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Empirical Assessment of the Role of Technology-Related Factors and Organization-Related Factors in Electronic Medical Records Implementation Success

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EMPIRICAL ASSESSMENT OF THE ROLE OF TECHNOLOGY-
RELATED FACTORS AND ORGANIZATION-RELATED FACTORS
IN ELECTRONIC MEDICAL RECORDS IMPLEMENTATION
SUCCESS

By

RANGARAJAN PARTHASARATHY

A DISSERTATION SUBMITTED TO THE SCHOOL OF
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EMPIRICAL ASSESSMENT OF THE ROLE OF TECHNOLOGY-RELATED FACTORS AND ORGANIZATION-RELATED FACTORS IN ELECTRONIC MEDICAL RECORDS IMPLEMENTATION SUCCESS

ABSTRACT

The implementation of Electronic Medical Records (EMR) in the United States and around the world has been fraught with problems and delays, resulting in unsuccessful or partially successful implementations. While the success and failure of information technology (IT) and management information systems (MIS) implementations have been extensively studied in other domains, there have been relatively few studies in the healthcare domain which have focused on successful IT/MIS implementations, especially on factors associated with successful EMR implementations. The objective of this research was to investigate if certain technology-related and organization-related factors that have most often been associated with successful IT/MIS implementations in other information technology/ information science domains are also associated with successful EMR implementations. This research uncovered a unique set of technology-related factors and organization-related factors associated with successful EMR implementations from the perspective of healthcare enablers and healthcare providers. Specific technology-related factors considered in this research were the innovativeness of EMR (measured with respect to the relative advantage, compatibility and complexity of EMR), privacy and security attributes of EMR, and usefulness of EMR. Specific organization-related factors considered were the readiness of the organization for change and the level of product/process innovation in the organization where the EMR was implemented.

A questionnaire survey based on the Likert scale was used for the data collection. The data so obtained was analyzed using statistical techniques. Results show that readiness of the organization for change, relative advantage of EMR, and compatibility of EMR have statistically significant positive associations with EMR implementation success. Contrary to the conventional wisdom, which is supported by research in many domains other than EMR implementation research, there is no statistically significant relationship between product innovation within the organization, process innovation within the organization, or complexity of the EMR system itself, and implementation success for EMR systems.

This research study is important for two reasons. It is the first study to consider the impact of a unique set of technology-related factors and organization-related factors known to impact successful information technology (IT) implementations in other domains, on EMR implementation success. This focus is consistent with a systems approach to problem solving and considers the fit and the combined ability of the unique set of factors to enable successful EMR implementations. Secondly, it contributes to the fields of healthcare information technology (HIT), information science (IS), information technology (IT), management information systems (MIS) and other related domains by way of providing actionable information useful to academic researchers and industry practitioners alike. It enables academic researchers to gain an understanding of how EMR implementations are similar to and different from technology implementations in other domains with respect to technology factors and organizational factors associated with implementation success. It allows industry practitioners to facilitate successful EMR implementations by paying attention to the specific technology and organizational factors associated with successful EMR implementations identified by this study.

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CHAPTER 1: INTRODUCTION

Background and Broad Overview of the Study

Healthcare is a trillion dollar industry in the United States, with spending reaching 17.5% of the gross domestic product (or \$9,523 per United States resident) in the year 2014 (Kaiser Foundation Report, 2014). A multitude of laws governing the realm of healthcare exist in the United States to ensure proper regulation of the industry and to protect the public. To be in compliance with these laws at all times requires attention to detail and a significant amount of resources dedicated to this task, and puts a significant amount of financial/other resource pressure on the healthcare industry. At the same time, there is pressure on the United States healthcare industry to perform efficiently and effectively and offer health care of a high quality to the public at an affordable price. Such lofty goals are not easy to achieve without the use of technology. Fortunately, the proliferation of Internet and computer technology in the last decade has made available the necessary tools to assist healthcare organizations in the United States (and around the world) in achieving these lofty goals.

The widespread use of the Internet and computer technologies has changed the traditional patient-doctor interaction paradigms in healthcare (known in healthcare jargon as an “encounter”), wherein the doctor was the centerpiece and the provider of health related information while the patient was a passive receptor reliant on the doctor for healthcare and medication information (Cotton, 2002; Fieschi et al., 2003; Wald, Dube & Anthony, 2007; Wilson, 1994). Such interactions or encounters traditionally took place in the doctor’s office at a brick-and-mortar hospital or healthcare facility, with the doctor usually having the dominant role in the encounters (Cotton, 2002; Fieschi et al., 2003; Wald, Dube & Anthony, 2007; Wilson,

1994). Access to a vast amount of healthcare-related information on the Internet has altered this doctor-patient interaction paradigm. Today, patients are able to access healthcare websites (such as *WebMD.com*, *FamilyDoctor.org*, *Mayoclinic.com*) on the Internet and obtain health, disease and treatment related information in the comfortable, familiar and safe environment of their homes, rather than in the unfamiliar and sometimes stress-producing environment of a hospital or healthcare facility (Cotton, 2002; Fieschi et al., 2003; Wald, Dube & Anthony, 2007; Wilson, 1994). This development has alleviated some of the pressure on the hospitals and the healthcare system to the extent that many patients now come to the doctor in a traditional brick-and-mortar hospital setting more for touch-and-feel clinical interactions, lab tests and diagnosis of serious illnesses, and relatively less for diagnosis of minor illnesses (say, the common cold) or for informational needs (AHRQ Report, 2001; Littlejohns, Wyatt & Garvican, 2003; Nancarrow, 2004; Ortiz & Clancy, 2003).

Electronic Medical Record (EMR) is an entire patient health record in digital form and includes the patient's health history, treatments, medications, diagnoses, allergies, lab results and all other pertinent health information and records (Bates et al., 2003; DesRoches et al., 2008; Häyriinen, Saranto & Nykanen, 2008; Jha et al., 2009; Miller & Sim, 2004). In the United States, most healthcare providers have purchased and implemented EMR systems developed by reputed vendors, while a few have developed and implemented their own EMR systems. According to the United States' government web site (www.healthit.gov), EMR contains the standard medical and clinical data gathered in one provider's office while Electronic Health Record (EHR) goes beyond the data collected in a provider's office and includes a more comprehensive patient history. Thus EHR contains and shares information from all providers involved in a patient's care, and can be created and managed by authorized staff from across more than one healthcare

organization. Considering this, EHR systems may include additional technology to facilitate interoperability and information exchange with a broad range of healthcare providers within the United States and abroad. The terms EMR and EHR have been used interchangeably in both, research literature and practitioner literature (Hillestad et al., 2005). In this dissertation also, the terms are used interchangeably. In addition, the use of the term EMR in this dissertation refers to the implementation of the EMR such as a EMR technology/system. A more elaborate discussion pertaining to EMR will be presented in the next chapter.

In the United States, EMR has gained importance due to the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 which provides incentives to hospitals and doctors for implementation and use of EMR as well as penalties for not implementing and using EMR. This has provided an impetus to the rapid adoption and use of EMR within the United States. The adoption and use of EMR is not limited to the United States however. Due to the advantages offered by EMR with respect to patient management and patient care, EMR is being implemented and used by most countries around the world today, and many more are in the process of implementing EMR (Gummadi et al., 2014; Jha et al., 2009; Menachemi & Collum, 2011; Stanberry, 2011; Vreeman et al., 2016). It is expected that EMR will continue to be implemented by countries around the world for many years to come, and EMR systems that have already been implemented will continue to be improved for many years to come (Gottlieb et al., 2015; Gummadi et al., 2014; Jha et al., 2009; Menachemi & Collum, 2011; Miller & Sim, 2004; Stanberry, 2011; Williams et al., 2015).

According to the Stakeholder Theory (Freeman, 1994), every organization has key stakeholders that affect and are affected by the processes in the organization. In the case of EMR implementation and use, the key stakeholders are the healthcare enablers and providers (doctors,

nurses, information technology staff, facility administrators, other hospital staff such as implementers/users/maintainers of EMR) on one side, and the healthcare receivers (patients) on the other. This study focused on the perspectives of the healthcare enablers and providers.

This study uncovered and ranked a unique set of technology-related factors and organization-related factors associated with successful EMR implementations from the perspective of healthcare enablers and providers. The specific technology-related factors considered in this study were the innovativeness of EMR (measured by considering relative advantage, compatibility and complexity of EMR), privacy and security attributes of EMR, and usefulness of EMR. The specific organization-related factors considered in this study were the organization's readiness for change and the level of innovation (process and product innovation) in the organization where the EMR was implemented. Definitions and related literature are presented in Chapter 2.

Importance of this Study

This section discusses reasons for the importance of this study.

Monetary Considerations Associated with Information Technology/Management Information Systems Projects (specifically EMR Implementations)

Organizations undertake information technology (IT) and management information systems (MIS) projects for a variety of business reasons such as performance improvement, cost reduction, productivity enhancement and improvement of product and process quality (Jha et al., 2009; Schwalbe, 2015; Ward & Peppard 2016). One such project is EMR implementation (Obal & Lin, 2015; Sumner, 2015). When such projects

fail, there is a huge cost to the organization, which exceeds billions of dollars in some cases (Brynjolfsson & Hitt, 2003; Dalcher & Genus, 2003; Kagerman, 2005; Menachemi & Collum, 2011; Sumner, 2015).

Failed IT/MIS projects waste time, money and organizational resources (Brynjolfsson & Hitt, 2003; Dalcher & Genus, 2003; Kagerman, 2005; Menachemi & Collum, 2011; Sumner, 2015). Cost of failed IT/MIS projects have amounted to billions of dollars (Brynjolfsson & Hitt, 2003; Dalcher & Genus, 2003; Kagerman, 2005; Menachemi & Collum, 2011; Sumner, 2015). This is money wasted. Such money could be better utilized by directing it towards projects that give the concerned organization a competitive edge in the highly competitive business world of today. Because this study focused on factors associated with successful EMR implementations, it is expected to help the healthcare industry in reducing or eliminating implementation failures and in achieving successful implementations, which could result in considerable monetary savings. For this reason, this study is important.

Role of Successful EMR Implementations in Creating Benefits for Healthcare Receivers (Patients) and Healthcare Providers

The success of EMR implementations is important because successful EMR implementations create benefits for both healthcare receivers/patients and healthcare enablers/providers such as ease of patient information sharing, enhanced quality of healthcare (due to availability of better patient information) and other similar benefits (Bates et al., 2003; DesRoches et al., 2008; Häyrynen, Saranto & Nykänen, 2008; Jha et

al., 2009; Miller & Sim, 2004). Benefits are discussed in greater detail in a later section of this dissertation.

Successful implementation of EMR is expected to result in providing clinicians more opportunities to deliver higher quality of healthcare (based on facts and evidence i.e. evidence-based healthcare) to the public due to the ability to easily store, analyze, mine and share patient data with multiple healthcare providers and specialists and also with the patients themselves (Frankovich, Longhurst & Sutherland, 2011; Ivbijaro et al., 2015). This study focused on the key factors which will facilitate successful EMR implementations and thereby create benefits for healthcare receivers/patients and healthcare providers, and is therefore important.

Role of Successful EMR Implementations in Creating Benefits for the United States Healthcare Industry

The United States healthcare industry is trying to achieve effectiveness, efficiency and cost reduction in the delivery of healthcare through the use of technology, specifically information technology (Bates et al., 2003; DesRoches et al., 2008; Häyriinen, Saranto & Nykänen, 2008; Hollenbeck et al., 2015; Jha et al., 2009; Miller & Sim, 2004; Shaha, 2015).

The successful implementation and use of modern computer based technology such as EMR is expected to be crucial to healthcare organizations now and in the future to function efficiently and effectively. This will be instrumental in providing high quality healthcare at a reasonable cost to the public (Attaallah et al., 2016; Hollenbeck et al., 2015; Shaha, 2015). This study focused on the factors supporting successful EMR

implementation which can create significant operational benefits for the healthcare industry and is therefore important.

Problems Associated with EMR Implementations

The implementation of EMR around the world has been slow and fraught with problems (Ford et al., 2009; Kaplan & Harris-Salamone, 2009). This situation persists in the United States too despite the monetary incentives provided by the government (Ford et al., 2009; Kaplan & Harris-Salamone, 2009). It is known from research literature that 50% to 95% of IT/MIS projects fail to be implemented successfully and 20-30% of EMR implementations fail within the first year (Palvia, Jacks & Brown, 2015; Sumner, 2015).

It has been predicted that healthcare providers will continue to have issues with healthcare information technology (HIT) implementations in the foreseeable future (Ford et al., 2009; Kaplan & Harris-Salamone, 2009). It has also been predicted that smaller United States healthcare providers will continue to be involved with EMR implementations till as late as the year 2024 (Ford, Menachemi, Peterson, & Huerta, 2009). Surfacing and ranking critical technology-related and organization-related factors will pave way for successful EMR implementations. Based on the predictions in research literature and practitioner literature, the current focus on EMR implementation issues will likely continue for many years to come, which makes this study important.

Contributions of this Study to Research Literature

While the success and failure of IT/MIS implementations in the domains of commerce (e-commerce), manufacturing (e-manufacturing), education (e-education) and other information science/ information technology domains have been researched extensively in research literature, there have been relatively few research studies that considered factors associated with the success and failure of IT/MIS implementations in healthcare, especially with respect to EMR implementations (Häyrinen, Saranto & Nykänen, 2008; Menachemi & Collum, 2011; Thakur, Hsu & Fontenot, 2012). This is a research gap which this study fills, which makes it important.

There is no overarching framework that encompasses all IT/MIS implementations (Alavi & Joachimsthaler, 1992; Kwon & Zmud, 1987), and therefore understanding factors associated with the success of IT/MIS implementations in individual application areas such as healthcare is important. This study attempts to create a framework for successful EMR implementations by uncovering key technology and organizational factors associated with EMR implementations. No other study in the healthcare domain has examined the association of the unique combination of technology-related and organization-related factors which have been considered in this study, on EMR implementation success.

The unique combination of technology-related and organization-related factors considered in this study have been arrived at after an extensive literature review of success/failure factors associated with IT/MIS implementations in related domains such as e-commerce, e-manufacturing and e-education. The factors considered in this study have been most often associated with success/failure of IT/MIS implementations in

related domains such as e-commerce, e-manufacturing and e-education (Agarwal & Prasad, 1997; Amoako-Gyampah, 2007; Häyrynen, Saranto & Nykänen, 2008; Menachemi & Collum, 2011; Teng, Grover & Guttler, 2002; Thakur, Hsu & Fontenot, 2012; Yang et al., 2015). Thus this study makes significant contributions to research literature and is therefore important.

Benefits to Academic Researchers and Industry Practitioners

This study enables academic researchers to gain an understanding of how EMR implementations are similar to and different from technology implementations in related domains (such as IT/MIS implementations in e-commerce, e-manufacturing, e-education). In doing so, it opens up several areas for future research (which are discussed in the last chapter of this dissertation). Additionally, this study is not just relevant to researchers in the United States, but is of value and importance to researchers in all countries around the world.

This study enables industry practitioners to modify their EMR implementations based on its findings so as to achieve successful EMR implementations in the healthcare industry. Achieving successful EMR implementation and minimizing or eliminating EMR implementation failures in the healthcare industry will have significant positive consequences for healthcare providers and healthcare receivers. In summary, this study is of equal importance to the academic researcher and the industry practitioner alike, and for this reason assumes a lot of importance.

Problem Statement

The healthcare system in the United States is very complex, in part due to the various types of healthcare providing institutions and the many insurance establishments involved in providing healthcare, as well as due to the complex laws that cover healthcare schemes such as Medicare and Medicaid (Byrd & Clayton, 2015; Ferlie & Shortell, 2001; Thakur, Hsu & Fontenot, 2012; Trzeciak & Rivers, 2003). The ever-increasing healthcare costs and ever-changing complex laws make delivering high-quality evidence-based healthcare at an affordable cost a perpetual challenge for healthcare providers in the United States (Byrd & Clayton, 2015; Ferlie & Shortell, 2001; Thakur, Hsu & Fontenot, 2012; Trzeciak & Rivers, 2003). It is anticipated that the use of modern health information technologies will alleviate the resource pressures on the healthcare system by leveraging the processing power of the computer and facilitate the delivery of high-quality evidence-based healthcare at an affordable cost to the public (Byrd & Clayton, 2015; Ferlie & Shortell, 2001; Thakur, Hsu & Fontenot, 2012; Trzeciak & Rivers, 2003).

EMR implementation is an important aspect of HIT, perhaps the most important aspect, since it has the potential to directly impact cost reduction and quality improvement in healthcare delivery through: (i) lowering the processing times associated with enormous amounts of patient information within and between hospitals, (ii) enhancing the speed and quality of communications between patients and the healthcare providers, and between healthcare providers and other healthcare providers or specialists that need to be involved in patient care, and (iii) delivering evidence-based high-quality healthcare through collection and mining of patient information using computers (Hillestad et al., 2005; Jardim & Martins, 2016; Sharma et al., 2016). HIT and EMR are eventually expected to contribute to the delivery of high-quality

healthcare to all sections of society at a reasonable cost (Byrd & Clayton, 2015; Ferlie & Shortell, 2001; Jardim & Martins, 2016; Sharma et al., 2016; Thakur, Hsu & Fontenot, 2012; Trzeciak & Rivers, 2003).

Several laws have been enacted in the United States in the interests of the citizens to control and regulate the sharing of private information such as healthcare information and health insurance information pertaining to the public. Prominent among them are the American Recovery and Reinvestment Act (ARRA) of 2009, the HITECH Act of 2009 and the Health Insurance Portability and Accountability Act (HIPAA) of 1996. These laws are explained in detail in a later section of this dissertation. ARRA and the HITECH Act encourage and support the implementation and use of HIT and EMR. The use of HIT and EMR is expected to help healthcare providers be in compliance with the complex and multiple laws pertaining to healthcare (Appari & Johnson, 2010; Helms, Moore & Ahmadi, 2008; Taylor et al., 2014). In addition, investment in HIT and EMR is expected to improve public health management and result in a healthier society overall (Byrd & Clayton, 2015; Ferlie & Shortell, 2001; Jardim & Martins, 2016; Sharma et al., 2016; Thakur, Hsu & Fontenot, 2012; Trzeciak & Rivers, 2003).

As stated earlier, EMR implementation and adoption in the United States has been fraught with problems and has not been as successful as it was expected to be (Ford et al., 2009; Kaplan & Harris-Salamone, 2009). Also as stated earlier, it is expected that healthcare providers will continue to have issues with HIT implementations in the foreseeable future (Kaplan & Harris-Salamone, 2009), and that smaller United States healthcare providers will continue to be involved with EMR implementations till as late as the year 2024 (Ford et al., 2009).

Successful EMR implementations will go a long way in addressing the issues and problems discussed in preceding paragraphs, and therefore it is important that factors associated

with successful EMR implementations be identified and studied. This research study uncovered key technology-related and organization-related factors associated with successful EMR implementations, which will help with the reduction in EMR implementation failures in the future.

Objectives of this Research

The objective of this research was to study whether certain technology-related and organization-related factors that have been most often associated with successful IT/MIS implementations in other domains such as e-commerce, e-manufacturing and e-education (per current research literature) are also associated with successful EMR implementations. Thus this study created a framework for successful EMR implementations. The research model is shown in Figure 1.

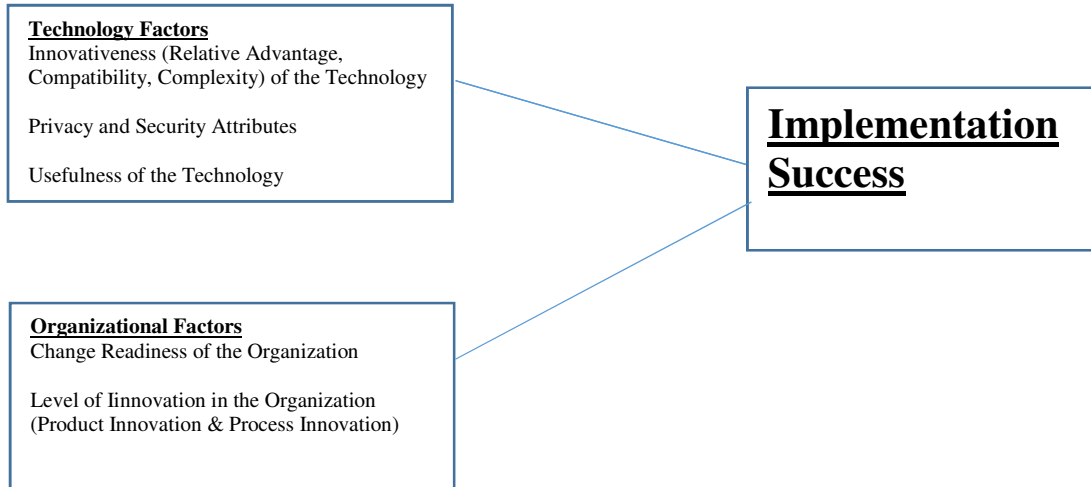


Figure 1. The Research Model

Chapter Summary

EMR implementations in the United States and elsewhere around the world have been fraught with problems and delays, and many EMR implementations have been unsuccessful. While the success and failure of IT/MIS implementations in the domains of commerce (e-commerce), manufacturing (e-manufacturing) and education (e-education) have been presented in research literature, there has been relatively less research pertaining to the factors associated with the success and failure of IT/MIS implementations in healthcare, especially with respect to EMR implementations. This study created a framework for successful EMR implementations by way of uncovering certain key technology and organizational factors associated with successful EMR implementations. Chapter 2 will present a review of research literature pertaining to Electronic Medical Records (EMR), Project Success, Technology-related Factors and Organization-related Factors as well as the hypotheses developed for this study.

CHAPTER 2: LITERATURE REVIEW AND HYPOTHESES

This chapter presents a review of research literature pertaining to Electronic Medical Records (EMR), Project Success, Technology-related Factors and Organization-related Factors. It also presents the hypotheses and the theory/literature review leading to the hypotheses.

Information Technology and Management Information Systems in Healthcare

IT and MIS have traditionally played a significant role in the healthcare industry. They continue to play a significant role in the healthcare industry by empowering the healthcare providers and the healthcare receivers through innovative products and services (Cresswell & Sheikh, 2013; Miriovsky et al., 2012; Smith & Koppel, 2014; Yen & Bakken, 2012). Cresswell and Sheikh (2013) analyzed research literature to showcase how IT is inter-twined with social and organizational factors leading to HIT innovation for both the organization and its individuals. For continued success, they call for a degree of alignment or “fit” amongst these factors and cite several successful HIT implementations that sought to fulfill this goal. Mirovsky et al. (2012) focused on HIT-enabled Comparative Effectiveness Research (CER) and its potential to answer several questions for cancer care discovery and intervention like prevalence and patterns of immunization in near real-time and the ability to advance personalized medicine through rapid-learning healthcare. Yen and Bakken (2012) mapped the IT system development life cycle to a progressive integration of usability framework for a more seamless user-task-system-environment interaction.

There is pressure on the healthcare industry in the United States to deliver high quality healthcare at a reasonable and affordable cost, and this is possible through the use of technology.

As noted earlier, the United States healthcare industry is trying to achieve effectiveness, efficiency and cost reduction in the delivery of healthcare through the use of technology, especially information technology (Bates et al., 2003; DesRoches et al., 2008; Häyrynen, Saranto & Nykänen, 2008; Jha et al., 2009; Miller & Sim, 2004).

One example of IT/MIS use in healthcare industry is a hospital information system (HIS). HIS focuses mainly on the administration needs of hospitals and is a comprehensive, integrated information system designed to manage all the aspects of a hospital's operation including medical, financial, and legal issues, and the corresponding processing of services (Singh & Chaudhary, 2016). Singh and Chaudhary (2016) compiled a list of various software applications involving IT/MIS that have been part of the healthcare industry landscape for several years in the past. Cresswell, Bates and Sheikh (2017) have underscored key considerations for optimization of large-scale healthcare information technologies.

Some studies in research literature have focused on the use of HIT to improve patient care quality outcomes in disease treatment (Hussain et al., 2016; Or, Tao & Wang, 2016; Sadoughi et al., 2016). Or, Tao and Wang (2016) found that the use of healthcare information technology was effective for self-management in patients who had experienced heart failures. They concluded that such use reduced the risk of mortality, lowered the risk of hospitalization and shortened the length of hospital stay. Sadoughi et al. (2016) cite advances such as HIT-enabled diagnosis acceleration and treatment and increase in physician productivity and efficiency gains from improved healthcare workflow via integrated access to patient records as key benefits. Several researchers agree that information technology and management information systems will continue to play a big role in the realm of healthcare for decades to come (Cantiello et al., 2016; Koppel, 2016; Payne et al., 2016; Slight & Bates, 2016).

Technology Change

Technology change and the need to deal with it is a common theme in this day and age. While acknowledging that pressures to secure competitive advantage coupled with technology changes can be problematic unless managed well, Kearns (2004) support management of technology change by allowing prospective users to see the inadequacies of the current system and the benefits of the proposed system. IT changes in healthcare are difficult and require the consideration of a range of technical, social and organizational factors (Cresswell & Sheikh, 2013; Miriovsky et al., 2012; Smith & Koppel, 2014; Yen & Bakken, 2012). Large part of technology change focuses on interactions between the technology and the user in order to find factors that facilitate implementation success (Bano & Zowghi, 2015; Bitner, Ostrom, & Meuter, 2002; Collette et al., 2006; Cooper & Zmud, 1990; Ward & Peppard, 2016). Bano and Zowghi (2015) attempted to explore the relationship between end-user involvement and implementation success through an analysis of research literature spanning three decades. Their study revealed that factors such as early identification of users, degree of user involvement during implementation and the stage of the system development when they become involved all have an impact on this relationship. Bitner, Ostrom and Meuter (2002) studied key factors impacting customer satisfaction of self-service technology implementations. Collette et al. (2006) conducted a longitudinal study during a technology implementation over a five year period at the Geneva police service. The study by Collette et al. (2006) uncovered two key success factors, namely intensive individual interaction and guidance and a solid training program to acclimate users to the technology change early on.

Systems Approach

The defining feature in Information Systems (IS) theory is the Systems Approach, which views the system as more than the sum of its parts. Therefore, in applying the systems approach to technology implementations in healthcare settings, it is necessary to consider the fit between technical (technology-related) and organizational (organization-related) factors and their contribution to implementation success (Bolton & Hannon, 2016; Griffin et al., 2016; Lehman et al., 2016; Unertl, Holden, & Lorenzi, 2016; Venter & Goede, 2016; Wang & Wang, 2016; Werner et al., 2016). Venter and Goede (2016) emphasized the need for a ‘social process’ when developing and implementing software such as business intelligence systems for organizational decision making, performance improvement and competitiveness enhancement. They proposed the use of paradigms such as critical systems thinking (CST) which are derived from systems thinking/ systems approach and social theory, and which combine the concepts of holism and social intervention in order to improve problematic social contexts.

Wang and Wang (2016) highlighted the role of technical factors and organizational factors in implementation success. The technical factors they highlighted were perceived benefits from the technology implementation, its complexity and its compatibility with current work styles and experiences. The organizational factors they highlighted were availability of sufficient resources for implementation, the organization’s readiness to integrate its current infrastructure, expertise and skills, support from senior executives, inherent organizational culture and the competitive pressures of the environment. Werner et al. (2016) focused on how a human factors and ergonomics (HFE) systems approach could be used to improve patient care transition across healthcare settings. By adopting a user-centered work system approach they argued that care transitions could be handled in a more efficient and less expensive manner which holistically

accounted for physical ergonomics, cognitive ergonomics and macro-ergonomics. This research study tested a unique combination of technology-related and organization-related factors for their association with EMR implementation success.

Healthcare Information Technology (HIT)

Healthcare Information Technology is a term used in a broad sense to include technology related to gathering, processing, storing and disseminating healthcare information. Research literature refers to eight major HIT implementations which are as follows: Electronic Health (E-health), Healthcare Information Systems(HIS), Health Informatics (HI), Healthcare Websites, Mobile Health (mHealth), Telemedicine and Electronic Medical Records/Electronic Health Records (EMR/EHR). Since HIT is a relatively new and evolving field, there is a lack of consistency in research and practitioner literature in defining these categories, and overlaps and conflicts in definitions and descriptions are common.

E-health is defined as the use of information and communication technologies (ICT) in healthcare (Blaya, Fraser & Holt, 2010). Abdelhak et al. (2001) defined E-health as the use of emerging information and communication technology, especially the Internet, to enable or improve healthcare. Research literature on E-health is based mostly on process indicators rather than on patient outcomes.

According to Cullen (2002), a Healthcare Information System (HIS) includes and encompasses the management and utilization of large amounts of healthcare-related data, electronic health records, and data mining (with a view to use the results in evidence-based

healthcare practice). HIS is considered a part of providing evidence-based healthcare (Landry et al., 2005; Mahmoud & Rice, 1998).

Health Informatics (HI) is defined as the application of information science methods to analyze and understand healthcare information, and to progress from raw data to knowledge for improved problem solving, decision making and care delivery (Dalrymple, 2011). It is also defined as the science that deals with health information, its structure, acquisition, and uses (Abdelhak et al., 2001).

Healthcare websites provide information relating to diseases and their treatment, medical interventions, medicines and their side effects and other related medical information to the public. Some examples of popular healthcare websites in use today are webmd.com, familydoctor.org, and mayoclinic.com. With the proliferation of computers and the Internet, many patients prefer to get healthcare and disease related information online and see the doctor only for clinical interactions needed in case of serious illnesses (Chyna, 2001; Misra, Mukherjee & Peterson, 2008). This has changed the traditional doctor-patient interaction and encounter paradigms wherein the doctor was like an instructor and a provider of directions and the patient was a relatively passive receptor from whom compliance and obedience were sought (Misra, Mukherjee & Peterson, 2008; Weber, 1999; Wilson, 1994). Misra, Mukherjee and Peterson (2008) explored this paradigm shift by studying the adoption of self-serve virtual communities for healthcare information exchange and support (such as WebMD.com, eHealth.com and MayoHealth) by patients. They put forth a 'consumer value-creation model' based on the different roles assumed by patients, which made the need for a doctor's presence secondary in this mode of information exchange.

Greater patient interest in the use of healthcare websites for information and diagnosis is leading to the development of emotional or hedonic healthcare websites which consider the patient's current emotional state and provide an emotion-improving experience during the human-computer interaction process of obtaining health and disease related information (Allen et al., 1992; Dash, 2000; Huang, 2009; Parthasarathy & Fang, 2013; Picard, 2000; Tuch et al., 2012). Such hedonic experience is obtained through color and imaging, sounds and music, videos, photos, interactive games, chat rooms, real time domain expert interactions, blogs, interactive quizzes and other such features that pique user interest and encourage the user to use healthcare websites. The feedback loop can be active or passive, with the most sophisticated computer and Internet technologies being used for active feedback.

Mobile health (mHealth) is essentially electronic health (E-health) and telemedicine delivered through mobile devices. Therefore it has been nicknamed "pocket healthcare" and "mobile phone healthcare." mHealth is defined by the 'global observatory for E-health' of the World Health Organization (WHO) as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices" (Van Heerden et al., 2012). Curioso and Mechael (2010) elaborated the widespread and increasing emergence of mHealth projects leading to applications that enable data collection, diagnostic and treatment support access, and healthy behaviors by the public. Thirumurthy and Lester (2012) emphasized that mHealth interventions could be applied to a broad range of health related behaviors with a view to improving them, and that rigorous evaluations of small and large interventions could reveal the extent to which mHealth could provide cost effective solutions to public health challenges.

Telemedicine utilizes computer and Internet-based technologies and interfaces for patient interactions with the doctors and nurses (Roh, 2008; Schooley, 1998; Whitten et al., 2010). It is possible for telemedicine to cater to patients in rural areas and in other areas that are not easily accessible. Chau and Hu (2004) contended that the role of the clinical administrator and consensus were critical to success in telemedicine implementations. Patient base and service/facility capacity impact telemedicine utilization. Strode et al. (1999) emphasized the increasing popularity of store-and-forward teleconsultations involving static images (also known as tele-radiology). They also emphasized that clinical effectiveness and cost effectiveness of telemedicine needed to be studied more. Ganapathy and Ravindra (2009, 2008, 2007) found the key issues and challenges in telemedicine implementation were acceptance by patients, physicians and hospital administrators, design of cost-effective hardware and software, provision of appropriate training, and the availability of grants and sufficient funds which would facilitate the extension of telemedicine to rural and suburban areas. One of the continuing challenges to the widespread adoption of telemedicine has been the issue of reimbursement for use and lack of proper guidelines for the same (Bashshur & Lovett, 1977; Estai et al., 2016; Hufferberger, Martin & Hanson, 2016; Sanders & bashshur, 1995). Telemedicine reimbursements have been a problem because insurers consider advice over the phone as insufficient to qualify for medical consultation reimbursement. A related concern has been that the increased use of telemedicine may result in a reduction in the unit price of service, but will not reduce the financial liability of insurers, especially fee-for-service insurers.

Yoo and Dudley (2009) argued that though there was an increasing use of telemedicine and evidence for positive impact of telemedicine in the Intensive Care Unit (ICU), research into defining a conceptual framework of the ICU and how exactly telemedicine positively impacted it

was still inconsistent and unequivocal. They pointed out that “tele-ICU improves care” was not a testable hypothesis and therefore future research must emphasize components of ICU present *before* telemedicine and what was added *after* telemedicine, and use such information to evaluate telemedicine effectiveness in the ICU. Field and Grigsby (2002) stated that telemedicine would continue to evolve slowly but steadily, as research clarified its benefits, limitations and costs.

With the proliferation of HIT, there are concerns about technology-based errors and safety aspects in its use and implementation. Several researchers (Borycki, 2013; Kushniruk et al., 2005; Magrabi et al., 2012) studied technology-induced errors in HIT implementation and use. Borycki (2013) studied technology-induced errors that included slips and mistakes. Slips have been defined as errors “which at some point the user notices and corrects.” An example of this would be an incorrect medication entry that the user amends. Mistakes are errors which are not observed or corrected by the user. For example, the user enters a medication dose thinking it is correct and a default auto-populates the field with another dose. Another example would be a situation wherein more than one patient record is open on the computer screen and the doctor inadvertently enters patient data into the wrong record after being called away from the computer to deal with a patient issue.

Borycki (2013) stated that such errors also included information transfer errors that were occurring on the back end of a system which users may not be aware of. All researchers of technology-based errors in the use and safety of HIT contend that technology induced errors must be identified, mitigated or eliminated as a priority. Borycki (2013) suggested methods such as heuristic evaluation, usability testing, clinical simulations and cognitive walkthroughs that may be used proactively and reactively for safety assurance.

Electronic Medical Records (EMR)

As stated earlier, the terms EMR and EHR have been used interchangeably in both, research literature and practitioner literature (Hillestad et al., 2005) and are used interchangeably in this dissertation also.

EMR implementation is an important aspect of HIT, perhaps the most important aspect, since it has the potential to directly impact cost reduction and quality improvement in healthcare delivery through: (i) lowering the processing times associated with enormous amounts of patient information within and between hospitals, (ii) enhancing the speed and quality of communications between patients and the healthcare providers, and between healthcare providers and other healthcare providers or specialists that need to be involved in patient care, and (iii) delivering evidence-based high-quality healthcare through collection and mining of patient information using computers (Hillestad et al., 2005; Jardim & Martins, 2016; Sharma et al., 2016).

While calling EMR a “silent giant” Stanberry (2011) elaborated on the factors necessary for increased use of EMR such as cost, privacy and laws/regulations, and alluded to United States laws that present challenges to EMR implementation such as anti-kickback laws, anti-referral laws, malpractice exposure laws and privacy regulations. The stated implication was that the laundry list of issues relating to cost, privacy and laws/regulations must be addressed before EMRs can be successfully used to manage and communicate healthcare information. Luchenski et al. (2013) researched the patient and public views on EHR and their uses in the United Kingdom (UK) through a cross-sectional survey administered to patients and members of the public. They found that the use of EHR/EMR was supported in general, but there were

concerns relating to privacy safeguards and lack of awareness regarding secondary uses. Of the 2,857 responses obtained, over 89% favored EHR use for personal healthcare with over 66% preferring that their complete medical history should be included in the record. About 62% supported the use of EHRs for secondary purposes such as planning, policy and health research. Older participants were less favorable towards EHRs than the younger demographic. Patients had concerns relating to privacy safeguards for secondary use of EMR/EHR, but responded that they would be amenable if specific criteria to ensure privacy were met.

Miller and Sim (2004) pointed to the barriers and solutions pertaining to the use of EMR by physicians. They conducted over ninety interviews across healthcare organizations of diverse sizes, durations and types of EMRs used. They identified common barriers like high up-front financial costs, slow payoffs that were often uncertain, mandatory workflow changes and physician's attitudes. The difficulties identified relating to the use of the technology included poor usability features, need to customize vendor products and lack of electronic data exchange with other complementary technology systems. They proposed solutions such as the establishment of community-wide data exchanges, improved "pay-for-performance" rewards for physicians and demonstrations and evaluations which would encourage physicians to adopt EMRs.

Wang et al. (2003) provided an in-depth cost-benefit analysis of the net financial benefit and cost of implementing EMR in primary care. They used EMR data collected at Partners HealthCare System in an ambulatory-care setting along with published studies and expert opinions for their research. They concluded that the estimated net benefit from using EMRs for a 5-year period would be around \$86,400 per provider. Over this time, savings would also accrue from drug expenses, efficient use of radiology tests, improved quality of data relating to medical

payments and reduced billing errors. While the magnitude of these returns would depend on several factors including capitated patients and discount rates, EMR implementation in a primary care setting could result in a positive financial return on investment.

EMRs are finding widespread use in diverse areas of healthcare. Perera et al. (2011) elaborated upon how patients and doctors balance the perceived benefits and harms of sharing electronic health data from EMRs for patient care and secondary purposes. As part of their study, 511 patients and 46 physicians at St. Joseph's hospital in Ontario, Canada were administered the Health Information Privacy Questionnaire (HIPQ) before and after an extended use of EMRs for a period of over six months. Analysis of survey results showed that more than 90% of physicians and patients supported the sharing of digital patient records among healthcare professionals while less than 70% agreed on the sharing of de-identified information outside of the healthcare circles. 58% of patients and 70% of the physicians believed that benefits of computerization outweighed the risks of loss of confidentiality while a smaller percentage of them supported the notion that computerized records were more private than paper records. The researchers concluded that further discussion on 'reasonable' levels of secondary use and information sharing were required in the current era of unprecedented data communication and data exchange involving EMRs.

Kho et al. (2011) studied the use of EMRs in genetic research. They analyzed data collected from EMRs and Genomic Networks (eMERGE) study sites to identify disease phenotypes like dementia, cataracts and type 2 diabetes. By leveraging Natural Language Processing (NLP) techniques, their study was able to identify phenotypes with positive predictive values ranging from 73 to 98%. They argued that efforts to increase implementation of

interoperable EMRs would significantly improve such secondary uses of EMR data which in turn would have benefits for public health.

Wilke et al. (2011) studied the use of EMRs in pharmacogenomics. They surveyed current efforts to examine EMRs for adverse drug reactions and for extracting drug efficacy in subjects exposed to certain drugs. This was done in an effort to highlight advances in pharmacogenomics through retrospective assessments of EMRs, for discovering associations in observational cohorts and for enabling real-time drug decision support.

Perlis et al. (2012) elaborated upon the potential benefits of using EMRs in the field of Psychiatry, especially in the treatment of depression. They applied NLP techniques on the Partners HealthCare EMR data from 127,504 patients, to examine outcomes of antidepressant treatment in major depressive psychiatric disorders. Their results showed that incorporating NLP increased the probability of predicting psychiatric disorders emphasizing the importance of yet another secondary use of EMR data.

Considering the benefits and applications of EMR in various areas of medicine to improve patient care and the quality of healthcare, it may be argued that successful EMR implementation will be an important consideration for the healthcare industry now and in the future because EMRs are apparently an important and integral part of the current and future healthcare scenario (Florman, 2015; Holroyd-Leduc et al., 2011; Klompas et al., 2012; Lau et al., 2012; Loo et al., 2011; Taylor et al., 2014).

Laws Governing EMR/EHRs in the United States

Several laws govern the implementation and use of EMR/EHR in the United States. The American Recovery and Reinvestment Act (ARRA) of 2009 was enacted as an economic stimulus bill. The rationale for ARRA was based on theories of Economics which argue that in times of recession, the decrease in private sector spending should be offset by an increase in public spending to create and save jobs and to prevent further economic deterioration. In support of ARRA, billions of dollars were allocated by the government for various activities including investments needed to increase economic efficiency by spurring technological advances in healthcare. For instance, \$25 billion were allocated for HIT investments and incentive payments.

The Health Information Technology for Economic and Clinical Health (HITECH) Act was signed into law as part of ARRA in February 2009. The primary goal of the HITECH Act was to stimulate the adoption of EMR/EHR and technology that supports EMR/EHR. The HITECH Act is perceived to be an important part of healthcare reform in the United States. According to the HITECH Act, healthcare providers would be offered financial incentives for demonstrating “meaningful use” of EMR/EHR till the year 2015, after which time penalties would be levied for failing to demonstrate such use. The amount of incentives provided for implementation and use of EMR/EHR was on a declining scale system whereby early adopters were offered more incentives than late adopters. In addition, the act required that the guidelines for meaningful use of EMR/EHR be implemented in three stages, with providers needing to demonstrate two years in a row in each stage before moving to the next one.

The Office of the National Coordinator (ONC) for HIT was established as part of the Department of Health and Human Services. The HITECH Act gave ONC the authority to set and manage standards for the stimulus programs. The meaningful use requirements include an ONC-

Certified EMR/EHR Technology (CEHRT) use requirement. As part of this requirement, ONC writes certification rules that EMR/EHR vendors must apply to their medical records software in order for their customers to receive incentives.

The Health Insurance Portability and Accountability (HIPAA) Act of 1996 was a legislation intended to establish data security and privacy provisions for safeguarding the medical information of the public. HIPAA regulates the use and disclosure of the so-called Protected Health Information (PHI). Part of HIPAA is the security rule that deals specifically with Electronic Protected Health Information (EPHI). An important digital update to this act called the “Omnibus Rule” was enacted in 2013. The Omnibus Rule is based on the developments in HIT, and allows for modification of HIPAA rules to implement statutory amendments under the HITECH Act. Though HIPAA and HITECH Acts are separate acts with different primary goals, they reinforce each other in some ways. For instance, the HITECH Act stipulates that any technologies and standards created under this act shall not contradict the data security and privacy provisions stipulated by HIPAA. Similarly, it also stipulates that hospitals and physician clinics that attest to meaningful use must have performed the HIPAA security assessment specified in the Omnibus Rule.

While EMR/EHR implementation is required by certain laws, it is also expected that implementation of EMR/EHR will help and support the process of being compliant with all healthcare related laws in the United States.

Benefits of EMR/EHR Implementation

Academic/research literature and practitioner literature presents several benefits associated with EMR implementations.

Perhaps the most important benefit of EMR/EHR implementation is the ability to deliver high quality healthcare at an expected relatively lower cost in the long run along with improved data availability and enhanced patient communication (Bates et al., 2003; Gummadi et al., 2014; Middleton et al., 2013; Stanberry, 2011; White & Danis, 2013, Woods et al., 2013). Stanberry (2011) estimates that the Medicare system in the United States would attain over \$20 billion of potential savings per year and private payers would attain over \$30 billion of potential savings per year with the implementation and use of EMR. Bates et al. (2003) refer to substantial benefits realizable through routine use of EMR including improved quality, safety and efficiency of healthcare. They refer to a paper by the National Alliance for Primary-Care Informatics which argues that the information and decision support needs of patients and providers of this day and age can be satisfied only through the use of EMR. DesRoches et al. (2008) found that hospitals with EMR had better performance relative to those without with respect to prevention of surgical complications, reduced length of hospital stay for specific illnesses, and comparable inpatient costs, and marginally better performance with respect to the hospital alliance quality metrics.

Menachemi and Collum (2011) emphasize the potential benefits of EMR such as clinical outcomes (improved quality, reduced medical errors), organizational outcomes (financial and operational benefits), and societal outcomes (for example, improved ability to conduct research, improved population health, reduced costs). Häyriinen, Saranto and Nykänen (2008) point to studies that indicate that use of an information system was conducive to more complete documentation by healthcare professionals and documentation that includes more data in

addition. In the light of research by Murff et al. (2011) with respect to the application of natural-language processing to electronic data to help clinicians track adverse events after surgery, Jha (2009) underscored the significance of EMR in its ability to transform healthcare delivery.

Miller and Sim (2004) emphasize the ability of physicians to pursue more powerful quality improvement programs through the use of EMR than would be possible with paper based records. Middleton et al. (2013) elaborate on the recommendations of the American Medical Informatics Association (AMIA) about the impact of usability on the effective use of health IT, which could lead to safer and higher quality healthcare with the adoption of the 'useable electronic health record'. Several researchers have underscored the benefits of and issues with the transportability of patient information (Dos Reis et al., 2014; Radhakrishna et al., 2014; Stanberry, 2011; Vreeman et al., 2016; Walker et al., 2014).

Reduction of medication errors, diagnosis errors and procedural errors in the treatment of patients due to the use of EMR has been researched extensively and the related benefits have been talked about in research literature (Dalal & Schnipper, 2016; Goo, Huang & Koo, 2015; Jha & Provonost, 2016; Moja et al., 2016; Murphy et al., 2014; Phansalkar et al., 2013; Singh et al., 2013). Improved work flow and patient flow in healthcare organizations is a benefit of EMR/EHR implementation that many researchers agree with (Fleming et al., 2014; Laird-Maddox, Mitchell, & Hoffman, 2014; Liu et al., 2013; Patterson et al., 2015; Reddy & Jack, 2014; Silow-Carroll, Edwards & Rodin, 2012). Patients of today are more invested in their own health and it has become easier for doctors and nurses to help patients manage their own healthcare through the use of EMR/EHR (Jacelon, Gibbs & Ridgway, 2016; Lee et al., 2016; Wolff et al., 2016). Other potential benefits of EMR/EHR identified in research literature and practitioner literature include improved record keeping, possible reduction in malpractice

exposure, serving as a barometer of patient health and public health, serving as seamless records for transfer patients and second opinions in cases of serious illnesses, being valuable tools for health education, and being a medium that helps to develop holistic healthcare solutions (Ballaro & Washington, 2016; Miller & Tucker, 2016; Nazi et al., 2016; Stanberry, 2011; Yang & Asan, 2016).

Barriers to Successful EMR/EHR Implementation/Use

Possible barriers to successful EMR implementation have been alluded to in research and practitioner literature.

Stanberry (2011) points to the complex laws in the United States including paper-era state regulations, anti-kickback laws, and privacy and data security laws as potential obstacles to the successful implementation and use of EMR. Luchenski et al. (2012, 2013) emphasize the need to understand public perceptions of data security and data privacy in the context of healthcare data and use such perceptions to influence healthcare policy in order to remove barriers and facilitate successful EMR implementations.

Miller and Sim (2004) highlight several barriers to successful EMR implementations. The first barrier is technology-related. Some healthcare practitioners may find the technology to be complicated to use, in part due to the multiplicity of screens and navigation aids. Related to this is the second barrier of excessive time demands placed on the healthcare practitioners due to the need to enter information into screens and the need to find more efficient ways to use EMR. Other possible and related barriers are the need to customize patient specific and disease specific forms and redesigning work flows and process flows. Barriers such as lack of incentives,

workflow disruptions, negative office culture and negative staff attitudes may be potential organization-related factors that impede successful EMR implementations (DesRoches et al., 2008; Decker, Jamoom & Sisk, 2012; McGinn et al., 2011; Mennemeyer et al., 2015; Miller & Sim, 2004; Wallach, 2015).

Interoperability or rather the lack of it, which impacts the sharing of information through EMR/EHR could be a barrier to successful implementation (Jawhari et al., 2016; Kuziemyky & Peyton, 2016; McGinn et al., 2011). There is an immediate need, especially in the United States, to integrate existing technical standards with evolving healthcare processes in a manner as to promote interoperability (Graber, Johnston & Bailey, 2016; Padgham, Edmunds & Holve, 2016). Removing the barriers to successful EMR/EHR implementation will be an important consideration for the healthcare industry (Florman, 2015; Holroyd-Leduc et al., 2011; Klompas et al., 2012; Lau et al., 2012; Loo et al., 2011; Taylor et al., 2014).

Project Failure and Success

The failure of information technology (IT) /management information systems (MIS) project implementations is a topic that has been studied extensively in research literature (especially in the domains of commerce, manufacturing and education) because such failures cost a significant amount of time, money and resources to the organizations involved (Collerette et al., 2006; Ginzberg, 1981; Harper & Utley, 2001; Schneider & Sarker, 2005). Collerette et al. (2006) in their study cited factors like ineffective management of people issues and inefficient organizational processes surrounding the technology change as leading factors associated with failed implementations. Harper and Utley (2001) explored organizational factors behind the drop in productivity from new IT initiatives. They conducted a 3-year study of 18 companies of

various sizes involved in government and commercial ventures that were in the process of implementing IT change. They identified cultural attributes like rigid rules for employees, adherence to lines of authority, and a track record of being too careful and too predictable as the drivers for IT implementation failures. Interestingly, early research studies have focused more on the reasons for project failure rather than on the reasons for project success (Avots, 1969; Balachandra & Raelin, 1984).

Many IT/MIS implementations fail because they are cut short before they are completed for reasons related to financial support, organizational support or technology support (Cecez-Kecmanovic, Kautz & Abrahall, 2014; Drummond & Hodgson, 2003; Marchewka, 2014; Olson, 2014; Schneider & Sarker, 2005). Drummond and Hodgson (2003) pointed to the tracking of IT implementation failures for over a decade by the Standish Group, in which a survey of over 280,000 IT projects in companies of varying sizes revealed that 23% were cancelled before completion due to being deemed out of control. They posit that many such projects are never reported. Marchewka (2004) highlighted the Federal Bureau of Investigation's (FBI) Virtual Case File initiative that was abandoned five years into implementation, costing \$170 Million of tax payer funds. The FBI contracted Science Applications International Corp. (SAIC) to develop the system software. The project was divided into three phases, each mired with signs of failure including poor documentation of current-state infrastructure, lack of strategized and prioritized requirements, scope creep without adequate change control mechanisms, missing redundancy plans and procedures, mismatched employee skills, lack of a formal transition plan when key stakeholders departed the project and growing mistrust between the FBI and contracted vendor. In April 2005, the FBI officially terminated the project and announced it would develop a new system from scratch.

Schneider and Sarker (2005) documented a case study involving a large public university in the northwestern part of the United States which aimed at developing a modern maintenance management system to consolidate its legacy platforms. While the IT staff were careful to avoid typical pitfalls, their vendor selection process was riddled with inconsistencies ranging from lack of documented critical non-functional requirements to lack of clarity in identifying decision makers with respect to the vendor selection process. The executive committee selected a vendor without seeking inputs from the IT department. This vendor did not meet key requirements, which caused strife amongst key stakeholders and led to one of the vendors not selected filing an appeal with the state's department of information services. The project was ultimately cancelled citing procedural errors and resulted in wasted money and resources.

Other IT/MIS implementation fail when they are completed with partial functionality which may not match the intended purpose of the project/application (Cecez-Kecmanovic, Kautz & Abrahall, 2014; Drummond & Hodgson, 2003; Marchewka, 2014; Olson, 2014). In all such cases, the sponsoring organization is robbed of the full benefits of the IT/MIS implementation project after having spent valuable time, money and human resources on the implementation. Hence it is important to understand the reasons associated with failed implementations of IT/MIS projects and also understand what would have made such project implementations successful.

A few studies have highlighted project success factors (Belassi & Tukel, 1996; Chow & Cao, 2008; Cooke-Davies, 2002; Fortune & White, 2006). Fortune and White (2006) conducted an expansive literature review to cite critical factors associated with IT implementation successes. These included support from senior management, establishment of realistic objectives early in the project, a detailed plan kept up-to-date, suitably qualified staff, an effective change

management system, strong leadership to champion the cause of the project and an effective risk management strategy with monitoring and control mechanisms.

Morris and Hough (1997) have listed technology uncertainty, innovation and dealing with problems related to the implementation as some of the critical success factors related to projects. Pinto and Slevin (1989) have identified, among others, technical tasks, top management support, communication, and monitoring and feedback as factors associated with project successes. Belassi and Tukel (1996) have grouped project success factors rather than identify them individually. Some of these groupings are factors related to the external environment (such as the technology environment), factors related to the organization (such as top management support), factors related to the project itself (such as uniqueness, size and value) and factors related to the team members (such as technical background and commitment).

Unfortunately, there is no overarching framework in research literature that encompasses all IT/MIS implementations (Allavi & Joachimsthaler, 1992; Kwon & Zmud, 1987; Pellegrinelli, Murray-Webster & Turner, 2015; Schwalbe, 2015). Given the inherent variation in types of information systems such as management information systems (MIS), transaction processing systems (TPS) and decision support systems (DSS), Alavi and Joachimsthaler (1992) posited that each leads to a different utilization pattern that further inhibits the creation of a common framework. Beyond the nature of such systems themselves, the notion of injecting strategic organizational change within the constructs of portfolios, programs and projects creates further nuances (Pellegrinelli, Murray-Webster & Turner, 2015).

The above presentation should clarify the importance of uncovering and understanding the factors associated with IT/MIS project implementation success in various application areas such as healthcare, business and manufacturing.

Role of Organization-Related Factors in New Technology Implementations

Factors related to the organization have been shown to have an association with the successful implementation of new technologies, technological processes and technology modules (Clegg et al., 1997; Cooper & Zmud, 1990; Damanpour, 1987; Edmondson, Bohmer & Pisano, 2001; Park, Ribiere & Schulte Jr., 2004; Premkumar & Ramamurthy, 1995). Especially with respect to new technology implementations, research studies have emphasized the importance of organization-related factors in successful technology implementations (Grant, 2016; Hung et al., 2016; Lehmann et al., 2016; Prajogo, 2016; Wang & Wang, 2016; Wang et al., 2016). Dezdar and Ainin (2012, 2011) examined specific organizational factors (such as top management support, training and education, enterprise-wide communication) for their association with enterprise resource planning system implementations and found evidence of such association. A few studies have emphasized the significance of organization-related factors in technology implementations in healthcare settings (Cresswell & Sheikh, 2013; Dezdar & Ainin, 2012, 2011; Gagnon et al., 2016; Kok, Basoglu & Daim, 2016; Ramsey et al., 2016).

A key organization-related factor known to be associated with new technology implementations is resistance to change. Resistance to change must be identified, considered and addressed for technology implementations to be successful (Ali et al., 2016; Davis & Songer, 2008; Frohlich, 2002; Fabry & Higgs, 1997; Keen, 1981; Laumer et al., 2016; McMaster et al., 2016; Newstrom & Davis, 1986; Oreg, 2003; Vakola, Tsaousis & Nikolaou, 2004). In studies relating to successful implementation of new technologies (such as Total Quality Management or TQM), Shea and Howell (1998), and Weeks et al. (1995) found organizational readiness for change to be an important factor. Other studies have stressed the important of organizational

readiness for change in successful technology implementations (Caldwell et al., 2008; Haffar et al., 2016; Wandersman, 2016; Wiegmann, 2016).

Size of the organization may play a role in successful implementation of new technologies such as EMR. Relatively smaller organizations suffer from a constraint referred to as ‘resource poverty’ which includes financial constraints, time constraints and expertise constraints (Welsh & White, 1981). Studies have emphasized the possibility that organizations that are relatively smaller in size may not have enough resources at their disposal to successfully implement new technologies (Boonstra & Broekhuis, 2010; Leal-Rodríguez et al., 2015; Nwankpa, 2015; Raymond, 1985). The size of a healthcare organization is commonly measured by the number of beds (Hung et al., 2010; Watcharasriroj & Tang, 2004). Healthcare organizations of a relatively larger size/more beds have more resources and to that extent, have an advantage over smaller healthcare organizations when it comes to implementing innovations and/or new technologies (Dewar & Dutton, 1986; Goldstein et al., 2002; Goldstein & Schweikhart, 2002; Hung et al., 2010; Watcharasriroj & Tang, 2004).

Other organization-related factors associated with the successful implementations of innovations/newer technologies in research studies are top management support, innovativeness of the organization in terms of higher levels of product and process innovation in the organization, user training and support, user involvement in design, evidence that a new technology/innovation does not increase physical/cognitive workload and attitude of colleagues towards the new technology/innovation (Bhupendra & Sangle, 2015; Caldwell et al., 2008; Gagnon et al., 2016; Ju, Li & Lee, 2006; Karami et al., 2015).

Hypotheses Development and Related Theory

The foregoing section presented a literature review of relevant technology-related and organization-related factors in general. This section discusses the development of the hypotheses related to this dissertation by presenting relevant theory from research literature pertaining to the specific factors considered in this study.

Technology-Related Factors

Technology-related factors most often associated in research literature with successful IT/MIS implementations are innovativeness of the technology (Al-Jabri Sohail, 2012; Bunker, Kautz & Nguyen, 2007; Wei, 2012; Yang & Cipolla, 2007), privacy and security attributes (Alexander, 2001; Johnston & Warkentin, 2008; Jones & Kochtanek, 2004; Lippert & Swiercz, 2007; Miller & Tucker, 2009; Mubarak, Zyngier, & Hodkinson, 2013), and usefulness of the technology (Jahangir & Begum, 2007; Lang, 2001; Ramamurthy, Premkumar & Crumm, 1999; Ramayah & Lo, 2007). Hence these are the technology-related factors considered in this study.

Innovativeness of Technology

Several different definitions of innovations and innovativeness exist in research literature. An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption (Rogers, 1962). One appropriate definition of innovation in the context of this study is “implementation of best demonstrated practices to ensure safety and best outcomes for patients and to improve the performance of the organization” (Thakur, Hsu & Fontenot, 2012). EMR is considered to be a technology innovation in the realm of healthcare (Crane & Crane, 2006;

Dansky et al., 1998; Lee et al., 2016; Lee, 2000). The most popular theory that has been used by researchers to study the innovativeness of technology and the successful implementation/use of IT innovations in organizations (especially with respect to e-commerce and e-business implementations) is 'Roger's Diffusion of Innovation Theory' (Agarwal & Prasad, 1997; Brancheau & Wetherbe, 1990; Moore & Benbasat, 1991; Mustonen-Ollila & Lyytinen, 2003). This theory is therefore discussed in more detail in the next section.

Roger's Diffusion of Innovation Theory

According to Roger's Diffusion of Innovation Theory (Rogers, 1962), five characteristics of innovations impact their rate of diffusion. These five characteristics are: Relative Advantage, Complexity, Compatibility, Observability and Trialability. Diffusion is the process by which an innovation is adopted and communicated to members of a social group over time (Rogers, 1962).

Relative advantage refers to the increased benefits and advantages in terms of the outputs brought about by the implementation of the innovation, in comparison to outputs from the technology or system that was in place prior to the implementation of the innovation. Expressed differently, relative advantage is the perception of an innovation being better than the idea/process/system that was in place before it. Complexity is the degree of perception about the difficulty of use of an innovation. It speaks to the relative difficulty (or the lack of it) in using the innovation under consideration in comparison to its predecessor system or technology, to achieve similar results. Compatibility refers to how consistent an innovation is with the existing systems and technologies in the organization (more compatibility leads to easier integration with existing technologies). Compatibility could also refer to consistency with existing process/practices, past experiences/processes and needs of potential adopters. Observability refers to the ease which the innovation under consideration affords to its end users to observe its outputs and merits and

compare them to those with the predecessor system or predecessor technology. In other words, observability refers to how easily the results from using an innovation are apparent to potential adopters and also how easily such results may be communicated to others. Trialability refers to the ease and ability of the innovation to lend itself to testing by potential adopters. Trialability allows for an innovation to be tried by potential adopters to gauge its suitability for use under their own conditions of use, and may help to dispel uncertainty about it in users' minds.

Applications of Roger's Diffusion of Innovation Theory

Research studies have applied Roger's theory to new technology adaptations/diffusions in various domains. Many studies in research literature have considered only some of Roger's factors (and not all of them) while other studies have considered all of Roger's factors, but found statistically significant associations for only some factors and not others. Grgurović (2014) used the diffusion of innovation theory and five of Roger's factors to research and explain how the implementation of online learning in a computer lab impacted the process of blended learning in addition to face-to-face classroom learning. The study found the innovation to be beneficial because it saved the teacher considerable time in certain aspects and provided individualized feedback to the students, thus providing a relative advantage compared to the system that was in place before it. The innovation was compatible with the teachers' needs. It could be tested through self-exploration or in training workshops thereby lending itself to trialability, and its use could be observed by colleagues easily and therefore providing observability.

Ahmad et al. (2014) used the diffusion of innovation theory to examine the determinants of e-commerce adoption among small and medium sized enterprises in Malaysia by considering three of Roger's factors, namely relative advantage, compatibility and complexity. They found that the adoption of an innovation was associated with its perceived relative advantage and

perceived compatibility, with both being statistically significant elements. However, perceived complexity did not associate with e-commerce adoption. Emani et al. (2012) studied patient perceptions about electronic patient health records (PHR) adoption using Roger's theory. They found relative advantage and ease of use to have a statistically significant association with perceptions of PHR use. Hsbollah and Idris (2009) studied the adoption of e-learning as a teaching tool using Roger's theory. They found support for relative advantage, trialability and academic specialization in understanding the adoption decision. Moore and Benbasat (1991) developed an instrument designed to measure the various perceptions that an individual may have of adopting an information technology innovation, using Roger's factors.

Agarwal and Prasad (1997) contended that it is important to consider the technology at hand before assigning factors because not all perceptions may apply well to all technologies. They considered relative advantage, compatibility, observability and trialability in their research study involving the adoption of an innovation in the context of the world-wide web. They found relative advantage to be overwhelmingly important to user acceptance, while compatibility and trialability were found to be important for initial use. Iacovu, Benbasat and Dexter (1995) referred to the extensive use of the diffusion of innovation theory in research literature to identify attributes of an innovation that influence its adoption. They found that the most commonly investigated electronic data interchange (EDI) characteristics that promote the adoption of the technology are relative advantage, compatibility and trialability. They point out that relative advantage is the most cited in research literature for EDI adoption. They also identified technology complexity as an inhibitor to EDI adoption. Al-Jabiri and Sohail (2012) studied mobile banking adoption/implementation using Roger's theory, and found that relative advantage, compatibility and observability had significant associations with the outcomes while

trialability and complexity did not appear to have a significant effect. They attribute this to a majority of survey respondents being in the 18-25 years demographic and having grown up with a good foundational knowledge of using this technology.

A study by Lin (2011, 2008, 2006) found that perceived relative advantage, ease of use, compatibility, competence and integrity significantly influence attitude, which in turn leads to behavioral intention to adopt or continue to use mobile banking. Lee et al. (2011) tested a research model that meshed Roger's innovation attributes with the Technology Acceptance Model (TAM). Results showed that the effects of relative advantage, compatibility, trialability and complexity on perceived usefulness were significant. Other studies by various researchers have asserted that relative advantage is the most significant factor associated with the adoption of technology innovations (Kendall et al., 2001; Mehtens et al., 2001; Poon & Swatman, 1999; Premkumar & Roberts, 1999). Kendall et al. (2001) applied Roger's model to study the receptivity of small and medium sized enterprises (SME) in Singapore to the adoption of e-commerce. Their findings indicated that relative advantage followed by compatibility were important factors associated with successful adoption and implementation. Mehtens et al. conducted a similar study involving the adoption of Internet and e-commerce by SMEs in New Zealand. Their study concluded that the relative advantage afforded by the technology over traditional methods of conducting business was the most important factor that influenced adoption.

Yet another study involving the motivation of small business in Australia to adopt Internet technologies found that relative advantage including cost savings and productivity gains outweighed other factors (Poon & Swatman, 1999). Premkumar and Roberts (1999) investigated factors influencing the adoption of Internet based technologies by rural small businesses in the

United States. They found awareness of the technology and its relative advantage were the primary drivers for adoption and use. Kwon and Zmud (1987) underscored the association of multiple contextual factors on technology implementation stages including the impact of complexity. Tornatzky and Klein (1982) have shown that there is a negative relationship between the complexity of technology and its successful implementation.

Of the five Roger's factors, various research studies have found different sets of factors to have significant associations with the outcomes. However, most research studies have agreed on the significance for relative advantage, compatibility and complexity (Agarwal & Prasad, 1997; Iacovou, Benbasat, & Dexter, 1995; Teng, Grover, & Guttler, 2002; Tornatzky & Klein, 1982; Wu & Wang, 2005). This study will consider whether the same is true for EMR implementations.

Based on the above discussion, the following hypotheses were developed for this study:

- **H1a:** *With respect to innovativeness of EMR, relative advantage will positively correlate with EMR implementation success.*
- **H1b:** *With respect to innovativeness of EMR, compatibility (with existing technologies) will positively correlate with EMR implementation success.*
- **H1c:** *With respect to innovativeness of EMR, complexity will correlate negatively with EMR implementation success.*

Privacy and Security Attributes

Data security refers to how securely the data is stored and maintained by the technology under consideration in terms of the data being accessible to authorized users only while being inaccessible to those who may misuse it, and how such data storage/maintenance facilitates legal and statutory compliance (Boyle & Panko, 2014; Gaikwad & Raut, 2014; Joshi, 2014; Shah, Desai & Vashi, 2014). Data privacy has to do with the sharing and dissemination of data on a need-to-know basis to those who are authorized to receive such data and guaranteed not to misuse it, with a view to preserving the anonymity of all the individuals to whom the data pertains to in the most appropriate and effective manner (Garcia-Alfaro et al., 2014; Greenbaum, Harmanci, & Gerstein, 2014; Wu et al., 2014; Yu et al., 2014).

Several research studies have focused on the relevance and importance of data security and privacy perceptions in technology applications. Gritzalis (1998) found information security perceptions to be a key issue in healthcare information systems adoption and use and contended that most aspects concerning information security became of considerable or even critical importance when handling healthcare information. Gritzalis (1997) pointed out the importance of identifying and analyzing the generic security characteristics of a healthcare information system. Frenzel (2003) elaborated on the importance of addressing data security issues and perceptions arising out of integration of wireless access into healthcare networks. Vaast (2007) considered the social representations of information systems security of different communities working in a healthcare organization and addressed the question of perception of information systems security as socially constructed depending on how people make sense of their context of work.

Appari and Johnson (2010), while underscoring the importance of data privacy and data security in the healthcare sector, presented a review of research literature pertaining to data

privacy and data security perceptions in healthcare applications. Reidenberg (2000) explored the divergences in approach and substance of data privacy perceptions between Europe and the US, and underscored the importance and resolution of conflicting international data privacy rules in cyberspace. Wilkowska and Ziefle (2012) studied the role of perceptions of data security and data privacy in the adoption and use of medical assistive technologies in e-health. They found various aspects of data security and data privacy to be important to respondents in good health and respondents in poor health. In addition, they found that women attached a relatively higher importance to perceptions of data security and data privacy in comparison to men.

Research studies have discussed the wide scope of data security and privacy perceptions and concerns pertaining to HIT implementations including external security (security from external intrusions), internal security (security from unauthorized users) and disaster planning/recovery (DesRoches et al., 2008; MacKinnon & Wasserman, 2009; McGinn et al., 2011; Palvia et al., 2015). Tentori, Favella and Rodriguez (2006), while accepting the fact that hospitals were convenient settings for the deployment of pervasive computing technologies, talked about how autonomous agents could help developers design privacy-aware systems that handled threats raised by pervasive technology thereby addressing privacy perceptions. Zhang and Liu (2010) acknowledged the increasing use of cloud services in healthcare and data security and privacy issues arising therefrom, and pointed to important concepts relating to the sharing and integration of EHRs in “healthcare clouds” and security and privacy issues and perceptions pertaining to the access and management of EHRs. Al-Ameen, Liu and Kwak (2012) emphasized the highly private nature of healthcare records and elaborated on security and privacy issues and perceptions in wireless sensor networks for healthcare applications. With a focus on the

regulation text of HIPAA, Breaux and Antón (2008) analyzed regulatory rules for privacy and security requirements and emphasized those that impact privacy and security perceptions.

An attribute is a quality, feature or a characteristic by definition. Research studies have regarded data security and privacy attributes of information technologies and their impact on users' perceptions about the technologies as important considerations in successful implementations (Bansal & Chen, 2011; Fujinoki, Chelmecki, & Henry, 2014; Kassim & Abdullah, 2010; McCole, Ramsey, & Williams, 2010; Yang et al., 2015). A key reason for the presence and perceptions of data security and privacy attributes being important considerations in IT/MIS implementations is compliance with laws in the United States and around the world which have been enacted to safeguard the privacy and security of the health information of the public (Appari & Johnson, 2010; Hiller et al., 2011; Pitre & Malone, 2011; Yang et al., 2015). The attributes of data security and privacy in a technology/system under consideration creates trust in the users' minds with respect to using such technology/system which leads to better perception of data security and privacy (Hartono et al., 2014; Kim, Chung & Lee, 2011; Menachemi & Collum, 2011; Shin, 2010). This study considers the perceptions of data security and data privacy with respect to EMR implementation, maintenance and use as it relates to EMR implementation success.

Based on the above discussion, the following hypotheses were developed for this study:

- **H2a: *Higher perceptions of data security of EMR will positively correlate with EMR implementation success.***

- **H2b: Higher perceptions of data privacy of EMR will positively correlate with EMR implementation success.**

Usefulness of the Technology

Usefulness of a technology in terms of benefits anticipated from it plays a major role in the successful implementation and adoption of the technology (Benbasat, Bergeron & Dexter, 1993; Gilbert, Balestrini & Littleboy, 2004; Iacovou, Benbasat and Dexter 1995; Pfeiffer, 1992; Thong, 1999). A technology perceived to have significant potential benefits is more likely to be perceived by potential organizational users as being useful and is more likely to gain organizational resources needed to implement it (Benbasat, Bergeron & Dexter, 1993; Gilbert, Balestrini & Littleboy, 2004; Iacovou, Benbasat and Dexter 1995; Pfeiffer, 1992; Thong, 1999). Research pertaining to the adoption and continued use of e-commerce, e-business and e-manufacturing technologies has shown that when the technology/system is perceived to have significant benefits to the users and perceived to be useful, it is more likely to be implemented and used in the longer term than otherwise (Abou-Shouk, Megicks, & Lim, 2013; Frewer et al., 2011; Oliveira & Martins, 2011; Seyal, Rahman, & Abid, 2013; Sun & Ifeanyi, 2014).

Iacovou, Benbasat & Dexter (1995) studied the major factors influencing technology adoption and found an association between perceived benefits and technology adoption/implementation success. Benbasat, Bergerone & Dexter (1993) found that higher managerial understanding of the advantages (and thereby the usefulness) of a technology increased the likelihood of allocation of managerial, financial and technological resources necessary to implement the technology. With respect to the adoption of technology involving

Materials Resource Planning (MRP), Cooper and Zmud (1990) found that the interaction of managerial tasks with IT were associated with the adoption/implementation of MRP systems.

The Technology Acceptance Model (Davis, Bagozzi & Warshaw, 1989) posits that people form intentions to perform behaviors toward which they have a positive affect, and perceived usefulness contributes to forming a positive affect with respect to adoption and use of the technology under consideration. Doyle et al. (2012) researched physician acceptance of electronic health records and found that when physicians clearly understood the perceived and anticipated benefits of electronic health records, the initial skepticism and concerns they had about the potential negative effects of the technology were mitigated or ceased to persist, which led to EHR contributing to facilitating collaborative physician-patient relationships. Kuziemyk and Keshavjee (2015) have elaborated the benefits/usefulness of EMR over a system of paper records.

Amoako-Gyampah (2007) found that managerial efforts at increasing users' perceptions about the usefulness of a technology will have an association with its adoption. Several research studies in related domains have suggested an association between higher perceptions of usefulness of a technology and its successful adoption (Amoako-Gyampah, 2007; Park, Kim & Ohm, 2015; Rana et al., 2015; Schoville & Titler, 2015). This study will consider how perceptions of usefulness of EMR relate to EMR implementation success.

Based on the above discussion, the following hypothesis was developed for this study:

- **H3: *Higher perceptions of EMR usefulness will positively correlate with EMR implementation success.***

Organization-Related Factors

Organization-related factors most often associated in research literature with successful IT/MIS implementations are the organization's readiness for change (Benjamin & Levinson, 1993; Gargeya & Brady, 2005; Holt et al., 2007; Ludwick & Doucette, 2009) and the level of process/product innovation in the organization (Calantone, Cavusgil, & Zhao, 2002; Camisón & Villar-López, 2014; Cooper & Zmud, 1990; Ju, Li & Lee, 2006). Hence these are the organization-related factors considered in this study.

Readiness of the Organization for Change

Organizations are made up of human beings and resistance to change is a human trait (Newstrom & Davis, 1986; Oreg, 2003; Vakola, Tsaousis & Nikolaou, 2004). Resistance to change has been known to impede technology implementations (Davis & Songer, 2008; Fabry & Higgs, 1997; Frohlich, 2002; Keen, 1981). Hence, resistance to change needs to be addressed in order for technology implementations to succeed (Backer, 1995; Lehman, Greener & Simpson, 2002; Smith, 2005). Although resistance to change is not exactly the same as readiness for change, the two are closely related and successful efforts to enhance readiness for change can prevent active resistance to change from occurring (Armenakis, Harris & Mossholder, 1993; Backer, 1995).

Research literature emphasizes the importance of change readiness, particularly for implementations pertaining to healthcare settings (Al-Balushi et al., 2014; Caldwell et al., 2008; Jennett et al., 2003; Weiner, Amick & Lee, 2008). Al-Balushi et al. (2014) conducted an expansive literature review involving critical readiness factors for incorporating lean operating principles in healthcare organizations. They identified strong leadership support, better

understanding of value and customer groups in healthcare, undertaking a holistic process view to eliminate waste, training personnel on lean principles, reward systems aligned to lean adoption and an optimal management of demand and capacity levels to improve value flow within the organization as key readiness factors. Caldwell et al. (2008) studied the impact of change readiness in the organization with respect to the general orientation towards change on the ultimate success of implementing the change. They investigated the implementation of a strategic change in a healthcare organization located in a large metropolitan area in western US with over 4,000 physicians. Their study was divided into two phases; in the first phase they interviewed 38 leaders in four of the medical centers during the time when the change was rolled out. The second phase was conducted via a survey of 38 medical departments after the change was implanted. Results showed an association between strategy, norms for change readiness and leaders' actions on implementation success. Weiner, Amick and Lee (2008) sought to identify key definitions and measurements for organizational readiness for change in health services through an exhaustive literature review. They posited that given the substantial investment of time, energy and resources typically involved in change efforts, the development of such a knowledge base would strengthen organizational efforts to implement changes and ultimately improve health care quality and safety. Regardless of whether the change is widely supported in the organization or not, organizations and organizational units may differ in their overall orientation towards change depending on group norms, which are socially shared standards against which the appropriateness of behavior can be evaluated (Birenbaum & Sagarin, 1976; Caldwell et al., 2008; Deutsch & Gerard, 1955; O'Reilly & Chatman, 1996; Ray, Barney & Muhanna, 2004).

When organizations and organizational units display high levels of the norms for change readiness, there is a greater chance of successfully implementing changes even when the changes are not supported by all members of the organization due to the ubiquitous trait of resistance to change (Caldwell et al., 2008; Deutsch & Gerard, 1955; O'Reilly & Chatman, 1996; Ray, Barney & Muhanna, 2004). When high levels of change readiness norms are prevalent, people adapt their behavior to accept the change in anticipation of rewards or to avoid repercussions and this leads to stable behavior patterns from the members of the organization/organizational unit (Caldwell et al., 2008; Deutsch & Gerard, 1955; O'Reilly & Chatman, 1996; Ray, Barney & Muhanna, 2004). Therefore, creating an atmosphere of readiness for change within the organization would be expected to be conducive to the successful implementation and adoption of new systems/technology such as EMR.

Ranganathan and Afnan (2012) argue that change readiness capacity in a healthcare organization facilitates the mitigation of challenges arising during EMR implementation. Research studies have confirmed that readiness for change has a strong association with project/technology implementation success (Ahmadi et al., 2015; Hornstein, 2015; Jones, Jimmieson & Griffith, 2005; Lehmann et al., 2016; Motwani et al., 2002; Weiner, Amick & Lee, 2008). This study will consider how the readiness of the organization for change, demonstrated by high levels of norms for change readiness, relates to EMR implementation success.

Based on the above discussion, the following hypothesis was developed for this study:

- **H4: *Readiness of the organization for change will positively correlate with EMR implementation success***

Level of Innovation in the Organization

EMR implementation is considered to be a technology innovation in the realm of healthcare (Crane & Crane, 2006; Dansky et al., 1998; Lee et al., 2016; Lee, 2000). Innovating is critical to an organization's success and survival in this day and age (Çakar & Ertürk, 2010; Rao et al., 2001; Utterback & Abernathy, 1975; Van de Ven, 1986). To the extent an organization is able to quickly and continuously innovate and bring a new product or service to the market, and to the extent competitors would be hard pressed to imitate such developments quickly and with resources at their disposal, such developments become a sustainable competitive advantage for an organization (Eisenhardt & Martin, 2000). A higher desire and ability to innovate within the organization results in successfully bringing any new product or service to the market, or in successful implementation of a product or process innovation (Çakar & Ertürk, 2010; Rao et al., 2001; Utterback & Abernathy, 1975; Van de Ven, 1986).

Another way of expressing an organization's high desire and ability to innovate is in terms of its level of innovation or its innovation capability, which is the organization's ability to mobilize the knowledge possessed by its employees to create new knowledge resulting in the successful implementation of a product or process innovation (Çakar & Ertürk, 2010; Rao et al., 2001; Therin, 2003; Utterback & Abernathy, 1975; Van de Ven, 1986). A firm that has the ability to enhance its organization learning and integrate existing knowledge with new knowledge also has the capability to successfully develop and implement product and process innovations (Therin, 2003). The types of innovation in an organization such as product and process innovation influences the innovation capability of the organization, which in-turn influences the innovation performance of the organization (Mir, Casadesus & Petnji, 2016). The level of product and process innovation in the organization could be used to assess the

innovation capability of an organization (Ju, Li and Lee, 2006). It could be argued from the above discussion that an organization with a high level of innovation would have the experience and know-how to successfully implement a technology innovation such as an EMR system.

This study will consider how the level of product innovation and process innovation in an organization relates to EMR implementation success.

Based on the above discussion, the following hypotheses were developed for this study:

- **H5a:** *The level of process innovation in the organization will positively correlate with EMR implementation success.*
- **H5b:** *The level of product innovation in the organization will positively correlate with EMR implementation success.*

Dependent Variable-EMR Implementation Success

There are as many IS success measures in research literature as there are studies, and measuring system success/implementation success as a dependent variable has always been a huge challenge in IS research (DeLone & McLean, 1992; Molla & Licker, 2001). The difficulty in finding an appropriate dependent variable when it comes to information system success is in part because information, when viewed as the output of an information system or a message in a communication system, could be measured at different levels such as the technical level, the semantic level and the effectiveness level (Delone & Mclean, 1992). A commonly used model in IS research for understanding key success dimensions and their interrelationships is the Delone and McLean's IS success model (Petter, Delone & McLean, 2008).

After a thorough and careful review of current IS research literature, user satisfaction and system functionality success were found to be the most appropriate constructs to measure the dependent variable implementation success in the context of this study. These constructs are discussed below.

User Satisfaction

Delone and Mclean (1992) have suggested that when the use of an information system/technology is required, as opposed to being voluntary use or non-mandatory use, measures of success such as system use become less useful and less relevant. They further suggested that when the use of a specific system/technology is geared towards a specific purpose, user satisfaction may be an appropriate measure of success. User satisfaction has the advantage of having a high degree of face validity since it is hard to deny the success of a system which its users say they like, while other measures of success become relatively less valuable when compared to user satisfaction because they are either conceptually weak or empirically difficult to obtain (Delone & Mclean, 1992).

EMR implementation is concerned with medical records in electronic format and hence involves a specific and unique system/technology. With few exceptions, EMR implementation and use is required (as opposed to being voluntary or non-mandatory) in the United States per laws such as ARRA and HITECH (which have been discussed earlier in this dissertation). Considering the context, the research findings of Delone and Mclean (1992) are quite relevant with respect to EMR implementations in the United States. McGill, Hobbs and Klobas (2003) used the Delone-Mclean model to test the success of information systems involving user-

developed applications. Using Seddon and Yip's (1992) four item scale for user satisfaction, they found strong support for the relationships between user satisfaction and perceived system quality, user satisfaction and perceived information quality, user satisfaction and intended use, and user satisfaction and perceived individual impact.

Therefore user satisfaction has been adopted as one of the constructs in this study to measure the dependent variable EMR implementation success.

System Functionality Success

Implementing a new technology innovation such as EMR involves considerable expense of time and money, and so it is conceivable that organizations implementing EMR will want to assess the success of the implementation in terms of the value offered by the EMR system through its functionality versus the cost to implement. With respect to enterprise resource planning technology implementation, Laughlin (1999) regarded functionality as one of the major factors for implementation success. Hong and Kim (2002) also stressed the importance of functionality in the context of a new technology (ERP) implementation success. Again in the context of ERP implementation, Rolland and Prakash (2001) emphasized the role of customization to achieve system functionality desired by the customer as being a major factor in successful implementation.

EMR and ERP systems have a lot in common, such as both being relatively new technologies in their respective application areas, both having generic software modules that need to be customized in order to successfully implement the system to satisfy end users, and both being cost and labor intensive IS technologies. Therefore it is safe to extrapolate that major

implementation success measures that are applicable to ERP will also be applicable to EMR, and system functionality is one of them as presented above.

Do-Carmo-Caccia-Bava, Guimaraes & Harrington (2006) developed an instrument with eight items for measuring system success (*a la* system implementation success) which are: payback for cost, reliability, improved response, competitive advantage, employee satisfaction, reduced effort or costs, and ease of use. Of these, the items payback for cost, reliability, improved response, competitive advantage, reduced effort or costs, and ease of use speak to the functionality of the system that has been implemented. Employee satisfaction is already being measured in this study as a separate dependent variable using Seddon and Yip's (1992) four item scale as discussed in the previous section, and hence need not be included in a measure of system functionality. A system that is very functional has to be part of any successful technology implementation. System functionality would thus be valuable as a dependent variable in understanding the implementation success of new technologies and new technological innovations such as EMR.

In consideration of the above, system functionality (defined by the following items from the list proposed by Do-Carmo-Caccia-Bava, Guimaraes & Harrington, 2006: payback for cost, reliability, improved response, competitive advantage, reduced effort or costs, and ease of use) has been adopted as one of the constructs in this study to measure the dependent variable EMR implementation success.

Chapter Summary

This chapter presented a detailed review of literature pertaining to Electronic Medical Records, Project Success, Technology-related Factors and Organization-related Factors. It also presented the hypotheses and the theory/literature review leading to the hypotheses. The terms EMR and EHR have been used interchangeably in research literature and practitioner literature and hence in this dissertation also. EMR implementation is an important aspect of HIT, perhaps the most important aspect. Several laws govern the implementation and use of EMR/EHR in the United States. The American Recovery and Reinvestment Act (ARRA) of 2009 was enacted as an economic stimulus bill. The Health Information Technology for Economic and Clinical Health (HITECH) Act was signed into law as part of ARRA in February 2009. The primary goal of the HITECH Act was to stimulate the adoption of EMR/EHR and technology that supports EMR/EHR. The HITECH Act is perceived to be an important part of healthcare reform in the United States.

While EMR/EHR implementation is required by certain laws, it is also expected that implementation of EMR/EHR will help and support the process of being compliant with all healthcare related laws in the United States. Perhaps the most important benefit of EMR/EHR implementation is the ability to deliver high quality healthcare at a relatively lower cost in the long run along with improved data availability and enhanced patient communication. The failure of Information Technology (IT) /Management Information Systems (MIS) implementation projects is a topic that has been studied and discussed extensively in research literature because such failures cost a significant amount of time, money and resources to the organizations involved. Also, there is no overarching framework that encompasses all IT/MIS implementations. This makes it important to find and understand the factors that are associated

with the success of IT/MIS implementation projects in various application areas such as healthcare, business and manufacturing.

According to Roger's Diffusion of Innovation Theory, five characteristics of innovations impact their rate of diffusion. These five characteristics are: Relative Advantage, Complexity, Compatibility, Observability and Trialability. Diffusion is the process by which an innovation is adopted and communicated to members of a social group over time. Of the five factors in Roger's theory of innovation, different research studies have found different sets of factors to be significant. However, most studies agreed on significance for relative advantage, compatibility and complexity. This study will consider whether the same is true for EMR implementations. Several research studies have focused on the relevance and importance of data security and privacy in technology applications. This study will consider how perceptions of data security and privacy attributes relate to EMR implementation success. Usefulness of a technology in terms of benefits anticipated from it plays a major role in the successful implementation and adoption of the technology. A technology perceived to have significant potential benefits is more likely to gain organizational resources needed to implement it, and is more likely to earn the support of potential organizational users since they will perceive it as being useful. This study will consider how perceptions of usefulness of EMR relate to implementation success.

With respect to new technology implementations, research studies have discussed the importance of organization-related factors in successful technology implementations. This study will consider how the change readiness of the organization, demonstrated by high levels of norms for change readiness, relates to EMR implementation success. EMR implementation is considered to be a technology innovation in the realm of healthcare. Innovating is critical to an organization's success and survival in this day and age. A higher desire and ability to innovate

within the organization results in successfully bringing any new product or service to the market, or in successful implementation of a product or process innovation. This study will consider how the level of product innovation and process innovation in an organization relates to EMR implementation success. There are as many IS success measures in research literature as there are studies, and measuring system success/implementation success as a dependent variable has always been a huge challenge in IS research. After a thorough and careful review of current IS research literature, user satisfaction and system functionality success were found to be the most appropriate constructs to measure the dependent variable implementation success in the context of this study.

The next chapter will focus on the research methodology that was used in this study.

CHAPTER 3: RESEARCH METHODOLOGY

The term 'methodology' refers to a system of methods used in a particular area of study.

This chapter discusses the research methodology used in this study.

Data Sources

The target sources of data for this research study were consultants, project managers, healthcare facility administrators, physicians and nurses involved with the implementation/use/maintenance of EMR in the healthcare industry for a period of one year or more. The types of organizations within the healthcare industry in which the target sources were employed include single hospital systems, multi-hospital systems, integrated delivery systems, ancillary medical centers (healthcare provider associated with a college or university), ancillary clinical service providers, hospital owned or independent ambulatory clinics, federal/state/local government institutions, community health centers, long-term care facilities, payer/insurer managed care organizations, privately owned physician offices, public health organizations and other healthcare provider organizations. The purpose of the research was to assess the roles and associations of specific technology- related factors and organization-related factors in successful EMR implementations.

Mixed Methods Approach and Data Gathering Phases

Research literature presents a strong case for use of a mixed methods approach in research studies and suggests that this is a desirable paradigm when used with pragmatism, because it enables the researcher to gain the advantages of more than one approach of data collection and analysis (Johnson & Onwuegbuzie, 2004; Sale, Lohfeld, & Brazil, 2002;

Tashakkori & Teddlie, 2010, 2003, 1998). Benbasat, Goldstein and Mead (1987) have emphasized the advantages of using a mixed methods approach in IS research. Other researchers have emphasized the advantages of using a mixed methods approach in all types of research, particularly in IS and IT research (Kaplan & Duchon, 1988; Pinsonneault & Kraemer, 1993; Small, 2011; Venkatesh, Brown, & Bala, 2013). In this research study, a mixed methods approach was utilized because the current state of knowledge specific to the research model used in this study is limited (as was explained in chapter 2) and hence there was value in obtaining the views of industry practitioners and other domain experts prior to launching a large scale data collection.

Consistent with the philosophy of a mixed methods approach, data was collected and analyzed in three phases which are as follows:

- a) Phase I Data Gathering: Phone Interviews (to gain an overall understanding of real-world EMR/EHR implementations, validate research variables and develop a preliminary version of the questionnaire)
- b) Phase II Data Gathering: Pilot Study (to make appropriate modifications to the preliminary questionnaire which led to the development of the final version of the questionnaire)
- c) Phase III Data Gathering: Questionnaire (large scale data collection and statistical analyses using the final version of the questionnaire)

These three phases are explained in greater detail below.

Phase I Data Gathering - Phone Interviews:

Objective

The two main objectives of the phone interviews were:

- (1) *Objective#1: To validate the research model, the variables included in the research model and the hypotheses:*

The interviewees were questioned in detail about their real-world experiences involving EMR/EHR implementations. These experiences were interpreted by the researcher in light of the variables and the hypotheses in the research model. Such an approach involving researcher-practitioner collaboration in research study design, especially in the early stages of the research process, has been advocated as an efficient method for research design and for conducting research studies (Amabile et al., 2001; Eden & Huxham, 1996; Rynes, Bartunek, & Daft, 2001; Wagner, 1997). The discussions with the interviewees enabled the researcher to gain an overall understanding of the issues involved in real-world EMR/EHR implementations.

The feedback obtained from the interviewees enabled the researcher to confirm that the variables included in the research model (that were obtained from current research literature) made sense and aligned with the variables involved in real-world EMR/EHR implementations. Variables/factors found to be irrelevant at this stage were eliminated from further consideration. For example, organizational knowledge absorption capacity (i.e. the ability of the organization to learn from the experiences of other organizations) is a variable known to be associated with e-business and e-commerce implementation success per current research literature. But from the

interviewees' real-world experiences involving EMR/EHR implementations, it became apparent that knowledge absorption capacity would not be as important with respect to EMR/EHR implementations. This is because healthcare organizations tended to be secretive and confidential about their own EMR implementations. Additionally, the general know-how about the implementation came from consultants who were employed by the same EMR system vendors. Such know-how or knowledge-base was therefore available to all healthcare organizations implementing EMR systems from the same vendors and consultants and for this reason, knowledge absorption in this regard from other healthcare organizations was neither possible nor required. Therefore this variable was eliminated from further consideration.

The interviewees were asked if they could think of other variables based on their real-world experience that are not currently included in this study, but should be. The interviewees replied in the negative. With the elimination of the one variable (knowledge absorption), the interviewees were satisfied with the variables/factors that had been included in the study and saw the congruence with respect to real world EMR implementations. Furthermore, the interviewees approved of the research model and the research hypotheses as presented. This exercise enabled the researcher to refine the research model by eliminating irrelevant and superfluous variables/factors. In addition, it helped the researcher to confirm that no important variables/factors have been overlooked from a real world implementation perspective, and also verified the congruency of the research model and research hypotheses with respect to real world implementations.

(2) *Objective#2: To gather insights using an interpretative phenomenological analysis approach :*

The “interpretative phenomenological analysis approach” involves asking interviewees about their opinions and perceptions with regards to the subject matter at hand (in this case, the various aspects of EMR/EHR implementation), and the researcher/interviewer performing the role of an analyst in interpreting the responses to understand the respondent’s ‘sense-making’ of the situation thereby procuring subjective and impressionistic insights (Brocki & Wearden, 2006; Pringle et al., 2011; Smith, 2004; Smith, Flowers, & Larkin, 2009). Such an approach is also known as an “idiographic approach” (Brocki & Wearden, 2006; Pringle et al., 2011; Smith, 2004; Smith, Flowers, & Larkin, 2009). In the interpretative phenomenological analysis approach, the researcher accepts the participant’s responses in a questioning way, looks for common themes in responses, analyzes the responses in the light of the research study at hand, and then uncovers the meaning of the responses by placing them in an appropriate context (Pringle et al., 2011; Smith, Flowers, & Larkin, 2009; Standing, 2009). Thus the interpretative phenomenological analysis approach is concerned with the participant/interviewee’s account of an object or event as opposed to an attempt to have the participant/interviewee’s produce an objective statement of the account or event. In addition, it takes into account how individuals make sense of their particular experiences in their personal/professional/social world, and deals with the multi-faceted and dynamic meaning making process which can sometimes be hard and conflictual (Smith, 1996; Smith, Flowers & Osborn, 1997).

The researcher, having done a thorough literature review and due to his extensive industry experience, was familiar with prior implementations of technological innovations in e-business, e-commerce, e-education and e-manufacturing, and the success (and failure) factors pertaining to such implementations. This facilitated the researcher's use of the interpretative phenomenological analysis approach to understand and interpret the interviewees' responses in the context of their experiences, and translate and view such responses in light of the research model.

In one case, the concept of innovative technology was perceived too broadly by the interviewees who stated that any new technology including new software could be called innovative technology. However the researcher, being aware that new technology could very well be "old wine in a new bottle" and need not necessarily be innovative technology, probed them with questions about what aspects of the technology they considered to be innovative. The interviewees replied that the new technology (i.e. the EMR system that has been implemented which has all patient information in the database and in a readily transmittable and shareable format) enabled them to do work in new and more efficient ways when compared to the previous technology (parts of patient records stored in the computer in electronic format through data entry into databases and other part stored as a scanned copy of paper forms which is not really an electronic database). From this the researcher was able to conclude that the interviewees were referring to the relative advantage aspect of the new/current EMR system in comparison to the system/process that was in place previously. Such conversations also provided valuable insights that were used later for framing the survey questions.

Participant Selection

Participant selection/recruitment for research studies (including phone interviews) is a difficult and time consuming process, especially when the participant sees no immediate benefits from the participation (Gibbs, 1997; Mapstone, Elbourne, & Roberts, 2007; Yancey, Ortega, & Kumanvika, 2006). When the research study requires the involvement of participants with specific or special interests, word-of-mouth participant recruitment is often the most successful method (Burgess, 1996; Gibbs, 1997; Van Hoye & Lievens, 2009).

For the first phase of this research study (phone interviews), participants were recruited by word-of-mouth. Through word-of-mouth, it became possible to obtain eight interviewees who met the desired criteria. These interviewees had significant industry and consulting experience with respect to EMR implementations. Their voluntary participation in this research study was confirmed through an initial phone call during which an appointment for a detailed phone interview was made.

Methodology

Phone Interviews: Interviewing is a research technique that has been widely used in qualitative research (qualitative/unstructured interviews) and quantitative research (semi-structured/structured interviews), and has been known to yield valuable information for research purposes (Alvesson, 2003; Leedy & Ormrod, 2015; Silverman, 1998; Yeung, 1995). Interviews allow the elicitation of information about observations in real-world implementations, interactions, artefacts and rituals, and perception variations as these pertain to the focus of a

research study (DiCicco-Bloom & Crabtree, 2006; Patton, 2005). Such information allows the researcher to gain valuable insights into the real-world implementation aspects and practitioner views of the elements present in the research model.

Unstructured interviews used in qualitative research consist of open-ended questions pertaining to past events, behaviors and perspectives, tend to be flexible, and yield information that the researcher had not planned to ask for (Leedy & Ormrod, 2015). By contrast, structured interviews used in quantitative research consist of closed-ended questions, in which the researcher asks a standard set of questions and nothing more (Leedy & Ormrod, 2015). In between these lie the semi-structured interviews which consist of a few central questions, but are otherwise unstructured. Semi-structured interviews provide the advantages of both structured and unstructured interviews and are thus likely to result in insights that may prove valuable to the researcher, while still retaining the focus and scope of structured interviews (Drever, 1995; Hove & Anda, 2005; Leedy & Ormrod, 2015).

Interviews can be also be face-to-face interviews or telephone interviews. Face-to-face interviews enable the researcher to establish rapport with the interviewee and yield the highest response rate, but may be time consuming and expensive (Leedy & Ormrod, 2015). From prior interactions with healthcare industry professionals the author of this research study was aware that they carry a huge responsibility on their shoulders, consider their time to be valuable, and are difficult to gain access to for long periods of time (especially with respect to face-to-face access). Hence face-to-face interviews may not have worked very well when the respondents are healthcare industry professionals. In qualitative and quantitative research, phone interviews have been a successful and widely accepted alternative to face-to-face interviews (Aziz & Kenford, 2004; Knox & Burkard, 2009; Leedy & Ormrod, 2015; Sturges & Hanrahan, 2004). Phone

interviews are known to be less expensive and less time consuming than face-to-face interviews, less annoying to interviewees that are constantly busy (such as healthcare industry professionals), and have been known to yield higher response rates than questionnaire surveys, albeit a relatively lower response rate than face-to-face interviews (Aziz & Kenford, 2004; Knox & Burkard, 2009; Leedy & Ormrod, 2015; Sturges & Hanrahan, 2004).

For this research study, the format used for the detailed phone interview was the semi-structured interview format wherein with the exception of some core/structured questions, the rest of the interview was unstructured. The phone interview began by asking the interviewees about their experiences with real-world EMR/EHR implementation(s) including, but not limited to, the specific role they played in the implementation, the progression of the implementation process, the role of various organizational staff at various levels in the implementation, the degree of success (or failure) of the implementation, lessons learned from such implementation and comments the interviewee wished to make with regards to the implementation. The core/structured questions were based on the research model and consisted of questions pertaining to technology factors, organizational factors and measures of implementation success as they were presented in the research model. This allowed the researcher to both, obtain answers to the core/structured questions that were based on the research model, and enabled the respondents to talk elaborately on issues/matters they considered important with respect to the implementations. Using this approach, the researcher was able to get valuable additional insights into real world EMR/EHR implementations in addition to having his core/structured questions answered.

The interview protocol was based on guidelines suggested by McCracken (1988), which included a “preconditioning” in the form of a detailed introduction of the research study and clear statement of scope by the researcher at the very beginning of the interview to prevent scope

creep and maintain the interview within the framework of the research model. The preconditioning also improved the clarity of instructions to the interviewees, which in turn provided for the interview to be kept on track (Gilbert & Dabbagh, 2005). The average duration of the phone interview was 45 minutes. The researcher facilitated and moderated the interviews in an appropriate and professional manner.

Data Preparation and Editing: The researcher took detailed notes during the phone interview including the main takeaways. Before the conclusion of each phone interview, the researcher went over these notes with the interviewee to ensure the accuracy of what he recorded and avoid misunderstandings and misinterpretations.

Analysis of the Interview: Interview results were analyzed and evaluated using the Qualitative Content Analysis (QCA) method (Berelson, 1952; Glaser & Strauss, 1967; Strauss & Corbin, 1997). QCA focuses on the “story that the data tells” by examining the central issue in terms of what happened and how it happened, the insights that the researcher gleaned from talking to the interviewees, the key relationships that contributed to the story, addressing threats to trustworthiness, condensing and extracting key details pertinent to the research, and providing meaningful contextual interpretation of all of the above (Forman & Damschroder, 2007; Graneheim & Lundman, 2004; Hsieh & Shannon, 2005; Mayring, 2004).

Results of the Data Gathered in this Phase

At the conclusion of first phase, the research model, constructs and hypotheses stood validated and finalized. The next logical step was to develop a preliminary questionnaire (survey instrument). Questionnaires are an appropriate tool to obtain data pertaining to relationships

between the various variables in an instrument, provide the respondents adequate anonymity so as to facilitate truthful responses, are simple and provide equivalence across studies, and enable easy coding and analysis (Bernard & Bernard, 2013; Dillman, 1978; Goodman, 1997; Leedy & Ormrod, 2015; Wright, 2005).

Based on the data and information obtained from the semi-structured interviews in Phase I, a questionnaire based on the Likert Scale was developed for administration to a larger sample. The purpose of doing this was to get quantitative data with respect to the implementation of EMR and the association of specific technology-related factors and organization-related factors on the successful implementation of EMR in the healthcare industry.

A questionnaire was designed to elicit the following information from the respondents:

- (a) Information pertaining to demographics
- (b) Information pertaining to the role and experience of the respondents in the implementation of electronic medical records
- (c) Responses to the items (questions) pertaining to the association of specific technology factors on the successful implementation of electronic medical records
- (d) Responses to the items (questions) pertaining to the association of specific organization factors on successful implementation of electronic medical records

The questionnaire consisted of the following types of questions:

- (a) Questions pertaining to demographics
- (b) Multiple choice questions based on the Likert scale.

Constructs, variables (independent and dependent) and items from previous research studies were used in order to capitalize on the experience and expertise of past researchers who have had many years of experience in information systems research. A big advantage in using constructs and items from previous research studies is that their reliability and validity (especially construct validity, criterion validity and content validity) would have been already established and therefore, there may not be a need to perform reliability and validity studies again. Using already validated items eliminated errors associated with developing items from the scratch. A table listing the constructs and items used in this study and their sources is provided in Appendix 1.

Phase II Data Gathering: Pilot Study:

Objective

The objective of the pilot study was to serve as small-scale preliminary study preceding large-scale data collection using a questionnaire survey. It enabled the researcher to get an assessment of the time, cost and other parameters associated with a full scale study. It also enabled the validation of the preliminary questionnaire with respect to format, verbiage and clarity of the questions using the rich real world experience of the respondents/participants. The pilot study confirmed the face validity of the questionnaire. Face validity is a subjective measure of whether a questionnaire appears to measure what it purports to measure.

Participant Selection

The difficulty involved in participant selection/recruitment, especially when the participant sees no immediate benefits from the participation, was explained in the previous section. Therefore the participants recruited for the phone interviews were invited to participate in the pilot study. All the participants from the phone interviews agreed to participate in the pilot study.

Methodology

The researcher explained the need and purpose of the pilot study to the participants. The survey was administered electronically, using the online survey tool SurveyMonkey™. The participants were invited by email or phone to participate in the survey. The web-link to the survey was provided to the participants so that they could access the survey through the Internet. Once a participant took the survey, the researcher made a follow-up phone call to debrief the participant and gain additional insights. The feedback thus obtained was used to appropriately modify the questionnaire with a view to making it as unambiguous and straightforward as possible.

Results of the Data Gathered in this Phase

During the debriefing, the respondents/participants provided useful suggestions. Some of the participants suggested adding brief explanatory notes to clarify certain terms in order to avoid misunderstandings and misinterpretations. For example, some respondents/participants stated

that the term “innovativeness of the EMR technology” is likely to be misinterpreted and misunderstood unless there is an explanatory note specifying the meaning and context in which related questions should be answered. Based on this feedback, a brief explanatory note was added to explain such terms in the questionnaire. Other such useful suggestions were implemented to enhance the clarity and understanding of the questionnaire. At the time of conclusion of Phase II (pilot study), the preliminary questionnaire had been appropriately modified and had taken the form of the final questionnaire ready to be distributed for the final (large-scale) data collection.

Phase III Data Gathering: Questionnaire:

Objective

The last phase of data gathering consisted of administering the final version of the questionnaire to a large number of potential respondents with a view to gathering adequate amount of quantitative data (to achieve statistical significance) which then could be used to test the hypotheses. The questionnaire/survey design was aimed at collecting information pertaining to demographics, role and experience of the respondents with EMR implementation, and the association of specific technical and organizational factors on EMR implementations. The questionnaire covered all areas of the research model and contained demographic questions and multiple-choice questions.

Participant Selection

Healthcare researchers are often interested in the data collected from subjects who have certain common characteristics. Data collected from subjects not meeting the common characteristics stated would be of no use to the research. Collecting data from the general population in such situations would be a wasteful expenditure of resources because only a small fraction of the general population may have the characteristics desired in the sample. Therefore the group of people that have the common characteristics desired by the researcher forms the population under consideration in some research studies. In this study the population under consideration comprised of consultants, project managers, healthcare facility administrators, physicians and nurses involved with the implementation/use/maintenance of EMR in the healthcare industry for a period of one year or more.

In probability sampling, sampling is done in a way as to comprise of random selection and be representative of the population under consideration such that each segment of the population will be represented in the sample unlike in non-probability sampling (Cresswell, Bates, & Sheikh, 2017; Leedy & Ormrod, 2015). Methods such as simple random sampling, stratified random sampling, cluster sampling and systematic sampling are random sampling methods. By contrast, non-probability sampling techniques do not guarantee that each element of the population under consideration will be represented in the sample and non-probability sampling does not rely on probability theory (Cresswell, Bates, & Sheikh, 2017; Leedy & Ormrod, 2015). For this reason, non-probability sampling techniques such as convenience sampling, quota sampling and purposive sampling are often viewed as lacking the rigor of probability sampling techniques and are hence considered inferior to them. For instance, convenience sampling considers people that are readily available such as people that arrive on

the scene by mere happenstance (Leedy & Ormrod, 2015), such as attendees arriving at a healthcare conference.

Nevertheless, non-probability sampling is necessary in research work when it is not feasible or practical to do a probability sampling. Particularly in healthcare industry related research such as this study, the convenience sampling approach (within a pre-defined population as explained earlier) is necessary and optimal, because despite carrying some of the disadvantages of non-probability/convenience sampling, this approach assures sampling from a group that is qualified to provide data due to its' involvement in the researcher's area of interest. Thus the advantages of such sampling in this particular situation outweigh its' disadvantages. Given the diversity of healthcare provider organizations (for example, big hospitals, small hospitals, ambulatory clinics, physician clinics, teaching hospitals and so on), it would be practically impossible to ensure that each and every sub-group is equally represented during sampling. In summary therefore, convenience sampling with the population comprised of consultants, project managers, healthcare facility administrators, physicians and nurses involved with the implementation/use/maintenance of EMR in the healthcare industry for a period of one year or more was the best and most optimal approach of data collection for this research study.

The researcher had postcards printed with a synopsis of the research study and the qualifications required of respondents. The postcard contained the web-link to the survey on it. The researcher associated himself with the activities (such as conferences, social events, periodic meetings, webserver based information dissemination) of leading societies in the healthcare arena such as the Healthcare Information and Management Systems Society (HIMSS), the American Health Information Management Association (AHIMA), and the American Society for Quality (ASQ) to name a few and used these opportunities to distribute the description of the

research study, qualification required of respondents and the survey link through mailed postcards or other means. He also contacted organizations such as the Illinois Hospital Association whose members were closely involved with healthcare and related projects. After obtaining the required permissions, the survey link and relevant study details were made accessible to the members of such organizations through their internal IT systems (such as their intranet). The researcher also reached out to his own industry contacts as well as to other industry contacts found through the use of social media and blogs and made available to them the description of the research study, qualification required of respondents and the survey link through mailed postcards or other means. In this manner, a multi-pronged approach was utilized to maximize the number of qualified survey respondents.

Methodology

The data was collected by uploading the questionnaire into the website SurveyMonkey™. The respondents were provided with the web-link to the survey website which allowed them to respond to the questionnaire survey online. The data from the survey was then downloaded and analyzed using statistical methods and statistical software.

Results of the Data Gathered in this Phase

The results of the data gathered in this phase are presented in chapter 4.

Chapter Summary

This chapter presented the research methodology used. A mixed methods approach was used and data was gathered in three phases. The goal of the first phase of data gathering was to gain an overall understanding of real-world EMR implementations and to develop a preliminary version of the questionnaire. A semi-structured interview was used during the first phase. The goal of the second phase of data gathering was to make necessary modifications to the preliminary questionnaire to enhance its clarity and understanding, and to thereby arrive at the final version of the questionnaire. A pilot study was performed during the second phase. The goal of the third phase of data gathering was large scale data collection to facilitate statistical analyses and drawing of conclusions pertaining to the hypotheses. The researcher distributed postcards with a link to the survey to potential participants. The next chapter will discuss the statistical analysis methodology and data analysis results.

CHAPTER 4: STATISTICAL DATA ANALYSIS

METHODOLOGY AND RESULTS

Data Analysis- Methodology

This section discusses the methodology used for the statistical analysis of the data.

Primary Data Analysis Technique

Consideration of Latent Variables

Variables (also called constructs or factors) in the research model which cannot be measured directly are known as latent variables. Latent variables may be theoretical constructs. Examples of latent variables in Psychology are motivation, extraversion and self-esteem, and in Economics are quality of life and business confidence. When there are latent variables in the research model, items (questions in a questionnaire survey) consisting of measurable variables which are manifestations of the latent variable are used to indirectly measure the latent variables.

Byrne (2016, 2011) calls the latent variables as ‘unobserved variables’ and the items as ‘observable variables’ and states that the unobservable variable is linked to that which is observable. In this research study, the latent variables are the innovativeness of EMR (measured by considering the relative advantage, compatibility and complexity of EMR), privacy and security attributes of EMR, usefulness of EMR, readiness of the organization for change where the EMR was implemented, and the level of process/product innovation in the organization where the EMR was implemented. Each of these latent variables corresponds to one or more questions in the survey. The observable variables in this research study are the items (questions) corresponding to each latent variable in the questionnaire.

Structural Equation Modeling

Structural Equation Modeling (SEM) is a combination of factor analysis and regression or path analysis in which the emphasis is on the theoretical constructs represented by latent variables. SEM is the most commonly used method of data analysis when the research model contains latent variables (Byrne, 2016, 2011; Hox & Bechger, 1998; Wang & Wang, 2012).

SEM is used to investigate the plausibility of theoretical models (the research model in this study) that explain the inter-relationships between a set of variables through the use of fit indices (Hu & Bentler, 1999). The overall objective of SEM is to establish that a research model constructed on the basis of theory (derived from research/academic literature) is confirmed by sample data by considering the research model as a whole (Byrne, 2016, 2011; Dion, 2008; Hox & Bechger, 1998; Wang & Wang, 2012).

SEM has several advantages over other traditional methods such as multiple or hierarchical regression, some of which are as follows (Byrne, 2016, 2011; Dion, 2008; Hox & Bechger, 1998; Wang & Wang, 2012). SEM estimates all coefficients by considering the research model as a whole which enables one to see the strength of a particular relationship in the context of the entire model. Additionally, it offers a simpler analysis in comparison to some forms of regression such as hierarchical regression. Effects of such issues as multi-collinearity and measurement error are relatively easy to address in SEM in comparison to other statistical methods.

While SEM has undisputable advantages with regards to data analysis for research models involving latent variables, it does have certain limitations also. SEM requires that the full test model be specified in advance of the analysis along with all the relationships to be modeled and requires an advance perception of the paths representing critical relationships.

Since the research model in this study consists of latent variables, SEM would be the most appropriate statistical analysis method and hence was the chosen method of analysis for this study.

Fit Indices

Model fit in Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) is assessed by the use of one or more model fit indices, which speak to a good fit (or the lack of it) between the hypothesized model and the observed data. It is recommended that more than one fit index be reported because different indices reflect a different aspect of model fit (Crowley & Fan, 1997). However it is also not necessary or prudent to report every possible fit index since this will burden the reader and the reviewer (Hooper, Coughlan & Mullen, 2008). In selecting fit indices for evaluation, it is important that the cut off criterion for a given fit index should result in minimum Type I error rate (the probability of rejecting a null hypothesis when it is true) and Type II error rate (the probability of accepting a null hypothesis when it is false) (Hu & Bentler, 1999).

The Comparative Fit Index (CFI) is one of the commonly used fit indices in CFA and shows consistency even under conditions of missing data, lower sample size and moderate departure from normality with the maximum likelihood estimator (Bentler, 1990, 1980; Bentler & Bonnet, 1980; Finch & Zautra, 1992; Gonzalez-Manteiga & Crujeiras, 2013; Hooper, Coughlan & Mullen, 2008; Peters & Enders, 2002; Stoica & Viberg, 1996; Tabachnick & Fidell, 2012).

According to Hooper, Coughlan and Mullen (2008), CFI is a revised form of the Normed Fit Index (NFI) which takes into account sample size (Byrne, 2016, 2011) and performs well

even when sample size is small (Tabachnick & Fidell, 2012). As with the NFI, values for this statistic range between 0.0 and 1.0 with values closer to 1.0 indicating good fit. A cut-off criterion of $CFI \geq 0.90$ was initially advanced, but further research studies have shown that a value greater than 0.90 is needed in order to ensure that mis-specified models are not accepted (Hu & Bentler, 1999). Research studies continue to portray a CFI value greater than or equal to 0.90 to be indicative of an acceptable fit (Motl et al., 2007; Siegrist, 2000; Verhagen & van-Dolen, 2011). CFI is included in all SEM software programs and is one of the most popularly reported fit indices due to being one of the measures least affected by sample size (Fan, Thompson, & Wang, 1999). According to Iacobucci (2010), there is agreement among researchers that the value of CFI must be reported.

The Tucker-Lewis Index (TLI), which is also known as the Non-Normed Fit Index (NNFI), is a widely accepted and popularly reported fit index (Bentler, 1990, 1980; Bentler & Bonnet, 1980; Byrne, 2016, 2011; Tabachnick & Fidell, 2012; Tucker & Lewis, 1973). For a good fit, TLI value of 0.80 has been suggested (Hooper, Coughlan and Mullen, 2008), with Birch et al. (2001) stating that values greater than 0.90 are indicative of an increasingly good fit as they approach 1.0.

The fit indices NNFI/TLI and CFI are sensitive to model misspecifications and do not depend on sample size as strongly as χ^2 (Fan, Thompson, & Wang, 1999; Hu & Bentler, 1999; Rigdon, 1996), and therefore they should always be considered (Schermelleh-Engel, Moosbrugger & Müller 2003).

Root Mean Square Residual (RMR) and the Standardized Root Mean Square Residual (SRMR) are the square root of the difference between the residuals of the sample covariance matrix and the hypothesized covariance model (Hooper, Coughlan & Mullen. 2008). The range

of the RMR is calculated based upon the scales of each indicator. Therefore, if a questionnaire contains items with varying levels (say some items may range from 1 – 5 while others range from 1 – 7) RMR becomes difficult to interpret (Kline, 2005). The standardized RMR (SRMR) resolves this problem and is therefore much more meaningful to interpret. The SRMR value indicates the variance unaccounted for in the data or in other words, the average magnitude of the residual (Anderson & Gebring, 1991, 1984; Hu and Bentler, 1999; Tabachnick & Fidell, 2012). Values for the SRMR range from zero to 1.0 with well-fitting models obtaining values less than .05 (Byrne, 2016, 2011; Diamantopoulos and Siguaw, 2000), however values as high as 0.08 are deemed acceptable (Hu and Bentler, 1999).

According to Iacobucci (2010), differences between data and model predictions comprise the residuals, their average is computed, and the square root taken. SRMR is a badness-of-fit index (larger values signal worse fit), and it ranges from 0.0 to 1.0. SRMR is zero when the model predictions match the data perfectly. SRMR is enhanced (lowered) when the measurement model is ‘clean’ with high factor loadings (Anderson & Gerbing, 1991, 1984). The index is an indicator of whether the researcher's model fits the data, because it is relatively less sensitive to other issues such as violations of distributional assumptions.

In this research study, the fit was assessed using the following fit indices: Comparative Fit Index (CFI), Standardized Root Mean Square Residual (SRMR) and the Tucker Lewis Index (TLI/NNFI) (Bentler, 1990; Bentler & Bonnet, 1980; Heck & Thomas, 2000; Iacobucci, 2010; Tabachnick & Fidell, 2012). In addition, the factor loadings (standardized loadings/ standardized correlation coefficients) and the R-Square (Coefficient of Determination) values were used for fit assessment.

Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) is a technique used to define and measure the dimensions of the constructs involved in the research model. According to Long (1983), in a CFA model, the researcher imposes substantively motivated constraints. These constraints determine (1) which pairs of common factors are correlated, (2) which observed variables are affected by which common factors, (3) which observed variables are affected by a unique factor, and (4) which pairs of unique factors are correlated. Statistical tests can be performed to determine if the sample data are consistent with the imposed constraints or, in other words, whether the data confirm the substantively generated model. It is in this sense that the model is thought of as confirmatory.

CFA is a type of structural equation modeling that deals specifically with measurement models, i.e. the relationships between observed measures or indicators (e.g., test items, test scores, behavioral observation ratings) and latent variables or factors (Brown, 2014; Brown & Moore, 2014). The goal of latent variable measurement models (i.e., factor analysis) is to establish the number and nature of factors that account for the variation and co-variation among a set of indicators. A factor is an unobservable variable that influences more than one observed measure and which accounts for the correlations among these observed measures. In other words, the observed measures are inter-correlated because they share a common cause (i.e., they are influenced by the same underlying construct); if the latent construct was partialled out, the inter-correlations among the observed measures would be zero.

A measurement model such as CFA provides a more parsimonious understanding of the co-variation among a set of indicators because the number of factors is less than the number of measured variables. In CFA, the researcher specifies the number of factors and the pattern of

indicator-factor loadings in advance, as well as other parameters such as those bearing on the independence or covariance of the factors and indicator-unique variances. The pre-specified factor solution is evaluated in terms of how well it reproduces the sample covariance matrix of the measured variables. CFA is almost always used in the process of scale development to examine the latent structure of a test instrument. CFA verifies the number of underlying dimensions of the instrument (factors) and the pattern of item-factor relationships (factor loadings) (Brown, 2014; Brown & Moore, 2014).

The term “measurement model” in CFA is used to describe a model that examines the relationship between a latent variable (unobserved variable) and its measures (observable variables). By contrast, a “structural model” in CFA denotes the relationships between the latent variables. Once a model which consists of some hypothesized relationships has been designed, the next step is to assess the reliability and validity of the measures employed and a measurement model is tested to validate the measuring instruments (Cheng, 2001). Such a measurement model consists of a set of observed indicators, which serve for respective measurement instruments of the latent variables (Joreskog & Sorbom, 1993). Prior to the test of the hypothesized relationships among constructs, the measurement model must hold. If any indicators do not measure its underlying construct and/or are not reliable, the model must be modified. To modify a measure, an indicator is deleted if it cannot measure the underlying construct and/or is indicated to measure more than one construct. In addition, a measure is dropped if it has extremely low internal consistency. This implies that the hypothesized relationships among constructs may need to change during the process (Cheng, 2001).

In this research study, the constructs and items were borrowed from published research works by experts/academicians and therefore the fit between the items and the related constructs

could be taken for granted. Even so, a CFA was performed to confirm the fit, further details of which are presented in the results section of this chapter.

Sample Size

Appropriate Sample Size

Larger sample sizes increase power and decrease estimation error (Moore, McCabe & Craig, 2014). In reality however, factors such as access to survey respondents, costs involved in data collection and the ability to find willing participants severely restrict the availability of large sample sizes. Past research work has suggested approaches to obtain an optimal sample size that will provide statistical validity and generalizability of results, while also minimizing the sample size. Standard sampling tables and sample size calculators available from websites on the Internet allow for easy calculation of sample size. These calculators balance criteria such as power, effect size, confidence level and margin of error when calculating the sample size.

It is worthwhile to mention a few studies that speak to sample size requirements, especially in the context of using Structural Equation Modeling (SEM) and Confirmatory Factor Analysis (CFA). From a data normality perspective, Kim (2013) refers to $N < 50$ as a small sample size, $50 < N < 300$ as a medium sample size, and $N > 300$ as a large sample size. In the same context, Bentler (1990, 1980) used a number of data and model conditions to evaluate the performance of commonly used fit indices and found that there were 12% improper solutions at $N = 50$, a trivial number of improper solutions at $N = 100$, and none at $N \geq 200$. Hoyle and Gottfredson (2015) stated in the context of Structural Equation Modeling (SEM) that the performance of estimators with samples in the 50–100 range can be problematic and to achieve desired levels of power for models of typical complexity, samples sizes of 200 or more are desirable. In the context of factor analysis, Tabachnick and Fidell (2012) suggest a sample size

of 300 or more, while Pedhazur and Schmelkin (1991) suggest 50 participants per factor. Tabachnick and Fidell (2012) also state that solutions that have several high loading marker variables ($> .80$) do not require such large sample sizes (about 150 cases should be sufficient) compared to solutions with lower loadings.

For this study, the sample size was calculated using several approaches- Bartlett, Kotrlik and Higgins (2001)'s approach, Naing, Winn and Rusli (2006)'s approach, and using sample sizes tables/calculators available on the Internet (www.surveymonkey.com, www.raosoft.com, www.surveysystem.com, www.powerandsamplesize.com, www.sciencebuddies.org). The results obtained from these approaches were compared and the highest sample size number was chosen. Additional details about the sample size chosen are presented in the results section of this chapter.

Kaiser-Meyer-Olkin Test of Sampling Adequacy

The Kaiser-Meyer-Olkin (KMO) test measures the sampling adequacy for each variable in the model and for the complete model. The partial correlation X_{ij} of two variables (i,j) that share a common factor with other variables should be small, indicating that they share a unique variance. When $X_{ij}=0$, $KMO=1$ and the implication then is that two variables are measuring a common factor. When $X_{ij}=1$, $KMO=0$ and the implication then is that two variables are not measuring a common factor.

Kaiser-Meyer-Olkin (KMO) test values >0.70 are considered to be acceptable while values >0.80 (between 0.80 and 1.0) are considered to be very good (Kaiser, 1974; Meng, Tepanon & Uysal, 2008; Williams, Onsmann & Brown, 2010). The outcome of this test for the data set used in the in this study is presented in the results section of this chapter.

Bartlett's Test of Sphericity

The Bartlett's test of sphericity is used to determine whether the samples were drawn from populations with equal variances in order to ascertain homoscedasticity, otherwise referred to as homogeneity of variance. The desirable result of the Bartlett's test is a significance value of less than 0.05 or $p < 0.05$ (Bartlett, 1937; Meng, Tepanon & Uysal, 2008; Williams, Onsman & Brown, 2010). In regression calculations and other statistical calculations, homoscedasticity is desirable and lack of homoscedasticity, referred to as heteroscedasticity, could often cause many difficulties in calculations and interpretation (Bartlett, 1937; Jarque & Bera, 1980; Williams, Onsman & Brown, 2010).

When the Bartlett's test results in a significance value of less than 0.05 ($p < 0.05$), this speaks to the suitability of the data collected to assess the central goal (dependent variable) of the study. The outcome of this test for the data set used in the in this study is presented in the results section of this chapter.

Validity and Reliability

Validity of a measurement instrument (i.e. questionnaire survey) is the extent to which the instrument measures what it is intended to measure. Validity comprises of face validity, content validity, criterion validity and construct validity (Leedy & Ormrod, 2015). Face validity refers to whether the instrument, on the surface and in subjective terms, looks like it is measuring a particular characteristic. Since face validity is subjective, there is less value attached to it.

Content validity is the extent to which the instrument is a representative sample of the content area or domain being measured. Criterion validity refers to whether the results of an assessment instrument correlate with a related measure. Construct validity refers to whether the

instrument contains appropriate constructs which measure characteristics (variables) that cannot be directly measured, but must be measured through some other measurable characteristic (variable). In the language of structural equation modeling, such constructs are also known as latent variables.

Reliability of a measurement instrument is the extent to which it yields consistent results when the characteristic being measured hasn't changed (Leedy & Ormrod, 2015). A reliable instrument is free of random and unstable error and hence can be used with confidence for research purposes (Cooper, 2003). In research involving questionnaire surveys, internal consistency reliability is regarded as the most important, and should always be measured before an instrument is used for research purposes (Leedy & Ormrod, 2015; Tavakol & Dennick, 2011; Nunnally, 1967; Cronbach, 1951). Internal consistency reliability is the extent to which all the items within a single instrument yield similar results (Leedy & Ormrod, 2015). The most often used measure for internal consistency reliability is Cronbach's Alpha, with Cronbach's Alpha values higher than 0.70 speaking to good instrument reliability (Streiner, 2003; Nunnally, 1967; Cronbach, 1951). The evaluation of validity and reliability of the instrument used in this study are discussed in the next section of this chapter.

Features of the Software

The CFA/SEM software Mplus (Version 7) was used to analyze the data. The "Maximum Likelihood Estimator (MLE)" method is the most common method of calculation/estimation used by CFA/SEM software in general, and has been proved to be the most consistent method of estimation/calculation (Kirby & Bollen, 2009; Kiefer & Wolfowitz, 1956; Scholz, 1985). Past research has shown MLE to be quite robust even in the event of a violation of the normality

assumption (Boomsma & Hoogland, 2001; Curran, West & Finch, 1996; Chou & Bentler, 1995; Chou, Bentler & Satorra, 1991; Muthén & Muthén, 2010, 2002, 1998; West, Finch, & Curran, 1995).

According to Schermelleh-Engel, Moosbrugger and Müller (2003), simulation studies suggest that under conditions of severe non-normality, MLE parameter estimates are still consistent. Schermelleh-Engel, Moosbrugger and Müller (2003) further state that corrections have been developed to adjust ML estimators to account for non-normality. The Satorra-Bentler scaled χ^2 (Satorra & Bentler, 2001, 1994) is computed on the basis of the model, estimation method, and sample fourth-order moments and holds regardless of the distribution of the observed variables (Hu & Bentler, 1999). As simulation studies demonstrate, robust maximum likelihood estimators based on the Satorra-Bentler scaled χ^2 statistic have relatively good statistical properties compared to least squares estimators (Boomsma & Hoogland, 2001; Hoogland, 1999). In robustness studies, the scaled χ^2 statistic outperformed the standard ML estimator (Chou, Bentler, & Satorra, 1991; Curran, West, & Finch, 1996), and robust standard errors yielded the least biased standard errors, especially when the distributions of the observed variables were extremely non-normal (Chou & Bentler, 1995).

Mplus software incorporates powerful flavors of the MLE method, one of which is the Robust Maximum Likelihood Estimator (MLR) otherwise known as the maximum likelihood parameter estimator with robust standard errors (Muthen & Muthen, 2010, 2002, 1998). The Mplus user's manual defines the MLR estimator as a maximum likelihood parameter estimates with standard errors and a chi-square test statistic (when applicable) that are robust to non-normality. According to Byrne (2016, 2011), the Mplus software program uses the calculation developed by Satorra and Bentler (2001, 1994) in the robust estimation method, which is capable

of analysis that is robust to non-normality including robust versions of the Cumulative Fit Index (CFI), Tucker-Lewis Index (TLI) and the Root Mean Square Error of Approximation (RMSEA).

Based on the above discussion, the MLR became our estimator of choice in the Mplus software for the data analysis involved in this study.

Data Analysis- Results

Statistical analysis of the data collected using the survey (questionnaire) was performed using the software packages SPSS-Statistics (Version 24) and MPLUS (Version 7). The construct names and a shortened version of the name for inputting into the software are shown in table 1.

Table 1.
Construct Names

<i>Technology Factors</i>	
Tech Factor- Innovativeness- Relative Advantage	<i>tech1innoRA</i>
Tech Factor- Innovativeness- Compatibility	<i>tech1innocompat</i>
Tech Factor- Innovativeness- Complexity	<i>tech1innocomplex</i>
Tech Factor- Security	<i>tech2secu</i>
Tech Factor- Privacy	<i>tech2priv</i>
Tech Factor-Usefulness	<i>tech3useful</i>
<i>Organizational Factors</i>	
Organization Factor- Change Readiness	<i>org1change</i>
Organization Factor- Level of Innovation	<i>org2level</i>
Organization Factor- Level of Process Innovation	<i>org2levelproc</i>
Organization Factor- Level of Product Innovation	<i>org2levelprod</i>
<i>Implementation Success</i>	
Implementation Success-Combined	<i>implemen</i>
Implementation Success-User Satisfaction	<i>imp1usersat</i>
Implementation Success- System Functionality	<i>imp2sysfunc</i>

Demographic Information

The sample comprised of consultants, project managers, healthcare facility administrators, physicians and/or nurses who had a minimum of one year of experience working on the implementation, maintenance and/or use of EMR in the healthcare industry. Table 2 shows the distribution of the years of experience the respondents had with implementation/use/maintenance of EMR in the five years prior to taking the survey. It is evident that a majority of the respondents (62%-63%) had between one to three years of experience with implementation/use/maintenance of EMR in the five years prior to taking the survey.

Table 2.

Summary of Years of Experience of the Respondents

<u>Years of Experience in Last</u> <u>Five Years-----></u>	1 to 3 years	>3 to 5 years
EMR Implementation (“deployment of a fully functional EMR system”)	62%	38%
EMR Maintenance (“ongoing updating of hardware and application programs including fixing of bugs and installing newer versions, with a view to ensuring EMR system and software perform optimally at all times”)	62%	38%
EMR Use (“use of EMR instead of the process or system that was in place before it”)	63%	37%

With respect to the recentness of the involvement of the respondents with an EMR implementation, the distribution of responses is shown in Table 3. 77.5% of the respondents were part of an EMR experience that ended within the last one year, 15.21% of the respondents were part of an EMR experience that ended between one to two years ago, and 6.67% of the respondents were in the midst of an EMR experience at the time of taking the survey.

Table 3.

Demographic Information- Recentness of Involvement

Answer Choices	Responses	
I was a part of an EMR experience that ended within the last one year	77.50%	372
I was a part of an EMR experience that ended between one to two years ago	15.21%	73
I am in the midst of an EMR experience	6.67%	32
I was a part of an EMR experience that ended between two to three years ago	0.63%	3
I was a part of an EMR experience that ended between three to four years ago	0.00%	0
I was a part of an EMR experience that ended between four to five years ago	0.00%	0
I was a part of an EMR experience that ended more than five years ago	0.00%	0
Total		480

With regards to the type of organization in which the EMR experience of the respondent took place, the distribution of responses is as shown in Table 4 and Figure 2. Multiple responses were allowed for this question since it is possible that the respondents' organizations fell into more than one category. The distribution of responses shows that one of the major types that the respondents' organization fell under is single hospital/multi-hospital system/integrated delivery system (83.51%). It also shows that a majority of the respondents were associated with bigger organizations such as hospitals (83.51%), public health organizations (42.17%) and community

health centers (30.06%) rather than with smaller organizations such as privately owned physician’s offices (4.38%) and ancillary clinical services providers (12.11%).

With regards to the highest educational qualification attained by the respondents, the distribution of responses is as shown in Table 5 and Figure 3. Multiple responses were allowed for this question since it is possible that the respondents possessed more than one educational qualification. The distribution of responses shows that a majority of the respondents possessed educational qualifications in Information Systems/Information Science (54.79%) followed by Management/Business (40%). An almost equal number of respondents possessed educational qualifications in Computer Science/Computer Engineering (27.92%) and Medicine (27.29%).

Table 4.

Demographic Information- Type of Organization

Answer Choices	Responses	
Single Hospital/Multi-Hospital System/Integrated Delivery System	83.51%	400
Public Health Organization	42.17%	202
Community Health Center	30.06%	144
Long-term care facility	21.92%	105
Ambulatory Clinic (Hospital Owned)	15.24%	73
Government Institution (Federal/State/Local Government)	14.61%	70
Ancillary Clinical Services Provider	12.11%	58
Payer/Insurer Managed Care Organization	9.60%	46
Academic Medical Center (healthcare provider affiliated with a college or university)	6.26%	30
Physicians Office (Privately Owned)	4.38%	21
Ambulatory Clinic (Independent)	1.25%	6
Other (please specify)	0.84%	4
Total Respondents: 479		

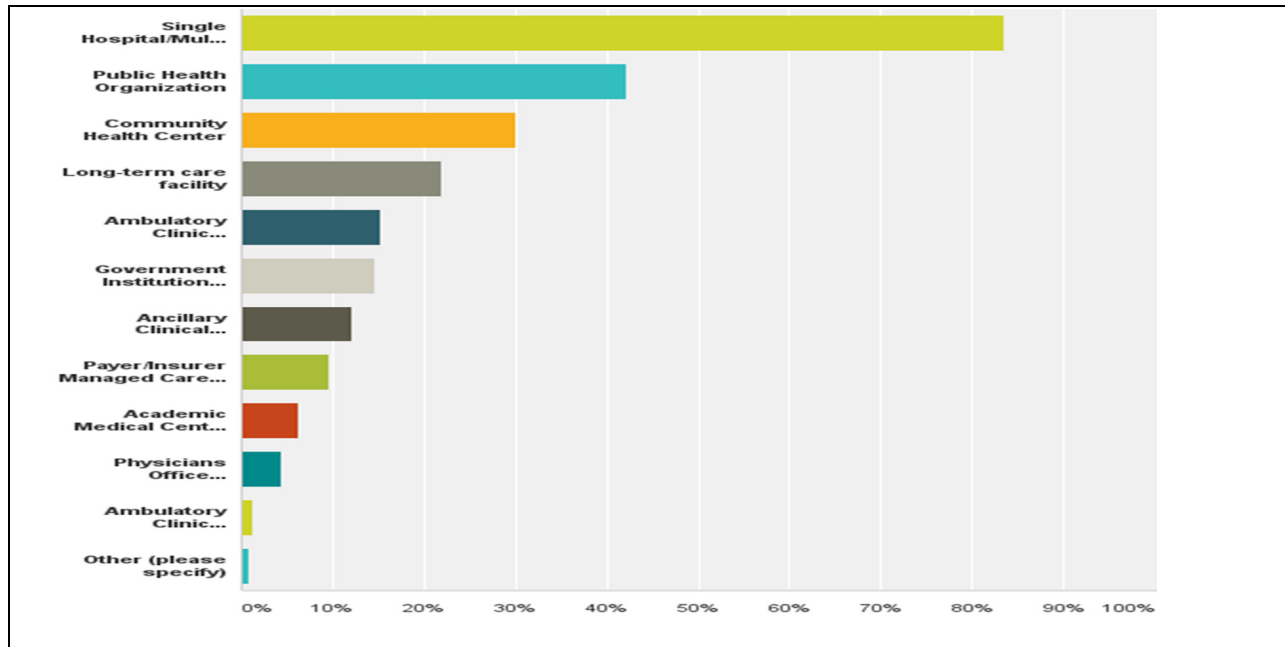


Figure 2. Demographic Information- Type of Organization

Table 5.

Demographic Information- Educational Qualification

Answer Choices	Responses
Information Systems and/or Information Science (includes Systems Analysis, Project Management, and Health Information Technology)	54.79% 263
Management/Business	40.00% 192
Computer Science and/or Computer Engineering (includes Programming, Networking and Software Engineering)	27.92% 134
Medicine (Doctor)	27.29% 131
Medicine (Nursing and/or other professions such as Physical Therapy and Pharmacy related)	11.67% 56
Medicine-Other (Includes Medical Equipment Technician education, Medical Transcription education, and Medical Billing education)	8.54% 41
Other (please specify)	0.42% 2
Total Respondents: 480	

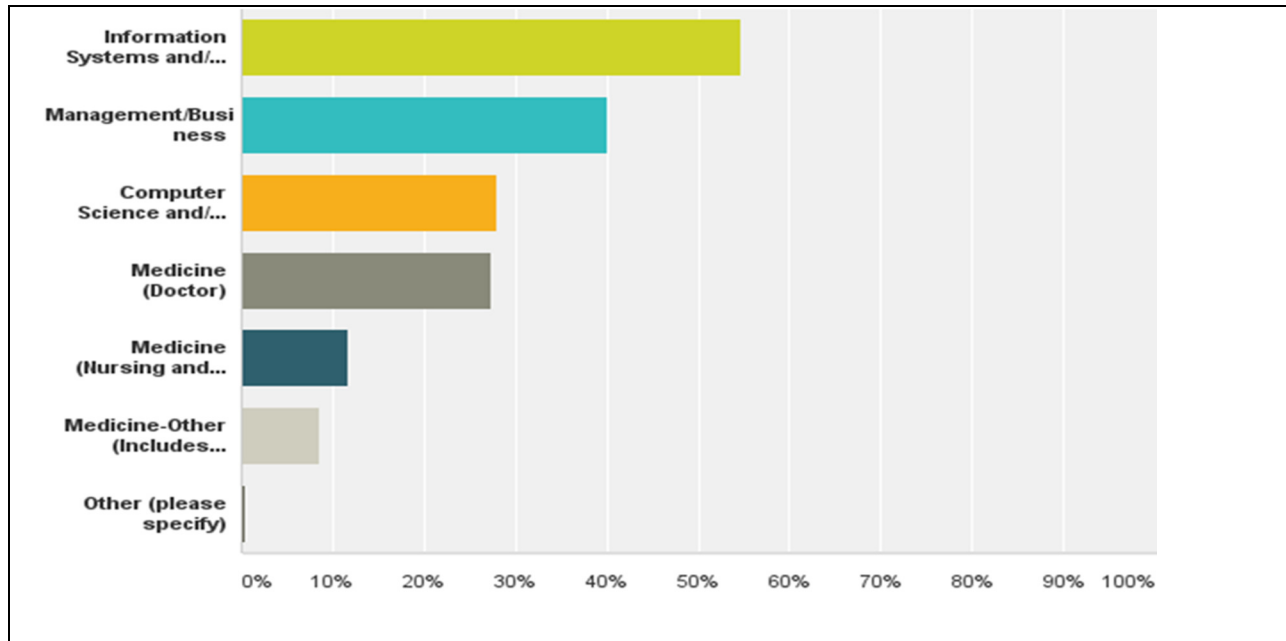


Figure 3. Demographic Information- Educational Qualification

With regards to the primary occupational area of the respondents, the distribution of responses is as shown in Table 6 and Figure 4. A large proportion of respondents (42.92%) had technical (IT/IS consultant, programmer, systems developer) as their primary occupational area while 31.25% of the respondents had medicine/medical professional as their primary occupational area. 16.04% of the respondents had project management as their primary occupational area.

With respect to the specific role they were in during their most recent EMR experience, the distribution of responses are as shown in Table 7 and Figure 5. While 33.75% of the respondents participated as project managers in their most recent EMR experience, 23.54% participated as information technology staff consultants/experts and 19.58% participated as hospital administrators.

Table 6.

Demographic Information- Primary Occupational Area

Answer Choices	Responses
Technical (examples: IT/IS Consultant, programmer, systems developer)	42.92% 206
Medical Professional (examples: doctor, nurse, physician's assistant, pharmacist, physical therapist)	31.25% 150
Project Management (examples: project manager, project assistant)	16.04% 77
Business (examples: business manager, operations manager)	9.17% 44
Other (please specify)	0.63% 3
Social (examples: social worker, volunteer)	0.00% 0
Total	480

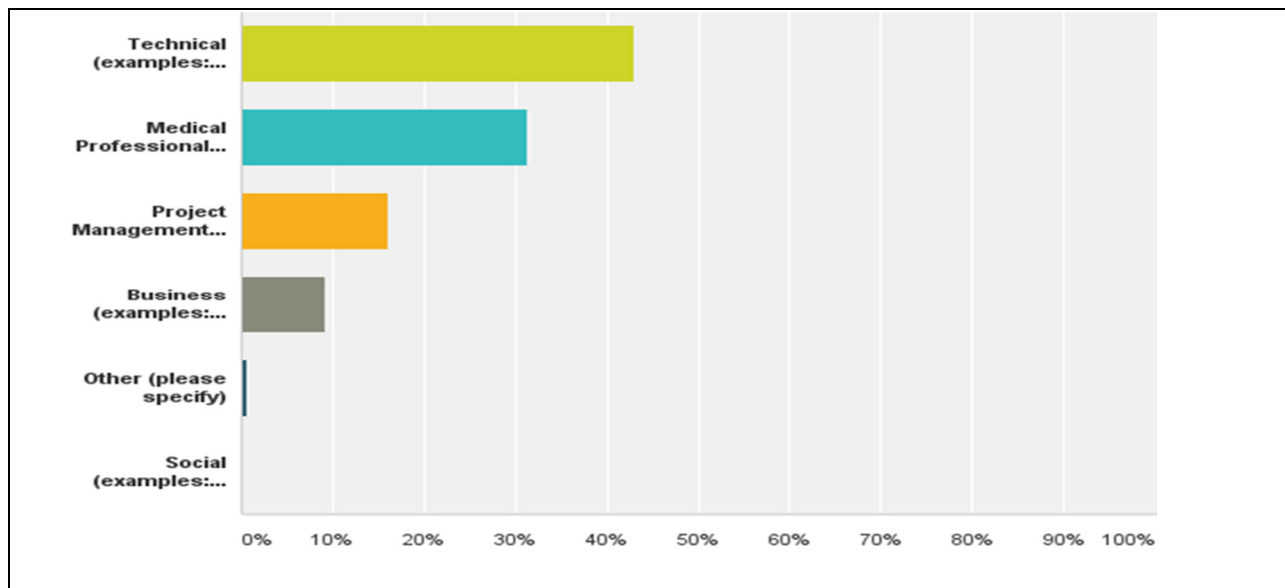


Figure 4. Demographic Information- Primary Occupational Area

Table 7.

Demographic Information- Role in EMR Experience

Answer Choices	Responses
Project Manager	33.75% 162
Information Technology Staff/Consultant/Expert (employee of the organization where EMR experience took place)	23.54% 113
Hospital Administrator	19.58% 94
Doctor	8.75% 42
Management Staff/Consultant(employee of the organization where EMR experience took place)	6.25% 30
Other Professional Hospital/Clinic Staff (Pharmacist, Physical Therapist etc.)	3.54% 17
Nurse	2.50% 12
Information Technology Staff/Consultant/Expert (not an employee of the organization where EMR experience took place)	1.04% 5
Management Staff/Consultant(not an employee of the organization where EMR experience took place)	1.04% 5
Other (please specify)	0.00% 0
Total	480

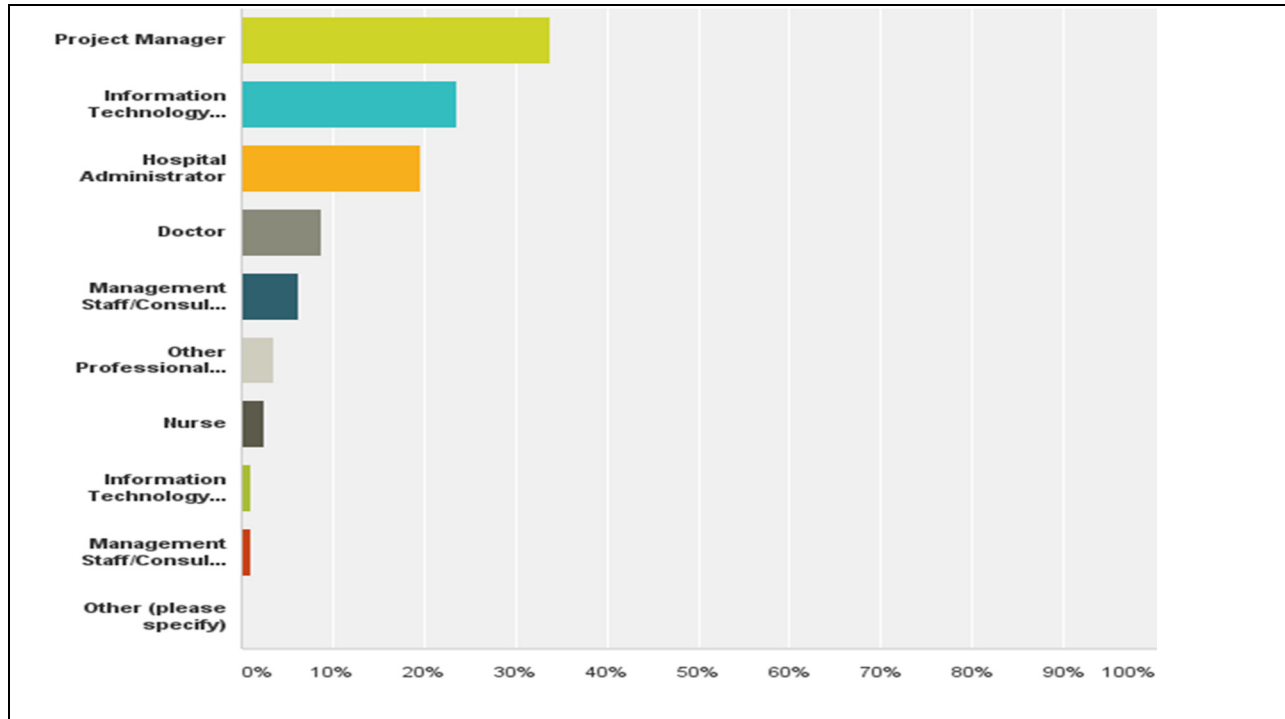


Figure 5. Demographic Information- Role in EMR Experience

With respect to how many EMR experiences the respondent had been involved with (excluding the most recent EMR experience), the responses were distributed as shown in Table 8 and Figure 6. 63.33% stated that their most recent EMR experience was also their first EMR experience, while 30% of respondents had been involved with one other EMR experience. Only 5% of the respondents had been involved with two other EMR experiences.

Table 8.

Demographic Information- Number of EMR Experiences

Answer Choices	Responses
This is my first EMR experience	63.33% 304
I have been involved with one other EMR experience	30.00% 144
I have been involved with two other EMR experiences	5.21% 25
I have been involved with three other EMR experiences	0.83% 4
I have been involved with more than five other EMR experiences	0.63% 3
I have been involved with four other EMR experiences	0.00% 0
I have been involved with five other EMR experiences	0.00% 0
Total	480

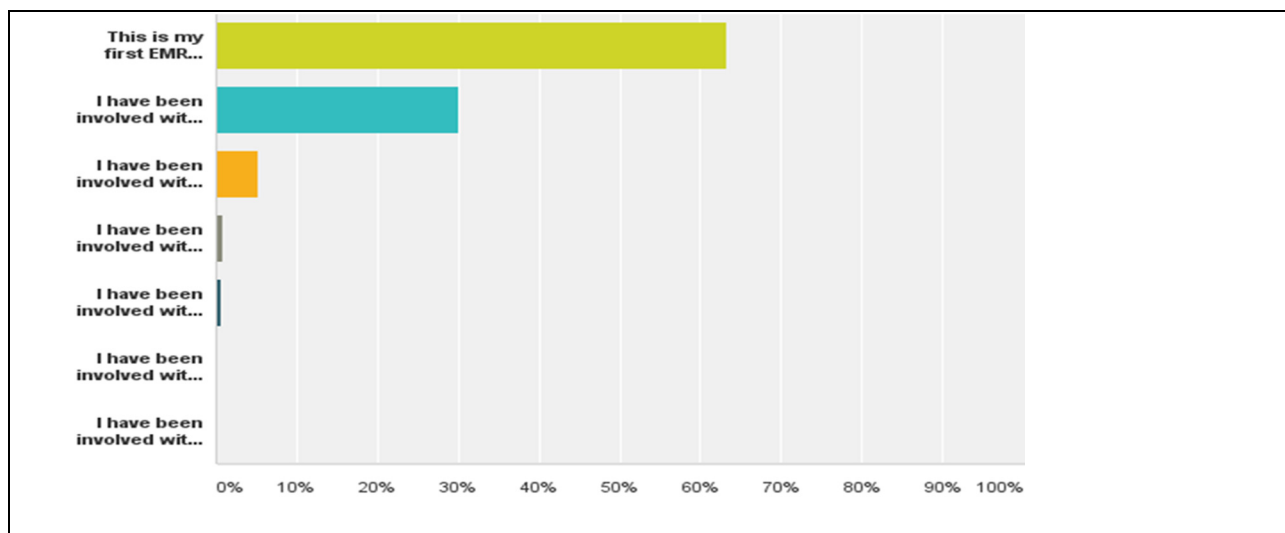


Figure 6. Demographic Information- Number of EMR Experiences

The approximate total annual revenue (in US dollars) of the organization in which the EMR was implemented was distributed as shown in Table 9 and Figure 7 per the survey responses. While 27.29% of the organizations had an approximate total annual revenue of greater than \$3 Million but less than \$5 Million, 20.83% of the organizations had an approximate total annual revenue of greater than \$5 Million but less than \$10 Million. The percentage of organizations that had an approximate total annual revenue of greater than \$1 Million but less than \$3 Million, and greater than \$0.5 Million but less than \$1 Million were about equally distributed at 17% each. While only 2.71% of the organizations had an approximate total annual revenue exceeding \$1 Billion, only 5.21% of the organizations had an approximate total annual revenue of \$0.5 Million or less. Assuming that annual revenues exceeding \$3 Million are substantial, 56% of the organizations the respondents were affiliated with organizations that had substantial annual revenues while only 26% had annual revenues of \$1 Million or less.

Table 9.

Demographic Information- Annual Revenue

Answer Choices	Responses	
Greater than 3 Million but less than 5 Million	27.29%	131
Greater than 5 Million but less than 10 Million	20.83%	100
Greater than 500,000 but less than 1 Million	17.71%	85
Greater than 1 Million but less than 3 Million	17.50%	84
Greater than 10 Million but less than 1 Billion	7.71%	37
500,000 or less	5.21%	25
Greater than 1 Billion	2.71%	13
Unable to estimate	1.04%	5
Total		480

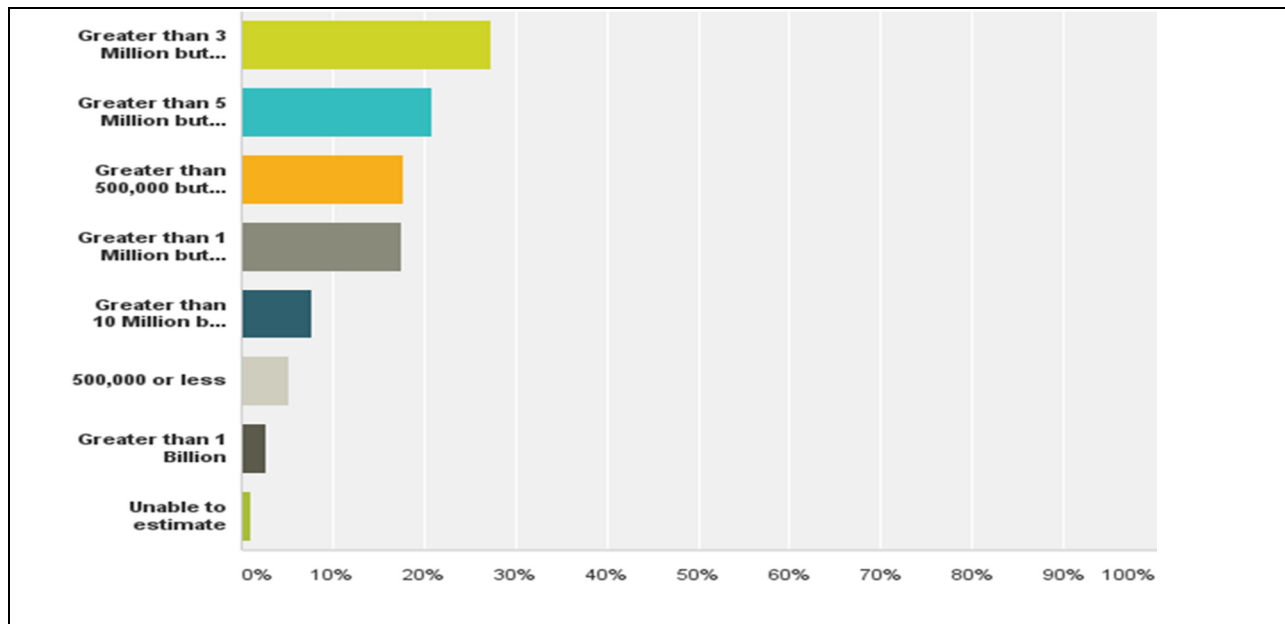


Figure 7. Demographic Information- Annual Revenue

With respect to the number of full time employees (including full time contractors) that worked on the EMR implementation at the location where the respondents' most recent EMR experience took place, the responses were distributed as shown in Table 10 and Figure 8. The percentage of organizations in which between 25 to 50 full time employees, between 50 to 100 full time employees and between 100 to 250 full time employees worked on the EMR implementation at the location where the respondents' most recent EMR experience took place were about equally distributed at 26.30%, 29.97% and 22.96% respectively, thus accounting for about 77% of the organizations involved. More than 500 full time employees worked on the EMR implementation at the location where the respondents' most recent EMR experience took place in only 5.43% of the organizations involved.

Table 10.

Demographic Information- How Many Worked on EMR Implementation

Answer Choices	Responses	
50 to 100	27.97%	134
25 to 50	26.30%	126
100 to 250	22.96%	110
250 to 500	12.53%	60
More than 500	5.43%	26
1 to 25	4.59%	22
Unable to estimate	0.21%	1
Total		479

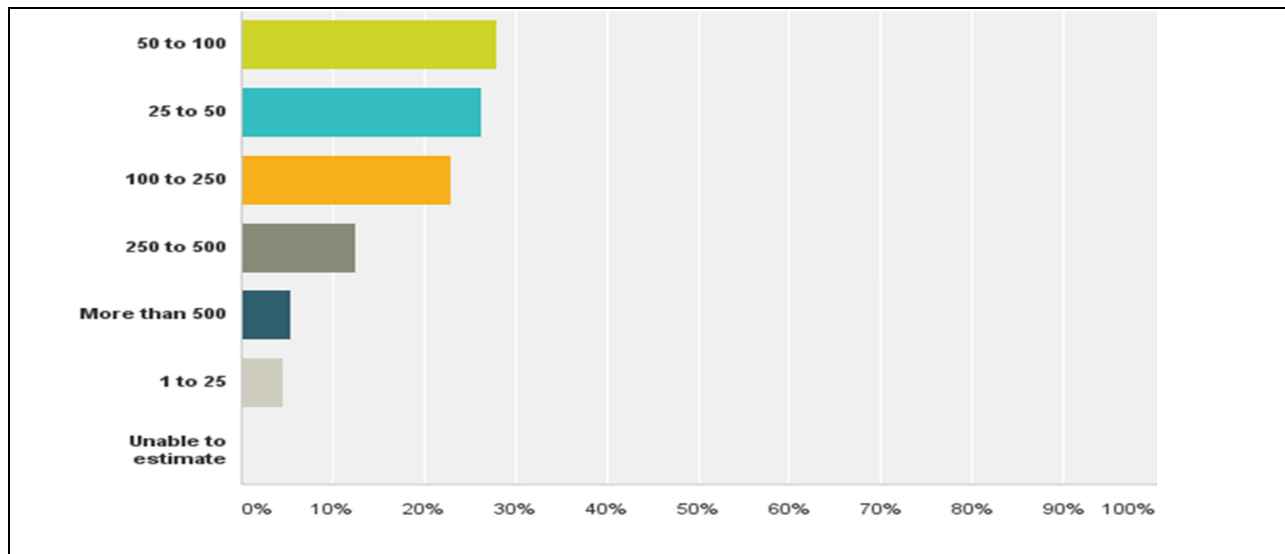


Figure 8. Demographic Information- How Many Worked on EMR Implementation

With respect to how many people working at the location where the respondents' most recent EMR experience took place were full time direct employees of the organization (excluding consultants, contractors and other staff that were not direct employees of the organization at this location), the responses were distributed as shown in Table 11 and Figure 9. While 25.68% of the organizations had 3001 to 6000 full time direct employees, 21.09% of the organizations had 1001 to 3000 full time direct employees. Only 8.56% of the organizations had as high as 6001 to 10,000 direct employees, while only 8.98% of the organizations had as low as 101 to 500 direct employees. This shows that a majority of the respondents were affiliated with healthcare organizations with a substantial employee head count.

With respect to the distribution of the region of the United States where the respondents most recent EMR experience took place (international locations were answered as 'other), the responses were distributed as shown in Table 12 and Figure 10. Most of the respondents' most recent EMR experience took place in organizations located in the western part of the United States (40.83%) followed by the southern part of the United States (29.17%) and the northeastern part of the United States (24.79%).

The distribution of the professional societies that the respondents' belonged to were distributed as shown in Table 13 and Figure 11. Multiple responses were allowed for this question since it is conceivable that the respondents may have belonged to more than one professional society. The highest percentage of respondents (92.29%) belonged to the Health Information and Management Systems Society (HIMSS) followed by the American Health Information Management Association (AHIMA) (45%) and the Project Management Institute (PMI) (23.96%).

Table 11.

Demographic Information- Number of Full-time Direct Employees at Location

Answer Choices	Responses	
3001 to 6000	25.68%	123
1001 to 3000	21.09%	101
751 to 1000	16.28%	78
501 to 750	12.32%	59
101 to 500	8.98%	43
6001 to 10000	8.56%	41
More than 10001	3.97%	19
1 to 100	2.92%	14
Unable to estimate	0.21%	1
Total		479

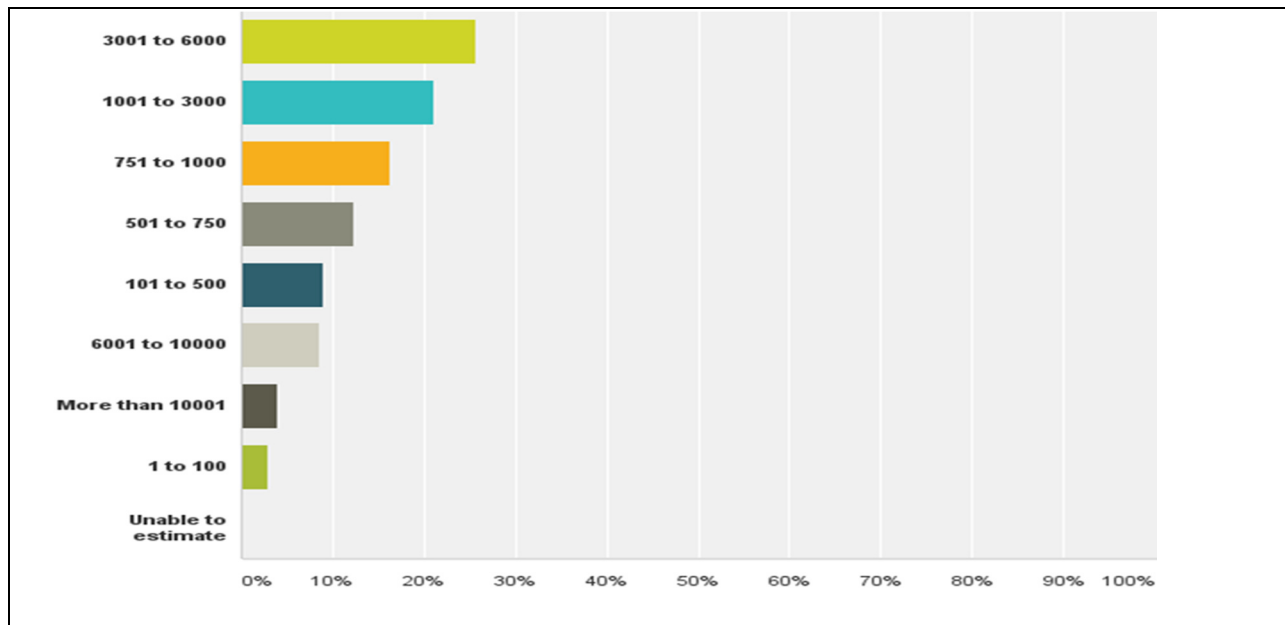


Figure 9. Demographic Information- Number of Full-time Direct Employees

Table 12.

Demographic Information- Distribution by Region

Answer Choices	Responses
West (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, California, Hawaii, Oregon, and Washington)	40.83% 196
South (Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, Washington D.C., West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas)	29.17% 140
Northeast (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania)	24.79% 119
Midwest (Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, N/S Dakota)	5.00% 24
Other (please specify)	0.21% 1
Total	480

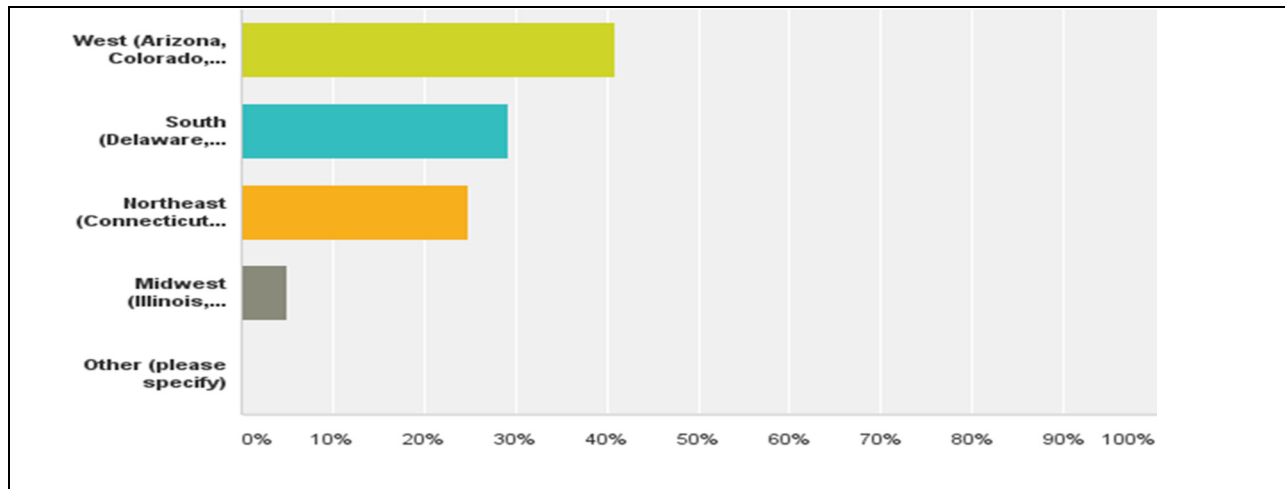


Figure 10. Demographic Information- Distribution by Region

Table 13.

Membership in Professional Societies

Answer Choices	Responses
Health Information and Management Systems Society (HIMSS)	92.29% 443
American Health Information Management Association (AHIMA)	45.00% 216
Project Management Institute (PMI)	23.96% 115
American Society for Quality (ASQ)	12.50% 60
Other (please specify)	3.96% 19
American Medical Association (AMA)	1.25% 6
Total Respondents: 480	

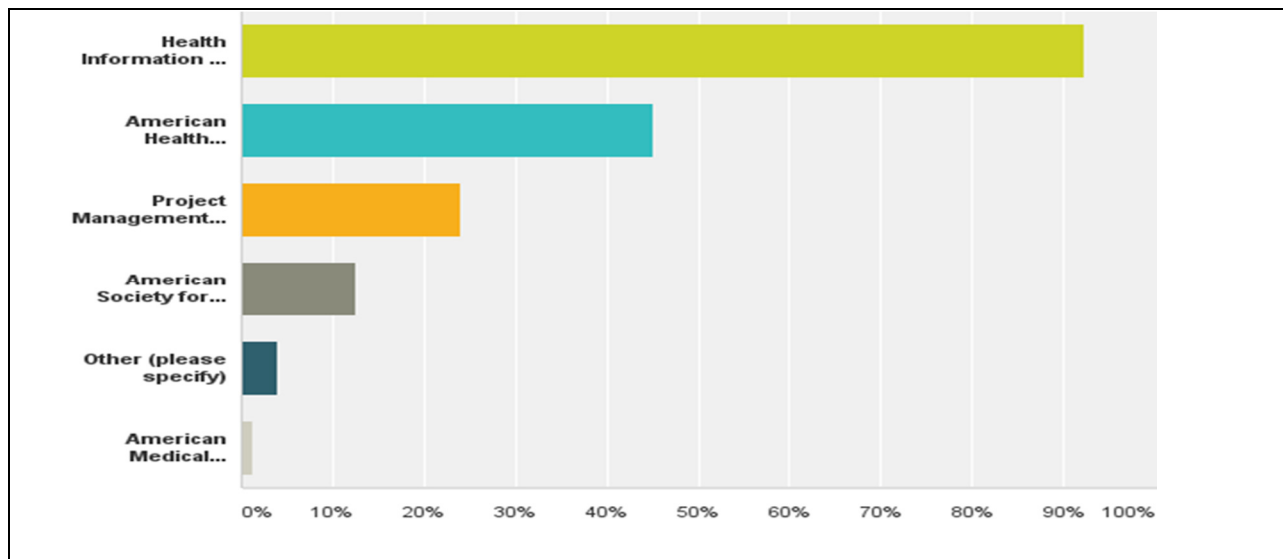


Figure 11. Demographic Information- Membership in Professional Societies

Calculation of Sample Size

For this study, using Bartlett, Kotrlik and Higgins (2001)'s sample size table, the sample size required for statistical significance is 370. Using Naing, Winn and Rusli (2006)'s sample size table and formula, the sample size required for statistical significance is 384. Using standard sample sizes tables/ calculators available on the Internet (www.surveymonkey.com, www.raosoft.com, www.surveysystem.com, www.powerandsamplesize.com, www.sciencebuddies.org), the sample size required for statistical significance is 384. The data collection for this study resulted in N=480 useful/useable data points thereby exceeding the sample size calculated by the above mentioned methods.

Result of Kaiser-Meyer-Olkin Test of Sampling Adequacy

As noted earlier, Kaiser-Meyer-Olkin (KMO) test values >0.70 are considered to be acceptable while values >0.80 (between 0.80 and 1.0) are considered to be very good (Kaiser, 1974; Meng, Tepanon & Uysal, 2008; Williams, Onsmann & Brown, 2010). For the data set used in this research study, the KMO measure of sampling adequacy was found to be 0.96.

Result of Bartlett's Test of Sphericity

As noted earlier, when the Bartlett's test results in a significance value of less than 0.05 ($p < 0.05$), this speaks to the suitability of the data collected to assess the central goal (dependent variable) of the study. For the data set used in this research study, the Bartlett's test of sphericity yielded a significance value of zero ($p < 0.01$).

Results Pertaining to Validity and Reliability

The items (questions) and constructs in this study were borrowed from published research studies in other domains conducted by experts and academicians with a significant amount of domain expertise. The originators/authors of the constructs have thoroughly assessed them for all forms of validity and confirmed that they have face validity, content validity, criterion validity and construct validity. Therefore the validity of the items and constructs were taken for granted. In addition, the pilot study (discussed in the previous chapter) confirmed the face validity of the questionnaire.

The originators/authors of the constructs have thoroughly assessed them for reliability as well, and so it was safe to take the reliability of the items and constructs for granted. Regardless, the Cronbach's Alpha values for the constructs used in this study were calculated and are presented in table 14. All of the Cronbach's Alpha values are >0.70 which speaks to the reliability of the instrument (questionnaire).

Results Pertaining to Confirmatory Factor Analyses

The results of the Confirmatory Factor Analysis (CFA) for the independent variables (technology factors and organizational factors) are displayed in the table 15 and table 16.

With respect to the technology factors, the CFI values are all >0.90 , TLI values are all >0.90 , and SRMR values are all <0.05 indicating a good model fit. The loadings of the questions (items) on their respective constructs are between 0.696 and 0.937 with most being >0.8 , indicating strong relationships (all were statistically significant $p<0.01$).

R-Square (Coefficient of Determination) values represent the proportion of variance in the dependent variable that is predictable from the independent variable. In CFA, the R-square value is interpreted as the proportion of variance that each variable shares with its corresponding construct (the latent variable). The R-square values for the technology factors range from 0.485 to 0.878 with most values being greater than 0.60.

Based on the CFA for the technology factors, it may be concluded that the corresponding latent variables are multi-dimensional constructs with the items representing the multi-dimensionality.

With respect to the organizational factors, the CFI, TLI and SRMR values for the construct 'organizational change readiness' were indicative of an acceptable fit (CFI=0.958, acceptable fit with CFI>0.90, TLI=0.949, acceptable fit with TLI>0.90, SRMR=0.024, acceptable fit with SRMR<0.05). However the CFI, TLI and SRMR values for the construct 'level of innovation in the organization' were not indicative of an acceptable fit (CFI=0.778, unacceptable fit with CFI<0.90, TLI=0.831, unacceptable fit with TLI<0.90, SRMR=0.08, unacceptable fit with SRMR>0.05). Upon further investigation and analysis, a possible reason for this was that the survey respondents who perceived a high level of process innovation in their organization did not perceive a high level of product innovation in their organization and vice-versa. Therefore when the items for the two innovations (product and process innovation) were hypothesized as one construct (namely the level of innovation), the directionally opposing nature of the responses to the two types of innovations caused the misfit.

Table 14.**Cronbach's Alpha Values**

<u>Construct</u>	<u>Items</u>	<u>Cronbach's Alpha</u>
<i>Tech1innoRA</i>	Q17, Q18, Q19, Q20, Q21	0.914
<i>Tech1innocompat</i>	Q22,Q23,Q24,Q25	0.866
<i>Tech1innocomplex</i>	Q26,Q27,Q28	0.817
<i>Tech2secu</i>	Q29,Q30,Q31	0.867
<i>Tech2priv</i>	Q32,Q33,Q34,Q35,Q36	0.928
<i>Tech3useful</i>	Q37,Q38,Q39,Q40,Q41	0.927
<i>Org1change</i>	Q54,Q55,Q56,Q57,Q58,Q59, Q60,Q61,Q62, Q63,Q64,Q65	0.972
<i>Org2levelprod</i>	Q66,Q67,Q68	0.938
<i>Org2levelproc</i>	Q69,Q70,Q71	0.906

Table 15.

Confirmatory Factor Analysis- Technology Factors

Confirmatory Factor Analysis- Technology Factors						
Construct	CFI	TLI	SRMR	Items/Questions	Factor Loading*	R-Square
(Latent Variable)				(Observable Variables)	(Correlation)	
<i>tech1innoRA</i>	0.962	0.924	0.026	Q17	0.824	0.679
				Q18	0.783	0.613
				Q19	0.843	0.711
				Q20	0.849	0.721
				Q21	0.86	0.74
<i>tech1innocompa</i>	0.973	0.919	0.026	Q22	0.79	0.623
				Q23	0.735	0.54
				Q24	0.771	0.595
				Q25	0.836	0.699
<i>tech1innocomple</i>	1	1	0	Q26	0.891	0.795
				Q27	0.825	0.68
				Q28	0.696	0.485
<i>tech2secu</i>	1	1	0	Q29	0.937	0.878
				Q30	0.709	0.503
				Q31	0.839	0.704
<i>tech2priv</i>	0.998	0.996	0.012	Q32	0.864	0.746
				Q33	0.833	0.694
				Q34	0.827	0.684
				Q35	0.853	0.728
				Q36	0.872	0.76
<i>tech3useful</i>	0.983	0.966	0.021	Q37	0.801	0.642
				Q38	0.818	0.669
				Q39	0.879	0.773
				Q40	0.868	0.753
				Q41	0.873	0.762
* All significant p<0.01						

Table 16.

Confirmatory Factor Analysis- Organizational Factors

Confirmatory Factor Analysis- Organizational Factors						
Construct	CFI	TLI	SRMR	Items/Qu	Factor Loading**	R-Square
(Latent Variable)				(Observa	(Correlation)	
<i>org1change</i>	0.958	0.949	0.024	Q54	0.86	0.74
				Q55	0.835	0.697
				Q56	0.867	0.752
				Q57	0.836	0.699
				Q58	0.871	0.759
				Q59	0.887	0.787
				Q60	0.86	0.74
				Q61	0.882	0.778
				Q62	0.868	0.753
				Q63	0.873	0.762
				Q64	0.876	0.767
				Q65	0.887	0.787
<i>org2level</i>	0.778	0.831	0.08	Q66	0.89	0.792
				Q67	0.861	0.741
				Q68	0.902	0.814
				Q69	0.762	0.581
				Q70	0.736	0.542
				Q71	0.763	0.582
<i>org2levelprod</i>	1	1	0	Q66	0.938	0.88
				Q67	0.869	0.755
				Q68	0.933	0.87
<i>org2levelproc</i>	1	1	0	Q69	0.91	0.828
				Q70	0.76	0.578
				Q71	0.968	0.937
** All significant p<0.01						

Based upon this reasoning, the latent variable 'level of innovation in the organization' (*org2level*) was split into two latent variables, namely, level of product innovation in the organization (*org2levelprod*) and level of process innovation in the organization (*org2levelproc*). The CFA was performed again. This time the CFI, TLI and SRMR values for the constructs *org2levelprod* (CFI=1.0, acceptable fit with CFI>0.90, TLI=1.0, acceptable fit with TLI>0.90, SRMR=0, acceptable fit with SRMR<0.05) and *org2levelproc* (CFI=1.0, acceptable fit with CFI>0.90, TLI=1.0, acceptable fit with TLI>0.90, SRMR=0, acceptable fit with SRMR<0.05) were indicative of an acceptable fit.

The loadings of the questions (items) on their respective constructs for the organizational factors ranged between 0.76 and 0.968 with most being >0.8, indicating strong relationships (all were significant at $p<0.01$). The R-square values for the organizational factors ranged between 0.578 to 0.937. Based on the CFA for the organizational factors, it may be concluded that the corresponding latent variables are multi-dimensional constructs with the items representing the multi-dimensionality.

The CFA for the dependent variable (implementation success) was performed with the two sub-constructs (user satisfaction and system functionality success) entered as such into the software. The output of the CFA performed using Mplus displayed a message indicating possible negative/residual variance for a latent variable (called Heywood case), correlation greater than or equal to one between two latent variables, or a linear dependency among more than two latent variables. A situation involving multicollinearity between items in the two sub-constructs user satisfaction and system functionality was suspected. Therefore it became necessary to hypothesize at this stage that the dependent variable items load into a single dependent variable

construct (implementation success) rather than into two sub-constructs in order to eliminate the problem of multi-collinearity.

The CFA for the dependent variable (implementation success) was repeated with the items (questions) for the two sub-constructs (user satisfaction and system functionality success) merged and loading on one single construct (namely, implementation success). This time, the output of the CFA did not contain any error messages. The results of this CFA are shown in table 17. The fit indices indicated acceptable fit (CFI=0.969, acceptable fit with CFI>0.90, TLI=0.962, acceptable fit with TLI>0.90, SRMR=0.028, acceptable fit with SRMR<0.05).

The loadings of the questions (items) on their respective constructs were all >0.744 indicating strong relationships between the construct and the observable variables measuring it. (all were significant at p<0.01). R-square values ranged from 0.554 to 0.848. Overall, the CFA for the dependent variables showed a good fit and confirmed that the construct had been adequately defined.

Table 17

Fit Indices and Factor Loadings Summary- Implementation Success

Table #. Fit Indices and Factor Loadings Summary- Implementation Success (Dependent Variable)						
Construct	CFI	TLI	SRMR	Items/Questions	Factor Loading***	R-Square
(Dependent Var.)				(Observable Variables)	(Correlation)	
<i>implemen</i>	0.969	0.962	0.028	Q42	0.747	0.558
				Q43	0.744	0.554
				Q44	0.77	0.593
				Q45	0.749	0.561
				Q46	0.759	0.576
				Q47	0.791	0.626
				Q48	0.785	0.616
				Q49	0.851	0.724
				Q50	0.861	0.741
				Q51	0.858	0.736
				Q52	0.883	0.78
				Q53	0.921	0.848
*** All significant p<0.01						

Results Pertaining to Structural Equation Modeling-Full Model Fit

Next the full SEM model was considered and the overall fit of the model as well as the fit between the constructs and the dependent variables (based on the estimated correlation matrix) were examined. The fit indices for the overall model were as follows: CFI=0.937 (acceptable fit with CFI>0.90), TLI=0.934 (acceptable fit with TLI>0.90) and SRMR= 0.04 (acceptable fit with SRMR<0.05). As noted earlier, for an acceptable model fit, CFI>0.90, TLI>0.90 and SRMR<0.05 are expected. Based on this, the overall model had an acceptable fit in this case.

However, the Mplus output displayed a message indicating a possible multicollinearity situation. Because the Mplus output indicated a possible multicollinearity situation, it became necessary to perform further analyses to understand the relationships between the factors and items, and to also find better ways of grouping them in order to mitigate the effects of the multicollinearity.

An EFA is performed generally for newly developed items in questionnaire surveys to generate one or more factors/constructs from a list of items and to match the items with corresponding factors. In this study, because pre-grouped items and corresponding factors/constructs were borrowed from published research works, it was not considered necessary to perform an EFA initially. However because of the Mplus message indicating the possibility of multicollinearity, it then became necessary to perform an EFA at this juncture. An exploratory factor analysis (EFA) was conducted using SPSS to examine the situation by considering the total amount of variation explained by the constructs.

Fabrigar et al. (1999) argue that the best extraction method in EFA is principal axis extraction when the data is suspected to be non-normal (with respect to SPSS). In questionnaire

surveys using Likert scales, the data is almost always non-normal and so using principal axis extraction is the safest bet (with respect to SPSS) as suggested by Fabrigar et al. (1999). Further, Tabachnick and Fidell (2012) recommend that an oblique rotation (which considers correlated factors) should be first performed during EFA and then the correlations between the factors should be examined to determine further course of action. Based on these recommendations, an EFA with principal axis extraction and oblique rotation was performed, and the correlations between the factors were examined.

After a careful examination of the results of the EFA, a five factor model with two distinct technology factors and three distinct organizational factors were gleaned as the optimal combination with which to run a full SEM model. The two distinct technology factors were complexity (Q26, Q27 and Q28 of the questionnaire) and a second factor comprised of the technology-related constructs relative advantage, compatibility, privacy, security and usefulness. This made sense from a theoretical standpoint as well, because complexity is the only technology factor that may be expected to correlate negatively with EMR implementation success (higher complexity of technology/EMR will be negatively associated with its implementation). The constructs relative advantage, compatibility, privacy, security and usefulness may be expected to correlate positively with EMR implementation success and would be well aligned as a second factor as suggested by the EFA output.

With respect to organizational factors, change readiness, level of process innovation and level of product innovation emerged as distinct factors based on the EFA. This made sense from a theoretical standpoint and agreed with the CFA results which, as noted earlier, had indicated that the constructs 'level of process innovation' and 'level of product innovation' should be considered as two distinct constructs instead of as one construct.

The full SEM was re-run with the above factors gleaned from the EFA. This time around, the fit indices indicated an acceptable model fit: CFI=0.931 (acceptable fit with CFI>0.90), TLI=0.927 (acceptable fit with TLI>0.90), SRMR=0.039 (acceptable fit with SRMR<0.05). The correlations for the newly emerged technology factor (combination of constructs relative advantage, compatibility, privacy, security and usefulness) and the organizational factor change readiness were significant ($p<0.05$). The correlation for complexity was not significant ($p=0.081$ i.e. $p>0.05$). The correlations for product innovation ($p=0.267$, i.e. $p>0.05$) and process innovation ($p=0.636$, i.e. $p>0.05$) were not significant.

When all the technology factors and organizational factors are considered together in the SEM model, the organizational factor change readiness and the technology factor (combination of constructs relative advantage, compatibility, privacy, security and usefulness) are found to be associated with EMR implementation success with statistical significance.

The constructs pertaining to each hypothesis were regressed with the dependent variable. In each case, the fit indices were in the acceptance range (CFI>0.90, TLI>0.90, SRMR<0.05). The estimated correlation matrix is summarized in table 18. The results of the estimated correlation matrix have to be looked at in conjunction with the results of the SEM analysis to arrive at an overall picture of hypothesis acceptance/rejection. This is discussed in the next section.

Table 18.

Fit Between Constructs and Dependent Variable

Table: Fit between Constructs and Dependent Variable			
Construct	Short Name	Hypothesis	Correlation
			Coeffecient
Tech Factor- Innovativeness- Relative Advantage	<i>tech1innoRA</i>	H1a	0.921
Tech Factor- Innovativeness- Compatibility	<i>tech1innocompat</i>	H1b	0.883
Tech Factor- Innovativeness- Complexity	<i>tech1innocomplex</i>	H1c	-0.33
Tech Factor- Security	<i>tech2secu</i>	H2a	0.952
Tech Factor- Privacy	<i>tech2priv</i>	H2b	0.958
Tech Factor-Usefulness	<i>tech3useful</i>	H3	0.99
Organization Factor- Change Readiness	<i>org1change</i>	H4	0.966
Organization Factor- Level of Process Innovation	<i>org2levelproc</i>	H5a	0.85
Organization Factor- Level of Product Innovation	<i>org2levelprod</i>	H5b	0.688

Hypotheses Acceptance/Rejection Discussion

Hypothesis H1a (Relative Advantage) With respect to the innovativeness of EMR, relative advantage will correlate positively with EMR implementation success: Supported.

The estimated correlation matrix yielded a correlation coefficient of 0.921 which indicates a strong positive correlation (absolute value of correlation coefficient > 0.75). The full SEM model indicates statistical significance for relative advantage as part of a technology factor combination consisting of the constructs relative advantage, compatibility, privacy, security and usefulness.

Therefore it is reasonable to conclude that hypothesis H1a is supported (null hypothesis is rejected).

Hypothesis H1b (Compatibility) With respect to the innovativeness of EMR, compatibility (with existing technologies) will correlate positively with EMR implementation success: Supported.

The estimated correlation matrix yielded a correlation coefficient of 0.883 which indicates a strong positive correlation (absolute value of correlation coefficient > 0.75). The full SEM model indicates statistical significance for compatibility as part of a technology factor combination consisting of the constructs relative advantage, compatibility, privacy, security and usefulness. Therefore it is reasonable to conclude that hypothesis H1b is supported (null hypothesis is rejected).

Hypothesis H1c (Complexity) With respect to the innovativeness of EMR, complexity will correlate negatively with EMR implementation success: Not Supported.

The estimated correlation matrix yielded a correlation coefficient of minus 0.33 which indicates a very weak negative correlation (absolute value of correlation coefficient < 0.5). The full SEM model indicates lack of statistical significance ($p=0.081$ i.e. $p > 0.05$) for complexity. Therefore it is reasonable to conclude that hypothesis H1c is not supported (fail to reject null hypothesis).

Hypothesis H2a (Security) Higher perception of data security in EMR will correlate positively with EMR implementation success: Supported.

The estimated correlation matrix yielded a correlation coefficient of 0.952 which indicates a strong positive correlation (absolute value of correlation coefficient > 0.75). The full SEM model indicates statistical significance for security as part of a technology factor combination consisting of the constructs relative advantage, compatibility, privacy, security and usefulness. Therefore it is reasonable to conclude that hypothesis H2a is supported (null hypothesis is rejected).

Hypothesis H2b (Privacy) Higher perception of data privacy in EMR will correlate positively with EMR implementation success: Supported.

The estimated correlation matrix yielded a correlation coefficient of 0.958 which indicates a strong positive correlation (absolute value of correlation coefficient > 0.75). The full SEM model indicates statistical significance for privacy as part of a technology factor combination consisting of the constructs relative advantage, compatibility, privacy, security and usefulness. Therefore it is reasonable to conclude that hypothesis H2b is supported (null hypothesis is rejected).

Hypothesis H3 (Usefulness) Higher perception of EMR usefulness will correlate positively with EMR implementation success: Supported.

The estimated correlation matrix yielded a correlation coefficient of 0.99 which indicates a strong positive correlation (absolute value of correlation coefficient > 0.75). The full SEM model indicates statistical significance for usefulness as part of a technology factor combination consisting of the constructs relative advantage, compatibility, privacy, security and usefulness. Therefore it is reasonable to conclude that hypothesis H3 is supported (null hypothesis is rejected).

Hypothesis H4 (Organizational Change Readiness) Higher levels of readiness for change within the organization will correlate positively with EMR implementation success: Supported.

The estimated correlation matrix yielded a correlation coefficient of 0.966 which indicates a strong positive correlation (absolute value of correlation coefficient > 0.75). The full SEM model indicates statistical significance for change readiness. Therefore it is reasonable to conclude that hypothesis H4 is supported (null hypothesis is rejected).

Hypothesis H5a (Level of Process Innovation in the Organization) Higher levels of process innovation in the organization will correlate positively with EMR implementation success:

Not Supported.

The estimated correlation matrix yielded a correlation coefficient of 0.85 which indicates a strong positive correlation (absolute value of correlation coefficient > 0.75). However, the full SEM model indicates lack of statistical significance ($p=0.267$, i.e. $p>0.05$) for level of process innovation in the organization. Therefore it is reasonable to conclude that hypothesis H5a is not supported (fail to reject null hypothesis).

Hypothesis H5b (Level of Product Innovation in the Organization) Higher levels of product innovation in the organization will correlate positively with EMR implementation success:

Not Supported.

The estimated correlation matrix yielded a correlation coefficient of 0.688 which indicates an acceptable positive correlation (absolute value of correlation coefficient > 0.5 but < 0.75 expected for a strong correlation). However, the full SEM model indicates lack of statistical significance ($p=0.636$, i.e. $p>0.05$) for level of product innovation in the organization. Therefore it is reasonable to conclude that hypothesis H5b is not supported (fail to reject null hypothesis).

Chapter Summary

In this chapter, the methodology and results pertaining to the statistical analyses of the survey results were presented. The CFA approach was used to ascertain the multi-dimensionality of the constructs. The full SEM model showed the significant relationships between the independent variables and the outcome variable implementation success. The constructs pertaining to each hypothesis were regressed with the dependent variable to address the question whether the hypotheses pertaining to this research study were supported or not supported. It was found that when SEM analysis was performed by considering all the constructs from the research model, only the organizational factor 'change readiness' and the technology factor (combination of constructs relative advantage, compatibility, privacy, security and usefulness) were associated with EMR implementation success with statistical significance. In the next chapter, these results will be analyzed from the perspective of current research literature and with respect to their academic and industry/practitioner implications.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

Introduction/Background

This chapter discusses the implications of the findings/results of the data analyses with respect to connection to research literature and practical implications relating to successful EMR implementation.

Based on a literature review of factors that were most often associated with the success and failure of technology implementations in e-commerce, e-education, e-manufacturing and other related areas, this research study proposed a framework for successful EMR implementations by way of identifying and ranking the key technology-related and organization-related factors associated with successful EMR implementations. Specific technology-related factors considered were the innovativeness of EMR (measured by considering the relative advantage, compatibility and complexity of EMR), privacy and security attributes of EMR, and usefulness of EMR. Specific organization-related factors considered were the change readiness of the organization and the level of innovation (product innovation and process innovation) in the organization where EMR was implemented.

Discussion of Findings

Table 19 summarizes the results presented in Chapter 4. This section examines these results in more detail, looking first at technology-related factors and later at organization-related factors. For each type of factor, we will summarize the results, relate them to the literature,

discuss the possible impact of demographics on outcomes, and consider the significance of the research's findings.

Table 19.

Summary of Relationship between Factors Isolated by Study and EMR Implementation Success

<u>Category</u>	<u>Factors</u>	<u>Expected Result</u>	<u>Actual Result</u>
Technology-Related	Innovativeness (Relative Advantage)	Positive Relationship	Positive Relationship
	Innovativeness (Compatibility)	Positive Relationship	Positive Relationship
	Innovativeness (Complexity)	Negative Relationship	No significant relationship
	Privacy and Security	Positive Relationship	Positive Relationship
	Usefulness	Positive Relationship	Positive Relationship
Organization-Related	Change Readiness	Positive Relationship	Positive Relationship
	Product Innovation	Positive Relationship	No significant relationship
	Process Innovation	Positive Relationship	No significant relationship

Technology-Related Factors

Overall Summary of Results

There is a positive association with statistical significance between innovativeness of EMR (based on its relative advantage and compatibility with existing technologies) and EMR implementation success. There is a positive association with statistical significance between

privacy and security of EMR and EMR implementation success. There is also a positive association with statistical significance between usefulness of EMR and EMR implementation success. However, as discussed later, the expected statistically significant negative relationship between system complexity and EMR implementation success was not found.

The statistical analysis results show statistically significant support for the association of all the technology-related factors considered in this study with implementation success except for complexity. Results of the exploratory factor analysis extracted two distinct technology-related factors based on the amount of variation in the dependent variable explained by them – complexity and a second factor that combines relative advantage, compatibility, privacy, security and usefulness. Exploratory factor analysis works on the basis of achieving a parsimonious fit and the results of the exploratory factor analysis are, of course, dependent on the particular selection of constructs and items used in the instrument and on the survey responses obtained (i.e. a different selection of constructs/items may produce different results).

The results of the full SEM analysis support the association of the technology-related factors relative advantage, compatibility, privacy, security and usefulness with EMR implementation success.

Making Sense of the Findings-Relating Findings to Literature

An extensive literature review pertaining to the importance of the technology-related factors chosen was presented in chapter two. Based on the application of Roger's theory of innovation and its' components in other domains, this study considered the association of relative advantage, compatibility and complexity with EMR implementation success. The results of this

study indicates that among the components of Roger's theory of innovation which were considered in this study, two of them, relative advantage and compatibility have a statistically significant association with EMR implementation success.

When the EMR under consideration provides improved quality of work and outputs, greater effectiveness, and greater control over the work in comparison to the system that was in place before it, it creates a situation of relative advantage leading to greater support for using it. This in-turn leads to implementation success. Likewise, when the EMR under consideration is compatible with existing technology by not contradicting existing IT applications, supporting the existing infrastructure, and is supported by IT human resources, there is relatively greater support within the organization for implementing it which facilitates implementation success. This outcome is consistent with research literature (discussed in detail in chapter two) which found that relative advantage and compatibility have been associated with the implementation success and/or adoption of computer based systems operating in other domains (Al-Jabiri & Sohail, 2012; Iavocu, Benbasat & Dexter, 1995; Lee et al., 2011; Lin, 2011, 2008, 2006; Teng, Grover & Guttler, 2002; Wu & Wang, 2005).

When the EMR under consideration is perceived to offer adequate levels of security by ensuring the data is well protected, storage and transfer of data are secure, and data access is strictly controlled, there is relatively greater support within the organization for implementing it which facilitates implementation success. Similarly when the EMR under consideration is perceived to offer adequate levels of privacy by ensuring that the confidentiality of test results are ensured, anonymity of the patient/user is assured, and data is out of the reach of unauthorized users, there is relatively greater support within the organization for implementing it which facilitates implementation success. This outcomes are consistent with research literature in other

domains (discussed in detail in chapter 2) which found that security and privacy are important considerations in the implementation success and/or adoption of computer based systems because they create trust in the users' minds with respect to using such systems (Fujinoki, Chelmecki & Henry, 2014; Hartono et al., 2014; Kim, Chung & Lee, 2011; Menachemi & Collum, 2011; Palvia et al., 2015; Yang et al., 2015).

As stated earlier, the Technology Acceptance Model (Davis, Bagozzi & Warshaw, 1989) posits that people form intentions to perform behaviors towards which they have a positive affect, and perceived usefulness contributes to forming such a positive affect with respect to adoption and use of technology. Along these lines, the current study finds that when the EMR under consideration is perceived to be useful by enabling the staff to work more quickly, improving job performance, increasing productivity, and making it easier to do the job, there is relatively greater support within the organization for implementing it which leads to implementation success. This outcome is also consistent with research literature in other domains (discussed in detail in chapter 2) which found that usefulness has an association with the implementation success and/or adoption of computer based systems (Amoako-Gyampah, 2007; Park, Kim & Ohm, 2015; Rana et al., 2015; Schoville & Titler, 2015).

Kwon and Zmud (1987) underscore the association of multiple contextual factors on technology implementation stages. One such factor they emphasize is the complexity characteristic of the technology itself. Tornatzky and Klein (1982) have shown that there is a negative relationship between the complexity of technology and its successful implementation. However, this study did not find statistical significance for the association of complexity on implementation success and in this respect, it contrasts with previous research studies in other domains (Agarwal & Prasad, 1997; Iacovou, Benbasat & Dexter, 1995; Lee et al., 2011; Teng,

Grover & Guttler, 2002; Tornatzky & Klein, 1982; Wu & Wang, 2005). A possible explanation for this is that most computer based systems employed in the healthcare industry tend to have a complex design or be complex in use due to the multitude of laws and the regulatory environment governing the field of healthcare in the United States. These systems require the operators/users to exercise a great deal of technical skills, caution and mental effort when working with them and tend to be frustrating to use. Further, healthcare workers are accustomed to working in a scientifically and technologically complex world, where computer systems may not appear as complex as the equipment and concepts that they handle daily. Last but not least, laws enacted in the United States such as ARRA and the HITECH act mandate the implementation of EMR.

Possible Impact of Demographics on the Outcomes

In any research study involving sampling, it is likely that the demographics of the respondents may have played a role in the outcomes that emerged. In this research study too, this is a possibility.

A majority of respondents were affiliated with hospitals and healthcare providers such as public health organizations, community health centers and long term care facilities which are likely to have significant people and monetary resources at their disposal. In addition, assuming that annual revenues exceeding \$3 Million could be considered substantial for the healthcare industry, 56% of the organizations the respondents were affiliated with had substantial annual revenues. Such organizations are likely to have spent relatively more time and money on training their staff in the use of EMR relative to smaller healthcare providers such as privately owned

physician's offices or payer/insurer managed care organizations. Well trained staff may be less sensitive to the complexity of EMR than relatively less trained staff. This may be yet another explanation for not finding a statistically significant association between EMR complexity and EMR implementation success in this study. Further, larger hospitals and healthcare providers may possess staff who are simply more comfortable with complexity than the staff at small clinics, for example.

Importance of the Findings

This study considered a unique set of technology-related factors that were hitherto unconsidered in the healthcare domain. The findings of this study provide concrete evidence that the relative advantage offered by EMR, its compatibility with existing systems, its privacy and security features, and its usefulness in enhancing better job performance are all significant factors that contribute to EMR implementation success. This understanding can be of use to practitioners in determining where to focus their resources during EMR implementations to get the desired result of a successful implementation with reduced or eliminated chances of failure. Based on this finding, industry practitioners will be well-advised to pay close attention to the attainment of relative advantage through addition of features that make the current EMR system under consideration more attractive to use in comparison to the system that was in place before it, compatibility with existing systems both technically and otherwise, privacy and security of data through implementation of authentication and authorization protocols and other security protocols, and attainment of overall usefulness of the EMR system being implemented by ensuring that the current EMR system under consideration enables employees to perform their job more efficiently and effectively. These recommendations are consistent with conventional

wisdom for implementing computerized systems. However results do not uphold the accepted theory for the negative role of complexity in successful system implementation.

It may be concluded from the findings that though complexity may be an undesirable trait in general, because operators/users in the healthcare field are already trained in and habituated with complex system use, complexity in EMR/EHR may not be a factor impeding implementation success. Considering together the findings of the study with respect to relative advantage and complexity of EMR, it is reasonable to conclude that designers and implementers of EMR systems should not shy away from complex systems or from modifications adding complexity if this added complexity has relative advantages over other alternatives. In fact, system complexity may be necessary in a healthcare environment in order to support other desirable elements, such as preserving privacy, providing security, ensuring overall effectiveness and compatibility with existing systems.

Organization-Related Factors

Overall Summary of Results

Results of the exploratory factor analysis extracted three distinct organization-related factors based on the amount of variation in the dependent variable explained by them – change readiness, level of process innovation and level of product innovation. There is a positive association with statistical significance between change readiness of the organization and EMR implementation success. However, contrary to expectations there was no statistically significant association found between either level of process innovation or level of product innovation and EMR implementation success.

Making Sense of the Findings-Relating Findings to Literature

An extensive literature review pertaining to the importance of the organization-related factors chosen was presented in chapter two. Several organization-related factors were found to be associated with successful implementations of innovations/new technologies from research literature. Of these, the organization-related factors most often associated with information technology implementations were change readiness of the organization, level of process innovation in the organization and the level of product innovation in the organization (Benjamin & Levinson, 1993; Calantone, Cavusgil & Zhao, 2002; Camison & Villar-Lopez, 2014; Cooper & Zmud, 1990; Gargeya & Brady, 2005; Holt et al., 2007). For this reason the above mentioned organization-related factors were considered in this research study.

The change readiness construct in this study considered norms for change readiness such as willingness to try new ideas, changing the way things are processed, ability of the people to come together to implement new ideas/technologies, willingness to share credit for successes and information as needed, and recognizing that mistakes/failures are a part of changing/trying new ideas. This study found a strong association between change readiness and implementation success. Research literature speaks to the greater chance of successfully implementing major changes even when the changes are not supported by all organizational members as long the organizational units display high levels of the norms for change readiness (Caldwell et al., 2008; Deutsch & Gerard, 1955; O'Reilly & Chatman, 1996; Ray, Barney & Muhanna, 2004). Thus the finding of this research study pertaining to change readiness for EMR implementations is consistent with research literature undertaken previously in other domains.

As explained in the research literature review presented in chapter two, a higher desire and ability to innovate within the organization typically results in successfully bringing a new

product or a technology innovation such as EMR to the market (Crane & Crane, 2006; Lee et al., 2016; Cakar & Erturk, 2010). However, this study found no statistical relationship between EMR implementation success and either product or process innovation within the organization. A possible explanation for this may have to do with the complicated and time consuming process involved in qualifying innovations for use in the healthcare industry. Due to the multitude of laws and the regulatory environment that govern the healthcare industry in the United States along with a strong motivation to prevent inadvertent harm to patients/human beings, there is an affinity for risk aversion in the healthcare industry and any system/technology change has to be subjected to an elaborate and painstaking qualification process which costs time and money. Operators/users in the healthcare environment are trained to be extremely cautious, especially when it comes to making changes. Conservative thinkers and conservative approaches are preferred by the healthcare industry. Considering this, it may not be an exaggeration to state that though innovation in patient treatment is cautiously embraced by the healthcare industry, innovating in the healthcare industry and high levels of innovation within a healthcare facility are neither expected nor rewarded. Healthcare organizations deal with so much complexity every day that they may just want technology to work, while considering innovating a luxury in a sense. This may explain the finding of this study that the association of the levels of product and process innovation with EMR implementation success is not statistically significant.

Possible Impact of Demographics on the Outcomes

Healthcare organizations such as hospitals and larger healthcare providers likely have more financial and human resources than smaller healthcare providers such as clinics run by doctors. Because every employee in an organization has to deal with change (or more aptly, resistance to change), the more the employee headcount in an organization, the higher the cumulative resistance to change and more important is the organization's readiness for change when a new technology is implemented. From the discussion about the demographics (in chapter four), it is clear that a majority of the respondents were affiliated with organizations having substantial annual revenues (hence relatively bigger organizations) and substantial employee headcount. Such healthcare organizations are more likely to have invested money and other resources in change management techniques and in developing their employees to deal with change effectively. This may have resulted in higher levels of change readiness in the organization and also resulted in their employees' positive attitudes towards implementation of changes/innovations such as EMR. This in-turn explains the result associating higher levels of readiness for change in the organization with EMR implementation success, and explains the statistical significance of change readiness with respect to EMR implementation success. A similar study involving healthcare organizations with lesser resources or of smaller size may very well yield different results.

Healthcare organizations such as hospitals and larger healthcare providers are likely to be very risk averse because any issues that arise is likely to put the future of such large and established healthcare organizations in jeopardy. Also the painstaking and expensive process involved in qualifying innovations in the healthcare industry in the United States may discourage established organizations such as hospitals and larger healthcare providers from being innovative

with respect to both, process innovations and product innovations. This is likely why this study did not find a statistically significant association between the level of the process innovation and product innovation in the organization and EMR implementation success.

Importance of the Findings

This study considered a unique set of organization-related factors that were hitherto unconsidered in the domain of EMR system implementation. The findings of this study provide concrete evidence that the change readiness of the organization is a significant factor that contributes to EMR implementation success. This is of great value to industry practitioners because it tells them where to focus their resources during EMR implementations to get the desired result of a successful implementation with reduced or eliminated chances of failure. Industry practitioners will be well-advised to practice change management techniques to mitigate resistance to change in order to improve the readiness of their organizations for change. An organization that is change ready will have a better chance of achieving EMR implementation success. The findings of this study should also assuage the fears of organizations that may not be very innovative as to their ability to successfully implement EMR. Because the United States healthcare industry adopts a highly cautious approach towards innovations, it is possible that healthcare organizations may not place a day-to-day emphasis on innovating process/product, but this will not hinder successful EMR implementation. This is contrary to earlier findings in other domains.

Limitations of the Study

This study did not consider the perspective of the healthcare receivers /patients. Hospitals are being increasingly judged by the perceptions of their patients with respect to the quality of care they received. Patient perceptions about the use of EMR by physicians and nurses while providing healthcare to them, and their perceptions about the overall efficiency and effectiveness of the healthcare organization is likely to impact their responses pertaining to EMR implementation and use. It is possible that if the perspective of the healthcare receivers /patients were considered, the results/findings will be different.

This study considered a unique combination of technology-related and organization-related factors. In addition this study did not consider all of Roger's factors. The factors considered were because they were found to be the ones most often associated with new technology implementation success from research literature. It is possible that if a different combination of technology-related and organization-related factors were to be considered, the results/findings will turn out to be different.

The survey respondents were drawn largely from those with memberships in professional associations such as the Healthcare Information and Management Systems Society (HIMSS), the American Healthcare Information Management Association (AHIMA), and the American Society for Quality (ASQ). Most members of these professional associations are likely a part of large hospital systems (which in-turn are likely to have abundant resources) and this is also evident from the demographics information. It is possible that the responses of those that do not belong to these professional associations or those that come from other types/sizes of healthcare organizations may be different.

As discussed in chapter 4, this study used convenience sampling involving a population that met the stated criteria, belonged to professional associations mentioned in the preceding paragraph, and attended conferences/meetings of such professional associations. This limits the generalizability of the results.

This study was conducted in the United States. Hence it is possible that all of the respondents were citizens of the United States. If this study were done in other countries/cultures thereby including citizens of those countries/cultures, it is possible that the results/findings will turn out to be different.

This study focused on EMR implementation. EMR is, but one subset of Healthcare Information Technology (HIT). There are many other subsets of HIT such as Mobile Health (mHealth), Telemedicine, and Electronic Health (E-Health). This study did not consider these other subsets of HIT.

Opportunities for Future Research

EMR/EHR offers patients the opportunity to access, view and share their own health records through the Internet. Through healthcare portals offered by some healthcare institutions today, patients are able to even communicate about their healthcare records with their doctor/nurse and obtain clarifications and healthcare recommendations. Some hospitals today provide patients with a tablet/notebook upon admission as in-patients so that they can view the progression of their treatment and their healthcare records in real time. Due to such benefits to the patients, future research should consider the perspectives of patients with regards to EMR/EHR implementations. It will be interesting to see if / how the results of the study change

when patient perspectives are considered. It is recommended that future research consider patient perspectives.

Future research could consider more or all of Roger's factors. It is possible that the results may be different if more or all of Roger's factors were considered due to the likelihood of moderating effects. The need for security and privacy with respect to patient information are dependent on cultural factors including religious factors. For example, certain test results pertaining to a woman's health may be subjected to a much higher degree of privacy in certain countries/cultures than they are in the United States owing to the cultural and religious factors in these countries/cultures. By a similar token, organizational values are also likely to be a function of the cultural values and vary by country/culture. For example, organizations located in certain countries may consider some healthcare /patient information to be less private than others and may be willing to share such information with other hospitals and their government, whereas this may be in contradiction of the practices in the United States where a majority of the healthcare / patient information sharing is subject to strict laws. Therefore the survey responses obtained from respondents situated in other countries/cultures may be quite different from those of United States citizens when it comes to issues such as security and privacy. Future research could include survey respondents from other countries/cultures to see if/how the results differ. In other words, it is recommended that future research consider the impact of cultural and religious differences.

Change readiness and resistance to change are significant aspects of organizational culture dependent upon how change is managed within organizations. In the light of the findings of this study about the association of change management with EMR implementation success, there is a need to identify specific techniques most useful in implementing change readiness for

an EMR (and other such computer-based / technology) implementations in risk adverse health organizations. Future research could focus on identifying and ranking such techniques.

Since the current state of technology in countries around the world is not the same, the views of respondents from various countries with respect to implementation of technology innovations such as EMR is likely to be different from those of the citizens of the United States. The dictum ‘what is good for the goose is good for the gander’ is not valid in this context. For example, based on the current state of healthcare related technology in a particular country and the healthcare needs of their public, the EMR system may or may not offer a net relative advantage to them over the system they currently have in place. Here again, considering the survey responses from other countries (which would likely involve a different demographic group) in future research may help to see how the state of technology impacts EMR implementation success.

Future research could consider a case-study based approach involving EMR implementations in individual doctors’ offices/clinics since such an approach is likely to reveal perspectives and issues specific to small-scale medical establishments. Such an approach may also be conducive to studying EMR implementations in rural and less developed areas.

This study focused on EMR implementation. EMR is, but one subset of Healthcare Information Technology (HIT). Future research could consider the impact of the technology-related and organization-related factors considered in this study on the many other subsets of HIT such as Mobile Health (mHealth), Telemedicine, and Electronic Health (E-Health).

A fertile ground for future research lies in further exploration of the differences among organizational domains and how these differences may translate into differing research results.

This research identified one domain-specific example where accepted research simply cannot be directly applied. There likely are others.

Summary/Concluding Comments

The successful implementation of EMR/EHR has assumed considerable importance in the United States in the light of the American Recovery and Reinvestment Act (ARRA) and the Health Information Technology for Economic and Clinical Health (HITECH) acts of 2009. The benefits arising from the use of EMR/EHR for patients and healthcare providers have made the successful implementation of EMR/EHR important the world over. Research literature indicates that the implementation of EMR/EHR has been slow and fraught with problems. Though IT/MIS implementations in other domains have been extensively studied, there have been few studies concerned with successful EMR/EHR implementations such as this one. Therefore a research gap existed which needed to be addressed.

The objective of this research work was to study if a unique set of factors (technology-related and organization-related factors) that have been most often associated with successful information technology / management information systems implementations in other domains (such as e-commerce, e-manufacturing and e-education) are also associated with successful EMR/EHR implementations. No other study in the healthcare domain has considered the impact of the unique set of technology-related and organization-related factors considered in this study on EMR implementation success. The unique set of technology-related and organization-related factors considered in this study are the ones most often associated with successful technology implementations in other/related domains.

Findings of the study are interesting both in terms of the factors important in other domains that are also associated with EMR implementation success, and in terms of the factors important in other domains that are not associated with EMR implementation success. Factors

that are associated with implementation success in both EMR and in other traditionally studied system domains are:

- Level of system innovation.
- System handling of privacy and security issues
- Organizational readiness for change

On the other hand, factors that are associated with implementation success in other traditionally studied domains, but not with EMR implementation success are:

- System complexity
- Organization's process innovativeness
- Organization's product innovativeness

This study provides useful information to practitioners and researchers concerning which of the factors studied are of greatest importance in the successful implementation of EMR systems. It provides concrete evidence that the relative advantage offered by EMR, its compatibility with existing systems, its privacy and security features, and its usefulness in enhancing better job performance are all significant factors in the successful implementation of EMR systems. It also uncovered the finding that complexity in EMR/EHR may not be a factor impeding implementation success which is contrary to literature and conventional wisdom.

At least equally importantly, the research calls attention to the fact that academic research does a disservice when it assumes that once something is demonstrated conclusively for some domains, results automatically will apply to other domains.

APPENDICES

APPENDIX 1: CONSTRUCTS, ITEMS AND THEIR SOURCES

<u>Construct</u>	<u>Item (Question)</u>	<u>Source</u>	<u>Original Wording in Source</u>
(Technology Factor) Innovativeness of the Technology: Relative Advantage	Using EMR improves the quality of work.	Moore and Benbasat (1991)	Using a personal work station improves the quality of work I do
(Technology Factor) Innovativeness of the Technology: Relative Advantage	The advantages of using EMR far outweigh its disadvantages.	Moore and Benbasat (1991)	The disadvantages of my using a personal work station far outweigh the advantages
(Technology Factor) Innovativeness of the Technology: Relative Advantage	Overall, using EMR is advantageous.	Moore and Benbasat (1991)	Overall, I find using a personal work station to be advantageous in my job
(Technology Factor) Innovativeness of the Technology: Relative Advantage	Using EMR enhances effectiveness on the job.	Moore and Benbasat (1991)	Using a personal work station enhances my effectiveness on the job.
(Technology Factor) Innovativeness of the Technology: Relative Advantage	Using EMR gives greater control over the work.	Moore and Benbasat (1991)	Using a personal works station gives greater control over my work.
(Technology Factor) Innovativeness of the Technology: Compatibility	EMR is acceptable to the prevalent corporate culture and value system.	Lin (2008)	Implementation of e-business is acceptable to corporate culture and value system.
(Technology Factor) Innovativeness of the Technology: Compatibility	EMR does not contradict the current internal IS applications.	Lin (2008)	Implementation of e-business does not contradict the current internal IS applications.
(Technology Factor) Innovativeness of the Technology: Compatibility	EMR is supported by the existing IS infrastructure.	Lin (2008)	Implementation of e-business is supported by the existing IS infrastructure.
(Technology Factor) Innovativeness of the Technology: Compatibility	EMR is supported by the organizational IT human resources.	Lin (2008)	Implementation of e-business is supported by the organizational IT human resources.

APPENDIX 1: CONSTRUCTS, ITEMS AND THEIR SOURCES (Continued)

<u>Construct</u>	<u>Item (Question)</u>	<u>Source</u>	<u>Original Wording in Source</u>
(Technology Factor) Innovativeness of the Technology: Complexity	Using EMR requires a lot of mental effort.	Tan and Teo (2000); Moore and Benbasat (1991)	Mobile banking requires a lot of mental effort.
(Technology Factor) Innovativeness of the Technology: Complexity	Using EMR requires technical skills.	Al-Jabri and Sohail (2012); Laukkanen and Cruz (2009)	Mobile banking requires technical skills
(Technology Factor) Innovativeness of the Technology: Complexity	Using EMR can be frustrating.	Tan and Teo (2000); Moore and Benbasat (1991)	Mobile banking can be frustrating.
(Technology Factor) Security	EMR offers the highest possible data protection in general.	Wilkowska and Ziefle (2012)	How important are the following security factors when it comes to use medical assistive devices: highest possible data protection in general
(Technology Factor) Security	EMR provides secure data storage and transfer.	Wilkowska and Ziefle (2012)	How important are the following security factors when it comes to use medical assistive devices: self-determination of data storage and transfer
(Technology Factor) Security	EMR enables strict data access control.	Wilkowska and Ziefle (2012)	How important are the following security factors when it comes to use medical assistive devices: strict data access control
(Technology Factor) Privacy	EMR safeguards anonymity.	Wilkowska and Ziefle (2012)	How important are the following security factors when it comes to use medical assistive devices: safeguarding of anonymity
(Technology Factor) Privacy	EMR protects intimacy.	Wilkowska and Ziefle (2012)	How important are the following security factors when it comes to use medical assistive devices: protection of intimacy
(Technology Factor) Privacy	EMR provides confidentiality of test results.	Wilkowska and Ziefle (2012)	How important are the following security factors when it comes to use medical assistive devices: confidentiality of measurement results

APPENDIX 1: CONSTRUCTS, ITEMS AND THEIR SOURCES (Continued)

<u>Construct</u>	<u>Item (Question)</u>	<u>Source</u>	<u>Original Wording in Source</u>
(Technology Factor) Privacy	EMR has a non-stigmatizing design.	Wilkowska and Ziefle (2012)	How important are the following security factors when it comes to use medical assistive devices: not stigmatizing design
(Technology Factor) Privacy	EMR is invisible to outsiders and unauthorized users.	Wilkowska and Ziefle (2012)	How important are the following security factors when it comes to use medical assistive devices: invisibility to outsiders
(Technology Factor) Usefulness	EMR enables working more quickly.	Davis (1989)	Using the (new technology/system-) electronic mail enables me to accomplish tasks quickly
(Technology Factor) Usefulness	Using EMR improves my job performance.	Davis (1989)	Using electronic mail proves my job performance
(Technology Factor) Usefulness	Using EMR increases productivity.	Davis (1989)	Using electronic mail increases my productivity
(Technology Factor) Usefulness	Using EMR makes it easier to do the job.	Davis (1989)	Using electronic mail makes it easier to do my job
(Technology Factor) Usefulness	Overall, EMR is useful.	Davis (1989)	I find the electronic mail system useful in my job
(Organizational Factor) Change Readiness	In general, there is an expectation that new things will be tried even when it is possible that they may not work.	Caldwell et al. (2008)	Generally, we expect to try new things even when it is possible that the new ideas won't work out
(Organizational Factor) Change Readiness	The most respected members of the department/organization display a sense of urgency about changing the way they do things when the situation requires it.	Caldwell et al. (2008)	The most respected members of our department display a sense of urgency about changing the way we do things

APPENDIX 1: CONSTRUCTS, ITEMS AND THEIR SOURCES (Continued)

<u>Construct</u>	<u>Item (Question)</u>	<u>Source</u>	<u>Original Wording in Source</u>
(Organizational Factor) Change Readiness	When faced with a problem or challenge, the expectation is that organizational/departmental staff will work together to deal with it.	Caldwell et al. (2008)	When we have a problem or challenge, the expectation is that all of us will work together to deal with it
(Organizational Factor) Change Readiness	There is an expectation that people will move quickly in response to new initiatives, policy or some other type of change.	Caldwell et al. (2008)	When there is a new initiative, policy, or some other type of change, we expect people to move quickly in response to it
(Organizational Factor) Change Readiness	The willingness of staff to be open and share information is valued.	Caldwell et al. (2008)	We value department members' willingness to be open and share information
(Organizational Factor) Change Readiness	Mistakes are seen as a normal part of efforts in trying new approaches.	Caldwell et al. (2008)	When someone in our department tries new approaches, we see mistakes as a normal part of their efforts
(Organizational Factor) Change Readiness	Credit for successes are shared with one another and with the team.	Caldwell et al. (2008)	People in our department expect to share credit for successes with one another

APPENDIX 1: CONSTRUCTS, ITEMS AND THEIR SOURCES (Continued)

<u>Construct</u>	<u>Item (Question)</u>	<u>Source</u>	<u>Original Wording in Source</u>
(Organizational Factor) Change Readiness	The people most respected are those who support trying new things even if those efforts do not work out as well as expected.	Caldwell et al. (2008)	The people in who are most respected in our department are those who support trying new things even if those efforts do not work out as well as expected
(Organizational Factor) Change Readiness	We move quickly in responding to change.	Caldwell et al. (2008)	We move more quickly than other departments in responding to change
(Organizational Factor) Change Readiness	Team players are valued in the department and the organization.	Caldwell et al. (2008)	In our department, we value people who are team players
(Organizational Factor) Change Readiness	People who try new things are valued, even when they are not successful.	Caldwell et al. (2008)	Generally, we value people who try new things—even if they are not successful
(Organizational Factor) Change Readiness	There is a commitment to changing the way things are done.	Caldwell et al. (2008)	The members of our department express a commitment to changing the way we do things
(Organizational Factor) Level of Innovation (Product Innovation) in the Organization	The degree of product innovation in the organization is high.	Ju, Li & Lee (2006)	The degree of product innovation to the firm is high.
(Organizational Factor) Level of Innovation (Product Innovation) in the Organization	The degree of product innovation relative to the competitors is high.	Ju, Li & Lee (2006)	The degree of product innovation relative to the competitors is high.
(Organizational Factor) Level of Innovation (Product Innovation) in the Organization	The potential applications of the product innovation in the organization are high.	Ju, Li & Lee (2006)	The potential applications of the product innovation in my organization are high.
(Organizational Factor) Level of Innovation (Process Innovation) in the Organization	The degree of process innovation in the organization is high.	Ju, Li & Lee (2006)	The degree of process innovation to the firm is high.

APPENDIX 1: CONSTRUCTS, ITEMS AND THEIR SOURCES (Continued)

<u>Construct</u>	<u>Item (Question)</u>	<u>Source</u>	<u>Original Wording in Source</u>
(Organizational Factor) Level of Innovation (Process Innovation) in the Organization	The degree of process innovation relative to the competitors is high.	Ju, Li & Lee (2006)	The degree of process innovation relative to the competitors is high
(Organizational Factor) Level of Innovation (Process Innovation) in the Organization	The potential applications of the process innovation in the organization are high.	Ju, Li & Lee (2006)	The potential applications of the process innovation in my organization are high.
(Dependent Variable) [*not binary answers, based on multi-point Likert scale] Implementation Success (System Functionality Success)	EMR provides or will provide good payback for cost	Do-Carmo-Caccia-Bava, Guimaraes & Harrington (2006)	(The specific system has) provided good payback for cost
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (System Functionality Success)	EMR is reliable and problem free	Do-Carmo-Caccia-Bava, Guimaraes & Harrington (2006)	Been reliable and problem free
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (System Functionality Success)	EMR facilitates an improved turnaround or response time	Do-Carmo-Caccia-Bava, Guimaraes & Harrington (2006)	Improved turnaround or response time

APPENDIX 1: CONSTRUCTS, ITEMS AND THEIR SOURCES (Continued)

(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (System Functionality Success)	EMR creates a competitive advantage	Do-Carmo-Caccia-Bava, Guimaraes & Harrington (2006)	Provided a competitive advantage
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (System Functionality Success)	EMR increases employee satisfaction overall	Do-Carmo-Caccia-Bava, Guimaraes & Harrington (2006)	Resulted in increased employee satisfaction
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (System Functionality Success)	EMR reduces effort or costs	Do-Carmo-Caccia-Bava, Guimaraes & Harrington (2006)	Reduced our efforts or costs
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (System Functionality Success)	EMR is easy to use	Do-Carmo-Caccia-Bava, Guimaraes & Harrington (2006)	Been easy to use
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (System Functionality Success)	Provide an overall rating in your opinion for the functionality and value offered by EMR	Do-Carmo-Caccia-Bava, Guimaraes & Harrington (2006)	Overall results

APPENDIX 1: CONSTRUCTS, ITEMS AND THEIR SOURCES (Continued)

<u>Construct</u>	<u>Item (Question)</u>	<u>Source</u>	<u>Original Wording in Source</u>
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (User Satisfaction)	How adequately do you feel the EMR system meets information processing needs?	Seddon and Yip (1992)	How adequately do you feel your GL (computer based general ledger) system meets the information processing needs of your area of responsibility?
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (User Satisfaction)	How efficient do you feel EMR is?	Seddon and Yip (1992)	How efficient do you feel your GL system is?
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (User Satisfaction)	How effective do you feel EMR is?	Seddon and Yip (1992)	How effective do you feel your GL system is?
(Dependent Variable)) [*not binary answers, based on multi-point Likert scale] Implementation Success (User Satisfaction)	Overall, how satisfied are you with EMR?	Seddon and Yip (1992)	Overall, are you satisfied with your GL system?

APPENDIX 2: GLOSSARY OF TERMS

The following definitions are provided to help readers understand the terminology used in this research study:

AHIMA: American Health Information Management Association. It is a premier association of healthcare information management professionals worldwide. It has over 60,000 members who are involved in, among other activities, implementation, use and maintenance of electronic health records and electronic medical records

ARRA ACT: American Recovery and Reinvestment Act. The American Recovery and Reinvestment Act (ARRA) of 2009 was enacted as an economic stimulus bill. In support of ARRA, billions of dollars were allocated by the government for various activities including investments needed to increase economic efficiency by spurring technological advances in healthcare.

EMR/EHR: Electronic Medical Records/Electronic Health Records. EMR contains the standard medical and clinical data gathered in one provider's office while Electronic Health Record (EHR) goes beyond the data collected in a provider's office and includes a more comprehensive patient history.

HIMMS: Healthcare Information and Management Systems Society. HIMSS North America has over 64,000 individual members, 640 corporate members, 450 non-profit organizations and thousands of volunteers committed to transforming health and healthcare through the best use of information technology.

HIPAA ACT: The Health Insurance Portability and Accountability (HIPAA) Act of 1996 was a legislation intended to establish data security and privacy provisions for safeguarding the medical information of the public. HIPAA regulates the use and disclosure of the so-called Protected Health Information (PHI). Part of HIPAA is the security rule that deals specifically with Electronic Protected Health Information (EPHI).

HIT: Healthcare Information Technology. Healthcare Information Technology is a term used in a broad sense to include technology related to gathering, processing, storing and disseminating healthcare information.

HITECH ACT: Health Information Technology for Economic and Clinical Health (HITECH) Act. This act was signed into law as part of the American Recovery and Reinvestment Act in February 2009. The primary goal of the HITECH Act is to stimulate the adoption of EMR/EHR and technology that supports EMR/EHR.

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