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Critical Issues in EHR Implementation: Provider and Vendor Perspectives

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Abstract:

Stakeholders, both internal and external, can have differing and sometimes conflicting perspectives and priorities even though each has a vested interest in organizational success. Using the lens of stakeholder theory, we examine the differing views of stakeholders (namely, medical providers and vendors) in the implementation of electronic health record (EHR) systems. The implementation process itself can be broken down into three phases: pre-implementation, during implementation, and post-implementation. After determining a comprehensive set of seventeen key issues relevant to each phase, we discovered that there are significant differences in the perceptions of EHR vendors and their customers in terms of which issues in each phase of an EHR implementation are most important. These findings indicate that vendors tend to underestimate the role of nursing staff and that providers tend to underestimate the role of security. Both groups, however, agree that physician support throughout the implementation is essential for success.

Keywords: Electronic Health Records, Implementation, Stakeholder Theory, Health Information Technology

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I. INTRODUCTION

Most IT projects fail to meet deadlines, run over budget, or fail to satisfy their users (Thibodeau, 2013). The figures associated with failed IT projects vary greatly according to the study: 50 percent failure rate (Kaplan & Harris-Salamone, 2009), 66 percent failure rate (Damschroder et al., 2009), 70 percent failure rate (Peltokorpi et al., 2008), or even 94 percent failure rate (Thibodeau, 2013). No matter how it is measured, the outlook for successful project implementations is grim. Nowhere is this more evident than in the area of health information technology (HIT). The Affordability Care Act (ACA) website, Healthcare.gov, that launched on October 1st in the United States has been called one of the worst IT project disasters of 2013 (Kanaracus, 2013; Klein, 2013). Similarly, the United Kingdom's efforts to create an electronic health record (EHR) system for its national health service has also been labeled a failure (Klein, 2013).

In February 2009, the Health Information Technology for Economic and Clinical Health (HITECH) Act was signed into law in the US to finance and manage extensive investments in HIT throughout the country (U.S. Department of Health and Human Services, 2010). The U.S. Congress appropriated over US\$20 billion towards HIT at that time (Lapointe, Mignerat, & Vedel, 2011). The HITECH Act focused on improving the delivery of American healthcare and patient care. Since February 2009, approximately \$800 million has been invested in various initiatives that further the adoption of electronic health records (EHR) throughout the US. Similarly, in Western Europe, spending in modernizing the healthcare sector has increased from US\$9 billion in 2006 to US\$12 billion in 2011 (Lapointe et al., 2011). The motivation for this type of spending derives from the conception that the benefits are significant and widely advocated (Jha et al., 2009).

In spite of the increased spending and governmental initiatives, many healthcare providers in the US have been slow to adopt EHRs. The lack of urgency towards adopting EHR systems can be attributed in part to the issues encountered at various stages of the implementation process (Lorenzi, Kouroubali, Detmer, & Bloomrosen, 2009). Additionally, the EHR system vendors may view the implementation process as a significant barrier to successfully distributing their solutions throughout the medical community. As such, in this paper, we explore the dynamics involved in the EHR implementation process from both vendors' and medical providers' perspectives. The results provide a greater understanding of each stakeholder's needs and goals and shifts the focus toward improving EHR system implementation success.

IT implementation is one of the core activities in information systems (IS) practice and research (Aubert, Barki, Patry, & Roy, 2008). HIT lags far behind other industries with respect to IT adoption and implementation (MacKinnon & Wasserman, 2009). Where "adoption" refers to simply making a decision to use a new innovation (Castillo, Martinez-Garcia, & Pulido, 2001), "implementation" refers to:

the constellation of processes intended to get an intervention into use within an organization; it is the means by which an intervention is assimilated into an organization. Implementation is the critical gateway between an organizational decision to adopt an intervention and the routine use of that intervention; the transition period during which targeted stakeholders become increasingly skillful, consistent, and committed in their use of an intervention. (Damschroder et al., 2009, p. 3).

The national organization HIMSS (healthcare information and management systems) defines electronic health records (EHR) as "a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting". Ford, Menachemi, Peterson, and Huerta (2009) predict that EHR adoption will not reach the 90 percent mark in U.S. small clinical practices until at least the year 2024. Thus, the focus on successfully implementing an EHR system will be of utmost importance for many years to come. Hospitals, in particular, are organizations where HIT applications frequently see problems in implementation (Kaplan et al., 2009).

The benefits of successfully implementing an EHR system are numerous. EHR systems can improve workflow, reduce costs, and improve the quality of care for patients (Kaplan et al., 2009). In addition, they can also reduce medical error rates and support the provider's decision making process (Castillo et al., 2010). They have been shown to simplify prescribing diagnostic procedures and reduce the number of adverse drug events (Lapointe et al., 2011). HIT is unlike any other industry that uses an IS in that "what is at stake is not just people's livelihoods, but in fact their lives". Researchers have estimated that up to 98,000 people die every year from medical errors that occur

in hospitals (Kohn, Corrigan, & Donaldson, 2000) that may have been circumvented with a well-implemented HIT (MacKinnon & Wasserman, 2009).

One potential cause of HIT implementation failure is stakeholders' lack of involvement (Peltokorpi et al., 2008; MacKinnon & Wasserman, 2009). Failure rates of 75 percent are common due to the lack of stakeholder participation during implementation (Lapointe et al., 2011). Stakeholders directly impact the implementation process (Boonstra & Govers, 2009). According to Freeman's classic definition, a stakeholder in an organization is any group or individual who can affect or is affected by the achievement of the organization's objectives (Freeman, 1984; Jawahar & McLaughlin, 2001). Stakeholder involvement has reached such a level of critical importance that the recent release of the fifth edition of the *Project Management Book of Knowledge* (PMBOK) now includes a new tenth knowledge area for stakeholder engagement. Stakeholder theory has similarly been proposed as a useful framework for understanding successful HIT implementation (Lapointe et al., 2011).

This study focuses on two important stakeholders in the EHR implementation process: clinical providers inside the organization and vendors from outside the organization. Stakeholders in healthcare organizations tend to be more loosely coupled; therefore, analyzing their differing perspectives is essential to successful implementation (Boonstra & Govers, 2009). Healthcare organizations typically implement new systems with a high level of engagement from an implementation partner such as a vendor or consultant who bring their previous experience to bear on the new project (MacKinnon & Wasserman, 2009). Identifying issues that may be perceived differently by these two types of stakeholders should prove valuable in increasing the level of success of any EHR implementation on a practical level. Thus, with this study, we answer a frequent call for more research based on stakeholder theory in the specific context of healthcare (Lapointe et al., 2011; MacKinnon & Wasserman, 2009; Laplume, Sonpar, & Litz, 2008; Peltokorpi et al., 2008; Jawahar & McLaughlin, 2001).

Properly implementing EHR is critical to the system's overall effectiveness. Unresolved issues that arise during the implementation process can significantly hinder the system's effectiveness and create a false sense of buyer's remorse with regards to the benefits of the system. The implementation process can be divided into five phases: 1) decision, 2) selection, 3) pre-implementation, 4) implementation, and 5) post-implementation (Lorenzi et al., 2009). This research focuses on the last three phases after the decision to adopt has been made and the specific EHR system has been selected. Typically, any issues with implementation that will arise can be found during these three phases (Boonstra & Govers, 2009; Damschroder et al., 2009; Lorenzi et al., 2009). In these phases, there is an increased need for constant open communication between the EHR vendor and the medical provider in order to stay on schedule and effectively address any issues that may arise (Lorenzi et al., 2009). EHR vendors may view different areas of the implementation process as important compared to medical providers who are adopting the new system. This potential disconnect between vendors and medical providers warrants an investigation into the differing perspectives during the three phases of the implementation process. Thus, we address two research questions:

1. What are the critical issues during the pre-implementation, implementation, and post-implementation phases of an EHR system from the perspectives of vendors and healthcare providers?
2. How do these critical issues differ between these stakeholders?

To address the research questions, we distributed a survey to providers and vendors that asked them to rank critical issues in the three phases of EHR implementation. The results of the survey form both a framework for future researchers and actionable recommendations for practitioners.

This paper is organized as follows. In Section 2, we discuss the theoretical foundation of stakeholder theory. In Section 3, we outline the EHR implementation issues. In Section 4, we describe the methodology and, in Sections 5 and 6, we present the results of the survey. The remaining sections include a discussion (Section 7), the contribution (Section 8), limitations (Section 9), future research (Section 10), and conclusion (Section 11).

II. THEORETICAL FOUNDATION

According to Freeman (1984), a stakeholder in an organization is any group or individual who can affect or is affected by the achievement of the organization's objectives. Stakeholder theory asserts that any organization will have multiple stakeholders (i.e., groups of people that should have their needs satisfied in order for the organization to be successful). These groups can include people both internal and external to the organization. Furthermore, these groups will typically have different needs and even conflicting goals. In classic stakeholder theory, a firm has multiple stakeholders including customers, communities, employees, trade associations, suppliers, governments, investors, political groups, and the firm itself (Freeman, 1984).

Stakeholder theory has been labeled as controversial due to the fact that it questions the conventional assumption that the pursuit of profitability is the most important management concern (Laplume et al., 2008; Jawahar & McLaughlin, 2001). In fact, the evolution of stakeholder theory in the management literature has had an increasingly normative tone in its growth from strategic management to business ethics to studies on sustainability in organizations (Laplume et al., 2008; Donaldson & Preston, 1995). Despite this ethical thrust, some researchers have claimed that effective stakeholder management typically leads to improved firm financial performance (Laplume et al., 2008).

Mitchell et al. (1997) identify three key features of stakeholders: power, urgency, and legitimacy. Specifically, stakeholders must have 1) power in the form of a valued resource, 2) urgency in the sense of having time-sensitive and critical claims on organizational resources, and 3) legitimacy in that they fulfill socially accepted roles (Laplume et al., 2008). Doctors and nurses on the internal stakeholder side meet these three criteria. Likewise, vendors and consultants on the external side meet the definition as well. Furthermore, any IS implementation will typically involve a shift in power from one stakeholder group to another (Boonstra & Govers, 2009). This aspect of stakeholder theory is particularly relevant to EHR implementation because doctors typically view an EHR implementation as a loss of autonomy and power (Ford et al., 2009).

Stakeholder theory has only recently been adopted in IS research and has been called “highly appropriate in the field of IT” (Lapointe et al., 2011, p. 106). In IS research, stakeholders have been examined in the context of e-commerce and include customers, the internal organization, suppliers, investors, regulators, and indirect groups such as trade organizations (Chua, Straub, Khoo, Kadiyala, & Kuechler, 2005). In the context of e-government, multiple stakeholders exist at differing levels of government and in different governmental agencies who often have conflicting concerns (Scott, Golden, & Hughes, 2004). Pouloudi (1999) has called for more research on stakeholder relationships in IS research. Lapointe et al. (2011) has called for more research in stakeholder relationships in HIT implementations specifically, which has received less attention. Stakeholder theory may be particularly salient to the healthcare field due to the moral dimension of providing high-quality patient care over and above shareholder value.

Research on stakeholders in HIT implementations typically focuses on the fact that different stakeholders are involved in the process. EHR implementations include many stakeholders with unique perceptions (McGinn et al., 2011). These stakeholders tend to play different roles with different levels of involvement during implementation (Boonstra & Govers, 2009). Stakeholders in HIT can be divided into three main groups: administrators, physicians, and nurses (Lyons et al., 2005). Alternatively, they can be divided into four main categories: the producers of an HIT, its users, the patients, and the administrators/payers (Kazanjian & Green, 2002). A more broad division includes physicians, healthcare organizations, patients, insurance companies, pharmacies, consultants, project coordinators, nurses, managers, and other organizations in the healthcare value chain (MacKinnon & Wasserman, 2009). Stakeholder engagement is what drives, in part, whether an EHR implementation is successful or not (MacKinnon & Wasserman, 2009; Peltokorpi et al., 2008). Stakeholders in the EHR process do this through influencing decision makers, providing access to resources (or not), and assisting in creating a vision of the final outcome (Peltokorpi et al., 2008). To date, there is little research on how to measure the differing perceptions of stakeholders in the EHR implementation process. Understanding stakeholder expectations, attitudes, and values will lead to better acceptance of newly implemented EHR systems (Boonstra & Govers, 2009). Indeed, Peltokorpi et al. (2008, p. 429) state:

In the future, stakeholder research in healthcare will need to move beyond the simplistic but conventional idea that stakeholders matter in determining change success outcomes. The types of stakeholder networks and their influence on the change process needs to be elaborated in more normative detail. Research will have to filter the tentative ideas we present into concrete, testable hypotheses and propositions...in different healthcare contexts.

We answer this call for more research with this paper.

Despite the low (but growing) amount of research into EHR implementations, few studies point to some potentially testable hypotheses. For example, Heeks (2006) suggests that there are three different rationalities (or stakeholder backgrounds) at work in any EHR implementation. These include technical, managerial, and medical backgrounds. If we combine the roles of technical consultants and project managers, we can draw a sharp contrast with the clinical group. Where clinical personnel usually focus on issues such as quality of care, health outcomes, and clinical efficiency, non-clinical managers tend to focus more on cost, organizational issues, and overall operational performance (Lapointe et al., 2011).

While the stakeholders for a comprehensive EHR implementation may include such diverse groups as the clinical staff of doctors and nurses, administrative staff, patients and their families, hospitals, ambulatory practices,

insurance companies, labs, pharmacies, radiology, government agencies, vendors, and consultants, this exploratory study examines the differing perspectives of two important stakeholders: medical providers inside a healthcare organization and vendor/consultants external to a healthcare organization. Prior research on EHR implementations has primarily focused on the customer's perspective (i.e., the adopting medical provider's point of view) (Miller & Tucker, 2009; Jha et al., 2009). In particular, the physician's role in the adoption and implementation process has been extensively studied and established as being a major contributor to slow EHR adoption rates in the US (DeVore & Figlioli, 2010; Angst & Agarwal, 2009). What is novel about the current study is the contrast between the provider perspective and the vendor perspective.

The vendor perspective is vital because studies have underscored a strong fear (on the part of providers) that an EHR vendor may go out of business or otherwise be unable to provide ongoing technical support (McGinn et al., 2011; Ford et al., 2009; DesRoches et al., 2008). Where more traditional ERP system vendors are fairly mature, EHR vendors have not been in business as long and, therefore, provide a major cause for concern. Nevertheless, the vendor's active participation in the EHR implementation is necessary due to project management and change management expertise that the vendor possesses and that may be missing or insufficient in the healthcare organization (MacKinnon & Wasserman, 2009). The EHR vendor presumably has expertise in the implementation process based on their past experience and, thus, has a certain set of priorities in order to achieve a successful rollout in a health organization. At the same time, the health organization may have a different perspective on how a successful rollout is to be achieved. If there is not strong alignment between these two perspectives, there may be conflicts in expectations of deliverables, project delays, and even implementation failures as Boonstra & Govers' (2009) case study of a hospital's implementing EHR evidences. Thus, there is a strong need to not only identify the specific critical issues during an implementation but identify any potential differences in perspectives that may lead to future problems if they are not addressed. As such, we hypothesize:

H1: Stakeholders' perceptions of the importance of critical EHR implementation issues will differ in each phase of EHR implementation.

H2: Stakeholders' perceptions of who the actual stakeholders are will differ in each phase of EHR implementation.

Table 1: Summary of Critical Issues in EHR Implementations Base on the Literature Review

Source	Critical issues	Description
Castillo et al. (2010)	Factors for adopting clinical information systems	User attitude towards information systems, workflow impacts, interoperability, technical support, communication among users, expert support
Damschroder et al. (2008)	Key elements in health service implementation framework	Intervention characteristics, outer setting, inner setting, characteristics of individuals, and the implementation process
DesRoches et al. (2008)	Barriers to adoption of EHR	Amount of capital needed, uncertainty about return on investment, resistance from physicians, capacity to select, contract, install, and implement, concern about loss of productivity during transition, concern about inappropriate disclosure of patient information, concern about illegal record tampering, concern about the legality of accepting electronic records from hospital, concern about physicians' legal liability, finding an electronic records system to meet needs, and concern that system will become obsolete.
Lorenzi et al. (2009)	Barriers to EHR use	EHR products are expensive and require a major investment; EHR applications are not standardized; EHRs are more difficult to use than paper-based records; EHR implementation reduces practice productivity and disturbs workflow; EHR benefits accrue to others (society and payers) not to providers.
MacKinnon & Wasserman (2009)	Theoretical success factors	Resource requirements, physician support, project champion, planning, project management, and process reengineering.
McGinn et al. (2011)	Common EHR implementation factors	Design or technical concerns, privacy & security concerns, cost issues, lack of time and workload, motivation to Use EHR, productivity, perceived ease of use, patient and

		health professional interaction, interoperability, and familiarity, ability with EHR.
Rahimi, Vimarlund, & Timpka (2009)	Key areas for implementation of Health Information System	Management involvement, motivation and rationales, surveillance of system effectiveness, information needs assessments, education and training support, implementation process and methods, work routine and workflow integration, system integration, trust, participation and user involvement, technical system performance.

A handful of studies have attempted to compile a list of critical issues for EHR implementations (see Table 1). There is, however, no generally accepted definitive list of critical issues. None of the studies accommodate the differences in stakeholder roles because they approach the issue from the perspective of the provider alone. Nor do they accommodate the detailed phases of implementation. Hence, we developed a representative list of critical issues based on industry implementation surveys and our own literature review of academic research (See Table 2).

In this paper, we focus on the insights both stakeholders can provide for the three stages of implementing EHR systems (i.e., pre-implementation, implementation, and post implementation). The “pre-implementation” phase can be characterized as requiring consistent and clear communication between key stakeholders in the project management team, the organization of workflows, the establishment of a schedule for the project, and the procurement of timely and appropriate training for the users of the EHR system (Lorenzi et al., 2009). Most of an EHR implementation’s success relies greatly on the planning that occurs prior to implementing the system (Adler, 2007). The “implementation” phase can be characterized as the major conversion from the previous information management system to the new EHR system in a fast and effective manner with extensive amounts of support for the adopting institution (Lorenzi et al., 2009). Lastly, the “post-implementation” phase can be characterized as involving “continuous updating, training, and evaluation” (Lorenzi et al., 2009, p. 102). Altogether, a successfully implemented EHR system should provide the healthcare facility with a “secure, scalable, flexible, distributed, semantically interoperable, [and] portable EHR system” (Blobel, 2006). We focus on the issues that EHR vendors and medical providers encounter during these three phases of the implementation process of an EHR system (i.e., after a vendor has been selected). Figure 1 shows the research framework.

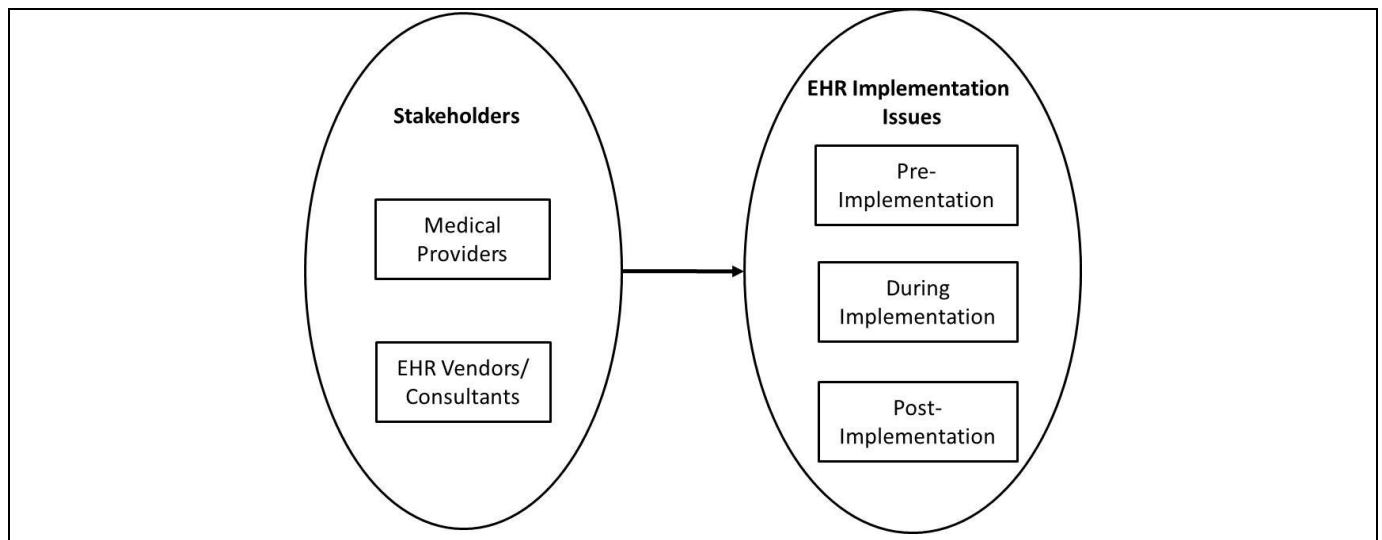


Figure 1. Research Framework

III. EHR IMPLEMENTATION ISSUES

Both vendors and providers need to intensively focus on the various details of planning the EHR implementation. Similar to a business project management plan, clear goals and detailed documentation of the implementation process must be established early on. This ensures that key stakeholders are involved and work in concerted effort to fine tune the project plan. A thorough cost-benefit analysis should be completed for all parties involved to understand the financial implications and the potential benefits of the system. There are several financial and non-financial benefits that an adopting organization can realize once the EHR system is fully operational (Lorenzi et al., 2009), such as improved office efficiency and patient care. The EHR vendor must also detail the service-level agreement with the adopting organization, which includes details on technical support of the system, upgrades to the system, and problem resolution channels. System downtime can be detrimental to patient care in a healthcare

organization. Thus, it is essential to make certain that, as problems are encountered, there is a seamless process toward resolution to minimize the level of interference with day-to-day operations.

The EHR system should be physically and digitally secure from external intrusions and from unauthorized internal users. The physical security plan of the EHR system should also include business continuity planning for disaster recovery situations such as system failures or attacks on system security. There are also serious privacy concerns that EHR systems may permit private and protected patient information to unauthorized persons, whether in an individually identifiable or aggregate form (Angst & Agarwal, 2009). Other critical areas in the implementation process include the standards associated with the EHR system, such as having a Certification Commission for Healthcare Information Technology (CCHIT) certification and the physical infrastructure for the system that is dedicated in the organization, such as space, climate control, and electricity.

Successful implementations achieve an optimal level of integration between the EHR and the adopting organization's current IT and business processes. The EHR must be aligned with both clinical and operational processes to fully support the business strategy of the healthcare organization (Venkatraman, Bala, Venkatesh, & Bates, 2008). To facilitate integration, the U.S. Federal Government set an ambitious goal to have a national health IT network by 2014 (Miller & Tucker, 2009). Another important reason for this network of health IT systems is to advance research on a national and regional level through access to integrated information and up-to-date knowledge (Venkatraman et al., 2008). This desired feature is encapsulated in the clinical decision support capabilities of EHR systems, which transforms this element into an important factor in the implementation process. Also, establishing a fully functional EHR system will allow authorized parties to access and share patient data, test results, and billing information to help facilitate a fluid patient care delivery process.

Successful implementations are characterized as those that recruit "clinical champions" from the early stages of the planning process (DeVore & Figlioli, 2010; Lorenzi et al., 2009). These clinical champions are closely involved in the entire implementation process by "providing input into design, workflow sign-off process, and live support" and are from various divisions in the organization; they include physicians, nurses, and allied health staff (DeVore & Figlioli, 2010, p. 665). Other key members of the EHR implementation's support structure include those designated to manage the entire implementation project and the EHR project team. It is the responsibility of the management team to ensure the entire implementation process is progressing toward the goals established by all stakeholders in the planning phase. The management team also ensures that crucial people are closely involved in the process and that issues are resolved accurately and efficiently through the prior designated channels. Boonstra & Govers (2009) provide evidence that a failure to understand different stakeholder expectations, both internal and external, may lead to an HIT project failure.

There are many potential areas of concern and even conflict between providers and vendors during an EHR implementation. However, these issues have not been completely identified or prioritized systematically in the literature and the majority are qualitative case studies. Additional quantitative work is now needed. Furthermore, there is a gap in the previous research as to how these concerns evolve through the various stages of the implementation process and the nature of the differences between internal and external stakeholders. To answer the research questions, we surveyed both types of stakeholders' opinions on the three phases of implementation.

IV. METHODOLOGY

Instrument creation

We gathered the survey's initial questions from prior surveys in the domain of interest. In particular, we used EHR readiness surveys to understand what vendors were already asking potential customers. These surveys included 1) the Info-Tech Research Group EMR Readiness Assessment Questionnaire, 2) the Accustat EMR Questionnaire, and 3) an EMR Questionnaire from Laerum & Faxvaag (2004). The Info-Tech Research Group is an IT consulting firm that works closely with CIOs to guide strategic decision making in various implementations including EHR. The Accustat EMR Questionnaire is sponsored by the North Carolina Medical Society as a tool to guide successful EHR implementations. And the Laerum & Faxvaag (2004) Questionnaire is based on actual observations of active EHR environments by a team of researchers that has been rigorously validated in four studies. We selected these three questionnaires because they represent key issues from a wide variety of both internal and external stakeholders. After reviewing those questionnaires, it appeared their domains of interest were very similar and addressed the core issues found in Table 1 above; thus, we constructed a more concise questionnaire from these three questionnaires. We used seven-point Likert scales from "not at all important" to "extremely important" for all questions; each questionnaire item was a single-item construct. We build definitions for all terms into the new survey with a total of seventeen critical issues (see Table 2).

Pre-Test and Pilot

Three individuals familiar with the EHR domain conducted a pre-test of the survey. These individuals included a doctoral-level researcher, a primary care physician, and an upper-level research assistant. Based on their evaluations, we refined the questionnaire to improve the focus of the remaining questions. We then submitted the updated questionnaire to two EHR vendors and an EHR implementation consultant. Following their valuable suggestions, we further modified the questionnaire to improve its quality and the appropriateness of the issues relative to the information sought.

We conducted a pilot study with thirteen executives from EHR vendors that were closely involved with EHR implementation projects. The positions of these executives varied from presidents, vice presidents, and CEOs to other top-level managers. Eight of the thirteen executives selected the pre-implementation phase as the most important phase of the EHR implementation process. In all three phases, they ranked physician support as the most important issue, followed by nurse support. While the pilot provided helpful suggestions for full survey administration, the seventeen issues incorporated into the questionnaire required no changes.

Critical EHR Implementation Issues

Table 2 lists the seventeen issues, in no particular order, and their corresponding definitions that we used in the survey. We provide additional descriptions of each issue with support from literature below.

1) Integration of System into Current IS and IT Used in the Organization

Successful implementations achieve an optimal level of integration between the EHR system and the current IT and applications of the adopting organization. The EHR system must be aligned with the clinical and operational processes to fully support the business strategy of the healthcare organization (Castillo et al., 2010; Lorenzi et al., 2009; Rahimi et al., 2009; Kaplan et al., 2009; Venkatraman et al., 2008).

2) Management Project Support

The management team has the responsibility to ensure the entire implementation process is progressing toward the goals established in the implementation planning phase (Lapointe et al., 2011; Rahimi et al., 2009; MacKinnon & Wasserman, 2009). The management team also ensures that the crucial people are closely involved in the process and that all issues are being resolved accurately and efficiently through the prior designated channels.

Table 2: Critical Issues in EHR Implementation

No.	Issue	Definition
1	Integration of system into current IS and IT used in the organization.	New system easily and productively connects to current/future IT systems.
2	Management project support.	Managers truly see value in the system and fully support its implementation.
3	Physician project support.	Physicians truly see value in the system and fully support its implementation.
4	Nurse project support.	Nurses truly see value in the system and fully support its implementation.
5	Allied Health (support staff) project support.	Allied staff truly see value in the system and fully support its implementation.
6	System easily integrates with current business processes.	The system's interfaces and processes are easily adapted into the way business is done in the organization.
7	Security; i.e. from outside the organization intrusions.	System is secure from being hacked, being disabled, patient data being stolen.
8	Business continuity planning; i.e. a plan if system stops working so the organization can continue working.	If the system stops working, there is another practical way to still conduct business.
8	System capabilities for clinical decision support.	System has features to assist clinicians in decision making.
10	Privacy, system properly allows certain professionals to see only information that is needed.	System properly allows the right people to see only the information relevant to their job function.
11	CCHIT certification.	Certification Commission for Health Information Technology certification of the system is necessary.
12	Physical infrastructure for the system, e.g. space,	Self-explanatory



	climate control, electricity.	
13	Service-level agreement; e.g., technical support, upgrades of system, problem resolution, etc.	Entails system operation, support if systems fails, training, technical support questions, upgrades, etc.
14	EHR project team composition.	Necessary skills and relevant people are included on the team.
15	Clear system/project goals and documentation.	Goals being clearly defined and documented.
16	Integration with HIE, RHIO, or other organizations to share patient data, test results, billing, etc.	How well and easily the system can be integrated with local and regional health networks
17	Cost-benefit analysis.	Cost-benefit analysis was conducted and well documented.

3), 4), and 5) Physician Project Support, Nurse Project Support, and Allied Health (Support Staff) Project Support

Successful implementations are characterized as those that recruit “clinical champions” from the early stages of the planning process (DeVore & Figlioli, 2010; Lorenzi et al., 2009). These clinical champions are closely involved in the entire implementation process by “providing input into design, workflow sign-off process, and live support” (p. 665) and are from various divisions in the organization; they include physicians, nurses, and allied health staff (Sheikh et al., 2011; Castillo et al., 2010; DeVore & Figlioli, 2010; MacKinnon & Wasserman, 2009, DesRoches et al., 2008; Rahimi et al., 2009).

6) System Easily Integrates with Current Business Processes

Ludwick and Doucette’s (2009) research revealed certain “socio-technical factors or “fit” factors” that can further complicate the implementation process of health information management technology. These socio-technical factors can be viewed as the current processes that the healthcare workers use on daily basis, which may differ from the standard EHR system process. It is essential that the new EHR implementation is fully aligned with the current business processes in order to minimize the disruption to the workflow and day-to-day operations in the healthcare organization (MacKinnon & Wasserman, 2009; Lorenzi et al., 2009; Rahimi et al., 2009).

7) Security

The HITECH Act encourages medical practitioners to digitalize their records in order to facilitate the sharing of patient medical records providing a more holistic approach to patient care (U.S. Department of Health and Human Services, 2010). However, the added benefit of allowing authorized users to access information from various locations also increases the pool of those who may attempt to harm the system (Gritzalis & Lambrinoudakis, 2004). The EHR system should be physically and digitally secure from any external intrusions and from unauthorized internal users (McGinn et al., 2011; Robertson et al., 2010; DesRoches et al., 2008; MacKinnon & Wasserman, 2009)

8) Business Continuity Planning

In addition to addressing the security of the EHR system, the physical security plan of the EHR system should also include a business continuity plan for disaster recovery situations. These situations can range from natural disasters and construction mistakes to system failures and attacks on the system security. A suggested approach to the system implementation should include provisions for these types of unforeseen situations to ensure that the organization can continue to operate at minimal business functional levels (DesRoches et al., 2008; Lowes, 2005).

9) System Capabilities for Clinical Decision Support

The federal government has an ambitious goal to have a national health IT network by 2014 (Miller & Tucker, 2009). A part of the reasoning behind this network of health IT systems is to advance research on a national and regional level through access to integrated information and up-to-date knowledge (Venkatraman et al., 2008). This desired feature is encapsulated within the clinical decision support capabilities of the EHR system (McGinn et al., 2011; Lapointe et al., 2011; DesRoches et al., 2008), transforming this element into an important factor in the implementation process.

10) Privacy, System Properly Allows Certain Professionals to See Only Information that Is Needed

With electronic patient databases, traditional rights to personal privacy may be compromised (Gostin, 1997). Although Health Insurance Portability and Accountability Act (HIPAA) privacy laws have been enacted in the US, the management of privacy concerns is still a big issue. There may be serious privacy concerns in that EHR systems may allow private and protected patient information to be available to unauthorized persons, whether in an individually identifiable or aggregate form (McGinn et al., 2011; Angst & Agarwal, 2009; MacKinnon & Wasserman, 2009; DesRoches et al., 2008).

11) CCHIT Certification

Another critical area in the implementation process involves the standards associated with the EHR system, such as having a CCHIT certification (MacKinnon & Wasserman, 2009). CCHIT-certified EHR systems are rigorously inspected and evaluated on functionality, security, reliability, and interoperability ("CCHIT Certifies Inpatient EHRs", 2007; Terry, 2006). For those who have minimal experience with EHR systems, such as physicians and nurses, this type of certification can be especially important.

12) Physical Infrastructure for the System

The physical infrastructure for the system that is dedicated in the organization, such as space, climate control, and electricity, is vitally important to the maintenance and reliability of the information management system (McGinn et al., 2011; MacKinnon & Wasserman, 2009; Damschroder et al., 2008).

13) Service-Level Agreement

The EHR vendor must detail the service-level agreement with the adopting organization, including details on technical support of the system, upgrades to the system, and problem resolution channels (Castillo et al., 2010). System downtime can be detrimental to patient care in a healthcare organization. Thus, it is essential to make certain that, as problems are encountered, there is a seamless process toward a resolution to minimize the level of interference with day-to-day operations (Rahimi et al., 2009).

14) EHR Project Team Composition

Key members of the support structure for the EHR implementation are those designated to manage the entire implementation project and the EHR project team. Members may include those with domain knowledge, technical knowledge, and project management and communication skills (Castillo et al., 2010; MacKinnon & Wasserman, 2009; Damschroder et al., 2008).

15) Clear System/Project Goals and Documentation

Both the vendors and the providers need to intensively focus on the various details of planning the EHR implementation. Similar to a business project management plan, clear goals and detailed documentation of the implementation process must be established early on (MacKinnon & Wasserman, 2009; Rahimi et al., 2009). This ensures that key stakeholders are involved and work in concerted effort to fine tune the project plan.

16) Integration with HIE, RHIO, or Other Organizations to Share Patient Data, Test Results, Billing, etc.

The HITECH Act stresses the importance of EHR systems that are able to smoothly integrate with other health information management systems (U.S. Department of Health and Human Services 2010). The purpose of this initiative is aimed at reducing the severe information overload and confusion that can occur when health information management systems do not easily integrate with each other. Establishing a fully functional EHR system should allow authorized parties to access and share patient data, test results, and billing information to help facilitate a seamless patient care delivery process (McGinn et al., 2011; Rozenblum et al., 2011; Castillo et al., 2010).

17) Cost-Benefit Analysis

A thorough cost-benefit analysis should be completed in order for all parties involved to understand the financial implications and the potential benefits of the system (McGinn et al., 2011; Ford et al., 2009; DesRoches et al., 2008). There are several financial and non-financial benefits that the adopting organization can realize once the EHR system is fully operational (Lorenzi et al. 2009; MacKinnon & Wasserman, 2009), such as improved office efficiency and quality of patient care.

While there may be additional issues, these were determined to be comprehensive based on the literature and expert feedback. Nevertheless, the survey did include areas for the participants to add their own issues if necessary.

Full Study Procedures

The full study procedures included identifying the target sample from the healthcare industry, sending emails to the subjects in the sample, collecting data, and analyzing the data by each phase and stakeholder. We first targeted providers and vendors in the local regional area, which yielded a limited number of responses. Later, we extended the sample to the entire United States. We used the Healthcare Information and Management Systems Society (HIMSS) analytics database of healthcare executives sponsored by the Dorenfest Institute to collect data. Using the HIMSS analytics database, we surveyed a national sample of IT decision makers in healthcare organizations. In total, we sent 43,132 email requests. We also sent subsequent email reminders that provided an incentive of four \$25 Barnes & Noble gift card drawings. Since this was an older database, many email addresses were incorrect or defunct. We received a total of 456 responses, many of which were incomplete. Note that low response rates are

endemic to healthcare IT research (Frost & Sullivan 2010; Hikmet & Chen 2003). However, the sample size is comparable or higher than those used in similar surveys.

V. SURVEY RESULTS

Sample Size

As we mention above, we received a total of 456 responses with 128 being mostly incomplete, which left a usable sample size of 328 responses. Of these, 284 were from physician providers and 44 were from EHR vendors and consultants . While the sample sizes of the two groups appear skewed, this reflects an industry where the customers greatly outnumber the vendors; as such, the data was appropriate for further analysis. We believe our results to be reliable because we received a varied and good range of demographics (see Table 3).

Table 3: Sample Demographics		
	Demographic item	Count
Stakeholder	Provider	284
	Vendor & consultant	44
Years in business	Average	57
	Median	51
	Maximum	190
	Minimum	1
Number of employees	Average	2,016
	Median	680
	Maximum	60,000
	Minimum	1
Number of physicians	Average	527
	Median	100
	Maximum	60,000
	Minimum	1
Type of business	Public	119
	Private	99
Most used EHR systems	Meditech	63
	Cerner	54
	Epic	38
	McKesson	28
	CPSI	19
Provider specialty	Orthopedics	46
	Family practice	34
	Internal medicine	32
	Cardiology	23
	General surgery	20
	OB/GYN	17
	Surgery	15
	Primary care	14
	Oncology	10
	Medicine	9

Top issues in Pre-Implementation Phase

The top three pre-implementation issues ranked by the providers were physician project support (#1), management project support (#2), and nurse project support (#3). The bottom-ranked issue was physical infrastructure (#17). The top three pre-implementation issues ranked by the vendors were physician project support (#1), security (#2), and



privacy (#3). The bottom-ranked issue was again physical infrastructure (#17). Table 4 shows the complete rankings for the pre-implementation.

Table 4: Pre-Implementation Rankings

Issue	Provider rank	Mean	Std. Dev.	Vendor rank	Mean	Std. dev.
Physician project support	1	6.54	0.79	1	6.48	0.95
Management project support	2	6.51	0.77	4	6.36	0.99
Nurse project support	3	6.5	0.77	6	6.23	0.94
Security	4	6.46	0.86	2	6.45	0.95
Clear system project goals and documentation	5	6.46	0.77	7	6.23	1.01
Business continuity planning	6	6.42	0.81	5	6.32	0.91
EHR project team composition	7	6.37	0.82	8	6.14	0.95
Service-level agreement	8	6.35	0.82	10	6.07	1.09
Privacy	9	6.33	0.86	3	6.39	0.97
System capabilities for clinical decision support	10	6.32	0.86	9	6.07	0.97
Allied health support staff project support	11	6.09	0.98	13	5.86	1.03
Integration of system	12	6.05	1.24	11	5.91	1.12
System easily integrates with current business processes	13	6.05	1.03	15	5.68	1.25
CCHIT Certification	14	6	1.13	16	5.61	1.45
Integration with HIE, RHIO, or other organizations	15	5.94	1.02	12	5.91	1.1
Cost/benefit analysis	16	5.93	0.95	14	5.84	1.1
Physical infrastructure	17	5.86	0.94	17	5.39	1.4

Top Issues During Implementation Phase

The top three during-implementation issues ranked by the providers were the same as in the first phase but in a different order: nurse project support (#1), physician project support (#2), and management project support (#3). The bottom-ranked issue was cost/benefit analysis (#17). The top three during-implementation issues ranked by the vendors were physician project support (#1), management project support (#2), and security (#3). The bottom ranked issue was CCHIT certification (#17). Table 5 shows the complete rankings for the during-implementation phase.



Table 5: During Implementation Rankings

Issue	Provider rank	Mean	Std. Dev.	Vendor rank	Mean	Std. dev.
Nurse project support	1	6.61	0.73	5	6.28	0.85
Physician project support	2	6.6	0.76	1	6.55	0.68
Management project support	3	6.57	0.7	2	6.53	0.64
Clear system project goals and documentation	4	6.41	0.83	6	6.28	0.99
EHR project team composition	5	6.39	0.81	7	6.2	0.82
Security	6	6.36	0.89	3	6.43	0.78
Privacy	7	6.36	0.85	8	6.18	0.87
Business continuity planning	8	6.34	0.84	4	6.38	0.74
Service-level agreement	9	6.34	0.84	9	6.18	1.17
Integration of system	10	6.3	0.98	10	6.13	0.88
Allied health support staff project support	11	6.27	0.95	12	5.93	0.86
System capabilities for clinical decision support	12	6.27	0.89	11	6	0.88
System easily integrates with current business processes	13	6.24	0.9	13	5.93	1.07
Integration with HIE, RHIO, or other organizations	14	6.04	1.04	14	5.9	0.96
Physical infrastructure	15	6.01	1.02	15	5.75	1.08
CCHIT certification	16	5.9	1.22	17	5.48	1.72
Cost/benefit analysis	17	5.7	1.28	16	5.68	1.25

Top Issues in Post-Implementation Phase

The top three post-implementation issues ranked by the providers were similar to the previous phase with physician project support (#1) and nurse project support (#2), but management project support was replaced by business continuity planning (#3). The bottom-ranked issue was again cost/benefit analysis (#17). The top three post-implementation issues ranked by the vendors were physician project support (#1), security (#2), and business continuity planning (#3). The bottom-ranked issue was again CCHIT Certification (#17). Table 6 shows the complete rankings for the post-implementation.

Table 6: Post-Implementation Rankings

Issue	Provider rank	Mean	Std. Dev.	Vendor rank	Mean	Std. dev.
Physician project support	1	6.5	0.84	1	6.63	0.63
Nurse project support	2	6.49	0.77	5	6.39	0.79
Business continuity planning	3	6.46	0.81	3	6.45	0.69
Security	4	6.46	0.91	2	6.45	0.72
Service-level agreement	5	6.42	0.87	6	6.37	0.75
System capabilities for clinical decision support	6	6.37	0.84	7	6.32	0.77
Privacy	7	6.37	0.89	4	6.42	0.76
Management project support	8	6.32	0.94	9	6.24	0.85
Allied health support staff project support	9	6.3	0.92	12	5.97	0.82
Integration of system	10	6.25	1.14	10	6.11	1.06
System easily integrates with current business processes	11	6.24	1.04	11	6.08	0.97
Clear system project goals and documentation	12	6.08	1.06	13	5.97	1.1
Integration with HIE, RHIO, or other organizations	13	6.03	1.11	8	6.29	0.84
EHR project team composition	14	5.98	1.05	15	5.79	1.04
CCHIT certification	15	5.97	1.29	17	5.39	1.76
Physical infrastructure	16	5.92	1.24	14	5.79	1.23
Cost/benefit analysis	17	5.68	1.46	16	5.66	1.32

In addition to the list of issues above, we also asked the participants which phase of EHR implementation they felt was most important and why. Of the providers, 77 percent said the pre-implementation phase was the most important, 12 percent said during implementation, and 10 percent said post-implementation. Of the vendors, 71 percent said the pre-implementation phase was the most important, 14 percent said during implementation, and 14 percent said post-implementation. Thus, there was substantial agreement that the pre-implementation phase was, by far, the most important. Moreover, many respondents emphasized in their comments the necessity of getting buy-in from all the stakeholders at the start of the project.

VI. DIFFERENCES BY STAKEHOLDER

In order to answer the second research question, we conducted an ANOVA analysis to see which means were significantly different between the two stakeholder groups according to each implementation phase. Table 7 shows the results. Of the 17 issues, four had differences that were statistically significant ($p < 0.05$) in the pre-implementation phase: nurse project support, easily integrate with current business process, CCHIT certification, and service-level agreement were rated significantly higher by the providers. Four issues had differences that were significant in the during-implementation phase: nurse project support, easily Integrate with current business process, CCHIT certification, and allied health support staff were rated significantly higher by the providers. Finally, only two issues had differences that were significant in the post-implementation phase: CCHIT certification and allied health support staff were rated higher by the providers.



Table 7: ANOVA Results of Differences Between Groups

	Pre-implementation		During implementation		Post-implementation	
	F	Sig.	F	Sig.	F	Sig.
Integration of system	.526	.469	1.143	.286	.525	.469
Management project support	1.332	.249	.123	.726	.231	.631
Physician project support	.241	.624	.145	.704	.918	.339
Nurse project support	4.630	.032	7.081	.008	.468	.494
Allied health support staff project support	2.036	.155	4.651	.032	4.209	.041
System easily integrates with current business processes	4.496	.035	4.136	.043	.753	.386
Security	.002	.962	.182	.670	.005	.946
Business continuity planning	.572	.450	.057	.811	.011	.915
System capabilities for clinical decision support	3.070	.081	3.183	.075	.117	.732
Privacy	.133	.716	1.659	.199	.133	.716
CCHIT certification	4.032	.045	3.741	.054	5.816	.017
Physical infrastructure	8.201	.004	2.246	.135	.367	.545
Service-level agreement	4.047	.045	1.202	.274	.120	.730
EHR project team composition	2.923	.088	1.894	.170	1.122	.290
Clear system project goals and documentation	3.234	.073	.804	.371	.299	.585
Integration with HIE, RHIO, or other organizations	.043	.837	.637	.426	1.851	.175
Cost/benefit analysis	.317	.574	.012	.913	.008	.928

VII. DISCUSSION

In general, the results provided partial support for H1 (that stakeholder perceptions of the importance of critical EHR implementation issues would differ in each phase of EHR implementation). While there was more agreement than disagreement on the whole, there were still some important differences in the rankings. A useful way to interpret the results is to examine the overall trends through the three phases. Looking at the top of the list for providers, stakeholder buy-in is paramount. Especially important is the role of nurses throughout all three phases. In the middle of the list, security and privacy concerns were consistently viewed as more important than system integration concerns. And, at the bottom of the list, CCHIT certification, cost/benefit analysis, and physical infrastructure were consistently ranked low. While CCHIT certification and physical infrastructure can be readily explained away as intuitively less important than the other issues on the list, the fact that cost/benefit analysis was consistently at the bottom is at first puzzling. Determining the costs and measures of success are traditionally a vital part of project management, especially in the pre-implementation phase. However, an EHR project may be different in that providers typically perceive more benefits for patients and payers than they do for providers themselves (Lorenzi et al., 2009), which would help explain this result.

Vendors, on the other hand, painted a different picture. For them, the physicians were ranked as the top key stakeholder throughout all the phases. Security and privacy concerns were consistently higher than system integration issues but also higher than support from other stakeholders such as nursing staff. CCHIT certification, cost/benefit analysis, and physical infrastructure were at the bottom. These results provide strong evidence that the two groups view physician support throughout the project as being extremely important. Yet, there is also evidence that vendors underestimate the contributions of nursing staff, which the providers see as critical to a successful implementation. This finding points to a key understanding from this study and provides support for H2 (that stakeholder perceptions of who the actual stakeholders are will differ in each phase of EHR implementation). Vendors see the doctors as the key stakeholders, but doctors view nurses as key stakeholders as well. Vendors also consistently ranked other key stakeholders such as allied health support staff as lower in importance in each phase than the providers did. It appears that there is a difference in perspective between the stakeholders on who exactly the stakeholders are in an EHR implementation.

It is insightful to examine the evolution of key issues as implementation proceeds. While there was emphasis on physician support, nursing support, and management support during all phases, it was decidedly more important in the earlier phases. The establishment of clear goals and team composition were also important in the earlier stages. However, as the implementation proceeds, business continuity plans, security, and service-level agreements took more predominance in the later stages. This is an important finding because many prior studies treat implementation as if it were a static one-time event. On the contrary, implementation is a dynamic and longitudinal process (Sheikh et al., 2011). Priorities shift during the process and stakeholders need to adjust accordingly.

Finally, based on the finding that the pre-implementation phase was judged to be the most important, any discrepancies in perceptions among the stakeholders in this phase should receive special scrutiny. The consistent emphasis, from both groups, on the importance of physician support through an EHR implementation is good news in that both stakeholders are aligned in their #1 priority. At the same time, however, the vendors tended to rank security much higher than nurse project support. The discrepancy over the perceptions of the role that nurses play is perhaps easy enough to interpret. It seems likely that the doctors who interact with the nurses daily see firsthand that the nurses are the ones who are really using the new system; therefore, the doctors understand that nurses are the ones who need to take ownership of the success of the new system. This supports the notion that end users, such as nurses, have first-hand knowledge of what will help or hinder a successful EHR implementation (McGinn et al., 2011) This may not be as obvious to the vendors who are more focused on meeting the requirements of the providers who are presumably paying for the new system. However, because of the relatively high importance of the pre-implementation phase, vendors should be obtaining nursing staff buy-in at the very start of the project. According to MacKinnon and Wasserman (2009), the beginning stage of any project is the appropriate time to deal with physician resistance to a new EHR system. However, note that resistance may be better addressed if vendors address the needs of the nursing staff continually throughout the implementation. In a similar vein, the vendors seem to have a heightened sense of the importance of security, which the doctors may take for granted as simply a technology feature that is built into the new system rather than being an area that affects every aspect of their work flow.

VIII. CONTRIBUTION

This study makes a novel contribution to research in two ways. First, the framework of critical issues for the last three phases of an EHR implementation strikes a useful balance between parsimony and actionable detail. Second, the lens of stakeholder theory draws special attention to how these issues can and should be interpreted. This study extends stakeholder theory into an appropriate context with useful results. Specifically, the comparison of differing provider and vendor stakeholder perspectives is novel because past literature has focused on the provider perspective alone.

The contribution to practice is equally important, and this study provides specific guidance on how vendors and practitioners must approach EHR implementation during its various phases. While there is alignment in some areas, the perception of who exactly the stakeholders are must be broadened to be more inclusive of nursing staff and allied health support staff, especially in the pre-implementation phase in order to increase the chances of a successful EHR implementation.

IX. LIMITATIONS

As with any survey-based research, sample size and composition will always be a limitation. In this case, a sample of 328 respondents from organizations with differences based on size, location, and specialty should provide a reasonable level of generalizability to other healthcare organizations. While the response rate was low, the absolute sample size was adequate for analysis. One could also argue that the list of critical issues selected for the survey is not comprehensive enough; however, we intentionally kept the list as short as possible and feel that it is closely representative of the issues previously identified by researchers and practitioners alike.

X. FUTURE RESEARCH

Some of the significant differences in the ANOVA analysis provide useful guidance for future EHR project leaders. Easily integrating a new system into existing work flow may be a key area for concern. Providers rated this issue significantly higher than vendors, which may be due to divergent expectations between the stakeholders. The providers would like a system where they do not have to change their existing work flow, whereas the vendors know, based on their experience, that almost every aspect of the provider's workflow is going to change. Other issues that did show statistical difference in the ANOVA analysis may not have as much practical significance, such as CCHIT certification and allied health support.

Future research should continue to closely examine stakeholders' shared and divergent perceptions in the EHR implementation process. Useful areas of research include 1) analyzing which areas are important, when they are

significantly different, and which lead to negative outcomes such as project delays and/or failures; 2) determining how stakeholder perceptions can be better aligned in the pre-implementation phase in order to set the stage for success in the post-implementation phase; and 3) expanding this area of research to include additional stakeholders besides providers and vendors (e.g., top level management).

XI. CONCLUSION

We present a framework of seventeen critical issues in EHR implementations to guide a survey of clinical providers and vendor/consultants to determine the relative importance of issues during the pre-implementation, implementation, and post-implementation phases of EHR systems. Using the lens of stakeholder theory, we determined that stakeholders diverged in their estimation of the criticality of various issues. More importantly, the perception of the importance of different stakeholders at different phases of the implementation process changed in interesting ways. We found important differences between the providers and vendors. While both groups agreed that the pre-implementation phase was the most important, the vendors rated the importance of nursing staff involvement during the pre-implementation phase significantly lower than the providers, which points to a potential deficiency in understanding the critical nature of obtaining stakeholder buy-in up front. We encourage both vendors and providers to be mindful of each other's differing perspectives for a successful EHR implementation.

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Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that:

1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
2. The contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
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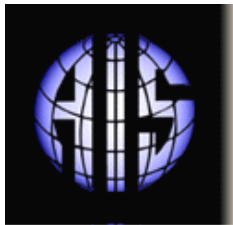
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