The Impact of Electronic Medical Records Systems on Healthcare Subunit

Performance: A Dynamic Capabilities Study

by

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Abstract

This thesis focuses on the impact of electronic medical records (EMR) systems on healthcare subunit performance. EMR systems are a relatively new artifact in the healthcare industry and have come under a great deal of attention lately, seen as a way of reducing healthcare costs and improving healthcare quality. We have taken a dynamic capabilities perspective for this research. We developed a model that suggests that two dynamic capabilities: process management and change management, will positively impact usage of EMR systems, and that EMR use is the key driver of operational performance at the subunit level. We tested our theory with a sequential mixed method approach. Our unit of analysis was hospital emergency clinicians. Our quantitative data collection method was through the use of an online survey of mainly nurse and nurse managers. Survey data was analyzed using structural equation modeling. Our qualitative data collection method was through the use of qualitative interviews with emergency department stakeholders. The interviews were conducted to obtain additional insight into the issues surrounding implementation and use of EMR systems and to help explain our quantitative results. We found that process management and pre-implementation change management positively impact EMR use, and that EMR use positively impacts clinician related performance. Post-implementation change management was found to have a negative effect on EMR use. Finally, we found that process management had a direct positive effect on patient-related performance and EMR use had an indirect positive effect on patient-related performance, mediated by clinician-related performance.

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Chapter 1: Topic Motivation

Healthcare in the United States and Canada

There are few more important topics in the public eye lately, particularly in the United States, than that of healthcare and healthcare reform. Awareness of the problem has risen to the highest levels of the U.S. government, with both former U.S. president George Bush and current president Barack Obama each addressing the crisis. During the 2008 U.S. Presidential election, the candidate's views and ideas for healthcare reform were given a high priority (Davila, 2008). There are three main crisis points facing those lawmakers and healthcare professionals tasked with healthcare reform. The first is providing healthcare coverage for all U.S. citizens. The United States is the only industrialized nation that does not ensure that all its citizens have healthcare coverage. It is estimated that 16% of the U.S. population does not have health insurance, and pays roughly \$30 billion per year out of pocket for healthcare. Approximately \$56 billion in healthcare provided to the uninsured goes uncompensated (Hadley, Holahan, Coughlin, & Miller, 2008). The second crisis point in U.S. healthcare is cost. According to the Kaiser Family Foundation ("Health Care Spending in the United States and OECD Countries," 2007), the United States spends more per capita on healthcare than any other country, and also has one of the highest growth rates of per capita healthcare spending in the world. The third crisis point is healthcare quality. According to the World Health Organization ("World Health Organization Assesses the World's Health Systems," 2000),

despite spending more per capita on healthcare than any other country, the U.S. ranked 37th out of 191 countries on five performance indicators.

The U.S. government has attempted to address some of these issues with the passage of The Patient Protection and Affordable Care Act in 2010, which is designed to expand health care coverage, reform the insurance industry, and lower health care costs across the United States. However the impact of the new health care legislation is still uncertain and many of its provisions have not yet taken effect. (Harrington, 2010; Schoen, Doty, Robertson, & Collins, 2011).

Canada faces its own challenges with respect to healthcare. In contrast to the United States' private healthcare system, most healthcare in Canada is funded by provincial governments, overseen by the federal government. While a popular system with most Canadians, sharp cutbacks in the federal budget in the 1990s have resulted in less access to medical specialists, longer waiting times for non-critical procedures, and the closure of facilities (Iglehart, 2000). While universal coverage has been achieved in Canada, curbing rising costs and improving quality are challenges shared by both countries.

Healthcare Information Technology and Systems

One area in which the U.S. healthcare system lags behind other countries and indeed most other industries within the U.S. is in the adoption and use of information technology (Davis et al., 2007). The healthcare industry in the United States is a massive information enterprise and yet is surprisingly inefficient when it comes to information management (Hillestad, Bigelow, Bower, Girosi, & et al., 2005). Some estimate that U.S. healthcare

lags other industries by decades with respect to information technology (IT) adoption and utilization (Ford, Menachemi, & Phillips, 2006; Raghupathi, 1997). Bates *et al.*, (2003) report that the healthcare industry spends 2% of gross revenues on IT, compared to 10% for other information intensive industries. Coile (2000) suggests that although healthcare is a knowledge based enterprise, knowledge is not considered part of the value proposition. With healthcare costs spiraling out of control some mechanism or program is being sought to help reign in healthcare costs while maintaining or even improving the quality of delivered healthcare. In nearly every high level discussion of healthcare reform and improvement, the role and promise of information technology is emphasized, suggesting that such technologies will play a key role in reducing costs and improving healthcare quality (Thompson & Dean, 2009). In 2004, President Bush announced an initiative to provide an electronic health record (EHR) for every American by the year 2014 (Swartz, 2004), and the U.S. Department of Health and Human Services (HHS) earmarked \$140 million in grants to promote IT use in healthcare. Under current President Obama, the American Recovery and Reinvestment Act (ARRA), commonly known as the economic stimulus package, provides over \$17 billion dollars to reward Medicare and Medicaid providers that use certified healthcare information technology in a meaningful way (Amatayakul, 2009). Lawmakers believe the healthcare information systems expenditures outlined in the stimulus bill will result in cost savings in the long run ("Can Information Technology Cut Healthcare Costs," 2009). Two separate studies by the RAND Corporation and the Center for Information Technology Leadership estimate the annual cost savings of approximately \$80 billion per year if all healthcare providers adopted and used appropriate healthcare information technology (Hagen,

2008). As for improving healthcare quality, in 1994 the American Medical Association reported 98,000 preventable deaths per year due to errors in medical information (Swartz, 2004). Khoubati, Themistocleous and Irani (2006) report 850000 medical information errors per year, resulting in 64 deaths per day in the United Kingdom. It is believed that integrated healthcare oriented information systems such as Electronic Medical Records (EMR) systems will put accurate and up-to-date patient information in the hands of healthcare providers, thereby increasing healthcare quality (Goldschmidt, 2005). Telemedicine systems will enable healthcare providers to consult with and diagnose patients in remote and underserved areas, thereby giving such patients access to higher quality medical advice and treatment than they would otherwise have (Rao, 2001).

The aforementioned American Recovery and Reinvestment Act contains criteria for what has been dubbed “meaningful use” of EMR systems, outlining incentives for the use of such programs with the Medicare and Medicaid programs (Burchill, 2010).

Despite very different funding mechanisms between the U.S. and Canada, the situation regarding information technology in Canada is much the same. A 2007 status report released by the Canadian Medical Association suggests that information technologies can serve to alleviate the problems caused by rising costs, shortages of medical personnel, and the increased prevalence of chronic disease. They suggest that IT will contribute to better healthcare outcomes, increased accessibility, increased integration between healthcare silos, cost efficiencies, and greater consumer satisfaction (Canadian Medical Association, 2007, p. 1)

Healthcare Information Systems (HCIS) Research

Not coincidentally, interest in healthcare information technologies and systems has increased in the world of academic research in recent years. As mentioned, until recently, the healthcare industry was believed to be 10-15 years or more behind other industries in the adoption and use of modern information technologies (Ford et al., 2006; Raghupathi, 1997), and research into healthcare information systems related phenomena has followed a similar trend. That trend is changing however, and while still not overwhelming, researcher interest in the healthcare arena is growing quickly (Chiasson & Davidson, 2004), evidenced not only by an increase in healthcare information systems research in mainstream academic journals, but by the emergence of journals and conferences focusing on healthcare information systems. Additionally, a new information technology (IT) profession has emerged: Health Informatics. The area of healthcare remains a rich field for information systems researchers (Wilson & Lankton, 2004). Since healthcare lags other industries in IT/IS adoption and use, IS researchers can lend their expertise to an industry where challenges and issues surrounding these systems is relatively new. These researchers can also test established theories in a new setting (Wilson & Lankton, 2004). Raghupathi (1997) suggests that there will be great benefits from the integration of the healthcare and information technology disciplines. Research into HCIS phenomena is important for another reason. Unlike other industries that utilize information systems, what is at stake is not just corporate advantage and sustainability, or even people's livelihoods, but in fact their lives (Atkinson, Eldabi, Paul, & Pouloudi, 2001).

Gaps in the HCIS Research

While there seems to be near universal belief in the ability of healthcare practitioners to use information systems to help deliver higher quality healthcare, there has been very little empirical research into whether such systems do in fact contribute to increased healthcare quality.

Broadly speaking, healthcare information systems can be broken down into three categories: 1) clinical systems, 2) administrative systems, and 3) strategic systems. Clinical systems directly support healthcare delivery, such as an electronic prescribing system. An example of an administrative system would be one used to track resources and do patient billing. Decision support systems and executive information systems would fall under the strategic systems category (Bhattacharjee, Hikmet, Menachemi, Kayhan, & Brooks, 2007).

Using this typology we can assume that clinical information systems are the primary IS mechanism that will theoretically be used to deliver higher quality healthcare. However as stated, the research linking the use of clinical information systems and higher quality healthcare is minimal. In a comprehensive review of articles in the academic literature from 1990 to the present, few articles were found that considered the link between healthcare information systems and healthcare quality and such studies are almost entirely absent from the mainstream information systems journals (Hartman, Fok, Fok, & Li, 2002; Orme, Parsons, & McBride, 1992; Rivers & Bae, 1999; Rosser & Kleiner, 1995; Shaffer & Shaffer, 1996).

Electronic Medical Records Systems

Specialized technologies such as Electronic Medical Record systems (EMR, sometimes electronic health record / EHR) offer the promise of delivering higher quality healthcare across the spectrum of healthcare organizations, including geographically underserved areas and developing countries (Miller et al., 2003; Rao, 2001). Howe and Warren (1977) made the call for integrated patient records systems back in 1977, suggesting that such systems would add a level of quality and consistency to the healthcare a patient receives, particularly in rural areas where, as mentioned, physician turnover is high, and where several different healthcare professionals will access such records over the life of a patient. More than three decades later, many healthcare organizations have yet to fully realize the use of such systems.

Electronic Medical Record systems are a hybrid system with clinical, administrative, and strategic functionalities built in (sometimes optionally). At the heart of an EMR system is a centralized database of electronic health records (EHR, sometimes computerized patient records; CPR). While there are a number of new healthcare information technologies, the greatest interest seems to be in EMR systems. EMR systems are not entirely new, but due to advancing technology and the changing requirements of healthcare practitioners they are becoming an increasingly necessary piece of technology. Therefore IS researchers interested in the healthcare area should look to EMR system related phenomena as a potential research focus. Physicians began adopting EHRs in the 1980s. The Institute of Medicine declared CPRs essential for healthcare in 1991 and again in 2001 (Berner, Detmer, & Simborg, 2005). By the late 1990s approximately 5%

of U.S. physicians were using EHRs. In 2004, U.S. President George Bush stated a goal of most U.S. residents having an EHR by 2014 (Goldschmidt, 2005). While estimates of current EMR system use vary, ranging from 5-15% for U.S. practices, Ford, Menachemi and Phillips (2006) predict EMR adoption by 90% of U.S. practices by the year 2024. Protti (2006) reports that the U.S. and Canada are lagging behind other countries in moving towards nationwide EMR systems.

EMR system functionality varies from developer to developer. Some packages are made generic enough to be customized for a variety of healthcare uses and specialties whereas others are developed for particular specialties. They do share many common functions such as (Valerius, 2007, p. 56):

- Document and content management
- Clinical Messaging
- Point of care charting
- Physician order entry
- Electronic prescribing
- Patient tracking
- Clinical decision support

Researchers and practitioners believe that EMR systems will result in significant advantages to the healthcare industry such as reduced record keeping costs, less “chart chasing”, improved workflow, automated information sharing and improved information quality leading to improved healthcare quality (Goldschmidt, 2005). Hillestad *et al.*,

(2005) suggest that EMR systems have the potential for savings of \$142-371 billion in annual healthcare costs, as well as improving patient safety.

There are some barriers to EMR acceptance and adoption by healthcare practitioners. Clinicians are not always eager to adopt new technologies. They also fear changes to the culture of how healthcare is practiced and fear that EMR technology will depersonalize the clinician / patient relationship. There are also concerns over security and privacy of electronic records (Griener, 2005; Silverman, 1998; Swartz, 2005). Please note that while EMR systems are, as indicated, hybrid systems, for this research we are primarily interested in the clinical functionality of EMR systems and therefore they will be referred to as clinical information systems.

Research Questions

This research seeks to understand the impact, if any, of EMR systems on healthcare delivery in healthcare organizations. As with other IS impact studies, the question of whether information systems can and do lead to improved organizational performance cannot be definitively answered by a simple yes or no. There are many organizational factors to consider, as well as interaction effects with other variables. A better way to frame the question is not simply with the word if, but also how, *viz., Are healthcare organizations using EMR systems to improve the quality of delivered healthcare, and if so, how are they accomplishing it?*

However, making the link between the adoption and implementation of EMR systems and improved healthcare quality is likely a bridge too far for a single study. Therefore

we will build upon the work of Soh and Markus (1995) (described in chapter 2) and reduce the scope of the study. In this research we will study the transformation of IT assets into IT impacts in healthcare organizations at the departmental level. If IT assets such as EMR systems have a positive impact upon the operations of healthcare organizations or subunits, then it is reasonable to suggest that such impacts can lead to improved healthcare quality or other organizational performance measures (Dey, Sinha, & Thirumalai, 2013). Thus, our specific research questions are:

1. What organizational capabilities are required for a healthcare organization to transform IT Assets into positive IT Impacts?
2. Does the use of clinical information systems such as Electronic Medical Records (EMR) systems positively impact operational performance of healthcare subunits?

We build a more comprehensive case for the specific research questions in chapter 3.

Because we are interested not in *if* EMR systems have an impact on healthcare operations, but rather in *how* healthcare organizations transform EMR systems into positive operational impacts, the theoretical lens by which we will conduct this research will be the Dynamic Capabilities View (DCV). DCV is a perspective first introduced by Teece, Pisano, and Shuen (1997) as an extension of the Resource Based View of the Firm (RBV) (Barney, 1991). Dynamic capabilities are the firm's ability to integrate, build, and reconfigure internal and external competences to adapt to rapidly changing

environments (p. 516), such as the introduction of potentially disruptive technological innovations such as EMR systems.

We believe this approach is appropriate because we are interested in how healthcare organizations reconfigure their processes and internal competences to integrate this new technological resource into their operations.

Contribution

Good scholarly research contributes to both theory and practice (Corley & Gioia, 2011). Electronic medical records systems are a relatively recent artifact. We will make the case in the following chapters that EMR systems are similar in type to Enterprise Resource Planning (ERP) systems. The research into ERP systems implementation and critical success factors is quite robust and this will allow us to develop a theoretical foundation for our research. Our contribution to theory involves taking these theoretical underpinnings into the healthcare area where, as we have pointed out, information systems research has not penetrated as deeply. Healthcare organizations are quite different than the typical manufacturing organizations, where the bulk of ERP research has been conducted. Healthcare organizations are often non-profit and do not share the same fiscal imperatives, such as gaining market share, as other organizations. Healthcare organizations are often much smaller than the typical firms studied in the ERP literature. Healthcare organizations have a high percentage of knowledge workers, and many of the key personnel in healthcare organizations (physicians) have a high degree of power and autonomy, many in fact being independent contractors. Additionally there is a well-

established antipathy between physicians and healthcare administrators, as well as a well-documented tradition of physician resistance to new information systems.

We intend to contribute to theory and management practice by identifying the dynamic capabilities that healthcare organizations can develop to facilitate the process by which they transform IT assets such as EMR systems into positive impacts such as improved performance. In doing so we will also be answering the call for more applied dynamic capabilities theory, as seen in the literature. There have also been calls for more quantitative studies using the dynamic capabilities perspective and for more studies in the public sector and this research contributes to both.

This research will focus on the use of the EMR system as a key to realizing positive impact from the investment in such systems. The IT use literature is growing but is still relatively sparse. In this research we do not treat use as a black box, but as a multi-part construct. We examine the antecedents to EMR use as well as its impact on performance. More researchers are looking at IT usage as a more appropriate independent variable than IT investment when examining the impact of IT on firm performance, but few studies focus on how organizations achieve the intended levels of EMR use. This is an important consideration for researchers and healthcare practitioners.

Thesis Chapters

The remaining chapters of this thesis will be as follows: In support of the research questions, chapter 2 will be a literature review. We will cover the IT/IS impact and use literature, the dynamic capabilities literature, and any relevant EMR/healthcare literature.

Chapter 3 will introduce the theoretical model employed in this research, including support for the variables posited in the model. Chapter 4 will detail the research method employed in this research, including the design of the quantitative survey. Chapters 5 and 6 will present the results of the analysis of the quantitative and qualitative data collected, respectively. Chapter 7 will contain a discussion of the findings, and the implications for theory and practice and chapter 8 will conclude this thesis with an explanation of the contribution and limitations of this research and recommendations for future research.

Chapter 2 Literature Review

In this chapter we survey and synthesize the relevant extant literature on IT value (sometimes referred to as IT impact), including research on IT investment, IT use, and process theory perspectives. We also discuss the dynamic capabilities view (DCV), which we have identified as the theoretical lens through which we will approach this research, and its relevance to IT/IS research in general and healthcare in particular. Finally, since we have a specific IT artifact in view (EMR systems), we will finish with a section on the current state of EMR adoption and implementation research, and how it can contribute to answering our research questions.

Section 2.1: IT Value / Impact

The IT value / impact literature appears to be divided along two streams depending on the way researchers operationalize the IT variable. The first is where the primary independent variable is investment in information technology. This appears to be the predominant form of IT value research, especially the earlier studies (Brynjolfsson & Hitt, 1996; Cline & Guynes, 2001; Davis, Collins, Eierman, & Nance, 1993; Hitt & Brynjolfsson, 1994; Kauffman & Weill, 1989; Mahmood & Mann, 2005; Mahmood & Mann, 1993; Weill, 1992a, 1992b; Weill & Olson, 1989). The second is where some form of IT usage is the primary independent (or intervening) variable (Albadvi, Keramati, & Razmi, 2007; Barua et al., 2010; Boynton, Zmud, & Jacobs, 1994; El-Mashaleh, O'Brien, & Minchin Jr, 2006; Lucas, 1993; Nan, 2011; Trice & Treacy, 1988; Wang,

Gopal, & Zions, 1996; Wilson, Mao, & Lankton, 2010). There is an additional stream of literature, related to IT use that emphasizes a process theory perspective when conducting IT value research. We discuss these below in each subsection. We will also include discussion of relevant research conducted in a healthcare context.

Section 2.1.1 IT Investment

The Productivity Paradox

Organizations expect investments in information technology to improve firm productivity and performance (Brynjolfsson, 1993; Melville, Kraemer, & Gurbaxani, 2004; Stratopoulos & Dehning, 2000). They expect IT to provide competitive advantage by enabling rapid response to a changing marketplace (Clemons, 1986; Porter & Millar, 1985); to provide timely and accurate information to enable quality decision making (Mooney, Gurbaxani, & Kraemer, 1996); to reduce costs by substituting capital for labor and transaction automation (McFarlane, 1984; Mooney et al., 1996; Porter & Millar, 1985; Weill, 1992b); to allow companies to compete where specific technology is required (e.g. ATMs for banks); to provide flexibility to fulfill a wider array of customer needs without cost increase (Weill, 1992b); and to provide a technological platform to enable other business systems to be produced (Soh & Markus, 1995; Weill, 1992b). However, investments in information technology have not always delivered on these expectations. Research into the link between IT investment and firm performance has yielded poor theory and contradictory and inconclusive results (Jain, 2004; Kauffman & Weill, 1989; Mahmood & Mann, 1993; Paré, Bourdeau, Marsan, Nach, & Shuraïda, 2008; Weill & Olson, 1989). The inconsistent results of IT value research have given

rise to the term “IT productivity paradox”, whereby firms not only do not realize increased productivity from investments in information technology, but in some cases productivity appears to be negatively related to IT investment (Belleflamme, 2001; Brynjolfsson, 1993).

Inconsistent Measures

Many researchers suggest that the IT productivity paradox is a result of deficiencies in the measures and methods for assessing the impact of such investments rather than any actual negative impact of IT investments on firm performance (Barua et al., 2010; Belleflamme, 2001; Griliches, 1994; Schryen, 2013). Some suggest poor theory accounts for the inconsistent results (Mahmood & Mann, 1993). Definitions and measures of both IT investment, and firm performance vary widely in the literature (Kauffman & Weill, 1989; Weill & Olson, 1989). Hitt and Brynjolfsson (1994) for example, suggest that IT value is related to the distinct measures of productivity, business performance, and consumer value. The authors analyzed IT investment and firm performance data obtained on 367 firms from the International Data Group and Compustat. They found significant positive impact of IT investment on firm productivity, no significant impact on business performance, and significant positive impact on consumer value.

Researchers also suggest that inconsistent research results can be explained in part by a failure of firms in outlining clear expectations for the IT investments and then measuring impact against those expectations (Cline & Guynes, 2001; Mooney et al., 1996).

Part of the reason for the productivity paradox may also stem not from what is being measured, but where measures are being applied. Tracing the impact of IT investments

all the way to firm level measures of productivity is a difficult task (Paré et al., 2008; Stiroh, 2001; Wang et al., 1996). There are many intervening and confounding variables that can impact and even negate any positive impacts from IT investments (Barua, Kriebel, & Mukhopadhyay, 1995). Researchers are suggesting focusing on unit of analysis when conducting IT impact research and measuring IT impact closer to the area where the technology is being used (Chan, 2000; Davern & Kauffman, 2000; Kauffman & Weill, 1989), where the benefits will most likely be realized (Weill, 1992b).

Typology of IT

The problem with much of the IT value research, as suggested earlier, is from studies being too broad (Bardhan & Thouin, 2013; Barua et al., 1995; Devaraj & Kohli, 2000; Hitt & Brynjolfsson, 1994; Ko & Osei-Bryson, 2006). Not all IT investment is equal, and not all types of information technology can be expected to produce similar results (Aral & Weill, 2007; Bhattacharjee et al., 2007; Cline & Guynes, 2001). Many authors suggest creating a typology of IT and IT investments to narrow down the scope of IT value research (Schryen, 2013). Cline and Guynes (2001) suggest a typology of four different IT investment categories. Strategic systems extend services to new customers. Tactical systems are analytical systems for managerial decision making. Transactional systems support day to day operations. Threshold systems support ancillary but necessary processes (ie: infrastructure). In a case study of the railroad industry, Cline and Guynes (2001) found different impacts from IT investment as a result of their typology. Investments in strategic IT yielded greater sales volume but not necessarily increased revenue. Investments in tactical IT were most correlated with increased profitability due

to IT's support for better decision making. Investments in transactional IT were found to be most impactful on decreasing expenses, tied to process improvements. Threshold IT investments were not found to impact performance. Weill and Olson (1989) also make use of a four way topology of IT systems: strategic, informational, transactional, and threshold. Strategic IT changes a firm's product or how it competes. Informational IT is infrastructure. Transactional ITs are the systems that support day to day operations. Threshold investments are those IT investments necessary to keep pace with the competition. Weill (1992a) found that investment in transactional IT had a positive impact on firm performance with a one year time lag. Aral and Weill (2007) suggest investments in strategic IT will impact product innovation, whereas investment in transactional IT will impact costs.

Of particular interest to this research is Bhattacharjee et al's (2007), healthcare IT typology. The authors suggest a three way typology of clinical, administrative, and strategic systems. Clinical systems are those designed to improve patient care, such as a physician order entry system. Administrative systems are designed to improve internal data processing activities such as billing. Strategic systems are designed to support strategic decision making, such as business intelligence and ERP systems. This research will focus primarily on the clinical functionality of EMR systems and the value they are purported to provide, e.g. improved healthcare quality, lower costs, better record keeping, decision support, etc.

Complementary Assets and Activities

Conversion effectiveness (Weill, 1992a; Weill & Olson, 1989), the conversion of IT assets into increased firm performance, is a key aspect of realizing value from IT investments, but is also inadequately understood (Smith & McKeen, 2003). How is conversion effectiveness achieved? Researchers suggest that it is the fact that IT payoff is considered separately from other organizational practices that results in the inconsistent results from IT value research (Davern & Kauffman, 2000; Ko & Osei-Bryson, 2006). Complementary capabilities such as change management, process redesign, and IT management are considered important factors in achieving value from IT investments (Aral & Weill, 2007; Davern & Kauffman, 2000; Davis et al., 1993; Schryen, 2013; Smith & McKeen, 2003). For example, in a study of eight hospitals implementing an administrative healthcare information system, Davern and Kauffman (2000) found the strongest impact on profitability was the interaction of IT support and business process reengineering.

Section 2.1.1.1 IT Investment Summary

There are several items of importance in this section. Overall it seems reasonable to suggest that one of the underlying reasons for the “productivity paradox” and the inconsistent results from IT impact research is that the scope of many of the studies is simply too broad. Productivity gains realized by IT investment may be negated by other organizational factors and offset by other intervening variables (Barua et al., 1995; Devaraj & Kohli, 2000; Hitt & Brynjolfsson, 1994; Ko & Osei-Bryson, 2006; Ray, Muhanna, & Barney, 2005). Narrowing the scope of IT value research will involve both focusing on smaller units of analysis (such as departments), measuring the impact of IT

closer to where it is being used (Chan, 2000; Davern & Kauffman, 2000; Kauffman & Weill, 1989) (Weill, 1992b), and on different measures of performance other than firm-level financial performance (Cline & Guynes, 2001; Kauffman & Weill, 1989; Mooney et al., 1996; Weill & Olson, 1989). Another suggestion made in multiple papers was that it is important to create a typology of information systems to help refine the research (Aral & Weill, 2007; Bhattacharjee et al., 2007; Cline & Guynes, 2001; Weill & Olson, 1989). Both of these suggestions are important because by targeting business units and differentiating types of information systems, researchers are able to narrow and refine the scope of IT value research. This is the approach this research takes. Finally, it is important to consider IT assets as part of an organizational system, and not to consider them in isolation. IT value researchers need to consider complementary assets and activities such as process redesign, change management, and IT support (Aral & Weill, 2007; Davern & Kauffman, 2000; Davis et al., 1993; Schryen, 2013; Smith & McKeen, 2003). Of these, process redesign and change management consistently emerge throughout this review in subsequent sections as important factors in the realization of improved performance from investments and use of information technology.

Many researchers have suggested that reducing the scope of IT value research and focusing on the processes involved in the implementation and use of new information systems may yield more consistent results. The next section will focus on the IT value literature where the emphasis is on IT use as an important step in the transformation of IT assets into improved organizational performance.

Section 2.1.2 IT Use

IT use is the other primary independent variable in the IT value literature. Much of the IT use literature is based on Davis' (1989) technology acceptance model (TAM) (Jasperson, Carter, & Zmud, 2005; Kukafka, Johnson, Linfante, & Allegrante, 2003). TAM views *intention* to use IT systems as dependent upon the perceived usefulness and perceived ease of use of such systems by the users. The theory has been widely tested, but has limited usefulness for this research, since it is predicated on the premise that IT usage is voluntary and in modern healthcare organizations that have adopted clinical information systems, use of such systems is typically not voluntary (Francisco, 2010; Hennington, Janz, Amis, & Nichols, 2009). Secondly, we are interested in actual system use and not intention to use. Behavioral intention has limitations as a predictor of actual use (Liang, Xue, Ke, & Wei, 2010; Venkatesh, Brown, Maruping, & Bala, 2008). IT use researchers are gradually moving away from the standard technology adoption models and extensions, and toward theoretical models that highlight the dynamic processes where individual IT-use behaviors and interactions create group-level patterns and outcomes (Nan, 2011, p. 505).

Post-Productivity Paradox

Some IT value researchers are suggesting that we are past the productivity paradox; that there is no longer any question as to *if* investments in information technology yield increased performance, but rather *how* (Aral & Weill, 2007; Barua et al., 2010; Dehning & Richardson, 2002; Kohli & Grover, 2008; Ravichandran & Lertwongsatien, 2005;

Schryen, 2013). As we have seen in the previous section, IT value research has yielded inconsistent outcomes, due in part to such studies being too broad. Researchers are suggesting a narrowing of the scope of IT value research and that IT use is a more appropriate independent (or intervening) variable than IT investment (Barua et al., 2010; Devaraj & Kohli, 2003; Doll & Torkzadeh, 1998; Kohli & Grover, 2008; Lucas, 1993; Soh & Markus, 1995; Trice & Treacy, 1988). Although the IT use literature is not as comprehensive as the IT investment literature, there is empirical evidence that IT use is positively related to measures of firm performance (Bharadwaj, 2000; Dehning & Richardson, 2002; Devaraj & Kohli, 2003; El-Mashaleh et al., 2006; Maiga, Nilsson, & Jacobs, 2013; Stiroh, 2001).

This line of inquiry is reasonable and logical. No amount of IT investment will yield positive results if the technology is not used appropriately, either because it is not designed or suited for the tasks for which it was purchased (Goodhue & Thompson, 1995; Lucas, 1993), or because users either cannot or will not use it to the extent and purposes for which it was purchased (Soh & Markus, 1995). However this brings up a new question, related to our research questions: How do organizations achieve the levels of IT usage necessary to positively impact firm performance? While there are a number of factors suggested by researchers that enable IT use, there are two consistent answers to this question in the IT use literature: process management and change management. This is consistent with what was seen in the IT investment section.

Process Management

As we saw in the IT investment literature, complementary assets and/or activities may account for the inconsistent results in IT value research. Process management (process redesign and reengineering) is thought to be one such complementary activity. Process redesign/reengineering is seen as a mediating variable between IT investment and IT value (Boynton et al., 1994). The implementation of information technology is shown to be supportive of process change, and process change enables the use of information technology, which in turn supports increased performance (Albadvi et al., 2007; Bharadwaj, 2000; Boynton et al., 1994; Kohli & Grover, 2008; Soh & Markus, 1995).

Change Management

Change management also emerged from the IT value literature as a complementary activity in the process of transforming IT investment into increased performance and is also prominent in the IT use literature (Kohli & Grover, 2008). Change management is about changing the belief structures and consequently the behaviors of organizational actors to accommodate the dynamic nature of organizations (Kotter, 1995; Tsoukas & Chia, 2002). Organizational actors often tend to resist any change, including the implementation of new information systems (Lawson & Samson, 2001; Ngai, Law, & Wat, 2008; Zand & Sorensen, 1975). In the healthcare information systems literature, the topic of clinician resistance to new systems is widespread (Doolin, 2004; Gagnon, Lamothe, Fortin, Cloutier, & et al., 2005; Lapointe & Rivard, 2005). Overcoming that resistance and getting users to embrace and use new technology is a major undertaking for organizations (Benjamin & Levinson, 1993; Liang et al., 2010; Robey, Ross, & Boudreau, 2002). Visible top management support of new information systems is a

critical success factor for information systems implementation (Liang, Nilesch, Hu, & Xue, 2007; Liang et al., 2010; MacKinnon & Wasserman, 2009) and executive level change management efforts are antecedent to proper use of new information systems (Motwani, Mirchandani, Madan, & Gunasekaran, 2002; Motwani, Subramanian, & Gopalakrishna, 2005; Trice & Treacy, 1988). Once organizational actors are convinced of the efficacy of the new system and become accustomed to its use, it becomes self-reinforcing. Personnel who use IT more frequently are more satisfied with it, and those with more positive attitudes towards technology are motivated to use it more (Koivunen et al., 2010).

Unit of Analysis

Attempting to trace the impact of IT investment all the way to measures of firm performance is very difficult, as we saw in the IT investment literature (Schryen, 2013; Stiroh, 2001). Not all firms utilize information technology effectively. Focusing on IT use allows researchers to narrow the scope of IT value research, to focus on intermediate outputs of IT usage, and then those intermediate outputs with firm level performance (Wang et al., 1996). By changing the level of analysis from the firm level to a more intermediate level, researchers are able to more closely relate the performance measure to the purpose of the information system, increasing the likelihood of finding results (Kohli & Grover, 2008; Lucas, 1993). IT use researchers suggest that using measures of performance that are close to the point of IT use will give a clearer picture of the impact of the IT artifact in question (Barua et al., 2010; Chan, 2000; Jain, 2004; Kohli & Grover, 2008; Lucas, 1993; Wang et al., 1996).

Process Perspective

Researchers suggest variance theories are inadequate for identifying sufficient and necessary causal variables that will positively impact firm performance (Beath, Goodhue, & Ross, 1994; Jain, 2004; Markus & Robey, 1988; Soh & Markus, 1995). The process view allows researchers to make sense of IT impact upon organizational performance by examining IT use and other intermediate processes (Barua et al., 1995; Bharadwaj, 2000; Mooney et al., 1996; Nan, 2011; Schryen, 2013).

Process theory, in distinction from the more common variance theories, posits that certain outcomes are the result of a series of necessary, but individually insufficient causes (Mohr, 1982). A simplified example of this can be shown from what we have seen already in this chapter. In order for firms to realize performance improvements from Information Technology, the firm must obviously invest in such technology. It is a *necessary* condition. However as we have seen, investment in IT does not always result in improved performance, even when varying the levels of investment. Therefore IT investment alone is *insufficient* for the desired outcome. True process theory research is not widespread in the literature, due in part to the fact that testing process models usually takes the form of in-depth, longitudinal case studies. Researchers are often under time constraints and are reluctant to commit to such methods (Radeke, 2010; Soh & Markus, 1995). However it is not unusual for researchers to develop models from a process perspective and test them using variance methods (Gregor, 2006; Ravichandran &

Lertwongsatien, 2005; Soh & Markus, 1995; Wheeler, 2002). That is the direction this research will take.

Soh and Markus (1995) is a foundational paper for this research. The authors make note of the IT productivity paradox and the insufficiency of treating all the intervening steps between IT investment and increased firm performance as a black box. They build upon the theoretical work of Lucas (1993), Grabowski and Lee (1993), Beath et al., (1994), Sambamurthy and Zmud (1994), and themselves (Markus & Soh, 1993) in tracing the path between IT investment and various firm level improvements. The result of their synthesis of these authors' work is a process model that identifies 3 phases of "necessary but insufficient" steps in realizing value from IT investments. The authors state that *"process theories can provide powerful explanations even when causal agents cannot be demonstrated to be sufficient for the outcome to occur"* (p. 29). The authors suggest that many IT value studies contain, either implicitly or explicitly, a cause-effect argument of necessary, but not sufficient, which characterizes process theories. Below is their process model.

Figure 2.1: How IT Creates Business Value: A Process Theory (Soh and Markus, 1995, p.37)

In phase 1, the firm goes through the IT conversion phase whereby IT investments are successfully deployed, becoming IT assets. Such assets are useful, well designed applications, a flexible IT infrastructure, and high levels of user IT knowledge and skill. In phase two, the IT assets are transformed into IT impacts through appropriate use of the system. Such impacts would include new or improved processes or products /services, better decision making, or improved coordination / flexibility. Phase three is where these IT assets will be converted into improved organizational performance such as improved productivity or financial performance (p. 37). The authors suggest the greatest need for empirical work is in phase two. While other researchers have expanded on this model (Jain, 2004; Ravichandran & Lertwongsatien, 2005), a significant gap remains in researcher's understanding of how firms promote appropriate use (p. 39). This study builds upon this research in the development of our theoretical model, focusing on phase two and addresses the question of how firms enable use of EMR systems.

Section 2.1.2.1 IT-Use Summary

As demonstrated in the IT investment section, attempts to link IT investment to improved firm performance has proven to be difficult for researchers. By focusing on use of the IT artifact rather than simply the fact that it exists, researchers have significantly narrowed the scope of IT value research (Barua et al., 2010; Bharadwaj, 2000; Devaraj & Kohli, 2003; Doll & Torkzadeh, 1998; El-Mashaleh et al., 2006; Kohli & Grover, 2008; Lucas, 1993; Stiroh, 2001; Trice & Treacy, 1988). Additionally, as recommended in the previous section, researchers are measuring the impact of IT use at levels closer to the use of the system (Barua et al., 2010; Chan, 2000; Jain, 2004; Kohli & Grover, 2008; Lucas, 1993; Wang et al., 1996), and considering complementary factors that impact IT utilizations, such as change management (Benjamin & Levinson, 1993; Liang et al., 2010; Robey et al., 2002) and process redesign (Albadvi et al., 2007; Bharadwaj, 2000; Boynton et al., 1994; Kohli & Grover, 2008). Some researchers are approaching IT value research from a process perspective, focusing on IT use. The literature clearly demonstrates that the necessary condition of IT investment is insufficient to create the condition of increased firm performance. Successful firms are engaging in certain *processes* that transform that firm's IT assets into positive impacts (Soh & Markus, 1995). In this study we are particularly interested in discovering the process of converting IT assets into IT impacts, addressing the shortcomings and inconsistency that troubles much of the IT value research. In the next section we will introduce the Dynamic Capabilities perspective, which is a process perspective with a significant stream of literature to help shape this research.

Section 2.2: Dynamic Capabilities Perspective

The Dynamic Capabilities View is an appropriate theoretical lens for this research. The DCV is compatible with a process perspective and focuses on the internal resources, processes, and competences that enable an organization to keep pace in dynamic industries such as healthcare (Ambrosini & Bowman, 2009; Pablo, Reay, Dewald, & Casebeer, 2007; Ravichandran & Lertwongsatien, 2005; Reeves & Ford, 2004). This section will provide a definition of the view as well as a synthesis of the dynamic capabilities literature relevant to this study. We will seek to understand those capabilities that allow healthcare organizations to utilize EMR systems in pursuit of greater subunit performance.

The Dynamic Capabilities View (DCV) was introduced as an extension to the Resource Based View (RBV) of the firm. The RBV posits that firms are bundles of resources, and that such resources are often heterogeneously distributed across firms. The resource-based view suggests that sustained competitive advantage can be realized by exploiting resources that are rare, valuable, inimitable, and non-substitutable (Barney, 1991; Dierickx & Cool, 1989; Singh, Mathiassen, Stachura, & Astapova, 2011). The RBV has been criticized in part for the assumption that such resources simply exist, with little thought to how such resources (such as capabilities) are acquired or developed. The resource based view has been called conceptually vague and tautological (Priem &

Butler, 2001a, 2001b). It has also been faulted for not considering dynamic markets (Pablo et al., 2007).

Dynamic Capabilities Definition

The DCV was first formally articulated by Teece, Pisano, and Shuen (1997), to help explain how firms build competitive advantage during periods of rapid change. *“Dynamic capabilities are the firm’s ability to integrate, build, and reconfigure internal and external competences to adapt to rapidly changing environments”* (p. 516). If such capabilities are difficult to imitate, they may provide the firm with competitive advantage. The term “dynamic” refers to the firm’s ability to renew their competences to adapt to changing environments. The term “capabilities” refers to the firm’s ability to adapt, integrate and reconfigure internal and external organizational skills, resources, and competences to adapt to changing environments. The other seminal paper for the Dynamic Capabilities View is Eisenhardt and Martin (2000). These authors define dynamic capabilities as processes embedded within firms that are specific and strategic, such as new product development or alliancing. These processes, that often exhibit commonalities across firms, are often known as “best practices” (p. 1106). This is echoed by Ridder et al., (2007). Dynamic capabilities take on different natures depending upon the dynamism of the industry. Turbulent environments are not always necessary for dynamic capabilities to be present. In fairly stable industries, dynamic capabilities more closely resemble traditional routines, whereas in dynamic industries, dynamic capabilities become simple, experiential, and unstable processes that rely on quickly created new knowledge that produce adaptive but unpredictable outcomes

(Eisenhardt & Martin, 2000; Zahra, Sapienza, & Davidsson, 2006). Depending upon the industry, dynamic capabilities can create value without necessarily creating competitive advantage. Capabilities may allow an organization to “*integrate organizational structures, human resources, and strategic planning processes in order to define and attain strategic objectives*” (Reeves & Ford, 2004, p. 298), or to improve organizational performance without necessarily achieving profit (Pablo et al., 2007). This is an important consideration, because in many healthcare organizations, achieving competitive advantage or profit are not organizational imperatives.

Complementary Resources

In the IT investment section, we examined literature that suggested that researchers consider complementary assets and activities to IT implementation that may give a clearer picture of how firms can transform IT investments into improved performance. Greater organizational or subunit performance may be achieved by leveraging complementary resources such as technology and capabilities (Helfat, 1997; Song, Droge, Hanvanich, & Calantone, 2005). IT resources, such as EMR systems, alone are unlikely to be sufficient to produce sustained competitive advantage (Clemons & Row, 1991; Wade & Hulland, 2004). Dynamic capabilities can provide a firm with advantage to the extent to which it enhances the productivity of other resources the firm possesses (Makadok, 2001). IT resources may have a direct effect on firm performance, but are more likely to have a complementary and contingent effect, such as from the complementary use of IT and capabilities such as human resource capabilities (Banker,

Bardhan, Chang, & Lin, 2006; Powell & Dent-Micallef, 1997). This is important in the context of healthcare organizations using EMR systems. EMR systems are technological resources that require integration into the organizational life and processes of the units or departments where they are to be utilized. Therefore we seek to identify dynamic capabilities that allow a healthcare organization to integrate EMR systems into their processes (Eisenhardt & Martin, 2000).

Reconfiguration of resource base

Dynamic capabilities allow organizations to reconfigure their resource base (Eisenhardt & Martin, 2000; Teece et al., 1997; Wang & Ahmed, 2007; Zahra & George, 2002). As stated earlier, resources can be tangible such as technology, or intangible such as capabilities, or a combination of both. Organizations that are able to respond to changing environments often do so by reconfiguring existing resources into new ones that better match the environment. This may include gaining, releasing, combining, or redeploying resources. Coordination and integration are processes that help in the deployment of the new or reconfigured resources (Menon, 2008, p. 27). Wang and Ahmed (2007) state: *“if a firm is viewed as a bundle of resources and capabilities, dynamic capabilities underline the processes of transforming firm resources and capabilities into outputs in such forms as products or services that deliver superior value to customers”* (p.36).

The integration of EMR systems into the life and processes of a healthcare organization require dynamic capabilities to reconfigure a healthcare organization’s existing resources such as processes and knowledge, to accommodate the new system. Consistent with the

IT investment and IT use literature, process management and change management emerge from the dynamic capability literature as important complementary capabilities to IT investment and use.

Change Management as a dynamic capability

We have seen in the previous section that change management is being recognized as a key element in realizing value from IT investment, to prepare the organization and its users for the impact of the new system and ensuring that it is accepted and used properly. In the dynamic capabilities literature, change management also emerges as an important capability (Becker, Lazaric, Nelson, & Winter, 2005; Zahra & George, 2002). The difference between ordinary capabilities and dynamic capabilities is that dynamic capabilities are those which enable organizational change, whether of processes, products, or other capabilities (Winter, 2003). Dynamic capabilities can be those which enable incremental change, and not just radical change of the organization or of organizational routines and capabilities themselves (Helfat & Winter, 2011; Nelson & Winter, 1982). In the healthcare industry, change management is an important dynamic capability because it aids in the diffusion of healthcare information technology and the transformation of the healthcare organization necessary to accommodate the new technology (Davison & Hyland, 2002; Singh et al., 2011).

Process Redesign as a dynamic capability

Another key element in realizing value from IT investment that emerged from the previous section is that of process redesign / reengineering. The mainstream IS literature, especially the enterprise resource planning (ERP) literature often suggests that process redesign is an essential element in the successful implementation of information systems. Therefore we look to the dynamic capabilities literature to see what role process redesign / reengineering plays in dynamic organizational environments. The ability to restructure core organizational processes is considered to be a key dynamic capability (Zollo & Winter, 2002).

Deming was one of the first to suggest that process redesign is one of the most effective ways of improving organizational performance (Latzko & Saunders, 1995). Therefore if a firm has the capability to redesign its processes better than the competition, that capability could be a source of competitive advantage or at least a means of improving performance (Kim, Shin, Kim, & Lee, 2011). Processes must be continuously redesigned to align with the organization's changing environment and new information systems as they are adopted and implemented (Daniel & Wilson, 2003; Ridder et al., 2007; Trkman, 2010). The value of new information systems should be measured at the activity / process level, where the prime effects are expected to be realized (Trkman, 2010, p. 126).

Section 2.2.1 Dynamic Capabilities Summary

The dynamic capabilities literature is somewhat diverse, but there is an overall theme, best described by Eisenhardt and Martin (2000); that dynamic capabilities are those that

enable a firm to deploy or reconfigure resources to meet changing demands (Makadok, 2001; Wang & Ahmed, 2007). We suggest that EMR systems are such resources.

Another key finding in the dynamic capabilities literature is the importance of process management (redesign / reengineering) (Becker et al., 2005; Daniel & Wilson, 2003; Davison & Hyland, 2002; Ridder et al., 2007; Trkman, 2010; Zollo & Winter, 2002) and change management (Davison & Hyland, 2002; Helfat & Winter, 2011; Ridder et al., 2007; Winter, 2003; Zahra & George, 2002). These activities are what Singh et al., (2011) would identify as “transformational capabilities”. The following table provides a synopsis of the various definitions of dynamic capabilities in the literature.

Table 2.1: Dynamic Capabilities Definitions

Dynamic Capabilities	
Author	Features
Teece, Pisano, and Shuen (1997)	The firm's ability to integrate, build, and reconfigure internal and external competences to adapt to rapidly changing environments.
Eisenhardt and Martin (2000)	Processes embedded within firms that are specific and strategic. Processes that integrate resources.
Makadok (2001)	Can provide a firm with advantage to the extent to which it enhances the productivity of other firm resources.
Zahra (2006)	Create value without creating competitive advantage. Can be present even without turbulent environments.
Ridder et al., (2007)	Strategic routines or processes. Best practices.
Zollo and Winter (2002)	Routinized activities directed to the development and adaptation of operating routines.
Wang and Ahmed (2007)	Firm's capacity to deploy resources.
Winter (2003), Becker et al., (2005), Helfat and Winter (2011), Zahra and George, 2002	Enable organizational change.
Kim et al, (2011)	Firm's ability to change processes.

Section 2.3 Electronic Medical Records Systems

In this section we review and synthesize the literature specifically relating to EMR systems, to discover any additional insights that might help inform our research. The literature reviewed is from both academic and practitioner oriented journals.

Healthcare lags other industries

As we pointed out in Chapter 1, the healthcare industry in the United States lags other industries in the adoption and use of information technology (Cresswell & Sheikh, 2013; Scholl, Syed-Abdul, & Ahmed, 2011). Abraham and Junglas (2011) suggest that U.S. healthcare quality has not kept pace with the rest of the world because of a lack of relevant patient info at the time of care, such as what EMR systems can provide. At the heart of an EMR system is the patient's electronic health record (EHR), a comprehensive record of the patient's healthcare history, including doctor and hospital visits, diagnoses, medical procedures, allergies, and prescribed medications. A complete and accurate medical history is essential for clinicians to provide the best possible care (DesRoches et al., 2008; Hoerbst & Ammenwerth, 2010; Kalra & Ingram, 2006).

Motivation to adopt EMR systems.

While there are other information technologies utilized in healthcare, EMR systems are getting the most attention. EMR systems, as we have stated, offer the promise of improved healthcare quality, lower healthcare costs (Bardhan & Thouin, 2013; Cresswell, Worth, & Sheikh, 2011; Lapointe, Mignerat, & Vedel, 2011), increased patient safety, increased efficiency (Batley, Osman, Kazzi, & Musallam, 2011; Vishwanath, Singh, & Winkelstein, 2010; Winston & Medlin, 2011; Xiao et al., 2012; Xue et al., 2012), and a decrease in medical errors. EMR systems can intercept drug interactions, a significant cause of morbidity and mortality (Handel & Hackman, 2010). Patients also have expectations for EMR systems. Patients believe EMR systems will improve the quality of the care they receive, and allow them to make better informed decisions about their own healthcare (Winston & Medlin, 2011). Management of knowledge assets is critical

to improving hospital performance because healthcare organizations are knowledge intensive organizations (Gastaldi, Lettieri, Corso, & Masella, 2012). EMR systems have the potential to serve as a solution to the knowledge management needs of healthcare organizations, but hospitals underutilize such systems (Gondalia, 2012).

Positive outcomes of EMR systems

There are numerous examples in the literature that indicate EMR systems are starting to live up to their potential. Bardhan and Thouin (2013) obtained EMR usage data from a survey of hospital CIOs, and obtained healthcare process quality data from government databases on four medical conditions: AMI (acute myocardial infarction) heart failure, pneumonia, and surgical infection preventions. They found positive associations between clinical (EMR) and financial information systems, and best practices for AMI, heart failure, and pneumonia. Financial systems were positively associated with lower operating costs. They conclude that EMRs have the potential to drastically reduce prescription and drug interaction errors and that implementation of healthcare information technology such as EMR systems positively impacts conformance to best practices, related to improved healthcare quality, and the reduction of operating expenses. In a time series study of 251 Chinese hospital physicians, Xue et al, (2012) found that EMR systems had a positive effect on length of stay and infection and mortality rates, but no effect on healthcare costs. EMR systems also can have a positive impact on healthcare by providing clinicians with better access to complete and accurate patient data (Matheson et al., 2012). In developing countries, EMR systems can play a different role in healthcare. Haiti, for example, is subject to strife and natural disasters. In a study

of EMR systems in Haiti, Matheson et al., (2012) found disruptions in EMR use during those times, but heavier use and reliance on EMR systems to reestablish clinic operations during the aftermath. In some studies of the impact of EMR systems on healthcare delivery, the impact is perceptual rather than objectively measured. In a study of an emergency department EMR, Likourezos et al., (2004) found both physicians and nurses are generally satisfied with the EMR system. Physicians were satisfied with impact on their work but do not believe the system has a positive impact on patient care. Nurses report ability to get their job done much faster. Clinicians also have apprehensions about privacy and security with new system.

Impact beyond EMR using department

EMR systems can have a positive impact beyond the department where the EMR system is being used. The additional work incurred by those who input data into the EMR system can yield non-clinical benefits such as better billing or cost recovery (Scholl et al., 2011). One of the most critical pieces of patient care is the handoff (to a new department or hospital). In many hospitals, all information is put on paper (copied or printed from EMR), and faxed to the next stop. The next stop in the healthcare process is then called to verify receipt of the data, which is then inputted into the new system. Much time and error reduction can be saved by inputting everything into the EMR system, and electronically transmitting it to the next stop. Time is saved, and better patient care and standardized information is the result (Braun, 2012).

Inconsistent EMR outcomes

While there is evidence of the positive impact of EMR systems on healthcare processes, quality, and cost reduction, in some cases, the impact is not uniform. Many IT projects within healthcare, EMR implementations included, are not successful (Garcia-Smith & Effken, 2013; Gastaldi et al., 2012; Lapointe et al., 2011). Some reports suggest that 20-33% of EMR implementation fail within the first year (Handel & Hackman, 2010). Many implementations have been plagued by problems, both technical and organizational (Cresswell et al., 2011). Not only are EMR implementation outcomes inconsistent, in some cases there has even been an increase of errors and mortality rates (Altavilla, Thornton, & Almodovar, 2011; Handel & Hackman, 2010). While EMR systems offer the promise of greater efficiency and time reductions, those results have also been mixed. Many healthcare organizations report reduced medication and order turnaround time, but clinician documentation time has increased, either because the interface is cumbersome or the EMR system requires more thorough documentation (Harle & Menachemi, 2012; Vishwanath et al., 2010; Winston & Medlin, 2011). Some physicians believe EMR and computerized physician order entry (CPOE) improves their personal performance (less chart chasing) and the quality of their performance (better access to accurate info), yet many feel just the opposite (too many clicks and screens to get the info needed). Many physicians feel like they are working longer hours to make up lost productivity. They believe it is an inefficient use of resources to have highly paid clinicians spend so much time on documentation. They believe in the potential benefits of healthcare information technology, but inefficiency of extended documentation is real and awaits better data entry interfaces such as voice recognition (Holden, 2010).

Little theoretical research

Because healthcare lags other industries in adoption and implementation of information technology, it is no surprise that theoretical research on IT in healthcare is also sparse. Researchers have been calling for more theory based research in this area, especially on the organizational impact and changes that result from the adoption and implementation of healthcare IT (Abraham & Junglas, 2011; Cresswell & Sheikh, 2013; Cresswell et al., 2011). Rippen et al., (2013) point out that most studies of healthcare IT are case studies and are too focused and non-generalizable. They suggest researchers bring in theories from outside the healthcare area, especially theories relating to IT use and the organizational environment that enables use.

Inconsistent findings in EMR research

Of the theoretical and empirical research that has been done regarding IT in healthcare, the results have been mixed, especially on the issue of physician efficiency (Xiao et al., 2012). Some researchers have found that EMR systems improve legibility, reduce errors, improve quality and provide better billing, but also result in increased documentation time (as much as five fold), conflicts with clinical workflow, and results in incomplete charts. Physicians are distracted by the demands of the EMR system from other necessary tasks and will often employ workarounds if possible (Park, Lee, & Chen, 2012). The productivity paradox is also evident in the healthcare industry. Possible reasons for the productivity paradox include: measurement error (of the variables), time lag for realization of impact, redistribution of profits, and mismanagement of IT. Stakeholder involvement is often a missing element in healthcare IT implementations. Measurements must be done at the right place with the right stakeholders (clinicians,

administrators, etc) (Lapointe et al., 2011). Most prior research attempts to link IT investment with hospital level performance. Such a strategy is too broad, often with poor measures of IT and performance. Researchers need to assess impact closer to the use of the application (Bardhan & Thouin, 2013). This is consistent with what we found in the IT value literature in the previous sections.

Barriers to EMR success

There are a number of barriers to the successful adoption and implementation of EMR systems. One such barrier is a general lack of IT skills among clinicians. Another is a concern over the impact of the EMR system on physician / patient interactions (Vedel et al., 2012). There are also the issues of long learning curves and clinician resistance to EMR systems (Xiao et al., 2012) as well as concerns over the security of the data stored in the EMR system (Cresswell et al., 2011).

Clinician resistance

Clinician resistance to healthcare IT implementations, including EMR systems is a significant issue in the healthcare literature. Clinicians, especially physicians, have a great deal of power and autonomy in healthcare organizations and can wield considerable influence in the success or failure of EMR implementations (Abraham & Junglas, 2011; Batley et al., 2011). In some cases, clinicians are skeptical that EMR systems will deliver on their purported benefits (Harle & Menachemi, 2012). Clinicians are also resistant to changes in their workflow necessitated by the introduction of an EMR system, and the (often greatly) increased documentation time required by such systems (Vishwanath et

al., 2010; Winston & Medlin, 2011). Vishwanath et al., (2010), in a longitudinal study of EMR implementation at a cancer care center, report that attitudes towards the EMR system were made early by physicians and changed little over time, and that physician satisfaction with the EMR system was significantly lower than pre-EMR expectations. They also report that prior attitudes towards technology in general inform physician perceptions of EMR system rather than their specific thoughts about EMR systems. Handel and Hackman (2010) suggest that one of the biggest challenges is translating the patient –physician encounter, which is essentially narrative in nature, to template-ized information. Clinicians resist the changes to medical practice required by the EMR system and feel like they are losing the art of healthcare (MacKinnon & Wasserman, 2009; Winston & Medlin, 2011). They feel a loss of professional autonomy and an overdependence on technology (Handel & Hackman, 2010).

Critical success factors

Much of the EMR literature is focused on critical success factors for implementation and use in healthcare organizations. These critical success factors are fairly consistent with those found in the enterprise resource planning (ERP) and other IS/IT literature.

Process redesign

A recurring critical success factor in the EMR implementation literature is that of process redesign or reengineering. Like ERP systems, EMR systems often require significant changes to workflow in the healthcare delivery process (Abraham & Junglas, 2011; Altavilla et al., 2011; Cresswell & Sheikh, 2013; Handel & Hackman, 2010; Matheson et

al., 2012; Richards, Prybutok, & Ryan, 2012; Winston & Medlin, 2011). EMR researchers suggest that alignment between EMR systems and healthcare related workflows is essential, and that the expected benefits of EMR systems are only possible through significant changing of workflows (Scholl et al., 2011; Vishwanath et al., 2010), and that such process redesign must be dynamic (Abraham & Junglas, 2011; Gastaldi et al., 2012; Richards et al., 2012).

Change management

Another important critical success factor for EMR implementation is change management. EMR system implementation is a disruptive episode in a healthcare organization or department and requires significant change efforts to get stakeholder buy-in to the project (Cresswell & Sheikh, 2013; Rippen et al., 2013; Scholl et al., 2011; Winston & Medlin, 2011). Yet change management is often not considered or not given enough emphasis in EMR implementations (Gastaldi et al., 2012; Lapointe et al., 2011; Vedel et al., 2012). Healthcare IT implementation requires alignment of technological, social, and organizational dimensions. Resistance to healthcare technology can be overcome if users are convinced of the benefits and advantages of the new system (Cresswell & Sheikh, 2013).

Stakeholder involvement

Successful change management begins with top management commitment to the EMR implementation project (Rippen et al., 2013; Winston & Medlin, 2011). Secondly, all stakeholders should be included in the adoption and implementation process, especially

clinicians, since they will be the primary users of the system (Abraham & Junglas, 2011; Altavilla et al., 2011; Cresswell & Sheikh, 2013; Lapointe et al., 2011; Richards et al., 2012; Rippen et al., 2013; Vedel et al., 2012).

Project champion

The IS literature, particularly the ERP literature, regularly lists the existence of a project champion as a critical success factor for implementation (Beath, 1991; Esteves & Pastor, 2002; Nah, Lau, & Kuang, 2001; Nah, Zuckweiler, & Lee-Shang Lau, 2003). Likewise in our review of the EMR literature, we find that successful EMR system adoption and implementation requires a change agent (Winston & Medlin, 2011) or project champion (Cresswell & Sheikh, 2013). Ideally, the project champion should be a clinician (Cresswell et al., 2011; Handel & Hackman, 2010; Scholl et al., 2011). Sometimes the project champion will take the form of a “super user”, a clinician expert in the system who can assist people in adjusting to and using the new system (Altavilla et al., 2011; Vedel et al., 2012).

Phased implementation

A number of researchers recommended phased implementations of EMR systems as a key success factor, giving the clinicians and other users time to learn and adapt to the system (Altavilla et al., 2011; Handel & Hackman, 2010; Scholl et al., 2011). Some ERP researchers also cite phased implementation as a success factor (Motwani et al., 2002; Motwani et al., 2005; Scott, 1999). However phased implementations can take much longer than so called “big bang” implementations, resulting in higher costs, and the

possibility of losing user buy-in of the system (Gargeya & Brady, 2005; Sandoe, Corbitt, & Boykin, 2001).

System design

System design is an important consideration for EMR implementation projects. Proper design of an EMR system is important to achieve acceptance of the system (Batley et al., 2011). The system must have a high degree of usability (Scholl et al., 2011). Often it is necessary for the EMR system to be customized to fully realize its potential and to achieve a successful outcome (Altavilla et al., 2011).

Use as a determinant of EMR success

A recurring theme in the EMR literature, consistent with Devaraj and Kohli (2003) is that EMR usage is the main determinant of EMR implementation success (Bardhan & Thouin, 2013; Richards et al., 2012; Winston & Medlin, 2011). Full benefits of the EMR system cannot be realized unless the system is used extensively (Holden, 2010; Matheson et al., 2012; Xiao et al., 2012). Studies have shown clinicians either do not use healthcare IT, work around it, or do not use the full capabilities of the system. However much of the evidence for the positive impact of healthcare IT on healthcare quality is anecdotal. There is a shortage of studies that objectively examine the link between usage and quality of care (Bardhan & Thouin, 2013). Achieving appropriate levels of use of EMR systems can be a problem for healthcare organizations. Healthcare organizations do not always understand the organizational and process changes necessary to use the full range of functions and benefits of EMR systems (Gastaldi et al., 2012; Rippen et al., 2013).

Section 2.3.1

EMR Systems Summary

We have pointed out that healthcare lags other industries in respect to IT adoption and implementation (Abraham & Junglas, 2011; Cresswell & Sheikh, 2013; Scholl et al., 2011), but currently there is a great deal of motivation to adopt new IT such as EMR systems in an effort to improve healthcare quality and lower costs (Bardhan & Thouin, 2013; Batley et al., 2011; Cresswell et al., 2011; Gastaldi et al., 2012; Handel & Hackman, 2010; Lapointe et al., 2011; Vishwanath et al., 2010; Winston & Medlin, 2011; Xiao et al., 2012; Xue et al., 2012). Consistent with what we saw in the IT value literature as a whole, we have seen mixed results from research investigating the impact of EMR systems on healthcare organization performance. There have been studies which support the idea that EMR system live up to their potential (Bardhan & Thouin, 2013; Likourezos et al., 2004; Matheson et al., 2012; Xue et al., 2012) and others that do not (Altavilla et al., 2011; Cresswell et al., 2011; Garcia-Smith & Effken, 2013; Gastaldi et al., 2012; Handel & Hackman, 2010; Harle & Menachemi, 2012; Holden, 2010; Lapointe et al., 2011; Vishwanath et al., 2010; Winston & Medlin, 2011). Because IT in healthcare has lagged, theoretical research into IT related phenomena in healthcare has lagged as well. Information systems research in healthcare, therefore, has the potential to be a fruitful research stream (Abraham & Junglas, 2011; Cresswell & Sheikh, 2013; Cresswell et al., 2011; Rippen et al., 2013). Much of what we see in the EMR literature is consistent with the IT value literature. The critical success factors for EMR implementation, such as top management support (Rippen et al., 2013; Winston & Medlin, 2011), project champions (Cresswell et al., 2011; Handel & Hackman, 2010;

Scholl et al., 2011), and stakeholder involvement (Abraham & Junglas, 2011; Altavilla et al., 2011; Cresswell & Sheikh, 2013; Lapointe et al., 2011; Richards et al., 2012; Rippen et al., 2013; Vedel et al., 2012) are similar to what is seen in the ERP literature. Actual use of the EMR system is considered to be key to realizing the potential of such systems (Bardhan & Thouin, 2013; Garcia-Smith & Effken, 2013; Holden, 2010; Matheson et al., 2012; Richards et al., 2012; Winston & Medlin, 2011; Xiao et al., 2012). Process management (Abraham & Junglas, 2011; Altavilla et al., 2011; Cresswell & Sheikh, 2013; Gastaldi et al., 2012; Handel & Hackman, 2010; Matheson et al., 2012; Richards et al., 2012; Scholl et al., 2011; Vishwanath et al., 2010; Winston & Medlin, 2011) and change management (Cresswell & Sheikh, 2013; Gastaldi et al., 2012; Lapointe et al., 2011; Rippen et al., 2013; Scholl et al., 2011; Vedel et al., 2012; Winston & Medlin, 2011) emerge as the two main enablers of the use and success of EMR systems. Where healthcare diverges from other industries, making it a unique industry for study, is in the high percentage of knowledge workers employed in the healthcare process, and in the level of resistance to EMR systems by organizational actors (clinicians) who have a great deal of power and autonomy (Abraham & Junglas, 2011; Batley et al., 2011; Handel & Hackman, 2010; Harle & Menachemi, 2012; MacKinnon & Wasserman, 2009; Vishwanath et al., 2010; Winston & Medlin, 2011).

Section 2.4 Conclusion

The goal of this review of the literature was to examine the current research in view of gaining insights into our research questions. We seek to discover what organizational capabilities are necessary for healthcare organizations to transform IT assets such as

EMR systems into improved organizational performance. We also want to know whether EMR systems live up their promise and positively impact operational performance.

Capabilities

In every section, process management (process redesign and process reengineering) and change management emerge as important factors for successful implementation of information systems. A strong criticism of much of the IT investment literature is that many of the studies are far too broad, and that researchers must consider complementary assets and activities that factor into the process of transforming IT investment into improved performance. Process redesign and change management are consistently considered as complementary activities to IT investment. However at this point these activities are simply additional ingredients in the black box of IT conversion. In the IT use literature process management and change management are identified as capabilities specifically complementary to IT use, which in turn is identified as a far more appropriate explanatory variable for IT related performance impact. The dynamic capabilities literature identifies process management and change management as key dynamic capabilities in the process of introducing new information technologies into organizations. Likewise process and change management are prominent as success factors in the EMR literature. By examining EMR use in conjunction with these two capabilities, we help unlock the black box of IT value and begin to see, from a process perspective, how healthcare organizations can transform IT assets into improved performance.

EMR system impact on performance

The deficiencies in the EMR literature are consistent with the IT value literature as a whole. There is sufficient evidence to indicate that EMR systems can and do positively impact performance, but the research results are inconsistent. Because healthcare lags other industries in IT adoption and implementation, healthcare organizations appear to be making some of the same mistakes regarding IT implementation made in other industries, such as manufacturing. In many ways EMR systems are similar to enterprise resource planning systems, and so many of the same lessons learned by organizations implementing ERP systems are applicable to healthcare organizations, such as process redesign, top management support, stakeholder involvement and project champions.

Building theory

IT value researchers and EMR researchers are calling for better theory. We believe that this literature review has provided enough information to formulate a workable and testable theory for EMR systems implementation in healthcare organizations. It is clear that investment in EMR systems is necessary but insufficient to achieve improved performance. Therefore actual use of the EMR system, building upon the Soh and Markus (1995) model, will be a primary explanatory variable in our theory. The IT value literature is also clear that measures of performance that are far removed from the usage of the system are often inadequate. The differential performance effects are often too small to be detected in firm level performance measures, or there may be confounding influences that may moderate or even negate any positive impact from the new system. Therefore we will propose performance measures close to the use of the system. Finally we will take a dynamic capabilities perspective on how the appropriate levels of EMR

usage are actually achieved, focusing on process and change management. The DCV focuses on the internal capabilities of an organization and the process by which the organization develops and leverages these capabilities to reconfigure its resource base. Knowledge workers (clinicians) in healthcare organizations are notoriously resistant to new information technologies, so it is important to understand the capabilities that healthcare organizations must develop to be successful in a dynamic technology environment. In the next chapter we will formally describe and explain our theoretical model.

Chapter 3 Theoretical Model and Hypotheses

The goal of this chapter is to develop a theoretical model that is rich in explanatory power and yet parsimonious enough to empirically test (Plouffe, Hulland, & Vandenbosch, 2001).

There are two primary questions for this research:

1. What organizational capabilities are required for a healthcare organization to transform IT Assets into positive IT Impacts?
2. Does the use of clinical information systems such as Electronic Medical Records (EMR) systems positively impact operational performance of healthcare subunits?

The question of whether to obtain and utilize EMR systems in healthcare organizations is fast becoming moot; legislation, incentives, and the relentless advance of technology all combine to suggest that the question is not whether to adopt such technology, but how to do it successfully.

This research seeks to discover what capabilities healthcare organizations must focus on developing to transform the acquisition and implementation of EMR systems into improved operational performance of healthcare subunits.

Section 3.1 Theoretical Model Foundation

This section will deal with the foundation of our theoretical model. The model is a variation and extension of the model proposed by Soh and Markus (1995) as shown in figure 2.4, and discussed in the previous chapter. Specifically, we are going to focus on the process of transforming IT assets into IT impacts, as shown in Figure 3.1.

Figure 3.1 IT Assets to IT Impacts: Adapted from (Soh & Markus, 1995, p. 37)

As discussed in the previous chapter and shown in the partial model above, we suggest the IT use process is key to transforming IT assets to IT impacts. But what facilitates the IT use process is also important. From our review of the literature, we believe that there are two dynamic capabilities that organizations can bring to bear upon the IT use process: Change Management and Process Management. Thus our theoretical model is shown in Figure 3.2.

Figure 3.2 Theoretical Model

Despite the fact that our research has been informed by the literature on process theory, our model is a variance model. Soh and Markus (1995) and Radeke (2010) point out that methods for testing true process models are not well established; but usually take the form of in-depth longitudinal case studies. Our timeframe, and other practical constraints rule out such methods for this research. Soh and Markus (1995) also suggest that there are variance implications from process theory and that variance type predictions can be made (p. 39). Gregor (2006) asserts that *“it is legitimate to have an overall dynamic theory yet test hypotheses deduced from the theory in cross-sectional (variance) studies”* (p. 628). We will explain the model and hypotheses in the following sections.

Section 3.1.1 IT Impact: Subunit Performance

In many respects, EMR systems can be considered as a type of medical enterprise resource planning (ERP) system. EMR systems consist of assorted functionalities integrated around a common database (MacKinnon & Wasserman, 2009). As is the case with more traditional ERP systems, EMR systems are often phased into healthcare organizations on a department by department or module by module basis (Banas, Erskine,

Sun, & Retchin, 2011; Harrington, 2010; Pennell & Fishman, 2011). As we saw in the previous chapter, much of the IT value research suffers from being too broad in scope, and several researchers have called for examining IT value at intermediate levels, such as departments or subunits, closer to the actual IT artifact (Barua et al., 1995; Kauffman & Weill, 1989; Lucas, 1993; Mooney et al., 1996; Wang et al., 1996). Ray, Muhanna, and Barney (2004; 2005; Ray, Muhanna, & Barney, 2007) suggest that operational performance, as opposed to financial performance, is a more effective way of assessing potential improvements derived from resources or capabilities. Ravichandran and Lertwongsatien (2005) suggest that more conclusive results are expected when IT investments are related to process or operational performance.

Therefore for this research we assessed the impact of EMR systems on the operational performance of healthcare organization subunits or departments, such as the intensive care or emergency departments. We did this by assessing the subjective perceptions of clinical workers who use the information system as part of the healthcare process in these subunits. Aggregating this data should provide an appropriate group level effect (Thomas, 2011).

Section 3.1.2 EMR Use

Soh and Marcus (1995) suggest that the primary factor in transforming IT assets into IT impacts is appropriate use of the information system, a process shaped by organizational culture, processes, and organizational structure (p. 37). As discussed in Chapter 1, there are legislated incentives under the American Recovery and Reinvestment Act of 2009

that mandate meaningful use of EMR (EHR) systems in order to receive federal stimulus funds (Amatayakul, 2011; Bigalke, 2009; Burchill, 2010). Therefore in our model, EMR use becomes the primary independent variable by which IT assets are transformed into IT impacts.

Lucas (1993) suggested that well designed IT leads to greater levels of IT usage, which in turn leads to increased performance. Likewise Trice and Treacy (1988) predict increased utilization of IT resources will lead to positive increases in organizational performance, provided that the system is designed efficiently enough so that the tasks performed by use of the system are performed more quickly than without the system. As noted in the previous chapter, Devaraj and Kohli (2003) also predict greater organizational performance as a result of greater usage of IT systems. Other papers in support of this suggestion surfaced in the previous chapter. We define EMR use as *use of the system functionality consistent with the purposes for which it is intended*, and *use of the system with the frequency that is consistent with the job tasks of the user and the capabilities of the technology* (Liang et al., 2010).

Thus our first hypothesis is as follows:

H1: Greater levels of use of EMR systems will be associated with increased operational performance of healthcare subunits.

Our first hypothesis is linked to our second research question. If we are correct in our assertion that greater levels of use is the key to realizing performance improvements from

EMR systems; that leads us to our next question, *viz*: How can healthcare organizations foster use of such systems by their clinical workers?

Based upon the results from our review of the relevant literature, we suggest two key dynamic capabilities are important for encouraging and enabling use of EMR systems: Process management and change management. The following sections will address these two variables.

Section 3.2 Dynamic Capabilities: Process Management and Change Management

As mentioned previously, both process management (which encompasses process reengineering or redesign) (PM) and change management (CM) have emerged from the literature as factors which can contribute to realizing increased performance from IT investment. This is unsurprising. The literature for IT/IS implementation often identifies process management and change management as critical success factors, especially for implementing integrated systems such as ERP and EMR (MacKinnon & Wasserman, 2009; Øvretveit, Scott, Rundall, Shortell, & Brommels, 2007; Parr & Shanks, 2000; Pellerin & Hadaya, 2008). While the purpose of process management and change management in the context of information systems implementation is all about the integration of resources (Eisenhardt & Martin, 2000; Reeves & Ford, 2004), they are not widely identified as dynamic capabilities in the literature. Identifying process management and change management as key dynamic capabilities that are antecedent to EMR use is one of the contributions of this research (Chen, 2004). Another important

point is that this research considers PM and CM as IT *enabling* capabilities (specifically, IT use), whereas we saw from the literature review on dynamic capabilities in IS and healthcare research, the majority of the research was on identifying IT *enabled* capabilities (Singh et al., 2011; Wang, Klein, & Jiang, 2007; Wheeler, 2002; Zhang, 2007). We suggest that change management will help equip the user with the knowledge, perceptions and attitude necessary for thorough use of the system. Adapting processes or workflow around the capabilities and limitations of the new system will help achieve alignment between the technology and the tasks performed by the user (Goodhue & Thompson, 1995).

We believe this approach to IT impact research is important because EMR systems, like all information systems, are sociotechnical systems (Alter, 2003; Berg, Langenberg, Berg, & Kwakkernaat, 1998). As such, successful implementation of such systems requires organizations to address both the technical and the social aspects of the system. As we have seen from the seminal research in this area, willingness to use new technologies, assessing IT's fit with the organization and user tasks, and satisfaction with the technologies is as much a matter of perception as it is technical reality (Davis, 1989; DeLone & McLean, 1992; Goodhue & Thompson, 1995; Venkatesh, Morris, Davis, & Davis, 2003). Process management capability allows the organization to address the technical aspects of the system and the organizational processes. Change management is about managing the change in perceptions of the process participants towards the technology.

Section 3.2.1 Process Management Capability

It should be noted that we are using the term *process management (PM)* rather than the possibly more familiar terms of *business process reengineering (BPR)* or *process redesign*. We wanted to use a term that was broad enough to encompass both process redesign and reengineering.

Process improvement through redesign became the focus of organizations as part of the Total Quality Management (TQM) movement in the early 1980s. W. Edwards Deming, considered to be one of the “fathers” of TQM, suggested that improving quality and performance in an organization was best achieved through process improvement, rather than employee incentives to work faster or better (Latzko & Saunders, 1995). H. James Harrington was also a strong advocate of process redesign. The approach taken by Deming, Harrington, and other TQM advocates was the incremental improvement of business process, such as the elimination of bottlenecks, streamlining, and removal of redundancies (Harrington, 1998; Latzko & Saunders, 1995).

Hammer, Champy, and Davenport are considered to be the founders of business process reengineering (Kleiner, 2000). Hammer and Champy (1993) define BPR as “*the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance*”(p. 32). These men suggested that some business processes were so unsuitable and unsustainable, that incremental improvements could not fix them. They advocated a radical redesign of

business processes starting from a “clean sheet of paper” (p.49). Information technology is a key enabler of BPR according to Hammer and Champy. However Michael Hammer is famous for coining the phrase: “*don’t automate, obliterate*” (Hammer, 1990), meaning that using technology to automate faulty processes simply meant that such faulty processes were done more quickly. Regarding use of technology, Hammer and Champy suggest “*reengineering, unlike automation, is about innovation. It is about exploiting the latest capabilities of technology to achieve entirely new goals. One of the hardest parts of reengineering lies in recognizing the new, unfamiliar capabilities of technology instead of its familiar ones*” (p.85).

Process management capability can include either process redesign, process reengineering, or both, depending on the organization and the circumstances. Integrating new technology resources into the healthcare unit may require radical reengineering of processes, or only incremental changes. The literature shows that information technology can act as an enabler of process redesign/reengineering, by automating certain processes or linkages between processes (Attaran, 2004); or process redesign/reengineering can act as an enabler of information technology usage, by redesigning the organization’s processes to match the processes already built into the technology, thus requiring the user to use the technology as it is designed. The latter approach is the one this research will focus on.

Much has been written about the need for process redesign/reengineering as a critical success factor for the implementation of enterprise resource planning systems (Boudreau

& Robey, 1999; Bradley, 2008). We have suggested that electronic medical records systems are essentially a healthcare oriented ERP system (MacKinnon & Wasserman, 2009), and since there is a rich stream of ERP implementation research, we will use that to inform this research.

Davenport (1998) notes that integrated enterprise systems are built around industry standard “best practice” processes, and because of the complex nature of the software, are somewhat inflexible regarding variations in the processes (Light, Holland, & Wills, 2001). Organizations are then faced with two options: to rewrite the software to match their processes, or to redesign their processes to match the software. The latter is generally considered to be the better option (Davenport, 1998). In a survey of 163 firms who implemented enterprise systems, Davenport et al., (2004) found process optimization to be an important factor for realizing value from enterprise system implementation. Likewise, in a case study of two firms implementing ERP systems, Holland and Light (1999) found process change to be a critical success factor for successful ERP implementation. In a comprehensive review of the ERP implementation literature, Ngai et al., (2008) found 18 commonly cited critical success factors, including process reengineering and change management.

Section 3.2.1.1 Process Management in Healthcare

Berg et al., (1998) state that IT systems such as electronic patient record systems are thoroughly intertwined with work practices and when the technology is changed, is often has unpredictable consequences for the healthcare organization. The authors caution that IT systems should support work, not generate work.

Bossen (2007) suggests the importance of the alignment between the IT artifact functionality and work processes in healthcare organizations. In a case study of 3 Danish hospitals that implemented an electronic medication plan system, the author suggests adopting a sociotechnical perspective when implementing such systems, bringing the system, people, and organization into alignment (p. 17). The new system required the adoption of new work processes in connection with drug prescription and administration. Boulus and Bjorn (2010) conducted two longitudinal ethnographic studies in Canada and Norway, regarding the adoption and gradual adaptation of electronic patient record systems in hospitals. They also suggest a sociotechnical approach to the implementation and integration of such system, and that the process be governed by cross-functional groups of stakeholders, and not driven by the IT group. They suggest that redesign of processes is inevitable and often ongoing in connection with these systems. Similar results and conclusions were made by Nicolini (2006) regarding telemedicine systems in Italian healthcare organizations.

It is clear that process redesign/reengineering has a long association with information technology and systems. We suggest that the adoption and implementation of integrated clinical systems such as EMR systems will require the organization to demonstrate process management capabilities to achieve alignment between the system and the organization's work processes. This in turn will positively impact use of the system.

H2: The level of process management capability will be positively associated with EMR use.

Section 3.2.2 Change Management Capability

One constant that is associated with the adoption and implementation of complex integrated systems such as ERP or EMR systems is that they are associated with organizational change. Tsoukas and Chia (2002) characterize organizational change as *“the reweaving of actors’ webs of beliefs and habits of action to accommodate new experiences”* (p. 567). Therefore the organization’s capability to manage organizational change becomes an important factor for achieving success from IT investments and implementation, however that success is defined. Deloitte Consulting (1998), in interviews with 164 individuals of 62 Fortune 500 companies, found change management as the single biggest critical success factor for ERP implementation. As stated earlier, much of the research concerned with whether organizational participants actually use new information systems appropriately centers on how the new systems are perceived. Change management therefore becomes important because change management is, among other things, about changing perceptions. Fuchs (2004) asserts that the change manager’s *primary* function in the implementation of new information systems is that employees actually use the system.

One of the earliest and well known theories of change management is from Kurt Lewin in the 1940s. Lewin proposed a process model of change in three phases: unfreezing, moving, refreezing. Lewin saw organizational systems as a type of dynamic social

equilibrium, with forces balanced for and against change. Lewis proposed a means of altering those forces in favor of “for-change” forces. Unfreezing refers to activities whereby the organization undertakes to make its participants receptive to change. Moving is the phase where the change is actually accomplished, and refreezing is where the new perceptions and behaviors are reinforced and “locked in” (Zand & Sorensen, 1975). Ngai et al., (2008) says change management involves balancing forces in favor of change over forces resistant to change, and that change management is a key success factor for information system implementation success.

Benjamin and Levinson (1993) observe that IT implementations often fail because so much investment and effort is put toward the technology itself and so little is given to changing organizational processes, structure, and culture. Like Lewin, the authors focus on the sociotechnical equilibrium between technology, processes and culture and that change involves upsetting, modifying, and restoring that equilibrium with new processes, technology and culture. The new state, the authors suggest, should address process by redesign, technology built around a common database, and culture by training and possible job restructuring. Likewise Legris and Colletette (2006) suggest that many firms neglect stakeholder involvement and social issues when implementing new systems.

John Kotter (1995) is considered one of the foremost authors in the change management field. His 8 step change model is as follows (p. 61):

1. Establish a sense of urgency.

2. Form a powerful guiding coalition.
3. Create a vision.
4. Communicate the vision.
5. Empower people to act on the vision.
6. Plan for and create short-term wins.
7. Consolidate improvements and produce still more change.
8. Institutionalize new approaches.

Although a bit more granular, we can see that these steps are consistent with Lewin's model: Unfreezing (steps 1-4), moving (steps 5-7), and refreezing (step 8). Although Kotter's framework remains a very popular model for organizational change, it was built from Kotter's own experience, without much scholarly support. Appelbaum et al., (2012) compare Kotter's model to the extant change literature and find support for most of the steps in the model, but did not find any scholarly treatment of all 8 steps as a whole. While affirming the model, they do suggest, contrary to Kotter, that a contingent approach to the model is prudent and that not every step will be appropriate in every context.

Orlikowski and Hofman (1997) suggest that change efforts should be more goal oriented, rather than plan oriented, especially when implementing flexible information systems such as groupware systems. They suggest that the project stakeholders should be able to

respond improvisationally to un-predicted issues in the process as they arise, always with the outcomes in sight.

Boudreau and Robey (1999) point out that information systems implementations and organizational change go hand in hand, but that there has been little theoretical contribution towards the process of technology-driven organizational change. This research intends to respond to that deficiency.

Hall (2002) suggests integrated information systems are powerful drivers of organizational change, such as the downsizing and delayering of organizations, decentralization of responsibilities, and increasing the range and depth of some skills while deskilling and routinizing other tasks (p.263).

Robey et al., (2002) emphasize user training as an important factor for overcoming knowledge barriers to the use of new integrated systems and any corresponding process changes. In case studies of firms implementing ERP systems, the authors found knowledge barriers that went beyond mere resistance to change, and that users truly did not understand the new system and the new processes they were expected to perform. Instead many of them found “workarounds”. The authors found that firms who spent more time and money on training, and took a more holistic approach to the entire change process rather than simply the use of the system, were more successful in overcoming those knowledge barriers. They also found that incremental changes were more effective than changing everything at once.

Lawson and Price (2003) suggest that there are 4 conditions for organizational change: First is giving organizational actors a purpose to believe in. Management must “sell the change” to stakeholders. Second is aligning organizational structures with the desired change, including processes and reward and recognition systems. Third is ensuring that employees have the necessary skills to accommodate the required change, through time and training. Last is modeling the change by people respected in the organization. Aiken and Keller (2009) come to similar conclusions. They insist that to facilitate change, management must create a compelling story on the need for change, including the elements that motivate their employees. They also agree that skills-training is an important change management activity, but remind their readers that changing perceptions is as important as changing skills and behavior. Ngai et al, (2008) also identify training as a crucial part of the change management process; training not only in the new system but of any new practices and processes.

This brings us to our third hypothesis:

H3: The level of change management capability will be positively associated with EMR use.

Hypotheses 2 and 3 are linked to our first research question.

Section 3.3 Summary

In this chapter we have demonstrated the development of our theoretical model, and offered three hypotheses. We suggest that use of EMR systems is a necessary condition

for realizing improved operational performance in healthcare subunits. We also suggest that an organization's change management and process management capabilities demonstrated during the EMR implementation process will be associated with levels of EMR use. We feel that much of the IT value research has suffered from being too broad in scope, therefore we have chosen to examine only the process of transforming IT assets to IT impacts. We believe that the process of transforming IT investments into IT assets has been covered adequately in the extant literature. We leave the investigation of IT impact to organizational performance for future research.

In the next chapter we will outline our methods of data collection and analysis.

Chapter 4: Research Design and Method

In the previous chapters, after a survey of the relevant IT value, Healthcare, and Dynamic Capabilities literature, we were able to develop a parsimonious theoretical model that we suggest will explain the process by which healthcare organizations can transform IT assets such as electronic medical records (EMR) systems, into IT impacts, such as subunit performance.

This chapter will cover the design and method for this research. In the following sections we will explain the methods and measures, research frame, unit of analysis, and methods of data analysis.

Section 4.1 Methods

This research seeks to understand *how* healthcare organizations transform IT assets into IT impact at the subunit level. The IT artifact is Electronic Medical Records (EMR) systems. We examined healthcare subunits that have recently implemented EMR systems to assess the user's perceptions on the process and the results. We decided to employ a mixed method design for this research. Mixing methods, such as quantitative and qualitative methods, helps to neutralize the bias inherent in any one method (Creswell, 2003, p. 174). Ju et al., (2006) suggest that multiple data collection methods *"not only provide sufficient evidences to explain and examine research problems but also support cross-validation for data correctness and reliability"* (p. 120). When deciding to adopt a mixed method approach, the researcher is faced with the decision of whether to

do the methods concurrently or sequentially, which method to give priority to, if any, and which order if adopting a sequential method (Ivankova, Creswell, & Stick, 2006). The researcher must ask whether the research is exploratory or explanatory (Teddlie & Tashakkori, 2006). Are we beginning with a theoretical lens and model or are we seeking to develop one? Do we have existing scales (if doing survey research) or do we plan to build them from scratch? For this research we adopted a sequential mixed method approach. The study is a two-phase, dominant-less dominant design suggested by Creswell (2003, p. 179), also known as a sequential explanatory design (Greene, Caracelli, & Graham, 1989; Hanson, Creswell, Clark, Petska, & Creswell, 2005). Because we have identified our theoretical lens and research questions, seek to test a theoretical model adapted from existing theory, and are employing existing survey scales (explained later in this chapter), the most appropriate design is to use quantitative methods as our primary method and qualitative methods as our secondary method (Creswell, 2003; Greene et al., 1989; Jick, 1979). The primary (dominant) data collection method was quantitative, through the use of a survey, to test the validity of our theoretical model and hypotheses, and answer our research questions. We supplemented the quantitative method with qualitative interviews (less dominant) with key healthcare professionals, to add richness and further insight to the data. Greene et al., (1989) call this approach “complementary”, as it seeks to elaborate, illustrate, enhance, and clarify the results of one method with the results of another method. Jick (1979) claims that supplementary “*qualitative data and analysis function as the glue that cements the interpretation of multimethod results*” (p. 609). By conducting and analyzing the survey results first, we were able to structure the qualitative interviews to fill in any gaps or

discover nuances that may be missing from the survey data (Onyia & Onyia, 2011). Sieber (1973) suggests that *“field (qualitative) methods can contribute to the analysis and interpretation of survey data by validating statistical results, aiding in their interpretation, and explaining unexpected findings”* (p. 1345). Researchers have been calling for more rigor in survey research and recognize that supplementing surveys with additional methods is one way to accomplish this (Grover, Lee, & Durand, 1993; Kaplan & Duchon, 1988; Malhotra & Grover, 1998; Orlikowski & Baroudi, 1991; Pinsonneault & Kraemer, 1993), rather than relying solely on survey data. Please note that we did do some qualitative work with a focus group to adapt our survey instrument to a new context, as explained later in the chapter.

Section 4.2 Quantitative Method

This section will cover the sample, survey, and analysis of the quantitative portion of this research.

Section 4.2.1 Data Sample

As discussed previously, we are interested in how healthcare organizations promote the use of electronic medical records systems in healthcare subunits and if the use of such systems improve operational performance of the subunit. For this research we have chosen the hospital emergency department (ED) as the research setting and emergency clinicians as the unit of analysis. ED Clinical Coordinators are chosen as the primary respondents. Clinical Coordinators oversee the operations of the emergency department and are usually registered nurses. Because emergency departments deal with a high

number of patients with a rapid throughput rate, we felt that this particular hospital department would be ideal for this research. One emergency physician we spoke with volunteered this opinion:

“While the implementation of an electronic medical record has brought change in all areas of healthcare, nowhere has it been more apparent and more dramatic than in the emergency department. The emergency room is the place where access to timely, accurate patient information is most critical. For a variety of reasons, patients themselves are not always the best historians, and are not always knowledgeable about the intricacies of their medical histories. An accurate, accessible, and expanding electronic medical record has become vital for rapid assessment and management of emergency room patients. It has been a practice-changing tool that helps emergency physicians to provide faster, more effective care to critically ill patients.”

Geisler et al., (2010) estimate that by 2006 close to half of all U.S. emergency departments had adopted EMR systems. In a 2006 report from the US Government’s Centers for Disease Control, Hing et al., (2010) report that over 72 percent of US emergency departments planned to be using an EMR system by 2009. In a discussion with an EMR Software representative a figure of over 75% currently was estimated. With such rapid growth in EMR adoption in the last ten years, the chances of connecting with ED personnel who have been through an EMR implementation is high.

We purchased an email list of approximately 2000 names from a healthcare list provider: MCH Strategic Data (data.mchdata.com). We also procured a list of emergency nurses

and nurse managers from an emergency department consultant. We communicated with these potential respondents by email, inviting them to participate in the study. We also did a follow-up communication to encourage non-respondents to participate. We used an online survey collection service: SurveyMonkey (www.surveymonkey.com). Online surveys have a number of advantages over traditional paper surveys such as ease of administration, lower cost to deploy, ease of follow-up and required completion of answers (Evans & Mathur, 2005, p. 197). We offered a chance to win an Amazon Gift Card as an incentive for people to participate. Email invitation recipients were also asked to forward the email to any nurse or physician colleagues that might be able to participate in the survey. Through this we hoped to broaden our respondent pool and improve response rate. It should be noted that while emergency nurses and physicians would both be acceptable respondents for this research, we are focusing on nurses. There are a few reasons for this. One, it was felt that physicians would be less likely to respond to survey requests than nurses. Two, in the course of treatment, nurses actually use the EMR system more than physicians, making them better able to answer the research questions (Manhattan_Research, 2012; Nelson, 2013). Lastly, in any given hospital department, there are simply more nurses than physicians, giving us a greater pool of potential respondents to choose from. Targeting physicians for similar research will be reserved for a future project.

Section 4.2.2 Survey

Pinsonneault and Kraemer (1993) suggest the survey method is appropriate for information systems research when (p. 78):

“(a) the central questions of interest about the phenomena are "what is happening?", and "how and why is it happening?" Survey research is especially well-suited for answering questions about what, how much and how many, and to a greater extent than is commonly understood, questions about how and why.

(b) Control of the independent and dependent variables is not possible or not desirable.

(c) The phenomena of interest must be studied in its natural setting.

(d) The phenomena of interest occur in current time or the recent past.”

We suggest that our research questions and setting meet these criteria, therefore we tested the hypotheses of our theoretical model primarily through the use of the survey method. Survey based research has a long history in the social sciences, including information systems research (Grover et al., 1993; Ju et al., 2006; Newsted, Huff, & Munro, 1998). Surveys are useful research tools because they allow the researcher to determine the values and relations of variables and constructs, provide responses that can often be generalized to other populations, predict behavior, and objectively test theoretical propositions (Newsted et al., 1998, p. 553).

Section 4.2.2.1 Instrument

To deploy a survey to test our theoretical model, we had to first operationalize our theoretical constructs into appropriate survey questions. To accomplish this, the researcher can create a new survey and go through the process of pilot testing, refining, and statistically verifying the validity and reliability of the instrument (Moore & Benbasat, 1991), or the researcher can adopt and adapt instruments that have already been empirically tested and statistically validated (Grover et al., 1993; Ju et al., 2006).

Validity refers to the degree to which the instrument measures what it purports to measure (Hardesty & Bearden, 2004). Reliability is the degree to which the instrument elicits the same response each time it is used under similar conditions. For this research we adapted and used instruments for the constructs of Change Management, Process Management, and Subunit Performance that were developed by Grant and Hlupic (Unpublished) and subsequently adapted and statistically tested for validity and reliability by Chen (2004) and Thomas (2011). For the IT use construct we adapted and used a validated instrument from Liang et al's., (2010) research on physician use of computerized physician order entry systems. All of the scales' wording were modified to reflect the emergency department and EMR context. We also substituted language for business terminology that might not be familiar to healthcare workers. Because we are employing the scales in a new context, we consulted with subject matter experts and obtained their feedback on the scope and content of the scales, and made appropriate adjustments to establish face validity of the instrument (Hardesty & Bearden, 2004; Nevo, 1985). We pretested the survey with a small pool of respondents and performed internal consistency tests to verify the usefulness of the scales in the new context. After pre-testing, we made necessary adjustments to the scales such as removal or rewording of items. A full description of the scale pretesting and refinement will be found in section 4.2.4. We then deployed the survey (Moore & Benbasat, 1991). We used a 5 point Likert scale to measure responses from *Strongly Disagree* to *Strongly Agree*. We also provided a *Not Applicable* option. Some researchers (Colman, Norris, & Preston, 1997; Dawes, 2008) suggest there is little statistical difference between 5 and 7 point scales and it was felt that a 5 point scale would be less confusing and intimidating to respondents.

Survey respondents were also assured of anonymity and the aggregation of the data. Respondent anonymity can help ameliorate problems such as central-tendency and social-desirability bias. Since our independent and dependent variables are being measured by the same, self-report method, common method bias is also a potential limitation. Respondent anonymity can also mitigate the effects of common method bias. Mixing scales from different sources, as we have done, can also help control common method bias (Podsakoff, MacKenzie, & Lee, 2003). We also sought independent verification of our hypotheses through the use of qualitative interviews.

Demographic Scale

The survey begins with several questions about the respondents and their place of employment. We used this information to generate descriptive statistical profiles of the research sample.

- D1:** *What is your age? (18-25)(26-35)(36-50)(50+)*
- D2:** *What is your gender?*
- D3:** *What is your job title?*
- D4:** *What is the size of your hospital? (<200 beds)(200-400 beds)(400+ beds)*
- D5:** *How long have you worked for this organization? (< 1 yr)(1-5 yrs)(>5 yrs)*
- D6:** *Is your hospital located in an urban or rural area?*
- D6:** *For how long has your department been using its current EMR system? (< 1 yr)(1-5 yrs)(>5 yrs)*
- D7:** *Have you personally been through an EMR implementation?*

Change Management Scale (Benjamin & Levinson, 1993; Chen, 2004; Grant & Hlupic, Unpublished; Kotter, 1995; Lawson & Price, 2003; Legris & Colletette, 2006; Ngai et al., 2008; Robey et al., 2002; Thomas, 2011; Zand & Sorensen, 1975)

CM1: *I clearly understand the purpose and objectives of the EMR system.*

CM2: *The benefits of the EMR system have been clearly identified and communicated.*

CM3: *I have received adequate training to use the EMR system.*

CM4: *Hospital management was highly supportive of and committed to the EMR related change process.*

CM5: *The hospital implemented an explicit change management plan related to the EMR implementation.*

CM6: *Efforts were made to involve affected hospital employees in designing the EMR related changes.*

CM7: *Roles to be assumed by hospital employees during and after the change were assigned.*

Process Management Scale (Berg et al., 1998; Bossen, 2007; Boulus & Bjorn, 2010; Chen, 2004; Davenport et al., 2004; Grant & Hlupic, Unpublished; Hammer & Champy, 1993; Holland & Light, 1999; Thomas, 2011)

PM1: *Emergency department processes have been re-designed to align with the new EMR system.*

PM2: *The redesigned processes meet the needs of both the emergency department and the EMR system.*

PM3: *Hospital management clearly articulated the scope of process re-design that would be necessary with the EMR implementation.*

PM4: *Hospital management assembled a cross-functional team to support EMR related process re-design.*

PM5: *The hospital established easy-to-apply evaluation criteria to measure the effectiveness of the redesigned processes.*

PM6: *Process owners have overall responsibility for EMR applications in their units.*

IT Use Scale (Adams, Nelson, & Todd, 1992; Liang et al., 2010)

U1: *I spend a lot of time using the EMR system every day.*

U2: *I use the EMR system frequently every day.*

U3: *I use the EMR system intensively every day.*

Subunit Performance Scale (Chen, 2004; Grant & Hlupic, Unpublished; Thomas, 2011)

P1: *The EMR system has greatly improved the quality and quantity of patient information available to me.*

P2: *I am able to make better decisions with the information I am able to retrieve from the EMR system.*

P3: *I am able to make decisions faster with the information I am able to retrieve from the EMR system.*

P4: *The EMR system is useful and has helped me to perform my job more effectively.*

P5: *The EMR system has improved the efficiency and effectiveness of emergency department processes.*

P6: *The EMR system has helped create new emergency department processes.*

P7: *I have a high degree of confidence in the information provided by the EMR system.*

Section 4.2.3 Quantitative Analysis

Although we are using scales that have been previously tested for validity and reliability, they have been adapted to a new research context, therefore we pretested and refined the instrument to verify that the scales are reliable in the new context. After full deployment of the survey, confirmatory factor analysis was used to test scale validity and Cronbach's

Alpha was used as a measure of reliability (Kline, 2005; Suhr, 2006). Survey research with multiple variables calls for some type of multivariate analysis of the data collected. The type of analysis that is appropriate is largely governed by the sample size and data characteristics. For sample sizes of up to approximately 200, ordinary least squares (OLS) is common (Montenegro, 2001). Structural equation modeling (SEM) is considered to be a more powerful and useful form of multivariate analysis, especially for measuring latent variables, but typically requires large sample sizes (>200 n)(Garver & Mentzer, 1999; Hoelter, 1983). Partial least squares (PLS) is also an option for smaller sample sizes, data that does not fit the assumptions necessary for OLS, such as data non-normality, and for models with a high number of predictors. We were able to obtain sufficient sample size to use Structural Equation Modeling.

Section 4.2.4 Instrument Pre-testing and Refinement

The proposed scales were presented to a focus group consisting of 2 emergency physicians, 1 emergency nurse, 1 hospital CIO, 1 emergency department consultant, and 1 social scientist specializing in survey research. The purpose of the focus group was to ensure face validity and possible refinement of the survey. To obtain additional feedback, the scales were posted on a weblog and the weblog link was posted to several Emergency Department, Nursing, and EMR related groups on the LinkedIn professional networking site (www.linkedin.com), requesting feedback. The emergency nurse in the focus group also solicited input from his colleagues. As a result, 4 new questions were added to the demographic scale, 2 questions were added to the change management scale, and 1 question was removed from the process management scale (PM6). The EMR use

questions were re-worded to be much more EMR specific and 1 question was added. The performance scale had 3 questions removed (P5, P6, P7) because it was felt they were either redundant or irrelevant. Five questions were added that were much more emergency department specific.

In order to reduce bias in the survey results, some of the questions were re-worded to be negatively valenced, and were broken out of their groupings and mixed together for the pretest and also for the full deployment.

The refined survey is below (still in groups).

Demographic Scale

D1: *What is your age? (18-24) (25-34) (35-44) (45-54) (55+)*

D2: *What is your gender? Male Female*

D3: *What is your job title or function? _____*

D4: *What is the size of your hospital? (beds) (<100) (100-199) (200-299) (300-399) (400+ beds)*

D5: *How long have you worked as a healthcare professional? (years) (< 1 yr) (1-5) (6-10) (11-15) (15+)*

D6: *How long have you worked for this organization?(years) (< 1 yr) (1-5) (6-10) (11-15) (15+)*

D7: *Is your hospital located in an urban or rural area? Urban Rural*

D8: *For how long has your department been using its current EMR system? (years) (< 1) (1-4) (5-9) (10-14) (15+)*

D9: *Is your department's EMR system specifically for Emergency Department's or part of a hospital-wide system? (ED Specific) (Part of Hospital-Wide System) (Don't Know)*

D10: *Have you personally been through an EMR implementation? Yes No*

D11: *Did you have a role in selecting the EMR system you are now using? Yes No*

If “yes”, please describe your role in selecting the EMR system.

Change Management Scale

CM1: *I clearly understand the purpose and objectives of the EMR system.*

CM2: *The benefits of the EMR system have been clearly identified and communicated.*

CM3: *I have not received sufficient training to learn to use the EMR system.*

CM4: *Hospital management effectively communicated the need for a new EMR system.*

CM5: *Hospital management was highly supportive of and committed to the EMR related change process.*

CM6: *No efforts were made to involve affected hospital employees in designing the EMR related changes.*

CM7: *The hospital implemented an explicit change management plan related to the EMR implementation.*

CM8: *Hospital management kept us informed of EMR related changes through frequent communication.*

CM9: *Responsibilities to be assumed by hospital employees during and after the change were assigned.*

Process Management Scale

PM1: *Emergency department processes have been re-designed to align with the new EMR system.*

PM2: *The redesigned processes meet the needs of the emergency department and the requirements of the EMR system.*

PM3: *Hospital management assembled a cross-functional team to support EMR related process re-design.*

- PM4:** *Hospital management did not clearly articulate the scope of process re-design that would be necessary with the EMR implementation.*
- PM5:** *The hospital did not establish easy-to-apply evaluation criteria to measure the effectiveness of the redesigned processes.*

EMR Use Scale

- U1:** *I use the EMR system for every patient that I treat.*
- U2:** *I use the features of the EMR system extensively.*
- U3:** *I use the EMR system for purposes other than direct patient care, such as staff scheduling, generating reports, referrals, etc.*
- U4:** *I use the EMR system only as much as I absolutely have to.*

Emergency Department Performance Scale

- P1:** *The EMR system has greatly improved the quality of patient information available to me.*
- P2:** *The EMR system has increased the number of errors in patient treatment process.*
- P3:** *The EMR system has helped me to perform my job more effectively.*
- P4:** *I am able to make better decisions with the information I am able to retrieve from the EMR system.*
- P5:** *The EMR system has reduced patient wait times for emergency services.*
- P6:** *The EMR system has improved patient oversight in the emergency department.*
- P7:** *I am able to make decisions faster with the information I am able to retrieve from the EMR system.*
- P8:** *The EMR system has reduced the length of stay of patients in the emergency department.*
- P9:** *The EMR system has increased the amount of paperwork in the emergency department.*

The instrument was then pretested for reliability. The survey was set up in online format on SurveyMonkey.com. An invitation for emergency department clinicians who had been through an EMR implementation to take the survey was posted on several healthcare related groups on LinkedIn, a professional social networking site. A total of 22 usable responses were collected and analyzed. 19 of the respondents were nurses, 2 were physicians, and 1 was a nurse practitioner. Reliability analysis was performed in SPSS. The scales for Change Management, Process Management, and Performance all returned a Chronbach's Alpha score of greater than 0.8. A score of 0.7 or greater is generally considered an acceptable measure of reliability in social science research (Stevens, 1996). The EMR Use scale only returned a Chronbach's Alpha score of 0.4. Further investigation revealed that the first two items held together at a score of 0.7 but that the other two questions did not hold together in the scale. The focus group was again consulted and it was agreed that one EMR Use question should be discarded (U4) and 5 additional questions were created. Question U2 was also reworded slightly for clarification. The final use scale is shown below.

- U1:** *I use the EMR system for every patient that I treat.*
- U2:** *I use the features of the EMR system extensively. (ie: to its fullest capabilities, within my authorization)*
- U3:** *I use the EMR system for purposes other than direct patient care, such as staff scheduling, generating reports, referrals, etc.*
- U4:** *I would not use the EMR system if it were not mandatory.*
- U5:** *I use the EMR system every time I interact with a patient. (ie: reassessment, updating charts, meds administration, etc)*
- U6:** *I use other methods of documentation other than the EMR system for some patient interactions, such as paper or dictation.*

U7: *I use the EMR system to improve communication between other providers or patients.*

U8: *I use multiple features of the EMR system. (ie: order entry, free-texting, charting, time-out documentation, assist-provider documentation, discharge paperwork, etc)*

The refined survey was re-deployed and the first 30 responses were analyzed. Scales for change management and process management both returned a Chronbach's Alpha score of greater than 0.8. The performance scale returned a score of greater than 0.9. The EMR use scale returned a score of 0.69. Although 0.7 is considered the threshold of acceptability for social science research, Nunnally (1978) suggests that greater than 0.6 is acceptable for exploratory research. Using the "scale if item deleted" feature of SPSS, it was discovered that removing question U6 from the scale would increase the Chronbach's Alpha score to 0.7. It was also noticed that the change management scale reliability score would significantly improve with the removal of question CM3 (*I have not received sufficient training to learn to use the EMR system.*). The wording of question CM3 led us to wonder if respondents considered the question to belong with the Use questions. Another reliability analysis was run by adding CM3 to the Use scale, and the Chronbach's Alpha score increased to 0.74. An optimal reliability score for the Use scale was achieved by adding question CM3 and removing questions U3 and U6. The focus group suggested that question U3 is more appropriate for nurse managers than for regular ER nurses and that U6 may simply not be relevant for most clinicians in an emergency department that uses an EMR system. This is not conclusive with such a small sample size but we will consider adding CM3 to the Use scale and removing U3

and U6 in the final data analysis. Also, Chronbach's Alpha tends to increase with more indicators and decrease with fewer (Cortina, 1993).

In considering the expanded performance scale, we noticed that it contained two basic types of questions: Those related to the impact of the EMR system on the performance of the clinician, and those related to the impact of the EMR system on the patient. Therefore we broke performance into two separate constructs: Clinician related performance (P1,P3,P4,P7,P9) and patient related performance (P2,P5,P6,P8). Reliability analysis on the sub-scales returned a Chronbach's Alpha score of 0.84 on clinician related performance (CRP) with an improvement if P9 is removed. For patient related performance (PRP), a score of 0.85 was returned. In light of this, we split our first hypothesis into two hypotheses:

H1a: Greater levels of use of EMR systems will be associated with increased clinician-related performance of healthcare subunits.

H1b: Greater levels of use of EMR systems will be associated with increased patient-related performance of healthcare subunits.

Section 4.3 Qualitative Method

This section will outline the qualitative data collection method and analysis of this research.

Section 4.3.1 Qualitative Data Collection

We conducted a number of personal interviews with key EMR stakeholders to add richness and clarity to our quantitative results. Interviews are one of the most common and powerful data collection methods in qualitative research (Myers & Newman, 2007; Schultze & Avital, 2011). We targeted people with an in-depth understanding of the issues surrounding EMR implementation and use, such as hospital CIOs, emergency department directors, and nurses. We conducted 12 telephone interviews. As with the quantitative data collection, interviewees were assured of the anonymity of themselves and their organizations. Interviewees were asked to comment on the general themes of this research such as:

- *Challenges of EMR implementation*
 - *What led your organization to adopt an EMR system? Were the reasons primarily operational, or financial, or something else?*
 - *What are the biggest obstacles to EMR implementation? Are they technical or organizational?*
- *Use of EMR systems*
 - *How does your organization overcome resistance to new technologies such as EMR systems?*
 - *How does your organization enable and encourage use of the EMR system?*
- *Process and Change Management*

- *Did your organization redesign its processes to fit the EMR system or vice-versa?*
- *Was the process redesign process organized or ad hoc?*
- *How did you “sell” the users on the need for the EMR system?*
- *How did your training process work?*
- *EMR system outcomes, perceived and/or actual*
 - *What has the impact of the EMR system been on your healthcare delivery process? Are you actually measuring impact or is it perceptual?*
 - *How does your organization define “success” in regard to the EMR system?*
 - *What lessons have you taken away from the EMR process? How would you advise other healthcare organizations who are about to go through an EMR implementation?*

These questions were modified as appropriate depending upon the type of respondent. The questions were also modified based upon the results of the analysis of the quantitative data. The purpose of the qualitative portion of this research is to provide greater insight into the issues surrounding the research questions that may not be provided by the quantitative survey. Interviews provide the researcher the freedom and flexibility to go more broadly or deeply into an issue than can be accomplished with a survey. Interviews were semi-structured in nature, keeping the respondents on topic but

allowing them the freedom to expand their answers and the interviewer to ask clarifying questions.

Section 4.3.2 Qualitative Analysis

For each interview we first studied each individual interview and drew out the relevant points. This is known as the “within-case” approach. Relevant data and themes are decontextualized and drawn out of the interview text (Ayres, Kavanaugh, & Knafl, 2003). After this came the “across-case” approach, where the key themes from the individual interviews are compared and aggregated to create themes or trends from the data as a whole (Larsson, 1993). Interview transcripts, obtained either from audio recordings or note-taking, were coded according to themes related to the research questions (Miles & Huberman, 1984). The codes allow for easier and more precise analysis of the qualitative data. We also used an external coder for a few of the interviews and compared the results to ensure inter-rater reliability.

We did not attempt to formally integrate our qualitative findings with the quantitative results. Rather we compared and contrasted the qualitative findings with the quantitative results to help clarify the primary research findings. We will elaborate on our total findings in the discussion and conclusion of this thesis.

Section 4.4 Summary

In this chapter we have outlined the research methodology we used to test our theoretical model. Primary data collection was through an online survey with Emergency Clinical

Coordinators and nurses as respondents. We also pre-tested and refined our survey items, which in turn led us refine our theoretical model by splitting our first hypothesis into two separate hypotheses. We supplemented the quantitative findings with qualitative interviews. Quantitative analysis was performed using structural equation modeling. We conducted within-case and across-case analysis of the interviews of key EMR stakeholders and used those findings to enrich our quantitative results.

Chapter 5 Quantitative Analysis

In the previous chapters we laid out our justification for the current research, the theoretical model, and the methods we intended to use to answer the research questions. In this chapter we will begin the process of data analysis by examining the results of the quantitative portion of the research. The results of the survey were analyzed with the SPSS and AMOS statistical packages. We will provide descriptive statistics as well as the results from confirmatory factor analysis (CFA) and structural equation modeling (SEM). We will use these results to determine the level of support for our four hypotheses. Any other insights that emerge from our analysis will be discussed.

Section 5.1 Data Collection

Survey responses were collected by the online survey company SurveyMonkey (www.surveymonkey.com). No identifying information was collected from the respondents for the EMR survey. Any respondent who wished to register for the Amazon Gift Card drawing and/or receive a copy of the research results were directed to a separate survey where they left their email address. As part of the second survey, respondents were also asked if they would be willing to be interviewed for the qualitative portion of this research. There are no linkages between the first and second survey so it is impossible to link email addresses from the second survey to their responses in the first survey.

Potential participants were invited to respond in 3 ways: By email invitation, by invitations posted on healthcare related groups on LinkedIn, and by personal invitation for 3 local hospitals. Respondents from the 3 local hospitals filled out paper versions of the survey. The email addresses for potential participants came from two sources: An online list broker (mchdata.com) and an emergency department consultant. SurveyMonkey has the facility to set up separate survey collectors with separate web links. Three separate collectors were set up to distinguish between respondents emailed by MCH Data, those whose emails came from the ED consultant, and those responding to posts on LinkedIn. The respondents from LinkedIn confound response rate calculation somewhat, since there is no way of knowing how many people viewed the posts, but it was decided that obtaining an adequate sample size ($>200n$) was of primary importance. Data collection began on the week of March 24 and completed on May 5th. All potential respondents were sent a reminder email approximately a week after the initial invitation. MCH Data sent out emails to 2403 potential respondents, primarily Emergency Department Clinical Coordinators. Of these, 1976 were delivered. 113 responses were obtained from this collection for a response rate of 5.7%. From a research perspective this response rate is quite small, but we were assured by our contact at MCH Data that for this type of email campaign the response rate is quite good. We must also keep in mind that some of the delivered emails may have been flagged as spam and so never seen by the potential respondent. Additionally, many of the potential respondents may simply have not qualified for this research, so while the response rate is still small, it is no doubt higher than 5.7%. From the list obtained from the ED consultant, a total of 975 emails were sent, with 853 delivered. These potential respondents were ED nurses and nurse

managers. 142 responses were obtained from this mailing, for a raw response rate of 16.6%. The same caveats apply for this mailing as for the first one regarding response rate. The overall response rate for the email campaign is approximately 9%. From the LinkedIn posts, an additional 78 responses were obtained. The 3 local hospitals provided 23 responses. While we cannot guarantee a single respondent per hospital, that was our expectation, so that multiple responses from a single organization did not unduly bias the results. For that reason we collapsed the local hospital responses into a single response per hospital, using the mean of the responses. In total we obtained 336 responses. While our exact response rate cannot be determined, it is undoubtedly low. This is unfortunately one of the common shortcomings with self-administered survey research in Information Systems (Pinsonneault & Kraemer, 1993; Sivo, Saunders, Chang, & Jiang, 2006). Busy, educated professionals are reluctant to participate in surveys because of the time involved. Others may be concerned with confidentiality or anonymity. Others, as we have pointed out, may simply not have qualified for this particular study. An analysis of potential non-response bias is essential and is reported later in this chapter.

Missing Data

Missing data from surveys can have a confounding effect on data analysis, especially if the missing data is not random. Missing data is either a result of not finishing the survey, or of choosing the Not Applicable (N/A) option for any of the questions. There are various methods of imputation for missing data, such as replacement by the mean or median of responses for that question, built upon the assumption that the data is missing at random, but the results are uncertain. Allison (2001) suggests that common methods

for salvaging missing data by imputation typically make things worse and introduce bias into the analysis (p. 12). During our analysis, we judged that much of the missing data was not random, being clustered around a few questions (PM2, U3). We decided that we could not justify using imputation for missing data and instead deleted all cases with missing data. An additional reason for this course of action is that AMOS, the statistical package we used for CFA and SEM, cannot provide Modification Indices for data sets with missing data. Modification Indices allow the researcher to see where the model can be improved by adding covariance or regression lines to the model, or by removing indicator variables that load too heavily on multiple latent constructs. Of the 336 total responses, 24 did not meet the survey criteria, because the respondent had not personally been through an EMR implementation. An additional 20 respondents did not complete the survey, and 44 responses had other missing data. Therefore our final sample is 248.

Section 5.2 Descriptive Statistics

Descriptive statistics serve to provide an overview of the profile of the respondents based on the demographic information captured during the survey. They may also serve to provide additional insight into the why certain results were obtained from the quantitative analysis. Table 5.01, below, gives the breakdown of respondents.

Table 5.01 Descriptive Statistics

Age	18-24 yrs	25-34 yrs	35-44 yrs	45-54 yrs	55+ yrs
	0%	5%	21%	42%	32%
Gender	Female	Male			
	81%	19%			
Function	Nurse	Nurse Practitioner	Physician	Physician's Assistant	
	96%	2%	2%	0%	
Are you a manager in the ED?	Yes	No			
	62%	38%			
Hospital Size (beds)	<100	100-199	200-299	300-399	400+
	27%	21%	17%	11%	23%
How long as a healthcare professional?	<1yr	1-5 yrs	6-10 yrs	11-15 yrs	15+ yrs
	0%	3%	3%	11%	81%
How long at current position?	<1yr	1-5 yrs	6-10 yrs	11-15 yrs	15+ yrs
	2%	14%	22%	15%	47%
Urban or Rural Hospital?	Urban	Rural			
	58%	42%			
How long using current EMR system?	<1yr	1-4 yrs	5-9 yrs	10-14 yrs	15+ yrs
	15%	48%	29%	5%	1%
Is your EMR system ED specific?	ED Specific	Hospital Wide			
	35%	65%			
Did you help select the EMR system?	Yes	No			
	25%	75%			

There are a few interesting observations from the respondent profiles. From the age, how long as a healthcare professional, and how long at current hospital questions, we can see that the respondents are mostly older individuals with a lot of experience. Since ED managers were the primary target respondent (62%), this makes sense. The majority of the respondents are female (81%), but the percentage of male nurses (19%) is higher than the national average of 9.6% (US Census Bureau, 2013). Also note that the majority of the EMR systems are hospital wide systems rather than specific to the emergency

department, and the great majority of respondents had no part in selecting the EMR system. These variables will be tested in our final structural model to see if they have any significant impact on the outcomes.

Section 5.3 Normality and Outliers

Many statistical analysis techniques, including regression and structural equation modeling, make the assumption of normally distributed data. Normality is measured by two characteristics, skewness and kurtosis. Skewness is a measure of the lack of symmetry of the distribution curve, and kurtosis is a measure of the “peakedness” or “flatness” of the distribution curve. Most statistical software packages will test for skewness and kurtosis. Absolute values greater than 2 for skewness (Stevens, 1996) and 10 for kurtosis (Kline, 2005) are reason for concern. Before we test for normality, it is important to test for outliers in the data sample. Outliers can be caused by data entry error or by persons taking the survey who answer completely different than the rest of the sample. Outliers can have a significant impact on the results of the analysis. In multivariate analysis, outliers can be detected by computing the Mahalanobis Distance from the centroid for each observation. Kline (2005) recommends a very conservative level of statistical significance ($p < .001$) for detecting outliers. Analysis revealed 5 observations at less than 0.001 significance. However as Stevens (1996) points out, just because an observation seems to be an outlier does not mean it should automatically be discarded. After examining these observations, we decided that there was not sufficient reason to discard them, and they were retained. We then moved on to assessment of normality. Two of our indicator variables, CM1 and U1, were outside of the ranges

recommended by Stevens (1996) and Kline (2005) (skewness of -2.7 and -2.5 respectively) and were removed from further analysis.

Section 5.4 Bias Analysis

We are primarily concerned with two types of bias in this research. Due to the low response rate, we will test our data sample for non-response bias, ie: that non-responders are significantly different than responders. Because we collected all quantitative data through the use of an online survey, we will also test for common method bias.

There are a number of ways to test for non-response bias. One of the most common ways is to divide the respondents into early and late responders, and compare the variance of the means of their responses. The idea is that late responders simulate non-responders (Armstrong & Overton, 1977). We decided to divide the respondents at the April 4 date. April 4 is the date that responses began to slow down and that we began to send out reminder emails. Early responders numbered 105, and late responders numbered 143. We conducted two tests for non-response bias. A one way analysis of variance (ANOVA) was conducted to test for equality of means in each variable between groups. Table 5.02 displays the results:

Table 5.02 ANOVA Results

	Sum of Squares	df	Mean Square	F	Sig.
CM2	1.733	1	1.733	1.985	0.16
CM3	1.736	1	1.736	1.451	0.23
CM4	2.145	1	2.145	1.722	0.191
CM5	0.102	1	0.102	0.12	0.73
CM6	0.566	1	0.566	0.406	0.524
CM7	1.464	1	1.464	1.222	0.27
CM8	0.394	1	0.394	0.326	0.569
CM9	0.296	1	0.296	0.323	0.57
PM1	2.171	1	2.171	1.969	0.162
PM2	1.553	1	1.553	1.098	0.296
PM3	1.831	1	1.831	1.404	0.237
PM4	1.141	1	1.141	0.873	0.351
PM5	3.37	1	3.37	2.585	0.109
U2	0.351	1	0.351	0.359	0.549
U3	6.23	1	6.23	3.694	0.056
U4	0.448	1	0.448	0.231	0.631
U5	0.251	1	0.251	0.388	0.534
U6	0.285	1	0.285	0.148	0.7
U7	0.034	1	0.034	0.031	0.861
U8	0.371	1	0.371	0.651	0.42
P1	1.487	1	1.487	1.095	0.296
P2	1.02	1	1.02	0.865	0.353
P3	0.119	1	0.119	0.07	0.791
P4	0.001	1	0.001	0.001	0.981
P5	0.027	1	0.027	0.02	0.887
P6	1.102	1	1.102	0.924	0.337
P7	0.543	1	0.543	0.391	0.532
P8	0.019	1	0.019	0.015	0.902
P9	0.006	1	0.006	0.005	0.946

The p-value of the F statistic is greater than 0.05 for each variable, which means that we do not reject the null-hypothesis of equality of means between early and late responders. We also conducted a Brown-Forsythe test, which is considered a robust measure,

especially if there is non-normality present in the data (Brown & Forsythe, 1974). Table 5.03 displays the results of the Brown-Forsythe test:

Table 5.03 Brown-Forsythe Test Results

Robust Tests of Equality of Means				
	Statistic	df1	df2	Sig.
CM2	1.91	1	207.075	0.168
CM3	1.413	1	212.691	0.236
CM4	1.684	1	214.646	0.196
CM5	0.124	1	237.108	0.725
CM6	0.413	1	230.042	0.521
CM7	1.252	1	233.396	0.264
CM8	0.328	1	226.696	0.567
CM9	0.322	1	222.577	0.571
PM1	2.015	1	233.027	0.157
PM2	1.12	1	231.947	0.291
PM3	1.394	1	221.197	0.239
PM4	0.895	1	233.626	0.345
PM5	2.662	1	235.064	0.104
U2	0.345	1	205.548	0.558
U3	3.693	1	224.09	0.056
U4	0.227	1	215.958	0.634
U5	0.382	1	216.865	0.537
U6	0.147	1	219.19	0.702
U7	0.031	1	227.819	0.861
U8	0.653	1	225.069	0.42
P1	1.048	1	204.844	0.307
P2	0.881	1	231.5	0.349
P3	0.072	1	230.4	0.789
P4	0.001	1	221.386	0.981
P5	0.02	1	209.962	0.889
P6	0.92	1	222.516	0.338
P7	0.377	1	207.927	0.54
P8	0.015	1	213.533	0.904
P9	0.005	1	224.636	0.946

Again, since all p-values are greater than 0.05, we do not reject the null hypothesis of equality of means. The results of these two tests give us confidence that non-response bias is not a significant concern.

To test for common method bias, we used Harmon's Single Factor test (Sharma, Crawford, & Yetton, 2009). In this test, a factor analysis is performed, where all indicator variables are forced to load on a single, un-rotated factor. If the single factor accounts for more than half the variance, then common method bias is a concern. The single factor accounted for approximately 36% of the total variance, indicating that common method bias is not a significant concern.

Section 5.5 Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) is an SEM technique similar to exploratory factor analysis (EFA) except that CFA is used to test the quality of theoretically pre-specified latent variables and their relationship to observed (indicator) variables (Kline, 2005). In some respects, it is more flexible than EFA in that it does not require exogenous variables to be uncorrelated. It is the appropriate technique for this research because we began with established scales and are testing theory rather than developing new survey instruments (DiStefano & Hess, 2005; Kline, 2005).

CFA begins with what is known as the measurement model. The measurement model links all indicator variables with their hypothesized latent variables, and allows all latent variables to correlate freely. A properly specified model will have all indicators loading strongly on their related latent variables and each latent variable will not correlate too

strongly with any other. If the measurement model does not meet these criteria, it can be re-specified and reanalyzed. The maximum likelihood (ML) estimation method will be used for both CFA and SEM. ML is the most widely used and usually the default method of performing CFA and SEM in statistical packages (Kline, 2005). Figure 5.1 below shows our initial measurement model.

Figure 5.1 CFA Measurement Model

Running the CFA with the above measurement model resulted in the following message:

The following covariance matrix is not positive definite (Group number 1 - Default model)

	PRP	U	PM	CM	CRP
PRP	1				
U	0.751	1			
PM	0.719	0.775	1		
CM	0.55	0.738	0.906	1	
CRP	0.792	0.981	0.729	0.568	1

Figure 5.2 Initial CFA results

A message of “covariance matrix is not positive definite” is a result of correlation being too high between some of the latent variables, indicating they that are not distinct (Wothke, 1993). As we can see in Figure 5.2, correlation between EMR use (U) and clinician related performance (CRP) is .981, and correlation between process management capability (PM) and change management capability (CM) is .901. Our model will have to be re-specified before we can analyze further. Model re-specification will consist mainly of the reduction of indicator variables. This has two purposes: First, to remove indicators that load too heavily on multiple constructs, resulting in poor discriminant validity (Kline, 2005, p. 56); second, to improve the statistical power of our analysis. With our sample size, we should have no more than 20 – 25 observed variables, for a ratio of 10-15 observations for each observed variable (Kline, 2005; Stevens, 1996). We may also remove indicators that simply don’t load well on their respective latent variables. On the whole, attempted to keep at least 3 indicators and no more than 4 for each latent variable (Bollen, 1989). In order to achieve discriminant validity, we sought

to keep correlations between latent variables to less than 0.85 (Kenny, 2012b; Kline, 2005). We will also check scale reliability (Chronbach's Alpha) during this process to validate the internal consistency of the new measures.

Model Re-specification

It is important to note that all model re-specification must be done without significantly altering the theoretical foundation of the model. While we aim to achieve a good fitting model, that must not be an end in itself.

To achieve discriminant validity (correlation < 0.85), we removed the following indicators: CM6, PM5, U4, U7, and P6. These indicators loaded strongly on multiple constructs, and we judged that our theory would not suffer by their removal. We also removed U3, U6, and P9 because of poor loadings on their respective constructs. As we anticipated as a result of the instrument pre-test, item CM3 loads more strongly with the EMR use factor than with change management, and improves its internal consistency. Because the question is associated with the use of the EMR system, we judged that there was sufficient theoretical and statistical justification to move that indicator to the Use variable and for it to be renamed U9. However that still left the change management variable with 6 indicators, and a correlation with process management of 0.83. Judging all remaining indicators to be important, and wishing to lower the correlation between PM and CM a little more, we examined the remaining indicators to see if it was feasible to separate change management into two separate latent variables. Questions CM2, CM4, and CM5 seemed to be about change management activities performed before the

EMR implementation began, and CM7, CM8, and CM9 seemed to be change management activities performed during the implementation. Accordingly, we separated the change management capability construct into two separate latent variables: Pre-implementation change management (CMA) and post-implementation change management (CMB). Modification indices also identified minor correlation between the errors for U2/U9 and PM1/PM4. The re-specified measurement model is shown below in figure 5.3.

Figure 5.3 Final Measurement Model

Table 5.04 shows the loadings for each indicator.

Table 5.04 Factor loadings

			Estimate
CM7	<---	CMB	0.693
PM1	<---	PM	0.532
PM2	<---	PM	0.698
PM3	<---	PM	0.687
PM4	<---	PM	0.687
U2	<---	U	0.712
U5	<---	U	0.478
U8	<---	U	0.66
P2	<---	PRP	0.331
P5	<---	PRP	0.878
P8	<---	PRP	0.894
P1	<---	CRP	0.804
P4	<---	CRP	0.853
P7	<---	CRP	0.822
U9	<---	U	0.6
CM2	<---	CMA	0.759
CM4	<---	CMA	0.696
CM5	<---	CMA	0.72
P3	<---	CRP	0.845
CM8	<---	CMB	0.728
CM9	<---	CMB	0.617

Note that the loading for indicator P2 is somewhat weak (.33). Normally we would consider discarding this indicator, but we are reluctant to use fewer than 3 indicators per latent variable (Bollen, 1989) and we believe there is sufficient theoretical justification to retain it, since it involves the impact of EMR systems on ED error rates, which is a key metric for emergency departments.

Table 5.05 displays the correlations for the latent variables in the model.

Table 5.05 Latent variable correlations

			Estimate
PRP	<-->	CRP	0.705
U	<-->	PRP	0.526
PM	<-->	U	0.751
CMB	<-->	PM	0.77
U	<-->	CRP	0.786
PM	<-->	CRP	0.788
CMB	<-->	CRP	0.423
PM	<-->	PRP	0.703
CMB	<-->	PRP	0.439
CMB	<-->	U	0.531
CMA	<-->	CMB	0.831
CMA	<-->	PM	0.767
CMA	<-->	U	0.726
CMA	<-->	PRP	0.49
CMA	<-->	CRP	0.587

Note that all correlations are now less than 0.85, indicating sufficient discriminant validity. As an additional test of discriminant validity, we performed a chi-square difference test on each pair of latent variables (Bagozzi & Phillips, 1982). To perform the test, a measurement model is created using pairs of constructs. An analysis is run with the covariance between constructs fixed to 1, and a second analysis is run, allowing the constructs to correlate freely. The difference in the two resulting chi-square values is calculated. A chi-square of 3.84 or greater for one degree of freedom is considered significant at the 5% level. If the chi-square difference value is significant, then the variables can be said to be distinct. For our model, all latent variable pairs had a chi-square difference of well over the critical value of 3.84.

Reliability

After refinement of the model, we again ran a reliability analysis to test the internal consistency of the new latent variables. The results are shown below in Table 5.06.

Table 5.06 Reliability Analysis

Latent Variable	Chronbach's Alpha
Pre-implementation change management (CMA)	0.77
Post-implementation change management (CMB)	0.72
Process Management (PM)	0.73
EMR Use (U)	0.71
Clinician Related Performance (CRP)	0.89
Patient Related Performance (PRP)	0.71

All Chronbach's Alpha values are greater than 0.7, indicating acceptable measure reliability (Stevens, 1996).

Model Fit

There are a number of measures of model fit available in structural equation modeling. Jaccard and Wan (1996) suggest reporting fit index values from multiple classes, to overcome the limitations of the individual indices. We have chosen to report the 4 most commonly used fit indices: Normed Chi-Square, Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA). Normed Chi-Square is the Chi-Square statistic divided by the degrees of freedom (CMIN/DF). This is considered more reliable than the chi-square statistic alone, because as sample sizes surpass 200, the chi-square statistic becomes significant ($p < 0.05$), leading to false rejections. The "good fit" cutoff for the normed Chi-Square is around 2 or less although some researchers will go as high as 3 or 5 (Kenny, 2012a; Kline, 2005). The Tucker Lewis and Comparative Fit indices are measures that compare the fit of the hypothesized model against an independent (no covariance) model. They

are robust against non-normality although somewhat sensitive to sample size. A value of 0.9 or greater is considered an acceptable fit, but some researchers place the cutoff at 0.95 (Hu & Bentler, 1998; Kenny, 2012a). RMSEA is a parsimony adjusted measure, favoring simple models over more complex ones. Cutoff values for RMSEA are <0.05 for good fit and <0.08 for adequate fit (Browne & Cudeck, 1993). Hu and Bentler (1998) suggest that values close to 0.06 as indicative of good fit. Most statistical programs also report the upper and lower 90% confidence intervals for RMSEA and it is suggested that the upper value (HI 90) be lower than 0.08 (Kenny, 2012a). Table 5.07 displays the fit indices for our re-specified measurement model.

Table 5.07 Fit Indices for Measurement Model

Fit Index	Value	
CMIN/DF	1.81	
TLI	0.93	
CFI	0.94	
RMSEA	0.057	HI90=.067

Based on the 4 fit indices, our model fit is quite good. We will now go on to test our structural model.

Section 5.6 Structural Model

In this section we will test our full structural model and determine if our 4 hypotheses are supported. Structural models represent the hypothesized relationships between the latent variables. The full model, with initial estimates, is shown in Figure 5.4 below.

Figure 5.4 Structural Model

Before we begin to interpret the results of the model above, it is important to note a few things. First, the standardized regression value between PM and U is greater than 1, which is an indication of potential model mis-specification (Kolenikov & Bollen, 2012). Second, the model assumes the relationships between PM, CMA, CMB, and the two performance variables are fully mediated by EMR use (U), which has not been tested. We will need to test the direct and indirect effects of each variable on the outcome variables and make appropriate adjustments if necessary. AMOS provides a resampling method known as bootstrapping to estimate direct and indirect effects and their significance. Bootstrapping creates multiple (>1000) subsamples from within the original dataset, simulating multiple samples from the general population (Kline, 2005).

Analysis of direct and indirect effects revealed a significant direct effect between clinician-related performance and patient-related performance. This makes theoretical sense. Clinicians use the EMR system in the process of treating patients, therefore if clinician performance is improved then it is reasonable to assume that patient-related performance will likewise improve in a causal relationship. Analysis also revealed that once a regression line was added between CRP and PRP, then the relationship between EMR use and patient-related performance became insignificant ($p>0.05$), suggesting that clinician-related performance fully mediates the relationship between EMR use and patient-related performance. A direct, significant effect was also discovered between process management capability, and patient-related performance. No other significant direct effects were discovered. Figure 5.5 shows the re-specified structural model.

Figure 5.5 Re-specified Structural Model

The following tables display the estimates for this model.

Table 5.08 Fit Indices for Structural Model

Fit Index	Value	
CMIN/DF	1.87	
TLI	0.92	
CFI	0.94	
RMSEA	0.059	HI90=.069

As shown in table 5.08, our fit indices indicate that we still have acceptable fit.

Table 5.09 Direct Effects

Standardized Direct Effects						
	CMB	PM	CMA	U	CRP	PRP
U	-0.641	0.918	0.556	0	0	0
CRP	0	0	0	0.857	0	0
PRP	0	0.319	0	0	0.461	0
Standardized Direct Effects - Two Tailed Significance						
	CMB	PM	CMA	U	CRP	PRP
U	0.002	0.005	0.02	...	...	...
CRP	...	...	...	0.001	...	...
PRP	...	0.001	...	...	0.002	...

Table 5.10 Indirect Effects

Standardized Indirect Effects						
	CMB	PM	CMA	U	CRP	PRP
U	0	0	0	0	0	0
CRP	-0.549	0.787	0.477	0	0	0
PRP	-0.253	0.363	0.22	0.395	0	0
Standardized Indirect Effects - Two Tailed Significance						
	CMB	PM	CMA	U	CRP	PRP
U	...	...	...	...	...	...
CRP	0.002	0.005	0.018	...	...	...
PRP	0.001	0.004	0.015	0.001	...	...

Table 5.11 Explained Variance

Squared Multiple Correlations:			
			Estimate
U			0.845
CRP			0.735
PRP			0.528

As reported above, process management capability and pre-implementation change management capability both have a direct positive effect on EMR use. Curiously, post-implementation change management capability has a direct negative effect on EMR use. We will discuss this in the next section. EMR Use has a direct positive effect on clinician-related performance, and an indirect positive effect on patient-related performance, mediated by clinician-related performance. Table 5.11 reports the squared multiple correlation values for our endogenous variables. This value is analogous to the r-squared value in regression analysis, which is the percentage of variance explained by

the predictor variables (Kline, 2005; Stevens, 1996). As we can see, the amount of variance explained is quite strong.

Section 5.7 Hypothesis Testing

Our first hypothesis states:

H1a: Greater levels of use of EMR systems will be associated with increased clinician-related performance of healthcare subunits.

With a direct positive effect value of 0.86, and a squared multiple correlation value of 0.74, we judge that this hypothesis is supported.

Our second hypothesis is related to the impact of EMR use on patient-related performance:

H1b: Greater levels of use of EMR systems will be associated with increased patient-related performance of healthcare subunits.

Our analysis found no significant direct effect of EMR use on patient-related performance. We did however find a modest (0.4) indirect effect on PRP as mediated by clinician-related performance. Therefore we suggest that hypothesis H1b is partially supported.

The third hypothesis in this research is about the relationship between process management capability and its impact on use of EMR systems.

H2: The level of process management capability will be positively associated with EMR use.

We found a strong effect (0.92) of PM on EMR use, therefore we judge that hypothesis H2 is supported.

Our final hypothesis was about the impact of change management capability on EMR use:

H3: The level of change management capability will be positively associated with EMR use.

As part of the refinement of our measurement model during confirmatory factor analysis, we split the change management construct into two separate constructs, the first relating to pre-implementation change management (CMA) and the second relating to post-implementation change management (CMB), with the expectation that both exogenous variables would have a positive relationship with EMR use. The results of our analysis are interesting. As we predicted, pre-implementation change management has a direct positive effect (0.56) on EMR use, but unpredictably, post-implementation change management had a direct negative effect (-0.64) on EMR use. This result is particularly surprising due to the fact that the bivariate correlation between CMB and Use is positive (see figure 5.3). Experimentally, we removed CMB from the model and re-ran the analysis. The regression weights for pre-implementation change management and process management both fell slightly, indicating that the inclusion of the post-implementation change management variable actually strengthens the predictive validity

of the other two exogenous variables. This is a phenomenon known as “suppression” (Cohen, Cohen, West, & Aiken, 2003). This occurs when the inclusion of a variable that is correlated with another predictor, “suppresses” the error variance of the other predictor, making its predictive validity stronger (MacKinnon, Krull, & Lockwood, 2000; Tzelgov & Henik, 1991). The inclusion of the suppressor usually improves the explained variance of the dependent variable, as it does in this case. The suppressor variable can also have a different sign for the regression coefficient than for its correlation, as in this case (Cohen & Cohen, 1983). This is because although the bivariate correlation between post-implementation change management and EMR use is positive, it does not take into account the other predictors. The partial correlation between these two variables can be negative, when controlling for the other predictor variables. This is reflected in the regression coefficients. Correlated predictors, as we have in this case, share some of the explained variance and influence on the dependent variable. Therefore the negative relationship is not necessarily between post-implementation change management and EMR use, but only between CMB and the variance in EMR use that is not explained by the other variables. In our qualitative interviews we will explore the possible reasons for a negative relationship between post-implementation change management and EMR use. Paulhus et al., (2004) argue that in suppressor situations, causal analysis is necessary even when results contradict theoretical assumptions. Therefore we suggest that hypothesis 3 is only partially supported.

Control Variables

We tested the demographic variables in our model to see if they had any impact on our endogenous variables. Three variables proved to have a slight, but statistically significant impact. Gender (D2) had a slight (0.12) impact on patient-related performance, indicating that males were more likely to judge that the EMR system improved patient-related performance. Whether the respondent was a manager (MGR) had a slight (-0.11) negative impact on patient-related performance, indicating that managers were slightly more likely to think that the EMR system did not improve patient-related performance. These two results must be interpreted cautiously, since they are categorical variables and thus do not have a normal distribution. Length of time since the EMR system was implemented (D8) had a small (0.25) positive effect on EMR use, indicating greater levels of use the longer the system was in place, which is unsurprising.

Section 5.8 Summary

In this chapter we performed statistical analysis of the survey data we collected for the quantitative portion of this research. We began with descriptive statistics, and followed by testing for non-normality, non-response and common method bias. We then conducted confirmatory factor analysis to test our assumptions about the nature of our latent variables and their indicator variables. After refining our model to assure discriminant validity, reliability, and statistical power, we achieved a model that was still theoretically sound and achieved an acceptable model fit. We then analyzed the structural model to test our hypotheses. Two of our hypotheses were supported and two were partially supported. We are a little concerned about the degree of multi-collinearity between our predictor variables. Multi-collinearity does not harm the predictive validity

of the model as a whole but it can make interpretation of the individual regression weight less certain (Cohen et al., 2003). While it is clear that pre-implementation change management and process management have a positive impact on EMR use, as we predicted, the strength of these impacts is less certain. It is possible that in the healthcare industry, the distinction between change management and process management is not as clear as in other industries. Ironically, the presence of a suppressor variable (post-implementation change management), actually strengthens the predictive validity of the other two predictors (MacKinnon et al., 2000). We will now move on to the qualitative portion of our research, to discover nuances in the research that are not explained by statistics, to validate or refute our statistical findings, and to answer questions that arose as a result of our quantitative analysis.

Chapter 6 Qualitative Analysis

As outlined in Chapter 4, this research follows a sequential mixed-method approach (Creswell, 2003). Qualitative interviews were used as the secondary method to supplement our primary method of quantitative surveys. Interviews are a common and effective method of obtaining qualitative data (Myers & Newman, 2007). We seek to discover nuances or additional details to validate and enhance our understanding of our quantitative findings (Ju et al., 2006). In this chapter we will show the results of the qualitative portion of this research. We will outline our data collection methods and respondent profiles. We will then discuss themes that emerged from our interviews and how they fit with our quantitative findings.

Section 6.1 Qualitative Data Collection and Analysis

As an incentive to participate in the quantitative survey, a chance to win a \$50 Amazon Gift Certificate was offered. At the end of the survey, those respondents who wished to register for the chance to win the gift card were invited to click a link that directed them to a second survey where they were asked to check any of three boxes: If they wished to register for the gift card drawing; if they wished to receive a copy of the results of the research; and if they would be willing to be interviewed as part of this research. If they chose any of the boxes, they were instructed to leave their email address. We conducted 12 interviews in all. 10 of the interviewees were clinicians who had participated in the quantitative portion of the research and had indicated that they would be willing to be interviewed. The other two respondents are a hospital CIO with EMR implementation

experience, and the president of an emergency department consulting firm with over 20 years' experience in the healthcare industry. All interviews were conducted over the phone, and 11 participants consented to the recording of the interview. The interviews lasted approximately 30 minutes. The interviews were semi-structured in nature, covering the themes outlined in Chapter 4. Respondents were asked specific questions, but were also free to provide additional detail and follow-up questions were used to clarify or extract additional information.

Qualitative Analysis

Once the interviews were complete, we conducted both within-case and across-case analysis of the interviews (Miles & Huberman, 1984). Although the interviews are not “cases” *per se*, the analysis concept is similar. Within-case analysis draws out the main points of each interview. The main points are coded to make identifying themes easier. Although interview coding can be very complex, we opted for simple descriptive phrases to identify emerging themes (Saldaña, 2012). Examples of codes used in this research are “*clinician resistance*”, “*mandated use*”, and “*process mapping essential*” to name a few. Across-case analysis involves using the codes from the individual interviews and adjusting and aggregating them across all the interviews to identify patterns and themes (Ayres et al., 2003; Creswell, 2003; Larsson, 1993; Miles & Huberman, 1984). Table 6.2, displayed at the end of section 6.4 will show the final codes, respondents, and typical quotes for each code. We also used an external coder with qualitative interview experience for two interviews to verify the accuracy of our coding (respondents 1 and 2). The external was not given the codes ahead of time but used his own descriptive coding.

All the descriptive codes identified by us were also identified by the external, indicating reliable coding.

Section 6.2 Respondent Profiles

As mentioned previously, a total of 12 qualitative interviews were conducted. Each respondent was asked about their job title, and some information about their hospital (urban/rural, public/private, size), and how long their EMR system had been in place. Table 6.1 shows the respondent profiles.

Table 6.1 Respondent Profiles

Respondent	Job Title	Hospital Size (beds)	Urban/ Rural	Time Since EMR Implementation	EMR Type (ED Specific / Hospital-Wide)
1	Director of Outpatient Services for Nursing	100	Rural	3 yrs	ED Specific
2	ER Nurse / Nurse Informatics	25	Rural	6 yrs	Hospital-Wide
3	Registered Nurse / ED	Large	Urban	7 yrs	Hospital-Wide
4	Chief Information Officer	98	Rural	2.5 yrs	ED Specific
5	Director of Emergency Nursing	464	Urban	10 yrs	Hospital-Wide
6	Clinical Nurse Manager / ED	155	Suburban	10 yrs	Hospital-Wide
7	Director of Emergency Services	150	Rural	2 yrs	ED Specific
8	President of Emergency Consulting Firm	N/A	N/A	N/A	N/A
9	Clinical Educator /ED	500	Rural	4 yrs	Hospital-Wide
10	ER Staff Nurse / Preceptor	256	Rural	10 yrs	Hospital-Wide
11	Director of Clinical Services	25	Rural	5 yrs	Hospital-Wide
12	Registered Nurse / ED; Clinical Advisory Team for EMR	50	Rural	8 yrs (3 yrs for CPOE)	Hospital-Wide

Out of the pool of potential clinician respondents, we chose a block of approximately 20 email addresses and invited them to participate in the survey. A total of 12 clinicians (all nurses) responded positively, but we were unable to finalize interview arrangements with two of them. With the CIO and ED consultant, our interviewees are 12 in number. Of course, before the interviews, we did not know the demographic details of any of the respondents, and so could not choose respondents based on any of those details. Fifty percent of our clinician interviewees are managers, compared to approximately 70% of our survey respondents. One of our clinician interviewees is male (10%), compared to 20% for our survey. Twenty seven percent of our hospital based respondents use ED-specific EMR systems compared to 38% of survey participants. The average time since EMR implementation is approximately 6 years. About 31 % of our survey respondents reported a time since implementation of 5-9 years. One to four years was the highest percentage (42%). The average hospital size for our interviewees is approximately 182. For our survey, the percentage of responses for the hospital size range 100-199 beds was 19%. The largest percentage was for the range 400+beds at approximately 25%. Twenty seven percent of the interview respondents worked in an urban area, whereas that percentage was 60% for the survey.

Other than hospital location (urban/rural), the demographics for the interview participants are reasonably close to that of the survey participants. Also, of the demographic variables, only manager status, time since implementation, and gender had a significant impact in our quantitative analysis and for each one the impact was slight. Therefore we are confident that our interviewees adequately represent the survey respondents.

Section 6.3 Interview Results

The following section outlines the major themes and issues that emerged from our qualitative interviews, and how they compare with our quantitative findings.

Driving Forces

We asked the interviewees about the driving forces behind the decision to adopt an EMR. The reasons varied but fell into a few consistent themes. The majority of the respondents cited government mandate or the Medicare meaningful use incentives (Amatayakul, 2011; Bigalke, 2009; Burchill, 2010) as reasons for adopting the system. Others also described the potential for enhanced and standardized patient care, better functionality, reduction of paperwork, and building a sharable database of historical patient information. Several also said that their organization simply saw EMRs on the horizon and decided to move proactively.

Change Management Capability

A clear theme that arose out of these interviews was that of resistance to change. When asked about the obstacles to implementation and use of EMR systems, the respondents invariably mentioned staff resistance, both of nurses and physicians, but especially physicians. Respondents said that the move away from paper was especially difficult for clinicians.

“Getting staff and doctors to realize that they didn’t have to have that piece of paper and have everything written down in front of them. That was a big struggle.” (respondent 1)

In our conversations about how organizations attempted to overcome resistance to the new system and effect the desired changes, such as thorough use of the EMR system, a few clear strategies emerged. The first was “selling the system”. Our respondents indicated that their hospitals spent a great deal of time and effort in explaining the purposes and benefits of the new system, why it was needed, and outlining the new features. They appealed to both the clinician’s desire for their job to be easier/better, and for patient care to be improved. One of our respondents even mentioned a specific “campaign” to get people on board, with signage, t-shirts, etc.

Conflict and resistance between clinicians and hospital administration is well documented in the healthcare literature (Doolin, 2004; Gagnon et al., 2005; Lapointe & Rivard, 2005), and this too was frequently mentioned in the course of our interviews. Clear top management support for the implementation, and including clinicians in the decision making and planning processes were repeatedly recommended as ways of overcoming resistance to using the new system. Part of top management support that was especially important to the interviewees was providing sufficient resources to the project, such as adequate staff, training time, IT support, and workstations. Getting clinician input into the decision making and implementation planning process was mentioned by nearly every respondent as a vital success factor for getting staff on board with the new system. One respondent mentioned that at his hospital, it was the emergency physicians who ultimately chose the EMR system, after vetoing the first system considered. In another case, physicians were offered the incentive to have the EMR system accessible from their home. One interviewee put it this way:

“Don’t forget to engage the bedside clinician. Bring them into the process. Utilize their knowledge and their clinical perspective.” (respondent 12)

Conflict between clinicians and the IT department and staff was also mentioned several times. In some cases it was inadequate IT support, or sometimes too heavy a reliance on IT. It was often mentioned that IT and the clinicians simply didn’t understand each other’s perspectives and needs. One interesting solution to this problem employed by some of our respondent’s hospitals is the use of clinical informaticists. Clinical informaticists (sometimes nurse informaticists) are hospital staff who are highly trained both as clinicians and information technologists. They are able to bridge the gap between clinicians and IT personnel in communicating requirements and formulating solutions to problems. Clinical informatics is a relatively new and growing field (Atkinson et al., 2001).

We have mentioned before that we consider EMR systems as a healthcare oriented type of enterprise resource planning (ERP) system, and have suggested that the critical success factors that are featured in the ERP implementation literature may also be applicable to EMR research. One such critical success factor related to change management is having a project champion (MacKinnon & Wasserman, 2009). Throughout the course of the interviews, a specific type of project champion was mentioned by nearly every respondent; that of super-user. Super-users are clinicians who have been highly trained in the use of the EMR system and are tasked with not only helping other users to use the system appropriately, but of championing the changeover to the new system. One interviewee said: *“they really are the individuals who help people work through*

frustrations.” (respondent 11) These super-user / champions will most often be nurses, but in one case it was physician assistants who assumed the role. Markus and Benjamin (1997) suggest that the most effective change agents are not necessarily top managers but those closer to the people affected by the change.

Not all institutions used incentives to encourage use of the EMR system, especially with physicians. As we have pointed out, physicians are typically more resistant to new processes and technologies than other staff, and have more power to resist (Doolin, 2004). More than one respondent indicated that some clinicians left the organization rather than use the new system. In one case computerized physician order entry (CPOE) capability was given to the nurses because of physician resistance. One interviewee said her hospital *“had to take the kid gloves off with the doctors.” (respondent 10)* In another case physicians were denied hospital privileges if they refused to train on the system.

In our theoretical model, we predicted that an organization’s change management capability would be positively associated with EMR use. But our quantitative findings were mixed. Pre-implementation change management activities, such as some of those outlined above, did indeed show a positive relationship with EMR use. Post-implementation change management however, showed a negative relationship with EMR use. So in our interviews we tried to find out why that result might occur.

One very common theme when exploring post-implementation change management was that of the hospital “dropping the ball” on the project once the system was up and running. Most of the effort at change management was expended before the

implementation and very little after the implementation. Ongoing communication of requirements and changes was often poor, with no sustainment strategy in place. One respondent put it this way, speaking of his own experience: *“Once we went live in 2005, in 2006 there was literally no support left.” (respondent 12)* This phenomenon is not uncommon in the ERP implementation literature, where firms sometimes lose focus on the project after the implementation phase. Nicolaou and Bhattacharya (2006) found that continuing the change process in the post-implementation phase of ERP systems led to greater firm performance.

Another common thread that emerged was that of older clinicians. Nearly all respondents spoke of the difficulty that older clinicians had with the changes brought about by the new system, even those who were bought in to the need for the system before it was implemented. It was suggested that even though the hospital was successful at “unfreezing” (Zand & Sorensen, 1975) the behaviors of the clinicians in the pre-implementation phase of the project, many of the older clinicians have difficulty handling the rate of change once the system was being used. As we have seen from the survey respondent profiles for this research, most of our respondents were older clinicians with a great deal of experience. We think it is safe to assume that most of that experience is in the “pre-EMR” phase of their careers. This may help explain this unexpected result.

The final consistent suggestion regarding post-implementation change management activities is that once the system is up and running and being used, clinicians stop thinking about the benefits and purpose of the new system and start focusing on all that they find wrong. One respondent suggests: *“People stop talking about what’s in it for*

them, and start focusing on all the things they don't like." (respondent 4) Conflict between the clinicians and the IT department crops up during this phase, with some clinicians placing the burden on the IT department to fix the problems and the IT staff frustrated because even if there isn't anything technically wrong with the system, they are expected to fix the perceived problems. One respondent said it was not unusual for departments to fail to take ownership of the project once the system was implemented. We should point out that several of our interviewees did not experience poor post-implementation change efforts but they were able to speculate on why there might be a negative result based on prior experience.

It is possible that although respondents have a negative view of their institution's post change management efforts, the positive forces driving EMR use (pre-change management, process change, hospital mandate, etc) were far stronger, resulting in a negative relationship. There are two other possible situations that might give the appearance of a negative relationship between post-implementation change management and EMR use. One: it is possible that pre-implementation change management and process management efforts are so successful at driving EMR use, that little post-implementation change management is necessary. Two: it is possible that in some cases there can be some reverse causation going on. If a healthcare organization realizes that they are not getting sufficient levels of usage of the EMR system after the system is implemented, they may have to take additional change steps to correct this.

Process Management Capability

In our theoretical model we hypothesized that process management capability would be positively associated with use, and this hypothesis was supported by the results of our quantitative analysis. We also found a direct positive effect between process management capability and patient related performance.

These results are also supported by the qualitative portion of this research. Interview participants also strongly emphasized the importance of process redesign and its impact on clinician's ability to use the new EMR system to its fullest. All but one of the hospital based respondents told us that processes were redesigned to accommodate the new EMR system, often extensively, although no one suggested a complete reengineering of processes from the ground up as recommended by Hammer and Champy (1993). Most described the process redesign as "streamlining." When asked about the importance of process redesign as part of an EMR implementation, one response we received was this: *"You have to. If you don't, you're just automating bad processes." (respondent 4)*

Our respondents indicated that EMR-based process redesign is a dynamic process. Most reported that the hospital had an organized process redesign plan in place for the implementation, but that ad-hoc process redesign was often necessary during the implementation when obstacles were encountered, or when new modules or new functionalities were brought on line. Several said that processes need to be reanalyzed at every step of the implementation. Like ERP systems in other industries, EMR systems have best practice processes embedded into them (Davenport, 1998), however unlike typical ERP system implementations, our respondents indicated that they worked with EMR vendors to customize the EMR systems to meet their own unique requirements

such as creating custom reports, embedding new processes, or eliminating unnecessary fields or functions. These activities not only produced the necessary new processes for use of the EMR system, but also drew clinicians into the redesign process and produced greater buy-in from them. This is what one clinician had to say:

“Really take the time, at the beginning, to look at your processes, for every department, from beginning to end, and really analyze how the migration is going to change your processes.” (respondent 2)

One very important process management theme that emerged from our interviews was the importance of process mapping, both of existing processes and proposed new processes. Several of the participants indicated that they did not really understand their existing processes until they were formally mapped out. One called the results “eye-opening.” One interviewee put it this way: *“Process mapping is crucial; it’s where you have to begin.” (respondent 4)* A few of the participants indicated that they did not do process mapping at the beginning of the implementation and later realized that it was a mistake.

When asked about the impact of process management on their ability to use the system, the consensus was that process management positively impacted their ability to use the EMR system, but only after a significant learning curve. A registered ER nurse and member of his hospital’s EMR advisory team offered this:

“Yes. When we are effective at coming up with a workflow, and a process and then educating that process and then auditing and following up on that process, we’ve been successful.” (respondent 12)

Some of our respondents also indicated that process management had a positive impact on the emergency department in general. We also found this in our quantitative analysis. The emergency department consultant we spoke to said that process redesign was often aimed at the emergency department as a whole, and not necessarily specific to the EMR implementation.

EMR Use

In addition to a hospital’s change management and process management capabilities, there are other factors that impact usage of EMR systems. One of the most significant is training. All of our respondents heavily emphasized the importance of thorough and relevant training as a key component of EMR use. Some of the interviewees indicated that they did not feel that the hospital provided enough training or enough time for training for their clinicians. Others felt that the vendor based training was inadequate and supplemented it with training developed in-house. Hospitals that adopted hospital-wide EMR systems sometimes had difficulties meeting the ER-specific training needs of the emergency department. The training was often “one size fits all” and thus much of it was not relevant to ER clinicians (such as EMR functionalities specific to inpatient or operating room processes). One respondent felt that it was important to provide baseline computer training before EMR training, especially for older clinicians. Some hospitals utilize simulations as part of the training. Auditing clinician performance with the EMR

system and providing corrective feedback was also considered to be an important part of the training process. Some hospitals employ a quality nurse to oversee the EMR auditing process.

There were two topics related to EMR use where our respondents were divided. One is the use of hard-stops, and the other is bedside workstations. Hard-stops are areas in the use of the EMR system that the clinician cannot bypass without filling in the appropriate information. While not every respondent reported that they had eliminated all paper from the patient care process, almost all respondents said that once the EMR system was in place, clinicians could not simply use paper if they didn't want to use the information system. Some of our respondents felt that hard-stops were a positive way of ensuring that all the necessary information was captured. Others felt that hard-stops slowed the emergency care process down too much. In implementations that do not utilize many hard-stops, clinicians sometimes use the free-text feature to develop a narrative-type patient assessment that used to be common when charting with paper. Other implementations would allow bypassing certain charting functions but will not allow the patient chart to be closed until all the required areas are filled in. Most agreed that for reporting or reassessment purposes (such as if the patient is admitted or transferred), information captured by the EMR templates was superior to free-texting. One clinician said that limiting hard-stops was appropriate during the shakedown and learning curve phase of the EMR implementation. The clinicians have to be able to bypass some of the charting requirements in order to get things done. Hard-stops can be built in later when people are more comfortable with the system. Some hospitals use hard-stops where the

information captured is related to patient safety or government regulation, but in other areas the clinician is allowed to go back and retroactively fill in the missing data. One interesting way of ensuring the EMR system was used to its fullest extent was suggested by the emergency department consultant; some hospitals utilize scribes in the ER.

“a human scribe is right there shoulder to shoulder with the clinician, and is an expert in using the EMR and they can, on a real time basis, record the information as the clinician verbalizes their examination of the patient, what they are doing, and what their course of treatment is.” (respondent 8)

He suggests that scribes can sometimes be the best solution to EMR based slowdown.

The other area of notable disagreement was the use of bedside workstations. Some of our clinicians felt it was absolutely crucial to do the EMR charting and assessment at the bedside, either with a built-in workstation or with COWs/WOWs (computer on wheels, workstation on wheels). They felt it would give the patient confidence and increase satisfaction. Some of our other respondents felt exactly the opposite; that the patient would feel neglected and dissatisfied if the clinician worked on the computer in front of them. They provided workstations outside the patient rooms or in a central nurse's station area. One clinician reported that they use handheld devices at the bedside. Although there was not consensus on the use of bedside IT, the majority of those who mentioned the issue were in favor of using the EMR system at the bedside.

Performance

In our model we broke emergency department performance into two separate constructs: clinician related performance and patient related performance. Therefore we asked our interviewees performance related questions along those same lines.

Clinician Related Performance

When asked about the impact of using the EMR system on clinician-related performance, the overwhelming consensus was that being required to use the system slowed the clinicians down significantly, especially in the time immediately after implementation. The respondents reported that many of the clinicians felt like they were “tied to the computer”, sometimes at the expense of the patient. However others said that while nurses were doing more work, and capturing more data than when they were using paper, it was data that they should have been capturing all along. The system forces nurses to document more things than can be charged. *“They (EMR systems) drive accountability from both the clinical and financial side” (respondent 4)*. When asked about quality of information, access to best practices, and ability to make better decisions, nearly all respondents felt that the EMR system had made a positive impact, in some cases a dramatically positive impact. Most EMR systems also have the ability to track the performance of clinicians, making specific corrective feedback possible, thus improving performance. Other positive benefits noted were greater consistency of care, and functionalities like medicine calculations. In terms of access to historical medical data on the patient, one nurse said: *“Prior to EMR, finding the medical record in our organization was pretty much nonexistent” (respondent 12)*. Less “chart-chasing” is often reported as an advantage of EMR systems over the days of paper charting. The

most common disadvantage reported with the loss of paper charting is the loss of narrative. In fact many EMR systems do have free-texting features for narrative charting but it is a supplement to template-based charting, not a substitute.

Patient Related Performance

Three main areas of patient related performance that we explored were wait time (time from entry to the ER until seen by a clinician), length of stay (treatment time until discharge), and error rate in the patient treatment process. Consistent with our quantitative results, we found little clear consensus on the impact of EMR systems of patient related performance. Time is of course a very important factor in the emergency department, and the majority of the interviewees did not feel like the EMR system had improved wait time or length of stay, although a few of the respondents did feel that throughput had improved. Many of the respondents did state that after clinicians became more comfortable with the EMR system, then wait times and length of stay returned to their pre-EMR levels. Most respondents felt that the sheer volume of documentation required by the EMR system did not allow overall wait time and length of stay to be reduced significantly. However they did feel some areas were definitely improved. Medicine reconciliation, the process of comparing meds ordered by the ER clinician with the patient's medication history, is much faster with the EMR. Most felt that discharge times were faster. One big advantage that most of our participants mentioned was patient tracking. Most EMR systems are able to track patients from registration through discharge, showing where the patient is, when they have been seen, who they have been seen by, what has been ordered, and how long they have been waiting. This is seen as a

big advantage in moving the patient through the treatment process as efficiently as possible. One other advantage that clinicians mentioned was that the wait for lab and imaging results was much faster because they are delivered electronically through the EMR system, assuming compatible systems were in place. One respondent did suggest that while forcing documentation may give the impression of increased wait and throughput times, that such times were not really being measured until the EMR implementation.

In terms of errors made in the patient treatment process, respondents were again divided. Some felt there was no real impact, some thought overall the error rate had improved, some thought that the system introduced new types of errors into the process. Some cited errors because of lack of integration with other systems. However there was one area of overall agreement: That Computerized Physician Order Entry (CPOE) had dramatically decreased errors related to handwriting. Poor physician handwriting is a cliché all over the Western world, but it is a very real and serious issue in actual healthcare settings. Forcing physicians to submit orders for meds / labs / procedures electronically has made a significant improvement in that part of the patient care process.

“CPOE? Yes, definitely. If you are looking at handwriting? Yeah, that’s totally changed, including prescription writing. It’s all computerized and then printed out. 100% better.” (respondent 6)

Some respondents indicated that errors, like wait and throughput times, were not really measured before the EMR implementation, and that even if the EMR did not decrease the overall error rate, it made locating errors easier. Best practices embedded into the EMR

system also reminds nurses of the proper process, and warns the user if they deviate from standard protocols.

EMR Impact Beyond the Emergency Department

The emergency department accounts for half of the hospital admissions in the United States (Gonzalez Morganti et al., 2013). Therefore we took the opportunity to ask the interview participants about the impact of the EMR system beyond the emergency department, or at the point where the patient moved from the ER to be admitted, referred, or transferred to another facility. While not unanimous, the overwhelming consensus was that the documentation captured by the EMR during the emergency department process was a significant advantage when the patient was admitted, referred to another provider, or transferred to another facility. In the pre-EMR days, when a patient was admitted, the in-patient staff had to regularly call down to the ER to verify or find out what had been done, what meds had been prescribed, diagnosis, etc. The same situation occurs when the patient is referred or transferred. This process has been made redundant by EMR use. The reports and data captured by the EMR in the emergency department are immediately available to all the care providers downstream with one caveat: that the downstream providers have identical or compatible systems. More than one clinician suggested that whatever time is lost in the ER because of extensive documentation is made up downstream. That record will remain and grow over time, follow the patient, and produce a survivable health-history of that patient. Interviewees also suggested that the EMR system in the emergency department produces better financial outcomes, because it forces the clinician to capture and record more billable events in the course of treatment.

The system also may provide better executive oversight of the emergency department because of structured reports and dashboards that are available in many systems.

Table 6.2 below, displays all the descriptive codes used in this analysis, including the respondents represented for each code and a representative quote where appropriate. The creation and display of such data is an important part of qualitative analysis and is important to create a chain of evidence to support our findings (Miles & Huberman, 1984). Please note that (+) and (-) indicate positive or negative impact or impression, respectively. Also note that most of the driving forces codes do not have a representative quote. Many of these codes represent answers without a great deal of narrative and do not have any theoretical impact.

Table 6.2 Interview Coding

Interview Codes	Respondents	Quotes
Driving forces		
Forward thinking	1,11,12	"Several years ago the research and literature out was about how everyone needed to be moving toward an electronic medical record so we kinda took a forefront on that and made that happen" (respondent 1)
Government mandate / Medicare incentive	1,3,4,6,7,8,9,11	
Better care	4,10	
Paperwork reduction	10	
Better record-keeping	2,6,8,10	
Efficiency	9,10	

New features	2	
Moved to new hospital	5	
Patient Safety	6	
Change management		
Clinician resistance	1,2,3,4,6,7,8,9,10,11,12	"some clinicians leave rather than use the system" (respondent 11)
Physician resistance	2,6,7,8,10,12	"physicians are the biggest barriers to change" (respondent 2)
Miss paper documentation / narrative	1,2,8	"people like narrative style (documentation) vs template style" (respondent 8)
Selling the system	1,2,3,4,5,6,9,10,12	"here's why this is important and what it will do for you" (respondent 4)
Clinician / Admin conflict	2,7	"resistance was due in part to suspicion of the ED director" (respondent 7)
Top management support	2,4,8	"executive sponsorship encourages EMR acceptance and use" (respondent 8)
Include clinicians in decision making	2,4,6,7,8,9,10,11,12	"make sure you have a clinical person in a leadership role" (respondent 2)
Clinician / IT staff conflict	4,7,8,11,12	"a high level of collaboration between clinicians and IT is critical for success" (respondent 12)
Super user / project champion	1,3,4,6,7,8,9,10,11,12	"superusers are one of the most effective things in making an EMR system implementation work" (respondent 8)
Older-clinicians have difficulty	1,2,3,6,7,8,10,11,12	I would venture to say if you did an analysis of younger vs older, you would see it would be more negative with nurses who have been nurses for a

		longer period of time and they're scared of computers" (respondent 1)
Must provide resources	4,7,11,12	"administration was committed to EMR but didn't commit enough FTE resources" (respondent 12)
Phased implementation	3,6,11	"we incrementalized our EMR rollout" (respondent 11)
Post implementation change management		
Once exposed, see flaws in system	2,4,11	"People stop talking about what's in it for them, and start focusing on all the things they don't like." (respondent 4)
Poor post-implementation support / communication	3,4,6,7,8,10,12	"after a week we were left on our own" (respondent 3)
Lack of ownership	4	"Departments that implement a system don't necessarily take ownership of a system, post implementation." (respondent 4)
Process management		
Process redesign essential	1,2,4,5,6,7,8,9,10,12	"you have to, if you don't you're just automating bad processes" (respondent 4)
Process mapping essential	1,2,4,6,8,9,10,11,12	"process mapping is tedious but important. It is really eye opening to see what our processes really are" (respondent 6)
Process management dynamic	1,2,6,9,12	"reanalyze processes at each step of the implementation" (respondent 2)
Process mgmt (+) EMR Use	2,4,5,6,7,10,11,12	"When we are effective at coming up with a workflow, and a process and then educating that process and then auditing and following up on that process, we've been

		successful.” (respondent 12)
EMR Use		
Training essential	2,3,5,6,7,9,10,11,12	"educate, educate, educate. Make training specific to the ED" (respondent 5)
Training inadequate	2,3,7,9,11	"too much to absorb in 4 hrs of training. Trainers were not flexible enough" (respondent 7)
Auditing use (+)	1,5,7,9,11	"employ a quality nurse, audit nurse's work to see that they are charting properly" (respondent 9)
Hard stops (+)	2,3,4,12	"We do utilize the hard stops, yes they make the charting complete and accurate" (respondent 3)
Hard stops (-)	7,9,10,11	"when learning the system, you have to be able to bypass to get things done" (respondent 11)
Bedside IT (+)	1,2,3,6,7,10	"we want the clinicians to keep the relationship with the patient while electronic charting" (respondent 2)
Bedside IT (-)	5,12	"staff didn't like to use the EMR system in front of patients" (respondent 5)
EMR customization (+)	1,2,6,8,9,11	"customize the product to meet the needs of the hospital" (respondent 9)
Mandated use / took paper away	1,2,3,4,5,6,7,9,10,11,12	"I basically told them (not using EMR) was not an option" (respondent 1)
Scribes	8	"scribes are the best solution to EMR based slowdown" (respondent 8)
Clinician-related performance (CRP)		
EMR-use (+) CRP	1,2,3,4,6,7,8,9,10,11,12	"slower, but better quality information, better decision making for nurses and

		doctors (respondent 10)
EMR use (-) doc time	2,3,4,5,6,9,10,11	"the system slows everyone down some, but especially older nurses, plus we are capturing more data" (respondent 12)
Capturing more data	4,6,8,12	"A great improvement. Complete documentation is a big plus" (respondent 6)
EMR use improves clinician performance tracking	5	"positively impacts our ability to monitor their performance" (respondent 5)
EMR use (+) meds calculations / reconciliation	4,8,10	"medication error rates are near zero" (respondent 10)
Better access to records	6,8,9,12	"quality of information is a dramatic improvement" (respondent 9)
EMR contains best practices	4,8,9,11	"best practices forces nurses not to forget things, deviation prompts the user" (respondent 4)
Patient -related performance (PRP)		
EMR use (+) wait time	1	"our wait time is very low but we can stay on top of it now because I can run a report on a daily basis and see how we are doing" (respondent 1)
EMR use (+) length of stay	1,6,10,12	"labs and imaging come through the EMR system, reducing time" (respondent 12)
EMR use (-) length of stay	8	"impact on throughput is negative" (respondent 8)
No impact on wait time or length of stay	2,9,11	"no direct impact but the system provides better oversight because of tracking" (respondent 11)
EMR Use (+) patient tracking	1,4,6,7,10,11,12	"patient tracking provides better oversight" (respondent 10)
EMR Use (+) error rate	1,3,4,10	"errors have decreased, you

		don't have wrong patient, wrong meds" (respondent 10)
EMR Use (no impact) error rate	2	"order entry is still on paper, no real impact" (respondent 2)
EMR use (+) handwriting errors (CPOE)	1,6,7,8,9,10,12	"CPOE is a dramatic improvement" (respondent 9)
EMR use (+) error tracking	5	"our ability to find errors has improved" (respondent 5)
Process management (+) wait times and length of stay	5,8	"EMR didn't improve wait time but new processes did, same with throughput" (respondent 5)
EMR can introduce errors	6,7,8,9,12	"fat finger errors, errors imported from previous visits" (respondent 7)
EMR impact beyond ED		
Strong impact when integrated with downstream systems	1,2,3,4,6,8,9,10,11,12	"no more duplicate questions, which erode patient satisfaction" (respondent 2)
More billable data captured	4,5,7,12	"billing is better because you are capturing more data on billable activities" (respondent 12)

Section 6.4 Open Ended Survey Questions

In addition to qualitative data obtained from our interviews, we also asked an open ended question as part of the quantitative survey. Respondents were asked to comment on their own experience with EMR implementation and use, or to comment on the survey itself if they chose, or both.

When data collection was complete, 109 participants opted to respond to the open ended question. Only one respondent wrote about the survey itself, saying that mixing positively and negatively worded questions was confusing. All remaining respondents commented on their own experience with their organization's EMR implementation and system. Through coding of the responses, we were able to condense the responses into 27 different topics. We will not list all of them here. Many of them were single occurrences and not relevant to our research. Many of them were complaints about their particular system and not helpful for this study. However there were several observations that are consistent with what we have seen from our interviews. Many of the respondents reported that the EMR system took longer to use, and had a steep learning curve. Some mentioned the importance of super-users and the advantages of patient-tracking functionality. Losing some clinicians because of the EMR system, and the difficulty for older clinicians were also themes. Inadequate training was reported by several participants. A few of the participants wrote that they missed being able to provide narrative style assessments. Some insisted that the nature of EMR documentation is eroding the clinician's ability to think critically. From one respondent:

"Because of the nature of "click and chart" I find it has lessened many nurses' ability to use clinical judgment or critical thinking when caring for patients. It has taken the opportunity for the "art of healthcare" away and squelched the ability to think through a patient issue when someone is looking to the EMR to guide nursing care. They rely on the EMR to guide what they should do for the patient, unfortunately."

MacKinnon and Wasserman (2009), when interviewing physicians to discover critical success factors for EMR implementation, had one physician offer his opinion that EMR

systems enhance the science of healthcare while losing the art (p. 5). Robles (2009) and Kossman (2006) both suggest that dependence upon EMR technology can impair critical thinking skills.

While many comments could be classified as complaints, not all were. Some spoke of handwriting errors being eliminated. Others said that despite the learning curve, they have become dependent on the new system. Better financial outcome was also mentioned. Several of the respondents offered advice for future implementations, such as the use of scribes, putting on additional staff during implementation, and making sure the system is customizable. Several also mentioned top management support as critical and that management was often not responsive to problems after the implementation had begun. There were many comments that came from different perspectives regarding ED specific EMR systems versus hospital wide systems. Several of the hospitals represented moved from an emergency department specific system to a hospital wide system and regretted losing ED specific functionality. Others with an ED specific system complained about the system not being integrated with the rest of the hospital.

There were 2 other themes that emerged strongly from the open ended question. More than 30% of the respondents felt that documentation was taking precedence over patient care. This is a serious perception that healthcare organizations will have to address. By its very nature, time is of the essence when treating patients in the emergency department. There may be any number of downstream advantages of EMR systems, but if clinicians think that such systems are actually hindering patient care, at least in terms of timely response to patient needs, then healthcare organizations will have a much harder time

achieving clinician acceptance. We will discuss this further in the next chapter. For the final theme from the open ended question; by way of recommendation, and consistent with our interview results, respondents strongly urged the inclusion of clinicians in the decision making and implementation processes.

Section 6.5 Summary

In this chapter we explained our approach to the qualitative portion of this research, our respondent profiles, and our data collection and analysis methods. We found support for our theoretical model and hypotheses consistent with our quantitative findings. There are a number of key lessons from the interviews, which we will discuss in detail in the next chapter.

Chapter 7 Discussion

We began this research with two questions:

1. What organizational capabilities are required for a healthcare organization to transform IT assets into positive IT impacts?
2. Does the use of clinical information systems such as Electronic Medical Records (EMR) systems positively impact operational performance of healthcare subunits?

After a comprehensive review of the literature, we developed a theoretical model that identified use of EMR systems as the key for healthcare organizations to realize value from their acquisition and implementation of such systems (Devaraj & Kohli, 2000; Soh & Markus, 1995; Trice & Treacy, 1988). We suggested that change management and process management are two key dynamic capabilities (Teece et al., 1997) for the enablement of EMR use. We chose hospital emergency departments as our research setting, emergency clinicians as our unit of analysis. Nurse / nurse managers were our primary respondents. We conducted a quantitative survey as our primary data collection, followed by qualitative interviews as the secondary method. In this chapter we will discuss the results of our collection and analysis of our quantitative and qualitative data. Good research should advance and test theory, but should also be relevant to practitioners (Corley & Gioia, 2011; Lee, 1999), therefore our discussion will be from theoretical and practitioner perspectives.

Section 7.1 Theoretical Perspective

This section will be a discussion of how this research specifically addressed our research questions and the results of our quantitative and qualitative analysis of the data we collected. We will discuss the theoretical implications and contributions of our findings.

Section 7.1.1 Research Question 1

What organizational capabilities are required for a healthcare organization to transform IT Assets into positive IT Impacts?

This research is not just concerned with *if* EMR systems positively impact operational performance of emergency departments (research question 2) but also *how* healthcare organizations transform IT assets such as EMR systems into IT impacts such as improved operational performance (research question 1). Building upon the work of Soh and Marcus (1995) and Trice and Treacy (1988), we placed use of EMR systems at the heart of our model. We hypothesized that use of EMR systems would positively impact operational performance of hospital emergency departments. In addition, we wanted to understand how healthcare organizations achieve the intended levels of use of EMR systems. Resistance to new information technologies is a common theme in nearly all industries, and may be even more pronounced in healthcare (Doolin, 2004; Gagnon et al., 2005; Lapointe & Rivard, 2005). Clinicians (physicians and nurses) are specialized knowledge workers who often view working with information technologies as an unnecessary distraction from their work. Therefore achieving thorough use of new IT systems in healthcare departments can be a challenge.

EMR systems are technological resources that must be integrated into the healthcare delivery processes and routines of hospital departments, such as the emergency department. Therefore we turned to the Dynamic Capabilities literature to inform our study. The Dynamic Capabilities View (DCV) is an extension of the Resource Based View (Barney, 1991) used to explain how firms achieve competitive advantage in times of rapid change by reconfiguring their resource base and internal and external competences (Teece et al., 1997). Eisenhardt and Martin (2000) and Menon (2008) suggest that processes that integrate resources (such as EMR systems) are dynamic capabilities. Our review of the literature suggests that there are two important organizational capabilities that are necessary for the successful integration of technological resources into organizational routines: process management and change management (Becker et al., 2005; Kim et al., 2011; Winter, 2003; Zahra & George, 2002; Zollo & Winter, 2002). The DCV is well represented in the IS literature, however most of the studies are about *IT enabled* dynamic capabilities (new product development, knowledge management, customer service, etc) whereas we are focusing on *IT enabling* capabilities, specifically use-enablement. Because of the similarity between ERP and EMR systems, we looked to the well-established ERP literature to inform our study of EMR systems. Process management (process redesign, business process reengineering) and change management are seen as critical success factors for successful ERP implementation (MacKinnon & Wasserman, 2009; Øvretveit et al., 2007; Parr & Shanks, 2000; Pellerin & Hadaya, 2008). However as far as we are able to ascertain, there are no empirical studies in the academic literature that identify process management and change

management capabilities as antecedents to information system usage, as we have done. Nor did we find any dynamic capabilities studies associated with EMR systems in the academic literature. Wheeler (2002) suggests there is a need for development and empirical testing of applied dynamic capabilities theories and Wang and Ahmed (2007) call for more quantitative studies with the dynamic capabilities perspective. Pablo et al., (2007) assert that there is a need for more dynamic capabilities studies in the public sector, where the goal for organizations is more concerned with improving organizational performance than achieving competitive advantage. We believe this research contributes to filling these gaps.

Process Management Capability Impact on EMR Use

We hypothesized that process management capability would have a positive impact on use of EMR systems. Both our quantitative and qualitative analysis support this hypothesis. Quantitative analysis also revealed that process management had a direct positive impact on patient-related performance. The emergency consultant we interviewed suggested that process re-design is often aimed at improvement of the emergency department as a whole, not just as part of the EMR implementation process. Qualitative analysis revealed that process mapping is a critical component of process redesign, and that process redesign is a dynamic process; as problems are encountered, the EMR is customized, or new modules are added, processes need to again be re-mapped, evaluated, and redesigned if necessary (Saull-McCaig, Pacheco, Kozak, Gauthier, & Hahn, 2006). In a study for the California Healthcare Foundation, Kushinka (2011), suggests that process mapping and analysis is not only crucial, but must be done

by the people involved in the process, and not left to the EMR vendor or consultant. In a presentation for the Minnesota State Health Department, Deering et al., (2011) suggest that process mapping prior to EMR deployment is a way to engage organizational members in the change process, and makes the connection between people, processes, and technology (p. 5). The authors also assert that process mapping should be part of dynamic process redesign. The official U.S. government website for information technology in healthcare lists process mapping as the first step in the EMR planning process (U.S. Government). We suggest that the process management survey instrument be changed to add questions relating to these issues.

Overall we believe this research confirms that process management is a key dynamic capability that is a necessary component to the integration of technological resources such as EMR systems (Davison & Hyland, 2002; Eisenhardt & Martin, 2000; Ridder et al., 2007).

Change Management Capability Impact on EMR Use

We hypothesized that change management capability would be positively associated with use of EMR systems. Confirmatory factor analysis revealed that our change management instrument actually measured two distinct constructs, which we called pre-implementation change management and post-implementation change management. Analysis of our structural model suggested that pre-implementation change management had a positive effect on EMR use, as we expected. Paré et al., (2011) suggest that change management efforts must begin well before implementation of clinical information systems, to provide a clear vision to clinicians about the need for new

systems. Qualitative interview respondents also strongly stressed the need for pre-implementation change management for realizing thorough use of the EMR system. However, we also found that post-implementation change management had a negative effect on EMR use, which was unexpected. We attempted to discover the possible reason for a negative relationship during the interview phase of the research and a few possibilities emerged. Several of our respondents indicated that support for the change process was significantly reduced after the EMR system was implemented, and this could account, at least in part, for this result. In a study of 5 community health networks implementing EMR systems, Miller and West (2011) reported only one network with significant post-implementation training and support. Blumenthal et al., (2006) suggest that investments in healthcare IT requires major organizational commitment that may span several years. Fickensher and Bakerman (2011) emphasize the importance of change management support and focusing beyond the go-live event. This phenomenon also appears in the ERP implementation literature. Many organizations implementing ERP systems focus on getting to “go-live”, but give little thought to what is needed for the project beyond that point (He, 2004; McGinnis & Huang, 2007). It is important to note that the strength and direction of the relationships of any given predictor on the outcome variables is also dependent on the presence of the other predictors. Therefore in our model, post-implementation change management has a negative effect on EMR use when both pre-implementation change management and process management are taken into account. We have suggested that the positive forces driving EMR use (pre-implementation change management and process management) are causing usage to be high, even in the face of lower post-implementation change management, resulting in

what appears to be a negative relationship. Nicolaou and Bhattacharya (2008), in a study of ERP implementation, found that while early post-implementation change activities had positive results, such activities undertaken later had a negative effect on performance. Likewise Vishwanath et al., (2010) suggest that post-implementation change efforts are more likely to be effective in EMR implementations if performed immediately after implementation. More than one of our interview respondents suggested that once the EMR system became a reality (ie: post-implementation), factors such as glitches and other technical difficulties, inadequate training and dissatisfaction with system functionality, coupled with the difficulties experienced by older, less tech savvy clinicians could result in a poor perception of the organization's post-implementation change efforts. We also suggest that it is possible that the cause/effect relationship we have suggested between post-implementation change management and EMR use may in fact be in the opposite direction. Several of our interviewees mentioned that they regularly audited clinician's use of the system, so they could intervene if the clinicians were not using the EMR system as expected. If an organization is experiencing lower than expected levels of EMR use, they may increase their post-implementation change management efforts to rectify the situation. This could also explain a negative relationship (Nicolaou & Bhattacharya, 2006).

Utilizing project champions in the form of super-users was a strong theme that came out of our qualitative interviews (Saull-McCaig et al., 2006). MacKinnon and Wasserman (2009) and Gagnon et al., (2010) found the presence of a project champion to be a critical success factor for EMR implementation. Chiang and Starren (2002) and Pare et al.,

(2008) cite lack of a project champion as a strong risk factor for EMR implementation failure. In a study of EMR implementation “best practices”, Keshavjee et al., (2006) say that super-users can provide not only technical support but generate enthusiasm and motivation in others (ie: the role of project champion). Johnson and Davis (2004) claim that change management is a critical success factor for EMR implementations and that super-users are the ones who will champion the project as the system is rolled out, unit by unit. We suggest that questions relating to the use of super-users/project champions be incorporated into the survey instrument.

Our research supports the idea that change management is a key dynamic capability for the successful implementation of EMR system (Davison & Hyland, 2002; Helfat & Winter, 2011; Johnson & Davis, 2004; Keen, 1981; MacKinnon & Wasserman, 2009; Ridder et al., 2007; Trice & Treacy, 1988; Winter, 2003; Zahra & George, 2002).

We also believe this research demonstrates not only that both process management and change management capabilities are necessary antecedents to EMR use, but that they are necessary to be employed well past the go-live event of an EMR implementation. Hospital administrators must understand that change efforts leading to effective use of EMR systems must be supported and sustained as clinicians begin using the system. They must train and rely upon project champions such as super-users to support the transition from the old way of doing things to embracing the new processes and possibilities enabled by the new technology. They must also be prepared to dynamically assess and respond to the inevitable problems or issues that emerge from the new work

environment and processes. We will discuss this further in the practitioner perspective section.

Section 7.1.2 Research Question 2

Does the use of clinical information systems such as Electronic Medical Records (EMR) systems positively impact operational performance of healthcare subunits?

Our review of the IT impact literature revealed the inadequacy of attempting to link IT investments with firm performance (Davern & Kauffman, 2000; Devaraj & Kohli, 2003; Mahmood & Mann, 1993). There are simply too many intervening variables and contingencies to draw consistent conclusions (Devaraj & Kohli, 2000; Hitt & Brynjolfsson, 1994; Ko & Osei-Bryson, 2006). Usage of IT is considered by many researchers to be a more appropriate independent or intervening variable to study the impact of IT (Barua et al., 2010; Devaraj & Kohli, 2000; Soh & Markus, 1995; Trice & Treacy, 1988). We found the state of the IT use literature to be much less developed than the IT investment literature. Many researchers also suggest measuring performance at a level that is closer to the point of use of the technology (Chan, 2000; Kauffman & Weill, 1989; Kohli & Grover, 2008; Lucas, 1993). This research places IT use as a key component of our model, and uses a level of analysis that is close to the point of use and thus makes a contribution to the IT use literature.

EMR Use

EMR Use is a multidimensional construct (Hennington et al., 2009). Beginning with Liang et al's., (2010) IT use instrument, we adapted it specifically for EMR systems. The

scale captures user's perceptions about their level of training, and their scope, depth, and frequency of usage. In the qualitative portion of our research, we discovered a number of additional facets of EMR use that are of interest and will be considered as theoretical refinements for future research. Shortcuts and workarounds are a factor in EMR use. A number of our respondents spoke of using the free-texting feature of their EMR to bypass (or supplement) some of the charting requirements, attempting to simulate as closely as possible the days of paper charting. Our respondents were divided on the use of hard-stops, some maintaining that forcing clinical staff to chart everything in real time was essential, others allowing their clinicians to retroactively complete their charts when they had time. Workarounds can be seen as important supplements to the EMR functionality, or as attempts to circumvent the design and intent of the EMR system (Saleem et al., 2008). This leads to the broader issue of customization. Many of our respondents told us that their systems, in cooperation with the EMR vendor, were often extensively customized to eliminate templates and forms that were unnecessary and to facilitate the use of the system. Safadi and Faraj (2010) suggest that customization is an essential part of successful EMR integration into healthcare organizational processes. In a study of emergency department implementation of EMR systems, Park and Chen (2012) view the customization process as an opportunity for the clinicians and the EMR system to adapt to each other to create a true socio-technical system. Another interesting factor to emerge from our qualitative interviews is the issue of real-time (ie: in the patient's presence) use of the EMR system. Some of our respondents felt that it was absolutely crucial, others felt just the opposite, and did not provide computers at the bedside. To ensure extensive use of the new EMR system, some hospitals performed quality audits and some even had

a quality nurse to oversee that the system was being used to the required extent (LaBranche, 2011). The final interesting feature to emerge from our qualitative analysis is related to the outsourcing of EMR use by the use of scribes. Some hospitals are employing clinically trained EMR experts to interact with the system on behalf of the physician. While this may be the best method to ensure that the system is being used to its fullest extent, it raises issues of patient satisfaction, cost, and confidentiality. In a study of an ambulatory urology practice, Koshy et al., (2010) found that the use of scribes increased both patient and physician satisfaction, although they were unable to determine whether their use improved productivity. Meyer (2010) suggests that physicians may lose 30% of their productivity to electronic charting and that scribes help eliminate that loss. Some clinicians are, however, questioning the cost of employing people to use a system that was supposed to be simpler and quicker than paper charting.

EMR Use Impact on Emergency Department Performance

We hypothesized that use of EMR systems would have a positive impact on emergency department performance. We broke our initial performance scale into two separate scales: clinician related performance and patient related performance and confirmatory factor analysis supported this decision.

Quantitative analysis revealed that EMR use did positively impact clinician related performance. Results of the interviews and the open ended survey question suggests that clinicians generally feel that the system slows them down, at least initially, but that the improved quality and accuracy of the information retrieved and access to best practices

outweigh the extra time required to use the system. Our hypothesis that use of EMR systems would positively impact patient related performance was only partially supported. Quantitative analysis did not reveal a significant direct effect of EMR use on patient related performance, but that there was a positive indirect effect, mediated by clinician related performance. Since patient outcomes are contingent upon the quality and efficiency of the work of the clinicians, this result makes theoretical sense. Qualitative analysis showed that emergency department performance rubrics such as wait time and length of stay are not perceived to be improved by the use of EMR systems, although several interviewees felt that after a learning curve, their wait times and length of stay metrics had returned to pre-EMR levels. None of the interviewees felt that the EMR system had an overall negative effect on patient throughput after the shakedown period. In terms of errors in the patient-care process, the clinicians were divided. There was strong consensus that the elimination of paper for functions such as physician orders (CPOE) had nearly eliminated errors related to handwriting. This is reflected in the literature. Bates et al., (1999), in a study of the impact of CPOE on 4 medical units reported a decrease in errors of 86%. Kaushal et al., (2003) studied 7 medical units implementing CPOE and reported 4 units with significant decreases in medical errors. The other 3 had non-significant results. While handwriting errors seem to have been reduced, several of the interviewees felt that other errors had been introduced, such as errors in the use of the EMR system itself (data entry errors, copy and paste errors). This suggests that for future research our survey instrument should contain questions relating to specific types of errors (Goldberg, Shubina, Niemierko, & Turchin, 2010). The interviews also revealed a strong theme that EMR systems had greatly improved patient

and clinician tracking, so subsequent research should include references to it. In a study by The Abaris Group for the California Healthcare Foundation, representatives from 51 California hospitals were surveyed about their perceptions of their EMR and EDIS (emergency department information systems) in the emergency department. When asked about the best practices the system had brought to the emergency department, the top response was improved patient tracking (The Abaris Group, 2008).

Overall we believe that the answer to our second research question is yes, usage of EMR systems does positively impact operational performance of healthcare subunits.

Section 7.1.3 Other Theoretical Insights

EMR Impact Beyond the Emergency Department

We are in agreement with several researchers that IT performance impact is best measured as close to the use of the system as possible and that is what we have done (Chan, 2000; Kohli & Grover, 2008; Lucas, 1993). However we also believe that improved performance at the subunit level will ultimately have a positive impact further downstream, such as improved financial performance, unless it is negated by other factors. Soh and Markus (1995) and Jain (2004) suggest that improved IT impacts can be transformed into improved organizational performance (figures 2.4 and 2.5 of this study) such as improved financial performance, greater stakeholder value, or increased productivity. This research supports that position. Participants in the qualitative interviews strongly believe that the data captured by the EMR system during the emergency care process is invaluable to healthcare providers further downstream if the

patient is admitted or transferred, or if the patient comes to the emergency room at a later time. The transfer process is much more efficient because downstream providers do not have to call the emergency department to find out what was done, what meds were prescribed, and what tests were ordered and their results. Ash and Bates (2005) assert that while it may take more time to fill out the electronic medical record initially, there will be “*impressive payoffs downstream*” (p. 11) and that these systems do not just represent a replacement of paper, but a fundamental and improved changing of workflow. It was also suggested that more “billable” incidents are captured by the EMR system than what was captured on paper, resulting in greater financial performance. Wang et al., (2003) noted this in a study of EMR adoption by primary care physicians. Likewise Kohl (2006) reports a significant increase in billable events captured in an EMR study of the surgical intensive care unit at the University of Pennsylvania. Hine (2006) reports similar results in a study of EMR systems in intensive care units.

Section 7.2 Practitioner Perspective

There are several takeaways from this research that are relevant to healthcare practitioners.

Capabilities

One of the criticisms of the Resource Based View (RBV) is that the theory simply assumes resources exist (Priem & Butler, 2001a). The Dynamic Capabilities perspective suggests that resources such as capabilities can be developed (Lawson & Samson, 2001; Rindova & Kotha, 2001). We have shown that both change management and process

management capabilities are a key part of new technology implementations such as EMR systems. Technology is ever changing, so new technology implementations are going to be a way of life for healthcare organizations. Some of the survey and interview participants indicated that they were already on their second or third EMR system. Therefore it would behoove healthcare organizations to take steps toward developing or enhancing change management and process management capabilities.

Project Stakeholders

There are three main internal project stakeholders for EMR implementations. They are hospital administration, clinical staff, and IT staff. This research suggests that the inclusion of clinical staff in the EMR decision making and implementation process is essential. Clinician resistance was mentioned by every interviewee, and the inclusion of clinical staff from the early stages of the project is seen as a way to mitigate that resistance. Fichman et al., (2011) relate that healthcare organizations are professionally driven and hierarchical (p. 421) and that clinicians, especially physicians, have a great deal of power to resist new technologies. Juciute (2009) suggests that engaging stakeholders in IT implementations in healthcare is one of the most important factors in sustainable change. A few of the interview participants brought up the issue of conflict between the clinical staff and the IT department over the functionality and responsibility for the EMR system. Gamble (2012) says hospital administration must make a concerted effort to foster cooperation between clinicians and the IT department. She says that the IT department can remove itself from EMR users and lose a sense of customer focus. However Roney (2012) warns that EMR implementations must not be considered an IT

project, and that clinicians must take ownership. Areas of ownership and responsibility for the EMR implementation must be articulated as part of the project plan. These issues are not new. Obtaining stakeholder involvement and delineating ownership and responsibilities is a prevalent concept throughout the IS and healthcare literature (Boulus & Bjorn, 2010; Keshavjee et al., 2006; Lapointe et al., 2011; MacKinnon & Wasserman, 2009; Nicolini, 2006; Somers & Nelson, 2001). However as Legris and Colletette (2006) point out, many organizations neglect stakeholder involvement when implementing new systems. Given the frequency of this topic being brought up by our interviewees and in the open-ended survey question, it would appear that this is also an issue in healthcare organizations.

EMR System Selection

Poor functionality was a common complaint of respondents to the open ended question on the survey. Obviously choosing the specific EMR system to be used is a crucial decision. The system must not only be functional, but compatible with other hospital systems in order to realize the downstream benefits already mentioned. Hospital-wide systems ensure compatibility but not always functionality. ED-specific systems will be more functional (theoretically) but may be more difficult to integrate with the other hospital systems. Berner et al., (2005) report that the controversy over single application suites or networked “best of breed” EMR systems started back in the 1980s and continues to this day. In 2004, Manjoney (2004) reported that a majority of hospital CIO’s were not planning enterprise (single vendor) strategies for the next two years. However the ED consultant we interviewed, and an EMR vendor we spoke to in the early stages of this

research said that hospital-wide systems are now the most commonly implemented systems, for compatibility reasons and also for ease of support by the IT staff. Likewise Bahensky et al.,(2011) claim that hospitals are moving away from best of breed adoption strategies. Clinician support for the EMR chosen will be very important so they should be part of the process. Wilhoit et al., (2006) describes how frontline nurses in one healthcare organization used their input and influence to redirect their organization's plans from a best of breed EMR implementation to a single-vendor system. This issue is consistent with what is seen in the ERP literature. Single vendor ERP systems offer the advantages of integration and compatibility, common data, etc. Best of breed systems offer greater flexibility but often more problems with maintenance and upgrades, and integration with other systems (Light et al., 2001).

Post-Implementation Change Management

From the interviews and the open-ended survey question, healthcare organizations often do not provide as much support for clinicians after the EMR implementation as before it was implemented. Healthcare organizations must plan to keep lines of communication open to support ongoing changes after the EMR system is up and running. As we discussed in the theory section of this chapter, the interaction between people, processes, and technology is dynamic and ongoing and organizations must prepare for it, and not consider the project completed at go-live. Henry (2005) suggests that extensive post go-live support is essential for successful EMR implementation. Zywiak (2001) reports that significant post go-live support, especially in terms of ongoing training, was one of the key success factors in Harvard Pilgrim Health Care's EMR system implementation.

Vendor selection is also a key factor because vendors play a role in the change management process. Vendors can provide technical support, additional training, and optimization of the EMR system as necessary. Healthcare organizations should partner with an EMR vendor that has a record of providing post-implementation support (Cortelyou-Ward, Noblin, & Martin, 2011; Henry, 2005; Mendez et al.; Singh, 2011).

Training

Extensive training is an important component of use of EMR systems. All interview participants spoke of the importance of thorough training. Healthcare organizations must plan on providing adequate training for clinical staff, as well as enough time for clinicians to participate in the training. This will be especially important for older staff, who may not have as much IT experience (Moody, Slocumb, Berg, & Jackson, 2004; Sackett, Erdley, & Jones, 2006; Valencia & Raingruber, 2010). Training must cover all the necessary functionality in a real time environment, but McCain (2008) recommends blending real-time, in class instruction with computer based instruction so as not to take up as much clinical time with training. Selection and training of super-users is also important. Super-users will serve as peer trainers and support for the rest of the clinical staff, and as project champions to help keep people motivated about using the system. Dastagir et al., (2012) discuss the advantages of peer led training. They surveyed 155 physicians who participated in a 3 day, peer led training session on EMR use. The participants noted increased job satisfaction after the training. When questioning clinicians about their preferred source of support, 78% chose peers. Likewise Lowes (2004) suggest making the most of in-house peer trainers in the form of super-users. He

also suggests that training must be done *after* workflow has been redesigned to accommodate the EMR system, and must be relevant to the individual needs of the practice or department. He also recommends that training be spaced out so that it has time to sink in.

Customization

Throughout this research we have mentioned our contention that EMR systems are essentially a specialized type of ERP system. We have looked to the ERP literature to inform our research and our results have generally been consistent with what is found in the ERP literature. However there is one area where the two research streams appear to diverge, and that is on the issue of customization of the system. It is generally accepted, albeit not universally, that with respect to ERP systems, less customization is preferred (Davis, 2005; Nah et al., 2003; Somers & Nelson, 2001). Customization can introduce software bugs into the system and cause difficulties with upgrades and maintenance (Parr & Shanks, 2000; Soh, Kien, & Tay-Yap, 2000). Where existing processes and ERP supported processes are misaligned, the conventional wisdom is for organizations to change their processes to match the system rather than vice-versa (Davenport, 1998). In contrast, several of our participants mentioned working with EMR vendors to customize their system. This is an area where clinician involvement is especially important and can generate buy-in. Customization is also an opportunity to reduce the amount of time clinicians spend on the system by eliminating unnecessary templates and steps. Bennett and Steen (2010) reported a significant increase in chart completion rates after customizing the interface and report structure of an EMR system in a medical center

employing 48 part time healthcare providers. Rose et al., (2005) suggest that the usability of EMR systems can be improved by the customization of the user interface. Allen et al., (2006) suggest “*customization to local work patterns is very important to any system’s usability*” (p. 840). The EMR literature is not universally in favor of customization however. There are studies that recommend limiting customization (Bergeron, 2006). As with ERP systems, there are risks and costs associated with customization (Maekawa & Majima, 2006). One of the key factors at play in this issue is whether the customization involves changing the underlying source code, and who is doing the changing. Major ERP systems are open source, allowing anyone to change the underlying source code (Sandoe et al., 2001) and many of the reported problems are a result of that type of modification. However custom reports and screen interfaces are generally not seen as a source of difficulty. All of our interviewees indicated that their customization was done in partnership with their EMR vendors so it is reasonable to assume that such problems are mitigated.

Performance

Time is a critical issue in the emergency healthcare process, and there is little doubt that time spent documenting on the EMR system is one of the biggest concerns of clinicians. We have already mentioned that many clinicians feel like documentation is taking precedence over patient care. Healthcare organizations must address both the reality and the perceptions of time spent on the system. Training and customization can reduce time spent on the system. Patient and clinician tracking can improve the healthcare oversight

process to keep things moving efficiently. Some hospitals may opt for the use of scribes to improve throughput in the emergency department.

Section 7.3 Summary

In this chapter we have discussed our research questions and specifically how we proceeded to obtain answers to them through this research. We believe the operation of two key dynamic capabilities: change management and process management, are crucial to achieving the intended levels of use of EMR systems. We believe our research also shows that use of EMR systems does positively impact emergency department performance. We suggest that this research provides both a theoretical and practical contribution to the information systems and healthcare fields. We have developed a model that is appropriate, theoretically sound, and well fitted to our data. We believe that this model is versatile enough to be adapted and tested in other types of healthcare departments or even in departments in other industries.

Chapter 8 Conclusion

Healthcare is an industry that has lagged behind other industries in terms of information technology acquisition and use, but is recently experiencing rapid technological growth. One of the IT artifacts that are prominent in this growth is electronic medical records (EMR) systems. Healthcare organizations are experiencing a great deal of regulatory and industry pressure to adopt and utilize these systems, in view of reducing costs and improving healthcare quality. We chose to study this phenomenon because of the relative lack of empirical research in the academic literature and for the benefit to healthcare organizations and practitioners. We find that change management and process management dynamic capabilities are important antecedents and enablers of usage of EMR systems. We discovered that organizations are often deficient in their post-implementation change management capability. We also found that EMR use has a direct positive impact on clinician related performance and an indirect positive impact on patient related performance.

This chapter will cover the contribution and limitations of this research, followed by a discussion of future research possibilities.

Section 8.1 Contribution

This research makes a number of contributions, both theoretical and practical. One of the primary motivations for this research is because of the lag in the healthcare industry to adopt and use information technology. Consequently there has also been a lag in

academic research in the healthcare area with regard to IT. This research is meant to, at least in part, fill that gap. EMR systems are a relatively new IT artifact and research into them is still relatively new with many aspects of their implementation, use, and impact largely unexplored. This research addresses those issues also.

Researchers interested in the Dynamic Capabilities perspective have called for more applied and empirically testable theories. They have also observed a lack of quantitative studies and studies in the public sector, where there are different organizational imperatives than competitive advantage. We have developed a model and chosen a research setting and research method that responds to those calls. We have developed an applied dynamic capability based theory, and empirically tested it in the public sector using both quantitative and qualitative methods. We have identified two dynamic capabilities that enable EMR system use. With support for two of our hypotheses and partial support for the other two, we have demonstrated that our model is theoretically sound. We suggest that it is suitable for testing in other healthcare departments and in other industries. It is a parsimonious model that is adaptable for other research settings.

This research makes a theoretical and methodological contribution by demonstrating the benefits of combining quantitative and qualitative methods. The ability to test the entire model using structural equation modeling allows us to model and test the process by which healthcare organizations transform IT assets (EMR systems) into IT impacts (dept. performance). Qualitative interviews allowed us to better interpret our quantitative findings and suggest improvements to our survey instrument for future research.

Many researchers have come to the conclusion that IT use is a key predictor of IT impact. By expanding Soh and Markus' (1995) model and empirically testing it, we have helped to open the "black box" of IT value by confirming that IT use is indeed an important intervening variable between IT investment and operational performance, and by identifying two of the important antecedents to IT use. The IT use literature is not as well developed as other IT impact research streams, and even fewer studies have looked at capabilities antecedent to IT use, as we have done.

We have suggested that EMR systems are similar in type to ERP systems and have tested ERP implementation critical success factor theory in a new context with a new artifact. Our results suggest that the critical success factors identified in the ERP stream of research are valid in the healthcare context. It is important to test whether theories are relevant in other contexts than where they were first developed.

This study contributes to practice by identifying capabilities that healthcare organizations should develop to keep pace with rapid technological change. It identifies issues surrounding usage of EMR systems, such as clinician resistance and increased documentation time. Hospital administrators must be prepared to address these issues proactively. This study reinforces the need for involvement by all the key stakeholders of an EMR implementation. Only 25% of our survey respondents indicated that they had a role in selecting the new system. Many of our qualitative interview respondents and

many of our open-ended question respondents recommended involving clinicians in the planning and adoption process.

Section 8.2 Limitations

No research model or method is without limitations and this research is no exception. The response rate for our survey is low, which raises concerns about sampling bias. Our respondents were mostly older, more experienced nurses. If a significant number of respondents had been younger, we might have gotten different results and therefore generalizability may be limited.

All of our quantitative data was collected using a survey, raising concerns for the various biases' that arise from such methods: (common method, central tendency, social desirability, etc.), although we took steps to mitigate against these problems (Podsakoff et al., 2003). Many of the variables that we measured (use, performance) were based on subjective perceptions rather than objective measurement.

Although we tested for discriminant validity between our predictors, there is no question that there is a strong degree of multi-collinearity between our predictors. Multi-collinearity does not harm the predictive capability of the model as a whole, or the variance explained, but it can make the interpretation of specific regression weights less reliable (Cohen et al., 2003).

This research is cross sectional, making causal inferences difficult and tentative. The use of structural equation modeling and a theoretical model that incorporates temporally

distinct steps in the EMR implementation and use process, as well as validation from our qualitative respondents gives us confidence that our causal inferences are reasonable.

Section 8.3 Future Research

There are many future directions this research can take. We have seen that although nurses and physicians share some of the same concerns over the introduction of new technologies in the healthcare process, the level of resistance, and the power to resist is often far greater with physicians. A similar study focusing on physicians as primary respondents will be important.

The IT department is another key stakeholder in EMR implementations and we have seen that there is concern and confusion over the role and authority of the IT department, so a study from their perspective would be useful.

There are additional capabilities that may be important to the use and impact of EMR systems, such as infrastructure and project management capabilities. Our model is adaptable enough to accommodate such changes.

We have said that we believe our model can be used in other healthcare departments. Since the emergency department bears a great part of the burden of initially populating the electronic medical record of patients admitted to the hospital (over half), it would be interesting to test the impact of EMR systems on departments that do not have that burden. For example, we contacted an emergency physician at a large urban hospital

who told us that most ED patients who are admitted are placed in the general medicine / hospitalist department of the hospital. It would be interesting to conduct a similar study in such a department that is linked to the ED EMR system to see what the impact is. We have also suggested that this model could be used in other industry settings, using a different artifact.

Cross-sectional studies often do not go as deeply into implementation issues as we would hope. A longitudinal study of a single EMR implementation might yield additional insights.

Lastly, we have taken the middle portion of Soh and Markus' (1995) model as the heart of our own model. That still leaves the other two processes (IT Expenditures to IT Assets, and IT Impacts to Organizational Performance) to be explored. We saw in our own study hints of the latter process. We had several respondents mention that the EMR system was positively impacting the financial performance of their hospital.

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Appendices

Appendix A: Email Request to Participate in Online Survey

[View As A Webpage](#) | [Forward to a Colleague](#)

Dear Healthcare Professional,

We are researchers at Carleton University. We are conducting research on the impact of Electronic Medical Records (EMR) systems on Emergency Department processes. We seek respondents who are healthcare providers in the emergency department who have been through an EMR system implementation and can provide insights into the implementation process and the impact of the EMR systems once implemented. Your participation is very valuable to us. All responses are completely anonymous and confidential. As an incentive to participate, we are offering a drawing for a \$50 Amazon Gift Card. The survey is very short and should only take 10-15 minutes to complete.

The survey can be found here: www.surveymonkey.com/s/EMR_ED

If there are others in your department who are also able to take the survey, or if you are unable to take the survey yourself, we would appreciate it if you would **forward this email** on to them.

Please contact us with any questions you may have. Thank you for your time.

Sincerely,

Bill MacKinnon
william_mackinnon@carleton.ca

Dr. Gerald Grant
Gerald_Grant@carleton.ca

Appendix B: Online Survey Message

Dear Healthcare Professional:

Thank you for responding to our survey request. Your input is appreciated. Allow us to reiterate

that all data collected is *anonymous and confidential*. We are interested only in aggregate data and it will not be shared with any other third party. After the survey is complete you will have the opportunity to enter your email address for the Amazon Gift Card drawing and/or if you wish to receive a copy of the report after the research is complete. Your email address will not be connected to the survey in any way. You are not obligated to answer any question you do not wish to (just click N/A), and you may withdraw from the survey at any time without penalty. If you withdraw before completing the survey, your answers will not be used. By answering the final question, you will be indicating your consent for us to use the data.

Respondents should be healthcare providers (nurse, physician, nurse practitioner, physician's assistant) in the emergency department who have been through an EMR implementation at their hospital.

This project has been reviewed and received ethics clearance through the Carleton University Research Ethics Committee. If you have any comments or concerns regarding the ethical administration of this study, please address them to the chair of the Carleton University Ethics Board:

Prof. Andy Adler & Prof. Louise Heslop, Co-Chairs
Carleton University Research Ethics Board
Tel: 613-520-2517
E-mail: ethics@carleton.ca

Should you have any questions please contact the researchers.

William MacKinnon	Dr. Gerald Grant
PhD Candidate	Ph.D. Supervisor, Associate Professor
Sprott School of Business	Sprott School of Business
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315-268-6684	613-520-2600 ext. 8006

Appendix C: Online Survey

(please note that the non-demographic questions were randomized for the survey participants)

Demographic Scale

- D1:** *What is your age? (18-24) (25-34) (35-44) (45-54) (55+)*
- D2:** *What is your gender? Male Female*
- D3:** *What is your job title or function? _____*
- D4:** *What is the size of your hospital? (beds) (<100) (100-199) (200-299) (300-399) (400+ beds)*
- D5:** *How long have you worked as a healthcare professional? (years) (< 1 yr) (1-5) (6-10) (11-15) (15+)*
- D6:** *How long have you worked for this organization?(years) (< 1 yr) (1-5) (6-10) (11-15) (15+)*
- D7:** *Is your hospital located in an urban or rural area? Urban Rural*
- D8:** *For how long has your department been using its current EMR system? (years) (< 1) (1-4) (5-9) (10-14) (15+)*
- D9:** *Is your department's EMR system specifically for Emergency Department's or part of a hospital-wide system? (ED Specific) (Part of Hospital-Wide System) (Don't Know)*
- D10:** *Have you personally been through an EMR implementation? Yes No*
- D11:** *Did you have a role in selecting the EMR system you are now using? Yes No*

If "yes", please describe your role in selecting the EMR system.

Change Management Scale

- CM1:** *I clearly understand the purpose and objectives of the EMR system.*
- CM2:** *The benefits of the EMR system have been clearly identified and communicated.*
- CM3:** *I have not received sufficient training to learn to use the EMR system.*
- CM4:** *Hospital management effectively communicated the need for a new EMR system.*
- CM5:** *Hospital management was highly supportive of and committed to the EMR related change process.*

- CM6:** *No efforts were made to involve affected hospital employees in designing the EMR related changes.*
- CM7:** *The hospital implemented an explicit change management plan related to the EMR implementation.*
- CM8:** *Hospital management kept us informed of EMR related changes through frequent communication.*
- CM9:** *Responsibilities to be assumed by hospital employees during and after the change were assigned.*

Process Management Scale

- PM1:** *Emergency department processes have been re-designed to align with the new EMR system.*
- PM2:** *The redesigned processes meet the needs of the emergency department and the requirements of the EMR system.*
- PM3:** *Hospital management assembled a cross-functional team to support EMR related process re-design.*
- PM4:** *Hospital management did not clearly articulate the scope of process re-design that would be necessary with the EMR implementation.*
- PM5:** *The hospital did not establish easy-to-apply evaluation criteria to measure the effectiveness of the redesigned processes.*

EMR Use Scale

- U1:** *I use the EMR system for every patient that I treat.*
- U2:** *I use the features of the EMR system extensively. (ie: to its fullest capabilities, within my authorization)*
- U3:** *I use the EMR system for purposes other than direct patient care, such as staff scheduling, generating reports, referrals, etc.*
- U4:** *I would not use the EMR system if it were not mandatory.*
- U5:** *I use the EMR system every time I interact with a patient. (ie: reassessment, updating charts, meds administration, etc)*
- U6:** *I use other methods of documentation other than the EMR system for some patient interactions, such as paper or dictation.*

U7: *I use the EMR system to improve communication between other providers or patients.*

U8: *I use multiple features of the EMR system. (ie: order entry, free-texting, charting, time-out documentation, assist-provider documentation, discharge paperwork, etc)*

Emergency Department Performance Scale

P1: *The EMR system has greatly improved the quality of patient information available to me.*

P2: *The EMR system has increased the number of errors in patient treatment process.*

P3: *The EMR system has helped me to perform my job more effectively.*

P4: *I am able to make better decisions with the information I am able to retrieve from the EMR system.*

P5: *The EMR system has reduced patient wait times for emergency services.*

P6: *The EMR system has improved patient oversight in the emergency department.*

P7: *I am able to make decisions faster with the information I am able to retrieve from the EMR system.*

P8: *The EMR system has reduced the length of stay of patients in the emergency department.*

P9: *The EMR system has increased the amount of paperwork in the emergency department.*

Open Ended Question

If you have any additional comments related to the EMR implementation in your Emergency Department and its impact on your work in the ED; or if you have comments or feedback about the survey itself, please feel free to use the space below.

Appendix D: Follow-up Email

Dear healthcare professional,

A little while ago, we sent you an invitation to participate in a research survey regarding EMR systems in Emergency Departments. If you filled out a survey, thank you very much. If you did not, please consider taking a moment to follow the link and participate. The survey is very short (10-15 minutes) and will greatly help our understanding of the issues faced by nurses and nurse administrators in emergency departments when EMR systems are implemented in their department.

Below is the original invitation with the survey link. Thank you for your time.

We are researchers at Carleton University. We are conducting research on the impact of Electronic Medical Records (EMR) systems on Emergency Department processes. We seek respondents who are healthcare providers in the emergency department who have been through an EMR system implementation and can provide insights into the implementation process and the impact of the EMR systems once implemented. Your participation is very valuable to us. All responses are completely anonymous and confidential. As an incentive to participate, we are offering a drawing for a \$50 Amazon Gift Card. The survey is very short and should only take 10-15 minutes to complete.

The survey can be found here: http://www.surveymonkey.com/s/EMR_ER

If there are others in your department who are also able to take the survey, or if you are unable to take the survey yourself, we would appreciate it if you would forward this email on to them.

Please contact us with any questions you may have. Thank you for your time.

Sincerely,

Bill MacKinnon email: william_mackinnon@carleton.ca

Dr. Gerald Grant email: Gerald_Grant@carleton.ca

Appendix E: Interview Themes

- *Challenges of EMR implementation*
 - *What led your organization to adopt an EMR system? Were the reasons primarily operational, or financial, or something else?*
 - *What are the biggest obstacles to EMR implementation? Are they technical or organizational?*
- *Use of EMR systems*
 - *How does your organization overcome resistance to new technologies such as EMR systems?*
 - *How does your organization enable and encourage use of the EMR system?*
- *Process and Change Management*
 - *Did your organization redesign its processes to fit the EMR system or vice-versa?*
 - *Was the process redesign process organized or ad hoc?*
 - *How did you “sell” the users on the need for the EMR system?*
 - *How did your training process work?*
- *EMR system outcomes, perceived and/or actual*

- *What has the impact of the EMR system been on your healthcare delivery process? Are you actually measuring impact or is it perceptual?*
- *How does your organization define “success” in regard to the EMR system?*
- *What lessons have you taken away from the EMR process? How would you advise other healthcare organizations who are about to go through an EMR implementation?*

Appendix F: Interview Consent Form

Consent Form

The Impact of Electronic Medical Records Systems on Healthcare Subunit Performance: A Dynamic Capabilities Study:

Date of ethics clearance: March 12, 2013

Ethics Clearance for the Collection of Data Expires: May 31, 2014

Thank you for agreeing to participate in this study. I expect the interview to take between 30 to 40 minutes of your time.

The purpose of the interview is to better understand how healthcare organizations transform Electronic Medical Records (EMR) systems into improved operational performance.

There are no anticipated emotional or psychological risks associated with your participation in this interview. The potential for any social or economic exposure associated with your answers is taken seriously and is mitigated by ensuring the anonymity of your participation and responses. I would like to make it clear that, if you agree to participate, you will not be obligated to answer any questions with which you are uncomfortable. Furthermore, you are entirely free to drop out

of the study at any time, without question, should you become uncomfortable with your participation in the study.

We will maintain the anonymity of your responses by assigning you an identification number that is linked to your name and contact information. This information will be only on a master list accessible solely to the principal researcher. This master list will be destroyed once the findings have been fully reported. Furthermore, your name and personal information will not be divulged in any report of the findings of this study. Statistical results will only be reported in the aggregate so that no individual's responses can be linked to the individual. Any quotes from your interview that are used in reports will be cited in such a way as to maintain your anonymity.

With your permission, we would like to digitally record the audio of the interview in order to accurately capture your ideas. Your name will not be mentioned on the recording, nor will any identifying information other than your ID number be associated with the recording. Audio interviews will be transcribed and the transcriptions will be stored in a hidden and encrypted folder on the researcher's password protected computer. As soon as the recordings are transcribed, the audio recordings will be destroyed. **If you prefer not to be recorded, the interviewer will collect the data by taking notes. The data generated by your interview may only be used in the present study and any future studies directly related to this topic**

You will be welcome to a copy of the final report if you want one.

This project has been reviewed and received ethics clearance through the Carleton University Research Ethics Committee. If you have any comments or concerns regarding the ethical administration of this study, please address them to the chair of the Carleton University Ethics Board:

Prof. Andy Adler & Prof. Louise Heslop, Co-Chairs

Carleton University Research Ethics Board

Tel: 613-520-2517

E-mail: ethics@carleton.ca

If you have any questions or comments about the interview process or the research project itself please contact us as indicated below:

William MacKinnon

Dr. Gerald Grant

PhD Candidate

PhD Supervisor, Associate Professor

Sprott School of Business

Sprott School of Business

Carleton University

Carleton University

william_mackinnon@carleton.ca

Gerald_Grant@carleton.ca

Interviewee Consent

-I understand the purpose of the research and agree to participate in the interview.

-I understand that I can stop the interview at any time and that the data collected up to that point will not be used in the study and will be destroyed.

☐ I give my permission for a digital audio recording of the interview to be made.

Participant Signature: _____ Date: _____

Researcher Signature: _____ Date: _____

(Duplicate Copies – 1 Copy for Participant, 1 Copy for Researcher)

Appendix G: Topics from Open Ended Survey Question

<u>Topic</u>	<u>Frequency</u>
Super-users a must.	1
Some improvement, some detriment	2
Poor reporting	2
Phased implementation (good)	2
Computer space not accounted for in plan	2
Patient tracking (positive)	2
Better billing	2
Miss narrative	2
Losing staff because of EMR	2
Wait time longer	3
Decreased performance while learning.	3
Top management support a must	3
Takes away critical thinking.	3
Handwriting errors eliminated	3
Dependent on EMR after time	3
Difficult for older people.	4
Not user friendly	4
Additional staff during initial period (use scribes)	4
Management not responsive to problems arising from implementation	5
System must be customizable	5

Moving from ER specific to hospital wide (bad)	6
Inadequate Training	7
Poor functionality.	8
Not integrated	10
Not built for ED	10
Need to involve clinicians in acquisition and implementation process	11
Documentation taking precedence over patient care.	34

Appendix H: Structural Models

Initial Structural Model

Re-Specified Structural Model