integrated view of healthcare delivery quality grounded in the work system theory. Collectively, these hypotheses as shown in Figure 4-3 represents a holistic view of the generic work system framework proposed by Alter (2006) and the healthcare work system framework as constructed in Figure 4-2. Figure 4-3 shows the proposed research framework for healthcare work system. The research model simplifies the theoretical model of work system framework in four ways. First, it combines the “infrastructure”, and the “technologies” constructs and calls it system performance. At the lowest level of the WSF, the infrastructure refers to the physical component of IT such as machines, cables, and storage drives, and, the technologies are the external software that IT shops employ i.e., all the vendor-based software that the target IS uses such as Linux, Java, and Oracle. The second simplification is done by considering the “processes and activities” construct of the WSF as the IT-Mediated function delivery

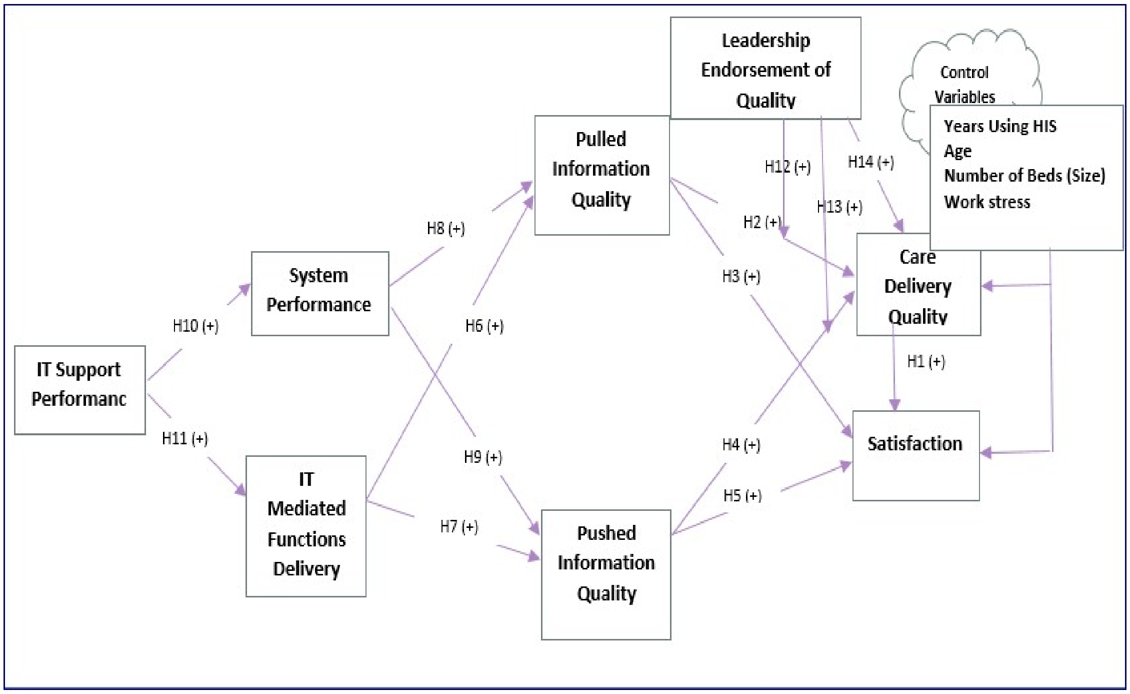

Figure 4-3 Research Model

(such as the functionalities that the HIS, e.g. EPIC provides). The third simplification is done by considering the “products and services” construct as the information that the customer retrieves (pulled information) or receives (pushed information). The fourth simplification involves identifying the customers. We chose nurses as the customers of the work system who use the information product to enhance their care delivery. The impact on customer (nurses) has been measured based on the care delivery quality and satisfaction they derive from the information product. These simplifications are necessary to reduce conceptual muddle and yet gain ample insight into the understanding of overarching phenomenon surrounding a work system.

Chapter 5
Survey Study Design

5.1 Study Design

This chapter describes a study design to provide support for the proposed framework on healthcare delivery quality. Healthcare is very complex and the proposed multi-stage model may help unravel the complexities. IS literature lacks a holistic framework to analyze the impact of the elements of a complete work system on care delivery quality as perceived by the care providers responsible for care delivery. The confirmatory phase of this study uses survey techniques and chooses nurses as participants to collect data. Nurses are important members of the care provider's community who use healthcare information system. The survey was designed to elicit nurses' responses that stem from the nurses daily use of IS and experiences with healthcare information system.

5.1.1 Data Collection

The unit of analysis in this work is the nurses working in a hospital. Nurses who work in a hospital setting use healthcare information system extensively and, therefore, we chose nurses as participants (Ammenwerth et al., 2007, Bates et al., 1999). Doctors, pharmacists, and other care providers also use the healthcare information system to deliver care but the decision to use only nurses helps preserve measurement equivalence across respondents (Rungtusanatham et al., 2008; Mellenbergh, 1989).

Data was collected using an anonymous web-based survey with the help of a third-party data collection agency. Respondents were asked if they use the HIS most of the time or not. Those who chose “NO” were terminated from continuing the survey. The survey included few attention filter related questions to remove inattentive participants. The attention filter also helps in checking if the participants are randomly choosing the answers or, in fact, are paying attention to the questionnaires. The survey was collected over a period of three weeks. Since reminders have been demonstrated to improve the response rate (Frohlich, 2002), reminders were given after the end of the first week and after the end of second week. From a total of 684 survey solicitations, a total of 165 valid responses were received (after removing the drop outs due to attention filter checks and non-qualified participants) yielding a response rate of 24.1 %. Out of 165 responses, three responses involved straight lining and so they were removed. There was no missing answer to any question since the survey had logic built in the flow to ensure every question is answered. The 162 responses provide medium effect size and provide 80% power at $\alpha = 0.05$ level of significance for the number of latent factors and manifest variables involved in the research model.

5.1.2 Scale Development

The constructs used in this research are either directly taken as is or adapted from the existing IS literature. Survey items were directly taken from the IS literature when items coincided with the theoretical concepts involved in this study. We modified questions through a multi-step process to refine the wording of the questions when items were adapted. A pilot survey was conducted on a small group of nurses who have worked in hospitals for more than ten years and have used HIS. In addition to completing the survey, pilot participants provided their feedback on the wording of the questionnaires. Questions that were confusing were reworded to reduce complexity with few grammatical changes. This also helps in mitigating the effect of method bias (Mac Kenzie and Podsakoff, 2012). The survey was designed to start from simple questions to more complex questions to reduce the cognitive load and facilitate retrospective recall and information retrieval lessening the confounding effects of survey method bias (Mac Kenzie and Podsakoff, 2012). Finally, to address fatigue which generally sets in towards the end of the survey, the least cognitively demanding demographic questions were enlisted. Questions related to control variables were spread throughout the survey. All measurement items unless otherwise stated, followed the original scales from the literature, used 7-point Likert scale from strongly disagree (1) to strongly agree (7). Appendix B lists the final questions along with their descriptive statistics.

5.1.2.1 Care Delivery Quality (CRDELQ)

The focal dependent variable in this research is care delivery quality (CRDELQ). Questions concerning care delivery were adapted from Marshall (1998) to capture the effectiveness and efficacy nurses experience with the use of information. This is 7-point Likert scale and varies from extremely worse (1) to much better (7) in evaluating nurses' responses in using the HIS. The explicative instruction about this question was, "This question is about how the HIS has impacted your effectiveness in delivering patient care.” The measure includes a wide range of nurses-patient encounter-related questions in which information plays a major role. CRDELQ consists of thirteen reflective items. During assessment of constructs, item CRDELQ5 lacked measurement validity due to statistically insignificant loading at $\alpha = 0.05$ and was removed from further analysis.

5.1.2.2 Satisfaction (WRKSAT)

Satisfaction has been one of the important constructs in IS literature for IS success evaluation (Ives et al., 1983). The scale was adapted from Bhattacharjee (2001). Respondents were asked, “How do you feel about your overall experience in using HIS?" Using 7-point Likert scale, four items were used on the perception of nurses ranging from very dissatisfied/very satisfied, very displeased/very pleased, very frustrated/very contented, and absolutely terrible/absolutely delighted.

5.1.2.3 Pulled Information Quality (PULLIQ)

Information quality has been used in a lot of IS research both as an independent variable and a dependent variable. Appendix A lists the extant literature on the use of information quality in IS literature that was published in major IS outlets. Items for pulled information quality have been adapted from Wixom and Todd (2005). Pulled information quality is a second-order reflective construct with first-order dimensions of accuracy, format, completeness, and timeliness. Each first-order dimensions were measured on three-item reflective scales. All items were measured on 7-point Likert scale from strongly disagree (1) to strongly agree (7). The explicative title to the questions on the quality of pulled information states, “This question is about the information aspects of the healthcare information system (HIS) that you use. Information aspects refer to the quality of data and information you get or see while using the HIS.”

5.1.2.4 Pushed Information Quality (PUSHIQ)

Pushed information is an information entity and can be treated just like the pulled information. Therefore, this study adapted the pushed information quality scale from the information quality scale developed by Wixom and Todd (2005). Pushed information quality is a second- order reflective construct with first-order dimensions of accuracy, format, completeness, and timeliness. First-order dimensions were measured on three-item reflective scales. The explicative title for this group of questions state, “This question is about the communication aspects of the healthcare alert/notification system that is automatically pushed to the recipients (nurses/doctors). In other words, nurses/doctors are recipients of the information that is pushed to them through vocera/email/pagers/texts/phones.” One item PUSHIQ14 had low loading and therefore was removed from further analysis.

5.1.2.5 Leadership Endorsement of Quality (LE)

Scales for leadership endorsement of quality was adapted from Ravichandran and Rai, (2000). The scale included five reflective items each measuring the response on a 7-

point Likert scale. All items loadings were above 0.7 and, therefore, they were kept for analysis.

5.1.2.6 IT Support Performance (ITSUPP)

Scales for IT support performance was taken from Ray et al. (2005). The ITSUPP scale included seven reflective items each measured on 7-point Likert scale. All items loading were above 0.7 and they were kept for further analysis.

5.1.2.7 System Performance (SYSPERF)

Scales for system performance were taken from Wixom and Todd (2005). However, Wixom and Todd included accessibility items in the system performance. Since this study, as discussed previously, separates system performance from IT-Mediated application performance, we regard accessibility dimension as more suited within the IT-Mediated construct which also includes accessibility. Another reason for excluding accessibility from system performance is that accessibility of information only happens by using the target application by the care providers (care providers cannot query the databases directly and independently from the application). Therefore, accessibility items were removed from system performance to avoid overlap of scales. System performance included nine items and one item SYSPERF7 was reverse coded. However, after reverse coding SYSPERF7 had low loading, it was removed from further analysis. All items were measured on a 7-point Likert scale from strongly disagree (1) to strongly agree (7).

5.1.2.8 IT-Mediated Function Delivery (ITFUNC)

Scales for IT-Mediated function delivery were adapted from Tan et al., (2013). All items were measured on a 7-point Likert scale. A total of 18 items were part of the scale but some items suffered and their loading was less than 0.7. Affected items due to low loading were ITFUNC11, ITFUNC 16, ITFUNC 17, and ITFUNC 18. They were removed. All items related to security aspect of the IT function suffered and had very low loading.

5.1.2.9 Control Variables

Several single-item control variables were introduced in this study to capture the covariance associated with relevant factors that are not directly substantive to the proposed framework. The selection of these variables was based on the previous studies in the healthcare domain. One exception to this single item control variable, is "work stress" which was measured on six-item reflective scale adapted from Cullen et al. (1985). Two items, STRESS3 and STRESS4 were reverse-coded and, therefore, they were re-coded for analysis. Loadings of all the items were above 0.7 and were kept in the study.

Participant's age and duration of experience have been used in many IS studies (Lin et al., 2012; Cosaque et al., 2011; Winkler and Brown, 2013; Slaughter and Kirsch, 2006). Firm size has been used as a control variable in many IS studies (Tiwana and

Konsynski, 2010; Ravichandran and Andrevski, 2010; Cho and Kim, 2001). Our study is situated in healthcare, we considered the size of the hospitals in terms of number of beds where respondents worked to become surrogate measure of the firm size.

There has been extensive research recognizing the work stress experienced by hospital nursing staff (Farquharson et al., 2012; Gray-Toft and Anderson, 1981; Beszterczey, 1977; Bates and Moore, 1975). Stress in nurses is an important issue as it can affect the quality of the care they provide (Leveck and Jones, 1996). Stress in nurses has been linked to reduced physical and psychological health, reduced job satisfaction, increased sickness, absence from work, and poorer job performance (Michie and Williams, 2003; Bowers and Becker, 1992). To measure work stress, a very elaborate nursing stress scale (NSS) with 33 items was developed to quantify the stress (Gray-Toft and Anderson, 1981). Another work stress scale (WSS) but with few items to measure stress perceived by healthcare staffs was developed by Hsu et al. (2007). We have adapted our stress scale from a shorter scale that was developed by Cullen et al. (1985).

5.1.2 Data Analysis Technique

The survey instrument collects the responses for the substantive constructs with multiple questions addressing the same construct. Our survey included many questions and many constructs. Some constructs in the model are second-order reflective constructs. Some constructs are first-order reflective. PLS is a method of choice when the sample size is low and number of manifest variables are less than 250 (Reinartz et al., 2009). An advantage of variance based PLS over covariance based CB-SEM is that variance based PLS can readily handle second-order constructs. PLS is the recommended method when the model is complex and hierarchical constructs are present (Ringle et al., 2012). Since our survey has a small sample size, and has second-order hierarchical constructs including multiple moderation relationships, use of the PLS-SEM technique by using SmartPLS was justified.

5.2 Construct Validity

Construct validity is a concern that the way operationalization of measures is done accurately captures the constructs of the study. The logical validity of survey questions was assessed through a pilot study where experienced nurses who used HIS provided feedback on their interpretation of constructs and wording of the questionnaires. In addition to this, statistical tests for convergent validity and discriminant validity is common in the IS field. Convergent validity assesses the degree to which measures of constructs that theoretically should be related are, in fact, related. Discriminant validity assesses the degree to which measures that theoretically should be unrelated are, in fact, unrelated. Several statistics (provided by Urbach and Ahlemann, 2010) are available directly from the SmartPLS for assessing thresholds for IS research models.

- Indicator reliability is validated by the item loadings. Loadings above 0.7 are considered good, with a minimal acceptable threshold of 0.4. In all cases the values should be significant at $\alpha = 0.05$ level.
- Unidimensionality is verified where there are no (zero) cross-loading items.

- Measure of internal consistency and reliability is provided by the composite reliability. This value should be greater than 0.7.
- Average variance extracted (AVE) represents the amount of variance due to the target construct as compared to the amount due to measurement error. AVE greater than 0.5 is recommended.

Chapter 6
Research Results

This chapter describes results from the hypotheses testing using SmartPLS, which is an implementation of PLS-SEM (Ringle et al., 2015). We used SmartPLS version 3.2.6. The multidimensional nature of some constructs and a large number of paths involved led to the decision to use PLS-SEM. The minimum sample size recommended for PLS-SEM requires 10 times the number of items in the construct that has the most items (Gefen et al., 2000). The ITFUNC construct with 13 retained items requires a minimum of 130 samples for the analysis. Comparisons done on SEM techniques suggest that PLS-SEM is more forgiving and suitable for a complex model such as ours (Goodhue et al., 2012, Reinartz et al., 2009). The results are presented in two parts consisting of the measurement model and the structural model. The outer measurement model shows the manifest variables (items or indicators) of the latent constructs, and the inner structural model shows relations amongst latent constructs. A bootstrap resampling technique is recommended where data is not normally distributed to calculate the standard error and probability levels for hypotheses testing. Our results is based on 5000 bootstrap samples recommended by (Hair et al., 2017).

6.1 Sample Characteristics

As described earlier, a total of 162 responses were qualified and included in this study. The demographic profile of the respondents is presented in Table 6-1 and hospital size (in terms of number of beds) is presented in Table 6-2. One interesting point about the respondents is that a majority of nurses have been working for more than 15 years and have been using HIS for more than 5 years. Their long tenure in using HIS add great value to our findings about the use of HIS in improving care delivery. Most of the nurses reported to have a four-year college degree or more. Almost 2/3rd of the nurses were employed in large-size hospitals with more than 250 patient beds.

Table 6-1 Demographics

Characteristics	Value	Count	Percentage
Gender	Male	18	11%
	Female	147	89%
Age	55+	74	45%
	45 to 54	31	19%
	35 to 44	21	13%
	< 35	39	23%
Years Working as Nurse	1 to 5	35	22%
	6 to 10	28	17%
	11 to 15	13	8%
	15+	89	53%
Years Using HIS	1 to 5 years	82	49%
	6 to 10 years	55	32%
	11 to 15 years	18	11%
	Over15 years	10	6%
Education	Less than HS	0	0%
	High School	3	2%
	Some College	10	6%
	2 years college	38	23%
	4 years college	79	48%
	Masters	30	18%
	Doctorate	1	<1%
	JD/MD	4	<3%
Income	<20,000	3	<2%
	20-30,000	4	<3%
	30-40,000	7	4%
	40-50,000	10	6%
	50-60,000	19	11%
	60-70,000	18	10%
	70-80,000	25	15%
	80-90,000	15	9%
	> 90,000	64	38%

Table 6-2 Hospital Size

Characteristics	Value	Count	%
Number of Beds	<100	22	13%
	101-250	38	23%
	250-500	82	50%
	>500	23	14%

6.2 Validity Assessment and Measurement Model

After the data collection, data were cleaned for hypotheses testing. Reverse-coded items were re-coded. Items that did not load above 0.7 were removed from analysis. Since our objective is to study the impact of a complete work system and its products on care delivery quality, we proposed a nomological network guided by work system framework proposed by Alter (2006). The reliability, the convergent and the discriminant validity, the outer loadings, and the cross loadings of the instrument were examined. Loadings above 0.7 (Chin 1998b) are considered good at $\alpha = 0.05$ level of significance. Some survey items failed to meet 0.7 value for the loading, so they were dropped. Items affected by low loadings are CRDELQ5, PULLIQ11, PUSHIQ14, ITFUNC7, ITFUNC 11, ITFUNC 16, ITFUNC 17, and ITFUNC18. For unidimensionality to hold, there should be no cross-loading items. All items of our survey showed greatest correlation with the construct that they were intended to measure compared to other constructs. We utilized Smart PLS that readily provides measure of Cronbach Alpha and Composite Reliability. Cronbach's alpha, with a value of 0.70 or above is usually evaluated as a means of measuring internal consistency. Cronbach Alpha and Composite Reliability were above 0.7 for each latent factor demonstrating internal consistency for the constructs. Average Variance Extracted (AVE) represents the amount of variance due to the target construct compared to the amount due to measurement error. Value of AVE above 0.5 shows good convergent validity (Fornell and Larcker, 1981) and all the constructs in our model demonstrated this. Discriminant validity is assessed using item cross loadings and Fornell-Larcker criterion. All items of the survey exhibited discriminant validity.

Measurement or outer model displays the relationships between the construct and the indicator variables. Our model is a hierarchical measurement model consisting of two second-order reflective constructs pulled information quality and pushed information quality with all its first-order constructs with three reflective items. Table 6-3 shows the Inter-Construct Correlations Matrix and Table 6-4 presents the construct reliability measures. The outer model loadings of all the items in the respective constructs are shown in Table 6.5. Appendix B list the survey items and descriptive statistics.

6.3 Structural Model

The structural model shown in Figure 6-1 presents the overall findings about the hypotheses testing. The path coefficients and the proportion of variance in the dependent variable explained by the independent variables are presented in Figures 6-1. In addition to reporting path coefficients (β), which represents the strength of the correlation, the p-values are also reported in Table 6-6. As theorized, 12 out of 14 hypotheses are empirically supported with the exception of H5 and H13. Support for each hypotheses is shown in Table 6-7.

Table 6-3 Inter-Construct Correlations Matrix.

	CRDELQ	IQ_ACC	IQ_CMP	IQ_CUR	IQ_FOR	ITFUNC	ITSUPP	LE	RCQ_ACC	RCQ_CMP	RCQ_CUR	RCQ_FOR	STRESS	SYSPERF	WRKSAT	YRS_USING
CRDELQ	0.836															
IQ_ACC	0.642	0.952														
IQ_CMP	0.693	0.785	0.936													
IQ_CUR	0.646	0.777	0.807	0.927												
IQ_FOR	0.657	0.718	0.817	0.684	0.956											
ITFUNC	0.741	0.725	0.748	0.653	0.743	0.795										
ITSUPP	0.548	0.546	0.518	0.450	0.450	0.582	0.851									
LE	0.550	0.434	0.439	0.464	0.496	0.497	0.483	0.905								
RCQ_ACC	0.592	0.593	0.577	0.543	0.492	0.607	0.478	0.411	0.949							
RCQ_CMP	0.611	0.586	0.626	0.531	0.659	0.688	0.415	0.390	0.793	0.966						
RCQ_CUR	0.584	0.570	0.612	0.532	0.585	0.623	0.406	0.367	0.805	0.868	0.954					
RCQ_FOR	0.600	0.602	0.608	0.531	0.665	0.722	0.431	0.453	0.807	0.879	0.811	0.964				
STRESS	-0.248	-0.231	-0.153	-0.128	-0.250	-0.329	-0.320	-0.272	-0.261	-0.271	-0.228	-0.309	0.810			
SYSPERF	0.720	0.763	0.753	0.661	0.800	0.810	0.673	0.466	0.562	0.637	0.596	0.653	-0.297	0.882		
WRKSAT	0.803	0.659	0.720	0.655	0.772	0.799	0.515	0.524	0.544	0.617	0.570	0.635	-0.303	0.764	0.957	
YRS_USING	0.072	-0.044	-0.066	-0.061	0.026	0.000	-0.062	0.057	-0.109	-0.079	-0.125	-0.040	-0.021	-0.028	0.001	1.000

CRDELQ – Care Delivery Quality; PUSH_ACC – Pushed Information Quality Accuracy; PUSH_CUR – Pushed Information Quality Currency; PUSH_FOR – Pushed Information Quality Format; PUSH_CMP – Pushed Information Quality Completeness; PULL_ACC – Pulled Information Quality Accuracy; PULL_CUR – Pulled Information Quality Currency; PULL_FOR – Pulled Information Quality Format; PUSH_CMP – Pulled Information Quality Completeness; LE- Leadership Endorsement For Quality; STRESS- Work Stress; WRKSAT- Work Satisfaction; ITSUPP- IT Support Performance; ITFUNC- IT Mediated Function Delivery; YRS_USING – Years Using HIS

Table 6-4 Construct Reliability

	Mean	SD	CA	CR	AVE
CRDELQ	5.081	1.371	0.957	0.962	0.699
PULL_ACC	5.201	1.368	0.897	0.951	0.907
PULL_CUR	5.501	1.291	0.917	0.948	0.859
PULL_FOR	5.281	1.433	0.953	0.970	0.914
PULL_CMP	4.993	1.518	0.929	0.955	0.876
ITFUNC	4.729	1.664	0.951	0.957	0.631
ITSUPP	5.119	1.393	0.936	0.948	0.723
LE	5.309	1.445	0.945	0.958	0.820
PUSH_ACC	4.939	1.413	0.945	0.965	0.901
PUSH_CMP	4.761	1.558	0.964	0.977	0.933
PUSH_CUR	4.921	1.429	0.950	0.968	0.909
PUSH_FOR	4.681	1.558	0.962	0.975	0.929
STRESS	4.296	1.597	0.897	0.919	0.656
SYSPERF	4.978	1.535	0.959	0.966	0.778
WRKSAT	4.386	1.746	0.969	0.978	0.916
YRS_USING	2.672	1.049	1.000	1.000	1.000

Note: CA – Cronbach's Alpha; CR – Composite Reliability; AVE – Average Variance Extracted

CRDELQ – Care Delivery Quality; PUSH_ACC – Pushed Information Quality Accuracy; PUSH_CUR – Pushed Information Quality Currency; PUSH_FOR – Pushed Information Quality Format; PUSH_CMP – Pushed Information Quality Completeness; PULL_ACC – Pulled Information Quality Accuracy; PULL_CUR – Pulled Information Quality Currency; PULL_FOR – Pulled Information Quality Format; PUSH_CMP – Pulled Information Quality Completeness; LE- Leadership Endorsement For Quality; STRESS- Work Stress; WRKSAT- Work Satisfaction; ITSUPP- IT Support Performance; ITFUNC- IT Mediated Function Delivery; YRS_USING – Years Using HIS

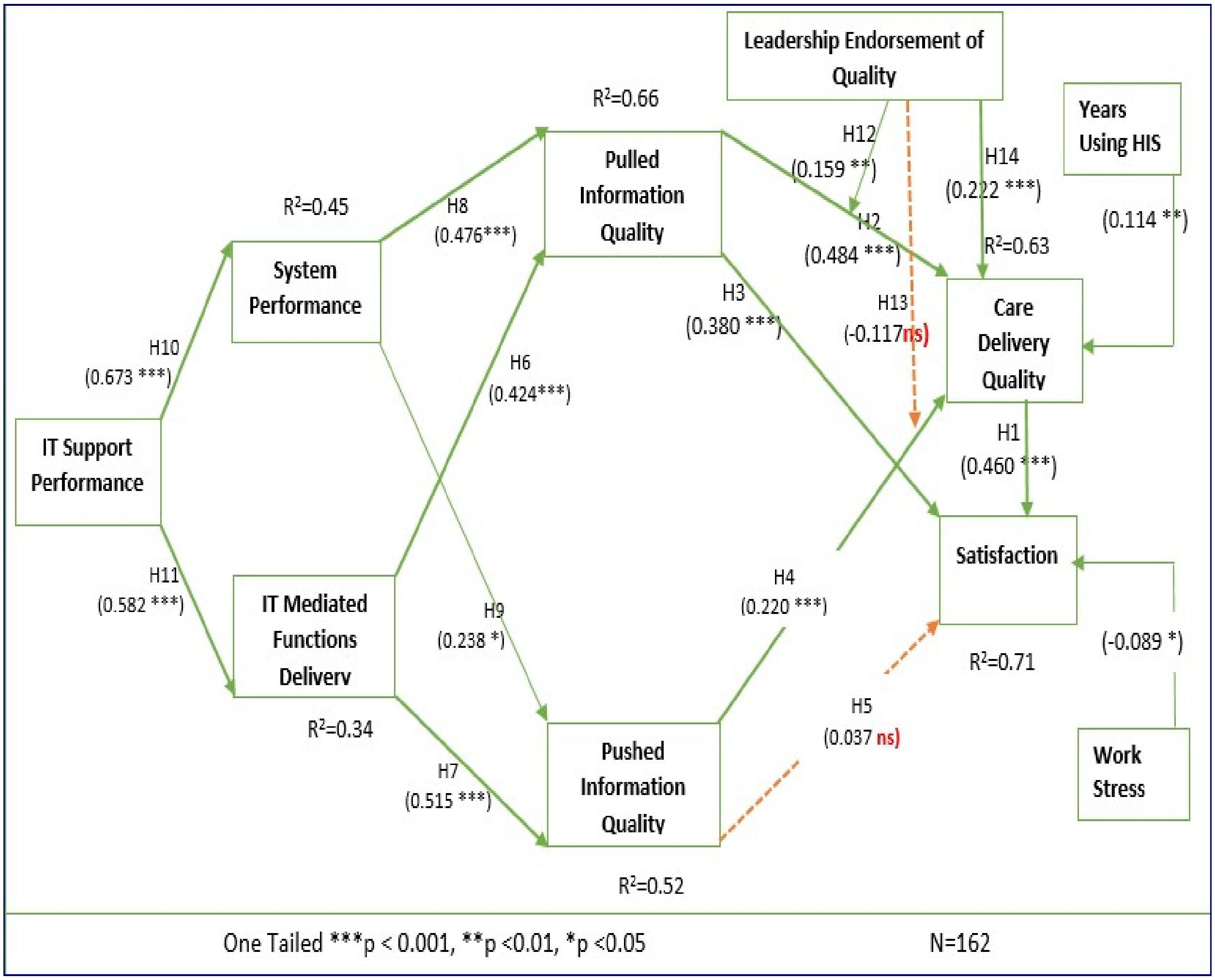

Figure 6-1 Structural Model and Path Coefficient

Table 6-5 Outer Loadings

Construct	Outer Loading	Construct	Outer Loading	Construct	Outer Loading
IT Mediated Function Delivery		Care Delivery Quality		Leadership Endorsement of Quality	
ITFUNC1	0.746	CRDELQ1	0.843	LE1	0.911
ITFUNC2	0.792	CRDELQ2	0.845	LE2	0.930
ITFUNC3	0.817	CRDELQ3	0.815	LE3	0.906
ITFUNC4	0.760	CRDELQ4	0.796	LE4	0.925
ITFUNC5	0.833	CRDELQ5	0.625	LE5	0.854
ITFUNC6	0.851	CRDELQ6	0.703	IT Support Performance	
ITFUNC7	0.855	CRDELQ7	0.818	ITSUPP1	0.831
ITFUNC8	0.750	CRDELQ8	0.858	ITSUPP2	0.805
ITFUNC9	0.602	CRDELQ9	0.815	ITSUPP3	0.868
ITFUNC10	0.751	CRDELQ10	0.793	ITSUPP4	0.891
ITFUNC11	0.634	CRDELQ11	0.857	ITSUPP5	0.823
ITFUNC12	0.709	CRDELQ12	0.837	ITSUPP6	0.867
ITFUNC13	0.785	CRDELQ13	0.874	ITSUPP7	0.866
ITFUNC14	0.743	Pulled Information Quality		Pushed Information Quality	
ITFUNC15	0.748	Currency	0.898	Currency	0.933
ITFUNC16	0.655	PULLIQ1	0.829	PUSHIQ1	0.852
ITFUNC17	0.497	PULLIQ2	0.829	PUSHIQ2	0.893
ITFUNC18	0.571	PULLIQ3	0.812	PUSHIQ3	0.881
		Completeness	0.946	Completeness	0.951
System Support Performance		PULLIQ4	0.903	PUSHIQ4	0.917
SYSPERF1	0.868	PULLIQ5	0.890	PUSHIQ5	0.893
SYSPERF2	0.870	PULLIQ6	0.848	PUSHIQ6	0.880
SYSPERF3	0.846	Format	0.899	Format	0.939
SYSPERF4	0.915	PULLIQ7	0.847	PUSHIQ7	0.912
SYSPERF5	0.920	PULLIQ8	0.853	PUSHIQ8	0.905
SYSPERF6	0.914	PULLIQ9	0.866	PUSHIQ9	0.874
SYSPERF7	0.264	Accuracy	0.884	Accuracy	0.909
SYSPERF8	0.789	PULLIQ10	0.872	PUSHIQ10	0.919
SYSPERF9	0.868	PULLIQ11	0.689	PUSHIQ11	0.794
Satisfaction From Using HIS		PULLIQ12	0.839	PUSHIQ12	0.910
WRKSAT1	0.965				
WRKSAT2	0.979				
WRKSAT3	0.964				
WRKSAT4	0.920				

Table 6-6 Summary of Hypotheses Results

#	Relationship	β	t	p	Support
H1	CRDELQ(+) ---> WRKSAT	0.460	6.732	0.000	YES
H2	PULLIQ(+) ---> CRDELQ	0.484	6.861	0.000	YES
H3	PULLIQ(+) ---> WRKSAT	0.380	5.216	0.000	YES
H4	PUSHIQ(+) ---> CRDELQ	0.220	2.983	0.001	YES
H5	PUSHIQ(+) ---> WRKSAT	0.037	0.691	0.245	NO
H6	ITFUNC(+) ---> PULLIQ	0.424	6.144	0.000	YES
H7	ITFUNC(+) ---> PUSHIQ	0.515	5.357	0.000	YES
H8	SYSPERF(+) ---> PULLIQ	0.476	6.952	0.000	YES
H9	SYSPERF(+) ---> PUSHIQ	0.238	2.360	0.018	YES
H10	ITSUPP(+) ---> SYSPERF	0.673	12.623	0.000	YES
H11	ITSUPP(+) ---> ITFUNC	0.582	10.822	0.000	YES
H12	LE * PULLIQ (+) ---> CRDELQ	0.159	2.421	0.008	YES
H13	LE * PUSHIQ (+) ---> CRDELQ	-0.117	1.308	0.904	NO
H14	LE(+) ---> CRDELQ	0.222	3.226	0.001	YES

6.3.1 Direct Effect Hypotheses

IT support performance exert large positive impact on system performance (β= 0.673, p< 0.001). IT support performance explains 45 percent of the variance in system performance. IT support performance has a direct positive relationship with IT-Mediated functions delivery (β= 0.582, p< 0.001). IT support performance explains 34 percent of the variance in IT-Mediated function delivery.

System performance strongly impact pulled information quality (β= 0.476, p< 0.001). System performance positively impact pushed information quality (β= 0.238, p< 0.05). IT-Mediated functions delivery has a positive impact on pulled information quality (β= 0.424, p< 0.001) and has a positive impact on pushed information quality (β= 0.515, p< 0.001). System performance and IT-Mediated function delivery together explain 66 % of the variance in pulled information quality and 50 % variance in the pushed information quality.

Pulled information quality exert large positive impact on care delivery quality (β= 0.484, p< 0.001) and on satisfaction from the HIS (β= 0.380, p< 0.001). Pushed information quality has a positive relationship with care delivery quality (β= 0.220, p= 0.001), however pushed information quality does not impact the satisfaction from the HIS (β= 0.037, p= 0.245). Leadership endorsement of quality positively impact care delivery quality (β= 0.222, p< 0.001). Together, pulled information quality, pushed information quality and leadership endorsement explain 63 percent variance in care delivery quality. Care delivery quality positively impacts satisfaction from HIS (β= 0.460, p< 0.001). Together, pulled information quality, pushed information quality and care delivery quality explain 71 percent variance in satisfaction from HIS.

6.3.2 Interaction Effect of Leadership Endorsement

In addition to assessing direct effect of leadership endorsement on care delivery quality, contingency effect of leadership endorsement of quality has also been analyzed in this study. The result supports that leadership endorsement of quality moderates the relationship between pulled information quality and care delivery quality (β= 0.159, p = 0.008) and the impact of pulled information quality magnifies on care delivery quality when the leadership endorsement is higher. However, the survey data does not support the moderation of leadership endorsement of quality on pushed information quality and care delivery quality (β= -0.117, p = 0.904). Figure 6-2 shows the interaction effect of leadership endorsement of quality on both pushed and pulled information quality.

Table 6-7 Summary of Description of Hypotheses and Its Support

#	Hypotheses	Support
H1	Care delivery quality positively impacts satisfaction from the HIS.	YES
H2	Pulled information quality has a positive relationship with care delivery quality.	YES
H3	Pulled information quality has a positive relationship with satisfaction from the HIS.	YES
H4	Pushed information quality has a positive relationship with care delivery quality.	YES
H5	Pushed information quality has a positive relationship with satisfaction from the HIS.	NO
H6	IT-Mediated functions delivery has a positive relationship with Pulled information quality.	YES
H7	IT-Mediated functions delivery has a positive relationship with Pushed information quality.	YES
H8	System performance is positively related to pulled information quality.	YES
H9	System performance is positively related to pushed information quality.	YES
H10	IT support is positively related to IT-Mediated functions delivery.	YES
H11	IT support is positively related to system performance.	YES
H12	Leadership endorsement of quality moderates the relationship between Pulled information quality and care delivery quality such that this effect will be stronger when leadership endorsement is strong than when it is weak.	YES
H13	Leadership endorsement of quality moderates the relationship between Pushed information quality and care delivery quality such that this effect will be stronger when leadership endorsement is strong than when it is weak.	NO
H14	Leadership endorsement for quality has a positive relationship with care delivery quality.	YES

6.3.3 Control Variable Hypotheses

Work stress exerts negative impact on satisfaction (β= -0.089, $p < 0.05$). Years of using HIS exerts positive impact on care delivery quality (β= 0.114, $p < 0.01$). Hospital size (number of beds) and age is not significant and therefore were removed from analysis. Each control variable contributed approximately 2% or less to the R^2, suggesting these factors do not justify significant attention.

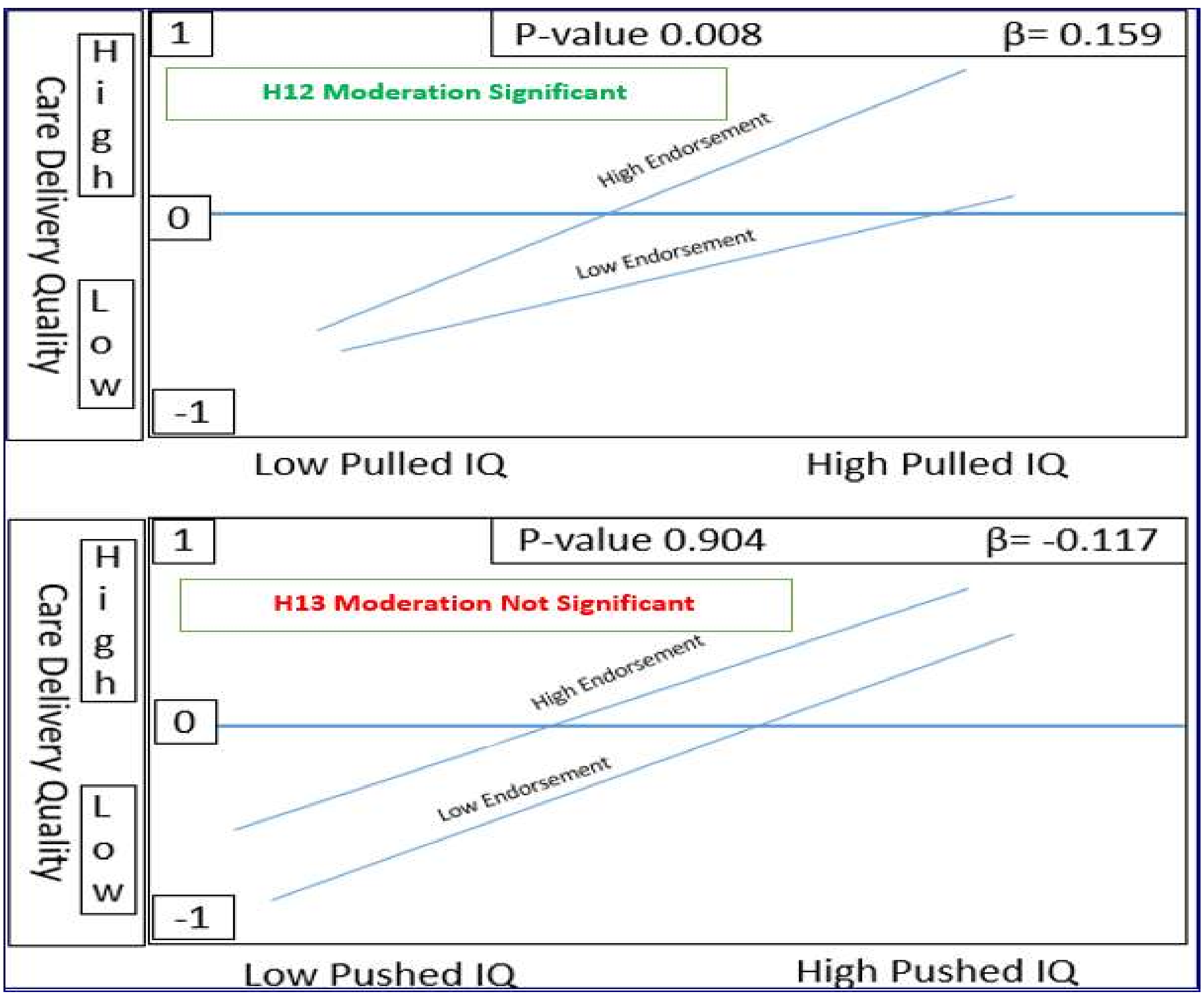

Figure 6-2 Moderation Effect of Leadership Endorsement of Quality

Chapter 7

Discussion and Conclusion

This study makes several contributions. Our model includes IT-Mediated function delivery which is one of the most dynamic elements of the IS deployment. Earlier studies have failed to incorporate software development life cycle (SDLC) based IT-Mediated function delivery along with information quality even though SDLC is the most prominent element of change management that causes gaps in service quality as found by Zhou et al. (2013). Changes in IT are inevitable, particularly the target application software goes through numerous changes during the SDLC. Since quality is generally perceived from a benchmark, the drivers of change can play a central role in causing changes in quality perception. These numerous changes in IT-Mediated function delivery throughout its life cycle can be perceived by the end user of the information system. Repeated perception of usage has been recognized to form overall opinion about the quality. Therefore, failure to include IT-Mediated function delivery will reduce the explanatory power of the framework.

We have also incorporated system performance in our study. System performance may vary because infrastructural elements are upgraded as the business requirements change. Organizations keep upgrading their hardware, operating systems, development software, storage, and network capacities to adjust to business needs. By incorporating vendor-based infrastructure system (since they go through very different change cycles driven by the vendors of the hardware, the storage, the OS, or the network) separately from a SDLC-based application (IT-Mediated function delivery), the research model gives opportunity to the user of work system to identify right pain points which may be very useful for designing managerial interventions.

Earlier studies did not differentiate between information receiving (pushed) and retrieving (pulled). We have identified push and pull as two distinct modes of information processing. While the pulled information serves instant need of the providers, the pushed information through notifications and alerts serves provider’s continuity in providing care services to the patient. During pulling of information, system latency due to infrastructural elements are detrimental to the dependable use of HIS since the user of HIS remains actively engaged and pressed with time. In order to pull the information in real time, the underlying infrastructure must remain reliable, responsive, and flexible so that the target application’s mediated functions can synchronously deliver information. On the other hand, pushed information is an asynchronous channel of information delivery and is facilitated through computer mediated communication. In an asynchronous mode of delivery, IT-Mediated functions still remain responsible for the delivery of the information, however, the demand on the underlying system is not as stringent as in the case of synchronous delivery. The result demonstrates this point empirically. In the case of pulled information quality, the result suggests that both system performance and IT-Mediated functions delivery have a strong positive impact on pulled information quality. In the case of pushed information, IT-Mediated function delivery has a strong impact on pushed information quality while system performance has a weak impact on the pushed information quality. This can be explained on the grounds that pushed information is computer mediated communication in which messages are asynchronously queued. In the case of failed delivery of queued messages, the messages can be re-delivered as long as IT-Mediated functions are performing, thus, relieving the stringent demand on system performance. If a notification is missed, it may be received later.

IS field lacks a framework in which SDLC driven IT-Mediated function delivery, infrastructural element (system performance), the total information quality (the pulled and the pushed), the impact of information quality on care delivery, and provider's satisfaction have been included. This study offers a comprehensive and prescriptive framework in which the end user of an information system uses the complete work system (the shaded part of Figure 4-1) and its product and assesses his/her effectiveness in delivering care and satisfaction.

The work system framework uses the word "participant", giving researchers the flexibility to identify the right user of a work system. Thus, in a fully deployed production environment, the participants are the production support staff; and in the event of operational outages, care providers reach out to production support staff for assistance. In the case of a development work system, the end users (probably the testing team) would reach out to development support team participants when they encounter any issues with the information system. Since in this study the end users of HIS are nurses working in hospital, we modeled IT support to take the role of participants in the healthcare work system framework. IT support teams are tasked to the smooth operation of the fully deployed work system and they are on the frontline in resolving the issues with HIS.

The result suggests that both pushed information quality and pulled information quality have a strong impact on care delivery quality. The results also demonstrated that while pulled information quality has a strong impact on satisfaction from the HIS, the impact of pushed information quality is not significant on satisfaction. This anomaly may be explained on the basis that pushed information is not necessarily attended by the same nurse, any nurses who are on the work rotation may attend it. Since the nurses would not be waiting for the information to arrive, they would not be able to register their satisfaction.

This study also includes external elements of work system framework. The impact of the external elements, the work environment (occupational stress), and the strategy (leadership endorsement of quality) have been operationalized and measured in this study. The result shows that leadership endorsement of quality moderates the effect of pulled information quality on care delivery quality. However, leadership endorsement of quality does not moderate the relationship between pushed information quality and care delivery quality. This can be explained based on the technical adequacy that asynchronous queuing nature of push delivery is designed to retry the message until acknowledged (Sashikanth et al., 2000), obviating the need for a leadership endorsement. Our result suggests that occupational stress under which nurses work has a significant impact on satisfaction. IS literature as discussed earlier also supports this finding.

We summarize the contribution of this study as follows. First, it shows that IT support performance has a strong impact on both the IT-Mediated functions delivery and on system performance. Second, it shows that both the IT-Mediated function delivery and the system performance strongly impact pulled information quality. Third, it shows that pushed and pulled information are impacted differently by IT-Mediated function delivery and by system performance. Fourth, it shows that the impact of pulled and pushed information quality is different on care delivery quality and satisfaction. Fifth, the contingent effect of leadership endorsement of quality also showed a different impact on pulled and pushed information quality. Sixth, this study makes specific contribution to the understanding of healthcare delivery process. Lastly, this is an empirical test on work system framework as proposed by Alter (2006). The way pushed and pulled information are impacted differently by their antecedents and the way pushed and pulled information impact their consequences confirm that these two types of information must be incorporated in the study of information quality where ever they are utilized. It is important to note that the two different modes needs to be treated separately as they are not mere increases in information output and cannot be clubbed under one single construct such as "big information quality". The pushed information is a different pathology. In fact, if we look at the work system framework, pushed information would appear to fit well as "information service" construct to take the role of "services" of the work system framework.

7.1 Implications for Theory

This research framework is likely to contribute to new modes of thinking. First, it is an empirical test of work system theory touching every aspect of work system as laid out in work system framework (WSF) proposed by Alter (2006). The result suggests the key importance of IT support on the smooth functioning of IT-Mediated function delivery and on the system performance. Using Ballou et al. (1999) information manufacturing concept, our model chose information as the product of WSF. Therefore, the model treats information quality as a downstream construct of system performance and IT-Mediated function delivery. This is an enhancement over theoretical models which do not include the work system, and therefore treat information quality and system quality at the same level in the variance models. By treating information as a product of work system manufacturing process and transformation activities, WSF is able to emphasize that stored data have to go through transformations to become information and therefore, information quality will likely be impacted by the transformation mechanisms of the IT-Mediated functions and system performance. Furthermore, our model measures the impact of IS products (pushed information and pulled information) on care delivery quality as perceived by care providers and the satisfaction they derive from the use of HIS. We believe that system performance, pushed and pulled information quality, IT-Mediated functions delivery, IT support performance are not independent players in the delivery of care and should be included together in the studies.

As computer mediated communication is becoming the modus operandi and mobile devices are becoming interoperable with computers, the totality of information includes not only the information pulled from the IS but also the information pushed on the computing devices or mobile devices. Information is obtainable not only from the active use of an information system but also as a passive recipient as it can be delivered anywhere anytime through communication and messaging. This offers a new outlook to servicing customers, patients, providers, and emergency responders. Therefore, IS research should consider including pushed information quality along with pulled information quality especially when the research is situated in the following areas such as:

- Healthcare
- Social Media

- Emergency Responders
- Service Industries

7.2 Implications for Practice

Since our survey included hospital nurses, findings drawn from this research may directly help the managers of HIS implementation. The model included most of the constructs of work system, and therefore, can offer guidance on all the aspects that the model touches upon. By separating pushed and pulled information quality, the framework offers practical insight into assessing their impacts on care delivery and work satisfaction separately. The separation of those modes of information will help direct appropriate managerial and engineering interventions for improving pushed and pulled information quality. The study suggests that both system performance and IT-Mediated functions would require corrective interventions when pulled information quality suffers, while IT-Mediated functions in comparison to system performance take the brunt in maintaining high level of pushed information quality.

Table 7-1 Managerial Interventions

Problem Symptom	**Root Cause Analysis**
Low pulled information quality	See if system performance or IT function delivery or both are suffering as immediate cause
Low pushed information quality	Focus on IT functions delivery more than system performance as immediate root cause analysis
Low care delivery quality	Focus on why the pushed and pulled information is suffering
Low satisfaction on work	Focus on improved care delivery
Low system performance	See if IT support is lacking
Low IT functions performance	See if IT support is lacking

The result demonstrates the strong impact of IT support performance on system performance and on IT-Mediated function delivery. This has implications for management since it suggests that taking the risk of purging IT support groups may result in counter productivity for HIS operations. Instead, setting up a strong production support group may be vital for healthcare delivery. Based on our results, some of the managerial recommendations are summarized in Table 7-1.

7.3 Future Research

Our model gives an entry point into IS research relating to push and pull modes of information. Although our research was conducted in a hospital setting, it goes without saying that these two modes are prevalent in many other areas as described above. A lot of information is pushed only, therefore, push-dimensions will play a major role in future studies when applied in other areas. Information quality researches related to service industry should include pushed information quality to offer greater insight since customer service often deals with after-sales follow-ups where customers are serviced with supplementary (pushed) information.

More refined IT-Mediated function delivery dimensions, especially industry specific dimensions, can be very useful in assessing information quality. Pushed information pathology and industry-specific outcome measurement will bring more insights into IS success measures. As devices play a major role in communication, an extension to this study can include the role of devices in assessing interaction effect on the care outcome. Where IS use is mandatory, role of training and its impact on the effectiveness of IS has been studied in many IS studies, therefore, inclusion of training in measuring care delivery quality may enable researchers to understand its role on the varying level of the outcome.

7.4 Limitations of This Study

We conducted this study using a small sample size which was sufficient for testing our model. The generalizability of this study can be achieved through an extensive gathering of data. Although all the participants were nurses which provides measurement equivalence in drawing conclusions, the survey can easily be administered to other care providers such as doctors and pharmacists to achieve generalizability across different care providers.

A limitation is that we conducted a one-time survey and, therefore, cannot reap the complete fruit of the work system life cycle as envisioned in WSLC presented by Alter (2013). An appropriate extension to this study would be a longitudinal study to see how the work system would continue to offer insight when put in a life cycle of change management, deployment, and maintenance.

IT-Mediated function is a continuously evolving area. We have used dimensions for measuring IT-Mediated function delivery from Tan et al. (2013). Of all the elements within the work system, IT-Mediated function is the most dynamic element, but it has not gained the proportionate attention that it deserves. Therefore, enhancements to tap in the appropriate measurement of IT-Mediated function are essential for greater insight. Enhanced industry-specific dimensions of IT-Mediated function will help researchers of IS field in gaining more fine grained insights.

Appendix A

Summary of Extant Literature on Quality Related Constructs

Source	Level	Concept	INDIVIDUAL PERFORMANCE	FIRM/ UNIT PERFORMANCE	BENEFITS/IMPLEMENTATION SUCCESS	IS PERFORMANCE	IT SUPP/ CUSTOMER SUPPORT	SERVICE QUALITY / PERFORMANCE	SYSTEM/INFRASTRUCTURE	IQ / DQ (PULLED)	IQ PUSHED (RCQ)	TMT/MGMT SUPP/LEADERSHIP ENDORSE	STRESS	CARE QUAL ITY	SATISFACTION
Agha 2014.	Organizational	Impact of health information technology (HIT) on the quality and intensity of medical care	X	X	X									X	
Angst et al., 2012	Organizational	Health IT (adoption/use) is positively associated with care quality.												X	
Au et al, 2008	Organizational	Higher levels of IS performance result in higher levels of End User Satisfaction.				X	X	X	X	X					X
Balas et al., 2000	Organizational	Dependable performance improvement in preventive care can be accomplished through prompting physicians. Health care organizations could effectively use prompts, alerts, or reminders to provide information to clinicians when patient care decisions are made.			X						X			X	
Bates et al., 2003.	Organizational	Improving Safety with Information Technology									X			X	
Bates et al, 1999.	Organizational	Impact of giving physicians computerized reminders about apparently redundant		X							X			X	

		clinical laboratory tests.													
Benlian et al., 2012	Organizational	SaasQual merges dimensions system (Reliability, Responsiveness) and service quality (IT-Mediated dimensions Features, , Flexibility, Security, Rapport)			X		X	X							
Cenfetelli et al., 2008	Organizational	Perceived Service functionality (IT-Mediated functions) leads to satisfaction and service quality.						X							X
Chang et al., 2012	Organizational	Quality of EMR data content and information quality impact user satisfaction significantly.								X					X
Chaudhry et al., 2006	Organizational	Health information technology has been shown to improve quality by increasing adherence to guidelines, enhancing disease surveillance, and decreasing medication errors.	X		X									X	
Chuanga and Linb. 2013	Organizational	Infrastructure capability positively affects Information Quality. Information Quality positively affects Customer Relationship Performance. Customer relations ship Performance positively affects Firm Performance.	X	X	X				X	X					
Coiera, 2006	Organizational	Communication Systems in Healthcare									X			X	

Cummings et al., 2009	Organizational	Communication technologies allow project members to communicate at a distance through the use of audio, video, text, graphics, and other features. An increase in synchronous communication will be associated with a reduction in coordination delay. An increase in asynchronous communication will be associated with a reduction in coordination delay.	X							X	X				
DeLone and McLean., 2003	Organizational (Conceptual)	Information Quality, Service Quality, System Quality impacts user's satisfaction that leads to Net Benefits.	X	X	X	X	X	X	X						X
Davis et al., 2008	Organizational	Use of HIS are better able to address coordination and safety issues, particularly for patients with multiple chronic conditions, as well as to maintain primary care physician workforce satisfaction.				X								X	X
Farquhar-son et al., 2013	Organizational	Nurse stress is related to particular tasks rather than to the job as a whole. Reductions in stress would probably increase job satisfaction, Improve retention of staff and nurse performance, and thus improve patient care.											X	X	X
Gable et al., 2008	Organizational	Commonly Used Satisfaction Items and their Overlap with Other Construct is detailed.			X				X	X					X

		Technical users and Operational users correlate most strongly with System Quality while Strategic users and Operational users with the other three dimensions.													
Gans et al., 2005	Organizational	Many benefits of using HIT to derive information like : Patient demographics Visit/encounter notes Patient medications/prescriptions Presenting complaint Physical exam/review of systems Past medical history Problem lists Procedure/operative notes Laboratory results Drug interaction warnings Radiology/imaging results Consult/reports from specialists Referrals to specialists Drug reference information Immunization tracking Drug formularies Clinical guidelines and protocols Integration with practice billing system			X					X				X	
Gattiker and Goodhue (2005)	Organizational	Greater data quality is associated with greater task efficiency/coordination improvements for the plant.			X					X					
Hsieh and Wang, 2007.	Organizational	Impact of System on net benefits and use	X		X				X						

Jamal et al., 2009	Organizational	HIT/HIS improves quality of medical and health care. Lists review of Care Quality literature on the use of HIS/HIT.												X	X
Kahai and Cooper, 2003	Organizational	Communication (Message clarity and Task oriented) quality leads to better decision quality.	X								X				
Kim et al., 2004	Organizational	System Quality and Service Level impacts customer satisfaction.						X	X	X					X
Kim et al., 2002	Organizational	Firmness, convenience, delight leads to Satisfaction			X			X							X
Kwon et al., 2014	Organizational	Data Quality positively affects data usage.			X					X					
Lee & Strong., 2003	Organizational	Knowing-what, knowing-how, and knowing-why about the three data production processes are associated with higher data quality.	X							X					
Lee et al., 2009.	Organizational	Separates Information quality from System Quality of both hardware and software. Perceived information quality is more influential than perceived system quality in increasing mobile data services (MDS) usage. Perceived system quality is more influential than perceived information quality in decreasing the usage of MDS.						X	X	X					

Lowry et al., 2009	Organizational	Two way Communication, synchronicity, control leads to increased communication quality which leads to process satisfaction.									X				X
Luo et al., 2012.	Individual	Design Characteristics and Customer Service moderates customer satisfaction.			X		X	X							X
Melville et. al., 2004	Organizational (conceptual)	The IT and non-IT resources and the business processes shape the focal firm's ability to generate and capture organizational performance impacts via IT. Infrastructure moderates the economic value of an inter-organizational IS. IT resource generate operational efficiencies.		X	X	X			X						
Montoya-Weiss et al., 2013	Organizational	Web Design features impacts service delivery perceptions						X							X
Myers et al, 1997.	Organizational	Conceptual	X		X			x	X	X	X				X
Negash et al., 2003	Individual	Information Quality is positively associated with user satisfaction. System Quality is positively associated with user satisfaction.						X	X	X					X
Rai et al., 2002.	Organizational	IQ has positive impact on Satisfaction.								X					X
Ravichand-ran and Rai., 2000.	Organizational	Top Management support leads to enacting and enforcing quality initiatives which leads to process efficiency which in		X		X						X			

		turn leads to product quality (IS Performance)													
Schmidt et al., 2002.	Organizational	Nurses communication and drug administration.									X			X	
Seddon, 1997.	Organizational	Several relationship amongst Customer orientation capability, Customer response capability, Information quality, Process sophistication.									X				X
Setia et al., 2013.	Organizational	Several relationship amongst Customer orientation capability, Customer response capability, Information quality, Process sophistication.		X			X	X		X					
Sharma and Yetton, 2003.	Organizational	The effect of management support on implementation success is a positive function of task interdependence. In low task interdependence contexts, the effect of management support on implementation success is weak.			X							X			
Susarla et al, 2003.	Organizational	The perceived provider performance has a positive impact on the satisfaction with application service provider (ASP). The technical service (system performance) guarantees of an ASP have a positive impact on perceived provider performance. The system performance guarantees of an ASP have a positive impact on the satisfaction with ASP.	X	X	X	X		X	X						X

		The functional capability (such as IT-Mediated services) of the ASP has a positive effect on the satisfaction with ASP. The functional capability of the ASP has a positive effect on perceived provider performance.													
Tan et al., 2013.	Individual	Perceived Service Content Quality, Perceived Service Delivery Quality, Overall E-Government Service Quality. Service quality is influenced by service content quality and service delivery quality (IT Mediated).				X		X							
Tan et al., 2016	Organizational	Enlists in table informational, functional and system attributes (Categorization of E-Service Literature)						X	X	X					X
Teo et al., 2008	Organizational	Information Quality, Service Quality, System quality positively impacts Satisfaction.						X	X	X					X
Wanlass et al., 2003	Organizational	Failures of communication are among the most common factors contributing to the occurrence of adverse events.									X			X	
Wang et al., 2006.	Organizational	User Support positively impacts ERP System Quality. Top Management Support positively impacts ERP System quality.							X			X			
Wixom and Watson, 2001.	Organizational	A high level of project implementation success is associated with a high level of	X	X	X	X			X	X		X			X

		data quality, and system quality A high level of management support is associated with a high level of organizational implementation success. A high level of resources is associated with a high level of organizational implementation success/project implementation success. A high level of user participation is associated with organizational implementation success/project implementation success.													
Wong et al., 2012	Organizational	Information integration of a firm's SC is positively associated with the firm's customer-oriented operational performance.		X	X					X					
Xu et al., 2013	Individual	An individual's perceived System Quality positively influences that individual's perceived IQ/Service Quality. An individual's perceived IQ positively influences that individual's perceived Service Quality. An individual's perceived SQ influences that individual's service satisfaction.	X		X			X	X	X					X

Appendix B

Survey Items, Descriptive Statistics and Summary Statistics

Table B-1 Survey Items

IT Support Performance (Ray et al.2005) 1-7: Strongly Disagree to Strongly agree		Loadings	Mean	Std Dev.
ITSUPP1	The IT support unit gives users of HIS prompt service.	0.831	5.250	1.210
ITSUPP2	The IT support representatives are never too busy to respond to users of HIS.	0.805	4.840	1.450
ITSUPP3	The IT support representatives are capable of solving the HIS problems.	0.868	5.340	1.240
ITSUPP4	When the IT support unit promises to do something for users of HIS by a certain time, it does most of the time.	0.891	5.190	1.260
ITSUPP5	When a user of HIS has a problem, the IT support unit shows sincere interest in solving it.	0.823	5.370	1.290
ITSUPP6	The IT support unit performs the service correctly the first time.	0.867	5.160	1.160
ITSUPP7	The IT support representatives understand specific needs of HIS users.	0.866	5.120	1.430
System Performance (Wixom & Todd , 2005) 1-				
SYSPERF1	The HIS operates reliably for patient care.	0.868	5.440	1.200
SYSPERF2	The HIS performs reliably for patient care.	0.870	5.440	1.190
SYSPERF3	The operation of the HIS is dependable for patient care.	0.846	5.460	1.240
SYSPERF4	The HIS is able to be adapted to meet a variety of needs during patient care.	0.915	5.170	1.400
SYSPERF5	The HIS is able to flexibly adjust to new demands or conditions during patient care.	0.920	4.950	1.480
SYSPERF6	The HIS is flexible in addressing needs as they arise during patient care.	0.914	4.930	1.480
SYSPERF7 (R)	It takes too long for the HIS to respond to my request during patient care.	0.264	Removed, weak Indicator	
SYSPERF8	The HIS responds in a timely fashion during patient care.	0.789	4.980	1.370
SYSPERF9	The HIS answers my requests quickly during patient care.	0.868	4.950	1.440
SYSPERF10	In terms of system performance, I will rate the HIS highly for patient care.	0.917	4.950	1.550
SYSPERF11	Overall, the HIS that I use is of high quality for patient care.	0.934	5.000	1.520
SYSPERF12	Overall, I will give the performance of HIS a high rating for patient care.	0.943	4.940	1.570

Pulled Information Quality (Wixom & Todd , 2005)				
PULLIQ1	The HIS provides me with the most recent information to care for the patient.	0.829	5.660	1.120
PULLIQ2	The HIS produces the most current information to care for the patient.	0.829	5.650	1.110
PULLIQ3	The information from the HIS is always up to date to care for the patient.	0.812	5.430	1.210
PULLIQ4	The HIS provides me with a complete set of information to care for the patient.	0.903	5.310	1.310
PULLIQ5	The HIS produces comprehensive information to care for the patient.	0.890	5.400	1.240
PULLIQ6	The HIS provides me with all the information to care for the patient.	0.848	5.210	1.370
PULLIQ7	The information provided by the HIS is well formatted to care for the patient.	0.847	5.714	1.450
PULLIQ8	The information provided by the HIS is well laid out to care for the patient.	0.853	4.960	1.470
PULLIQ9	The information provided by the HIS is clearly presented on the screen to care for the patient.	0.866	5.170	1.380
PULLIQ10	The HIS produces correct information to care for the patient.	0.872	5.560	1.100
PULLIQ11	The information I obtained from the HIS to provide patient care is error-free.	0.689	Removed, weak Indicator	
PULLIQ12	The information provided by the HIS is accurate to care for the patient.	0.839	5.340	1.200
Pushed Information Quality (Adapted from Wixom & Todd , 2005)				
PUSHIQ1	The notification system communicates to me the most current information about the patient.	0.852	4.980	1.370
PUSHIQ2	The notification system communicates the most recent information about the patient.	0.893	5.030	1.390
PUSHIQ3	The notification system communication is always up to date about the patient.	0.881	4.920	1.340
PUSHIQ4	The notification system communicates to me with a complete set of information about the patient.	0.917	4.870	1.470
PUSHIQ5	The notification system communicates comprehensive information about the patient.	0.893	4.850	1.500
PUSHIQ6	The notification system communicates to me with all the information about the patient.	0.880	4.740	1.530
PUSHIQ7	The notification system communication about the patient is well formatted .	0.912	4.740	1.470
PUSHIQ8	The notification system communication about the patient is well laid out.	0.905	4.690	1.520
PUSHIQ9	The notification system communication about the patient is clearly presented on the screen.	0.874	4.810	1.460
PUSHIQ10	The notification system communicates correct information about the patient.	0.919	5.080	1.320
PUSHIQ11	The communication from the notification system I obtain is error-free to provide patient care.	0.794	4.850	1.350
PUSHIQ12	The notification system communication is accurate to care for the patient.	0.910	5.090	1.300

		Loadings	Mean	Std Dev.
IT Mediated Function Delivery (Adapted from Tan et al.2013) 1-7: Strongly Disagree to Strongly agree				
ITFUNC1	I do not need to perform complicated steps in order to access HIS for providing patient care.	0.746	4.750	1.670
ITFUNC2	I do not face any difficulty in accessing the HIS for providing patient care.	0.792	4.700	1.670
ITFUNC3	I do not encounter any problem in accessing the HIS using my computer for providing patient care.	0.817	4.630	1.640
ITFUNC4	I do not find the presentation of instructions and procedures to be ambiguous and confusing when using the HIS to provide patient care.	0.760	4.860	1.460
ITFUNC5	HIS lets me navigate effortlessly through relevant pages while providing patient care.	0.833	4.690	1.600
ITFUNC6	HIS lets me easily understand the instructions and procedures for providing patient care.	0.851	5.020	1.460
ITFUNC7	I find using the HIS to be engaging when I am providing patient care.	0.855	4.560	1.620
ITFUNC8	I find using the HIS a stimulating experience.	0.750	3.930	1.680
ITFUNC9	The HIS is responsive and sensitive to my computer habits (such as spelling corrections, Auto-fill).	0.602	Removed, weak Indicator	
ITFUNC10	I am able to complete all patient care related work using the same HIS.	0.751	5.090	1.510
ITFUNC11	HIS lets me access services provided by different care units.	0.634	Removed, weak Indicator	
ITFUNC12	Various patient care services under the responsibility of different units are available through one single HIS instead of using many HIS.	0.709	5.120	1.480
ITFUNC13	Using the HIS, I do not experience delay in loading of new screens while providing patient care.	0.785	4.430	1.670
ITFUNC14	The HIS does not slow down at certain periods of time when providing patient care.	0.743	4.060	1.800
ITFUNC15	The HIS does not become cluttered or confusing over time due to changes in information content.	0.748	4.720	1.440
ITFUNC16	I beleive that information disclosed during patient care is transferred in a secured manner.	0.655	Removed, weak Indicator	
ITFUNC17	I trust that hackers will not be able to access the personal information when providing patient care.	0.497		
ITFUNC18	The HIS has built-in safeguard mechanisms that protect the disclosed personal information from being stolen when I provide patient care.	0.571		

Care Delivery Quality (Adapted From Marshall, 1998) 1-7: Much Worse to Much Better				
CRDELQ1	By using the HIS, the overall quality of health care that you give to your patients has become.	0.843	4.870	1.420
CRDELQ2	By using the HIS, the ability to adhere to clinical practice guidelines has become.	0.845	5.020	1.260
CRDELQ3	By using the HIS, the quality and content of your patient-clinical interaction has become.	0.815	4.570	1.480
CRDELQ4	By using the HIS, your ability to provide clinical preventive services (screening, counselling, immunizations) has become.	0.796	5.080	1.230
CRDELQ5	By using the HIS, your ability to detect medication dosing errors has become.	0.625	Removed, weak Indicator	
CRDELQ6	By using the HIS, your ability to prevent drug allergic reactions or drug-drug interactions has become.	0.703	5.641	1.111
CRDELQ7	By using the HIS, your ability to act on test results in a timely fashion has become.	0.818	5.480	1.120
CRDELQ8	By using the HIS, your overall diagnostic accuracy has become.	0.858	5.070	1.150
CRDELQ9	By using the HIS, your ability to coordinate the care of a patient with other departments and providers has become.	0.815	5.270	1.280
CRDELQ10	By using the HIS, your ability to do timely referral has become.	0.793	5.090	1.200
CRDELQ11	By using the HIS, your ability to care for acute problems or conditions has become.	0.857	5.070	1.260
CRDELQ12	By using the HIS, your ability to care for chronic problems or conditions has become.	0.837	5.120	1.110
CRDELQ13	By using the HIS, your overall work efficiency has become.	0.874	4.960	1.530
Leadership Endorsement For Quality (Ravichandran and Rai, 2000)				
LE1	Hospital Management has clear quality objectives.	0.911	5.430	1.400
LE2	Quality goals within organization are very specific.	0.930	5.520	1.340
LE3	There is a comprehensive Information system quality plan.	0.906	5.350	1.310
LE4	Quality goals and policies are understood within the department.	0.925	5.370	1.360
LE5	Significant importance is attached to quality as reflected in funding for HIS.	0.854	5.170	1.410
Work Satisfaction (Adapted from Bhattacharjee, 2001.)				
WRKSAT1	I am very satisfied with the HIS.	0.965	4.730	1.590
WRKSAT2	I am very pleased with the HIS.	0.979	4.620	1.600
WRKSAT3	I am very content with the HIS.	0.964	4.700	1.600
WRKSAT4	I am absolutely delighted with the HIS.	0.920	3.750	1.790

Control Variables				
Work Stress (Adapted From Cullen et al 1985) 1-7: Strongly Disagree to Strongly agree		Loadings	Mean	Std Dev.
STRESS1	When I'm at work, I often feel tensed or uptight.	0.859	4.410	1.610
STRESS2	A lot of the times, my job makes me very frustrated or angry.	0.855	4.170	1.690
STRESS3 (R)	Most of the time when I am at work, I don't feel that I have much to worry about.	0.740	4.510	1.550
STRESS4 (R)	I am usually calm and at ease when I am working.	0.831	3.440	1.310
STRESS6	There are a lot of aspects about my job that can make me pretty upset about things.	0.758	4.380	1.540
	Control Variables - Demographics And Work Related			
C1	Approximately how many patient beds are there in the hospital facility that you work in?	<100	22	0.13
		101-250	38	0.23
		250-500	82	0.5
		>500	23	0.14
C2	For how many years have you been using the HIS?			
		< 1	12	0.07
		1 to 5	72	0.43
		6 to 10	53	0.32
		11 to 15	18	0.11
		16 to 20	6	0.03
		> 20	4	0.02
C3	Age	55+	74	0.45
		45 to 54	31	0.19
		35 to 44	21	0.13
		< 35	39	0.23

(R)- Reverse Coded For Analysis

Table B-2 Items Cross Loadings

	CRDELQ	PULLIQ	ITFUNC	ITSUPP	LE	PUSHIQ	STRESS	SYSPERF	WRKSAT
ITSUPP1	0.412	0.439	0.481	0.831	0.427	0.369	-0.303	0.490	0.378
ITSUPP2	0.453	0.507	0.524	0.805	0.310	0.399	-0.272	0.552	0.423
ITSUPP3	0.478	0.483	0.532	0.868	0.444	0.443	-0.334	0.588	0.508
ITSUPP4	0.523	0.461	0.504	0.891	0.481	0.396	-0.231	0.557	0.424
ITSUPP5	0.473	0.430	0.443	0.823	0.406	0.393	-0.261	0.510	0.375
ITSUPP6	0.481	0.475	0.538	0.867	0.346	0.423	-0.289	0.573	0.467
ITSUPP7	0.515	0.454	0.556	0.866	0.468	0.383	-0.222	0.585	0.470
SYSPERF1	0.605	0.724	0.725	0.591	0.406	0.516	-0.286	0.868	0.619
SYSPERF2	0.607	0.701	0.703	0.585	0.359	0.500	-0.267	0.870	0.661
SYSPERF3	0.623	0.707	0.755	0.619	0.420	0.579	-0.341	0.846	0.652
SYSPERF4	0.679	0.796	0.776	0.561	0.426	0.634	-0.224	0.915	0.758
SYSPERF5	0.683	0.808	0.783	0.565	0.444	0.618	-0.226	0.920	0.759
SYSPERF6	0.667	0.763	0.761	0.581	0.469	0.594	-0.264	0.914	0.717
SYSPERF7_R	0.181	0.170	0.199	0.215	0.077	0.161	-0.248	0.264	0.233
SYSPERF8	0.527	0.604	0.610	0.594	0.317	0.494	-0.240	0.789	0.557
SYSPERF9	0.645	0.726	0.729	0.658	0.430	0.580	-0.255	0.868	0.642
SYSPERF10	0.668	0.830	0.795	0.526	0.484	0.589	-0.223	0.917	0.767
SYSPERF11	0.644	0.827	0.779	0.527	0.447	0.580	-0.248	0.934	0.760
SYSPERF12	0.660	0.819	0.785	0.555	0.455	0.592	-0.279	0.943	0.772
PULLIQ1	0.601	0.829	0.616	0.405	0.467	0.504	-0.122	0.630	0.604
PULLIQ2	0.603	0.829	0.600	0.391	0.433	0.506	-0.107	0.628	0.583
PULLIQ3	0.613	0.812	0.637	0.453	0.388	0.582	-0.127	0.630	0.632
PULLIQ4	0.674	0.903	0.692	0.469	0.398	0.608	-0.111	0.721	0.679
PULLIQ5	0.669	0.890	0.745	0.509	0.466	0.633	-0.177	0.746	0.715
PULLIQ6	0.612	0.848	0.708	0.476	0.365	0.560	-0.142	0.696	0.627
PULLIQ7	0.597	0.847	0.749	0.396	0.478	0.547	-0.209	0.773	0.725
PULLIQ8	0.640	0.853	0.784	0.427	0.452	0.579	-0.225	0.788	0.738
PULLIQ9	0.636	0.866	0.805	0.468	0.493	0.639	-0.284	0.812	0.751
PULLIQ10	0.600	0.872	0.708	0.522	0.399	0.571	-0.198	0.744	0.609
PULLIQ11	0.488	0.689	0.593	0.490	0.271	0.475	-0.213	0.640	0.519
PULLIQ12	0.638	0.839	0.720	0.518	0.428	0.612	-0.244	0.729	0.647
PUSHIQ1	0.536	0.625	0.574	0.356	0.341	0.852	-0.156	0.553	0.525
PUSHIQ2	0.558	0.586	0.586	0.391	0.377	0.893	-0.226	0.569	0.547

	CRDELQ	PULLIQ	ITFUNC	ITSUPP	LE	PUSHIQ	STRESS	SYSPERF	WRKSAT
PUSHIQ3	0.585	0.609	0.630	0.412	0.332	0.881	-0.268	0.575	0.560
PUSHIQ4	0.607	0.642	0.651	0.423	0.374	0.917	-0.251	0.607	0.599
PUSHIQ5	0.577	0.638	0.634	0.386	0.356	0.893	-0.245	0.612	0.588
PUSHIQ6	0.572	0.655	0.687	0.392	0.400	0.880	-0.292	0.635	0.601
PUSHIQ7	0.558	0.649	0.693	0.419	0.434	0.912	-0.310	0.645	0.619
PUSHIQ8	0.579	0.668	0.703	0.431	0.432	0.905	-0.299	0.663	0.616
PUSHIQ9	0.579	0.602	0.681	0.396	0.444	0.874	-0.286	0.605	0.601
PUSHIQ10	0.603	0.594	0.587	0.478	0.405	0.919	-0.272	0.547	0.540
PUSHIQ11	0.478	0.548	0.559	0.413	0.343	0.794	-0.236	0.507	0.475
PUSHIQ12	0.582	0.595	0.589	0.467	0.419	0.910	-0.233	0.530	0.528
PUSHIQ13	0.574	0.580	0.588	0.429	0.425	0.919	-0.249	0.555	0.543
PUSHIQ14	0.385	0.402	0.391	0.217	0.179	0.532	-0.067	0.401	0.368
PUSHIQ15	0.622	0.599	0.621	0.443	0.423	0.900	-0.228	0.566	0.534
PUSHIQ16	0.559	0.520	0.534	0.445	0.406	0.835	-0.217	0.471	0.469
PUSHIQ17	0.502	0.476	0.508	0.411	0.404	0.834	-0.216	0.419	0.448
PUSHIQ18	0.530	0.507	0.534	0.428	0.356	0.882	-0.239	0.473	0.454
ITFUNC1	0.487	0.632	0.746	0.395	0.308	0.448	-0.238	0.604	0.610
ITFUNC2	0.521	0.631	0.792	0.433	0.342	0.484	-0.266	0.628	0.616
ITFUNC3	0.540	0.643	0.817	0.465	0.402	0.517	-0.320	0.661	0.649
ITFUNC4	0.508	0.659	0.760	0.430	0.389	0.503	-0.205	0.610	0.560
ITFUNC5	0.573	0.722	0.833	0.424	0.399	0.539	-0.261	0.715	0.670
ITFUNC6	0.636	0.707	0.851	0.523	0.442	0.651	-0.306	0.703	0.676
ITFUNC7	0.680	0.715	0.855	0.471	0.480	0.646	-0.251	0.725	0.741
ITFUNC8	0.651	0.642	0.750	0.421	0.416	0.593	-0.216	0.618	0.743
ITFUNC9	0.382	0.481	0.602	0.297	0.277	0.395	-0.192	0.496	0.460
ITFUNC10	0.597	0.650	0.751	0.483	0.389	0.621	-0.267	0.622	0.579
ITFUNC11	0.550	0.538	0.634	0.430	0.439	0.555	-0.198	0.551	0.558
ITFUNC12	0.566	0.560	0.709	0.445	0.435	0.580	-0.213	0.594	0.539
ITFUNC13	0.602	0.620	0.785	0.481	0.409	0.529	-0.280	0.663	0.592
ITFUNC14	0.592	0.599	0.743	0.531	0.354	0.496	-0.304	0.679	0.624
ITFUNC15	0.602	0.620	0.748	0.488	0.339	0.543	-0.266	0.589	0.626
ITFUNC16	0.493	0.577	0.655	0.448	0.455	0.399	-0.238	0.568	0.483
ITFUNC17	0.380	0.397	0.497	0.333	0.381	0.214	-0.133	0.390	0.400
ITFUNC18	0.446	0.448	0.571	0.443	0.434	0.325	-0.191	0.512	0.403

	CRDELQ	PULLIQ	ITFUNC	ITSUPP	LE	PUSHIQ	STRESS	SYSPERF	WRKSAT
CRDELQ1	0.843	0.683	0.704	0.496	0.432	0.541	-0.235	0.667	0.780
CRDELQ2	0.845	0.640	0.661	0.530	0.501	0.542	-0.205	0.673	0.677
CRDELQ3	0.815	0.635	0.676	0.489	0.444	0.546	-0.271	0.639	0.736
CRDELQ4	0.796	0.542	0.533	0.375	0.462	0.498	-0.174	0.515	0.541
CRDELQ5	0.625	0.432	0.416	0.409	0.373	0.332	-0.018	0.392	0.413
CRDELQ6	0.703	0.523	0.495	0.463	0.384	0.432	-0.044	0.464	0.465
CRDELQ7	0.818	0.593	0.565	0.485	0.479	0.487	-0.137	0.562	0.638
CRDELQ8	0.858	0.626	0.605	0.494	0.465	0.541	-0.187	0.593	0.649
CRDELQ9	0.815	0.572	0.598	0.400	0.415	0.563	-0.177	0.608	0.617
CRDELQ10	0.793	0.540	0.614	0.405	0.473	0.499	-0.191	0.549	0.596
CRDELQ11	0.857	0.615	0.652	0.423	0.445	0.600	-0.231	0.602	0.683
CRDELQ12	0.837	0.568	0.593	0.454	0.505	0.540	-0.211	0.531	0.610
CRDELQ13	0.874	0.668	0.722	0.475	0.451	0.582	-0.246	0.660	0.806
LE1	0.474	0.399	0.405	0.405	0.911	0.340	-0.254	0.364	0.415
LE2	0.500	0.436	0.451	0.417	0.930	0.375	-0.243	0.399	0.447
LE3	0.457	0.450	0.505	0.429	0.906	0.384	-0.260	0.461	0.475
LE4	0.505	0.433	0.483	0.446	0.925	0.380	-0.261	0.430	0.477
LE5	0.556	0.534	0.562	0.479	0.854	0.502	-0.219	0.485	0.536
STRESS1	-0.201	-0.212	-0.286	-0.278	-0.217	-0.270	0.859	-0.237	-0.270
STRESS2	-0.211	-0.242	-0.290	-0.289	-0.292	-0.268	0.855	-0.286	-0.296
STRESS3_R	-0.210	-0.144	-0.286	-0.258	-0.171	-0.166	0.740	-0.233	-0.214
STRESS4_R	-0.224	-0.244	-0.354	-0.318	-0.234	-0.291	0.831	-0.313	-0.293
STRESS5	-0.102	-0.052	-0.170	-0.170	-0.173	-0.133	0.809	-0.160	-0.150
STRESS6	-0.100	-0.025	-0.110	-0.164	-0.204	-0.142	0.758	-0.113	-0.166
WRKSAT1	0.772	0.764	0.783	0.471	0.515	0.585	-0.296	0.762	0.965
WRKSAT2	0.774	0.785	0.798	0.513	0.499	0.607	-0.282	0.777	0.979
WRKSAT3	0.748	0.734	0.780	0.497	0.500	0.610	-0.342	0.751	0.964
WRKSAT4	0.744	0.703	0.735	0.493	0.491	0.578	-0.241	0.720	0.920
WRKSAT5	0.040	0.020	-0.030	-0.079	0.021	0.038	0.052	-0.046	0.064

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Biographical Information

Rashid Manzar is a more than 20 years IT professional and has involved in IT projects in several roles. Rashid has worked as a programmer, an application developer, a database developer, a data warehouse developer, a database administrator, a database architect for some of the largest relational databases. Rashid started his IT career in India as Member of Technical Staff for Matlab Products. He did programming for embedded systems related to Motorola HC11 series. He has more than 10 years of experience in designing integration processes such as ETL and workflow orchestration. At Verizon Rashid has architected, designed and implemented Verizon's core customer facing database engines. He is an expert in Microsoft SQL Server, SSIS, and SSAS technologies. He was amongst the team for receiving Winter Corp Award in 2003 for maintaining one of the top 10 largest SQL Server instance. In his current role he serves as a Senior Member of Technical Staff in IT Security Team at Verizon. He has technological expertise in Graph database, Linux, Oracle, MariaDB, Excel, R, OLAP, Amazon Web Services and IT Security.

Rashid completed his undergraduate (B.Tech.) from the Indian Institute of Technology, Kharagpur, India in 1994. He is an associate Member of the Institution of Engineers, India. While working at Verizon he undertook academics part time. He completed his Masters in Computer Science and an MBA from University of Texas at Dallas. He completed his PhD at University of Texas at Arlington in 2017. He has taught Business Statistics at University of Texas at Arlington and has conducted Data warehouse workshops. He has published in Journal of Database Management and AMCIS.