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The Impact of IT-Enabled and Team Relational Coordination on Patient Satisfaction

Darryl S. Romanow
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The Impact of IT-Enabled and Team Relational Coordination on Patient Satisfaction

By

Darryl S. Romanow

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree
of
Doctor of Philosophy in the Robinson College of Business
of
Georgia State University

Center for Process Innovation
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ACCEPTANCE

This dissertation was prepared under the direction of the Darryl Romanow Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctoral of Philosophy in Business Administration in the Robinson College of Business of Georgia State University.

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Abstract

The 2009 American Recovery and Reinvestment Act has earmarked 27 billion dollars to promote the adoption of Health Information Technologies (HIT) in the US, and to gain access to these funds, providers must document "Meaningful Use" during the care process. While individual HIT use according to lean measures, including meaningful use, is prevalent in the IS literature, few studies have incorporated rich measures to account for the task, the technology, and the user in a team context. This dissertation conceptualizes Team Deep Structure Use of Computerized Provider Order Entry (CPOE) as an IT- enabled coordination mechanism, and Relational Coordination as the inherent ability of clinical teams to coordinate care spontaneously using informal, relationship based mechanisms. IT-enabled and Relational Coordination mechanisms are each evaluated across five maximally different patient conditions to simultaneously examine their impact on our outcome measure, Patient Satisfaction with the clinical care team.

The extant literature has established a deep understanding of IT adoption shortly after implementation, yet the literature is silent on the antecedents of IT use according to rich measures well after the shake down phase, a period in which the majority of organizations operate. We incorporate the Adaptive Structuration Theory (AST) constructs of Faithfulness of Appropriation, and Consensus on Appropriation as the focal antecedents of Deep Structure Use of the clinical system by team members. To our knowledge, no prior research has linked these two AST constructs to clinical outcomes through the incorporation of a rich use mediator such as Deep Structure Use of a Health IT.

To test our model, we relied on survey responses from 555 physicians, nurses and mid-levels which had cared for 261 patients across five patient conditions, ranging from vaginal birth, to

organ transplant, as well as pneumonia, knee/hip replacement and cardiovascular surgery. Our results confirm that the Adaptive Structuration constructs of Faithfulness of Appropriation and Consensus on Appropriation, generate positive and statistically significant path coefficients predicting Team Deep Structure Use of CPOE. We also report differential effects on Patient Satisfaction with the care team resulting from technology use. Results range from a significant positive path coefficient (.285) associated with higher Team Deep Structure Use on combined Pneumonia and Organ Transplant teams, to a significant negative path coefficient (-.174) on cardiovascular surgery teams. As expected, Pneumonia, Organ Transplant and Cardiovascular Surgery teams all reported positive effects on Patient Satisfaction with the care team as a result of higher Relational Coordination scores. For teams caring for patient conditions consistently associated with a shorter length of stay, including vaginal birth and knee/hip replacement, higher reported use of IT- enabled, or Relational Coordination mechanisms, did not result in a significant increase in Patient Satisfaction.

This dissertation contributes to the growing Health IT literature, and has practical implications for clinicians, hospital administrators and Health IT professionals. This dissertation is the first to operationalize a rich measure of use of an HIT by clinical teams, and to simultaneously measure the impact of IT enabled and Relational Coordination mechanisms on Patient Satisfaction. Secondly, through the introduction of Adaptive Structuration constructs, our model establishes a methodology for predicting rich, nuanced use in teams well after the initial shake down phase associated with recent HIT implementation. Through the juxtaposition of the impact of IT-enabled and Relational Coordination mechanisms across patient conditions, practitioners can design interventions and adjust the level of resources applied to process improvement accordingly.

CHAPTER 1 –Introduction

1.1 Motivation

Since the Institute of Medicine (IOM) issued its watershed report *To Err is Human: Building a Safer Health System* (Kohn, Corrigan, & Donaldson, 2000), academic and practitioner interest in Computerized Provider Order Entry (CPOE) systems has accelerated. The report opens with an estimate that each year, between 44,000 and 98,000 patients of the US medical system die as a result of *preventable* medical errors, and specifically mentions the use of CPOE as a potential solution to the calamity. Since *To Err is Human* was published, actual CPOE implementation rates have increased, yet use in the United States remains limited (Ash, Gorman, Seshadri, & Hersh, 2004; Cutler, Feldman, & Horwitz, 2005; Harle, Huerta, Ford, Diana, & Menachemi, 2013). While support for the efficacy and efficiency of CPOE systems is not universal, research over the last decade has *often* confirmed that CPOE systems are both an enabler of improved clinical outcomes (Garg et al., 2005; Kawamoto & Lobach, 2003; McCullough, Casey, Moscovice, & Prasad, 2010) and a mechanism for reducing overall costs (Hillestad et al., 2005; Kaushal et al., 2006).

Against this backdrop of an apparent paradox of a low adoption of CPOE technology despite the promise of improved outcomes, we reviewed the literature to better understand clinician use and resulting outcomes from CPOE system adoption in hospitals. Given that core functionality of CPOE incorporates standard clinical pathways, or treatment protocols based on best practices, as well as access to clinical results and progress notes during the hospital stay, of specific interest is the impact of CPOE as an effective *IT-enabled coordinating mechanism* for patient care. A rich literature supports our understanding of organizational coordination (Galbraith, 1973; Gittell, 2002; Malone & Crowston, 1994; Thompson, 1967). Yet CPOE is focused on the coordination of complex knowledge work, involving teams of specialists operating in dynamic and time-constrained environments (Faraj & Sproull, 2000; Faraj & Xiao, 2006). Previous research on clinical processes also highlights the "non-linear, context–dependent, interruption filled, uncertain, and collaborative nature of hospital clinical practice" (Koppel et al., 2005). Given the contingent nature of clinical work, providers are constantly required to amend standard work routines to respond to evolving patient conditions, thereby cancelling previous orders, and quickly instituting a corrective clinical protocol (Niazkhani, Pirnejad, Berg, & Aarts, 2009). As a result, clinical teams must regularly rely on both formal standardized treatment protocols, and informal, relational coordination mechanisms for patient care.

Despite strong endorsement of CPOE as a mechanism for the standardization of care based on best clinical practices (Kohn et al., 2000), previous research within the Health Information Technologies (HIT) domain has highlighted resistance to adoption by clinicians (Kane & Labianca, 2011; Kohli & Kettinger, 2004; Lapointe & Rivard, 2007) . Even amongst hospitals which have fully adopted Computerized Provider Order Entry (CPOE), important features of the core functionality of CPOE are often avoided due to "alert fatigue", or an aversion to "cookbook medicine" (Wright et al., 2009). As a result, the literature portrays a context whereby considerable variance exists in the use of CPOE according to the "spirit" of the technology (DeSanctis & Poole, 1994). Considerable variance also exists in adoption rates of other highly related Health IT systems across medical specialties. For instance, cardiologists are three times as likely to adopt an HIT such as Electronic Medical Records (EMR) than dermatologists or psychologists (Burt & Sisk, 2005), yet no prior studies investigate the drivers of use variance across medical specialties.

Given the potential of CPOE technology to transform medical delivery, coupled with the presence of resistance, and resulting slow adoption of the technology, we were motivated to study the impact of CPOE technology use across various teams of clinicians. Our study extends beyond the traditional, lean measures of IS use in the extant IS literature, and incorporates the more nuanced notion of *Deep Structure Use* of a Health IT (Burton-Jones & Straub, 2006). Few studies have attempted to understand the impact of rich measures of use of an IT on organizational outcomes (Burton-Jones & Straub, 2006), and no studies to our knowledge have established rich use measures such as deep structure use within an HIT context.

1.2 Research Questions

By framing CPOE as a patient care IT-Enabled Coordinating mechanism, our study is focused on the following research questions:

Why do clinician teams exhibit heterogeneity in the use of IT-based coordination mechanisms?

How does variation in clinician team use of IT-based and relational coordination mechanisms affect patient satisfaction?

The 2009 American Recovery and Reinvestment Act (ARRA) has earmarked up to $27 billion for HIT (Buntin, Burke, Hoaglin, & Blumenthal, 2011), as leaders of both sides of Congress have supported HIT initiatives based on the belief that these technologies will benefit the US through reduced costs and improved clinical outcomes. To gain access to these funds, healthcare providers are required to demonstrate “Meaningful Use” of the technology. These Meaningful Use guidelines, as developed by the Department of Health and Human Services, define specific levels of use of core functionality features inherent to healthcare technologies such as CPOE. While a given hospital may meet the Meaningful Use guidelines overall, the actual use of these core feature sets, or structures, are likely to be subject to considerable variance in use across providers. Patient satisfaction has been widely measured by hospitals, but since October 2012 it is of increased relevance, as reimbursements for medical care by the Centers for Medicare and Medicaid Services (CMS) are directly tied to patient satisfaction scores. Our intent is to understand the nuanced use of the technology across patient care teams, and the impact of the use of the key structures of the technology on patient satisfaction. To investigate our research questions, we engaged with a five hospital, not- for- profit hospital group in the US Southeast, which had successfully implemented CPOE at two of its hospitals up to nine years prior.

CHAPTER 2- Literature Review and Theoretical Foundation

2.1 Healthcare Information Systems and CPOE

2.1.1 What is CPOE?

Against the backdrop of the broader Health IT literature, which includes Electronic Health Records (EHR's) and Personal Health Records (PHR's), this study will focus on in-patient Computerized Provider Order Entry (CPOE). CPOE is defined as a computer-based system that allows a clinician to directly enter medical orders (Ash et al., 2007; Cutler et al., 2005; Doolan & Bates, 2002; Simon, Rundall, & Shortell, 2007). Specific examples of *medical orders* originated and maintained in a CPOE system are diagnostic tests (lab and imaging), medications, patient care, and referrals (Doolan & Bates, 2002). Based on common patient conditions, CPOE systems provide the ability for clinicians to create *pre-configured order sets*, (Payne, Hoey, Nichol, & Lovis, 2003), with the majority of these order sets intended for use in laboratory, pharmacy and nursing. Nursing orders, for instance, can provide patient care and workflow instructions such as vital signs monitoring, activity, or wound and dressing changes (Payne et al., 2003). Once an order is entered, the CPOE system provides the clinical team with a tracking mechanism for clinicians to review the status of each order (Hillestad et al., 2005). These orders can then be viewed simultaneously by multiple clinicians, or even remotely, which could be beneficial for the coordination of large clinical teams, especially when compared to a paper based record maintained at the patient bedside.

While CPOE order sets enable the standardization of care according to best practices, not all patients are created equal. Our unique genetic makeup mitigates our ability to establish protocols which can be used to treat each patient identically. Co-morbidities such as diabetes, high blood pressure, and high cholesterol, may require that the patient remain on medications for extended periods, and these medications may interfere with standardized protocols through drug-to-drug interactions. To incorporate patient specific conditions, CPOE systems provide an error checking mechanism (Queenan, Angst, & Devaraj, 2011). CPOE systems highlight potential drug-to-drug, and drug-to-allergy interactions based on information contained in the patient's electronic medical record (Hillestad et al., 2005). Many systems also include clinical decision support functionality, which informs the clinician of alternative medications, and the appropriate dosage for the given patient.

2.1.2 What do we know about CPOE?

Given that CPOE is often embedded within an Electronic Health Record (EHR) system, we reviewed the broader Health IT literature first, and then focused our attention on the specific context of CPOE as an IT-enabled coordinating mechanism, and organized the discussion of our literature review according to Table 1 below.

Table 1: Literature Review

Background Literature for CPOE as an IT-Enabled Coordinating Mechanism			
Research Area	**Description**	**Relevant Issues**	**Key References**
Health IT	HIT applications (e.g. EHR, CPOE, and PHR are studied in isolation.	CPOE - allows acute care clinicians to enter patient medical orders into a computerized tracking mechanism, rather than relying on a bedside medical chart	(Cho, Mathiassen, & Nilsson, 2008; Cutler et al., 2005; Davidson & Chismar, 2007; Doolan & Bates, 2002; Kohn et al., 2000; Payne et al., 2003; Yu et al., 2009)
		EHR as a digital record of the patient's medical history	(Angst & Agarwal, 2009; Burt & Sisk, 2005; Goldschmidt, 2005; Kazley & Ozcan, 2007; McCullough et al., 2010; Ozdemir, Barron, & Bandyopadhyay, 2011; Sykes, Venkatesh, & Rai, 2011)

		Privacy concerns – electronic records are perceived to be less secure than paper records	(Anderson & Agarwal, 2011; Angst & Agarwal, 2009; Goldschmidt, 2005; Huston, 2001; Malhotra, Kim, & Agarwal, 2004; Mercuri, 2004; Rindfleisch, 1997)
		Interoperability issues between provider systems limit the ability of providers to share data across institutional boundaries	(Goldschmidt, 2005; Grimson, 2001; Lumpkin & Richards, 2002)
		Resistance to Health IT by clinicians	(Bhattacherjee & Hikmet, 2007; Kane & Labianca, 2011; Kohli & Kettinger, 2004; Lapointe & Rivard, 2005, 2007)
		PHR as a digital record of the patient's medical history owned by the patient	(Agarwal, Gao, DesRoches, & Jha, 2010; Grimson, 2001; Halamka, Mandl, & Tang, 2008; Pratt, Unruh, Civan, & Skeels, 2006; Tang, Ash, Bates, Overhage, & Sands, 2006)
Team level impact of Health IT	Impact of associated Health IT artifacts are studied at the team level	Using social network analysis, the role and impact of centrality on HIT use and patient outcomes is studied	(Kane & Alavi, 2008; Kane & Labianca, 2011; Venkatesh, Zhang, & Sykes, 2011)
CPOE Outcomes	Outcomes associated with CPOE use in acute care settings	Clinical outcomes associated with CPOE use	(Bates et al., 1998; Garg et al., 2005; Kaushal, Shojania, & Bates, 2003; Kawamoto & Lobach, 2003; Koppel et al., 2005)
		Financial outcomes associated with CPOE implementation.	(Hillestad et al., 2005; Kaushal et al., 2006)
		Patient satisfaction outcomes as a dependent variable	(Queenan et al., 2011)
CPOE Implementation	Implementation of CPOE in an acute care context	Changes in medical practice routines can lead to unintended consequences	(Aarts, Ash, & Berg, 2007; Ammenwerth et al., 2006; Ash, Berg, & Coiera, 2004; Ash et al., 2007; Goh, Gao, & Agarwal, 2011; Han et al., 2005; Lapointe & Rivard, 2005; Niazkhani et al., 2009; van der Sijs, Aarts, Vulto, & Berg, 2006; Wright et al., 2009)
		Success factors for CPOE implementation	(Ash, Stavri, & Kuperman, 2003; Goh et al., 2011; Lorenzi, Novak, Weiss, Gadd, & Unertl, 2008)
Healthcare Coordination	Coordination in healthcare settings	Coordination primarily in acute care settings, yet without regard for CPOE as a formal coordinating mechanism	(Argote, 1982; Faraj & Xiao, 2006; Gittell, Seidner, & Wimbush, 2010; Gittell, 2002; Ren, Kiesler, & Fussell, 2008)

We are broadly informed of CPOE and related Health IT systems by two distinct literature streams. The first literature stream, which is far and away the largest (Agarwal et al., 2010), is represented by Health IT specific journals focused on research questions of interest to clinical IT practitioners. These journals, best represented by publications such as the Journal of American Medical Informatics Association (JAMIA) and the International Journal of Medical Informatics, propose potential solutions to questions such as "What is the best way to implement a CPOE system", and "What are the implications of clinical decision support on patient care?" However, to better understand questions which include the why, the when, and the how that these systems impact clinical care processes, we must rely more heavily on the theoretically motivated papers published in the mainstream IS journals.

We are informed of the extant Health IT literature represented in the mainstream IS literature by two comprehensive literature reviews. In the first literature review (Chiasson & Davidson, 2004), the authors systematically reviewed 17 journals that were deemed to be "Health IT friendly", from the period of 1985 to mid-2003. The authors searched ABI Inform, Ebsco Host Complete, and Uncover using combinations of the following keywords: physician, hospital, medical, information system, information technology, healthcare and health care. This search resulted in a list of 165 papers focused on healthcare domain perspectives. Romanow et al. (2012) extended the earlier review to include publications between mid - 2003 and 2011, as part of a *Management Information Systems Quarterly (MISQ)* editorial on Health IT. In addition to the 17 journals represented in the Chiasson and Davidson (2004) review, the Romanow et al. (2012) target journal list was extended to include all eight of the Association for Information Systems Senior Scholar recommendations for leading IS journals, as maintained on the AIS website. This change added the *Journal of the Association for Information Systems (JAIS)*, the *Journal of Information*

Technology (JIT), and the *Journal of Strategic Information Systems (JSIS)*, and the review period for these three journals extended back in time to include the 1985 – 2003 period. The updated Romanow et al. (2012) review resulted in a list of 218 papers published over an 8 1/2 year period. While theory development is often at the core of the contribution of IS journal articles, 37% of the 383 HIT papers published from 1985 to the end of 2011 were considered atheoretical (Chiasson & Davidson, 2004; Romanow, Cho, & Straub, 2012), and just 103 papers leveraged the unique attributes of the healthcare context to extend theoretical knowledge, leaving ample room for theoretical contribution in this space.

These broad reviews of the HIT literature confirm a growing adoption of these technologies, and that interest in HIT research has accelerated in recent years. Given the relative importance of healthcare to the US economy, representing 17.9% of GDP in 2011 (Hartman, Martin, Benson, & Catlin, 2013), Chiasson & Davidson reported a surprising statistic that only 1.2% of the published papers in leading IS journals focused specifically on the healthcare domain. Since the Chiasson & Davidson (2004) literature review drawing attention to the sparse representation of HIT in the mainstream IS literature, a number of Health IT special issues have been published, including the *European Journal of Information Systems (EJIS)* in December 2007, as well as the *JAIS* in February and March 2011, and *Information Systems Research (ISR)* in September 2011. Publications in the targeted IS journals represented in the literature reviews have accelerated from 9 per year during the initial 1985 – mid 2003 period to 26 per year in the more recent mid 2003 - 2011 period (Romanow et al., 2012).

While this research study is primarily focused on the use of a specific type of Health IT coined CPOE, as the functionality of health information technologies such as Electronic Health Records

(EHR's) and CPOE systems expand, it is increasingly difficult to distinguish between them. EHR's are digital versions of the traditional paper-based patient medical chart (Angst & Agarwal, 2009; Goldschmidt, 2005; Sykes et al., 2011), yet EHR systems, as well as CPOE, can offer clinical decision support to incorporate patient data into diagnosis and treatment. A clinical decision support system is designed to improve clinical decision making, by providing best practice recommendations for clinicians based on patient specific medical data (Garg et al., 2005; Kawamoto & Lobach, 2003). Patient specific medical data can be manually entered by clinicians, or retrieved automatically from an existing EHR. Examples of recommendations provided by clinical decision support systems include alerts of potential drug-to-drug interactions, reminders for preventative health related tasks, or advice for drug prescribing (Garg et al., 2005). Through these recommendations, clinical decision support has proven important for the standardization in treatment of patients, and the reduction of adverse drug events (Bates et al., 1998; Garg et al., 2005; Kawamoto & Lobach, 2003). Recent research has demonstrated that technologies which enhance clinician decision making have a larger impact on performance outcomes (DesRoches et al., 2010), and that early investment in EHR's may not produce a benefit until the decision support component is implemented (Agarwal et al., 2010). To clarify the scope of this study, the focus will specifically be on CPOE systems which incorporate decision support in addition to computerized order entry. CPOE systems can also integrate with EHR's to update the patient record with clinical results as they occur. Given that the CPOE system is integrated with the patient EHR at the research site, we highlight this useful functionality as part of the patient coordination mechanism.

Several contextual factors inherent to healthcare impact Health IT, and are thereby worthy of mention. The Health IT context is heavily influenced by patient privacy concerns (Angst &

Agarwal, 2009; Goldschmidt, 2005; Huston, 2001; Rindfleisch, 1997), and digital patient records are often perceived to be more vulnerable to disclosure than the traditional paper patient record. According to HIPPA(1996) laws governing medical privacy in the US, providers who are found negligent of inadvertently disclosing patient records are personally liable for fines of up to $250,000, and they may face up to 10 years in prison (Kluge, 2004; Mercuri, 2004). While each individual places varying degrees of concern with respect to their personal privacy, in general, medical and financial data is often viewed as the most sensitive (Malhotra et al., 2004).Yet research has shown that individuals are supportive of EHR's despite their privacy concerns, particularly if they suffer from a pre-existing chronic disease (Angst & Agarwal, 2009). Paradoxically, medical information is viewed as amongst the most sensitive of our personal data, but it is only useful when shared with, and between, our medical providers (Rindfleisch, 1997). Due to the potential for HIPAA violations, and the sensitive nature of medical records, clinicians and hospitals are understandably guarded, and somewhat skeptical, of the ubiquitous electronic patient record. Some hospitals even deny physicians remote access to clinical systems to mitigate potential legal liability (Ash & Bates, 2005), thereby eliminating the ability for physicians to quickly review recent medication orders and patient vital signs while at home, often cited as one of the primary benefits of CPOE (Niazkhani et al., 2009). Given that hospitals are wary of extending remote access to attending physicians from within the organization, sharing electronic medical data across institutional boundaries, including other providers or pharmacies is even more problematic.

While privacy concerns and the inherent risks to providers limit data sharing across institutional boundaries, health providers also face interoperability limitations (Goldschmidt, 2005; Grimson, 2001). Despite the development of industry standards such as HL7, interoperability across provider systems and institutional boundaries is limited (Goldschmidt, 2005; Grimson, 2001; Lumpkin & Richards, 2002). As a result, acute care clinicians may often be relying on outdated or *limited* patient record data. An incomplete hospital EHR might cause the CPOE system to overlook a potential drug-to-drug or drug-to-allergy interaction, or fail to incorporate other vital patient conditions in its decision support functionality. Therefore interoperability limitations inhibit the sharing of important medical data between willing provider organizations, mitigating the benefits of EHR's. While initiatives are underway to establish the ubiquitous patient record, access to patient data across institutional boundaries is limited, with notable exceptions including the Veterans Administration hospitals in the US.

The literature has highlighted clinician resistance to adopting HIT, including CPOE (Lapointe & Rivard, 2005), and research has suggested a number of potential sources of this resistance to adoption. One noteworthy example is the 2003 Cedars-Sinai hospital CPOE implementation, where physicians forced administrators to scrap an implementation already 2/3rd's complete, as the system was indicted for its distracting impact on medical practice (Bhattacherjee & Hikmet, 2007). Research has shown that CPOE can dramatically alter acute care clinical workflow (Aarts et al., 2007; Ash, Berg, et al., 2004; Ash et al., 2007), as the technology can impart influences on the long standing shared responsibilities between nurses, physicians, and support staff.

Physician resistance to CPOE is often viewed as the result of increased levels of physician data entry, which was previously performed by authorized administrative staff on their behalf (Aarts et al., 2007). While physicians are directly responsible for overall patient care, the perceived escalation of clerical tasks imposed by the CPOE system is considered by many physicians as not worthy of their valuable time. The CPOE system also issues alerts to clinicians when interactions between the patient record and clinician orders indicate the potential for drug or allergic reactions. While the generation of these alert triggers can be moderated by CPOE system settings according to the *consequences* (high medium low) of these drug-to-drug, or drug-to-allergy interactions, many clinicians complain of alert fatigue (Wright et al., 2009).

Finally, while decision support has proven useful for the standardization of care based on best clinical practices, physicians often resist the notion of "cookbook medicine" (Wright et al., 2009), whereby standardized clinical pathways direct patient care. Through their extensive medical training, physicians are able to leverage best practice, and then alter plans according to individual patient characteristics. As a result, physicians are accustomed to a great deal of autonomy with respect to patient care, and are therefore wary of any administrative influence on their medical practice (Kohli & Kettinger, 2004). Despite their high level of autonomy, physicians may still be inclined to follow standardized pathways despite better alternatives for fear of legal or administrative reprisals.

When we distill what we know about CPOE within the context of the overall Health IT literature, there are several gaps that emerge. The first gap is that Health IT research needs to account for the inherent heterogeneity across clinicians (Agarwal et al., 2010). For instance, we know that cardiologists and orthopedic surgeons are three times as likely to adopt an EHR compared to a Psychologist, or a Dermatologist (Burt & Sisk, 2005; Kokkonen et al., 2013), but research has yet to inform us why this occurs. While recent research confirms that the likelihood of adoption increases with the number of clinicians in the practice, and that Psychiatrists and Dermatologists are predominately solo practitioners (Kokkonen et al., 2013), perhaps the differential adoption is also due to the processes involved when caring for patients with heart conditions, compared to eczema or psoriasis patients. Therefore studies which incorporate attributes of the clinical user, such as occupation type, (physician/nurse/mid-level) or specialty (cardiology/ orthopedics/ OBGYN), will be in a position to exploit this gap in the literature.

Secondly HIT research needs to explicate the technology artifact with greater transparency (Agarwal et al., 2010). While HIT research may focus on one generic form of clinical IT, such as the EHR, CPOE order sets, or nursing documentation, in reality the functionality afforded by the generic technology is blurred across technology platforms and user environments. Clinical users in a given environment are unlikely to distinguish the fact that their entry of routine vital signs and medication orders in the documentation module may in turn populate the patient EHR, which is subsequently incorporated in the alert and decision support functionality of the CPOE module. Within the same user environment, some units in an acute care facility may choose to enter progress notes into the documentation module, while other units may choose to maintain a manual record. Progress notes are a free text representation of how the patient is responding to care, and can be entered by the physician or nursing staff. While the researcher may have a clear, distinct notion of the IT artifact such as CPOE, the clinical respondent is likely to have a more comprehensive perspective of the Health IT, such as the "Meditech", "Eclipsys", or "EPIC" system. Through password access to the HIT, the clinician is authorized to enter and access data from disparate modules, and incorporate the inherent functionality to the patient care process. Therefore it is important that HIT researchers provide reviewers with greater transparency with respect to all of the features and functions in use in the context of the research site.

Finally, prior research which has found positive outcomes related to HIT adoption have tended to be early adopters of "home grown", rather than commercially available systems (Agarwal et al., 2010).These early systems likely benefitted from heavy customization based on input from clinical staff, and are therefore limited in the generalizability of the findings (Agarwal et al., 2010). Papers which have studied the benefits of commercially available systems, which would in turn provide an opportunity for replication and generalizability, have yet to document positive outcomes with consistency. Therefore, research which documents the benefits accrued from the successful implementation of a commercially available Health IT system such as “Meditech”, “Allscripts”, or “Epic” CPOE system, would provide insights that are unique to the literature.

2.1.3 Outcomes Related to CPOE Use

From the health administration literature, we are informed by studies which emphasize changes in physician workflow, as well as the impact of CPOE on clinical outcomes (Ash, Gorman, et al., 2004; Garg et al., 2005; Kaushal et al., 2003; Kawamoto & Lobach, 2003; Niazkhani et al., 2009; Simon et al., 2007). Niazkhani et al. (2009) performed a systematic literature review to understand the impact of CPOE on clinical workflow, and found 51 related papers published from 1990 -2007. Among the most common positive results were 1) Clinical results and patient status could be accessed remotely, 2) improved order turnaround on laboratory results and prescriptions, and 3) the impact of clinical decision support. These benefits were at times dramatic; prescription order turnaround times were reduced by between 23% and 92%. Kawamoto & Lobach (2003) reviewed the results of 11 randomized trials, and performed meta-analysis to determine the effectiveness of clinical decision support systems embedded in CPOE. The study concluded that the CDSS was strongly associated with a desired change in physician behavior. Garg et al. (2005) performed a similar study to determine the effectiveness of CPOE with respect to improvement in physician performance. Of the 97 studies which met their selection criteria, they found evidence supportive of improved clinician performance in 62 of the studies. Many of the early studies of CPOE quality outcomes were based on prominent hospitals such as Brigham and Women's Hospital in Boston, and these systems were often "home grown" and therefore malleable to the clinical setting, rather than commercially available solutions (Agarwal et al., 2010).

While the majority of research publications highlight positive outcomes as a result of the implementation of CPOE, several papers have reported decidedly negative outcomes (Han et al., 2005; Koppel et al., 2005; van der Sijs et al., 2006). Koppel et al. (2005) found that CPOE systems amplified 22 types of medication errors, largely due to the fragmented display of patient medications and tests, as well as inflexible ordering formats. A highly controversial example of the potentially negative consequences of a CPOE system was highlighted in the Han et al. (2005) paper, which chronicled a commercially available CPOE system implementation at an acute care pediatric hospital in Pittsburgh. Han et al. (2005) found that following the CPOE implementation, the infant mortality rate showed a statistically significant *increase*. Circumstances surrounding the implementation pointed to a lack of preparation and training, which was amplified by their "Big Bang", hospital wide implementation over (6) days. While some have questioned the methodology of the Han et al. paper (Ammenwerth et al., 2006), the paper raises the distinct possibility that poorly executed implementations of HIT can have serious consequences.

Prior research has concentrated on clinical outcomes from CPOE systems use, yet a few studies have documented the expected cost savings as a result of adoption. In an overview of HIT and its expected impact on the U.S. healthcare industry, Hillestad et al. (2005) concluded that a widespread adoption of these technologies could reduce healthcare costs by between $142 and $ 371 billion dollars. Of these totals, it was estimated that CPOE systems could save $67.5 billion over the fifteen year period, largely due to anticipated reductions in adverse drug events. In a single case study at Brigham and Women's hospital in Boston, Massachusetts, Kaushal et al. (2006) calculated a detailed ROI of a CPOE system developed in house, and found that the system generated a cumulative net savings of $16.7 million over a ten year period.

2.2 Theoretical Perspectives

2.2.1 Theoretical Perspectives in HIT and CPOE Literatures

We are informed of CPOE deployment largely through descriptive accounts of outcomes associated with CPOE use (Hennington & Janz, 2007; Kaplan, 2001; Niazkhani et al., 2009), rather than theoretically motivated papers, yet recent interest within the mainstream IS research community has accelerated theory development pertaining to HIT. Several of the exemplar papers were firm level case studies which provided detailed longitudinal accounts of hospital HIT implementations; including CPOE (Davidson & Chismar, 1999, 2007), a decision support system (Kohli & Kettinger, 2004), and an "EMR" system implemented at three different hospitals (Lapointe & Rivard, 2007). The Kohli & Kettinger (2004) study involved a hospital administration led CDSS implementation, which initially resulted in adoption by cardiologists, yet after five years, only the cardiologists were using the CDSS. A subsequent physician led implementation of the same CDSS resulted in more widespread adoption of the technology. The Kohli & Kettinger paper focuses on "Clan" control, whereby the Clan, as represented by the physicians in the hospital, resisted the decision support system imposed upon them by the hospital administration group, whom the Clan felt lacked clinical legitimacy. The role of social influence was highlighted by comments from early adopters who indicated that their actions were influenced by the perceptions of their colleagues, rather than the direction provided by administration (Kohli & Kettinger, 2004). This reinforces the notion that clinician led, patient focused implementation teams, are a common prerequisite to the successful installation of a HIT (Ash et al., 2003; Davidson & Chismar, 1999; Kohli & Kettinger, 2004; Poon et al., 2004).

While putative IS models such as the Technology Acceptance Model (TAM) or the Unified Theory of Acceptance and Use of Technology (UTAUT) have provided parsimonious, generalized insights into IS system behavioral intention and use, few studies have incorporated these models in healthcare contexts (Chismar & Wiley-Patton, 2003; Holden & Karsh, 2010). Prior studies have also demonstrated that well established constructs such as perceived ease of use and subjective norms have failed to yield significant results in HIT contexts (Chau & Hu, 2002; Chismar & Wiley-Patton, 2003), yet questions remain regarding what aspects of the healthcare context might explain these anomalies. Therefore, prior HIT research may not have sufficiently incorporated contextual variables unique and salient to the healthcare domain into TAM related models (Holden & Karsh, 2010).

Chau and Hu (2002) performed a comparative study of the effectiveness of TAM, Theory of Planned Behavior (TPB), and a combined TAM/TPB model to explain behavioral intention with respect to telemedicine use amongst 400 physicians in Hong Kong. While each of the models explained roughly 40% of behavioral intention, perceived ease of use, and social norms, produced modest path coefficients (0.08) and (-.016) respectively, and both effects were statistically non-significant. Holden et al. (2010) performed a literature review of HIT papers which use TAM, and related theoretical perspectives, and found 20 papers which incorporated TAM, TAM2, TPB and UTAUT. While the studies were supportive of TAM as a suitable model for the health IT context, the unmodified TAM models may not capture key contextual attributes unique to the HIT environment (Holden & Karsh, 2010). Holden et al. (2010) make a number of suggestions to enhance the applicability of TAM related theories to HIT research, including modifications to instruments to contextualize variables to a healthcare setting (Holden & Karsh, 2010).

While we are well informed by individual level studies of HIT, until recently there were few studies which focus on team level HIT phenomena (Kane & Alavi, 2008). Through their study of clinicians using an HIT, Kane and Alavi (2008) use social network analysis to understand the role of centrality of IS within the social network, and the impact of indirect use of the IS on efficiency and quality of care. From social network analysis, centrality captures how well a particular node is directly, or indirectly situated relative to other relationships in the network, and IS centrality infers the centrality of IS nodes in the multimodal network (Kane & Alavi, 2008). Kane & Alavi (2008) contend that through social interaction, actors who are not engaged with the IS can be informed by the IS through these interactions with actors who are users of the system. Results of their study find that IS centrality, and the accompanying indirect use of the IT, is significantly and positively associated with team level efficiency and quality of care, yet paradoxically, the average strength of user-system interactions is not significant. Kane & Labianca (2011) later find that the centrality of IS *avoidance* is statistically significant at the configurable team level. These findings are of particular importance where intra team heterogeneity of use of an HIT system exists. For instance a team can benefit from indirect system use even if the attending physician does not engage with the HIT, yet if a key member whom the team relies upon for HIT proficiency conveys avoidance behavior then efficiency of care, quality of care, and patient satisfaction outcomes are negatively impacted.

The focus of our study is to understand the impact of CPOE as an effective *IT-enabled coordinating mechanism* for patient care. While we find few studies in the literature focused on the team level impact of Health IT (Kane & Alavi, 2008), we are well informed by a rich literature of organizational coordination from the management literature. We searched the management literature with the intent of leveraging existing theoretical perspectives on coordination, and applying them to the context of an acute care setting. From this literature stream we learn that IT-enabled coordinating mechanisms are an example of formalized coordination, and in the following section, we align our understanding of the extant HIT literature with coordination theory.

2.2.2 Coordination Theory for Acute Care Clinicians

Coordination within organizations is defined as the management of task interdependencies (Gittell, 2002; Malone & Crowston, 1994), or alternatively, the integration of work under conditions of task interdependence and uncertainty (Faraj & Xiao, 2006). Organizations which exhibit well -coordinated process are more likely to produce superior quality outcomes in a more efficient manner (Gittell, 2002). Much of our current understanding of organizational coordination stems from the seminal work of James Thompson, who argued that coordination in environments characterized by high levels of task interdependence requires mutual adjustment between team members, whereby work outputs from one task provide new inputs for other related tasks (Thompson, 1967). Thompson proposed three levels of increasing task interdependence, including pooled, sequential, and reciprocal, with the latter requiring mutual adjustment to facilitate coordination (Thompson, 1967). According to Thompson, most organizational work required low levels of task interdependence, and coordination could occur through supervision, and standardized work routines (Kogut & Zander, 1996).

Organizational work has changed somewhat since Thompson first proposed his theories (Gittell, 2009). Thompson argued that work requiring mutual adjustment was rare, and only required for tasks involving high uncertainty and task interdependence, yet modern organizational work is increasing on both dimensions (Gittell, 2009). This is especially true of complex knowledge work, where work is primarily accomplished by teams who apply specialized skills in uncertain and time sensitive environments (Faraj & Sproull, 2000; Faraj & Xiao, 2006; Gittell, 2002).Also, modern healthcare is predominately provided in interdependent group settings (Kane & Alavi, 2008). While coordination can be achieved through a variety of activities, and classified according to a myriad of typologies, we adopt the binary categorization of programmed versus non- programmed coordination mechanisms (Argote, 1982; Gittell, 2002). The distinction between the two mechanisms stems from the ability to determine activities and interdependencies between tasks a priori. Programmed coordination occurs through the use of rules, best practices, and scheduled tasks across organizational members determined in advance, as established through meetings of team members and supervisors (Argote, 1982).Yet based on traditional theory, routines and programmed coordination mechanisms provide only limited information processing capacity, and are therefore only effective in environments of low uncertainty and task interdependence (Argote, 1982; Galbraith, 1973; Van de Ven, Delbecq, & Koenig Jr, 1976), leaving more complex tasks to informal, interactive, coordination methods between agents (Faraj & Xiao, 2006). Routines, such as the clinical pathways embedded in CPOE order sets allow for the codification of best practices (Gittell, 2002; Queenan et al., 2011), thereby transforming individual expertise to organizational expertise. According to coordination theory, these routines not only positively impact quality, they also reduce the need for individual interaction, and are therefore a more cost effective way of coordinating work (Gittell, 2002).

Based on the previously mentioned description of hospital clinical work that is non –linear, interruption filled, and uncertain (Koppel et al., 2005), we add that the environment is high volume, time constrained, and must also operate error free (Faraj & Xiao, 2006). Such an environment relies heavily on the error reducing mechanisms inherent to tight structuring, formal coordination, and the clear delineation of tasks; yet due to uncertainty and the need for fast response, must also rely on flexible structures inherent to informal modes of coordination (Faraj & Xiao, 2006). As a result, the complex knowledge work which is inherent to hospital settings requires strong support from both formal protocols, and informal coordinating mechanisms (Brown & Eisenhardt, 1997; Faraj & Xiao, 2006). This recent view posits that formal and informal clinical coordinating mechanisms are mutually reinforcing, whereas traditional coordination theorists suggested that uncertain and highly interdependent tasks diminished the coordinating effects of formal protocols due to their limited bandwidth (Gittell, 2002). Through order sets, CPOE functionality provides clinicians with the ability to incorporate standardized, formal coordination structures for patient care. Yet clinicians are often required to improvise their treatment plans through informal, spontaneous coordination mechanisms. We reviewed the literature to understand the role of informal coordination, with a specific focus on clinical care settings, and in the next section report on a relevant measure of informal coordination called relational coordination.

2.2.3 Clinician Informal Coordination through Relational Coordination

To measure the informal coordinating mechanisms exhibited by clinician care teams, we rely on Relational Coordination theory as posited by Gittell (2002). Relational Coordination is defined as "A mutually reinforcing process of interaction between communication and relationships carried out for the purpose of task integration" (Gittell et al., 2010; Gittell, 2002). Relational coordination relies heavily on Coordination Theory (Malone & Crowston, 1994; Thompson, 1967), and its core belief is that effective coordination is based on strong personal ties; both within group, and between groups of actors. Relational coordination focuses on relationships *between roles* rather than on relationships *between unique individuals*.

Central to Relational Coordination is the view that effective coordination relies on four dimensional aspects of communication (Gittell, 2002); including timeliness (Waller, 1999), frequency (Ancona & Caldwell, 1992; Tushman, 1979), accuracy (O'Reilly & Roberts, 1977), (Tushman, 1979) and the problem solving nature of the communication (Rubinstein, 2000; Stevenson & Gilly, 1993). Coordination work is carried out through groups of individuals who leverage their existing relationships to carry out group tasks; therefore communication and coordination occur within the structure of these relationships (Gittell, 2002). Gittell posits three dimensions of relationships salient to coordination, including shared goals (March & Simon, 1958; Saavedra, Earley, & Van Dyne, 1993; Wageman, 1995), shared knowledge (Dougherty, 1992; Weick & Roberts, 1993), and mutual respect (Eisenberg, 1990; Rubenstein, Barth, & Douds, 1971). Relational Coordination, is therefore a formative construct comprised of four dimensions of communication, and three dimensions of relationships. Previous research has shown that Relational Coordination has a statistically significant, positive relationship on outcome measures salient to the airline industry (reduced customer complaints, mishandled baggage, late arrivals) and to hospitals (reduced length of stay, improved patient satisfaction) (Gittell et al., 2010; Gittell, 2002).

Recognizing that coordination is facilitated through the use of formal, standardized protocols as well as informal relational mechanisms (Gittell, 2002; Thompson, 1967) we aim to measure the strength of each across a broad range of clinical teams. While Gittell (2002) and Gittell et al. (2010) have previously studied the impact of relational coordination on patient satisfaction outcomes, no studies have simultaneously measured the adherence to standardized protocols, in terms of use of an IT such as CPOE, and relational coordination concurrently. Faraj & Xiao (2006) argue that standardized protocols are used by teams of clinicians to manage routine cases, with the intent of maintaining a positive patient condition trajectory. Once patient trajectory towards a positive outcome is diminished, there is a need for more rapid, flexible structures which rely on informal coordination mechanisms (Faraj & Xiao, 2006). The effectiveness of teams that rely on the informal coordination mechanisms, as argued by Gittell (Gittell et al., 2010; Gittell, 2002), is largely based on the effective communication and relationships based on shared goals, mutual knowledge, and respect, as measured by relational coordination.

Traditional coordination theorists (Galbraith, 1974; Thompson, 1967) argue that formal standardized coordination methods and protocols, such as standard operating procedures, developed and enforced through hierarchical reporting structures are the predominant organizational coordination mechanisms. These routines or standardized protocols are characterized as a coordination mechanism which exhibits low levels of bandwidth; conversely, team meetings are deemed to have high levels of information processing capabilities – or high bandwidth (Galbraith, 1973; Gittell, 2002) According to traditional theory in most organizational environments, highly uncertain tasks, as well as tasks which required a high level of task interdependence and thus mutual adjustment – were thought to be rare events. Tasks associated with a high level of uncertainty with respect to outcomes are expected to rely less on standardized formal protocols, in favor of informal mechanisms (Argote, 1982; Gittell, 2002; Thompson, 1967).

While uncertainty is a core tenant of coordination theory, numerous forms of uncertainty exist in the literature. Organizational uncertainty, when it is viewed as a function of the environmental complexity and its underlying rate of change is defined as environmental uncertainty (Sherman & Keller, 2011). Task uncertainty (Galbraith, 1973; Van de Ven et al., 1976) is defined as the relative variability and difficulty associated with the performance of the task. Input uncertainty is defined as uncertainty due to the number of input possibilities in the production process (Argote, 1982).

Argote and Gittell argue that uncertainty in a healthcare setting is a function of the differences in the patients themselves, due to patient co-morbidities. For instance, patients who undergo hip replacement surgery may often have chronic conditions such as diabetes or heart disease, which further complicates treatment that may otherwise be routine. To test this theory, Argote (1982) operationalized uncertainty at thirty hospital emergency rooms in terms of relative patient heterogeneity, which was termed input uncertainty. The study confirmed that formal protocols led to higher levels of organizational effectiveness when input uncertainty was low. Conversely, given higher levels of patient heterogeneity with respect to their clinical condition, informal coordination mechanisms contributed to higher organizational effectiveness. Gittell (2002) later operationalized input uncertainty in hip replacement patients at nine hospitals by measuring patient co-morbidities. The study hypothesized that caring for patients with higher levels of co-morbidities— that is potential complications due to concurrent conditions such as high blood pressure, diabetes and others— would cause clinical teams to place greater reliance on informal coordination mechanisms as measured by Relational Coordination. Gittell (2002) expected to confirm the Argote (1982) results, that uncertainty reduces the efficacy of standard protocols, and increases the influence of informal mechanisms (relational coordination) on patient satisfaction. Contrary to expectations, the Gittell (2002) study found that uncertainty *increased* the effectiveness of standardized protocols as well.

For clinicians to derive a benefit from an IS implies use of the technology. The benefits derived from an IT- enabled coordinating mechanism by a clinician team imply use by two or more members of the team, as coordination is by its definition the management of task interdependencies (Malone & Crowston, 1994). A rich body of knowledge exists within the IS discipline, particularly at the individual level of use, and the following section outlines our understanding of the Use construct in the extant IS literature, with a focus on clinical contexts.

2.2.4 Theoretical Perspectives on Use of Information Systems

Since the seminal Technology Acceptance Model (TAM) was introduced over two decades ago by Davis (Davis, 1989), the IS field has leveraged this parsimonious model in a myriad of contexts (Hsieh & Wang, 2007; Legris, Ingham, & Collerette, 2003), including the Healthcare IT realm (Holden 2010). TAM and variants of TAM, such as the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003) are individual level models which incorporate core antecedents such as perceived ease of use and perceived usefulness of a technology to predict behavioral intention to use the technology. Typically, TAM and TAM derivatives have been used as a theoretical lens to evaluate the behavioral intention to adopt an IT just prior to the implementation phase, or alternatively by lean measures of actual use shortly after implementation. UTAUT confirms that the effects of ease of use are attenuated, or not significant, in periods after initial adoption (Venkatesh et al., 2003). Within the healthcare domain, usefulness remains a significant predictor of intention and use of technology, yet ease of use, even during the introduction phase, is not a significant antecedent (Chau & Hu, 2002;

Holden & Karsh, 2010). As a result, the HIT context is an environment where empirical tests of even well-established IS theories can produce contradictory results.

While the impact of a technology on outcomes may produce the greatest *variance* immediately following implementation, accrued benefits to the organization rely on continued use after the shake down phase (Bhattacherjee, 2001). The implementation literature refers to this stage as Incorporation (Kwon & Zmud, 1987) or Routinization (Cooper & Zmud, 1990). Research focused on Information Technology in a *continued* use environment has been limited, with the IS Continuance Model (Bhattacherjee, 2001) serving as an early example of a conceptual model for studying use in environments well after the shake down phase. The ISC model relies on expectation confirmation theory (Oliver, 1980) from the consumer behavior literature, with Confirmation of expectations, and Satisfaction added to Perceived Usefulness (TAM) as antecedents to Continuance Intentions. Confirmation is defined as the perceived level of congruence between expectations from use of a technology, to the actual performance, whereas Satisfaction is defined as users' feelings about prior use (Bhattacherjee, 2001). In a continued use environment, Satisfaction with the IS was found as the primary predictor of IS Continuance Intention with Perceived Usefulness as a significant secondary antecedent, while Confirmation is the primary antecedent of Satisfaction. Studies suggest that hospitals in more advanced stages of HIT adoption derive a greater benefit (Agarwal et al., 2010; Borzekowski, 2009), which highlights the relevance of HIT research in extended use environments.

Research has concentrated on use in binary terms, rather than understanding the nuanced use of advanced IT systems (Burton-Jones & Straub, 2006; Hsieh & Wang, 2007). Attempts to describe the nuanced use of an IS across users include Extended Use (Hsieh & Wang, 2007; Saga &

Zmud, 1994), Effective Use (Pavlou, Dimoka, & Housel, 2008; Pavlou & El Sawy, 2006), Deep Structure Use (Burton-Jones & Straub, 2006; DeSanctis & Poole, 1994), and Rich Use (Burton-Jones & Straub 2006). Extended Use espouses the notion that over time, users incorporate an increasing array of the capabilities of an IT to support an increasingly comprehensive set of work tasks (Hsieh & Wang, 2007; Saga & Zmud, 1994). Deep Structure Use is defined as the use of key features of an Advanced IT that support the underlying structure of the task (Burton-Jones & Straub, 2006), whereas Very Rich Use such as Exploitive Use is described as the extent to which a user exploits the features of the technology to perform the task (Burton-Jones & Straub, 2006).

To conceptualize use in a contextually relevant manner, Burton-Jones & Straub (2006) suggest a two-staged approach, incorporating definition and selection. The definition stage requires that researchers provide an explicit definition of what constitutes system usage in their study and what are the associated underlying assumptions. During the selection stage, system usage is conceptualized and explicated in terms of its structure and function. Structure is formed through the elements of task, technology and users that are contextually relevant to the research study. Finally, function entails the selection of measures for each element of usage – the user, the task, and the technology, based on other constructs within the nomological network (Burton-Jones & Straub, 2006). By incorporating a structured approach to the conceptualization of use in a research study, researchers are more likely to uncover explanations for the use- performance relationships, particularly if rich and very rich measures of use are instituted (Burton-Jones & Straub, 2006).

Traditional lean measures attempt to capture use as a composite, without regard for the most relevant aspect of use in a specific context, whereas very rich measures incorporate the nature of the usage activity (Burton-Jones & Straub 2006).To date, there are few studies which attempt to describe according to Rich Use principles (Pavlou et al., 2008; Pavlou & El Sawy, 2006), perhaps due to the difficulties with identification when capturing a formative construct, when analysis is based on CBSEM techniques (Burton-Jones & Straub, 2006).

While we have learned a great deal about individual level use intentions, very few organizational studies of use incorporate group (Kane & Labianca, 2011), or firm level (Devaraj & Kohli, 2003) empirical analysis (Burton-Jones & Gallivan, 2008). Organizational research conclusions can often differ as a function of which level of analysis is emphasized (Burton-Jones & Gallivan, 2008; Klein, Dansereau, & Hall, 1994). This dissertation includes data collection at the individual and group (team) level, with the level of analysis and theory building occurring at the team level. We find Deep Structure Use (DSU) as a suitable lens to study nuanced use at the team level in a contextually relevant manner. Given that there are no studies that we are aware of that incorporate Team DSU in a healthcare environment, research establishing this construct would contribute to both the IS and Health IT literature streams

While perceived usefulness and perceived ease of use have proven to be salient *antecedents* to lean measures of individual level behavior intention to adopt an IT, far fewer studies have investigated the antecedents of Rich measures of Use at the team or group level (Burton-Jones & Straub, 2006). In the following section, we suggest that Structuration and Adaptive Structuration Theory (AST) provide a particularly useful theoretical lens in the healthcare context, and that the AST constituents of Faithfulness of Appropriation and Consensus on Appropriation are important antecedents to clinician use of a Health IT.

2.2.5 Antecedents to CPOE Use: An Adaptive Structuration Theory Perspective

Borrowing from the social sciences literature, IS researchers have embraced the meta-theory of Structuration Theory (Giddens, 1979, 1984) as an important contributor to the IS discourse (DeSanctis & Poole, 1994; Jones & Karsten, 2008). The central premise of Structuration Theory is that evolving social structures exist through the actions of human agents as they use, and then reshape existing social structures, and create new structures in the course of everyday life (Poole 2004). Giddens eschewed the adoption of the purely functionalist viewpoint, as well as the purely interpretivist viewpoint of social study research, saying that the functionalist view is strong on structure, yet weak on action; conversely the interpretivist view is strong on action yet weak on structure" (Giddens, 1979). According to Giddens, Structuration is meant to be interpreted as structure in action, and conceptually the term is meant to reinforce the notion of the duality of structure, through the mutual dependence of structure and agency (Giddens, 1979). Therefore Structuration implies that structures are continuously observed and reproduced over time through human interaction (Scott 1995).

While Giddens (1979, 1984) does not specifically mention technology within the context of his theory, the notion that technology is malleable and yet provides structures to human actors has proven appealing to IS researchers (Barley, 1986; DeSanctis & Poole, 1994; Orlikowski & Barley, 2001). Extending concepts from Giddens, two important IS theories were developed; Adaptive Structuration Theory (DeSanctis & Poole, 1994; Poole & DeSanctis, 1990, 1992), and the Duality of Technology (Orlikowski & Barley, 2001). From Structuration theory, DeSanctis and Poole espouse the notion that structures embedded in the IT continuously interact with human agents, thereby reshaping both human behavior and the IT itself over time (DeSanctis &

Poole, 1994). This notion is supported in a healthcare context, where there is strong support in the literature regarding the sizable impact of Health IT systems on clinical workflow (Aarts et al., 2007; Ash et al., 2007; Niazkhani et al., 2009), and clinician resistance to these changes through non-adoption even in mandated use environments (Lapointe & Rivard, 2005, 2007) Structuration Theory has become an important theoretic lens in the IS field, with over 331 papers published in the leading IS journals, and Adaptive Structuration has proven to be the most widely used application of Structuration Theory with over 65 papers (Jones & Karsten, 2008).

The underlying conceptual basis for Adaptive Structuration Theory (AST) are the notions of appropriation and spirit. Appropriations are posited as the instantiation of the functional structures inherent to an IS, which DeSanctis and Poole (1992, 1994) call structures-in-use. Appropriation can be either faithful, or ironic, where faithful appropriation is the degree to which an Information System is used in a manner which is consistent with its general intent (DeSanctis & Poole, 1994; Salisbury, Chin, Gopal, & Newsted, 2002). An ironic appropriation involves the use of the IS that is inconsistent with its spirit, or general intent, thereby introducing potential contradictions in the manner in which groups interact with the technology. Appropriations occur with varying agreement across actors on how the structures should be applied; also referred to as Consensus on Appropriation (DeSanctis & Poole, 1994; Salisbury et al., 2002). Attitudes towards the technology can be positive or negative, with positive attitudes reflecting the usefulness of the technology (Salisbury et al., 2002). For an IS to have its intended effects, its structures should be appropriated in a *stable* manner (Poole & DeSanctis, 1990, 1992). Stable appropriations require that the IS should be Faithfully Appropriated, with evidence of a high level of Consensus on Appropriation, and the group's attitudes toward the IS (usefulness) should be positive (Gopal, Bostrom, & Chin, 1992). Stable appropriations of a IS occur when the technology is well matched to the organizational tasks at hand, leading to superior outcomes.

Spirit is a core concept within AST, where faithful use would be considered in alignment with the spirit of the technology, or use as the system was designed. Spirit aligns conceptually with Giddens' "legitimation", whereby the technology provides a normative frame for behavior (DeSanctis & Poole, 1994). AST eschews the purely techno-centric view that technology use as intended by the developers is *always* good, and ironic use is *always* suboptimal or contrary to goals of the organization. Yet over time, the internal contradictions that can arise from ironic system use may lead to escalating tensions between group members. Teams which exhibit ironic use are more likely to report lower satisfaction, and ultimately achieve lower effectiveness with respect to group outcomes, than teams that exhibit Faithful Appropriation of the IS (Poole & DeSanctis, 1992).

The structural feature sets, together with spirit, form the structural potential of an advanced IT (DeSanctis & Poole, 1994). Groups may select structures and then adapt them to meet their specific needs, and as a result structures in use (appropriation) may vary in an organization, where the structural potential of the IT is in fact constant (Poole & DeSanctis, 1990, 1992). Therefore in an organization in which a technology has been in use for an extended period, individuals and groups of individuals may appropriate the same technology in entirely different ways. Groups may utilize some parts of the structural potential of a IS and leave other feature sets dormant. Yet if the team interaction with the Information System is inconsistent with its structural potential, then outcomes from the structure use will be inconsistent, and generally less favorable (DeSanctis & Poole, 1994).

AST is not without its critics (Jones & Karsten, 2008; Orlikowski & Barley, 2001). The core argument for the criticism is that AST conflicts with Giddens' presumption that structures are socially constructed, and therefore exist and adapt only in the minds of two or more human agents, whereas AST espouses the notion that structures are embedded in the IT, and are subsequently changed through the interaction between the material IT and the human actors. Secondly, Structuration Theory is conceptually based on propositions that operate at a high level of abstraction, which accentuates the complexity of incorporating AST constructs in applied empirical research (Pozzebon & Pinsonneault, 2005).

Despite the criticism aimed at AST, the use of AST as a theoretical lens is especially appealing in a healthcare context. The literature frequently mentions physician resistance to fully adopt the spirit of "cookbook medicine" inherent to environments which incorporate CPOE order set protocols and decision support (Gittell, 2002; Wright et al., 2009). Physicians are also wary of the potential administrative influence enabled by clinical decision support systems (Kohli & Kettinger, 2004; Lapointe & Rivard, 2007). Finally, the literature has highlighted alert fatigue, and difficulty with integrating clinical workflow (Wright et al., 2009) as unintended consequences of CPOE adoption and use.

The source of this resistance can possibly be traced to the manner in which knowledge workers such as physicians are managed. Traditionally, the physician was organized and "controlled" through community, independent of hierarchical control. Given that most physicians are "free agents", coordination has relied on collegial control (Adler, Seok-Woo, & Charles, 2008). This model is changing as physicians are increasingly hired by hospitals to avoid personal malpractice insurance, and are therefore facing more hierarchical pressures (Adler et al., 2008), and prior

CPOE research has documented differentiated workflow policy based on agency. Often, residents, who are hospital employees, were required to enter orders (CPOE), whereas attending physicians were not (Davidson & Chismar, 2007). Research has also demonstrated that clinicians in the United States respond negatively to mandated use policies (Ford, Menachemi, & Phillips, 2006; Miller & Sim, 2004), such as a physician led boycott of the HIT, leading to the eventual dismissal of the CEO who instituted the mandatory use policy (Lapointe & Rivard, 2007). As free agents, physicians are also able to respond to mandated use by practicing at an alternate site, thereby mitigating the effect of social influence inherent to mandatory IS environments (Venkatesh et al., 2003).

To compensate for workflow changes, clinicians either adapt their behavior and integrate workflow adjustments to their existing routines, or require that responsible hospital IT managers modify CPOE functionality to more closely align with established workflow procedures. Early, well cited studies which documented improvements in clinical outcomes due to CPOE use were vetted in settings such as Brigham and Women's Hospital, where the systems were custom designed in house, and subjected to significant modifications based on clinician input (Agarwal et al., 2010). To mitigate workflow disruptions, these modifications to core functionality may have included the elimination of alerts at order entry, substituted by an interface to the pharmacy information system, or the elimination of all mid and low level alerts.

Over time, as clinicians interact with the HIT, new innovations and adaptations to the core functionality of the system may be introduced by a limited number of clinical teams, or the adaptations may be diffused across the hospital, or hospital organization. Therefore neither the technology nor the clinical work routines are static. Based on the high level of resistance in the literature (Lapointe & Rivard, 2005, 2007), this suggests that clinicians are unlikely to acquiesce to a "vanilla" implementation and ongoing use of an HIT. Given the variability of adoption of HIT across clinicians (Burt & Sisk, 2005; Kokkonen et al., 2013), we expect to encounter highly nuanced use of CPOE even in environments with universal adoption. This view is consistent with AST, where DeSanctis and Poole (1994) contend that even in organizations that adopt the same technology, significant variations will occur in the appropriation of the homogenous technology across individuals and teams. Our intent is not to measure the appropriation changes that occur over time in an ethnographic sense, but to incorporate AST constructs as a theoretical lens to understand the variations in use that have occurred well after the shakedown phase. As a result, we posit that Adaptive Structuration Theory, which was developed in the context of Group Support Systems, provides an appealing lens to study the nuanced, extended use of a Health IT by teams of clinicians who provide patient care through knowledge work.

2.3 Patient Satisfaction as an Outcome Variable in the Healthcare Context

Patient satisfaction scores are widely measured in the US, and beginning in October 2012, changes instituted by the Centers for Medicare and Medicaid Services (CMS) directly tie patient satisfaction scores to hospital reimbursement for medical services (Long, 2012). As a result, patient satisfaction scores are becoming increasingly important outcome measures for practitioners and researchers. Micro, and macro level studies linking HIT adoption and patient satisfaction scores are now evident in the literature (Queenan et al., 2011; Sykes et al., 2011; Venkatesh et al., 2011). Sykes et al. (2011) performed a study of EMR adoption by 151 physicians at an 800 bed hospital, and found a positive and significant impact of EMR use on patient satisfaction.

The Queenan et al. (2011) paper uses large Health IT industry datasets from HIMMS analytics and the Leapfrog group to study the use of CPOE at 806 hospitals in the US, and the resulting impact on HCAHPS (Patient Satisfaction) scores. Queenan et al. (2011) reported a positive and significant impact from CPOE use on Patient Satisfaction, and to our knowledge it is the only study to establish this relationship. Queenan et al. operationalize CPOE use on a four point scale, based on Leapfrog group data. Hospitals were ranked from a 1, where CPOE had not been implemented (76%), to a 4, where medical orders were entered for at least 75% of patients. Hospitals coded as a 4 also had to report the availability of alert triggers for at least 50% of common serious medication orders, and that physicians were required to report reasons for any overrides. Hospitals were recorded as 2 for partial use (15%), and 3 (3%) for making progress towards the 75% target. While this study incorporates macro level CPOE order set use variance across hospitals, the incorporation of decision support and alerts in the care process is based on availability, and not actual reported use by care teams. Therefore research which investigates the impact of the use of CPOE on Patient Satisfaction beyond the presence of order set use, and incorporates the nuanced use of affiliated functionality such as alerts, decision support, or digital progress notes would make a significant contribution to academic research, and clinical practice. This view is also supported by previous research which suggests that the greatest impact from HIT use occurs after the incorporation of decision support functionality (Agarwal et al., 2010; DesRoches et al., 2010).

From the Coordination literature stream, we are informed of the positive impact of informal coordination mechanisms on patient satisfaction outcomes through the lens of the latent construct Relational Coordination (Gittell et al., 2010; Gittell, 2002). Gittell posited that teams that reported higher relational coordination would exhibit a greater propensity to coordinate patient care effectively, leading to improved patient satisfaction. These studies focused entirely on the relational aspects of coordination, without regard for the variance in use of the formalized clinical pathways embedded within the interactive coordination mechanism provided by CPOE. To our knowledge, no studies to date have incorporated Relational Coordination as an informal coordination mechanism, along with the more formalized organizational IT- enabled coordination mechanisms provided by CPOE. The juxtaposition of these two forms of coordination measured across teams of clinicians provides an opportunity to study their relative impact on patient satisfaction.

CHAPTER 3- Research Model, Theory Development, and Hypotheses

3.1 The CPOE Coordination Effectiveness Model

To test our research questions, we propose the CPOE Coordination Effectiveness Model (Figure 1), which attempts to explain the impact of IT- enabled, and Relational Coordination mechanisms on patient satisfaction with the clinical care team. As our outcome variable, we rely on patient perceptions of the overall quality of care received as an inpatient as measured by a patient satisfaction survey. Given that our level of analysis is at the clinical team level, it is important to establish our conception of a clinical team. The focal clinician on any clinical team is the attending (responsible) physician, and since this dissertation research concerns coordination, their central role establishes the attending physician as a requisite team member. In any an acute care setting, there are a large number of clinical staff who provide supporting roles in the care process, including nurses, therapists, lab and radiology technicians, pharmacists, and dieticians. For the purpose of this study, we focus on the clinicians who routinely present themselves at the patient bedside, and are authorized to carry out and amend patient care protocols through the patient stay. Therefore we argue that in addition to the attending physician, the clinical team includes all nurses (RN, LPN), mid-levels (Physician Assistant's, Nurse Practitioners), and additional physicians (MD, DO) who come into contact with the patient during their stay. These clinicians are deemed to impart the most influence on the overall rating and perception of the care provided, as reflected on the patient satisfaction survey.

We utilize Relational Coordination to capture the inherent capabilities of teams to spontaneously coordinate based on informal coordination mechanisms, (Gittell et al., 2010; Gittell, 2002), whereas Deep Structure Use (Burton-Jones & Straub, 2006) of CPOE by the clinician team represents the formalized, IT-enabled protocols used to coordinate patient care activities based on pre-determined clinical best practices. Under normal circumstances, the patient condition (Faraj & Xiao, 2006) improves based on standardized protocols, yet medical care is fraught with uncertainty often due to variability in patients themselves. When standardized protocols are ineffective, clinical teams must improvise by seeking out alternative treatment plans, often under extreme time constraints, placing more reliance on informal coordination mechanisms as measured by Relational Coordination.

Based on previous accounts of resistance to HIT technologies in the literature, we expect to find variance in the level of Deep Structure Use of CPOE across clinical teams even in an environment where clinical order set adoption is universal. We expect that not all clinical teams will report that the responsible physician who is fully trained to interpret and act upon system alerts, actually enters the orders. Not all teams will utilize the clinical decision support based on the patient medical record, and many will in the interest of time, choose to bypass or ignore the alerts generated by the HIT to minimize allergic reactions or drug interactions. Finally, not all teams will utilize the coordinating features of the clinical system such as physician and nursing progress notes to communicate patient response to treatment amongst team members in a timely manner. Yet full utilization of these features, including order sets to ensure timely coordination of care according to best practices, as well as alert and clinical decision support functionality aimed at prevention of adverse drug events, have demonstrated improvement in clinical care outcomes (Bates et al., 1998; Garg et al., 2005; Kawamoto & Lobach, 2003).

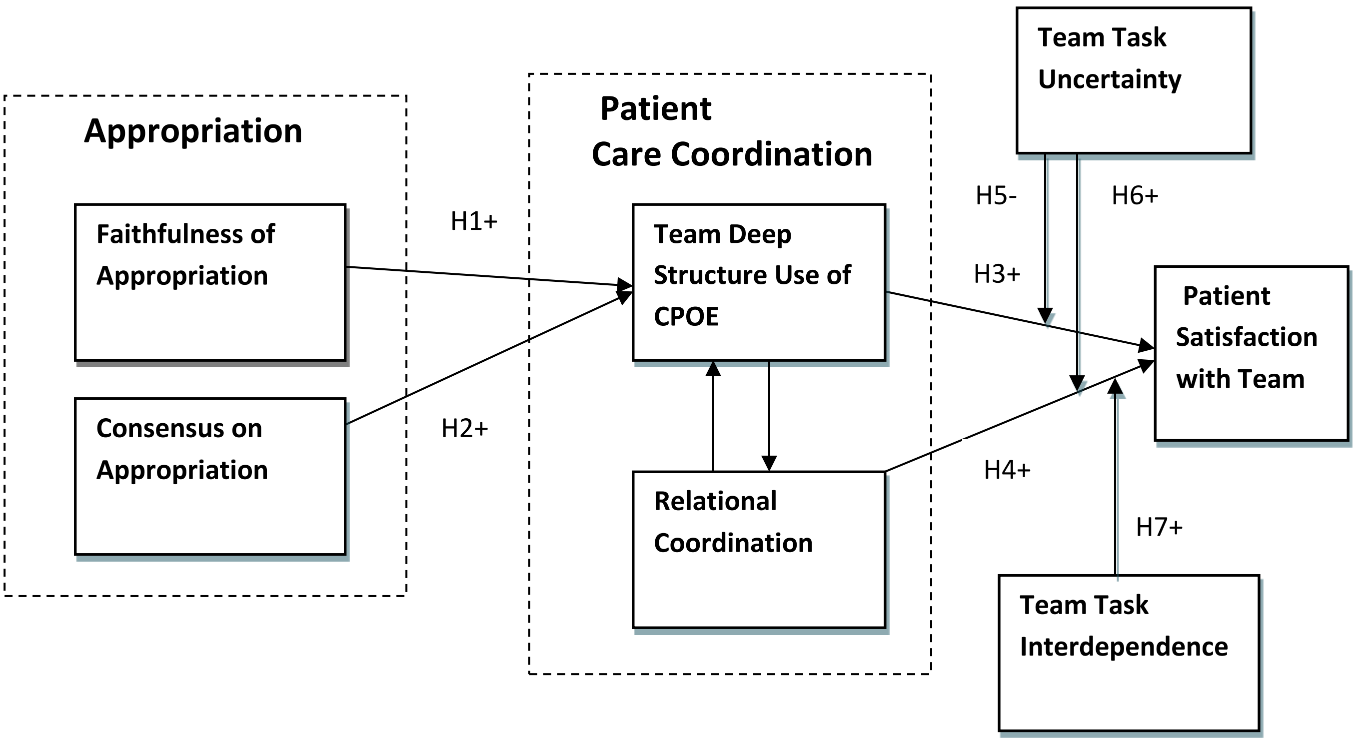

Figure 1: CPOE Coordination Effectiveness Model

3.2 Team Deep Structure Use of CPOE

Our research study incorporates Team Deep Structure Use as a mediator of the relationship between the Adaptive Structuration constructs of FOA and COA, and our dependent variable Patient Satisfaction. Following the prescription by Burton-Jones & Straub (2006) for conceptualizing and operationalizing use constructs, we first define the construct. Given that we view CPOE as an IT-enabled coordinating mechanism for patient care, our definition must incorporate use as a team level construct. Without a consistent level of use across team members of a collaborative or coordinating system, the utility of the individual use of the system would be attenuated. Therefore we view team level use of CPOE as the employment of one or more features of the CPOE system to perform a clinical task (Burton-Jones & Straub, 2006). Secondly, our assumptions follow that a *user* is defined as an individual actor who employs an IS to accomplish a task; a *task* is a goal oriented activity performed by a user according to predetermined requirements; and an *Information System* is an artifact that provides features to support functions in a task domain (Burton-Jones & Straub, 2006). While multiple user groups of CPOE exist within an acute care setting, such as radiologists, lab technicians, pharmacists, and dietary, we confine our study to those who most closely work directly with patients, the physicians, nurses, and mid-levels on a patient care team. Mid-level clinicians include nurse practitioners, midwives, and physician assistants, and through their training they are licensed to provide patient care services that exceed clinical tasks undertaken by registered nurses, such as writing prescriptions or making preliminary diagnosis. Mid-levels, however, work under the supervision of a physician, and may assist, but not perform surgery. Through their specialized skills, mid-levels are becoming increasingly important in acute care settings as a way of enhancing the productivity of the physicians that they support.

In Table 2 below, we capture the elements of CPOE use in terms of its structure. We recognize CPOE functionality as supportive of four overarching components which are salient to the task of coordinating care for patients. These four care components are i) Based on diagnosis, establish a standardized treatment plan for the patient based on best practices; ii) Error prevention (Queenan et al., 2011), where the standard treatment plan is compared to the actual patient medical record to ensure that standard care protocols do not interact negatively with the patient - i.e. drug to drug interactions; iii) Results integration and feedback, to ensure the timely completion of scheduled tasks to be performed by all clinical team members on behalf of the patient throughout their stay and; iv) Provide an ongoing assessment of the patient's progress relative to expectations, and allow for communication of the assessment between clinical team members to ensure a smooth delivery of care, which is especially salient during clinician shift changes.

Matching the four overarching tasks for patient coordination to the technology requires some assumptions regarding the technology environment. We assume that the HIT environment is mature, in that the CPOE system is embedded within an EHR, so that CPOE interacts directly with the electronic version of the patient record rather than creating alerts that require manual checking against a paper medical chart. Secondly, we assume that the system provides decision support to assist the clinician(s) with recommendations for patient co- morbidities and revised medication orders when drug-drug or drug-allergy interactions are triggered. Third, we assume that through the completion of order sets, results of clinical tests, vital signs, and medication are posted directly to the EHR, and results are available to all authorized clinicians hospital wide, or remotely. Finally, we assume that physician and nursing progress note functionality is present, providing the clinical team with the ability to communicate a qualitative assessment of patient status for all team members to view as a permanent record, rather than a paper record, or an ephemeral conversation between two team members.

We assume that a mature HIT environment has been reached, and each element of the technology and the structure that it can provide to the four overarching tasks is evident in the environment. Based on these assumptions being met, clinical workflow can be assisted by the technology accordingly. Teams of clinicians, including physicians and nurses, develop care pathways based on best medical practice, and then incorporate them into CPOE order sets for various patient conditions. Once patients are diagnosed, their treatment plans are initiated by the release of medical orders utilizing these predetermined order sets. The final treatment plan for each patient may rely entirely on the predetermined order sets, or clinicians may decide to incorporate alternative treatment plans, by entering orders on an ad hoc basis.

In an acute care setting, each patient is assigned an attending physician, also called the responsible physician, who manages the overall care process during the patient stay. Standardized, or ad hoc orders may be entered by the attending physician, or an authorized clinician on behalf of the physician, and reporting functionality may have the ability to flag orders released outside of standardized protocols. Once the orders are entered, CPOE enables a series of automated error checks. Utilizing information contained in the unique patient medical record, the order is reviewed for accuracy according to dosage based on age or body weight, as well as potential interactions with other medications or allergic conditions. Alerts are generated immediately following order entry, and alerts can be classified in terms of the severity of implication to the patient if left unattended. Alert and decision support functionality can be confined to the individual entering the order, or extended to all members of the patient care team based on system settings. Standardized reports may be available to track the status and disposition of alerts encountered by the clinician team, allowing for the tracking of clinician reaction to resolve the conditions reported by the CPOE system.

Based on the individual clinician security access, once established orders are entered on behalf of the patient, real- time status and clinical results integration is afforded by the technology. Interdependencies between tasks can be integrated into the predetermined order sets, and sequential tasks can be programmed to occur based on the completion of pre-requisite assignments. Access to update and monitor real time patient records is password driven, therefore open to all authorized clinicians on site, or offsite, based on hospital policy. Finally, progress notes can be entered by the attending physician, the individual nurses on the clinical team, or both groups of clinicians.

For this research study, we form Team Deep Structure Use of CPOE by capturing the use of features of the IS that support the underlying structure of the task (Burton-Jones & Straub, 2006). For each feature set, our measures anchor the period under study as “Over the past month”, and we anchor frequency of use with agreement to the phrase “Our patient care team *consistently* used CPOE”. For each feature set that support the four underlying clinical tasks (see Table 2 below), we capture responses regarding the overall team level of use, as well as individual responses to the level of use by *just* the responsible physician. For clarification, respondents are instructed that their assessment of the clinical team use *includes* the responsible physician. For teams that rely on authorized clinicians for order entry on behalf of the attending physician, alerts that are triggered and the subsequent decision support must then be forwarded to the attending physician for evaluation. While a nurse may be authorized to enter an order, the nurse is not trained or authorized to modify a medication order based on the decision support recommendation. Given that physicians are trained and authorized to respond to decision support mechanisms immediately, we isolated the use of each feature by the responsible physician on each patient care team. Therefore teams which reported a high level of interaction in CPOE by the responsible physician, would in turn have the highest reported Team Deep Structure Use of CPOE. Finally, our measures of Team Deep Structure Use are formulated to tie closely with other constructs within the nomological network (Burton Jones & Straub 2006). Our measures emphasize the technology use with reference to the "Coordination of care for patients", reinforcing the juxtaposition of IT-enabled and relational coordination mechanisms. Selection of the Patient Satisfaction measures also emphasized the structures afforded by the technology that would manifest positive patient responses such as 'How well the staff worked together to care for you", which is a clear assessment of the coordinating effects of either IT- enabled or Relational Coordinating mechanisms.

Table 2: Deep Structure Use of CPOE

Deep Structure Use (Burton-Jones & Straub 2006)		
Task	Technology	User(s)
Standardize patient care delivery (Kohn et al., 2000)	Order sets, order entry	Physician, Clinical Team
Error checking (Garg et al., 2005; Queenan et al., 2011)	Decision Support Systems and Alerts	Physician, Clinical Team
Clinical results integration and feedback (Niazkhani et al., 2009)	Hospital wide and remote access to real time patient status of lab results, vital signs, imaging, and medication	Physician, Clinical Team
Communication and coordination across clinicians	Progress notes	Physician, Clinical Team

While other studies (Queenan et al., 2011) have anticipated the coordinating benefits of specific core functionality, such as clinical decision support, the claims are based on the reported presence, rather than actual reported use, of decision support functionality. Our study is the first to our knowledge that establishes the Deep Structure Use of a Health IT, linking all aspects of the functionality afforded by the Health IT in a mature environment. Progress notes are an overall qualitative assessment of the patient condition, such as the patient reaction to medication, or the interpretation of lab results and vital signs. Progress notes are typically paper based, and from an HIT system perspective, progress notes are not typically associated solely with CPOE, but are part of the affiliated documentation system. This functionality, however, is accessed through the same commercially available clinical system. Progress notes that are legible, and accessible by all clinicians on a patient care team, provide an important overall snapshot of how the patient is doing, and form the basis for changes to standard protocols should the need arise. Therefore we view this functionality as supportive of communication and coordination across the clinical team, and our study, is the first to our knowledge, to include progress notes as a core component of a comprehensive, mature, HIT implementation.

3.3 Hypotheses

To our knowledge, there are no studies which directly link Faithfulness of Appropriation (FOA) and Consensus on Appropriation (COA) as antecedents to Deep Structure Use of an IT. Previous work by Chin & Salisbury (1997) and Salisbury et al. (2002) link the FOA and COA constructs directly to the dependent variable, Satisfaction with the IT. Our study incorporates the use of the formative construct, Team DSU of CPOE, as a mediator between the Adaptive Structuration antecedents of FOA and COA, and our outcome variable Patient Satisfaction with the care team.

As a result, we will rely on the results of previous studies of adoption and use of IT to support our hypotheses. Antecedents to individual intention behavior with respect to use of a technology are well studied and understood (Davis, 1989; Legris et al., 2003; Venkatesh et al., 2003). In addition to the FOA and COA constructs, our study incorporates many of the independent variables associated with individual level adoption and use of technology as control variables (see Table 6). To study the influence of these control variables on team level CPOE use and ultimately Patient Satisfaction with the Patient care team, we capture the controls at the individual level, and aggregate to the team level. The TAM variable perceived usefulness is expected to be a significant antecedent to Deep Structure Use, yet for parsimony and focus, we decided to deemphasize usefulness in our model, yet we measure and then account for the construct as a control. Perceived ease of use has also been proven to be a significant antecedent to use intentions in TAM related studies. Yet perceived ease of use has proven salient only in the early stages of technology adoption (Venkatesh et al., 2003). Knowledge workers who adopt a technology are more concerned with the usefulness of a technology, and are more inclined to invest the time to understand a new system despite its complexity (Keil, Beranek, & Konsynski, 1995). For knowledge workers, no amount of ease of use can overcome a lack of usefulness with respect to technology adoption (Keil et al., 1995). Studies of information technologies within the healthcare context have suggested that Ease of Use, may be nonsignificant even in early stages of adoption (Chau & Hu, 2002; Holden & Karsh, 2010). While we measure perceived ease of use, based on the healthcare context and the extended use environment, we expect an insignificant contribution to variance explained in our study. In addition to the TAM antecedents, we also incorporate team average age, proportion of females on the team, and average team experience with the technology, as controls, as these variables have been important contributors to use intention in previous studies (Venkatesh et al., 2003).

The focal antecedents for this study are Faithfulness of Appropriation and Consensus on Appropriation. According to AST, for an IT to have its intended effects, its structures should be appropriated in a *stable* manner (Poole & DeSanctis, 1990, 1992). Appropriations are the manner in which users adapt an advanced IT for their use, and appropriations can be faithful (used according to intent) or ironic (Poole & DeSanctis, 1990, 1992). Ironic appropriation involves use of the IS that is inconsistent with its spirit, or general intent, and therefore can manifest in potential contradictions in the manner in which teams of clinicians interact with the technology (DeSanctis & Poole, 1994). Consensus on Appropriation refers to the level of agreement between members on how to use an Information Technology; ranging from high to low. Attitudes toward the technology can range from positive to negative, and are influenced by the belief that a technology can be useful when performing organizational tasks (Salisbury et al., 2002). Stable appropriations require that the advanced IT should be faithfully appropriated, with evidence of a high level of Consensus on Appropriation, and the group's attitudes toward the advanced IT (usefulness) should be positive (Gopal et al., 1992; Salisbury et al., 2002).

According to Burton-Jones and Straub (2006), Deep Structure Use of an IT is use of features of the IS that support the underlying structure of the task (Burton-Jones & Straub, 2006; DeSanctis & Poole, 1994). Since appropriation implies use, as does Deep Structure Use, one could argue that Faithfulness of Appropriation predicting Deep Structure Use is axiomatic. Yet Faithfulness of Appropriation (FOA) is a measure of the degree to which use of an IT mirrors the spirit of the technology as intended by its developers, and is therefore considered an *evaluation* of use, rather than a measure of use of an advanced IT (Burton-Jones & Straub 2006). Prior research has also characterized FOA as an attempt to "Grasp" the intentionality of the technology, and is not based on physical usage (Schwarz & Chin, 2007). Deep Structure Use on the other hand evaluates the degree to which users apply all of the functionality that a technology affords the user to apply to a given set of tasks. Deep Structure Use implies not only the comprehensiveness of the use of features, but also the alignment of the feature set with the underlying task. Our operationalization of Team Deep Structure Use also isolates the physician use of each feature set, as well as the overall team use, resulting in a close representation of the three factor measurement of task, technology, and user that Burton-Jones and Straub (2006) coin as "Rich Use".

Therefore, we argue that Faithfulness of Appropriation and Deep Structure Use can in fact be orthogonal, and offer the following example. Consider the entry of orders on behalf of a given patient using CPOE technology by a team which provides care to hip replacement patients. The team has worked well together to develop an order set as a standard clinical pathway for both pre-operative, and post-operative care. The resulting order set is fully supportive of providing all clinicians on the patient care team with a solid coordination and tracking mechanism to manage their hip replacement patients. Yet for this particular team, the physician passes the responsibility for order entry to a junior nurse on the unit. The physician asks the nurse who is charged with order entry, to copy and paste all high level alerts triggered by the system, and email them to the physician. In this instance, this team exhibits Ironic, rather than Faithful Appropriation of the system, yet also exhibits components of Deep Structure Use of the features afforded by the technology through its work around. Over time the nurse charged with order entry could grow tired of emailing the alerts, and instead choose to ignore all alerts and rely on alternative pharmacy systems to capture and react to potential drug to drug interactions. This lapse in

Consensus on Appropriation could result from a lack of feedback from the physician to the nurse, or the nurse's impression that the work around rarely impacts patient care. This adaptation to structures by the team would not be characterized as *stable*. By avoiding or implementing a work-around for core components of functionality, the team short circuits complementary constituents afforded by the technology, mitigating the level of Deep Structure Use. Over time, such an arrangement could lead to tensions on the team, or errors in patient care, resulting in diminished outcomes.

To ensure stable appropriation of the technology, we posit that the tasks associated with the use of the Health IT should closely align with the underlying responsibility, and training of the clinician. The task of the entry of established CPOE orders, assuming that nuanced orders are not required for a given patient type, could easily be assigned to any clinical team member. If, however, the order subsequently triggers an alert, and the system then provides decision support which assumes advanced medical knowledge for interpretation, then the routine order entry task is ultimately associated with a physician's role. The advanced features of alerts and decision support, triggered by (hopefully) a complete and current representation of the patient medical record, and the incorporation of best medical practices embedded in the order set, represent the promise of CPOE as a mechanism for the reduction of medical errors (Kohn 2000). The extent to which clinical teams adeptly incorporate the feedback mechanisms associated with alerts and decision support in their work routines reinforce the positive, or negative, evaluations of FOA and COA of the technology by clinical team members. Clinical teams whereby the physician attends to orders, as well as the ensuing alerts and recommendations, are likely to report high FOA, COA, and Team Deep Structure Use. For teams that utilize an authorized clinician such as a nurse for order entry, the nurse immediately receives the resulting electronic alerts and decision support, yet the nurse is not authorized to act upon the messages and therefore must notify the attending physician and await further instructions. Provided that physicians routinely make adjustments to patient care protocols based on the decision support recommendations, and then relay those adjustments back to the order entry clinician without delay, then team respondents are also likely to report high FOA, COA and Team Deep Structure Use. The consistency to which the direct entry, or immediate physician feedback to the order entry designate on decision support messages reinforce a stable appropriation of the technology in an extended use environment. As Faithfulness of Appropriation, and Consensus on Appropriation are both constituents of stable appropriation, we hypothesize that:

H1: *Faithfulness of Appropriation will have a positive direct effect on Team Deep Structure Use of CPOE.*

H2: Consensus on Appropriation will have a positive direct effect on Team Deep Structure Use of CPOE.

Based on our operationalization of Team Deep Structure Use of CPOE, we formed hypotheses related to the impact of variance of the technology use on our dependent variable, Patient Satisfaction according to the extant literature. Prior IS research has demonstrated that teams that use technologies to a greater extent experience higher decision-making performance, and are more adept at managing and controlling their task performance (Sambamurthy & Chin, 1994). Additionally, research has confirmed that the efficient use of the features of a technology enable the team to achieve higher quality outputs (Poole & DeSanctis, 1992). Previous studies have also confirmed that use of a Health IT leads to improved patient satisfaction (Queenan et al., 2011; Sykes et al., 2011).

Queenan et al. (2011) posit that use of CPOE leads to process improvements, as it enables the codification of routines within hospitals (Queenan et al., 2011), and that CPOE enforces the use of these routines by clinicians, resulting in standardized processes across the organization (Davidson & Chismar, 2007). Secondly, use of these protocols extends across the many functional boundaries inherent to hospital work, thereby reducing the confusion and ambiguity of instructions at organizational boundary points where hospital errors often occur (Queenan et al., 2011). Thirdly, CPOE orders in an integrated HIT environment trigger alerts and decision support capabilities based on the patient medical record, and use of these features are often associated with improved clinical outcomes (Agarwal et al., 2010). Finally, a digital representation of progress notes enable team wide access to a legible assessment of how the patient is responding to treatment, augmenting the verbal communication between clinicians associated with nursing shift changes. We concur with Queenan et al. (2011), that hospital process improvement results from the proper implementation and use of CPOE leading to improved patient satisfaction.

We therefore find evidence in the literature that is supportive of our expectation that teams that report higher levels of Team Deep Structure Use (DSU) of CPOE, will generate higher levels of Patient Satisfaction (PATSAT). The mechanisms that will translate higher Team DSU of CPOE into higher PATSAT are fewer adverse events, an informed clinical team with respect to past and current patient conditions at all times, and a timely completion of tasks by clinician team members. When necessary changes to standard protocols are required, perhaps prompted by system generated alerts and aided by system generated clinical decision support recommendations, each clinical team member will then be broadly informed of the required changes through new CPOE orders and digital status of those new orders. Through the care process, patients will perceive that clinical teams which are well informed, and engaging with the patients themselves as well as their families on a timely basis are more likely to respond favorably to questions such as “How well the clinical team worked together to care for you” Therefore we posit:

H3: There will be a positive relationship between Team Deep Structure Use of CPOE and Patient Satisfaction.

Earlier studies have shown that higher levels of Relational Coordination as reported by team members in the hospital industry, correlate with positive effects on outcome variables such as length of patient stay and patient satisfaction (Gittell et al., 2010; Gittell, 2002). Team members who communicate well, and are focused on tasks based on relationships that demonstrate common goals, mutual respect and shared knowledge exhibit better outcomes. Gittell posits that Relational Coordination supports consistent communication across teams, leading to a reduction in the likelihood of errors – and the probability of improved outcomes (Gittell et al., 2010).

In a hospital environment where there is considerable task uncertainty, and task interdependence, clinical teams are often faced with seeking out alternative treatment plans under time constraints (Faraj & Xiao, 2006). As a result, clinical teams are often required to deviate from standard protocols and implement amended treatment plans expeditiously and consistently, without the luxury of planned meetings and the ability to build team consensus with respect to the new protocol. Therefore teams which report higher levels of relational coordination are more likely to perform well when the need for a high degree of informal, spontaneous coordination arises, based on their inherent coordination capabilities. Through the care process, patients will perceive that clinical teams which communicate well based on strong relationships are also more likely to respond favorably to questions such as "How well the clinical team worked together to care for you". Similarly, the same mechanisms which form the basis of Relation Coordination scores across clinical team members, are also likely to translate to higher perceived relationships between the clinical team members and the patient, often termed "bedside manner". Therefore we posit:

H4: There will be a positive relationship between Relational Coordination and Patient Satisfaction.

Coordination theory has emphasized the importance of task uncertainty and task interdependence (Galbraith, 1974; Thompson, 1967; Van de Ven et al., 1976) and within the healthcare domain, research has reinforced the notion that these constructs are particularly salient (Argote, 1982; Gittell, 2002).Therefore we capture these two constructs according to the five patient conditions. Previous research has often been contradictory, as uncertainty has exhibited a negative effect on the effectiveness of standardized protocols (Argote, 1982), as well as a positive effect (Gittell, 2002). We argue that task uncertainty varies by patient condition, as well as by the patient themselves with respect to co-morbidities. A pregnant mother is more likely to be in their physical prime, compared to a congestive heart failure, or pneumonia patient. As a result, based on the patient condition, a pregnant mother is also likely to have fewer co-morbidities, further reducing the task uncertainty within the vaginal birth patient condition. The difficulty associated with delivering a baby compared to treating a heart attack or pneumonia patient, under most instances, would also be much lower for vaginal birth, and the outcomes less variable. As a result, we would expect that as the task of caring for groups of patients with similar conditions become increasingly uncertain, the standardized clinical pathways embedded in CPOE order sets have a diminished effect on patient outcomes. Prior research has suggested that programmed mechanisms such as protocols and routines, which are the equivalent of order sets in CPOE, have lower levels of information processing capacity (Argote, 1982; Gittell, 2002) compared to informal, non-programmed mechanisms such as team meetings. Through their specialized knowledge, teams of clinicians are more likely to be adept at incorporating a myriad of contextual variables during a synchronous ad hoc meeting, than relying on pre-programmed routines that do not possess all of the relevant contextual variables a priori. Meetings inherently provide for enhanced information processing capacity, as teams are more likely to postulate, and evaluate, alternative treatment plans much more quickly based on recent patient data, than a standardized protocol which is designed to work under "most conditions". As a result, standardized protocols, such as those incorporated in CPOE order sets, are therefore less useful under conditions of increasing uncertainty (Argote, 1982).

Therefore we posit:

H5: The positive effect of Team Deep Structure Use of CPOE on Patient Satisfaction with Care Team will be negatively moderated by task uncertainty, such that the effect will be less positive for Patient Care teams with high task uncertainty than for those with low task uncertainty.

Highly uncertain patient conditions are apt to trigger these adverse changes in patient trajectory, and once patient trajectory towards a positive outcome is diminished, there is a need for more rapid, flexible structures which rely on informal coordination mechanisms (Faraj & Xiao, 2006). Teams which are adept at informal coordination are more likely to react quickly to adverse changes in patient trajectory. As a result, task uncertainty is expected to increase the performance effects of non- programmed coordinating mechanisms and processes (Argote, 1982; Gittell, 2002) characterized by teams that exhibit levels of high relational coordination.

H6: The positive effect of Relational Coordination on Patient Satisfaction with Care Team will be positively moderated by task uncertainty, such that the effect will be more positive for Patient Care teams with high task uncertainty than for those with low task uncertainty.

Earlier research focused on the effect of task interdependence on coordination outcomes, suggested that task relationships requiring mutual adjustment were rare, and required informal coordination mechanisms characterized by group meetings and supervisor oversight. Given that hospital work is highly uncertain due to the complexities imposed by the patients themselves, the need for adept informal coordination mechanisms is quite commonplace; yet these teams must *also* operate error free (Faraj & Xiao, 2006). Therefore such an environment also relies heavily on the error reducing mechanisms inherent to tight structuring, formal coordination, and the clear delineation of tasks. Research indicates that medical specialties adopt HIT at different rates (Burt & Sisk, 2005; Kohli & Kettinger, 2004), with cardiologists adopting at a rate three times that of dermatologists or psychiatrists. Specialties which require integrated involvement across a wide spectrum of clinicians, including radiology, laboratory results, post-operative care teams – indicating a much higher degree of task interdependence – may be pre-disposed to gain a greater benefit from an integrative technology. Consequently, as the level of task interdependence associated with the clinical processes increases, so does the potential coordination improvements afforded by the technology (Gattiker & Goodhue, 2005). Therefore we posit that the higher the level of task interdependence inherent to the clinical pathway based on the patient condition, the higher the potential coordinating affects that will be afforded by the technology.

H7: The positive effect of Team Deep Structure Use of CPOE on Patient Satisfaction with Care Team will be positively moderated by Task Interdependence, such that the effect will be more positive for Patient Care Teams with high task interdependence in their clinical workflow than those with low levels of task interdependence.

Previous descriptions of acute care clinical environments indicate that the work is non –linear, interruption filled, and uncertain (Koppel et al., 2005), but also high volume, time constrained, and must also operate error free (Faraj & Xiao, 2006). These environments rely on error reducing mechanisms present in formal coordination, and through the clear delineation of tasks; yet due to uncertainty and the need for fast response, must also rely on the flexible structures provided by informal modes of coordination (Faraj & Xiao, 2006). As a result, the complex knowledge work inherent to hospital settings requires strong support from both formal and informal coordinating mechanisms (Brown & Eisenhardt, 1997; Faraj & Xiao, 2006).

By measuring Relational Coordination, we can assess the strength of the informal coordinating mechanisms present on clinical teams. Relational Coordination reflects the role that frequent, timely, accurate and the problem solving nature of communication plays on coordination, as well as the impact of the level of shared goals, shared knowledge, and mutual respect present in team member relationships (Gittell, 2002). High quality relationships and communication across team membership likely improves the effectiveness of the implementation and use of complex coordination information systems such as CPOE. Prior research has demonstrated that strong levels of communication and coordination have a positive effect on IS implementation success (Akkermans & van Helden, 2002). In addition, the coordinating structures inherent to CPOE such as clinical pathways, real time status of patient vitals and lab reports, as well as clinician progress notes ensure that all team members are equally up to date on the status of their patients, thereby providing IT- enabled coordination. Therefore we posit:

H8: The interaction of Team DSU and Relational Coordination will have a positive influence on Patient satisfaction such that Team Deep Structure Use will have a stronger positive effect on Patient satisfaction when Relational Coordination is high than low.

Several additional contextual constructs were incorporated into our study. Based on previous research, medical specialty influences the propensity to adopt an HIT (Burt & Sisk, 2005; Kohli & Kettinger, 2004), yet this work has not investigated the drivers of use variance across medical specialties. Previous research also indicates that physicians form separate identities based on medical training (Pratt, Rockmann, & Kaufmann, 2006) leading to clan behavior (Kohli & Kettinger, 2004). As a result, physicians are more likely to adopt a technology if their peers, whom are best represented by others within the same specialty, respond favorably to a technology. Thus, we capture medical specialty as a control. While affiliated hospital groups often implement identical CPOE software solutions, variance in use can exist due to decentralized order set development, leadership, patient acuity levels, and auxiliary clinical system platforms at each hospital site in the group. We therefore capture hospital site as a control.

In summary, roughly ten years ago the Institute of Medicine published *To Err is Human: Building a Safer Health System* (1999), which essentially implicates US physicians for the preventable deaths of up to 98,000 patients a year, the equivalent of a 737 plane crash each and every day. As a solution, the report soundly endorses the use of CPOE, yet ten years later, less than 10% of US hospitals have adopted the technology (Yu et al., 2009). Even amongst hospitals reporting the availability of CPOE, 46% reported *less than half* of their physicians use the system (Ash, Gorman, et al., 2004). More recent research confirmed that of 2475 US hospitals that intended to gain CMS reimbursement through demonstration of meaningful use, only 313, or 13%, were able meet the guidelines (Harle et al., 2013). Of the hospitals that were unable to demonstrate meaningful use, non-compliance with the CPOE meaningful use guideline that at least 30% of patients have at least one medication order was cited as the predominant deficiency (Harle et al., 2013). Presumably these hospitals have only partially implemented the CPOE order set technology in some hospital units, and maintain paper records in the remaining services. Many subsequent studies have confirmed that CPOE technologies facilitate improved clinical outcomes, and reduce costs. Research to date has yet to explain the persistently low adoption rates in light of positive outcomes.

We examine CPOE use from the lens of the affordance of the technology, namely as an IT-enabled coordinating mechanism for patient care. Based on the patient condition, and the trajectory of the patient during their acute care encounter, we expect that teams of clinicians rely on IT- enabled protocols that are embedded in CPOE order sets, or alternatively they can instead rely on Relational Coordination mechanisms, which leverage shared knowledge, and strong interpersonal relations between team members. This study is the first that we know of that incorporates the simultaneous measurement of IT- Enabled and Relational Coordination mechanisms, and has important academic and practitioner implications.

Table 3: Hypotheses

Hypotheses	Rationale
H1: Faithfulness of Appropriation, will have a positive direct effect on Team Deep Structure Use (DSU) of CPOE	For a CIT to have its intended effects, its structures should be appropriated in a *stable* manner (Poole & DeSanctis, 1990, 1992). Stable appropriations require that the CIT should be faithfully appropriated, with evidence of a high level of Consensus on Appropriation, and the team's attitudes toward the CIT (usefulness) should be positive (Gopal et al., 1992)
H2: Consensus on Appropriation, will have a positive direct effect on Team DSU of CPOE	For a CIT to have its intended effects, its structures should be appropriated in a *stable* manner (Poole & DeSanctis, 1990, 1992). Stable appropriations require that the CIT should be Faithfully Appropriated, with evidence of a high level of Consensus on Appropriation, and the team's attitudes toward the CIT(usefulness) should be positive (Gopal et al., 1992)
H3: Team DSU of CPOE will have a positive direct effect relationship on Patient Satisfaction (PATSAT) with Care team	Teams that use technologies to a greater extent experience higher decision-making performance, and are better at managing and controlling task performance (Sambamurthy & Chin, 1994). Efficient use of features of a technology enable teams to achieve higher quality outputs (Poole & DeSanctis, 1992). Codification of routines through CPOE order sets, leads to process improvements across the organization, which in turn positively impacts patient satisfaction (Queenan et al., 2011)
H4: There will be a positive direct effect relationship between Team Relational Coordination and Patient Satisfaction with care team	Teams that communicate well, are focused on tasks based on relationships that demonstrate common goals, mutual respect, and shared knowledge exhibit better outcomes (Gittell et al., 2010). Relational Coordination supports consistent communication across teams, leading to a reduction in errors, and the probability of improved outcomes (Gittell et al., 2010)
H5: The relationship between Team DSU of CPOE and Patient Satisfaction with Care team will be negatively moderated by task uncertainty, such that Patient Care teams with high task uncertainty will derive a diminished benefit from CPOE	Programmed mechanisms such as protocols, and routines have lower levels of information processing capacity, and are therefore less useful under conditions of uncertainty (Argote, 1982; Gittell, 2002)
H6: The relationship between Relational Coordination and Patient Satisfaction with Care Team will be positively moderated by task uncertainty	Input uncertainty is expected to increase the performance effects of non- programmed coordinating mechanisms and processes (Argote, 1982; Gittell, 2002)
H7: The positive relationship between Team DSU of CPOE and Patient Satisfaction will be positively moderated by Task Interdependence, such that Patient Care teams with reciprocal relationships in their clinical workflow will exhibit higher PATSAT	As the level of task interdependence inherent in the processes increase, so does the potential coordination improvements afforded by the technology (Gattiker & Goodhue, 2005)
H8: The interaction between Team DSU of CPOE and Relational Coordination will positively impact Patient Satisfaction with the team	Strong levels of communication and coordination has shown to exert positive effects on IS implementation success (Akkermans & van Helden, 2002)

CHAPTER 4- Research Design and Data Collection

4.1 Research Site

Our sample was derived from the (1273) physicians, and (3309) nurses that have patient privileges within a private five hospital, not-for-profit group in the Southeastern United States. The sample mentioned above consists of clinicians at two of the affiliated five hospitals that have implemented the same commercially available CPOE software for a period of at least six years. Hospital A is an urban acute care hospital with 480 beds, whereas Hospital B is a community hospital with 150 beds. High acuity patients were occasionally moved by helicopter from Hospital B to Hospital A for serious conditions such as open heart surgery. Two of the other hospitals in the group were recently acquired, and had not yet implemented CPOE. Finally, a fifth community based hospital, with just fifty beds implemented the same CPOE system as the two targeted hospitals, yet it had just five months experience with the system. We therefore concentrated on just two of the five hospitals as they had a comparable level of experience, with the same commercially available HIT software package.

Both of the focal affiliated hospitals in the study had achieved and maintained universal adoption over a six year period, which even today is rare (Harle et al., 2013; Yu et al., 2009). With 1000 active order sets covering virtually every patient type under care, the hospital(s) continue to utilize these pre-configured order sets to enter medical orders for 100% of patients, on all in-patient units, thereby substantiating the “universal adoption” claim. Despite the seemingly comprehensive support of the clinical systems by the medical staff, it should not be construed that *all* related features of the CPOE system have been adopted in a comprehensive manner across all units, and it is the variance in use of the extended features that is of interest in our study. Thus, the hospital sites in this study provided a unique opportunity to investigate the impact of CPOE and related clinical systems in an environment with universal adoption across hospital units, rather than the norm which portrays clinician resistance (Lapointe & Rivard, 2007) and limited use across specialties and hospital units.

Most studies investigating the beneficial effects of CPOE implementation, especially those which document its impact on clinical outcomes, were conducted at sites where the clinical application was developed in- house, with substantial modifications made to suit the environment (Agarwal et al., 2010). Given that the IT artifact at both hospitals is a commercially available system, rather than a unique home-grown system, the results of this study could be replicated at other hospital sites using the identical base clinical system, which is supportive of generalization.

In 2003, which corresponds to the year that the first hospital in the group went live with CPOE, just 4% of hospitals in the United States had established hospital wide use of CPOE (Kaganer, Pawlowski, & Wiley-Patton, 2010). More recent statistics report that only 11.9% of US hospitals have either a basic or comprehensive clinical system, with the highest adoption rates reported in urban, academic hospitals that can mandate provider use (Ash et al., 2012). And while community based hospitals represent 86% of all US hospitals, just 6.9% report use of even a basic clinical system (Ash et al., 2012). Despite the flurry of HIT implementation activity related to the 2009 ARRA, in 2011 just 313 US hospitals were able to meet or exceed the Meaningful Use thresholds to obtain reimbursement from the CMS (Harle et al., 2013).

To operationalize the study design, and to gain access to the data required to address our research questions, the principal investigator engaged with the Chief Medical Information Officer (CMIO) over a three year period. The specialized position of the Chief Medical Information Officer is relatively new in the United States, where the incumbent is a medical doctor, and combines medical knowledge with knowledge of emerging clinical technologies such as CPOE and EHR's. The CMIO at the site was responsible for clinical systems over all five hospitals, and was highly supportive of the research initiative. The CMIO reported to the Executive Vice President and Chief Medical Officer, who was responsible for all clinical operations at the five hospitals, as well as research initiatives. The Chief Medical Officer was also very supportive over the period, and was instrumental in gaining approval of the research through the hospital IRB, and the required legal agreement between the hospital site and Georgia State. Despite the high level support, gaining access to the site through the Georgia State IRB, the Hospital IRB, and the hospital legal department culminated in a final comprehensive legal agreement, which required ten months to complete.

Over the three year study period, the clinical software and supporting infrastructure at Hospital A and Hospital B were maintained without substantial modifications; however, the environment at Hospital A in particular was subject to frequent downtime largely due to "hardware issues". In an effort to consolidate clinical software and hardware platforms across all five hospitals, the hospital group had planned to upgrade hardware and implement a new commercially available clinical system during 2013. Given that the objectives of the study were to investigate Appropriation antecedents and Team Deep Structure Use in an extended use environment, it was essential that the HIT systems involved were well past the shake down phase. Therefore the study had to be completed based on the existing systems prior to the new clinical system implementations at Hospital A and Hospital B in mid- 2013.

4.2 Study Design

This study relied on multiple sources of data, including archival data to support team formation, survey data to gain clinician opinions on their professional relationships and CPOE system use, and interviews to validate instruments. For our independent variables, the survey method was used to collect data and to test our model, as it is supportive of replication and large samples. Likewise for our dependent variable, patient satisfaction data at Hospital A and Hospital B was routinely collected by a 3rd party provider, through a random patient satisfaction survey. We were granted access to all 2952 completed patient surveys, captured from patients who were discharged from Hospital A and Hospital B between December 1, 2011 and August 31, 2012. These 2952 surveys, represented 100% of the surveys completed on behalf of the two hospitals over the nine month period, and each of these patients were considered to be part of our study.

While patient names, demographic data, and other Protected Health Information (PHI) were not included in the data set, each patient who had completed a survey was identified according to a unique patient visit identification (ID). The patient visit ID is created during the admitting process, and all system transactions for the patient during their hospital stay are captured according to the unique visit ID. Chronically ill patients may have been admitted multiple times, and while multiple entries to their Electronic Patient Record would exist, each visit would be assigned a unique visit ID. While it is impossible for the principal investigator to know if the same patient completed multiple surveys, the random selection process for sampling by the 3rd party provider was designed to minimize multiple survey requests from the same patient. Using the unique patient visit ID, and CPOE archival data captured by the Chief Medical Information Officer on all 2952 patients, teams of clinicians who provided care were matched with patients according to patient condition. High volume and maximally different patient conditions were evaluated for further study, and ultimately 796 unique patient care teams were identified for 796 of the 2952 patients, across five patient conditions. We assumed that *any* variation in the team membership would constitute a unique team, and given that the average team size was 10 clinicians, the resulting number of permutations and combinations of available clinicians resulted in a unique team for each patient in the study. The evaluation process used to determine which patient conditions were ultimately chosen, as well as the clinical team membership criteria are described in detail in section 4.3. Our research design ensured that we had supportive documentation which matched the patient with the actual members of the clinical team who had provided care, rather than loosely defined "teams" comprised of members of entire nursing units, common to prior research (Gittell et al., 2010; Gittell, 2002). Therefore, our sampling frame was identified by clinician name and occupation type a priori, and each clinician in our sample frame had provided care for at least one of the 796 patients.

Clinician surveys were administered according to five unique patient conditions across the two hospital sites including Vaginal Birth, Pneumonia, Knee and Hip replacement, Cardiovascular surgery, and Organ Transplant. For instance, orthopedic surgeons and nurses who have recently performed *hip replacement* surgery on a patient were asked to complete their survey with the context of Relational Coordination and CPOE use for a hip replacement team. To understand variance across the two hospitals within the hospital group, we surveyed hip replacement teams at both sites. Completed patient satisfaction surveys were grouped according to the patient conditions, and subsequently matched via the unique patient visit ID to the clinician teams who cared for them. This matching process was accommodated using CPOE system archival use data (see Appendix B for an excerpt report). The reports were generated by the Chief Medical Information Officer, and they included unique clinician and patient identifiers which facilitated the matching process. Clinicians or administrative staff other than the responsible clinician may have entered the orders; however, the report also contained an "Ordered on Behalf Of" field to delineate the ultimate responsibility for the transaction.

Team eligibility had two prerequisites; there must be a responsible physician respondent, as well as an 80% response rate from the overall, pre-identified clinical team membership. The responsible physician is liable for all aspects of clinical care, and while many other clinicians are involved in the care process, the assigned physician is ultimately responsible should issues arise, thereby supporting the initial pre-requisite. Despite the relative difficulty of obtaining survey data from physicians, and that prior relevant acute care studies incorporating patient satisfaction as a dependent variable do not specify physician response by each team as a prerequisite (Gittell et al., 2010; Gittell, 2002) it was considered essential for a study of coordination in a clinical setting. Secondly, a high response rate for each team was also considered essential, to ensure that composite scores reflected input from all members of the clinical team involved in direct patient care, as each team member involved in direct patient care likely influenced the overall patient satisfaction rating provided by the patient. Although to our knowledge, a firm response rate threshold associated team level research does not exist, recent publications range from 72.8%

(Maruping, Venkatesh, & Agarwal, 2009) to 91.3% (Kang, Lim, Kim, & Yang, 2012). We deemed an 80% minimum response rate to be representative of exemplary team level research, and therefore for a five member patient care team, responses from the responsible physician, plus three of the four nurses involved would be deemed acceptable, representing an eighty percent response rate across the pre-identified team membership.

The final version the survey was completed by May 2012, and loaded to Survey Monkey (a commercial site for hosting online surveys), followed by a pilot test of the instruments, with the intention of increasing the reliability, content validity and construct validity of the survey (Straub, 1989). Below, Table 4 provides an overview of the timeline from IRB approval to the end of the data collection on site at Hospitals A and B.

Table 4: Project Timeline

T0: IRB and legal Approval	T1: 1 Month Pre-Test, Initiate Archival Data Retrieval	T2- 1.5 Months Team Formation	T2 – 1.5 Months Finalize Teams Initiate Survey Collection Hospital B	T3 –3 Months Survey Data Collection Hospital B and A
Finalize GSU IRB, hospital IRB and legal agreement June 1, 2012	Pre Test Instrument at Hospital B 26 Nurse Manager Surveys Collected June 21 Request Access to Patient Satisfaction Survey Data from 3rd Party Provide unique visit ID's to CMIO	First Iteration Archival data retrieval by CMIO Load and analyze pre-test survey data Begin team formation process	Second iteration of archival data collection Finalize 800 teams Pre -Test 26 Nurse Managers at Hospital A Sept 19 Validate teams with CMIO, Nurse Managers at Hospital B	Based on clinician membership on patient condition teams, survey to collect individual and team perceptions of the technology and use, as well as between role relationships

4.3 Team Formation

Teams were formed according to a structured process, which required roughly 450 hours of systematic analysis over a six week period. We outline the team formation process according to the following nine step process involved.

Step 1: Obtain Patient Satisfaction Survey Per Unique Visit ID, n= 2952, Source: 3rd party Patient Satisfaction Survey Administrator

The process began with the 2952 completed patient satisfaction surveys, differentiated by their unique patient visit ID embedded in the digital survey record, and whose complete access to the survey data was granted by the hospitals and their 3rd party patient satisfaction survey provider. In an attempt to maximize the sample size within each patient condition, yet minimize the collection time from which the patient satisfaction surveys were collected, the principal investigator completed two iterations of steps 1-6 of the team formation process outlined below. The first iteration included *all* completed patient surveys for patients who were discharged from the two hospitals between March 1, 2012 and June 30, 2012, resulting in roughly 1200 surveys. The second iteration included all surveys completed by patients who were discharged from the hospitals between December 1, 2011 to March 1, 2012, and from July 1, 2012 to August 30 2012. The two iterations yielded a total of 2952 surveys, and all patient conditions were included in the total sample. Once a patient completed a patient satisfaction survey, however, they were automatically included in our study. While we are unable to comment on sample bias introduced by the third party survey provider, our study eliminated subsequent sample bias by including all patients identified within specific, high volume patient conditions.

Step 2: Extraction of Matching CPOE Order Data for Each Patient Visit (Source: Clinical Archival Data)

Each completed patient satisfaction survey included a unique patient visit ID, and this identifier, which excluded other Protected Health Information (PHI) such as patient name, address etc. was forwarded by the principal investigator to the Chief Medical Information Officer (CMIO) for retrieval of related archival clinical data. Based on the unique visit ID, the CMIO wrote a series of Structured Query Language (SQL) reports to extract data from the clinical systems. For each patient, 100% of the clinical orders placed through the CPOE system during their stay were collected. This file included a description of the order, who placed the order, who was the attending physician, who requested the order (usually attending physician), and whether or not the order was part of the original order set (i.e., knee replacement post op order set) designated for the patient. Each order was date-time stamped, and also included the clinician occupation code, such as MD, RN, or PA.

For all 2952 patients in the study, there were a total of 500,000 unique order records placed, and this archival data was transferred to the principal investigator while on site at the hospital. These orders were predominately released as part of pre-determined order sets for medication, lab, imaging, anesthesiology, and dietary for each patient type. In addition, ad hoc orders to supplement the routine order sets released during the course of the patient stay were also included in this file.

Step 3: Extracting Nursing/Physician Documentation and Diagnosis Codes (Source: Clinical Archival Data)

Based on the unique patient visit ID, the CMIO also extracted all nursing and physician documentation entered on behalf of each patient during their stay. This file included entries documenting the care process at each hospital, such as vital sign entries, fulfillment of medication orders, discharge orders, or progress notes. Once again, the clinician name and occupation code, description of the documentation entry, and date-time stamp were included in the file, which contained roughly 250,000 unique records placed on behalf of the 2952 patients. Additionally, for each patient visit, a digital record of the admitting, secondary, and discharge diagnosis codes were also provided to the principal investigator. In clinical terms, these diagnosis codes are often referred to as patient problem lists. The US government meaningful use guidelines require that hospitals report the percentage of patients with at least one diagnosis entry, and in the case of Hospital A and B, a valid diagnosis code was a required field for each patient.

Step 4: Associating and validating a Patient within a Condition

At Hospital A, the largest site in the group, there were 1000 active, pre-determined order sets available for clinicians to use based on unique patient conditions. Virtually every type of patient presenting themselves at the hospital was cared for using one of the active order sets. Initially, patient visit ID's were sorted according to the order sets released on their behalf, such as pneumonia, sepsis, or congestive heart failure. While this method was useful to establish high volume patient conditions, this method alone was imprecise, as many patients had multiple order sets released on their behalf upon admittance through the Emergency Department. In addition, order sets such as sepsis were often released as a prophylactic, and did not guarantee that the patient actually had sepsis. Therefore for the purpose of the study, the patient was first associated with a given patient condition by the order set(s) released during their stay, which was subsequently confirmed by the discharge diagnosis code, when available. While this added step did not have a large impact on "elective" patient conditions typically subjected to pre-admission and scheduled surgery times (knee /hip surgery), it did alter patient conditions care for under emergency conditions, which initially included patient conditions such as pneumonia, sepsis, congestive heart failure, and cardiovascular surgery.

Step 5- Selecting potential patient conditions:

The entire set of archival data, including orders, documentation and diagnosis codes (problem lists) were loaded into MS Access. All patient condition types were first summarized, counted and sorted according to the order set released, such as vaginal birth, or knee replacement. Given that we were selectively seeking patient conditions that would yield a final "n" of 30 or more patients, high volume patient conditions based on the occurrence of order set use of 50 patients or more were considered for evaluation. Patient conditions which were deemed similar in nature, such as knee replacement and hip replacement, were combined a priori to enhance the final "n". Our goal was to isolate distinct teams that cared for certain types of patients, in relatively high volume patient conditions.

Through the team creation process, which ultimately evaluated 1400 unique patient teams or close to half of the total sample, it became clear that certain types of high volume patients, such as congestive heart failure, stroke, sepsis, pneumonia, were admitted through the Emergency Department, and cared for by the near identical set of clinicians. Since each clinician would be surveyed once for a inclusion on teams of a pre-identified patient condition, clinicians who cared for multiple patient conditions would be automatically excluded from participation on the second, third or fourth patient type. Requesting that each clinician complete multiple surveys would lead to over-sampling, and a diminished response rate, from individual clinicians who would likely refuse to complete multiple iterations of a 15 minute survey. This reality, coupled with the requirement of an 80% response rate from all pre-identified clinicians on each team, prompted the need for an a priori identification of patient conditions with unique team membership characteristics. As a result, a number of high volume patient conditions, such as congestive heart failure, sepsis, bowel resection were reviewed but later discarded. In the case of bowel resection, 80 complete teams were assembled, but later excluded from the study due to overlap with other conditions such as knee hip replacement. Caesarean section was also a high volume condition that obviously had high overlap with vaginal birth, and vaginal birth was viewed as a more appropriate baseline condition according to perceived coordination properties.

Step 6 – Establishing Clinical Team Membership

Inclusion of individual clinicians on each patient care team was methodically conducted according to archival transactions and role based thresholds. These thresholds were implemented identically for each patient care team, across each patient type. Utilizing MS Access, all of the orders and documentation were summarized by patient, and reports were generated that counted the number of orders, and documentation entries, for each clinician associated with each unique patient visit ID. These reports were subsequently pasted to Excel for further evaluation, and to provide documentation of the team formation process. For each patient care team, the order set detail identified the responsible physician, and this individual was automatically included as a team member regardless of the number of transactions contained in the archival data. The CMIO confirmed that the identified responsible physician would consistently be a central provider in each patient care process.

Additional clinical team members were added according to their digital imprint. Normal procedure at the hospitals was that each patient had a physician/surgeon assigned as the responsible physician, as well as a night shift, and day shift assigned primary nurse. Depending on the specialty, often a mid–level provider such as a Physician's Assistant or a Nurse Practitioner entered all of the orders on behalf of the physician. This practice was especially common with orthopedic and cardiovascular surgery teams, but did not automatically include the PA or RN who entered the order as a team member for the purpose of the study. We did not want to include clinicians who simply added orders to CPOE at the request of the responsible physician, yet never met the patient at bedside during the care process. Therefore the primary driver of the inclusion of a team member was based on the number of transactions in the documentation system, which implied that the clinician provided care at bedside by taking the patient vitals, changing IV's, or administering medication. For mid-level clinicians, we often found confirmation that the clinician was clearly involved through the entry of progress notes, or they had documented and administered the discharge medication orders. These activities registered entries to the documentation system, in addition to the normal entry of orders to CPOE.

Initially, for each patient care team, any clinician regardless of occupation code who had entered four or more documentation orders were automatically included on the team. Clinical partners, who were not fully trained as an RN or an LPN, but often provided administrative support and performed collection of routine patient vitals, were initially identified and included as team members if they had recorded four or more transactions in the documentation system per unique patient visit ID. The defined role of clinical partner at the hospital typically resided at the front desk of the nursing station, but were not assigned as responsible for the care of any specific patient. Clinical partners covered the phones, took routine patient vital signs, and entered a substantial amount of patient data on behalf of the unit. Due to the large number of documentation entries entered by most clinical partners, coupled with their limited responsibility with respect to direct patient care, initially four documentation entries was determined as a threshold for this clinician type as a team member. Further discussion regarding the final disposition of the clinical partner role is covered below in Step 8.

Nurses, such as those designated as RN and LPN, were registered as team members and were automatically included with 3 or more transactions in the documentation file. Given that the average patient had 80 documentation entries, and 160 orders entered on their behalf, there was the potential for very large teams for each patient. Our intent was to capture all of the primary care providers during the patient stay, and exclude those who only provided order entry, or minor coverage during a lunch break, and therefore had little influence on the overall care process. It is possible that a nurse (RN) providing limited coverage could enter one, or possibly two, entries to documentation without being a primary provider. As a result, nurses (RN and LPN) with fewer than three documentation entries were then reviewed to identify those who had *also* made patient orders on behalf of the team. Combinations of at least one documentation entry, and any combination of unique orders and documentation entries exceeding three, led to the inclusion of any RN or LPN. This methodology allowed us to ensure that the maximum number of nurses who made multiple contributions to the care process was included, while minimizing the nurses who had just provided order entry, or cursory coverage during breaks.

Additional physicians (MD, DO) other than the attending physician, as well as all mid-levels, including those with the occupation codes of PA, NP, CNM (midwives) were included as team members provided they made just one or more entries to the documentation system, coupled with just one or more entries to the order set system archive file for the unique patient visit ID. This process was methodically completed in an identical manner for each patient, and the transaction thresholds were identical for each patient type. Entries by clinicians in these roles were relatively rare, and as a result of their status, it was deemed that their digital imprint was more likely due to their involvement in the patient care process. As a result, these clinicians were included in the team membership with far fewer transactions than RN's and LPN's.

This team formation process was inclusive of all nurses, physicians and mid-levels that made entries to the clinical systems during the patient stay. There were, however, other types of care providers that were identified in the order and documentation files, but were excluded. For instance, pharmacists, dieticians, and therapists were excluded, despite their importance in the overall the care process. These occupation types were typically small in numbers, but provided services to a broad range of patient conditions, thereby precluding them from identifying with any given patent care type. Secondly, including these occupation types as a separate group within the survey would have significantly lengthened the instrument. Finally, there is one final physician type that was identified for each team, but excluded from the survey collection process, and that is the anesthesiologist. Anesthesiologists were similar to pharmacists, in that they were few in numbers, but participated on almost all of the patient conditions, including all surgeries, as well as vaginal birth through epidurals. As a result, the anesthesiologist was identified, but excluded from the final clinical team as it was not practical to have them complete multiple surveys. Therefore the final patient care team was compiled to the best of our ability, to represent all of the physicians, nurses and mid-levels that would have most likely presented themselves at the patient bedside throughout the patient stay.

Step 7- Dealing with Clinicians Caring for Multiple Patient Conditions

Once the second iteration of the team formation process was completed, each team was loaded into MS Access for clinician pre-assignment to patient type. While most clinicians loaded cleanly onto only one patient type, despite the careful selection of distinct patient conditions, many nurses had cared for multiple patient conditions. This was especially true for float pool nurses, as well as nurses in pre-admission testing, pre-op, and PACU (post-op) units. Float pool nurses are usually highly trained, experienced nurses who were able to be assigned to an orthopedic unit one week, and the cardiovascular surgery unit the next. Many of these nurses had cared for multiple patients in multiple conditions, and were pre-assigned to a survey based on volume of patients, and the patient type. Given that Organ Transplant and Pneumonia had a much smaller number of patients who had completed a 3rd party survey than vaginal birth, or knee/ hip replacement, some of the nurses who cared for multiple patient conditions were assigned to an organ transplant patient, even though they may have cared for a greater number of knee hip patients. These "shared services" nurses significantly reduced the number of teams that could form at the 80% level or better, as their inclusion in one group such as Organ Transplant or Pneumonia, immediately eliminated their availability for inclusion as a team member for all other patient conditions. As a result, many teams that appeared to have formed at 80% or better based on a response from each clinician, were reduced to less than 80% when the survey response from shared service nurses did match the actual patient condition for the team. The impact of this cross-nesting was mitigated through a careful analysis prior to survey collection, which maximized the number of teams that would form at or above at least a 90% level, and minimized the impact on patient conditions with a smaller sample size such as pneumonia and organ transplant.

Step 8 – Team Validation - Input from the CMIO, Chief Medical Officers, Chief Nursing Officers, and Nursing Management

Throughout the team formation process, input was sought from the CMIO, and the final team creation process was later vetted through nursing leadership at Hospital B. Following the first iteration (1200 patients), a full review of the team creation process was completed with the CMIO, and a cross validation using separate archival data was performed on a sample of teams. Through the cross validation, the CMIO was satisfied with the representation of the clinical team, and had favorable comments with respect to the level of rigor associated with the process. One outstanding question remained, and that was related to the inclusion of clinical partners from a nursing perspective. There were two sub-classifications of clinical partner at the hospitals, one called clinical tech, the other called nursing staff. Initially both classifications were included, but there was concern that clinical partners may not be involved in the overall coordination of care for each patient, and unable to answer many of the survey questions accurately. The CMIO deferred judgment on this critical issue to the nursing leadership, and input was requested from a nurse management group at Hospital B. Each of the nurse managers reviewed the list of clinicians in their area that were identified as team members. All of the nurse managers had completed the survey during a prior meeting as part of the pre-test procedure, and a few of the managers reviewed the survey from the context of applicability to the clinical partners on their units. Through the discussion, the nurse managers felt strongly that both types of clinical partners should be excluded from the study, as the clinical partners were not authorized to perform, or able to comment on many of the tasks included in the survey. The clinical partners were not sufficiently trained to understand the functionality embedded in the system, or make alterations to the clinical care processes. This change was implemented at both hospitals, and significantly reduced the number of clinicians pre-identified for each team, as almost all of the clinical partners were represented on a significant number of teams. Each of the clinical partners was represented by the high number of documentation entries that they performed on each nursing unit. This change actually made it more difficult to obtain above the 80% participation level from team members, as it placed more emphasis on gaining a response from part-time nurses (PRN's) who may have only worked several shifts a month.

Step 9 – Final data preparation for survey collection

Once each clinician was assigned to a specific patient type in MS Access, additional information fields were added, such as the clinician hospital unit assignment, patient team size, total number of patient care teams for each clinician, date of first survey request, survey completion date, date that the clinician was excluded from the study, as well as who provided the information that the clinician was no longer employed at the hospital. This final database design provided the means for a comprehensive tracking mechanism of overall response rates, documenting the elimination of clinicians no longer affiliated with the hospital(s), as well as measuring the ongoing progress made towards team formation at or above an 80% response rate. While the creation of the database required a significant time commitment at the outset, it proved instrumental during the ensuing 12 week survey collection process on site at the two hospitals in the study. With the pre-tests, and the clinical teams identified on both sites, the survey collection process began in earnest the third week of October 2012 at Hospital B.

4.4 Survey Development and Collection

4.4.1 Measure Development

For the majority of the measurement items in the model, existing validated Likert scales were used to increase the reliability of the instrument, and to allow for comparison with other research (Straub, 1989). For Team Deep Structure Use, we relied on the extant IS Use literature within the IS and Health IT literature streams, as well as the US government guidelines for meaningful use. Multiple iterations of the instrument were evaluated by a broad group of individuals from the academic and clinical community; including Georgia State PhD student colleagues, committee members, and short interviews were conducted with the CMIO and CMO's at the hospitals, the VP of Quality, as well as affiliated physicians. The principal investigator used a stopwatch to time each clinician as they completed the survey, and most were completed in ten to twelve minutes. The instrument was modified a number of times to enhance face validity, add a marker variable, and reduce the overall length of the survey. Once the instrument was considered acceptable, five versions of the survey were completed according to each of the final five patient conditions identified in the team formation process. Variations in the wording were minimized so that all five versions could be compared during the data analysis phase (Karahanna, Straub, & Chervany, 1999). Table 5 below provides a summary of the primary constructs in the model, and similarly, Table 6 below, captures the moderators and control variables incorporated in the study.

Table 5: Primary Constructs

Construct	Definition	Level of Analysis & Chan Typology	Measures	Items
Faithfulness of Appropriation	The degree to which a coordinating IT is used in a manner which is consistent with its general intent (Chin, Gopal, & Salisbury, 1997; DeSanctis & Poole, 1994; Salisbury et al., 2002).	Clinician Team – Aggregation through Referent Shift Consensus	Reflective – Clinician Survey (Salisbury et al., 2002) $\alpha = .91$	5
Consensus on Appropriation	The extent to which team members using a CIT jointly agree on how to apply the technology to their work (DeSanctis & Poole, 1994; Salisbury et al., 2002).	Clinician Team – Aggregation through Referent Shift Consensus	Reflective –Clinician Survey (Salisbury et al., 2002) $\alpha = .85$	5
Clinician Team Deep Structure Use	The use of features of the IS that support the underlying structure of the task (Burton-Jones & Straub, 2006; DeSanctis & Poole, 1994).	Clinician Team-Aggregation through Referent Shift Consensus	Formative/Composite – Clinician Survey validated with archival data	16
Relational Coordination	Measurement of clinician team informal coordination, defined as "A mutually reinforcing process of interaction between communication and relationships carried out for the purpose of task integration"(Gittell et al., 2010; Gittell, 2002).	Clinician Team-Aggregation through Referent Shift Consensus	Formative/Composite Clinician Survey (Gittell et al., 2010) $\alpha = .86$	9
Patient Satisfaction With Care team	Inpatient perceptions of the quality of care provided by their respective clinical care team.(Gittell et al., 2010; Gittell, 2002; Queenan et al., 2011; Sykes et al., 2011)	Clinician Team –Overall patient care team	Reflective- Patient Survey – 3rd Party	3

**Aggregation methodology is described by (Chan, 1998)

Table 6: Moderators and Controls

Construct	Definition	Level of Analysis & Chan Typology	Measures	Items
Team Age- Control	Individual clinician age (Morris & Venkatesh, 2000; Venkatesh et al., 2003)	Team Average Age	Single Item - Clinician Survey	1
Team Gender Proportionality-Control	Individual clinician gender (Venkatesh et al., 2003; Venkatesh, Morris, & Ackerman, 2000)	Team proportion as female	Single Item-Clinician Survey	1
Team Task Uncertainty	Task uncertainty refers to the relative variability and difficulty with respect to performing a task (Argote, 1982; Galbraith, 1974; Gittell, 2002; Van de Ven et al., 1976)	Patient Condition	Expert Panel	0
Team Task Interdependence	The degree to which the interaction and coordination of team members are required to complete tasks (Galbraith, 1973; Gittell, 2002; Guzzo & Shea, 1992; Malone & Crowston, 1994; Thompson, 1967)	Patient Condition	Expert panel	0
Team CPOE Usefulness- Control	The degree to which team members of a CIT believe that system use would enhance team performance (Davis, 1989; Salisbury et al., 2002; Venkatesh et al., 2003)	Team- Aggregation through Direct Consensus	Reflective-Clinician Survey (Venkatesh et al., 2003)	6
Team CPOE Ease of Use-Control	The degree to which individual believes that use of a system will be free of effort (Davis, 1989; Salisbury et al., 2002; Venkatesh et al., 2003)	Team – Aggregation through Direct Consensus	Reflective-Clinician Survey (Venkatesh et al., 2003)	6
Team Hospital Affiliation-Control	Identifies the hospital(s) that the clinician provides care to patients	Team– Direct Consensus	Single Item-Clinician Survey	1
Length of Stay	Actual inpatient length of stay in relation to standard protocols for the patient condition	Individual Patient	Archival Data	0
Team Size	Number of clinicians, including physicians and nursing staff that provided care for a patient	Team	Archival Data	0
Team Physician-Related Expertise	Identifies clinicians as a mid-level, nurse, or a physician	Team - Proportion of nurses, mid-levels and physicians	Single Item-Clinician Survey	1
Team Satisfaction	Satisfaction is defined as the users' overall affect with the HIT, including their confirmation of expectation, and beliefs with respect to the ease of use and usefulness of the system (Bhattacherjee, 2001; Hsieh & Wang, 2007)	Team– Aggregation through Direct Consensus	Reflective-Clinician Survey (Hsieh & Wang, 2007) $\alpha = .97$	3
Total				57

4.4.2 Pre-Tests

A pre-test of the Pneumonia Team survey instrument was conducted on site June 21, 2012 at Hospital B, where the Chief Nursing Officer, 22 nursing managers, and subsequently 3 additional affiliated physicians took part. The purpose of the pre-test was two-fold; the primary reason was to evaluate the reliability and construct validity of the instrument (Straub, 1989). Additionally, the survey was administered to the nurse managers to help explain the purpose of the study, demonstrate the nature of the questions and the length of time required to complete the survey, and to gain their approval and support to conduct the research with their staff. This step proved instrumental in the survey collection process, as a number of the nurse managers would request the support of the nursing staff through email notification, and highlight that "I have taken the survey, and it really does take about ten minutes to complete." Most of the nurse managers were not part of identified teams in the study, so that their input to the pre-test would not contaminate the overall results. A subsequent pre-test iteration was conducted on September 18, at Hospital A, with 26 respondents comprised of additional nurse managers.

The pre-test data obtained from hospital A and B were analyzed using SmartPLS (Ringle, Wende, & Will, 2005) at the individual level, rather than the team level, as a full model test at the team level would have required a substantial sample. Therefore the pre-test measures were analyzed using individual level responses of Deep Structure Use as the dependent variable, and the antecedents measured at the individual level. The psychometric results of the original pre-test conducted at Hospital B, as well as the combined results of Hospital A and B are represented in Table 7 below.

Table 7: Pretest Results

Construct	Hospital B (n = 26)			Hospital A +B (n = 52)		
	Composite Reliability	Cronbach's Alpha	AVE	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation	.938	.915	.755	.940	.920	.760
Consensus on Appropriation	.891	.840	.628	.924	.893	.714
Perceived Usefulness	.944	.931	.740	.943	.931	.734
Perceived Ease of Use	.914	.875	.729	.940	.875	.700

Our pre-test results for reliability confirmed that Cronbach's Alpha scores were well above the standard .80 threshold, with the lowest, PEOU at .88. We also confirmed that all loadings were at or above .60, and that the square root of the AVE was much higher than all other paired correlations in the model, establishing construct validity. Based on the pre-test results, we concluded that we were ready to move forward with the survey collection on site at Hospital B.

4.3.2 Survey Collection

Survey data collection was conducted over a 12 week period, and required an on-site presence by the principal investigator that easily exceeded 850 total hours, to achieve the targeted 80% team level response rate threshold. The collection process commenced at Hospital B on October 17, 2012. Each patient type survey was loaded into a separate Survey Monkey URL, and clinicians on several nursing units at Hospital B were initially directed to visit the appropriate website by their respective managers to complete the survey. While clinicians are men and women of science, amenable to clinical trials and surveys in general, most at this particular site were unfamiliar with the lengthy surveys associated with behavioral science research. Perhaps if the site were a large teaching hospital rather than a private hospital group, the response rates based on an initial email request from their respective managers would have been substantially higher. Unfortunately, early response rates to the email requests were roughly 8-10%, which was far less than the required 80 – 90% response rate suitable for team level research. It should be noted, that only clinicians pre-identified as part of a clinical team were contacted throughout the study, rather than sending a large email to all clinicians at the hospital thereby requesting feedback from a substantially larger group.

Rather than relying solely on email requests for survey collection, the principal investigator felt quite strongly that given the chance to meet face-to-face with each clinician identified in the study, that response rates would be significantly higher. The process involved coordination with the nurse manager to meet with pre-identified clinicians on their nursing unit for each shift, and to provide a two minute overview describing the study, and its objectives, to each potential respondent. At the end of the overview, each respondent was requested to participate in the study through the completion of a paper copy of the survey. Respondents and other staff were also provided chocolates and small cheesecakes while the principal investigator was on site at the nursing unit. The Chief Nursing Officers, and each of the nursing managers, first at Hospital B, and then at Hospital A, were very supportive of the initiative. At the outset, nursing management warned that the process would be very time consuming, as the overview would likely be given to individuals rather than groups, and that the meetings would be required on the day shift, night shift, and weekends to connect with all of the staff. At Hospital B, meetings were initially coordinated entirely with the nursing manager on each of the appropriate units. After several weeks, one of the particularly helpful nurse managers introduced the staffing coordinator for Hospital B, who subsequently provided a hard copy of the day and night shift nursing staff for the entire hospital. The principal investigator (PI) was not permitted to obtain an electronic copy, or remove a paper copy of the nursing schedule off site, due to privacy concerns raised by the CNO. Each day at 4pm, the schedule for the following day was made available for manual comparison while the PI remained in the staffing office. Clinician schedules changed dramatically on a day-to-day basis, due to changes in the patient census on each nursing unit, and as a result, the projected one week staffing schedule was not very useful. The hospital wide schedule included all clinicians scheduled at each nursing unit, allowing the principal investigator to manually compare the scheduled staff to the clinicians identified in the study. Given that there were hundreds of clinicians in the study, and literally thousands of clinicians employed at the hospitals, this manual matching process took roughly one to two hours a day. Access to this data, however, significantly improved the ability of the principal investigator to meet with the greatest number of clinicians pre-identified as potential study respondents, on any given shift.

At the request of the nursing unit managers, access to the nursing units was restricted, between the hours of 7AM and 10 AM, due to shift change from nights to days. Similarly, access was restricted between 7PM to 10 PM, due to shift change from the day shift to the 12 hour night shift. As a result, the principal investigator was typically on site between the hours of 10 AM and 2:30AM the following day, for 6 to 7 days each week. Initially the principal investigator would wait on the unit until each nurse had completed the survey. On high acuity units such as the ICU, this process was not very successful, as the nurses were highly engaged with patients. As a result, the surveys would be left with the nurses, and the principal investigator would return several times over the shift to pick up completed surveys. This process was followed at Hospital

B for six weeks, and resulted in a 90.5% response overall rate across all nurses and mid-levels pre-identified as part of the study. Most of the remaining non-respondents were on medical leave, or worked part time, and unfortunately had not met with the principal investigator during the six week period. Two part time nurses that had met with the principal investigator near the end of the six weeks did not return the survey during their shift, signifying a 99% response rate from clinicians contacted through face-to-face meetings.

To improve the chances of a face-to-face meeting with the physicians and mid-levels, the Chief Medical Officer (CMO) at Hospital B agreed to allow access to the physician’s lounge and lunchroom, which was adjacent to the office of the CMO. Largely through serendipity and introductions by the CMO and other physicians, a significant number of surveys were completed over the lunch period, over a six week period. Each of the physicians that listened to the two minute study overview, subsequently completed the survey. All physicians that met with the principal investigator took the time to hear the overview, with the exception of one OBGYN that could only afford 30 seconds, which proved insufficient to convince the individual to complete the survey. Several of the physicians were met while on the nursing units, however, this method was not very productive as it was very difficult to identify each physician or mid-level on the unit, and determine if they were part of the study. Remaining physicians in the study that had not made it to the physician lounge during the time on the hospital campus, were emailed the appropriate Survey Monkey link with limited success. Overall, the response rate for Hospital B physicians was 66%.

Survey collection at Hospital A was equally successful, despite the size and complexity of the hospital itself. Patients were routinely air-lifted from Hospital B to Hospital A, therefore the acuity level of the average patient, and the subsequent attention that each clinician could afford to the study, was much more limited. To reduce the time required, and the complexity of the survey collection process at Hospital A, the Vaginal Birth and Pneumonia patient conditions were not collected at Hospital A. At the outset, the equivalent staffing coordinator at Hospital A was identified, and the process of manually matching the clinicians involved in the study with the system wide nursing schedule was initiated. Once again, the principal investigator was embedded on site each day from roughly 10 AM until 2:30 AM the following morning, on average six days a week. Given the larger distances between nursing units at Hospital A, efforts were extremely focused on the high volume units initially, leading to the subsequent inclusion of smaller specialty units at a later time. This process ensured that clinicians on each nursing unit were quickly familiar with the principal investigator, and with the process involved in collecting survey data for the study. Over a similar six week period, an 87.5% response rate was achieved from the nurses and mid-levels, in spite of the fact that the number of total required responses in the sample was 40% greater than at Hospital B.

Survey collection from physicians at Hospital A was accomplished through alternative means, as access to the physician's lounge was not granted by the CMO. The principal investigator was invited to do a short presentation of the study to the physician leadership at the hospital, and through the meeting established contacts across the medical specialties represented by the study. The physician contact for organ transplant became actively involved with the survey, arranged a separate presentation with the organ transplant surgeons, and provided follow up support with the surgeons that had not yet completed the survey. All but one of the transplant surgeons that heard the presentation by the principal investigator, completed the survey, for an 87.3%

physician response rate. Most of the cardiovascular surgeon responses were generated through chance meetings on the nursing units, with one additional response captured through the web survey, for a 60.5% response rate. The mid-level and orthopedic surgeon responses were generated through appointments at the surgeon offices nearby the hospital. The orthopedic surgeon response rate at hospital A was limited, at 42.9%. Overall the physician response rate at Hospital A was 60%.

A summary overview of the sample statistics is presented in Table 8 below. In total, 261 teams were created with the pre-requisite of a physician response, and an overall 80% response rate. To create these teams, a total of 555 responses were collected from clinicians at the two hospitals. While clinicians were pre-identified according to a single patient type, many of the clinicians were represented on multiple teams. A graphical representation of the care provider concentration is also presented in Figure 3 below. For instance, there were 147 clinicians in the study who were represented on only one patient care team, and 25 clinicians who were attached to 10 patient care teams. Therefore the survey opinion of these 25 clinicians was used as an equally weighted response on each of the 10 patient teams.

If we consider the cardiovascular surgery patient condition, we received responses from 162 Hospital A clinicians, including nurses, surgeons and mid-levels. In total, there were 101 cardiovascular surgery patients who completed a Patient Satisfaction survey, and using archival data, we assembled the 101 unique patient care teams who cared for each patient respondent. There were 1418 total "opinions" across the complete cardiovascular surgery clinician group, for an average team size of 14; however, many of the clinicians were nested in multiple cardiovascular surgery teams. We captured 1207 clinician responses from the 162 pre-identified cardiovascular surgery clinicians, out of a total available sample of 1418, for a reported 85.1% response rate. Despite the high overall response rate, we required a response from the cardiovascular surgeon who performed the open heart or related surgery. Given the 60.1% physician response rate, we were only able to create 43 valid teams from the initial 101 cardiovascular surgery patients in our overall sample.

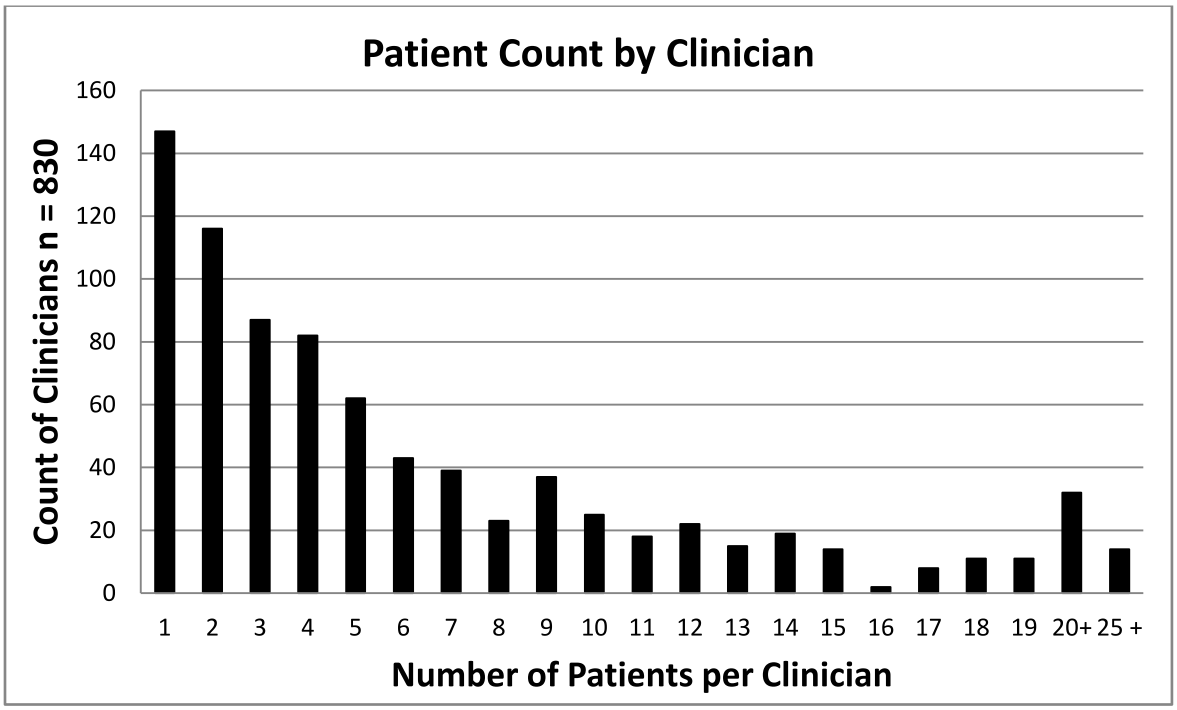

Figure 2: Care Provider Concentration

Table 8: Sample Statistics

	Hospital A			Hospital B		
	Organ Transplant	Cardiovascular Surgery	Knee/Hip Replacement	Knee/Hip Replacement	Pneumonia	Vaginal Birth
# of Qualifying Teams Total n = 261	34	43	37	74	21	52
Sample Teams n = 562	58	101	123	100	40	140
# of Respondents Total n = 555	79	162	45	63	121	85
Nurse/Mid-Level Response Rate	84.5%	87.4%	92.0%	93.5%	85.4%	90.4%
Physician Response Rate	87.3%	60.5%	42.9%	86.9%	66.2%	51.7%
Clinician Responses	469	1207	671	674	288	629
Total Sample Size	552	1418	794	728	352	771
Overall Response Rate by Patient Condition	85%	85.1%	84.5%	92.6%	81.8%	81.6%

CHAPTER 5- Analysis and Hypotheses Tests

5.1 Measurement – Aggregation, Operationalization of Controls, and Validation

5.1.1 Team Aggregation

Given that the level of analysis, and the level of theorizing, were conducted at the team level, it is imperative that we first describe the process of aggregation from the survey collection at the individual level, to the team level composite scores. We rely on the Chan (1998) typology to describe the aggregation process. The relevant methods of aggregation applicable to our study are additive, direct consensus, and referent shift consensus (Chan, 1998). Additive aggregation has been widely used, often in error, to transform individual level responses to team level constructs by simply calculating the mean of the individual scores, without establishing a measure of within-group agreement to justify aggregation (Burton-Jones & Gallivan, 2008). Essentially for each construct in the model, to be considered a team level construct, the responses from individual members of a team should converge in a manner that could not occur by chance. According to Chan (1998), to warrant aggregation from individual survey responses to a team level construct, the researcher must first establish within-group agreement, using techniques such as Rwg (James, Demaree, & Wolf, 1984). This is true for the referent shift and direct consensus approaches, both of which are used in the CPOE Effectiveness Model (See Table 5). Direct consensus is calculated identically to additive aggregation, but this approach is also validated by an established measure of within-group agreement (Chan, 1998). Finally referent shift consensus is established by framing the measures themselves to reflect a team level, rather than individual level perspective, and aggregation is subsequently supported by a measure of within-group agreement (Chan, 1998). For instance, a referent shift consensus measure would state "Our team found the system useful", rather than "I found the system useful". As a result, moving from additive, to direct consensus, to referent shift consensus is a hierarchical progression, whereby the researcher establishes a more substantive claim to the measurement of individual responses to establish a team level construct.

Most of the measures in the study were aggregated according to referent shift consensus (Chan, 1998). While survey responses were collected from pre-identified individuals, the survey questions were typically posed from the perspective of the clinical teams in which they participated through the patient care process. For example, the Faithfulness of Appropriation questions were presented as "Our clinical team used the system properly", rather than "I used the system properly". To create team scores, the individual scores from all respondents on the team were then aggregated, with the team composite score determined as the mean of equally weighted responses. The two Adaptive Structuration constructs, Faithfulness of Appropriation and Consensus on Appropriation were often used in group support system research, and as a result, the referent shift, team level perspective for these measures was suitable. Similarly, coordination is implicitly a team level construct, and therefore, the Relational Coordination was originally created for use at a team level perspective.

Several of the control variables, such as perceived ease of use, and perceived usefulness, (Davis, 1989; Venkatesh et al., 2003) are commonly incorporated in theoretical models such as TAM as individual level constructs. Rather than altering the measures to reflect the Chan referent shift typology perspective, these measures were maintained with their original format as individual level measures, and then aggregated to the team level as the mean of the equally weighted responses.

To establish the validity of the team aggregation process, the within-group agreement (Rwg) of each construct in the model was calculated to demonstrate team level within-group homogeneity. Essentially, within-group agreement establishes that teams or groups of individuals share common perceptions and beliefs regarding focal constructs. Conversely, low levels of agreement would suggest that with respect to the focal construct, team members have very disparate rather than cohesive perspectives, negating the notion of "team" and drawing into question the justification for aggregation. Teams may share other attributes in a very cohesive manner, and clearly perceive, or behave as a team manner overall. Therefore it is quite conceivable that teams share some characteristics, and are essentially a collection of individuals on other characteristics, which reinforces the relevance of establishing within-group agreement of each construct prior to aggregation.

We calculated Rwgj, and/ or Rwg using the R statistical package (R Development Core Team, 2013). The distinction between the two measures of within-group agreement is that Rwg is used for single item constructs, whereas Rwgj is used when constructs have multiple survey items, such as Faithfulness of Appropriation (4), or Perceived Usefulness (4). Extending Chan's (1998) work on the need to establish within-group agreement as a pre-requisite to data aggregation, subsequent multi-level research suggests that a median or mean Rwg that meets or exceeds a threshold of .70 provides justification for aggregation (Klein & Kozlowski, 2000) . For constructs which fail to meet the guideline, as a remedy the researcher can eliminate individual teams that fall below the .70 guideline to ensure that the overall Rwg for the focal construct exceeds the threshold (Klein & Kozlowski, 2000).

For each construct in the model, we calculated the Rwgj using R. Since the formative constructs Relational Coordination and Team Deep Structure Use of CPOE are used as composites, as well as in their original form of 7 and 4 measures, we calculated Rwg for the composites, and Rwgj for the original multi-item constructs. Table nine reports the within-group agreement scores, using either Rwgj or Rwg (James et al., 1984) for each construct in the model. Each of these scores is well above the .70 threshold (Klein & Kozlowski, 2000), thereby establishing justification for aggregation of individual scores to represent the team level construct. It is interesting to note that 6-10 years after implementation, the ease of use mean score of within group agreement is the lowest overall, at .783, suggesting that individual views on the relative ease of using CPOE while providing clinical care show moderate variance within teams. With most software packages, one would assume that through repeated use over the years that respondents would converge on fairly high scores on ease of use due to familiarity with the software. This assumption does not seem to hold at this particular site.

Table 9: Assessment of Within-Group Agreement

Construct (Measures)	Method	Median	Mean
Faithfulness of Appropriation (4)	Rwgj	0.9491	0.9005
Consensus on Appropriation (3)	Rwgj	0.9425	0.9287
Usefulness (4)	Rwgj	0.9161	0.8585
Ease of Use (3)	Rwgj	0.8354	0.7833
Relational Coordination (7)	Rwgj	0.9730	0.9684
Relational Coordination (1)	Rwg	0.9182	0.8987
Team Deep Structure Use (4)	Rwgj	0.8746	0.8278
Team Deep Structure Use (1)	Rwg	0.8650	0.8182

5.1.2 Control Variable Operationalization

Based on the prior research investigating Use (Venkatesh et al., 2003; Venkatesh et al., 2000), a number of salient dummy control variables were included in our model test. Control variables associated with Use were modeled as predictors of Team Deep Structure Use of CPOE. We operationalized gender as a dummy variable by coding male as 1, female as 2. Team gender proportionality was computed according to the mean of the equally weighted responses, and reported as the percentage of females on the team. Age was coded as a continuous variable consistent with prior research (Morris & Venkatesh, 2000). Team Average Age was computed according to the mean of the equally weighted responses.

Team Experience with the CPOE system was operationalized as a continuous variable. To aid respondents, we provided the implementation date of the system at each facility, and asked for the date that each respondent began using the CPOE system. For each respondent, the CPOE experience date was then subtracted from the survey date and computed as the number of days of experience. The Team Average Experience was then computed as the mean of the equally weighted responses, and reported as the average number of years' experience with the CPOE system. Finally, as teams can vary in composition in nurses, nurse practitioners/midwives, physician assistant and physicians, we controlled for Team Physician-Related Expertise. A team member's role was used to proxy for their physician-related expertise. Specifically, Nurses were coded as 1, Nurse Practitioners/Midwives as 2, Physician Assistant's as 3, and Physicians as 4, and these ratings reflect an increasing rate of education, and physician-related expertise and responsibility associated with the role[1]. Team Physician-Related Expertise was computed as a composite of the number of team members in each role multiplied with the role's score for physician-related expertise.

We also conducted a supplementary analysis using the proportion of physicians to the proportion of nurses/mid-levels on each team as a measure of Team Physician-Related Expertise. This alternative operationalization of Team Physician-Related Expertise had a modest impact on the variance explained, and path coefficients for each patient condition. We found that all our results were robust in significance and direction regardless of which operationalization of Team Physician-Related Expertise was used.

In addition to the controls which were expected to have impact on Team Deep Structure Use of CPOE, controls were also introduced on the dependent variable, Patient Satisfaction with the care team. Using archival data, the patient length of stay was captured as the difference between the admit date and the discharge date for each patient. The patient Length of Stay (LOS) is operationalized as a continuous variable, and LOS used in this study has *not* been adjusted according to patient co-morbidities. Prior studies (Gittell, 2002) have incorporated adjusted patient length of stay as an additional dependent variable. Given that this study did not have access to the adjusted data, we maintained focus on the PATSAT dependent variable. Patient Satisfaction with the team is captured at the individual patient level, and likewise, we incorporated the individual patient LOS in the model as a control on Patient Satisfaction. We do,

[1] An argument could be made that Nurse Practitioners and Physician Assistant's should share an equal rating as a 2, with physician rated a 3, and further sensitivity analysis may be warranted, but unlikely to impact results based on their limited numbers in the study.

however, report the mean overall patient length of stay according to patient condition below in Table 36.

In addition to (LOS), Team Size is captured as a control on PATSAT. Team Size is operationalized as a continuous variable. Using archival data, we captured the number of clinicians responsible for each patient, as identified in the 9 step Team Formation process above in section 4.3. The Team Size control variable reflected the total number of pre-identified clinicians on each team, and not the actual number of team respondents to the survey. Average Team Size by patient condition is also reported in Table 36 below. Prior research has indicated that higher nurse staffing levels are associated with improved patient outcomes (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007; Lang, Hodge, Olson, Romano, & Kravitz, 2004), and therefore Team Size could be deemed a relevant control for Patient Satisfaction.

5.1.3 Descriptives and Initial Reliability Assessment

While we will rely mostly on previously validated survey instruments, it is still important to measure the reliability and construct validity of the final instrument (Straub, 1989). Verification of the reliability of the *reflective* measures was assessed using Cronbach's alphas (Nunnally, 1967). Assessment of reliability, construct validity, and measurement invariance occurred through a multi-step, iterative process. Early in the analysis phase, it became clear that if PLS was allowed to freely calculate weights for the formative measures associated with Team Deep Structure Use of CPOE and Team Relational Coordination, the resulting loadings on the reflective measures in the model displayed measurement variance across patient conditions. Therefore as a remedy, we constrained the formative constructs in our model to composite index values based on unit mean scores of equal weights.

With respect to reliability as measured by Cronbach's Alphas, most scores were all above the standard .80 threshold for all reflective constructs in the model *prior* to the formation of the formative composites. Composite Reliability scores, however, were below threshold on several patient conditions for the standard TAM constructs of Perceived Usefulness and Perceived Ease of Use, as well as the AST antecedents at this stage. After the formative constructs were converted to composites, the overall Composite Reliability scores showed consistent improvement across patient conditions, while the Cronbach's Alpha scores remained at .80 and above. At this stage, only the Composite Reliability score for the Organ Transplant Perceived Ease of Use remained below threshold (.667), and this issue is addressed below in the measurement invariance section 5.15.

Rather than reporting multiple iterations of descriptive and psychometric data, Tables 10-15 below present the reliability and descriptive data for each patient condition generated *after* the formative constructs were formed as composites. For clarification on the process, the Team Relational Coordination composite was formed by the unit mean scores using equal weights across the seven formative measures. The Team Deep Structure Use construct was formed in a two-step process. First, the 14 measures were consolidated according to the four overarching tasks; namely orders, error checking, vital sign/order status monitoring, and progress notes. These four unit mean scores were then consolidated to a single composite, based on equal weights for each task.

Table 10: Vaginal Birth Reliability and Descriptive Statistics (n = 52)

Construct (a)	Mean	Standard Deviation	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (5)	5.862	0.336	0.936	0.913	0.749
Consensus on Appropriation (5)	5.705	0.332	0.936	0.915	0.746
Patient Satisfaction (3)	4.686	0.584	0.94	0.913	0.839
Relational Coordination (1) *	4.177	0.209	NA	NA	NA
Team Deep Structure Use (1)*	5.422	0.44	NA	NA	NA
Team Perceived Usefulness (6)	5.574	0.429	0.964	0.956	0.819
Team Perceived Ease of Use (4)	5.125	0.429	0.925	0.892	0.756
Team Gender Proportionality (Female)	88.7%	12.3%	NA	NA	NA
Team Ave Experience with CPOE (YRS)	4.145	0.958	NA	NA	NA
Team Average Age (YRS)	41.66	4.434	NA	NA	NA
Length of Stay (Days)	2.12	0.704	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 11: Pneumonia Reliability and Descriptive Statistics (n = 21)

Construct (a)	Mean	Standard Deviation	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (5)	6.12	0.218	0.894	0.839	0.650
Consensus on Appropriation (5)	5.915	0.223	0.815	0.86	0.494
Patient Satisfaction (3)	4.597	0.707	0.955	0.930	0.876
Relational Coordination (1) *	4.196	0.114	NA	NA	NA
Team Deep Structure Use (1)*	5.579	0.253	NA	NA	NA
Team Perceived Usefulness (6)	6.045	0.325	0.952	0.970	0.767
Team Perceived Ease of Use (4)	5.577	0.369	0.911	0.900	0.720
Team Gender Proportionality (Female)	85.8%	9.7%	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	3.927	0.794	NA	NA	NA
Team Average Age (YRS)	38.814	4.121	NA	NA	NA
Length of Stay (Days)	4.52	3.803	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 12: Hospital A Knee/Hip Reliability and Descriptive Statistics (n = 37)

Construct (a)	Mean	Standard Deviation	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (5)	5.905	0.484	0.979	0.973	0.904
Consensus on Appropriation (5)	5.834	0.403	0.959	0.946	0.823
Patient Satisfaction (3)	4.793	0.487	0.969	0.952	0.913
Relational Coordination (1) *	4.231	0.181	NA	NA	NA
Team Deep Structure Use (1)*	5.403	0.338	NA	NA	NA
Team Perceived Usefulness (6)	6.105	0.327	0.980	0.976	0.893
Team Perceived Ease of Use (4)	5.547	0.472	0.936	0.907	0.787
Team Gender Proportionality (Female)	76.2%	10.8%	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	7.196	1.052	NA	NA	NA
Team Average Age (YRS)	45.523	2.074	NA	NA	NA
Length of Stay (Days)	3.03	0.372	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 13: Hospital B Knee/Hip Reliability and Descriptive Statistics (n = 74)

Construct (a)	Mean	Standard Deviation	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (5)	5.871	0.294	0.943	0.924	0.769
Consensus on Appropriation (5)	5.659	0.314	0.919	0.907	0.696
Patient Satisfaction (3)	4.653	0.547	0.928	0.884	0.812
Relational Coordination (1) *	4.062	0.172	NA	NA	NA
Team Deep Structure Use (1)*	5.411	0.274	NA	NA	NA
Team Perceived Usefulness (6)	5.88	0.303	0.955	0.943	0.780
Team Perceived Ease of Use (4)	5.424	0.277	0.871	0.804	0.630
Team Gender Proportionality (Female)	83.6%	7.2%	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	5.43	0.838	NA	NA	NA
Team Average Age (YRS)	45.959	6.644	NA	NA	NA
Length of Stay (Days)	3.11	2.193	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 14: Cardiovascular Surgery Reliability and Descriptive Statistics (n = 43)

Construct (a)	Mean	Standard Deviation	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (5)	5.888	.284	0.963	0.952	0.839
Consensus on Appropriation (5)	5.675	.266	0.946	0.927	0.78
Patient Satisfaction (3)	4.692	.560	0.928	0.882	0.812
Relational Coordination (1) *	4.123	.129	NA	NA	NA
Team Deep Structure Use (1)*	5.580	.273	NA	NA	NA
Team Perceived Usefulness (6)	5.627	.415	0.977	0.97	0.894
Team Perceived Ease of Use (4)	5.050	.389	0.948	0.925	0.822
Team Gender Proportionality (Female)	81.1%	8.9%	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	5.237	.719	NA	NA	NA
Team Average Age (YRS)	38.714	6.538	NA	NA	NA
Length of Stay (Days)	8.41	3.244	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 15: Organ Transplant Reliability and Descriptive Statistics (n = 34)

Construct (a)	Mean	Standard Deviation	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (5)	6.198	0.193	0.931	0.915	0.731
Consensus on Appropriation (5)	5.954	0.236	0.936	0.907	0.752
Patient Satisfaction (3)	4.833	0.397	0.952	0.924	0.87
Relational Coordination (1) *	4.357	0.110	NA	NA	NA
Team Deep Structure Use (1)*	6.173	0.153	NA	NA	NA
Team Perceived Usefulness (6)	6.121	0.347	0.818	0.96	0.466
Team Perceived Ease of Use (4)	5.324	0.400	0.667	0.924	0.367
Team Gender Proportionality (Female)	75.3%	12.6%	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	6.030	0.855	NA	NA	NA
Team Average Age (YRS)	38.714	6.538	NA	NA	NA
Length of Stay (Days)	5.820	4.330	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

5.1.4 Assessment of Construct Validity

Construct validity represents the extent to which inferences can be legitimately supported, based on the operationalizations of the constructs represented in the research study (Trochim & Donnelly, 2008). Evidence of construct validity is supported by the establishment of two contrasting constituents of construct validity, namely convergent and discriminant validity. Measures that should be related, should demonstrate high inter-correlations, thereby establishing convergent validity; conversely, to establish discriminant validity, the inter-correlations with measures of unrelated constructs should be low (Trochim & Donnelly, 2008). For this dissertation, convergent and discriminant validity of the reflective constructs was assessed using confirmatory factor analysis (Gefen & Straub, 2005). Convergent validity is established when each measurement item loads above .50 with a significant t value on its intended latent construct (Gefen & Straub, 2005). We report the initial loadings *after* the formative constructs were forced to composites in Table 21 below. While most of the initial 102 reflective measure loadings were well above the standard .50 threshold, several of the measures on several of the patient conditions did not meet the established standard, including the Organ Transplant EOU4 (.304) and the Pneumonia FOA1 (.283). As a remedy to this validity threat, we subsequently trimmed several of the measures, and this process and the corresponding impact on construct validity is described in greater detail below in the measurement invariance section 5.15.

To establish discriminant validity in PLS,1) all loadings of items on the intended proxy of the latent construct should be substantively larger than on any other latent variable, and 2) the square root of the average variance extracted (AVE) for each proxy for the latent variable will verify that the construct correlates with its measures stronger than with any other latent variable in the model (Gefen & Straub, 2005). For each patient type, across all reflective constructs, the square root of the AVE exceeds the reported cross-correlation with all other constructs in the model. Considering the reflective constructs in the model, of the 234 cross correlations, just one major cross-correlation is reported above the .80 threshold, which is the .803 FOA and COA cross-correlation on the cardiovascular surgery patient condition.

5.1.5 Assessment of Measurement Invariance

Measurement invariance is considered an important pre-requisite when conducting cross–group comparisons (Vandenberg & Lance, 2000), as demonstration of measurement invariance ensures that respondents from different groups or cultures interpret a given measure in a conceptually similar manner (Vandenberg & Lance, 2000). To improve measurement invariance properties across all patient conditions and constructs, we implemented two remedial actions; calculating composites for the formative constructs, and secondly, trimming measures. To account for the impact of these changes, we initially report measurement invariance *after* the formative constructs were calculated as composites, and then again after the trimming process was completed on the reflective measures.

As a rule, PLS attempts to maximize variance explained on the dependent variable, in a manner similar to regression, and therefore we suspected that the principal source of the measurement variance occurred when PLS was allowed to freely calculate the weights associated with the formative constructs, namely Team Relational Coordination and Team Deep Structure Use of CPOE. Therefore, we first reduced the two formative constructs to composite scores based on equally weighted unit means. This process was initiated to allow an evaluation of measurement invariance on the remaining reflective constructs in the model as well as the control variables, and has precedent in the IS literature (Hsieh, Rai, & Keil, 2008).With the two formative constructs forced to equal weights, we report the loadings for all reflective measures across patient conditions in Table 16 below.

Table 16: Initial Assessment of Measurement Invariance – Reflective Measures

	Hospital A			Hospital B		
Measures	Organ Transplant	Cardiovascular Surgery	Knee Hip	Knee Hip	Pneumonia	Vaginal Birth
FOA1	0.816	0.850	0.962	0.819	0.283	0.850
FOA2	0.963	0.932	0.979	0.755	0.908	0.932
FOA3	0.701	0.939	0.918	0.850	0.940	0.939
FOA4	0.904	0.939	0.956	0.856	0.898	0.939
FOA5	0.869	0.917	0.937	0.885	0.809	0.917
COA1	0.845	0.737	0.863	0.819	0.307	0.737
COA2	0.509	0.867	0.855	0.755	0.923	0.867
COA3	0.964	0.900	0.909	0.850	0.755	0.900
COA4	0.961	0.949	0.970	0.856	0.531	0.949
COA5	0.967	0.945	0.935	0.885	0.818	0.945
EOU1	0.913	0.763	0.713	0.686	0.769	0.763
EOU2	0.424	0.959	0.923	0.736	0.807	0.959
EOU3	0.592	0.947	0.937	0.829	0.848	0.947
EOU4	0.323	0.944	0.953	0.906	0.958	0.944
USFL1	0.901	0.935	0.924	0.917	0.888	0.903
USFL2	0.905	0.930	0.959	0.891	0.851	0.942
USFL3	0.824	0.912	0.946	0.911	0.843	0.910
USFL4	0.539	0.963	0.951	0.912	0.853	0.917
USFL5	0.306	0.950	0.951	0.905	0.987	0.910
USFL6	0.320	0.940	0.938	0.751	0.822	0.846
PSAT1	0.955	0.777	0.940	0.870	0.955	0.777
PSAT2	0.973	0.947	0.971	0.914	0.887	0.947
PSAT3	0.867	0.967	0.956	0.918	0.964	0.967

Our findings here support earlier views that within a Health IT context, even well-established TAM measures may yield uncommon results when compared to other contexts (Holden & Karsh, 2010). This issue appears to be salient even within the same HIT context across various patient conditions. For instance, the loadings for the Organ Transplant Teams for Perceived Usefulness are quite low (USFL5 = .306, USFL6 = .32), whereas the Hospital A Knee/Hip team loadings for the same measures are considerably higher (USFL5 = .951, USFL6 = .938).While clinicians may support the notion that Health IT is supportive of improved clinical outcomes, many would not agree that the technologies improve productivity or are easy to use and free of mental effort (Holden & Karsh, 2010). Therefore we trimmed the measures which included productivity and mental effort in their stem, and reviewed the resulting impact on AVE values, as well as measurement invariance across patient conditions. Additionally, several of the measures associated with the AST constructs of Faithfulness of Appropriation (FOA1) and Consensus on Appropriation (COA1, COA2) generated loadings on some patient conditions that were well below the .50 threshold. These questions included "The developers would agree with how our team used the system", and "There was no conflict on our team with respect to the CPOE system". Given the problematic loadings we trimmed these measures, and report the resulting reliability and Average Variance Extracted (AVE's) for each patient type in Table 17– 22, and a second assessment of Measurement Invariance in Table 23.

Across virtually all patient conditions and all reflective constructs, the trimmed constructs resulted in improved construct validity, much higher AVE scores, and improved measurement invariance properties. For instance, of the 102 reflective measures across all patient conditions (Table 23), the lowest loading is on the COA4 for the Pneumonia condition (.584), which is well above the standard .50 threshold requirement to establish convergent validity. In addition, the lowest reported AVE score is now (0.658) for the Organ Transplant patient type Perceived Ease Of Use construct (Table 21). All reported scores of average variance explained (AVE) should exceed 0.50, as this would suggest that variance explained is greater than the variance unexplained (Segars, 1997). We do not feel that the reduction of measures substantially changes the underlying meaning of the constructs themselves; however, the trimming process substantially improved reliability, construct validity, and measurement invariance properties.

Table 17: Vaginal Birth Reliability Statistics (n = 52) Original versus Trimmed Measures

	Original			Trimmed		
Construct Trimmed Measures (a)	Composite Reliability	Cronbach's Alpha	AVE	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (4)	0.936	0.913	0.749	0.914	0.876	0.730
Consensus on Appropriation (3)	0.936	0.915	0.746	0.954	0.928	0.874
Patient Satisfaction (3)	0.94	0.913	0.839	0.940	0.913	0.839
Relational Coordination (1) *	NA	NA	NA	NA	NA	NA
Deep Structure Use (1)*	NA	NA	NA	NA	NA	NA
Team Perceived Usefulness (4)	0.964	0.956	0.819	0.964	0.950	0.869
Team Perceived Ease of Use (3)	0.925	0.892	0.756	0.945	0.914	0.852
Team Gender Proportionality (Female)	NA	NA	NA	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	NA	NA	NA	NA	NA	NA
Team Average Age (YRS)	NA	NA	NA	NA	NA	NA
Length of Stay (Days)	NA	NA	NA	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale after the measures were trimmed.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 18: Pneumonia Reliability Statistics (n = 21) Original versus Trimmed Measures

	Original			Trimmed		
Construct -Trimmed Measures (a)	Composite Reliability	Cronbach's Alpha	AVE	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (4)	0.894	0.839	0.650	0.940	0.915	0.797
Consensus on Appropriation (3)	0.815	0.86	0.494	0.819	0.886	0.610
Patient Satisfaction (3)	0.955	0.930	0.876	0.955	0.930	0.876
Relational Coordination (1) *	NA	NA	NA	NA	NA	NA
Deep Structure Use (1)*	NA	NA	NA	NA	NA	NA
Team Perceived Usefulness (4)	0.952	0.970	0.767	0.966	0.960	0.875
Team Perceived Ease of Use (3)	0.911	0.900	0.720	0.941	0.963	0.842
Team Gender Proportionality (Female)	NA	NA	NA	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	NA	NA	NA	NA	NA	NA
Team Average Age (YRS)	NA	NA	NA	NA	NA	NA
Length of Stay (Days)	NA	NA	NA	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale after the measures were trimmed.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 19: Knee/ Hip (A) Reliability Statistics (n = 37) Original versus Trimmed Measures

	Original			Trimmed		
Construct -Trimmed Measures (a)	Composite Reliability	Cronbach's Alpha	AVE	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (4)	0.979	0.973	0.904	0.974	0.964	0.902
Consensus on Appropriation (3)	0.959	0.946	0.823	0.969	0.952	0.913
Patient Satisfaction (3)	0.969	0.952	0.913	0.969	0.952	0.913
Relational Coordination (1) *	NA	NA	NA	NA	NA	NA
Deep Structure Use (1)*	NA	NA	NA	NA	NA	NA
Team Perceived Usefulness (4)	0.980	0.976	0.893	0.979	0.971	0.921
Team Perceived Ease of Use (3)	0.936	0.907	0.787	0.964	0.943	0.899
Team Gender Proportionality (Female)	NA	NA	NA	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	NA	NA	NA	NA	NA	NA
Team Average Age (YRS)	NA	NA	NA	NA	NA	NA
Length of Stay (Days)	NA	NA	NA	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale after the measures were trimmed.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 20 Knee/ Hip (B) Reliability Statistics (n = 74) - Original versus Trimmed Measures

	Original			Trimmed		
Construct -Trimmed Measures(a)	Composite Reliability	Cronbach's Alpha	AVE	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (4)	0.943	0.924	0.769	0.937	0.910	0.790
Consensus on Appropriation (3)	0.919	0.907	0.696	0.968	0.950	0.908
Patient Satisfaction (3)	0.928	0.884	0.812	0.928	0.884	0.812
Relational Coordination (1) *	NA	NA	NA	NA	NA	NA
Deep Structure Use (1)*	NA	NA	NA	NA	NA	NA
Team Perceived Usefulness (4)	0.955	0.943	0.780	0.952	0.933	0.833
Team Perceived Ease of Use (3)	0.871	0.804	0.630	0.917	0.865	0.787
Team Gender Proportionality (Female)	NA	NA	NA	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	NA	NA	NA	NA	NA	NA
Team Average Age (YRS)	NA	NA	NA	NA	NA	NA
Length of Stay (Days)	NA	NA	NA	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale after the measures were trimmed.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 21 Cardiovascular Reliability Statistics (n = 43) Original versus Trimmed Measures

	Original			Trimmed		
Construct -Trimmed Measures (a)	Composite Reliability	Cronbach's Alpha	AVE	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (4)	0.963	0.952	0.839	.970	.959	.890
Consensus on Appropriation (3)	0.946	0.927	0.78	.964	.943	.898
Patient Satisfaction (3)	0.928	0.882	0.812	.928	.882	.811
Relational Coordination (1) *	NA	NA	NA	NA	NA	NA
Deep Structure Use (1)*	NA	NA	NA	NA	NA	NA
Team Perceived Usefulness (4)	0.977	0.97	0.894	.973	.963	.899
Team Perceived Ease of Use (3)	0.948	0.925	0.822	.976	.964	.932
Team Gender Proportionality (Female)	NA	NA	NA	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	NA	NA	NA	NA	NA	NA
Team Average Age (YRS)	NA	NA	NA	NA	NA	NA
Length of Stay (Days)	NA	NA	NA	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale after the measures were trimmed.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 22: Organ Transplant Reliability Statistics (n = 34) Original versus Trimmed Measures

	Original			Trimmed		
Construct -Trimmed Measures (a)	Composite Reliability	Cronbach's Alpha	AVE	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (4)	0.931	0.915	0.731	.931	.915	.775
Consensus on Appropriation (3)	0.936	0.907	0.752	.987	.980	.960
Patient Satisfaction (3)	0.952	0.924	0.87	.952	.924	.870
Relational Coordination (1) *	NA	NA	NA	NA	NA	NA
Deep Structure Use (1)*	NA	NA	NA	NA	NA	NA
Team Perceived Usefulness (4)	0.818	0.96	0.466	.969	.968	.886
Team Perceived Ease of Use (3)	0.667	0.924	0.367	.850	.922	.658
Team Gender Proportionality (Female)	NA	NA	NA	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	NA	NA	NA	NA	NA	NA
Team Average Age (YRS)	NA	NA	NA	NA	NA	NA
Length of Stay (Days)	NA	NA	NA	NA	NA	NA

a) The number in the parenthesis represents the number of items in the scale after the measures were trimmed.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 23: Measurement Invariance – Trimmed Reflective Measures

	Hospital A			Hospital B		
Construct	Organ Transplant	Cardiovascular Surgery	Knee Hip	Knee Hip	Pneumonia	Vaginal Birth
FOA2	0.957	0.949	0.969	0.931	0.900	0.907
FOA3	0.691	0.917	0.924	0.785	0.945	0.879
FOA4	0.949	0.963	0.963	0.943	0.907	0.955
FOA5	0.898	0.945	0.942	0.888	0.814	0.642
COA3	0.973	0.917	0.945	0.952	0.777	0.911
COA4	0.986	0.966	0.984	0.946	0.584	0.975
COA5	0.981	0.960	0.936	0.962	0.942	0.917
EOU2	0.715	0.971	0.925	0.784	0.862	0.946
EOU3	0.727	0.967	0.957	0.926	0.886	0.913
EOU4	0.966	0.958	0.962	0.942	0.999	0.909
USFL1	0.975	0.947	0.921	0.930	0.950	0.921
USFL2	0.990	0.960	0.981	0.898	0.933	0.951
USFL3	0.973	0.947	0.980	0.916	0.930	0.942
USFL4	0.816	0.938	0.955	0.907	0.929	0.914
PSAT1	0.955	0.777	0.940	0.870	0.955	0.953
PSAT2	0.973	0.947	0.971	0.914	0.887	0.915
PSAT3	0.867	0.967	0.956	0.918	0.964	0.878

With respect to Measurement Invariance reported after the trimming process, 3 of the 102 reflective measure loadings were still slightly below the .70 threshold (Organ Transplant (FOA3) .691, Vaginal Birth (FOA5) 0.642, Pneumonia (COA4) 0.584. While this is still of some concern, rather than further reducing the measures across all patient conditions and compromising content validity, it was deemed appropriate to continue with analysis and results with the remaining measures.

Next we report the correlation matrix for each of the five patient conditions (Table 24-29), and to aid in the assessment of discriminant validity, we also report the square root of the AVE along the diagonal. Each of the correlation tables was computed after the formative constructs were constrained to composites, and after the reflective measures were trimmed. For each patient condition, the square root of the AVE for each proxy of its intended latent variable verifies that the intended reflective construct correlates with its measures more strongly than with any other latent variable in the model. Based on the analysis reported after both remedies were implemented, the reflective measures in the model demonstrate discriminant validity.

Table 24: Correlation Matrix Vaginal Birth (n= 52)

	AGE	COA	TEAM DSU	EOU	EXP	FOA	LOS	PAT SAT	RC	TPRE	TEAM SIZE	USFL
AGE	1.000											
COA	0.078	0.935										
DSU	0.137	0.648	1.000									
EOU	-0.128	0.504	0.483	0.923								
EXP	0.489	0.009	-0.079	-0.025	1.000							
FOA	0.155	0.733	0.762	0.464	-0.087	0.854						
LOS	-0.127	-0.062	0.039	0.002	-0.098	-0.056	1.000					
PATSAT	-0.072	-0.067	0.004	-0.043	0.026	0.020	-0.243	0.916				
RC	0.083	0.490	0.364	0.154	0.124	0.501	-0.141	0.101	1.000			
TPRE	-0.005	-0.090	-0.410	-0.175	0.164	-0.200	-0.267	0.307	-0.121	1.000		
SIZE	0.015	0.042	0.125	-0.012	-0.013	0.017	0.325	-0.178	0.060	-0.451	1.000	
USFL	0.181	0.493	0.604	0.703	0.136	0.497	-0.065	-0.057	0.156	-0.012	-0.060	0.932

1. Square root of AVE on diagonal

2. COA = Consensus on Appropriation; DSU = Team Deep Structure Use of CPOE; EOU = Team Perceived Ease of Use; EXP = Team Average Experience with CPOE; FOA = Faithfulness of Appropriation; LOS = Patient Length of Stay; PATSAT = Patient Satisfaction with Care Team; RC = Team Relational Coordination; TPRE = Team Physician-Related Expertise; Size =Team Size; USFL= Team Perceived Usefulness

Table 25: Correlation Matrix –Pneumonia (n = 21)

	AGE	COA	TEAM DSU	EOU	EXP	FOA	LOS	PAT SAT	RC	TPRE	TEAM SIZE	USFL
AGE	1.000											
COA	0.135	0.781										
DSU	0.039	0.529	1.000									
EOU	-0.186	0.390	0.178	0.917								
EXP	0.253	0.140	-0.029	-0.038	1.000							
FOA	-0.076	0.728	0.479	0.355	0.243	0.893						
LOS	0.389	-0.477	-0.035	-0.266	-0.102	-0.448	1.000					
PATSAT	-0.148	0.329	0.416	0.019	-0.222	-0.002	0.022	0.936				
RC	-0.372	0.526	0.056	0.592	0.140	0.369	-0.721	0.194	1.000			
TPRE	-0.204	0.433	-0.021	0.388	0.184	0.486	-0.636	-0.345	0.596	1.000		
SIZE	0.394	-0.357	0.077	-0.124	-0.047	-0.363	0.908	0.077	-0.664	-0.678	1.000	
USFL	-0.231	0.356	0.050	0.642	-0.177	0.392	-0.309	-0.318	0.451	0.488	-0.228	0.936

1. *Square Root of AVE on Diagonal
2. COA = Consensus on Appropriation; DSU = Team Deep Structure Use of CPOE; EOU = Team Perceived Ease of Use; EXP = Team Average Experience with CPOE; FOA = Faithfulness of Appropriation; LOS = Patient Length of Stay; PATSAT = Patient Satisfaction with Care Team; RC = Team Relational Coordination; TPRE = Team Physician-Related Expertise; Size =Team Size; USFL= Team Perceived Usefulness

Table 26: Correlation Matrix -Knee Hip Replacement Hospital B (n = 74)

	AGE	COA	TEAM DSU	EOU	EXP	FOA	LOS	PAT SAT	RC	TPRE	TEAM SIZE	USFL
AGE	1.000											
COA	0.122	0.953										
DSU	0.052	0.315	1.000									
EOU	-0.067	0.247	0.368	0.887								
EXP	0.103	0.123	-0.141	-0.202	1.000							
FOA	0.174	0.571	0.545	0.342	-0.139	0.889						
LOS	-0.058	-0.022	0.107	-0.026	-0.008	0.108	1.000					
PATSAT	0.052	-0.251	-0.292	-0.148	-0.043	-0.218	-0.224	0.901				
RC	0.256	0.352	0.484	0.287	0.162	0.625	0.043	-0.156	1.000			
TPRE	0.207	-0.037	0.168	0.125	0.018	0.091	-0.394	0.086	0.054	1.000		
SIZE	-0.082	-0.031	0.174	0.014	-0.071	0.184	0.786	-0.203	0.141	-0.585	1.000	
USFL	0.142	0.105	0.555	0.458	0.074	0.384	0.092	-0.292	0.629	0.011	0.073	0.913

1. Square Root of AVE on Diagonal
2. COA = Consensus on Appropriation; DSU = Team Deep Structure Use of CPOE; EOU = Team Perceived Ease of Use; EXP = Team Average Experience with CPOE; FOA = Faithfulness of Appropriation; LOS = Patient Length of Stay; PATSAT = Patient Satisfaction with Care Team; RC = Team Relational Coordination; TPRE = Team Physician-Related Expertise; Size =Team Size; USFL= Team Perceived Usefulness

Table 27: Correlation Matrix -Knee Hip Replacement Hospital A (n = 37)

	AGE	COA	TEAM DSU	EOU	EXP	FOA	LOS	PAT SAT	RC	TPRE	TEAM SIZE	USFL
AGE	1.000											
COA	-0.171	0.955										
DSU	-0.038	0.661	1.000									
EOU	0.052	0.653	0.833	0.955								
EXP	0.472	-0.149	0.041	0.120	1.000							
FOA	-0.384	0.727	0.676	0.600	-0.058	0.955						
LOS	0.173	-0.014	0.061	-0.020	-0.099	-0.071	1.000					
PATSAT	-0.008	0.004	0.115	0.030	0.135	0.015	-0.010	0.955				
RC	-0.323	0.342	0.162	0.101	-0.233	0.238	0.058	0.236	1.000			
TPRE	-0.265	0.268	-0.078	-0.147	-0.261	0.093	-0.273	-0.097	0.331	1.000		
SIZE	0.313	-0.211	-0.044	-0.049	-0.015	-0.056	0.379	-0.278	-0.358	-0.445	1.000	
USFL	-0.271	0.504	0.703	0.702	-0.192	0.604	0.009	0.101	0.189	0.154	0.052	0.955

1. Square Root of AVE on Diagonal
2. COA = Consensus on Appropriation; DSU = Team Deep Structure Use of CPOE; EOU = Team Perceived Ease of Use; EXP = Team Average Experience with CPOE; FOA = Faithfulness of Appropriation; LOS = Patient Length of Stay; PATSAT = Patient Satisfaction with Care Team; RC = Team Relational Coordination; TPRE = Team Physician- Related Expertise; Size =Team Size; USFL= Team Perceived Usefulness

Table 28: Correlation Matrix - Cardiovascular Surgery (n = 44)

	AGE	COA	TEAM DSU	EOU	EXP	FOA	LOS	PAT SAT	RC	TPRE	TEAM SIZE	USFL
AGE	1.000											
COA	0.116	0.948										
DSU	0.070	0.672	1.000									
EOU	0.080	0.689	0.615	0.965								
EXP	-0.088	0.238	-0.018	-0.079	1.000							
FOA	0.119	0.803	0.671	0.665	0.028	0.944						
LOS	-0.073	0.006	-0.201	-0.002	-0.030	0.055	1.000					
PATSAT	-0.045	-0.104	-0.032	-0.266	-0.098	-0.043	-0.287	0.901				
RC	-0.240	0.316	0.371	0.393	0.091	0.269	-0.146	0.224	1.000			
TPRE	0.126	0.051	0.064	-0.059	-0.022	0.054	-0.624	0.068	0.094	1.000		
SIZE	-0.075	-0.079	-0.160	0.052	-0.033	0.004	0.885	-0.136	-0.038	-0.720	1.000	
USFL	0.215	0.691	0.677	0.678	-0.028	0.649	-0.012	-0.105	0.143	-0.113	0.067	0.948

1. Square Root of AVE on Diagonal
2. COA = Consensus on Appropriation; DSU = Team Deep Structure Use of CPOE; EOU = Team Perceived Ease of Use; EXP = Team Average Experience with CPOE; FOA = Faithfulness of Appropriation; LOS = Patient Length of Stay; PATSAT = Patient Satisfaction with Care Team; RC = Team Relational Coordination; TPRE = Team Physician- Related Expertise; Size =Team Size; USFL= Team Perceived Usefulness

Table 29: Correlation Matrix Organ Transplant (n = 34)

	AGE	COA	TEAM DSU	EOU	EXP	FOA	LOS	PAT SAT	RC	TPRE	TEAM SIZE	USFL
AGE	1.000											
COA	-0.121	0.980										
DSU	0.086	0.394	1.000									
EOU	-0.089	-0.220	-0.238	0.811								
EXP	0.656	-0.055	0.048	-0.112	1.000							
FOA	-0.051	0.656	0.542	-0.545	0.121	0.880						
LOS	-0.119	-0.010	0.135	0.076	0.002	0.105	1.000					
PATSAT	0.119	0.073	0.180	-0.053	-0.003	0.117	-0.110	0.933				
RC	-0.126	0.087	0.301	-0.215	-0.423	0.384	0.057	0.327	1.000			
TPRE	-0.044	0.250	0.293	-0.540	-0.382	0.443	-0.020	0.152	0.580	1.000		
SIZE	-0.148	0.007	-0.003	0.310	0.180	-0.039	0.848	-0.185	-0.210	-0.406	1.000	
USFL	0.375	0.374	0.238	-0.139	0.066	0.312	0.057	0.060	0.131	0.360	-0.044	0.941

1. Square Root of AVE on Diagonal
2. COA = Consensus on Appropriation; DSU = Team Deep Structure Use of CPOE; EOU = Team Perceived Ease of Use; EXP = Team Average Experience with CPOE; FOA = Faithfulness of Appropriation; LOS = Patient Length of Stay; PATSAT = Patient Satisfaction with Care Team; RC = Team Relational Coordination; TPRE = Team Physician- Related Expertise; Size =Team Size; USFL= Team Perceived Usefulness

Finally, with reliability, construct validity, and measurement invariance within acceptable norms, we report the final values reflected in the descriptive statistics, based on the changes made through the Measurement Invariance testing and trimming process (Tables 30-35).

Table 30: Vaginal Birth Descriptive Statistics Comparison (n = 52)

	Original		Trimmed	
Construct -Trimmed Measures (a)	Mean	Standard Deviation	Mean	Standard Deviation
Faithfulness of Appropriation (4)	5.862	0.336	5.869	0.319
Consensus on Appropriation (3)	5.705	0.332	5.721	0.332
Patient Satisfaction (3)	4.686	0.584	4.686	0.584
Relational Coordination (1) *	4.177	0.209	4.177	0.209
Deep Structure Use (1)*	5.422	0.44	5.422	0.44
Team Perceived Usefulness (4)	5.574	0.429	5.653	0.423
Team Perceived Ease of Use (3)	5.125	0.429	5.181	0.459

a) The number in the parenthesis represents the number of items in the scale, after completion of the trimming process.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 31: Pneumonia Descriptive Statistics Comparison (n = 21)

	Original		Trimmed	
Construct -Trimmed Measures (a)	Mean	Standard Deviation	Mean	Standard Deviation
Faithfulness of Appropriation (4)	6.12	0.218	6.163	0.243
Consensus on Appropriation (3)	5.915	0.223	5.918	0.232
Patient Satisfaction (3)	4.597	0.707	4.597	0.707
Relational Coordination (1) *	4.196	0.114	4.196	0.114
Deep Structure Use (1)*	5.579	0.253	5.579	0.253
Team Perceived Usefulness (4)	6.045	0.325	6.075	0.322
Team Perceived Ease of Use (3)	5.577	0.369	5.759	0.348

a) The number in the parenthesis represents the number of items in the scale, after completion of the trimming process.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 32: Hospital B Knee Hip Descriptive Statistics Comparison (n = 74)

	Original		Trimmed	
Construct -Trimmed Measures (a)	Mean	Standard Deviation	Mean	Standard Deviation
Faithfulness of Appropriation (4)	5.871	0.294	5.918	0.292
Consensus on Appropriation (3)	5.659	0.314	5.742	0.325
Patient Satisfaction (3)	4.653	0.547	4.653	0.547
Relational Coordination (1) *	4.062	0.172	4.062	0.172
Deep Structure Use (1)*	5.411	0.274	5.411	0.274
Team Perceived Usefulness (4)	5.88	0.303	6.001	0.282
Team Perceived Ease of Use (3)	5.424	0.277	5.589	0.275

a) The number in the parenthesis represents the number of items in the scale, after completion of the trimming process.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 33: Hospital A Knee Hip Descriptive Statistics Comparison (n = 37)

	Original		Trimmed	
Construct -Trimmed Measures (a)	Mean	Standard Deviation	Mean	Standard Deviation
Faithfulness of Appropriation (4)	5.905	0.484	5.922	0.472
Consensus on Appropriation (3)	5.834	0.403	5.819	0.406
Patient Satisfaction (3)	4.793	0.487	4.793	0.487
Relational Coordination (1) *	4.231	0.181	4.231	0.181
Deep Structure Use (1)*	5.403	0.338	5.403	0.338
Team Perceived Usefulness (4)	6.105	0.327	6.116	0.327
Team Perceived Ease of Use (3)	5.547	0.472	5.616	0.510

a) The number in the parenthesis represents the number of items in the scale, after completion of the trimming process.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 34: Cardiovascular Surgery Descriptive Statistics Comparison (n = 43)

	Original		Trimmed	
Construct -Trimmed Measures (a)	Mean	Standard Deviation	Mean	Standard Deviation
Faithfulness of Appropriation (4)	5.888	0.284	5.903	0.293
Consensus on Appropriation (3)	5.675	0.266	5.643	0.280
Patient Satisfaction (3)	4.692	.560	4.692	.560
Relational Coordination (1) *	4.123	.129	4.123	.129
Deep Structure Use (1)*	5.580	.273	5.580	.273
Team Perceived Usefulness (4)	5.627	0.415	5.690	0.394
Team Perceived Ease of Use (3)	5.050	0.389	5.193	0.393

a) The number in the parenthesis represents the number of items in the scale, after completion of the trimming process.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

Table 35: Organ Transplant Descriptive Statistics Comparison (n = 34)

	Original		Trimmed	
Construct -Trimmed Measures (a)	Mean	Standard Deviation	Mean	Standard Deviation
Faithfulness of Appropriation (4)	6.198	0.193	6.201	0.205
Consensus on Appropriation (3)	5.954	0.236	6.039	0.238
Patient Satisfaction (3)	4.833	0.397	4.833	0.397
Relational Coordination (1) *	4.357	0.110	4.357	0.110
Deep Structure Use (1)*	6.173	0.153	6.173	0.153
Team Perceived Usefulness (4)	6.121	0.347	6.202	0.384
Team Perceived Ease of Use (3)	5.324	0.400	5.452	0.400

a) The number in the parenthesis represents the number of items in the scale, after completion of the trimming process.
b) *Deep Structure Use and Relational Coordination are formative constructs, and are comprised of (4) and (7) items composite scores computed as unit means.

5.1.6 Multicollinearity Assessment

We tested our model to ascertain the impact of multicollinearity on our results. Multicollinearity is the result of high correlations between latent exogenous constructs in the theoretical model (Grewal et al., 2004). The presence of multicollinearity can lead to inaccurate estimates of coefficients and standard errors (Grewal et al. , 2004), and in some cases produce parameter estimates of incorrect sign and implausible magnitude (Obrien, 2002). To detect the level of multicollinearity in our results, we examined tolerances and variance inflation factors (VIF's) for each of the 11 independent variables in our model, across each patient condition.

Variance inflation factor results that exceed ten has been a widely used rule of thumb indicating excessive multicollinearity (O'brien, 2002). Across the models for all the patient conditions, there were only two instances where the results exceeded the threshold; the Team Size control variable for Organ Transplant (11.2), and the Team Size control variable for Pneumonia (10.8). The other VIFs for Organ Transplant ranged from 1.532 (Team DSU) to 8.608 (Length of Stay) and for Pneumonia ranged from 1.708 (Clinician Age) to 8.463 (Length of Stay). The VIF's for the other patient conditions were in acceptable thresholds (1.193 – 7.87) for Cardiovascular Surgery; (1.421 – 6.467) for Hospital A Knee/Hip replacement; (1.206 – 4.926 for Hospital B Knee/Hip replacement; (1.205- 3.961) for Vaginal Birth and (2.050 – 8.838) for combined Pneumonia and Organ Transplant).

We evaluated the reason for the two VIFs, one for the Organ Transplant model and the other for the Pneumonia model, that were above acceptable thresholds. Our models incorporated two distinct controls on PATSAT, patient length of stay, and team size. While the two constructs are conceptually unique, given that each additional day that the patient remains in the hospital requires an additional assigned night and day shift nurse, the two constructs are correlated. The correlation between team size and length of stay is 0.848 for Organ Transplant (Table 29) and 0.908 for Pneumonia (Table 25). One potential remedy would be to eliminate one of the highly correlated constructs from the model, and given that Team Size generated the highest VIF in five of the seven patient conditions, it would be the most likely candidate. As a test, we dropped Team Size from each patient condition, and reviewed the resulting VIF scores. The resulting *highest* VIF within each patient condition ranged from 2.529 (Years of CPOE Experience, Combined Pneumonia and Organ Transplant) to 6.157 (Perceived Ease of Use, Hospital A Knee/Hip replacement). Thus we would conclude that after the elimination of the Team Size construct, the resulting VIF's are acceptable. Rather than deleting Team Size from the models for all patient conditions altogether, we evaluated the impact of the deletion of the variable on the results for the Organ Transplant and Pneumonia conditions.

We compared the variance explained, magnitude and direction of the path coefficients, and the resulting significance of each focal construct – before and after Team Size was deleted from the models for Organ Transplant and Pneumonia conditions. We found no differences in the results for Pneumonia or Organ Transplant due to the deletion of the Team Size control. As a result, we concluded that we would maintain the Team Size control in the model, and report results accordingly.

5.2 Common Method Bias

Common method bias is considered a major threat to construct validity, and it is the result of the simultaneous measurement of the independent and dependent variables within the same instrument (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Our study relies on clinician surveys for the independent variables, and a separate 3rd party patient satisfaction survey of perceived quality of care, completed by the patient, for the dependent variable. Therefore the independent and dependent variables are collected separately from two instruments, as well as from a completely different set of respondents. The separation of the survey data to two independent sources eliminates the principal source of common method bias, and is a major strength of this research study design.

5.3 Method Selection for Hypotheses Testing

Once the measurement refinement and validation tests were completed, confirming that our reliability, construct validity, and measurement invariance tests were within an acceptable range, we tested the CPOE Coordination Effectiveness Model and hypotheses using structural equation modeling (SEM). Structural equation modeling techniques such as Covariance Based Structural Equation Modeling (CBSEM), and Partial Least Squares (PLS), enables the researcher to estimate the measurement model, and the structural model simultaneously, leading to greater accuracy over traditional linear regression techniques (Gefen, Straub, & Rigdon, 2011). Each of these methods has unique advantages depending on model specification.

One advantage of CBSEM based software programs such as LISREL and MPLUS, is that they allow the researcher to model measurement error variance, thereby isolating random measurement error (Gefen et al., 2011). Modeling measurement error, however, requires that each construct in the conceptual model is well established in the literature, whereas PLS is favored for more exploratory research involving newly created measures or constructs, or when using secondary or archival data (Gefen et al., 2011). Our model incorporates both previously validated measures, and newly created measures for the Deep Structure Use of CPOE construct which favors an exploratory, and therefore PLS based estimation.

While PLS has been favored in studies with small sample sizes, the extent of this advantage has been questioned (Gefen et al. 2011). However, in comparison to CB-SEM, PLS is expected to be more suitable for smaller sample sizes especially with increases in model complexity. Finally, PLS has fewer restrictions related to distributional assumptions. For all of the above reasons, PLS analysis was chosen to test the hypotheses.

5.4 Hypotheses Test Results

5.4.1 Descriptive Statistics

In Table 36 below, we report the descriptive statistics for each patient type. Average patient length of stay across the five conditions varied considerably, ranging from 2.1 days for vaginal birth, to 8.4 days for cardiovascular surgery. Given that each patient is typically assigned a nurse (RN) for the day shift, as well as the night shift, there is a direct correlation to the patient length of stay and the average team size. As a result, the Organ Transplant and Cardiovascular Surgery teams were also on average significantly larger than the Vaginal Birth teams, averaging 10.4 and 14 clinicians per team, compared to just 5.6 for the Vaginal Birth. Longer stays may factor in the coordinating benefit of the technology, as the time investments from entering patient data early in the patient care process, provide a benefit over a longer duration. Additionally, for larger teams, the technology could provide an enhanced coordinating benefit as multiple clinicians can simultaneously access the patient record, unlike its paper chart counterpart.

Team average age across the two sites was 43 years, with a range from 38.8 years on the

Cardiovascular Surgery teams, to 46 years on the of Knee/Hip replacement teams. Team average age on the Cardiovascular Surgery units was the lowest, perhaps due to higher turnover brought on by the higher stress of caring for the Cardiovascular Surgery patients; many cardiovascular surgery patients were cared for by clinical teams on the ICU and CCU units. The Knee/ Hip replacement teams were typically comprised of longer term employees, which is supported by the higher levels of experience with the CPOE system at both Hospital A (6 years) and Hospital B (5.4 years), compared to Pneumonia teams at 3.9 years' worth of CPOE experience. Given that the CPOE system was implemented at Hospital B in 2007, most of the respondents to the Knee/Hip replacement survey had been with Hospital B since the Go Live date of 02/01/2007. Overall experience with the CPOE system across the two sites was quite high, ranging from 3.9 years for Pneumonia clinicians at Hospital B, to 6 years for the Organ Transplant and Knee /Hip replacement teams at Hospital A. The healthcare environment is staffed by predominately female clinicians, with the average team at the two hospitals comprised of 82% women.

Table 36: Team Descriptive Statistics

	Hospital A			Hospital B		
	Organ Transplant	Cardiovascular Surgery	Knee/Hip Replacement	Knee/Hip Replacement	Pneumonia	Vaginal Birth
# of Qualifying Teams Total n = 261	34	43	37	74	21	52
# of Respondents Total n = 555	79	162	45	63	121	85
Average Team Size	10.4	14	6.8	7.5	8.8	5.6
Length of Stay (Days)	5.8	8.4	3	3.1	4.9	2.1
Team Average Age YRS	43.5	38.8	45.5	46	38.9	41.7
Team Gender Proportionality (Female)	75%	80%	76%	84%	86%	89%
Team Experience With CPOE (YRS)	6.0	5.2	6.0	5.4	3.9	4.2

5.4.2 Hypotheses Test Results

For each of the hypotheses, we conducted a separate PLS analysis for each patient condition. We report the standardized path coefficients, standard errors, and level of significance for the control variables in Table 37 below, and the equivalent results for the focal constructs in the model in Table 38 below. To calculate the standard errors and T statistics for each of the patient conditions, we used standard PLS bootstrapping functionality, with the number of bootstrap samples set to 500.

The impact of the controls on our model varies across patient conditions. While Team Perceived Usefulness (PU) of CPOE is not significant for Organ Transplant or Pneumonia, as expected, Team PU was still the most consistent control on Team DSU, exerting a significant positive path coefficient on four of the six models. The other TAM variable PEOU, was not significant in five of the six conditions, which is consistent with prior research in a HIT context (Holden & Karsh, 2010). Team Average Age and Average Team Experience with CPOE is not significant in five of the six conditions, and path coefficients that are significant are modest (Team Average Age .081 *), (Team Experience with CPOE -.163*). Finally the Team Physician-Related Expertise (TPRE) path coefficients were significant in all three conditions at Hospital B.. The paths were negative for Vaginal Birth and Pneumonia and were positive Hospital B Knee/Hip teams suggesting that TPRE can lead to either more or less DSU depending upon the specific context.

With respect to controls on PATSAT, we expected that Team size could imply that additional resources were applied to the patient care process, thereby boosting the PATSAT score. Team Size, however, was only significant on one patient condition Cardiovascular Surgery (.469 *). Likewise, Patient Length of Stay (LOS) was only significant for two conditions, Vaginal Birth

Teams (-.193 *) & Cardiovascular Surgery Teams (-.708 ***), signifying that in this context patients were less satisfied with their care the longer they stayed in the hospital.

Table 37 Summary of Control Variable Path Coefficients

Path	Hospital A			Hospital B		
	Organ Transplant	Cardiovascular Surgery	Knee/Hip Replacement	Knee/Hip Replacement	Pneumonia	Vaginal Birth
AVE AGE → DSU	0.258 (.166) NS	0.081 (.047)*	0.084 (.070) NS	-0.105 (.161) NS	0.050 (.109) NS	-.001 (.078) NS
EXP YRS → DSU	-0.146 (.151) NS	-0.060 (.100) NS	0.011 (.061) NS	-0.163 (.091)*	-0.146 (.088) NS	-0.023 (.061) NS
TPRE → DSU	.064 (.176) NS	.097 (.059) NS	-.091 (.078) NS	.175 (.094)*	-.326(.124)**	-.279 (.067) ***
EOU → DSU	.133 (.258) NS	.094 (.094) NS	.416 (.111)***	-.044 (.085) NS	.115 (.171) NS	-.127 (.080) NS
USFL → DSU	-.063 (.232) NS	.358 (.096) ***	.247 (.108) **	.484 (.104) ***	-.212 (.171) NS	.423 (.093) ***
SIZE → PATSAT	-0.002(.267) NS	0.469 (.261) *	-0.257 (.102) NS	-0.005 (.180) NS	0.106 (.171) NS	-0.119 (.125) NS
LOS → PATSAT	-.140(.179) NS	-.708 (.255)***	.075(.078) NS	-.191(.166) NS	.238 (.226) NS	-.193 (.097) *

a) Standardized coefficients are reported.
b) *** p<.01, ** p<.05, * p<.10, NS: Not significant.
c) P values are represented by two tailed tests.

Table 38: Path Coefficients

Path	Hospital A			Hospital B		
	Organ Transplant	Cardiovascular Surgery	Knee/Hip Replacement	Knee/Hip Replacement	Pneumonia	Vaginal Birth
H1: FOA → DSU	0.595 (.129) ***	0.220 (.125)**	0.205 (.089) **	0.259 (.118) **	0.387 (.164)**	0.444 (.082) ***
H2: COA → DSU	0.064 (.140) NS	0.202 (.152) *	0.156 (.081) **	0.166 (.105) *	0.446 (.268) **	0.175 (.109) *
H3: DSU → PATSAT	0.107 (.143) NS	-0.174(.062) ***	0.079 (.097) NS	-0.260 (.110) **	0.393(.064)***	-0.004 (.102) NS
H4: RC → PATSAT	0.302 (.123)***	0.203 (.131) *	0.127 (.139) NS	-0.021 (.107) NS	0.414 (.145) ***	0.082 (.10) NS
$DSU\ r^2$	.335	.584	.766	.492	.440	.754
$PATSAT\ r^2$	.134	.190	.11	.123	.257	.076

Notes:
a) Standardized coefficients are reported.
b) *** p<.01, ** p<.05, * p<.10, NS: Not significant.
c) P values are represented by one tailed tests given directional hypotheses.
d) Numbers in parenthesis represent standard errors.

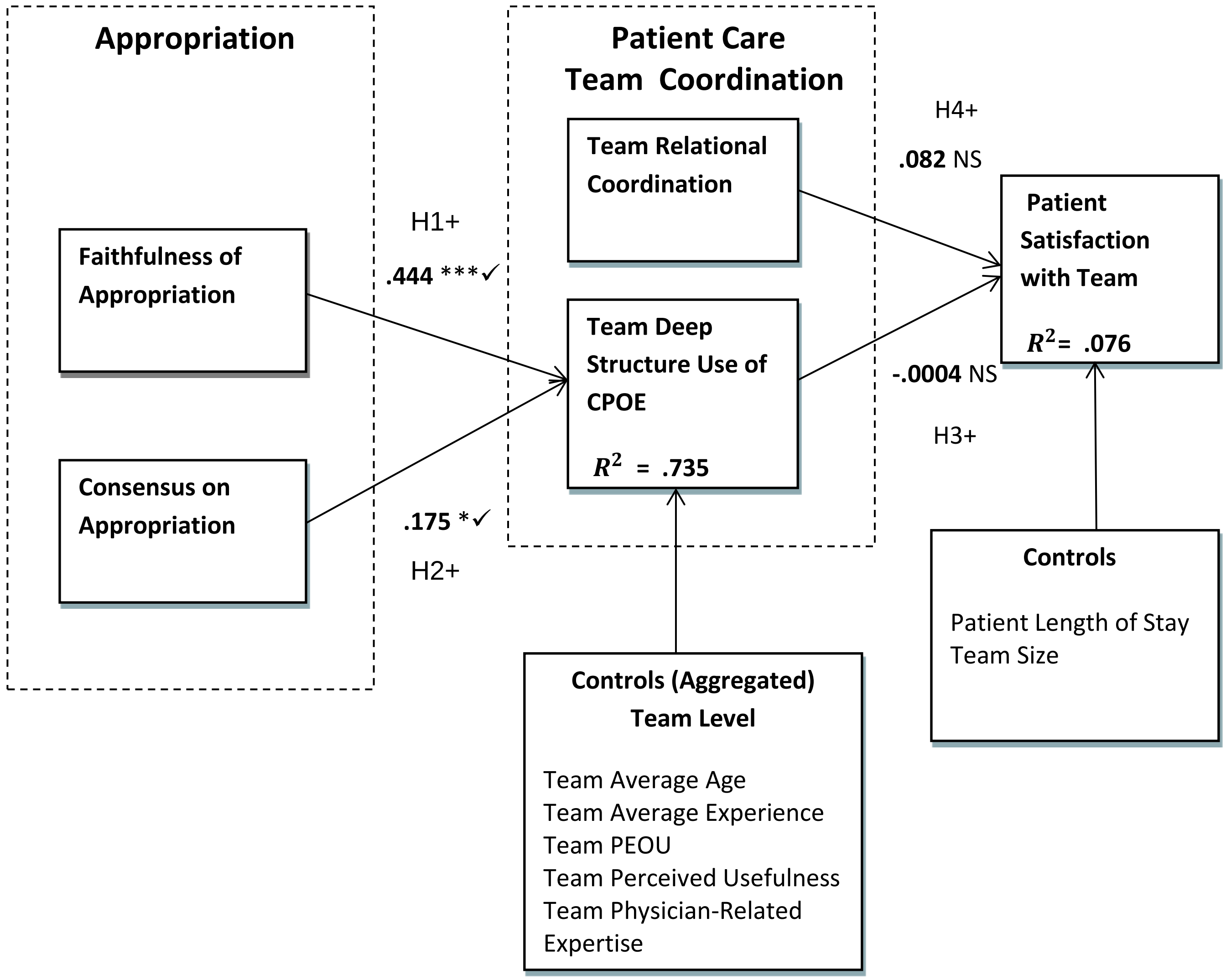

Figure 3: Results Vaginal Birth Hospital B (n =55)

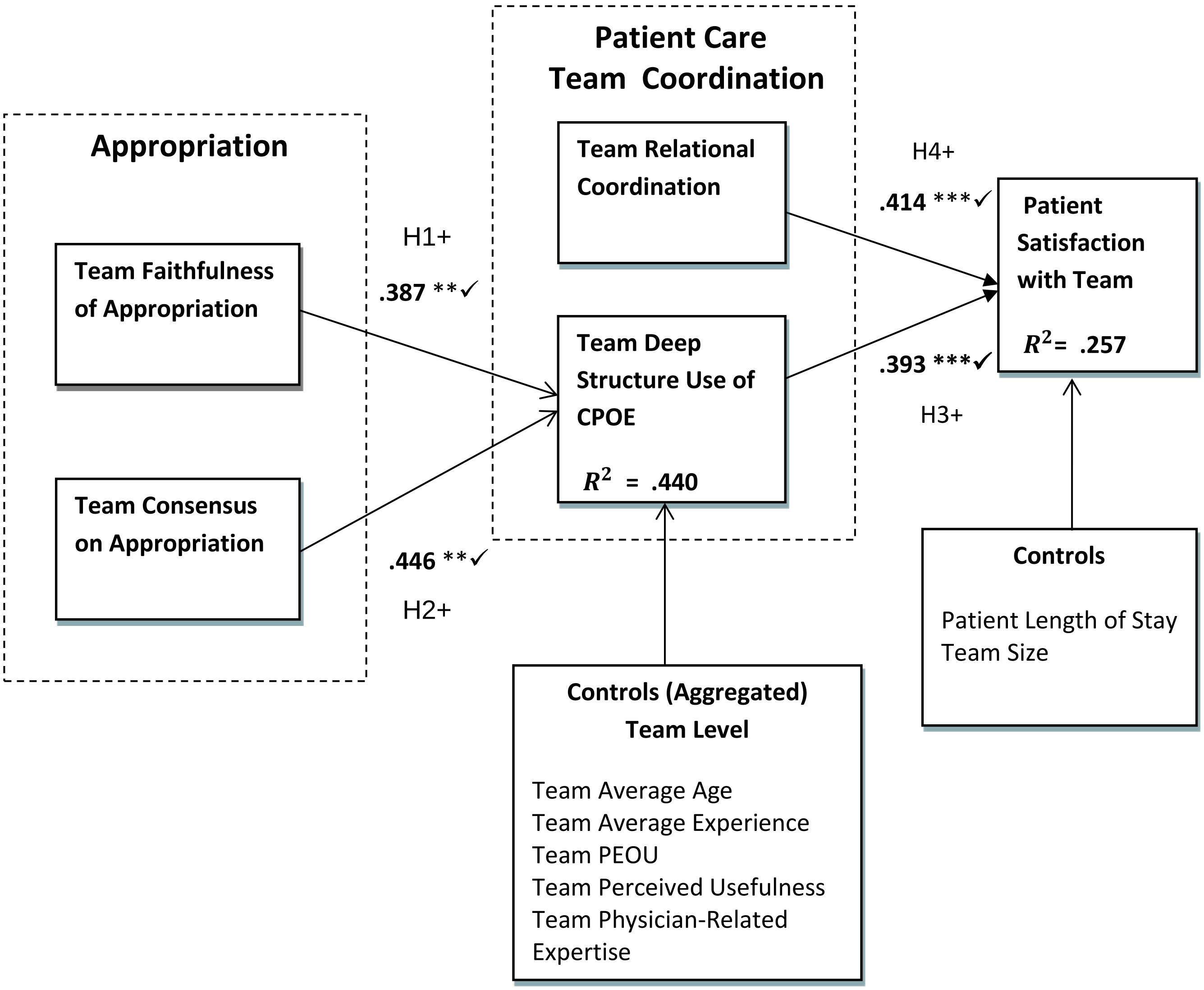

Figure 4: Results Pneumonia (n =21)

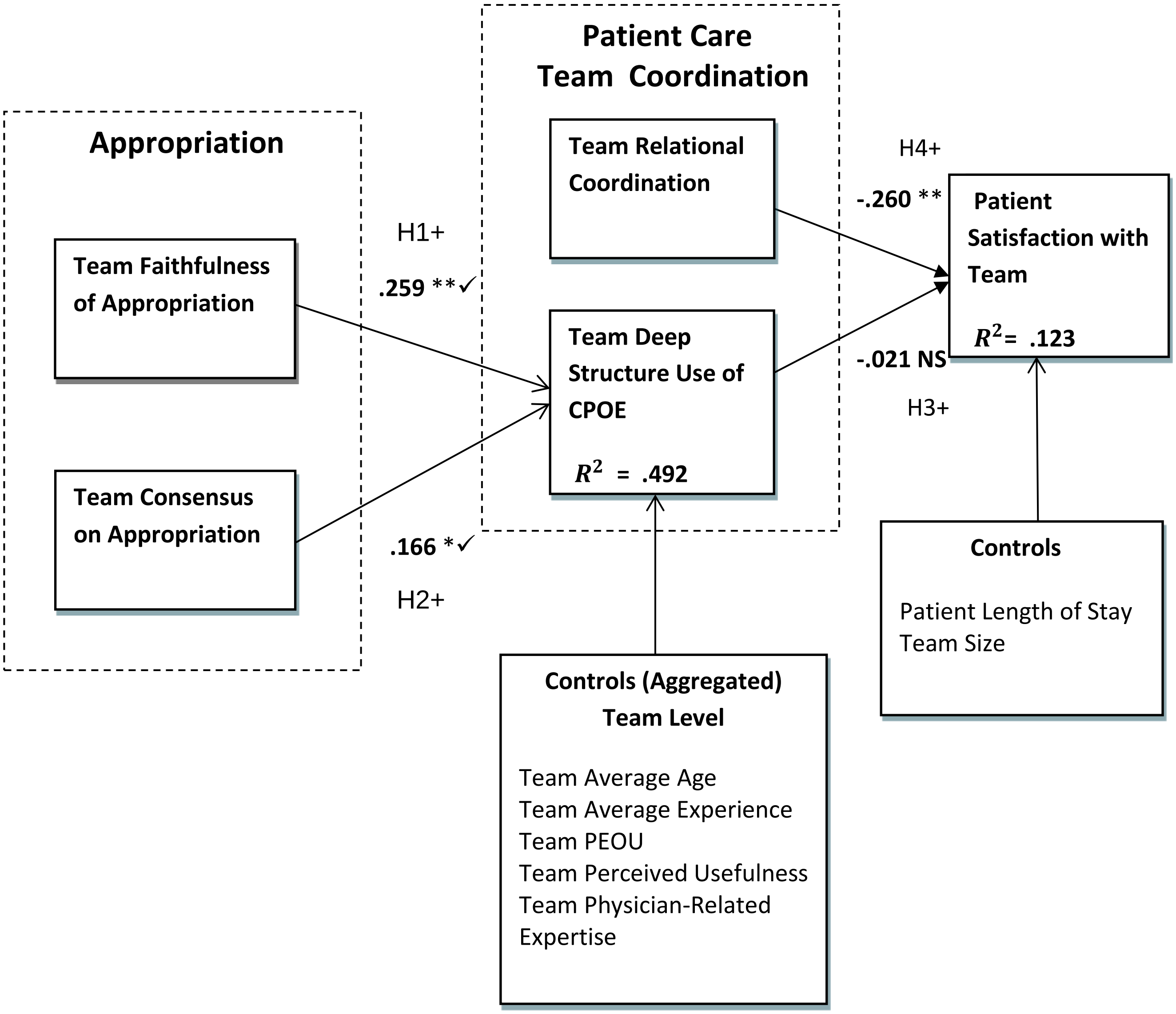

Figure 5: Hospital B Knee Hip Replacement Results (n=74)

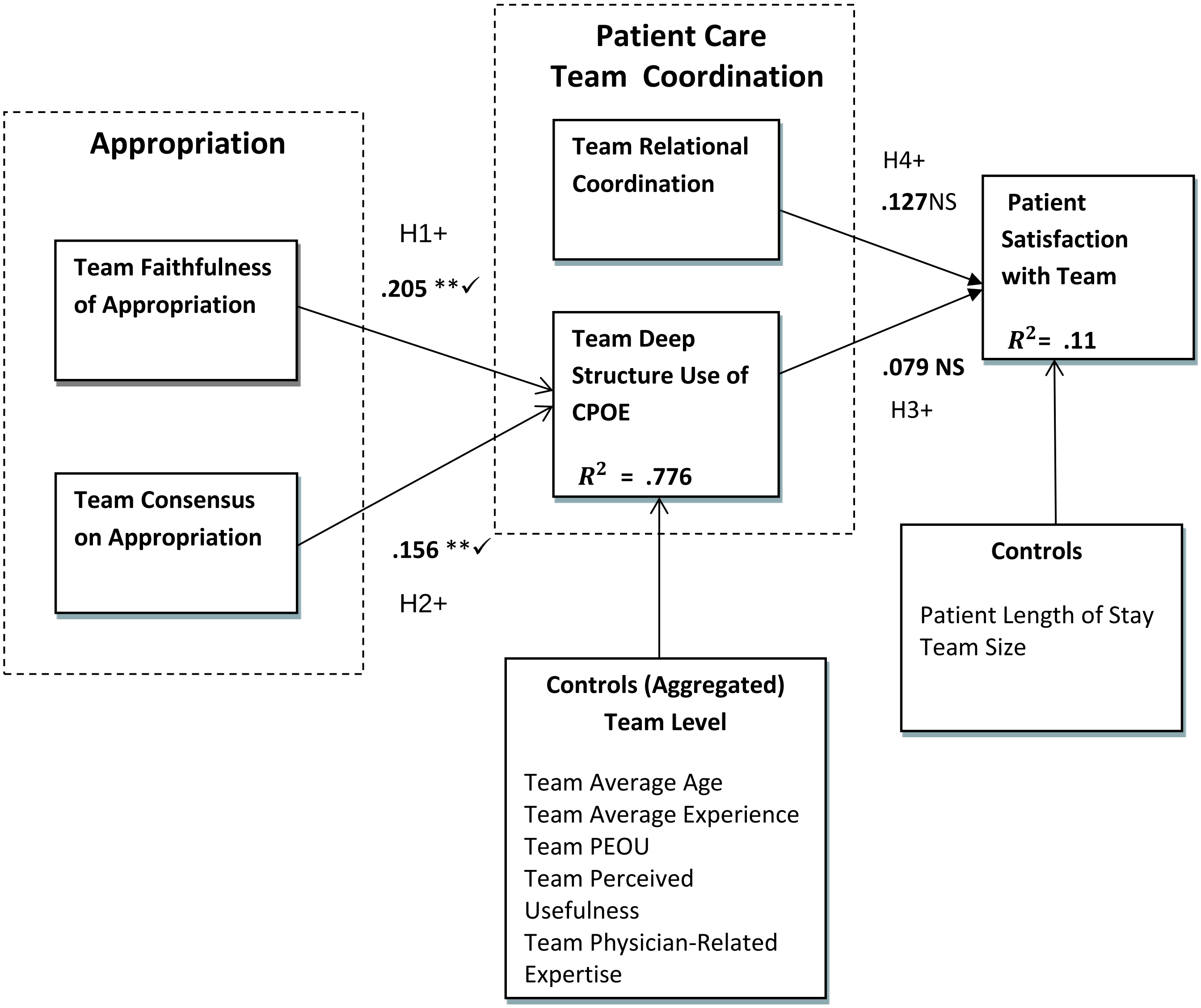

Figure 6: Hospital A Knee Hip Replacement Results (n =37)

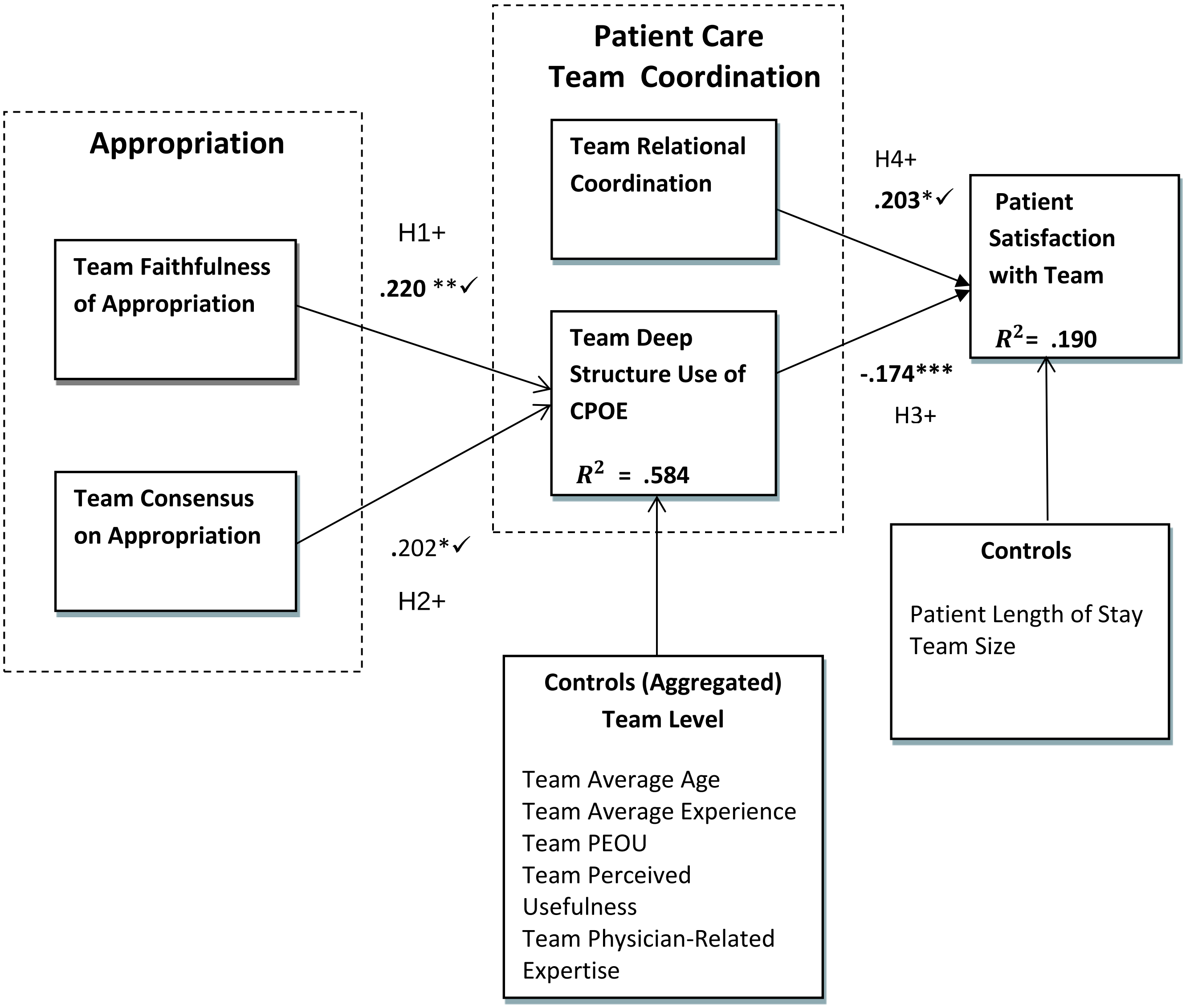

Figure 7: Results Cardiovascular Surgery (n = 43)

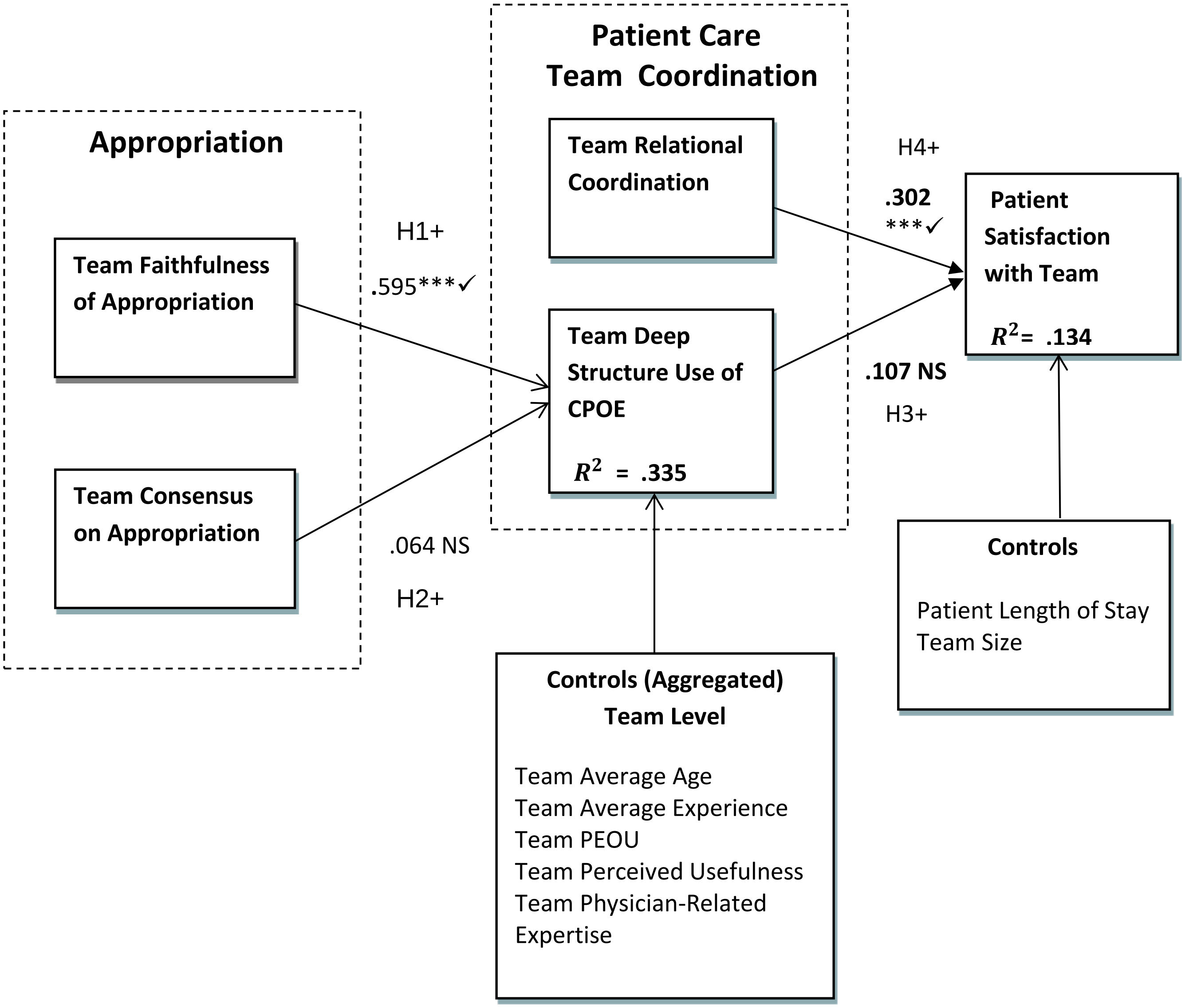

Figure 8: Results Organ Transplant (n = 34)

Two patient conditions have a positive path coefficient between Team DSU of CPOE and Patient Satisfaction with the clinical team, namely Pneumonia, and Organ Transplant. While the two patient conditions themselves are not homogeneous, engagement with the CPOE system by members of these clinical teams, including the responsible physician was comprehensive. Organ transplant teams were the only group of clinicians across the two hospitals to consistently maintain digital progress notes. Pneumonia patients were predominately cared for by hospitalist physicians, and as hospital employees, they are generally expected to enter orders on behalf of their patients. As a result, Organ Transplant and Pneumonia Teams reported the highest levels of Faithfulness of Appropriation, as well as the highest levels of Team DSU of CPOE. Given that the Organ Transplant and Pneumonia teams displayed similar use patterns, and that the sample sizes were small (33 and 21 respectively), we combined the two patient conditions and reported the psychometric properties below in Table 39, and the path coefficient outcomes in Figure 9.

Table 39: Organ Transplant Plus Pneumonia (n = 55) Trimmed Measures

	Trimmed Measures		
Construct (Trimmed Measures)	Composite Reliability	Cronbach's Alpha	AVE
Faithfulness of Appropriation (4)	.935	.908	.783
Consensus on Appropriation (3)	.959	.940	.887
Patient Satisfaction (3)	.951	.923	.866
Relational Coordination (1) *	NA	NA	NA
Deep Structure Use (1)*	NA	NA	NA
Team Perceived Usefulness (4)	.963	.961	.868
Team Perceived Ease of Use (3)	.962	.941	.894
Team Gender Proportionality (Female) (1)	NA	NA	NA
Team Ave. Experience with CPOE (YRS)	NA	NA	NA
Team Average Age (YRS)	NA	NA	NA
Length of Stay (Days)	NA	NA	NA

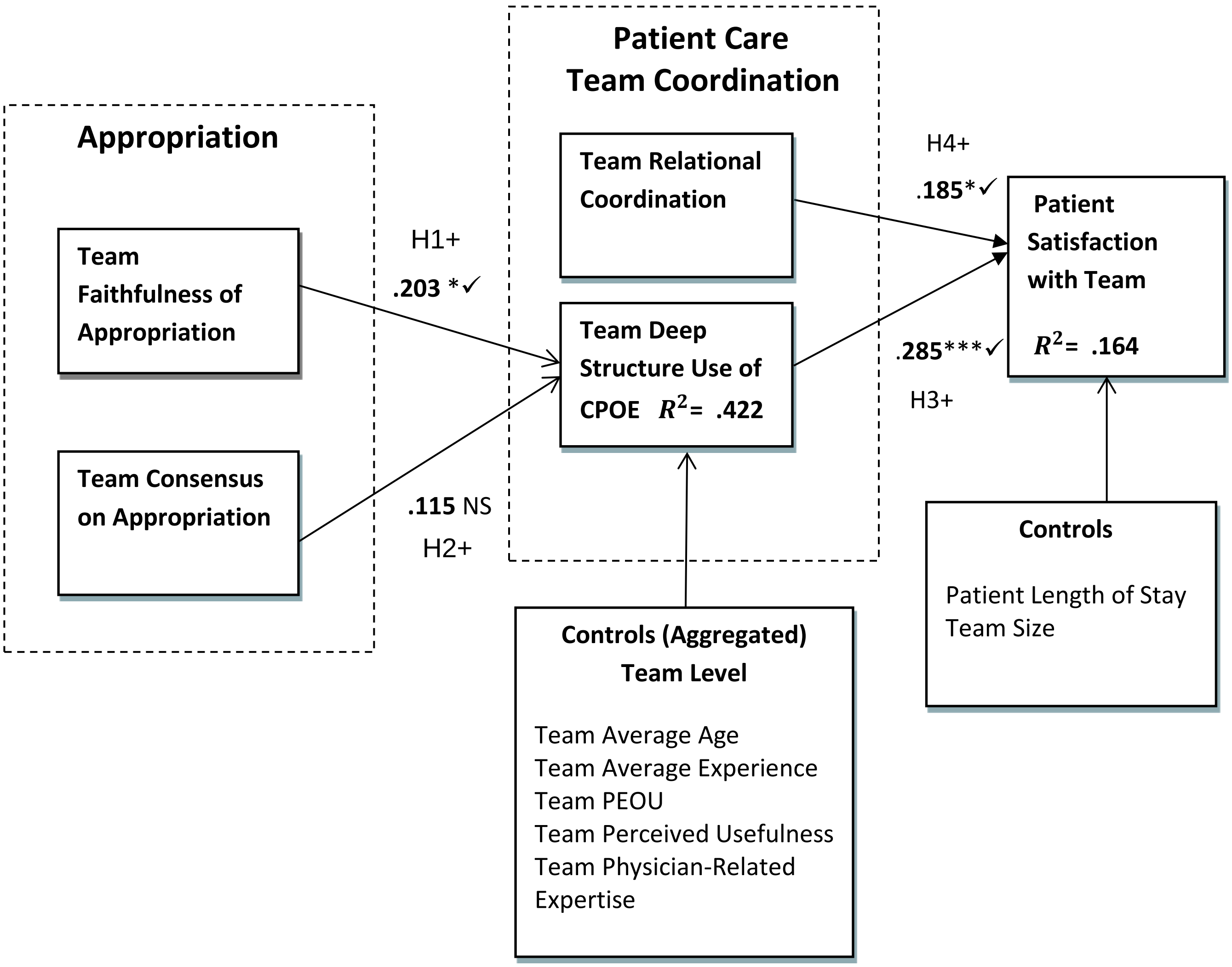

Figure 9: Results Organ Transplant Plus Pneumonia (n =55)

A summary of the hypotheses tests performed on the CPOE Coordination Effectiveness Model is presented in Table 40 below. Further discussion of these results, and their implications, occurs in Chapter 6. Next we present the results of our mediation tests, followed by the results of the hypotheses tests on the moderated model.

Table 40 Summary of Hypotheses Tests

Hypotheses		Hospital A			Hospital B		
	Organ Transplant + Pneumonia	Organ Transplant	Cardiovascular Surgery	Knee/Hip Replacement	Knee/Hip Replacement	Pneumonia	Vaginal Birth
H1: FOA will have a positive direct effect on Team DSU of CPOE	Supported	Supported	Supported	Supported	Supported	Supported	Supported
H2: COA will have a positive direct effect on Team DSU of CPOE	Not Supported	Not Supported	Supported	Supported	Supported	Supported	Supported
H3:Team DSU of CPOE will have a positive direct effect on Patient Satisfaction (PATSAT) with the care team	Supported	Not Supported	Not Supported	Not Supported	Not Supported	Supported	Not Supported
H4:Team Relational Coordination will have a positive direct effect on Patient Satisfaction with care team	Supported	Supported	Supported	Not Supported	Not Supported	Supported	Not Supported

5.4.3 Mediation Tests - CPOE Coordination Effectiveness Model

Our conceptual model incorporates Team Deep Structure Use acting as a mediating variable between the independent variables (FOA) and (COA) and the dependent variable PATSAT with the Care Team. Team DSU of CPOE can be said to act as a mediator when the following conditions exist: (1) variations in FOA and COA will significantly account for variation in Team DSU, (2) Subsequent variation in DSU will significantly account for variation in the dependent variable Patient Satisfaction with the Care Team, and 3) when controlling for the mediated path, the direct path between FOA and COA on Patient Satisfaction is no longer significant (Baron &

Kenny, 1986).The strongest case is made by a fully mediated model where the direct path between the antecedents (FOA, COA) and the dependent variable is reduced to zero.

Referring to Figure 10 below, using the Causal Steps approach established by Baron & Kenny (1986), requires that path a, b and c be significant, and for c' to be smaller than c (Baron & Kenny, 1986; Preacher & Hayes, 2008). More recent studies have suggested that the total effect of the independent variable on the dependent variable, as denoted by path c, does not require significance for mediation to occur (Collins, Graham, & Flaherty, 1998; MacKinnon, Krull, & Lockwood, 2000; Preacher & Hayes, 2008; Shrout & Bolger, 2002). This resulting approach from removal of the restriction of a required significant path c can be simply referred to as the revised Baron and Kenny Causal Steps Approach. Mediation can also be evaluated using the Product of Coefficients approach, which incorporates the use of the Sobel's test (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002; Sobel, 1982). We conducted the mediation analysis using (a) the Revised Baron and Kenny Causal Steps Approach, (b) and the Product of Coefficients Approach incorporating the Sobel's test while incorporating all constructs and controls in the model. Finally, we classified the results as no mediation, indirect-only or full mediation, competitive mediation, or complementary mediation (Zhao, Lynch, & Chen, 2010).

We conducted the mediation tests using PLS results from 500 bootstrapping samples to generate the standardized path coefficients and standard errors. For each mediation test, Team DSU of CPOE was incorporated as a composite, and the final trimmed measures for the antecedents FOA and COA were utilized. For the Sobel test, we are required to use unstandardized estimates, whereas PLS provides standardized estimates for all path coefficients (Bontis, Booker, & Serenko, 2007; Preacher & Leonardelli, 2003). To convert to unstandardized estimates, we multiplied the standardized coefficients by the standard deviation of the dependent variable PATSAT, and then divided by the standard deviation of the independent variables, FOA and COA (Bontis et al., 2007).

From Table 41, the results suggest that for all patient conditions, path a, which represents the effect of the independent variable FOA on Team DSU of CPOE, have significant t statistics. With respect to path b, which represents the effect of the mediator Team DSU of CPOE on the dependent variable PATSAT with the Care Team while partialling out the effect of the independent variable FOA, the results are mixed. For the Vaginal Birth, and the Organ Transplant conditions, the resulting t statistic is not significant, and therefore when using the Causal Steps procedure for these conditions, there are no significant mediation effects carried through Team DSU of CPOE from the independent variable (FOA) to the dependent variable, PATSAT with the care team.

From Table 41, the results suggest that for the Pneumonia, combined Pneumonia and Organ Transplant, Cardiovascular Surgery, and Hospital A and B Knee Hip Replacement patient conditions, Team DSU mediates the relationship between the independent variable (FOA) and the dependent variable PATSAT with the Care Team, as both a and b paths are significant. The final determinant is the difference between the total effect of FOA on PATSAT, denoted by path c, and the direct effect of FOA on PATSAT through Team DSU of CPOE, denoted as path c' (Preacher & Hayes, 2008).

Starting with Hospital B Knee/Hip replacement, we note that path c is (-0.105) and is not significant, whereas the direct path c' is reduced to (-0.088), and remains non-significant. Therefore based on the Causal Steps approach, we could conclude full mediation for this patient condition. After review of the Sobel test result of 2.81 which is also significant, the final disposition would remain as full mediation for this patient condition.

Moving to the Organ Transplant plus Pneumonia, we report in Table 41 that path c, reflecting the total effect of FOA on PATSAT with the Care Team, is (-0.112) and not significant, and after inclusion of the mediator, Team DSU of CPOE, the path coefficients of c' are (-0.170) and the results remain non-significant. Considering the Product of Coefficients approach and the significant Sobel test score of 3.173 we conclude that there is support for a full mediation claim for the Organ Transplant plus Pneumonia teams.

Considering the Cardiovascular Surgery teams, we report in Table 41 that path c, reflecting the total effect of FOA on PATSAT with the Care Team, is (.110) and not significant, and after inclusion of the mediator, Team DSU of CPOE, the path coefficient of c' barely changes to (0.116) and the results remain non-significant. The Sobel test score is (-2.48) and is significant; therefore we conclude that the results provide support for a full mediation claim on the Cardiovascular Surgery Teams.

For the Hospital A Knee/Hip replacement teams, we note that path c is (-0.163) and significant, whereas the direct path c' is marginally reduced in magnitude to (-0.160), yet remains significant in the presence of the mediator. The Sobel test result is 1.83 which is also significant. Given that the direct path is reduced in magnitude but remains significant, and that the Sobel test supports a mediation claim, we report partial mediation for this patient condition. Moreover, we find that the direct path is negative while the mediated path is positive (as both a and b are positive), suggesting competitive mediation and the likelihood of other mediators (Zhao et al., 2010).

Finally, we consider the Pneumonia patient type for mediation. The total effect path coefficient of FOA on the dependent variable PATSAT, as represented by path c is (.245) and it is not significant. The direct effect in the presence of the mediator, as measured by c', is substantially reduced in magnitude to (-0.348) with a t statistic of 3.09 which represents significance at the .01 level. The subsequent Sobel test is by far the strongest across the various patient conditions, at 6.03. Given that the direct effect is reduced in magnitude yet remains significant, and that the Sobel test supports a mediation claim, we report partial mediation for the Pneumonia patient type. Additionally, given that the direct path is negative while the mediated path is positive (as both a and b are positive), suggesting competitive mediation and the likelihood of other mediators (Zhao et al., 2010).

Next we review the mediation tests for the impact of the second antecedent independent variable Consensus on Appropriation and report the results in Table 42. Starting with the Causal Step approach, the results suggest that for path a, which represents the effect of COA on Team DSU of CPOE, only the Vaginal Birth, and the Hospital A and B Knee Hip replacement teams have path coefficients with significant t statistics. With respect to path b, which represents the effect of the mediator Team DSU of CPOE on the dependent variable PATSAT with the Care Team while partialling out the effect of the independent variable COA, the results are also mixed. Only the Hospital A and B Knee Hip replacement, Pneumonia, and the Organ Transplant plus Pneumonia teams have significant t statistics. As a result, only the Hospital A and Hospital B Knee Hip Replacement teams are eligible candidates for mediation, as these teams have significant results for both path a and b.

Starting with Hospital B Knee/Hip replacement, we note that path c is (-0.2122) which is significant, whereas the direct path c' is marginally reduced to (-0.2118), and remains significant. The subsequent Sobel test is 2.206 and is significant. Given that the direct effect is reduced in magnitude yet remains significant, and that the Sobel test supports a mediation claim, we report partial mediation for the Hospital B Knee/Hip patient condition. Since the direct path is negative while the mediated path is positive (Path A COA to Team DSU is positive), suggesting competitive mediation and the likelihood of other mediators (Zhao et al., 2010).

For Hospital A Knee/Hip replacement, path c is (-0.096), and not significant, while the direct path c' is a larger negative path coefficient at (-0.292) and it is significant. The subsequent Sobel test is 1.762 and is significant. Given that the direct effect is significant, and that the Sobel test supports a mediation claim, we report partial mediation for the Hospital B Knee/Hip patient condition. Additionally, given that the direct path is negative while the mediated path is positive (path a and path b are positive), suggesting competitive mediation and the likelihood of other mediators (Zhao et al., 2010).

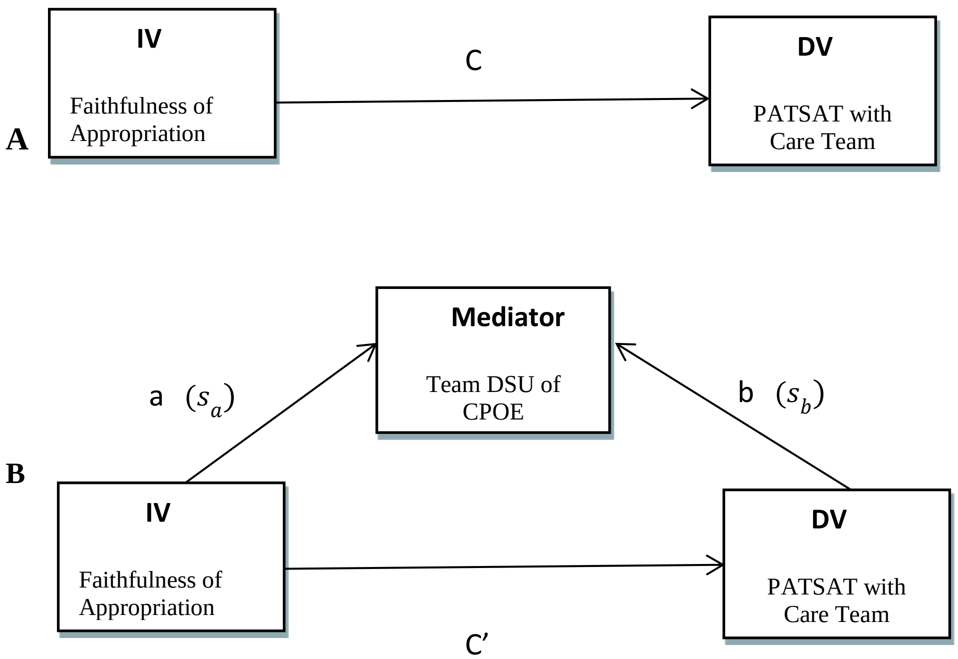

Figure 10 – Mediation Test

Table 41- Mediation Results – Standardized Coefficients- Faithfulness of Appropriation

Construct		Hospital A			Hospital B		
Faithfulness of Appropriation	Organ Transplant plus Pneumonia n = 55	Organ Transplant n =34	Cardiovascular Surgery n = 44	Knee/Hip Replacement n = 37	Knee/Hip Replacement n = 74	Pneumonia n=21	Vaginal Birth n = 52
a FOA>DSU	0.202*	0.612***	0.220**	0.205***	0.254**	0.387**	0.443***
b DSU>PAT	0.342***	0.137 NS	-0.254**	0.189**	-0.231**	0.555***	0.048 NS
c FOA >PAT	-.112 NS	0.056 NS	0.100 NS	-0.163**	-.105 NS	0.245 NS	.138 NS
c' FOA> PAT with mediator	-.170 NS	-.064 NS	0.116 NS	-.160 *	-.088 NS	-.348***	-.077 NS
(s_a)	0.127	0.1359	0.128	0.081	0.110	0.172	0.078
(s_b)	.126	0.1524	0.138	0.098	0.123	0.085	0.109
Sobel Test	3.173	2.223	-2.48	1.83	2.816	6.03	0.577
One Tailed	0.001	0.0131	0.007	0.0336	0.002	0	0.282
Mediation	Full	No	Full	Partial/ Competitive	Full	Partial/ Competitive	No

a) *** p<.01, ** p<.05, * p<.10, NS: Not significant.
b) P values are represented by one tailed tests given directional hypotheses
c) Sobel tests were calculated using unstandardized coefficients

Table 42- Mediation Results – Standardized Coefficients - Consensus on Appropriation

Construct		Hospital A			Hospital B		
Consensus on Appropriation	Organ Transplant plus Pneumonia n = 55	Organ Transplant n =34	Cardiovascular Surgery n = 44	Knee/Hip Replacement n = 37	Knee/Hip Replacement n = 74	Pneumonia n=21	Vaginal Birth n = 52
a COA>DSU	0.122 NS	0.064 NS	0.203 NS	0.156**	0.164*	0.359 NS	0.175 *
b DSU>PAT	0.287 ***	0.106 NS	-0.158 NS	0.262***	-0.209**	0.323***	0.121NS
c COA>PAT	.009 NS	.006 NS	-.064NS	-.096 NS	-.2122 ***	.165 NS	-.288*
c' COA> PAT with mediator	.006 NS	.003 NS	-.024 NS	-.292***	-.2118***	.153 NS	-.234**
(s_a)	0.132	0.140	0.162	0.088	0.101	0.289	0.122
(s_b)	0.108	0.137	0.129	0.084	0.111	0.110	0.095
Sobel Test	1.937	0.694	-1.813	1.762	2.206	3.269	1.401
One Tailed	0.026	0.243	0.0349	0.039	0.014	0.005	0.081
Mediation	No	No	No	Partial/ Competing	Partial/ Competing	No	No

a) *** p<.01, ** p<.05, * p<.10, NS: Not significant.
b) P values are represented by one tailed tests given directional hypotheses
c) Sobel tests were calculated using unstandardized coefficients

In summary, we conducted a number of mediation tests, including the canonical Baron and Kenny and Sobel tests. When all constructs and controls are included in the mediation test, for the independent variable FOA we find support for full mediation for the Organ Transplant plus Pneumonia, Cardiovascular Surgery, and Hospital B Knee Hip replacement teams, and partial/competitive mediation for the Pneumonia, and Hospital A Knee Hip replacement teams. Considering the COA independent variable, we find support for partial/competitive mediation for the Hospital A and B Knee/Hip replacement teams.

5.4.4 Moderated CPOE Coordination Effectiveness Model

Results for the *moderated* CPOE Coordination Effectiveness model are presented in Table 45, and Figure 11 and 12 below. The task interdependence and task uncertainty constructs were measured using an expert panel. The expert panel consisted of three members of the clinical leadership at the hospital(s), including the Chief Medical Officers at each site, and the Chief Medical Information Officer. Based on our definition of task uncertainty, which is the relative variability and difficulty associated with the performance of the task, the panel was asked to rate the level of task uncertainty of each of the 5 patient conditions as a composite of the difficulty associated with performing the standard care protocol, and of the variability of patient outcomes (Gittell, 2002; Malone & Crowston, 1994; Van de Ven et al., 1976). Secondly, the expert panel was asked to rank the level of task interdependence inherent to the clinical pathway for each of the five patient conditions. Contrasting levels of task interdependence from parallel, to sequential, to mutual adjustment (Malone & Crowston, 1994; Thompson, 1967) formed the basis of the ratings. Each member of the expert panel was provided definitions of the task interdependence levels, as well as supporting clinical examples to help explicate the terms.

Each member of the panel was provided with a description of task uncertainty and task interdependence, and asked to rate each patient condition according to a seven point scale. Scores were then averaged, and the lowest and highest conditions according to the task uncertainty dimensions were loaded to test the moderation effects of task uncertainty and task interdependence on patient satisfaction. For instance, for task uncertainty, team scores for Knee/Hip replacement, and Organ Transplant were loaded, with knee/hip replacement task uncertainty rated at 3.3, and Organ Transplant rated at 6.3. For task interdependence, team scores for Pneumonia and Organ Transplant were loaded with task interdependence rated at 4.3 and 6.7 respectively. For each moderation variable created in PLS, the indicator values were standardized prior to multiplication.

Table 43: Task Uncertainty Expert Panel

	Task Uncertainty				
	Vaginal Birth	Pneumonia	Knee Hip Replacement	Cardiovascular Surgery	Organ Transplant
Respondent 1	5	4	5	7	7
Respondent 2	2	3	3	5	6
Respondent 3	5	5	2	3	6
Mean	4.0	4.0	3.3	5.0	6.3

Table 44: Task Interdependence Expert Panel

	Task Interdependence Ratings				
	Vaginal Birth	Pneumonia	Knee Hip Replacement	Cardiovascular Surgery	Organ Transplant
Respondent 1	5	4	5	7	7
Respondent 2	7	5	6	7	7
Respondent 3	4	4	5	6	6
Mean	5.3	4.3	5.3	6.7	6.7

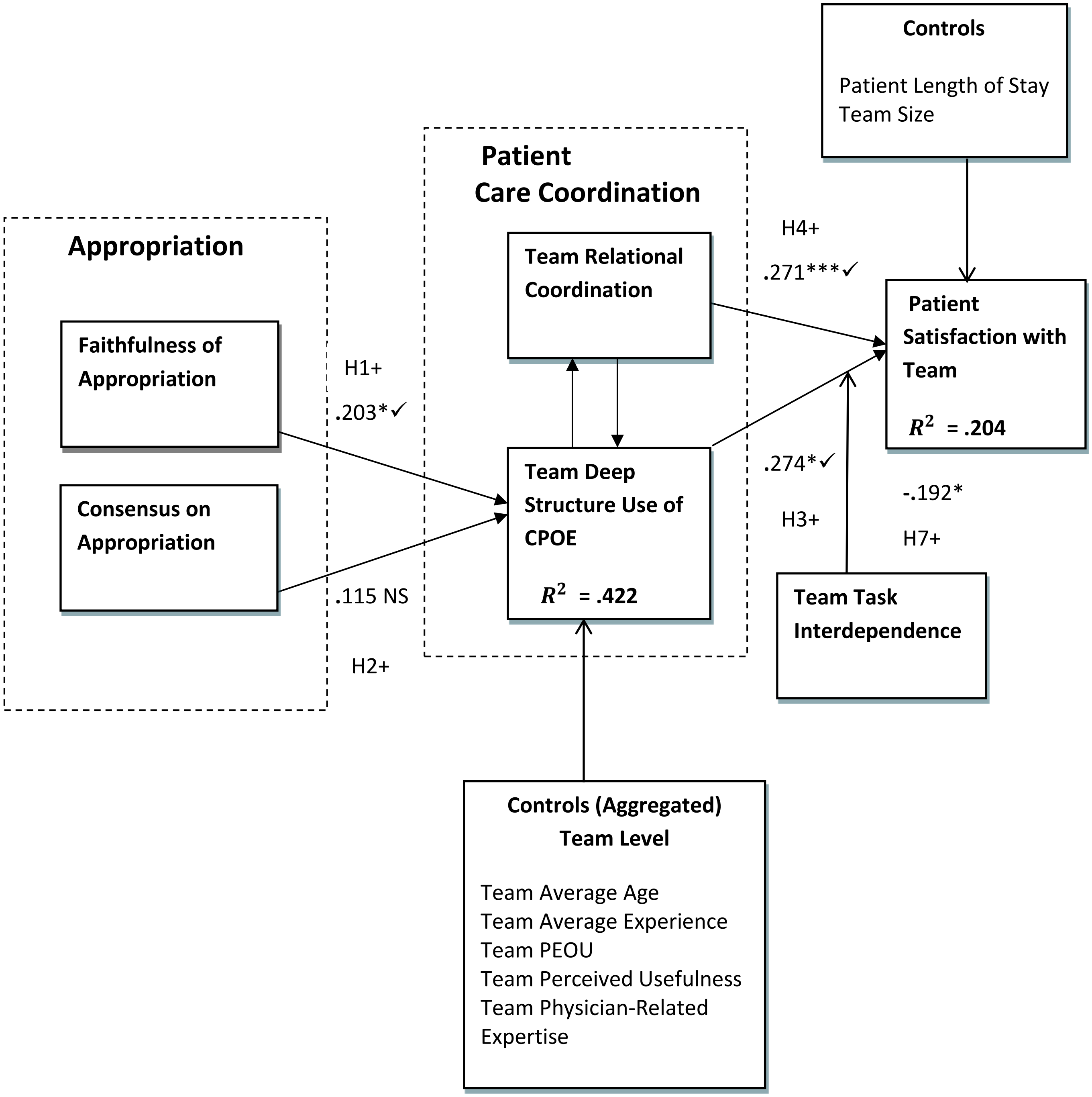

Figure 11: Moderation Task Interdependence

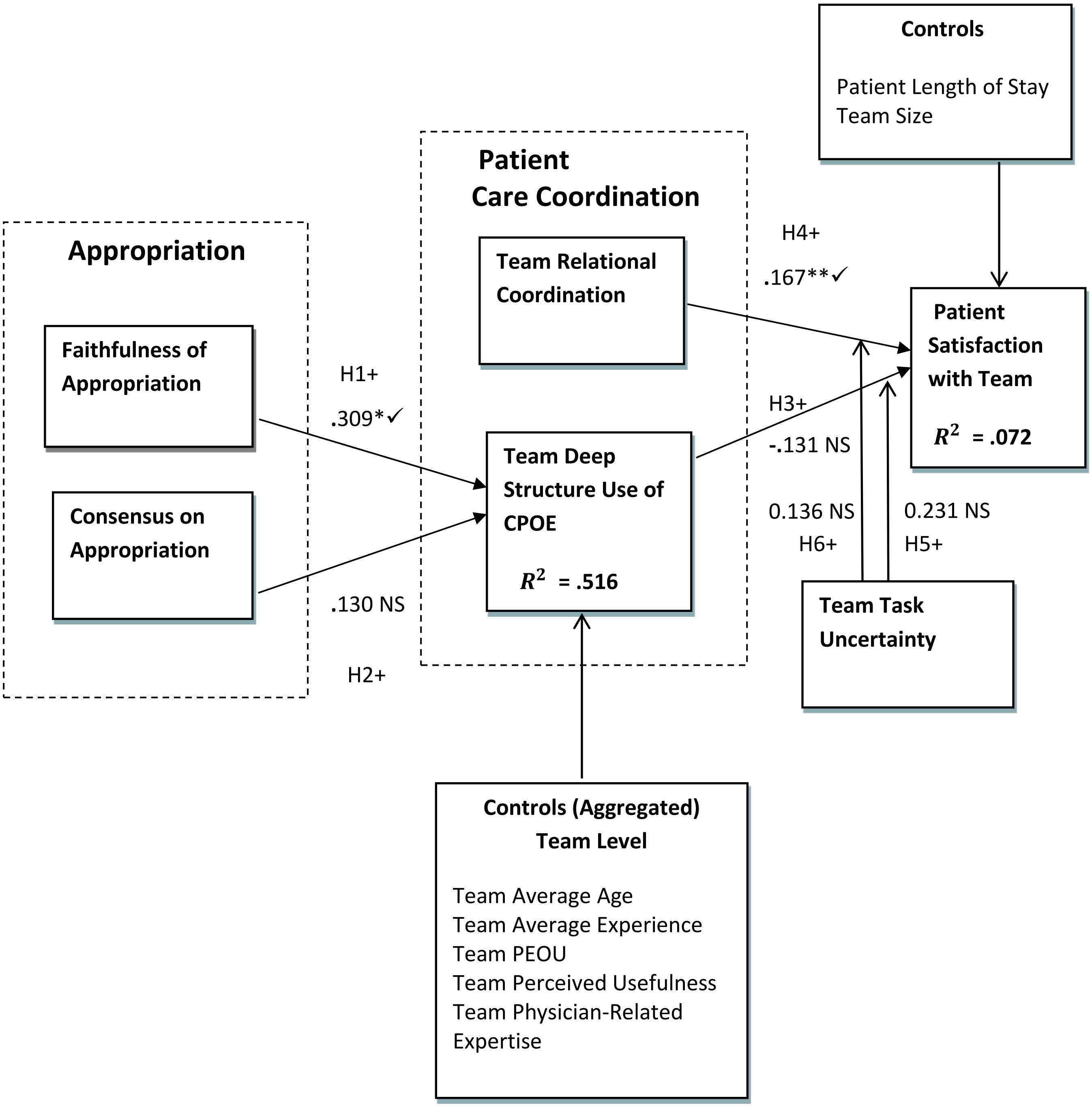

Figure 12: Moderation Task Uncertainty

Table 45: Moderated Model Results

	Task Interdependence			Task Uncertainty		
Path	Path Coefficient	Standard Error	Hypothesis Supported	Path Coefficient	Standard Error	Hypothesis Supported
H1: FOA → DSU	.203 *	.126	Yes	.309*	.090	Yes
H2: COA → DSU	.115 NS	.127	No	.130*	.090	Yes
H3: DSU → PATSAT	.274*	.175	Yes	-.131 NS	.202	No
H4: RC → PATSAT	.271***	.110	Yes	.167*	.127	Yes
H5: DSU*Uncert → PATSAT	NA	NA	NA	.231 NS	.333	No
H6: RC* Uncert → PATSAT	NA	NA	NA	.136 NS	.141	No
H7: DSU*Interd → PATSAT	-.192*	.138	No, negative	NA	NA	NA
H8: DSU*RC → PATSAT	-.189 NS	.210	No	-.045 NS	.206	No
$DSU\ r^2$	.422			.516		
$PATSAT\ \ r^2$	.215			.072		

a) Standardized coefficients are reported.
b) *** p<.01, ** p<.05, * p<.10, NS: Not significant.
c) P values are represented by one tailed tests given directional hypotheses.

Table 46 Summary of Moderation Hypotheses Tests

Hypotheses	Support
H5: The relationship between Team DSU of CPOE and Patient Satisfaction with Care team will be negatively moderated by task uncertainty, such that Patient Care teams with high task uncertainty will derive a diminished benefit from CPOE	Not Supported
H6: The relationship between Relational Coordination and Patient Satisfaction with Care Team will be positively moderated by task uncertainty	Not Supported
H7: The positive relationship between Team DSU of CPOE and Patient Satisfaction will be positively moderated by Task Interdependence, such that Patient Care teams with reciprocal relationships in their clinical workflow will exhibit higher PATSAT	Not Supported
H8: The interaction between Team DSU of CPOE and Relational Coordination will positively impact Patient Satisfaction with the team	Not Supported

CHAPTER 6- Discussion and Conclusions

6.1 Interpretation of Results

Rather than reviewing and interpreting the results for each patient condition, we grouped conditions and highlight the key findings according to their relevance and contribution. Below we interpret results sequentially according to our eight hypotheses, followed by theoretical and practical contributions, limitations, and suggestions for future research.

6.1.1 Interpreting H1 (FOA → DSU) Results Across Patient Conditions

We expected that clinical teams that reported higher levels of Faithfulness of Appropriation, would also report higher levels of Team Deep Structure Use of CPOE, implying a positive path coefficient across all patient conditions. Our results support H1 across all patient conditions. The standardized path coefficients for all patient conditions are positive, and significant, ranging from (0.595) for organ transplant, to (0.220) and (0.205) for Cardiovascular Surgery and Knee/Hip replacement at Hospital A. Therefore we find Faithfulness of Appropriation as a salient predictor of Team DSU of CPOE in an extended use environment, as the variance in the adoption of the structures provided by the CPOE system across patient conditions covaried with FOA.

Contrasting the mean scores for FOA across patient conditions, we find support for the theoretical argument that high FOA corresponds with greater adoption of the IT across the entire clinical team, including the responsible physician. For instance, the high FOA mean score

(6.203), and highly significant path coefficient (.595) for the Organ Transplant group was not a surprise, as throughout the hospital this group was recognized as having the most complete digital patient record. For Organ Transplant teams, vital signs were maintained digitally, and electronic progress notes were created by physicians and mid-levels with a high degree of frequency. A nurse from outside the Transplant unit that had provided services to Organ Transplant patients commented, “When I call a Transplant physician to add or change an order, it shows up immediately. It’s like their computer is joined at the hip.” Nurses from within the Organ Transplant unit commented that they were concerned when Organ Transplant patients were transferred to other units, based on their perception that other floors might be less diligent with their engagement with the electronic patient record and corresponding decision support. “We have had some patients transferred off the Transplant unit and they come back with a flu shot. Transplant patients can’t have anti-viral medications for six months prior, or after surgery, because their immune system is suppressed.” Presumably the CPOE decision support system would have alerted the clinician to the risks of administering a flu shot to a transplant patient. For the Organ Transplant group, the survey data supporting the high FOA, and subsequent high Team DSU, was also substantiated by the qualitative assessment of comments made by clinical staff during the survey collection process. Their overall appropriation of the CPOE system would be characterized as Faithful rather than Unfaithful, as their collective appropriation of the system was closely aligned with the spirit and general intent of the IS (DeSanctis & Poole, 1994).

Similar to the Organ Transplant patient care teams at Hospital A, the Pneumonia care teams at Hospital B also reported Faithful Appropriation of the CPOE system. Their overall mean team FOA score was the second highest, only slightly behind Organ Transplant, at 6.163, and with a standardized path coefficient from FOA to Team DSU of CPOE that was (0.387) and significant. For the pneumonia teams, most of the physicians were hospitalists, who were employed by the hospital and therefore more likely to engage with the CPOE system (Davidson & Chismar, 2007). While the responsible physician was highly involved with the CPOE system on Pneumonia teams, digital progress notes were not commonly utilized by this group, but overall appropriation would still be characterized as faithful.

For the Cardiovascular Surgery and the Knee/Hip replacement teams at Hospital A and B, most of the orders in the CPOE system were entered by a clinician other than the responsible physician, customarily by the mid-level. Often the nurses on these teams would comment that they had never seen the surgeons enter anything into the clinical system. One anonymous Cardiovascular Surgery nurse commented, " I just couldn't throw them (Surgeons) under the bus, because they are supposed to enter orders. So I might have bumped up their usage numbers a little on the survey." For the Cardiovascular Surgery teams, vital signs were maintained manually on *paper* charts while patients were on the ICU and CCU, and then digitally when transferred to nursing units associated with lower acuity patients. Also, digital progress notes were uncommon for Cardiovascular Surgery or Knee/Hip Replacement teams at either hospital. Given that the surgeons across these two patient conditions were not typically engaged with the CPOE order entry system, coupled with the inconsistent recording of vital signs on the cardiovascular care nursing units (Unfaithful Use), overall appropriation of the IS includes elements of Faithful and Unfaithful Use. As a result, the mean scores for FOA were lower than average for these teams; Hospital A Knee Hip (5.922), Hospital B Knee Hip (5.918), and Hospital A Cardiovascular Surgery (5.903), and the standardized path coefficients were (.205),

(.259), and (.220), respectively. Yet for all patient conditions, the path coefficient from FOA to Team DSU of CPOE was significant, thereby demonstrating strong support for H1.

6.1.2 Interpreting H2 (COA → DSU) Results Across Patient Conditions

We expected that clinical teams whose members reported higher levels of Consensus on Appropriation would also report higher Team Deep Structure use of CPOE. In accordance with Adaptive Structuration Theory, teams that can agree on how to use a technology to support their work, achieve better outcomes (DeSanctis & Poole, 1994). Conversely, in environments where Consensus on Appropriation is not reached, the effective *coordination* of users' collective efforts may prove to be challenging, thereby leading to unfavorable outcomes (DeSanctis & Poole, 1994; Salisbury et al., 2002). As expected, the standardized path coefficients between Consensus on Appropriation and Team Deep Structure Use of CPOE were all positive, and with the exception of the Organ Transplant team, all of the results were significant. The range of values for the standardized path coefficients were from (0.064) for Organ Transplant, to (0.446) on Pneumonia patient teams. Therefore we also find Consensus on Appropriation as a salient predictor of Team DSU of CPOE in an extended use environment, as the variance in the adoption of the structures provided by the CPOE system across *most* of the patient conditions covaried with COA.

Contrasting the mean scores for COA across patient conditions, we find less consistent support for the theoretical argument that high COA corresponds with greater adoption of the IT across the entire clinical team. Mean COA scores range from 5.643 on the Cardiovascular Surgery teams, to a high of 6.039 on the Organ Transplant teams. Paradoxically, the Organ Transplant teams had the highest COA mean scores, but were the only patient condition where COA was not a significant predictor of Team DSU of CPOE. For the Organ Transplant group, the strength of the association with other antecedents to DSU (particularly FOA) coupled with a modest standard deviation (.238), may partially explain the non-significance of the COA to DSU path. For Pneumonia teams, which reported the second highest COA mean scores at 5.918, these teams reported the highest standardized path coefficient at 0.446 which was also significant.

Consensus on Appropriation by its nature implies Use of an IS, and more importantly Use by a collective; in a clinical setting the notion that no individual is an island, and adoption and use of a technology are highly influenced by relevant others (Jasperson, Sambamurthy, & Zmud, 1999; Salisbury et al., 2002) is especially salient. In an extended use environment where universal adoption of CPOE orders across all units and patient conditions is present, capturing nuanced collective team use of specific advanced *features and functionality* of the technology provides deeper insights into the theoretical, and practical implications of group level technology appropriation.

Further research using actual archival use data may statistically uncover the source of the non-significant path for Consensus of Appropriation on Team Deep Structure Use within the Organ Transplant group; the integration of digital progress notes in the clinical process, and responsibility for progress note entry into the system for this particular patient condition likely played an important role. Though the clinicians on the Transplant unit were demonstrably committed to the Faithful Appropriation of the CPOE technology according to its spirit, through conversations with clinicians on the unit, progress note entry required a substantial time commitment. To reduce digital progress note entry time, several team members even mentioned that they had tried voice recognition software such as Nuance Dragon Medical. Dragon Medical is specifically programmed to understand medical terminology, and over time adapts to inflections in each user's voice. This software is able to convert recorded voice to free text, which can in turn populate specific fields in a clinical system such as progress notes. Yet despite the high level of adaptation to the medical field, clinicians on the Organ Transplant unit felt that the use of the Nuance Dragon software introduced more errors to the free text passage, requiring substantial editing and error checking, than the software offered in time savings through voice to digital text entry. Overall the clinicians on the unit were committed to a complete digital patient record, including digital progress notes, but were frustrated with an inability to quickly update the system. As a result, for the Organ Transplant group, overall perceptions of Consensus on Appropriation, and its subsequent influence on Team DSU were likely mitigated by the progress notes digital entry issues. Therefore other antecedents, most notably FOA, were more important antecedents to Team DSU of CPOE for Organ Transplant teams. For all other patient type teams, COA was a positive and significant predictor of Team DSU; albeit the overall size of the path coefficients, and the level of significance was lower than FOA, with the exception of Pneumonia teams.

6.1.3 Interpreting H3 (DSU → PATSAT) Results Across Patient Conditions

Our expectation was that higher levels of Team DSU of CPOE would have a positive effect on Patient Satisfaction (PATSAT) with Care team. Prior research consistent with this view included Sambamurthy and Chin (1994), Poole and DeSanctis (1992), and more recently Queenan et al. (2011) who posit that due to the codification of clinical processes through CPOE order sets, process improvements occur across the organization, leading to higher patient satisfaction overall. Our results with respect to this proposition are decidedly mixed, and in some cases contradictory. From Table 38 above, we report significant standardized path coefficients that range from negative (-.260) for Knee Hip Replacement Teams at Hospital B, to positive (.393) for Pneumonia Teams at Hospital B. We also report that Cardiovascular Surgery teams which achieved higher Team DSU scores, had lower patient satisfaction scores, as supported by a negative path coefficient that was significant (-.174). The results of Team DSU on Patient Satisfaction with the team were not significant for Vaginal Birth, Organ Transplant or Knee /Hip Replacement at Hospital A.

As expected, higher levels of Team DSU of CPOE by clinicians caring for Pneumonia and the combined Pneumonia and Organ Transplant patient conditions led to higher PATSAT. Clinicians from these teams utilized more of the advanced features of CPOE, as supported by their higher mean Team DSU composite scores, as well as the highest mean Faithfulness of Appropriation scores, suggesting that these teams appropriated the technology according to its spirit. By appropriating structures in a comprehensive manner across all roles, these clinicians were likely informed of the patient condition in a timely manner, and able to adapt to changes in patient trajectory when the need arose.

With respect to the unexpected negative path coefficients for the Cardiovascular Surgery and Hospital B Knee/Hip replacement patient conditions, we offer two perspectives. The first perspective entails an inconsistent integration of CPOE system across hospital units which may have affected some of the patient conditions negatively. Interpretation of the results requires the support of qualitative assessments of the CPOE system use across units, which was gathered during the survey collection process. One Hospital A nurse provided the following anonymous comment, “As a float pool nurse, comparing use of the system from unit to unit is like comparing apples to oranges.” For instance, while vital signs were maintained digitally in most units at Hospital A, on the ICU/CCU patient vitals were logged manually on paper charts in case the system went down. As a result, when a cardiovascular patient was transferred to and from the ICU/CCU units, their digital patient records were incomplete, negating the utility of the entry work of vital signs completed in other units of the hospital. The primary interface to the CPOE system on behalf of Orthopedic Surgeons for Knee/Hip Replacement at Hospital A and B, as well as the Cardiovascular Surgeons at Hospital A, was typically the mid-level physician assistant. While standard orders were entered for all patients, the consistency of the use of the error checking, decision support, vital sign maintenance and progress notes across team members was muted. One anonymous surgeon commented, “We only use CPOE and data viewing. We don’t enter documentation..… I believe alerts are ignored. No data. Just anecdotal observations.” Therefore the time expended by some team members engaged in Faithful Appropriation of the CPOE system may in fact be better spent on other tasks, such as an increased bedside presence, as the inconsistency of team appropriation across units, within a given patient type, may in fact impart a negative utility on higher Team DSU.

A second alternative explanation for the negative path coefficients revolves around the respective roles established within many of the surgery teams, and the operationalization of Team DSU. While the Pneumonia or Organ Transplant physicians were most likely to engage with the system to enter orders or progress notes, the Cardiovascular and Orthopedic Surgeons were most likely to delegate those tasks to an assigned Physician’s Assistant. This was especially true for the senior surgeons who handled the most volume of patients. While nurses/administrative staff are not trained to interpret and act upon the alerts triggered by interactions, mid-levels through their more extensive medical training would be able to interpret, and prescribe alternative medication or treatment protocols, and request physician support occasionally when required.

By design, clinicians were asked to report on each CPOE structure, including progress notes, use of clinical decision support, order entry and use of vital signs for monitoring according to the level of physician use, and secondly based on the level of overall team use, including the physician, nurses and mid-levels. As a result, on teams where the physicians were heavily engaged, these teams had a very high Team DSU, as the physician use was counted in both questions for each technology structure. For teams which relied on mid-levels for the CPOE interface in the clinical care process, the overall Team DSU scores would have been lower. The acronym CPOE originally stood for Computerized *Physician* Order Entry, based on the belief that physician entry was required to derive the maximum benefit from the system through the release of best practice orders and subsequent timely adjustment of patient care protocols through decision support. As a result, the operationalization of Team DSU was purposely aligned to reflect this desired work flow. Teams which include mid-levels in the CPOE work process, however, may have in fact had better overall outcomes with respect to PATSAT, as the responsible physician may have been able to divert time and attention to the patient themselves, while the mid-level was able to deftly attend to alerts, decision support or troubling vital sign progressions.

For Pneumonia teams at Hospital B, the responsible physician was typically a hospitalist, who was a hospital employee. On these Pneumonia teams, there *may* have been other physicians assigned to the team during the patient stay, but mid-levels were rarely part of the overall team membership. Therefore, unlike the Cardiovascular Surgery or Knee/Hip replacement teams with the presence of mid-level support, the delegation of CPOE entry tasks by the responsible physician would likely have fallen to a clinician who was unable to immediately act upon the clinical decision support without the subsequent intervention by a physician. As a result, order entry by nurses or clinical partners on Pneumonia teams impose an extra step in the patient care coordination process when alerts triggered required changes to the standard protocols. Therefore the coordinating benefits of CPOE system use for these teams would more closely align with the study design and operationalization of DSU of CPOE.

While team structure may have influenced the coordinating benefit of Team DSU of CPOE, the underlying complexity of the patient condition itself, as well as the average length of stay, seems to have impacted results. The path coefficient between Team DSU and Patient Satisfaction for the Vaginal Birth teams at Hospital B was not significant, and likewise, the path coefficient from Relational Coordination and Patient Satisfaction was not significant. Therefore the impact of both IT- enabled and Relational Coordination mechanisms in the context of patient care of vaginal birth patients is muted, and does not covary with patient satisfaction outcomes in our study. Given that Vaginal Birth patients have the lowest length of stay of just 2.1 days, and a standard deviation of (0.704), it would appear that the impact of IT-Enabled and Relational Coordination mechanisms might be limited by the short duration of the patient stay. Similarly, the knee hip replacement patients at Hospital A experienced on average a short length of stay (LOS) at 3.03 days, and limited variation in the LOS (SD = .372). For Hospital A Knee/Hip replacement teams, the path coefficients of Relational Coordination, and Team Deep Structure Use of CPOE on Patient Satisfaction were not significant. Therefore the impact of the coordinating benefit of Relational Coordination and IT-Enabled Coordination may be limited across some care teams by the condition itself. On the other hand, cardiovascular surgery patient care teams reported lower Faithfulness of Appropriation, Consensus on Appropriation and Team Deep Structure Use overall, and despite the longer LOS (8.4) and variability of LOS (SD= 3.24), the inconsistent application of the technology, or the implications of the role of the mid-level may have contributed to the negative path coefficient of Team Deep Structure Use on Patient Satisfaction.

6.1.4 Interpreting H4 (Relational Coordination → PATSAT) Results Across Patient Conditions

We expected that teams that reported higher Relational Coordination would leverage their ability to spontaneously coordinate when required, leading to higher patient satisfaction scores. Our results supported this proposition with a positive standardized path coefficient that was significant on three of the five patient conditions, including Pneumonia (.414), Organ Transplant (.302) and Cardiovascular Surgery (.203). The combined Pneumonia and Organ Transplant teams also reported a standardized path coefficient of (0.185) that was significant. Knee/hip replacement teams at Hospital A and B, and Vaginal Birth teams with higher reported Relational Coordination scores did not generate a benefit that was significant with respect to our dependent variable Patient Satisfaction.

Consistent with the results reported in H3, patient conditions reflecting a higher acuity level and corresponding longer duration of acute care, teams that reported higher Relational Coordination scores appear to have derived a larger benefit from their predisposition to spontaneously coordinate. The three conditions with the longest average hospital stay were Cardiovascular surgery (8.4 days), Organ Transplant (5.8 days) and Pneumonia (4.9 days), and the standard deviation of the length of stay on these conditions was also much more elevated than those of Knee/Hip replacement and Vaginal Birth patients. Therefore the likelihood of the need for spontaneous coordination by clinicians caring for a Cardiovascular Surgery or Organ Transplant patient would presumably be much higher than for a Vaginal Birth patient. As a result, we suggest that the coordinating benefit derived from a clinical team that is pre-disposed to leveraging their inherently stronger relationships in the event of a declining patient trajectory would also favor teams caring for higher acuity patient conditions. Our results appear to confirm this argument.

Isolating the Knee/Hip replacement patient teams, we expected that Relational Coordination would have a significant and positive effect on PATSAT, confirming the original Gittell (2002) results that were also based on providers caring for Knee/Hip replacement patients. While the Vaginal Birth and Hospital B Knee/Hip replacement teams had positive standardized path coefficients from RC to PATSAT, our results were not significant. One obvious difference in the Gittell (2002) study was that the n of the dependent variable PATSAT of knee/hip patients was 588, versus our study which incorporated 52 Vaginal Birth, 74 Hospital B Knee/Hip, and 37 Hospital A Knee/Hip PATSAT scores. While the overall R square associated with the Gittell (2002) model was similar at roughly 10% of PATSAT, the larger sample size likely aided the significance of the results.

Interpreting (H5-H8) Moderated Model Results

Detecting moderation in a theoretical model typically requires a large sample size to gain significance. We suspect that our modest sample size at the Team and Patient level played a role in the fact that most of our results from the Moderated CPOE Coordination Effectiveness Model were not significant. Future research initiatives which investigate similar propositions but incorporate larger sample sizes may in fact yield significant results.

6.1.5 Interpreting H5 (DSU*Uncertainty → PATSAT) Results

With respect to H5, our expectations were that patient conditions with higher levels of uncertainty would have a diminished effect resulting from the use of IT- enabled coordinating mechanisms, as protocols and routines have lower levels of information processing capacity, and are therefore less useful under conditions of uncertainty (Argote, 1982; Gittell, 2002). Thus, the use of standardized best practices embedded in order sets would require frequent amendments to standard protocols when caring for uncertain patient conditions. When required, enacting these protocol amendments across the clinical team would favor spontaneous coordination, rather than the formalized coordinating mechanisms associated with protocols and routines.

Our hypothesis was not supported as the standardized path coefficient of the moderator was in fact positive (.231), but not significant. Interpreting the positive path coefficient, our results may speak to the coordinating benefit of the *advanced* features such as decision support, rather than just the implementation of the order sets themselves. While the standard order sets are static, the alerts and decision support provide useful information to the clinical team for generating an alternative care path. Therefore testing for the efficacy of the advanced features of CPOE with larger samples may find significant path coefficients when engaged with patient conditions that are increasingly uncertain.

6.1.6 Interpreting H6 (Relational Coordination*Uncertainty → PATSAT) Results

As patient conditions increased with respect to task uncertainty, as rated by our expert panel, we expected that the performance effects of Relational Coordination would be amplified (Gittell, 2002). This was based on the expectation that on low uncertainty conditions, coordination could be achieved through programmed means in advance (Argote, 1982), more specifically, through pre-determined order sets established according to best practices. As the uncertainty level with respect to care of a patient type increases, then the likelihood of the occurrence of coordination requiring non-programmed means, whereby alternative protocols are worked on the spot by clinical team members, also increases. Thus, patient satisfaction ratings by patients from uncertain patient conditions were likely to favor teams pre-disposed to higher Relational Coordination scores. While the path coefficient of the moderation variable Task Uncertainty* Relational Coordination was positive (.136), the result was not significant. We suggest that the limited sample size, rather than alternative theoretical arguments was the most likely determinant of our non-significant results.

6.1.7 Interpreting H7 (DSU*Task Interdependence → PATSAT) Results

For H7, we expected that patient conditions with higher levels of task interdependence, as rated by our expert panel, would derive a greater coordinating benefit from the use of the technology (Gattiker & Goodhue, 2005). Coupled with our expectation that patient conditions with lower levels of task uncertainty would benefit the most from order set usage, we expected that surgical procedures with highly developed standardized procedures requiring mutual adjustment across clinician team members (i.e. Knee/Hip replacement), would also derive the greatest coordination benefit from use of the IT. Contrary to our expectations, results of the moderation effect indicated a *negative* path coefficient (-0.192), and the results were significant.

Our patient conditions incorporated in the moderation test for H7 were Pneumonia (low task interdependence), and Organ Transplant (high task interdependence). While our research team is not medically trained, we would certainly concur with the expert panel with respect to our perceived notion of the level of task interdependence involved in the care of Pneumonia versus Organ Transplant patients. Our results reinforce the views of early Coordination Theory research, which posits that standardized coordination mechanisms which utilize formalized protocols are only useful for tasks which are characterized by low levels of task interdependence (Argote, 1982; Galbraith, 1973; Van de Ven et al., 1976). Our hypotheses incorrectly sided with the contradictory, but more recent IS based research that suggested that the coordinating benefit of an IS increases as the level of task interdependence increases (Gattiker & Goodhue, 2005).

6.1.8 Interpreting H8 (DSU*Relational Coordination → PATSAT) Results

Our hypothesis stated that the interaction between Team IT Enabled and Relational Coordination mechanisms would positively impact Patient Satisfaction with the team. Prior research has shown that strong levels of communication and coordination exert positive effects on IS implementation success (Akkermans & van Helden, 2002) . While this site was an extended use environment, we expected that teams that communicate well and enjoy strong relationships should also gain the most advantage from extended use of an IT. Our hypothesis was not supported in either the Task Uncertainty or Task Interdependence moderated models. In fact the path coefficients of DSUCOMP*RCCOMP were (-.045) and (-.189) respectively, and neither path was significant in our study.

Our study attempts to incorporate long standing constructs in the Coordination Theory literature, namely Task Interdependence and Task Uncertainty, to explain variances regarding the impact of IT Enabled and Relational Coordination mechanisms on Patient Satisfaction. By using patient condition to establish differences across teams with respect to Task Uncertainty and Task Interdependence, we expected to gain insights into the benefits afforded by higher levels of use of a Health IT, as well as the impact of strong relationships and communications inherent to the teams of clinicians who provided care. We isolated the teams of clinicians to precisely those individuals who provided care to the patient respondent. Prior studies incorporating patient satisfaction as the dependent variable did not match actual usage patterns of a HIT (Queenan et al., 2011), or Relational Coordination scores of the actual team members who provided care (Gittell, 2002). While our design attempted to maximize the effect size of Task Uncertainty and Interdependence through maximally different patient conditions, our results may have been hampered by small sample sizes of patient care teams overall.

While our results were not significant with respect to moderation effects, the main effects, and in particular the antecedents to Team Deep Structure Use, as well as Relational Coordination on Patient Satisfaction did provide significant results under most patient conditions. What is also interesting is that the patient care teams in the organ transplant and pneumonia teams derived the most benefit from IT- Enabled Coordination, despite the fact that the patient conditions themselves are considerably different. Yet these teams on average reported the highest levels of

Faithfulness of Appropriation, highest levels of Consensus on Appropriation leading to the highest levels of Team Deep Structure Use of the technology.

6.2 Theoretical Contribution

From a theoretical perspective, our study makes four contributions of specific interest to the IS research community. The major contribution is the development and validation of a construct to assess IT-enabled coordination of clinical teams' processes, which we denote as Team Deep Structure Use of CPOE. HIT researchers have also called for a clarification of the Health IT artifact (Agarwal et al., 2010), and a demonstration of clinical benefits from commercially available systems, as opposed to home grown solutions prevalent in the early CPOE literature (Agarwal et al., 2010). Our study is the first to clearly establish the availability of the core features of a mature Health IT environment, and subsequently link clinician reported team level use of the core features of the technology used to the support clinical care processes to the overall patient satisfaction with the clinical team. The HIT artifact is a commercially available system, rather than a unique CPOE system developed in house, which supports a replication of the research and the expectation that other hospitals can derive similar benefits.

While a deep understanding exists within the literature regarding lean measures of individual use, few studies (Pavlou et al., 2008; Pavlou & El Sawy, 2006) incorporate a rich or very rich conceptualization of use at the group or team level (Burton-Jones, Straub 2006). Our study captures use at the intersection of task, technology and users at both the individual physician and team level, while our level of analysis and conceptual model focus at the team level, as coordination is an inherently team (group) level phenomenon. Our very rich conceptualization of team use thereby extends how HIT research conceptualizes the role of IT-enabled coordination of clinical processes.

This study extends our prior understanding of the impact of Relational Coordination mechanisms in a clinical environment. Earlier studies by Gittell (2002) have evaluated the efficacy of Relational Coordination mechanisms on patient outcomes, including patient satisfaction. Relational coordination is conceptualized as a construct which captures the conditions necessary in the relationships between team members that foster spontaneous, informal coordination (Gittell, 2002). Yet no prior studies have concurrently measured Relational Coordination with an IT-enabled coordinating mechanism such as CPOE. Therefore this study provides a comparative evaluation of the efficacy of relational vs. IT-enabled coordination of clinical-teams' processes with respect to patient care and satisfaction, thereby integrating and elaborating the two conceptualizations of coordination in healthcare processes.

Prior studies which have evaluated the effectiveness of Relational Coordination (Gittell et al., 2010; Gittell, 2002) on patient satisfaction have required additional assumptions in their research design with respect to clinical teams, in comparison to our design. For instance, Gittell (2002) compares the Relational Coordination scores across orthopedic surgery units at nine different hospitals. These nine teams represent all the clinicians who would regularly care for patients on a given orthopedic surgery unit, and does not attempt to match the actual clinicians who provided care to each patient. Essentially all of the Knee/Hip replacement surgery patients cared for at Hospital A were matched to a composite Relational Coordination score of the entire group of clinicians who provided care at Hospital A. Our design incorporates considerably enhanced granularity with respect to clinician team membership. Based on archival data, we assembled teams according to the actual clinicians who provided care on a patient by patient basis. Therefore our composite team score for relational coordination for each pneumonia team was not from the 121 individual respondent scores from the pre-identified pneumonia clinicians at Hospital B, but from the actual "nine" clinicians who provided care to the specific patient. As a result, our research establishes a more direct causal link between Patient Satisfaction and the Relational Coordination scores, resulting in a significant contribution to this literature.

This study intended to illuminate how coordination mechanisms can be appropriated effectively by clinical teams. By linking the antecedents Faithfulness of Appropriation and Consensus on Appropriation to Deep Structure Use of the CPOE system, we illuminate the relationship between the structural components of the technology and the clinicians who apply it to their work. Given the level of resistance to Health Information Technologies reported in the extant literature (Bhattacherjee & Hikmet, 2007; Lapointe & Rivard, 2005, 2007), we expected that these two constructs would be especially salient in the domain. Utilization of the technology according to its spirit was expected to exhibit significant variance even in an environment where universal adoption is demonstrated. While Faithfulness of Appropriation and Consensus on Appropriation have been empirically tested with Satisfaction as the outcome variable (Chin et al., 1997; Salisbury et al., 2002), and with individual level use of collaborative banking software (Kang et al., 2012) to our knowledge this study is the first to test the antecedents' impact on Team Deep Structure Use (Burton-Jones & Straub, 2006). Therefore this study extends the well-established perspectives in organization theory on the adaptive structuration of technology and work processes within the emergent context of HIT coordination.

Our study results across all patient conditions suggest that higher reported levels of Faithfulness of Appropriation predict higher Team DSU of CPOE. Similarly, our study results also suggest that higher reported levels of COA are predictive of higher Team DSU of CPOE, with the exception of the Organ Transplant group. Adaptive Structuration Theory suggests that Teams that demonstrate higher FOA and COA will derive positive outcomes as a result of their appropriation of the Advanced IT (DeSanctis & Poole, 1994). Our results suggest that the clinical task (variations in patient type), and the team structure (inclusion of mid-levels) impart a substantial impact on the relevance of the team appropriation of the IS and the related outcomes (PATSAT). These contextual influences add to our understanding of *when* Adaptive Structuration Theory constructs are impactful on theoretical models, and in particular, in the Health IT domain.

Relating our theoretical contributions to our original research questions, we suggest that our results offer strong support for our second research question, namely "How does variation in clinician team use of IT-based and relational coordination mechanisms affect patient satisfaction?**"** Here we have established a measure of rich use in a HIT context through Team DSU, and we are the first to concurrently measure IT-enabled and Relation Coordination as predictors of PATSAT. We find that for patient types of high complexity, teams which report higher levels of Team DSU of CPOE and higher Relational Coordination capability, also report increased PATSAT.

With respect to our first research question, "Why do clinician teams exhibit heterogeneity in the use of IT-based mechanisms?", our results are less conclusive, but still meaningful. To answer our first research question, we incorporated two theoretical perspectives, AST and Coordination Theory. From Coordination Theory, our expectation was that variation in the levels of task uncertainty and task interdependence, as reflected in the patient type rated by our expert panel, would establish a quantitative assessment of the moderating effect of patient type on the effectiveness of our two coordinating mechanisms. Our results were not significant, and therefore did not support our hypotheses five through eight. Our second theoretical perspective, AST, was found to be a significant predictor of the variance in use of Team DSU of CPOE, as were other well established TAM constructs such as Usefulness and Ease of Use in some contexts. In particular, Faithfulness of Appropriation was found to be salient across all patient conditions, which is unique to the IS literature, and offers insights into the question of "Why teams exhibit heterogeneity of IT-enabled coordination mechanisms. In this context, FOA proved to be an even more consistent predictor of Team DSU than Team Perceived Usefulness, which is of particular interest to the IS literature.

6.3 Practical Contribution

Practitioners gain *actionable* insight from the study in several respects. Our results suggest that the coordinating benefit derived from Team DSU of CPOE, and Relational Coordination is a function of not only the strength of clinician relationships and team level appropriation of the advanced features of the clinical IS, but also the patient condition. By isolating each of the user roles, relationships, clinical tasks, and IS feature set across maximally different patient conditions, our results suggest that as patient condition complexity and corresponding length of stay increases, so does the coordinating benefit provided by either IT-enabled or Relational Coordination mechanisms. This is especially apparent when focusing on the Vaginal Birth teams, which forms our baseline patient condition from a coordination perspective. It is important to note that Caesarean section births normally associated with more complicated deliveries had a separate CPOE order set and were purposely excluded from the study. Given that neither mechanism imparted a significant path to PATSAT, and that Vaginal Birth patients are arguably in the prime of health, with fewer comorbidities, and consistent short duration in the hospital, it would appear that administrative and clinical staff focus on IT-Enabled, or Relational Coordination improvement activities could be more effectively utilized elsewhere. We do not dispute that a positive impact related to the use of standardized best practices through order set creation and use could exist on Vaginal Birth teams. Our study was unable to detect the positive impact related to order entry due to universal adoption across medical units at Hospital A and B. We can only claim that reported use of the advanced features such as decision support, alerts or progress notes by Vaginal Birth teams does not covary with higher PATSAT.

Conversely, for patients with conditions characterized by higher acuity levels and associated with longer hospital stays, such as Organ Transplant, Pneumonia, and Cardiovascular Surgery, our results suggest that clinical teams derive an accentuated benefit through IT-Enabled *and* Relational Coordination mechanisms. The standardized Relational Coordination path coefficients for each of these conditions is positive and highly significant, suggesting that teams which communicate well, share goals, and demonstrate mutual respect achieve higher PATSAT. Ongoing research has shown that management interventions can be designed and implemented, that effectively improve team level attributes according to the seven dimensions measured by the Relational Coordination construct. For instance, organizations that invest resources focused on designing cross-functional spanner roles and cross functional performance measurement systems are shown to foster relationships that are robust to staffing changes over time (Gittell et al., 2010). Boundary spanners, or cross functional liaisons are individuals whose primary organizational objectives are to help integrate the work of others (Galbraith, 1973; Gittell, 2002). Examples of these individuals in a clinical setting are case workers, and primary nurses. In some hospitals, patients are assigned a primary nurse who is responsible for the patient for the duration of their stay (Gittell, 2002).

Our results suggest that clinical teams that appropriate CPOE functionality in a comprehensive manner, and maintain a complete patient record during a high acuity and lengthy hospital stay, derive a statistically significant benefit from the use of CPOE. While our supporting results were based on Pneumonia and the combined Organ Transplant and Pneumonia teams, we suspect that other patient conditions would derive similar results. It is important to note that our results weight equally the clinical structures supported by the features of the IS, namely the system alerts generated by drug-to-drug and drug-to-allergy interactions, clinical decision support functionality, system wide access to timely patient condition information such vital signs, and progress notes. Therefore we suggest that each of these clinical structures provides a complementary component in the clinical care process, which ultimately provides a coordinating benefit and improved patient satisfaction.

Our results on the Pneumonia and combined Pneumonia/Organ Transplant teams are confounded by statistically significant negative standardized path coefficients between Team DSU of CPOE and PATSAT on the Cardiovascular Surgery and Hospital B Knee/Hip replacement teams. The Cardiovascular Surgery results may have been impacted by the inconsistent processes associated with the maintenance of patient vital signs during the patient stay on Cardiovascular critical care units. Due to the incomplete digital records associated with patients that passed through these units during their stay, perhaps teams that avoided the considerable time associated with digital entry spent more time at the patient bedside. Managers should be aware that potentially negative results are associated with system use that is not comprehensive, or use that is inconsistent across units.

Our alternative explanation for the negative path coefficient on the Cardiovascular and Knee/ Hip replacement surgery teams at Hospital B is related to the role of the mid-level on these teams. Given our operationalization to Team DSU of CPOE, involvement with the CPOE system by the responsible physician highly influenced the overall Team DSU score. For surgical teams with mid-level assignment typically associated with senior surgeons at the hospital, the mid-level typically handled the interface with CPOE. Therefore these teams would systematically reflect much lower Team DSU scores, not necessarily from a lack of engagement overall, but from very low scores attributed to the responsible physician. Therefore our results might suggest that clinical teams which incorporate mid-levels for system engagement may in fact derive the highest patient satisfaction results. Since the trend to incorporate mid-levels in acute care facilities is nascent but growing quickly, our results with respect to the benefits of Health IT use by clinical teams with mid-level clinicians provide useful insights that will support further research into this role based phenomenon.

In summary, through the direct comparison of CPOE use according to lean measures (including Meaningful Use), along with Deep Structure Use, we found that the Faithful and Consensual Appropriation of the technology by clinical teams were salient predictors of favorable outcomes. Managers can then formulate nuanced combinations of user, task, and technology, and harmonize best practices across clinician care teams. Secondly, the juxtaposition of the two coordinating mechanisms, CPOE and relational coordination, enables the evaluation of the relative importance of the realization of CPOE technology compared with the ongoing development of team member relationships. Managers can then implement programs to enhance technology utilization or relationship building that is contextually relevant.

6.4 Limitations

While our study contributes to the IS, Health IT, and the Management literature streams, it is not without limitations. We attempt to gain deep insights from a single, five hospital not-for-profit organization, who were early adopters of a commercially available CPOE system. Given that our measures were used only in a single organization, further tests of our model would be appropriate at other hospital sites, especially those which are considered research institutions, or for-profit hospital organizations.

Despite attempts to maximize the sample of each of the five patient conditions, the strict adherence to the stated pre-requisite of an attending physician response, and an 80% overall team response rate, contributed to a small realized “n” for several conditions, namely Pneumonia (21) and Organ Transplant (34). These small sample sizes can result in inflated standard errors through PLS analysis, raising concerns with respect to the validity of our claims. We have attempted to mitigate these concerns by combining the Organ Transplant and Pneumonia team results, based on similar Appropriation characteristics, however, future research which establishes similar results with a larger sample using like or similar conditions is warranted.

The design of our study first captures all patients discharged from the hospitals between December 1, 2011 and August 31, 2012, who had subsequently completed a Patient Satisfaction survey. Our clinician survey was administered to the pre-identified clinical team members between October 17, 2012 and January 25, 2013 resulting in a significant time lag between the time of care, and the final completion of the clinician surveys. Perceptions regarding the Appropriation and Deep Structure Use of CPOE, as well as the underlying strength of relationships relevant to Relational Coordination may have shifted during the time lag. Given that this study involved an extended use environment (up to 9 years), even though variance occurred across patient care teams and conditions, it is unlikely that this variance occurred as a result of continued changes in the actual use patterns in similar teams. Had this design been incorporated in a study at a hospital site shortly after the shake-down phase, this noted limitation would have been a serious concern to the validity of the results.

We tested only one version of a CPOE system, and therefore the functionality that we tested may be unavailable, or more difficult to use at other sites than the commercially available system in use at our research site. Leadership at the hospital was also supportive of the technology, and the positive impact of leadership on the use of the technology may not apply at other sites to the same extent. Our research site was geographically located in the US Southeast, which has been home to a high number of Health IT software firms. Therefore the availability of trained clinicians, and trained consultants in this context may have led to improved outcomes, which are unique to the geographical location. The patient conditions included in our study were purposely selected due to the high variance in complexity of the conditions themselves. The variation from vaginal birth to organ transplant may not be available to most hospitals as a test site, which could reduce the ability to replicate our results. Our intention for the study was to capture the variance in benefit across maximally different patient conditions within this context, as the hospital group was unique in its ability to gain hospital wide order entry without a mandated use policy. While our measures are available for others to replicate and extend our study, our results are limited to a single organization located in the Southeast US.

6.5 Future Research

The dissertation was based on survey data for both the independent and dependent variables, and the use of archival data to enable team formation. At the time that the dissertation proposal was defended, it was unclear as to the full details of the archival data that would be made available, as the final legal agreement and access to the data were not reviewable by the principal investigator. Subsequent to gaining access to the archival data, the CMIO made available additional extracts of data generated through the patient care process at the two hospitals. While this additional information was not used to create and validate clinical teams, it will be useful for future research, and is therefore worthy of mention here. Additional archival data included all alerts triggered by the CPOE system, as well as the disposition to these alerts- such as unacknowledged or acknowledged- and whether the clinician entered free text documenting the disposition of each alert. Each of the roughly 15,000 alerts included the clinician name, and occupation code of the individual who was entering the orders when the alert was triggered. In addition, archival data documenting lookups and review of the patient record, including the reason for the lookup (i.e. patient consult) as well as the clinician name and occupation code were included. While only the order sets, documentation, and discharge diagnosis were used for team formation, this additional data will allow for a fairly complete assessment of the actual Team Deep Structure Use of the system using only archival, rather than survey data. Thus, the additional data is highly supportive of research questions which require granularity with respect to the actual role of the clinician who entered the data, as well as a clear delineation of which features of the CPOE system were enacted in the care process.

After survey collection was completed, several additional clinical outcome measures, including patient re-admittance, and patient expected length of stay adjusted for co-morbidities were added through a supplementary IRB. These additional measures were of interest to both the hospital and the principal investigator as meaningful clinical dependent variables. The inclusion of these additional measures strengthened the opportunity to publish in journals outside of the traditional IS space.

Future research would leverage the CPOE Coordination Effectiveness model, but rather than using survey data for the independent and dependent variables, it would incorporate the archival usage data to construct Deep Structure Use, and then determine its impact on the supplemental dependent variables. The dependent variables, patient re-admittance, and patient length of stay adjusted for co-morbidities, would replace the more subjective patient satisfaction, and would also likely impart higher variance in the dependent variable. For Deep Structure Use, structures in use will be verified according to actual keystrokes. The impact of physician entry of orders, disposition to alerts triggered by drug to drug or drug to allergy interactions, presence of team or physician progress notes, and whether or not a high percentage of orders were placed from outside of the order set can be used to replace survey opinions of team Deep Structure Use. This account of Deep Structure Use allows for a careful assessment of feature set use according to specific user, which is more in line with Very Rich Use guidelines (Burton-Jones & Straub, 2006). Assuming that Deep Structure Use established through archival data can be coded meaningfully and consistently across teams, this paper will resonate with academics and clinical practitioners. Actual team usage, and its impact on quantitative clinical outcomes, will gain credence with readers as it is based on hard data, rather than the more subjective survey based opinions of use and outcomes.

Based on the sizable number of teams established through the data collection process on site at the two hospitals, as well as the 65 items captured by the 3rd party satisfaction survey, the data provides an excellent opportunity to investigate research questions from a multi-level perspective. Of particular interest will be the impact of team level use behavior, and its impact on individual level outcomes, such as patient satisfaction with the physician. While CPOE was originally called Computerized *Physician* Order Entry, many specialties rely on their mid-levels (NP, PA) or nurses to maintain their digital entries to the clinical systems. While this practice may reduce the effectiveness of the error checking and decision support capabilities embedded in the technology, physicians may have more time to spend with patients at bedside, or perhaps have the ability to see additional patients. The extent to which the team maintains a complete, up to date digital record through Team Deep Structure Use may have a positive impact on physician performance when the physician requires an overall assessment prior to a consult. Nesting can occur at the hospital level, the patient condition level, and the team level.

The 2009 American Recovery and Reinvestment Act adopted by Congress included 27 Billion in stimulus funds for Health IT. To gain access to these funds, acute care hospitals and ambulatory physician practices must implement clinical systems that are certified versions of CPOE and Electronic Medical Records, from an approved list of software providers. Once the implementation occurs, clinical providers must then demonstrate "Meaningful Use" of the software. For instance for CPOE, hospitals must demonstrate that at least 30% of patients have at least one medication order entered electronically. Reimbursement is then accomplished through a premium reimbursement paid to the medical provider on all Medicare and Medicaid patients where meaningful use is demonstrated. By 2015, the carrot provided by the government in the way of incentive bonuses becomes a stick, as providers who fail to provide documented digital records of patient care process are reimbursed at a rate that is below the Medicare and Medicaid standard rate for that patient type (Agarwal et al., 2010).

The Meaningful Use guidelines were rushed into practice without a substantial amount of research to understand their impact on patient care outcomes. Therefore the impact of Meaningful Use on outcomes is warranted of further research (Agarwal et al., 2010). Furthermore, a detailed comparison of teams that meet Meaningful Use guidelines with teams that demonstrate more comprehensive use of the technology will inform clinicians and legislators of the relative merits of Meaningful Use, and a deeper understanding of the drivers of improved outcomes. No studies to my knowledge have investigated implications of technology use on clinical team members who are somewhat isolated from the core, day shift patient care team. Through the data collection process on site at the two hospitals, it was clear that night shift clinicians often felt unattached to their day shift counterparts, and in particular to the physicians on the clinical team. This group also felt that their input and subsequent impact on decisions related to order set creation, and amendments to the overall care process were muted. As a result, across patient conditions and clinical teams, this group reported Relational Coordination and Deep Structure Use of CPOE scores that were likely quite different than their day shift counterparts on the same clinical team environment. Recognizing this variance early in the data collection process, the principal investigator captured the night shift clinicians from the staffing coordinators at each hospital. While some nurses occasionally work both the night shift and the day shift, the majority of the nurses were consistently deemed “Night shift” or “Weekend day shift”. As a secondary check, clinicians who were coded as night shift through the schedule, can be verified as night shift during the actual care process through the date/time stamp in the order and documentation archival data. To our knowledge, the Relational Coordination construct has not been studied from a team perspective that incorporates a day shift/night shift perspective. Technology use could be supportive of asynchronous communication across team members, which may enable increased performance in night shift clinicians who may be more introverted than their day shift counterparts. Anecdotal evidence suggests that some night shift nurses choose to work the late shift to avoid the hassles of dealing with family members of patients, which would support the notion of a more introverted clinician group.

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Appendix A Patient Care Teams

	Specialty	Usage Total	Patients Per Day	Order Set	Facility
1	Emergency	14258	10.87	ED Cardiovascular/Resp/Pulm.	Hospital A
2	Emergency	8955	7.17	ED Cardiovascular/Resp/Pulm.-F	Hospital B
3	Nephrology	25804	8.36	Hemodialysis-Inpatient	Hospital A
4	Obstetrics	8177	4.68	OB Post Vaginal Delivery	Hospital A
5	Cardiology	11552	3.88	Chest Pain/Unstable Angina	Hospital A
6	Internal Medicine	11176	3.62	Anemia	Hospital A
7	Otolaryngology	5667	3.10	ENT Post Op Orders - F	Hospital B
8	Obstetrics	5270	3.02	OB Cesarean Section Post Op-P	Hospital A
8	Obstetrics	3500	2.00	OB Cesarean Section Scheduled	Hospital A
9	Obstetrics	5757	2.86	OB Post Vaginal Delivery.	Hospital B
10	Neurology	2995	2.26	Stroke Admit Clinical Pathway	Hospital A
11	Orthopedic Surg.	2017	1.81	Ortho Total Knee Pre-Op Orders	Hospital A
11	Orthopedic Surg.	2314	2.07	Ortho Total Knee Post Op	Hospital A
12	Cardiology	6520	2.36	Implant Explant Pre Op Orders	Hospital A
12	Cardiology	7480	2.42	Post Op Implant Orders	Hospital A
13	Nephrology	3993	2.18	Acute Renal Pathway	Hospital A
14	Cardiology	3773	2.03	Chest Pain Protocol - F	Hospital B
15	Internal Medicine	3077	1.66	Sepsis Protocol-Fayette	Hospital B
15	Internal Medicine	2317	1.70	Sepsis (Non-ICU). - F	Hospital B
16	Pulmonary Med.	3296	1.77	Pneumonia Pathway (NON ICU)-F	Hospital B
17	Internal Medicine	1932	1.46	Anemia Orders-F	Hospital B
18	Cardiology	4947	1.61	Congestive Heart Failure Pathway	Hospital A
19	Pulmonary Med.	3186	1.50	Pneumonia Pathway (NON ICU)	Hospital A
20	Obstetrics	1762	0.88	OB Cesarean Section Scheduled	Hospital B
20	Obstetrics	2752	1.37	OB Cesarean Section Post Op.	Hospital B
21	Internal Medicine	1420	1.18	Sepsis (Non-ICU) -P	Hospital A
22	Orthopedic Surg.	1061	0.95	Ortho Total Hip Pre Op Orders	Hospital A
22	Orthopedic Surg.	1199	1.07	Ortho Total Hip Replace Post Op	Hospital A
23	Gastroenterology	2230	1.13	Colonoscopy Order Set P	Hospital A
24	General Surgery	2024	0.66	Bowel Resection Pre-Op	Hospital A
24	General Surgery	3134	1.02	Bowel Resection- Post Op	Hospital A
25	Orthopedic Surg.	610	0.33	Ortho Total Knee Pre-Op Orders-F	Hospital B
25	Orthopedic Surg.	1147	0.86	Ortho Total Knee Replace Post	Hospital B
26	Cardiology	1625	0.88	CHF Pathway - F	Hospital B
27	Orthopedic Surg.	664	0.37	Ortho Total Hip Replace Post -F	Hospital B
27	Orthopedic Surg.	276	0.15	Ortho Total Hip Pre Op Orders-F	Hospital B

	Specialty	Usage Total	Patients Per Day	Order Set	Facility
28	Neurology	1260	0.71	Stroke Admit Orders - F	Hospital B
29	General Surgery	1245	0.68	Bowel Resection Post Op - F	Hospital B
30	Endocrinology	1394	0.45	Hypoglycemic Protocol	Hospital A
31	General Surgery	1303	0.42	Appendectomy Post Op Orders	Hospital A
32	General Surgery	530	0.29	Appendectomy Post Op - F	Hospital B
33	Gastroenterology	514	0.28	Colonoscopy Order Set - F	Hospital B
34	Pulmonary	390	0.18	ICU Pneumonia Pathway	Hospital A
35	Pulmonary	262	0.14	Pneumonia Pathway ICU - F	Hospital B
36	Otolaryngology	115	0.07	ENT Post-Op Surgery	Hospital A

Appendix B – Order Set Detail

Created	Enter Role	Order Name	Type Code	Part of Set	Order Set	Order Set Heading	Order Dept.
7/26/11	Physician	Attestation Order for Transfer	Medication	1	Appendectomy Post Op Orders	Admission	Pharmacy
7/26/11	Physician	Advance Diet as Tolerated	Other	1	Appendectomy Post Op Orders	Dietary	Nursing
7/26/11	Physician	D5 1/2NS	Medication	1	Appendectomy Post Op Orders	Pharmacy	Pharmacy
7/26/11	Physician	Bathroom Privileges	Other	1	Appendectomy Post Op Orders	Activity	Nursing
7/26/11	Physician	Intake And Output	Other	1	Appendectomy Post Op Orders	Nursing	Nursing
7/26/11	Physician	Incentive Spirometry	Other	1	Appendectomy Post Op Orders	Nursing	Nursing
7/26/11	Physician	Ondansetron injection	Medication	1	Appendectomy Post Op Orders	Pharmacy	Pharmacy
7/26/11	Physician	Vital Signs	Other	1	Appendectomy Post Op Orders	Nursing	Nursing
7/26/11	Physician	OxycoDONE tablet	Medication	1	Appendectomy Post Op Orders	Pharmacy	Pharmacy
7/26/11	Physician	Admit	Other	1	Appendectomy Post Op Orders	Discharge	Nursing
7/26/11	Nurse Practitioner	BK Virus (Polyoma) Blood	Diagnostic	0	NULL	NULL	Serology
7/26/11	Registered Nurse	Hepatic Function Panel	Diagnostic	0	NULL	NULL	Chemistry
7/26/11	Nurse Practitioner	Spine Lumbar AP And Lat	Diagnostic	0	NULL	NULL	Radiology
7/26/11	Physician	ECG	Diagnostic	0	NULL	NULL	Cardiology

Appendix C - Survey

CPOE Study Knee or Hip Replacement Team

This survey is part of a study of the ongoing use of Computerized Provider Order Entry, or CPOE, at your Hospital. The study was created by researchers in Computer Information Systems from Georgia State University, and your individual responses will remain confidential.

CPOE technology was developed to help clinicians improve the coordination, and standardization of patient care through pre- determined clinical pathways, called order sets. These order sets are updated on an ongoing basis in your respective facilities based on best practices. The CPOE system is designed with the capability to review the patient's electronic medical record (EMR) to highlight potential adverse drug interactions, or allergic reactions, to help improve patient safety. If potentially dangerous drug or allergy interactions are detected, the system will trigger an electronic warning or "alert".

To maximize the benefit of the CPOE system developers intended for the system to be used by clinicians as follows:

1) Teams of clinicians, including physicians, nurses, pharmacists and others develop order sets to treat patient conditions such as knee or hip replacement.
2) Actual patient orders are entered by the responsible physician or authorized care provider. Orders could include medication, lab tests, radiology studies, and nursing protocols.
3) Based on the patient's medical history and the orders created in (2), the system provides decision support to the clinician. This decision support could be in the form of a potential drug interaction alert, best practices to reduce patient risk to adverse conditions such as sepsis, or links to information sites related to conditions such as chronic disease.
4) Once orders are entered, clinicians have the ability to view order status and real time patient data on site or remotely, and progress notes can be added to further communicate opinions and plans regarding the patient, to the entire patient care team.

Please refer to the four bullet points above when answering questions related to ***<u>the developers intentions, and appropriate use</u>*** *of the CPOE system*. We appreciate your input to this research study.

As a member of a team who recently cared for a **<u>knee or hip replacement patient</u>**, please respond to the questions below in the context of this team.

1. **The developers of the CPOE system would agree with how our patient care team used the system.**

1	2	3	4	5	6	7
Extremely Unlikely	Quite Unlikely	Slightly Unlikely	Neither	Slightly Likely	Quite Likely	Extremely Likely

2. **Our patient care team used the CPOE system properly.**

1	2	3	4	5	6	7
Extremely Unlikely	Quite Unlikely	Slightly Unlikely	Neither	Slightly Likely	Quite Likely	Extremely Likely

3. The original developers of the CPOE system would view our patient care team's use of the system as appropriate.

1	2	3	4	5	6	7
Extremely Unlikely	Quite Unlikely	Slightly Unlikely	Neither	Slightly Likely	Quite Likely	Extremely Likely

4. Our patient care team used the CPOE system as it should have been used.

1	2	3	4	5	6	7
Extremely Unlikely	Quite Unlikely	Slightly Unlikely	Neither	Slightly Likely	Quite Likely	Extremely Likely

5. Our patient care team used the CPOE system in the most appropriate fashion.

1	2	3	4	5	6	7
Extremely Unlikely	Quite Unlikely	Slightly Unlikely	Neither	Slightly Likely	Quite Likely	Extremely Likely

6. Our patient care team was able to reach consensus on how to apply CPOE to coordinate patient care.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

7. There was no conflict in our patient care team regarding how we should incorporate the CPOE system to coordinate care.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

8. Our patient care team reached mutual understanding on how we should use CPOE to coordinate care.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

9. Our patient care team was able to reach consensus on how we should use CPOE to coordinate care.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

10. Overall, our patient care team agreed on how we should use CPOE to coordinate patient care.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

11. How frequently do the following types of care providers on your team communicate with you about patients?

	Never	Rarely	Occasionally	Often	Constantly
Physicians	**1**	**2**	**3**	**4**	**5**
Nurses	**1**	**2**	**3**	**4**	**5**

12. Do the following types of care providers on your team communicate with you in a timely way about patients?

	Never	Rarely	Occasionally	Often	Always
Physicians	**1**	**2**	**3**	**4**	**5**
Nurses	**1**	**2**	**3**	**4**	**5**

13. Do the following types of care providers on your team communicate with you accurately about patients?

	Never	Rarely	Occasionally	Often	Always
Physicians	**1**	**2**	**3**	**4**	**5**
Nurses	**1**	**2**	**3**	**4**	**5**

14. When problems arise regarding the care of patients, do the following types of care providers on your team work with you *to solve the problem*?

	Never	Rarely	Occasionally	Often	Always
Physicians	1	2	3	4	5
Nurses	1	2	3	4	5

15. How much do the following types of care providers on your team know about your role in caring for patients?

	Nothing	Little	Some	A Lot	Everything
Physicians	1	2	3	4	5
Nurses	1	2	3	4	5

16. How much do the following types of care providers on your team respect the role you play in caring for patients?

	Not at all	A Little	Somewhat	A Lot	Completely
Physicians	1	2	3	4	5
Nurses	1	2	3	4	5

17. How much do the following types of care providers on your team share your goals for the care of patients?

	Not at all	A Little	Somewhat	A Lot	Completely
Physicians	1	2	3	4	5
Nurses	1	2	3	4	5

18. The following types of care providers on my team work well together to spontaneously coordinate patient care.

	Not at all	A Little	Somewhat	A Lot	Completely
Physicians	1	2	3	4	5
Nurses	1	2	3	4	5

19. The following types of care providers on my team work well together to adjust patient care plans on the fly.

	Not at all	A Little	Somewhat	A Lot	Completely
Physicians	1	2	3	4	5
Nurses	1	2	3	4	5

Please answer the following questions in the context of your knee/hip replacement patient care team use of CPOE over a typical one month period. While several of the items are associated with the patient record(EMR), for consistency we reference CPOE functionality.

20. Including the responsible physician, our patient care team directly entered CPOE medication orders for _____ percent of unique patients.

21. The responsible physician on our patient care team directly entered CPOE medication orders for _____ percent of unique patients.

22. Our patient care team ensures that ____ percent of all patients had at least one diagnosis entry.

23. Including the responsible physician, our patient care team consistently utilized the drug-drug interaction alerts provided by the CPOE system as a prompt to find safer alternatives.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

24. The responsible physician on our patient care team consistently utilized the drug-drug interaction alerts provided by the CPOE system as a prompt to find safer alternatives.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

25. Including the responsible physician, our patient care team consistently utilized the drug-allergy interaction alerts provided by the CPOE system as a prompt to find safer alternatives.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

26. The responsible physician on our patient care team consistently utilized the drug-allergy interaction alerts provided by the CPOE system as a prompt to find safer alternatives.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

27. Including the responsible physician, our patient care team consistently used CPOE to update and monitor real time patient status such as vital signs, medication orders, and lab results.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

28. <u>The responsible physician</u> on our patient care team consistently used CPOE to update and monitor real time patient status such as vital signs, medication orders, and lab results.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

29. Including the responsible physician, our patient care team consistently used CPOE for clinical decision support - such as advice on medical conditions like sepsis, or for drug prescribing.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

30. <u>The responsible physician</u> on our patient care team consistently used CPOE for clinical decision support - such as advice on medical conditions like sepsis, or for drug prescribing.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

31. Including the responsible physician, our patient care team consistently used progress notes to update other team members on the care of our patients.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

32. The physician(s) on our patient care team consistently used progress notes to update other team members on the care of our patients.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

33. Our patient care team consistently used the standard CPOE order sets in the care of our patients, unless patient conditions prompted changes to standard protocols.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

34. Our patient care team consistently relied on all of the functionality of CPOE for the coordination of care of our patients.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

35. Our patient care team consistently relied on all of the features of CPOE for the coordination of care of our patients.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

Please respond to the remaining questions as an individual caring for a knee or hip replacement patient, rather than as a patient care team member.

36. Using CPOE *enables me* to improve patient care and management.

1	2	3	4	5	6	7
Extremely likely	Quite Likely	Slightly Likely	Neither	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

37. Using CPOE improves my performance with respect to patient care.

1	2	3	4	5	6	7
Extremely likely	Quite Likely	Slightly Likely	Neither	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

38. Using CPOE *enhances* my effectiveness with respect to patient care.

1	2	3	4	5	6	7
Extremely likely	Quite Likely	Slightly Likely	Neither	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

39. Using CPOE *makes it* easier to carry out patient care.

1	2	3	4	5	6	7
Extremely likely	Quite Likely	Slightly Likely	Neither	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

40. I *find CPOE* useful for coordinating patient care.

1	2	3	4	5	6	7
Extremely likely	Quite Likely	Slightly Likely	Neither	Slightly Unlikely	Quite Unlikely	Extremely Unlikely

41. Using CPOE *increases* my productivity with respect to patient care.

1	**2**	**3**	4	5	6	7
Extremely Likely	Quite	Slightly	Neither	Slightly	Quite	Extremely Unlikely

42. Interacting with the CPOE system does not require a lot of my mental effort.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

43. I *find* it easy to get the CPOE system to do what I *want* it to do.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

44. I *find* interaction with the CPOE system clear and understandable.

1 2 3 4 5 6 7

Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

45. I *find the CPOE system* easy to use.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

46. I am very satisfied with CPOE system usage.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

47. I am very pleased with CPOE system usage.

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

48. I am very content with CPOE system usage

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

49. Which best describes your role at the hospital?

Nurse
Nurse Practitioner
Physician Assistant
Physician

50. If you are a physician, which medical specialty(s) best describes your medical practice.

Anesthesiology
Cardiology
Colorectal Surgery
Emergency Medicine
Endocrinology
Family Practice
Gastroenterology
Hospitalist
Internal Medicine
Nephrology
Neurology
OB\GYN
Oncology
Ophthamology
Orthopedic Surgery
Otolaryngology
Pediactrics
Pulmonology
Radiology
Surgery

Urology

Other – Please specify
52. In what year were you born? (enter 4 digit birth year; for example, 1976)

53. Are you male or female?

Male ______ Female _____

The go live date for CPOE at Hospital A was 11/01/2003 and at Hospital B was 02/01/2007. I have been using CPOE since __________

55. I believe that the recently opened Hospital C will be an asset to the community

1	2	3	4	5	6	7
Strongly Disagree	Quite Disagree	Slightly Disagree	Neither	Slightly Agree	Quite Agree	Strongly Agree

Thank you very much for your valuable time and careful input.