Adoption, Usage, and Value of Health Information Exchange among Illinois Ambulatory Healthcare Clinics

BY

JOHN C. PENDERGRASS
B.S. Computer & Information Science, University of Alabama at Birmingham, 1989
M.S. Information Systems, DePaul University, 2007

THESIS

Submitted as partial fulfillment of the requirements
for the degree of Doctor of Philosophy in
Management Information Systems
in the Graduate College of the
University of Illinois at Chicago, 2015

Chicago, Illinois

Dissertation Committee:

Dr. Ranganathan Chandrasekaran, Chair and Advisor
Dr. Mary Beth Watson-Manheim
Dr. Stanley Sclove
Dr. Edward Mensah, Health Policy & Administration
Dr. Ali Tafti

It is with my deepest gratitude that I dedicate this thesis to my wonderful wife, Lise Hauser, without whom this endeavor would not have been possible. Her belief and support of my dream to pursue a Ph.D. was vital to my success.

ACKNOWLEDGMENTS

I would like to express gratitude to a number of people who have been of assistance to me for the completion of my dissertation. First, my deepest thanks to my advisor and committee chair Dr. Ranganathan Chandrasekaran for his guidance and support throughout my graduate program. I would also like to thank the members of my committee: Dr. Mary Beth Watson-Manheim, Dr. Stanley Sclove, Dr. Edward Mensah, and Dr. Ali Tafti for their support and assistance during my program. In addition, my thanks goes out to other professors within the Information and Decision Sciences department and in other departments at the University of Illinois at Chicago for all their support and assistance, as well. In addition, I truly appreciate the help that Vignesh Srinivasan and Hrishikesh Kotwal, two graduate assistants, provided me during this process.

I also have deep appreciation for the assistance provided by Eva Winckler with CHITREC, and Kathy Siebrasse with IL-HITREC, without whom survey recruitment would have been far more arduous and the response far less.

I am appreciative of having been accepted as a fellow into the Integrative Graduate Education and Research Training (IGERT) program funded by the National Science Foundation (NSF). The support from this program and the professors and staff who were a part of this program were instrumental to my success. The research presented here is funded in part by IGERT from NSF grant number 1069311, as well as the Center for Healthcare Information Management and Systems at the University of Illinois at Chicago.

Last, but certainly not least, is the gratitude I have for my family. The support and encouragement I received from them made this process achievable.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABREVIATIONS AND ACRONYMS

CB – Covariance-Based

CCC – Clinical Care Classification

CHITREC – Chicago Health Information Technology Regional Extension Center

CMS – Center for Medicare & Medicaid Services

DICOM – Digital Imaging and Communications in Medicine

EDI – Electronic Data Interchange

EHR – Electronic Health Records

EMR – Electronic Medical Records

EOT – Environmental-Organizational-Technological

ERP – Enterprise Resource Planning

ICD – International Classification of Diseases

IL-HITREC – Illinois Health Information Technology Regional Extension Center

IT – Information Technology

ITI – Information Technology Infrastructure

HIE – Health Information Exchange

HIT – Health Information Technology

HITECH – Health Information Technology for Economic and Clinical Health

LOINC – Logical Observation Identifiers Names and Codes

MIS – Management Information Systems

OHIT – Office of Health Information Technology

ONC – Office of the National Coordinator for Health Information Technology

OPRS – Office for the Protection of Research Subjects

PHI – Protected Health Information

PLS – Partial Least Squares

REC – Regional Extension Center

SEM – Structural Equation Model

SNOMED CT – Systematized Nomenclature of Medicine Clinical Terms

1 INTRODUCTION

1.1 Healthcare Information Systems Interoperability

Healthcare providers are increasingly using information technology (IT) for clinical care. Health IT (HIT) systems, such as electronic health record[1] (EHR) systems, are now common in many hospitals, clinics, and practices (McCann 2014b; Wood 2013). Although use of HIT was lagging among smaller and rural hospitals and practices as of a few years back (Bahensky et al. 2008; Fonkych et al. 2005; Reardon et al. 2007), recent usage among this group has increased significantly (Singh et al. 2012). However, silos of patient data have limited effectiveness and value if healthcare organizations are unable to communicate patient health information between themselves. Patient health information that is shared, or exchanged, among healthcare organizations provides a comprehensive clinical view of a patient, as well as providing a means for information about communities of patients. Relying on defined standards and protocols, HIT interoperability allows clinical practitioners to exchange patient health information with hospitals, laboratories, pharmacies, care facilities, health agencies, and others, thus enhancing the speed, quality, safety, and coordination of patient care, with the potential for lowering costs. An electronic health information exchange[2] (HIE) is a network enabling platform that facilitates electronic sharing of patient information among providers and healthcare organizations by acting as an infomediary between disparate HIT systems. The U. S. Department of Health and Human Services defines health information exchange as, "…the electronic movement of health-related information among organizations according to nationally recognized standards. The goal of

[1] Electronic Health Record (EHR) is used here to refer to any HIT system that collects, processes, and stores clinical patient data including those systems identified as Electronic Medical Records (EMR).
[2] Electronic exchange is frequently assumed when using the abbreviation HIE.

health information exchange is to facilitate access to and retrieval of clinical data to provide safer, timelier, efficient, effective, equitable, patient-centered care" (Health Resources and Services Administration 2012). As such, health information becomes portable, thus removing geographical and spatial barriers for accessing critical clinical information. HIEs are based upon standards for interoperability, security, and patient confidentiality, and are operated by public agencies, private organizations including vendor consortiums, and public-private collaborations. The potential benefits of using HIE have propelled efforts at the national, regional, and state levels to promote their use (CMS 2014; HealthIT 2012a; Williams et al. 2012). However, despite growing participation, there remains a number of reported barriers to the adoption and usage of HIE (DesRoches et al. 2013) that in the past have resulted in their failure (Brailer 2007; Lorenzi 2003; Vest et al. 2010).

There are three types of HIEs: 1) directed exchange used to securely send patient information directly to another healthcare organization, sometimes referred to as "push" HIE, 2) query-based exchange used to search and discover patient clinical records, sometimes referred to as "pull" HIE, and 3) consumer-mediated exchange that provides patients online access to their clinical information (HealthIT 2012b). HIEs operate at a community, regional, or state level, but a nationwide HIE does not yet exist. This research will focus on push and pull HIE at a state level for practices and clinics in the state of Illinois, United States of America.

A large diversity in data formats and coding in use among healthcare organizations makes the development of multi-lateral system interoperability solutions a difficult problem. Standardized data dictionaries across healthcare organizations is difficult since there does not exist a universal terminology standard that covers all domains of healthcare. Additionally, there is not one standard that covers all use cases. Architecture and formats differ between existing

terminology standards, and legacy data are generally lost when implementing a new coding standard (3M-HIS 2013; Shakib et al. 2002). Further complication also arises from the requirements and guidelines required to maintain patient confidentiality and security of their protected health information (PHI). To facilitate electronic exchange of clinical information, HIEs were developed as infomediaries between healthcare information systems, opening up the possibility for a number of benefits.

1.1.1 Potential Benefits of HIEs

HIEs have the potential to benefit patients, providers, healthcare organizations, public health agencies, and the community at large. Patients can benefit from improved care as a result of the comprehensive clinical view afforded to providers. Providers can benefit from improved decision-making and administrative efficiency. Healthcare organizations can benefit from improved efficiencies and favorable reimbursement models supported by HIE. Public health agencies benefit from timelier and more accurate reporting, and communities can benefit in a number of ways from potential improvement of population health including lower health costs to employers and the self-insured, improved productivity, and lower emergency management costs.

HIEs have the potential to improve safety and patient outcomes, reduce errors and risk, improve coordination of care, reduce administrative costs, and improve patient and clinician satisfaction. Additionally, healthcare organizations stand to benefit economically from participating in value-based reimbursement models afforded by HIEs (ValenceHealth 2013). One model – pay-for-performance – as implemented by the Center for Medicare & Medicaid Services (CMS) and other payers, define certain metrics for patient population health quality and adjust provider reimbursement rates accordingly. Failure to meet defined metrics can result in lower

reimbursement rates from the payer. HIEs have the potential for improving the efficiency and quality of this coordination, thereby leading to higher reimbursement rates and lower administrative costs. Furthermore, a short-term economic benefit available to providers and healthcare organizations are the financial incentives currently offered by some states and the federal government for demonstrating meaningful use of technology that includes HIE. An example is the Meaningful Use program administered by CMS (HealthIT 2010b).

1.1.2 Barriers to HIE

New technology can foster concerns of risk and value proposition thereby presenting a barrier to its adoption. For instance, in the early stages of Internet adoption, small businesses were concerned that the Internet or a Website would not lead to more efficiency or lower costs (Walczuch et al. 2000). So too is the case with HIE as smaller, resource constrained healthcare organizations evaluate this technology.

Despite potential benefits, significant barriers remain to the effective adoption and usage of HIEs (Fontaine et al. 2010a; Lau 2011). These barriers include high startup costs, uncertainty regarding participation of other players, workflow disruptions, training, ensuring patient privacy and information security, and return-on-investment uncertainty. Attempts to make HIEs work in the 1990s failed for a number of reasons, including lack of information technology (IT) infrastructure, a paucity of operational EHRs, steep costs, and unsustainable business models (Brailer 2007; Holmquest 2007; Vest et al. 2010). Crucial to HIE success in the current environment is an understanding of the barriers facing healthcare organizations. HIE is a socio-technical solution requiring IT, coordination with potential players, changes to intra- and inter-

organizational workflows, and adherence to regulatory requirements, particularly those regarding patient privacy and confidentiality.

HIEs require participating organizations to have a fundamental clinical information infrastructure in the form of a basic EHR solution with networking capability. Though adoption of these technologies is progressing and may be nearing a tipping point for diffusion, there continues to be resistance from some providers (Ajami et al. 2013; Ford et al. 2009).

Success of HIEs is also dependent on the network externalities of participation, making its adoption a classic chicken-and-egg dilemma. That is, players are hesitant to adopt a new innovation whose value is dependent on others also adopting and using the innovation. With the investment in time and money required to use an HIE, uncertainty about the intentions of others is a major barrier to its adoption.

Workflow issues can doom implementation efforts if not properly managed. Information systems literature is replete with examples of failed system implementations, and failure of health information systems, due to poor integration of workflows. (Dowling Jr 1987; Gladwin et al. 2002; Kaplan et al. 2009). HIEs complicate this issue as they inherently affect both intra- and inter-organizational workflows. HIE related workflows vary from site to site, even within the same organization, and vary drastically based on care giver roles (Bowens et al. 2010; Unertl et al. 2012). Organizations with poor workflow change management could experience failure in their use of HIE. Whereas larger organizations may have the change management resources to implement workflow changes, the lack of this capability among smaller organizations could prove to be detrimental.

High upfront costs, uncertainty about others intentions, requisite changes to workflow, and adherence to regulatory requirements are all major barriers that can result in healthcare organizations being reluctant in the adoption and usage of HIE.

1.1.3 Outcomes of HIE

HIEs have the potential to provide a wide-range of benefits and resulting value to ambulatory clinics. Potential value from the use of HIE include financial gain, quality improvement, patient and clinician satisfaction, reputation, and perhaps other measures. In general, however, it is not clear what actual value has been realized from using HIEs by healthcare organizations. Though many have expounded the potential benefits of HIE, there is little evidence of delivered value (Adler-Milstein et al. 2011; Chaudhry et al. 2006; Joshi 2011; Walker et al. 2005). This is particularly true among smaller healthcare organizations where adoption and usage has been lower. Whereas larger healthcare organizations with resources have been at the leading edge of using HIE, and are beginning to realize some return on their investment (Buntin et al. 2011), outcomes for smaller healthcare organizations are not well understood.

1.2 Research Motivation

Industry news and anecdotal reports indicate that HIE use is on the rise (DesRoches et al. 2013; Manos 2014; McCann 2014a). Though accounts differ, it is estimated that there are approximately 280 HIEs nationwide with half of all U.S. hospitals now using an HIE as provided by public agencies, private organizations, and public-private consortiums (AHRQ 2014). Literature on HIEs has recently grown to include news accounts, practitioner guides, and some

academic research. A scan of the literature, however, shows overwhelmingly that HIE literature is mostly prescriptive and descriptive in nature. Very little scholarly research has addressed this important phenomena.

The few lessons we have on HIEs primarily involve larger organizations. However, the American Medical Association 2012 Physician Practice Benchmark Survey reports that nearly 60 percent of all physicians work in practices with fewer than 10 physicians, and 65 percent of these practices are wholly-owned by physicians (Kane et al. 2013). Since smaller healthcare organizations lag in the adoption and usage of EHRs, and do not have the resources of a larger organization (Fontaine et al. 2010b; Lorenzi et al. 2009; Reardon et al. 2007), it follows that they lag in the adoption of HIE as well. Knowledge of HIE adoption and usage by larger healthcare organizations may not be applicable to ambulatory clinic that may lack the resources of larger institutions. With scholars calling for greater understanding of the adoption, use, and value of health information systems (Agarwal et al. 2010), an understanding of the factors leading to the adoption, use, and value from HIE among ambulatory clinics is needed.

1.2.1 Adoption and Usage

It is useful here to distinguish between *adoption* and *usage*. In the classic work, "Diffusion of Innovations", Rogers defines adoption as a decision-making process, a mental exercise, and implementation as an "overt behavioral change" (Rogers 2003). We choose "usage" instead of implementation so as to not confuse activity prior to actual use. After a decision to adopt has been made, technology is implemented (e.g. procurement, installation, and training) prior to usage. We define adoption as the planning, evaluation, or trial of HIE regardless if clinical use takes place. This may include the implementation of processes,

procedures, and equipment, but absent the use of HIE in the provision of patient care. Naturally, clinical use of HIE implies adoption.

Adoption of innovation in organizations is highly complex. Barriers can occur at multiple levels and interactively affect overall adoption and usage. Information systems literature is replete with stories of systems adopted and implemented by an organization only to fail when intended users did not use the system in part or in full. Likewise, a healthcare organization may make the decision to use an HIE, procure the requisite equipment, and define the required work procedures only to have its staff and clinicians not use, or fully use, the HIE. The process of assimilation of an innovation in an organization is complex, iterative, and often untidy. As such, it is important to understand the factors that affect both the adoption and usage of HIE.

1.2.2 Research Gaps

Research on HIE had a brief surge in the 1990s until HIE efforts began to fail. Around 2003 the federal government begin promoting IT use in healthcare and a resurgence in the literature began. A scan of extant HIE literature reveals a large number of articles that are primarily descriptive in nature, narrating the efforts undertaken by a state agency or by a health care provider. A large number of articles are prescriptive in nature that include toolkits, frameworks, and guidelines on how healthcare organizations can effective adopt and use an HIE (Dixon et al. 2010). Literature also contains lessons about past implementations (Frohlich et al. 2007; Holmquest 2007), the importance and effect of standards (Hagemeier 1997; Iossifova et al. 2013; Raths 2008; Warner 2012), discussion of potential benefits (Carr et al. 2013; Pevnick et al. 2012), issues of funding (Abramson et al. 2012; Kern et al. 2011; Liao et al. 2012), and issues of patient privacy and confidentiality (Angst 2009; Dimick 2009; Kim et al. 2013; McDonald 2009;

McGraw et al. 2009), among others. While these are useful, what is clearly lacking is theory-based, scholarly research on the very pertinent issues of adoption, usage, and outcome, especially among ambulatory healthcare organizations.

The proposed dissertation seeks to address the following critical gaps in the literature. First, our research aims to provide some insights into the extent of adoption and usage of HIE, especially in ambulatory settings. Second, our research aims to illuminate key factors associated with the adoption and usage of HIE by ambulatory clinics. Smaller providers face a different set of challenges including a lack of adequate IT infrastructure, managerial expertise, and financial resources that are critical for effective adoption and usage of HIEs (Fontaine et al. 2010b). Ambulatory clinics also face pressure from peer groups, parent organizations, and federal agencies to effectively utilize technology. Additionally, the limited resources of smaller organizations exacerbate the challenges of patient privacy and confidentiality that come with using digitized systems; a major impediment to implementing HIEs. We seek to focus on key environmental, organizational, and technological factors that affect the adoption and usage of HIEs among ambulatory clinics. Third, we seek to assess the value that independent ambulatory clinics derive from using HIEs. Understanding the outcomes from HIE is essential as considerable questions exist on the usefulness of HIEs among scholars and practitioners alike.

Information technology adoption in healthcare has been slow, and the success of HIE is not guaranteed, particularly given the failures of past efforts. Understanding the issues of this phenomena, particularly among ambulatory clinics, will be of great value to practitioners, policy makers, and academics.

1.3 Research Objective

We examine the adoption, usage, and outcomes of HIEs by ambulatory clinics using an environmental, organizational, and technological (EOT) framework (Tornatzky et al. 1990).

Specifically we seek to,

1. Understand adoption and usage of HIE by ambulatory clinics in the state of Illinois.
2. Investigate the key environmental, organizational, and technological factors associated with adoption and usage of HIE by these ambulatory clinics.
3. Examine the association between usage and outcomes derived from HIE.

Using a multi-method approach and drawing on a number of theories, our research objective in these goals is to identify and discuss the implications of our findings to research and practice. A conceptual model of the proposed research is shown in Figure 1.

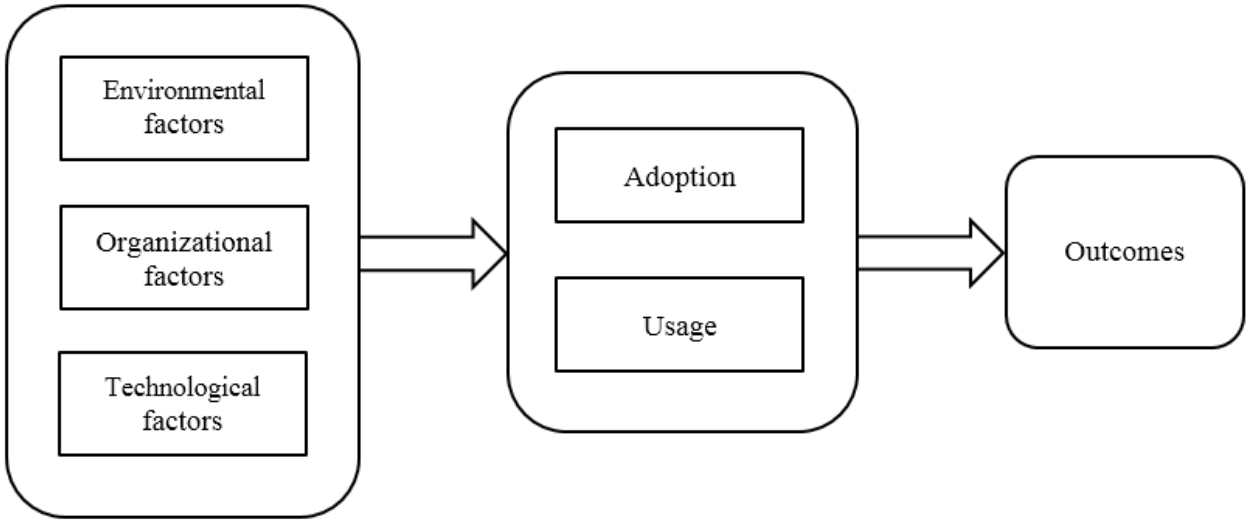

Figure 1.1. Conceptual model of factors affecting adoption, usage, and outcomes of HIEs.

2 LITERATURE REVIEW

The streams of literature reviewed are delineated in two sections. The first section is specific to the environmental, organizational, and technological contextual issues as they influence adoption and usage. The second section reviews studies of outcomes and value. Each section presents tables of relevant literature. The first table in each section is specific to HIE literature. The second is specific to other HIT systems, like EHRs. The third table in section 2.1.1 is non-HIT related literature.

The literature review tables listing work relevant to the EOT factors influencing adoption and usage have a column labeled "Key" that maps how the study fits within the conceptual model. The key mapping is shown in Table 1.

Table 2.1. Keys for mapping reviewed literature onto the EOT framework.

Key	Mapping
A	Environmental → Adoption
B	Organizational → Adoption
C	Technical → Adoption
D	Environmental → Usage
E	Organizational → Usage
F	Technical → Usage

At this early stage in the "diffusion of innovation" for HIE, there are no studies that have generalized results supported by statistically significant data from large samples. The empirical HIE studies reviewed are situationally specific and involve small sample sizes. Furthermore, the landscape for HIE, and HIT systems in general, is rapidly changing potentially rendering data

and analysis stale by the time studies are published, or soon thereafter. As such, much of what has been examined, even as of a few years ago, may have diminished relevance in the current environment. The primary focus, therefore, on HIE literature will be post 2004, the year President Bush called for the widespread use of EHRs within 10 years and created the Office of the National Coordinator for Health Information Technology (ONC) by executive order. However, most of the HIE literature, and much of the HIT literature in general, has been since 2009, the year ONC was legislatively mandated within the Health Information Technology for Economic and Clinical Health Act (HITECH) – itself a part of the American Recovery and Reinvestment Act of 2009.

Recent studies specific to adoption and usage of HIEs are few. However, in the last few years the number of operational HIEs has grown from about 55 in year 2009 to 119 in year 2012 with a market penetration of approximately 30% of hospitals and 10% of ambulatory practices participating in one of the HIEs (Adler-Milstein et al. 2013), though this varies considerably among states (Adler-Milstein et al. 2014). Consequently, the number of publications concerning HIE has grown, with twice as many publications in 2012 compared to 2008 based on our initial literature collection. However, as previously noted, most are not rigorous academic studies and very few examine actual use. As such, the extant scholarly literature on current HIEs is tenuous.

1.4 Factors Influencing Adoption and Usage

Environmental factors include: regulatory policy (Fontaine et al. 2010b), care provision (ER, chronic, etc.), financial incentives (Fontaine et al. 2010b; Gold et al. 2012; Patel et al. 2011; Ross et al. 2010), and payer reimbursement structure and incentives (Fontaine et al. 2010b; Ross et al. 2010). Technical assistance and support is also a major concern of providers (Fontaine et

al. 2010a; Fontaine et al. 2010b; Patel et al. 2011; Ross et al. 2010) with availability of support having a positive affect (Patel et al. 2011; Ross et al. 2010).

Despite existing environmental pressure from government, it has been suggested that stronger policies and incentives may be needed to convince organizations to electronically share patient health data (Adler-Milstein et al. 2014). Trust in HIE partners was a major issue (Ross et al. 2010; Rudin et al. 2009). Practices with meaningful professional and social networks appeared to be especially favorable settings for HIE adoption (Ross et al. 2010). It is unknown whether competition is influential on the decision to adopt as there are very few studies considering this aspect. One study reported it as a factor (Vest 2010), and another study as not a factor (Pevnick et al. 2012).

Organizational factors include organizational characteristics (Vest et al. 2010), strategic planning (Fontaine et al. 2010a; Zheng et al. 2009), strategic goals (Rudin et al. 2009), and organizational readiness (Korst et al. 2011; Lee et al. 2007; Zheng et al. 2009). Reported organizational challenges include poor planning, lack of tangible goals, and inadequate accountability (Melvin 2009). In a 2006 survey of primary care physicians, one-third cited the lack of a strategic plan as a difficult or insurmountable barrier to implementing major IT applications, and 52% cited lack of financial support as a difficult or insurmountable barrier (Anderson et al. 2006a). Since the HITECH act of 2009 funds Regional Extension Centers across the country that provide resources, consultation, education, and provisioning services to help primary care providers achieve meaningful use of EHRs (HealthIT 2010a), concern for financial support and strategic planning resources in the years since is unknown.

Factors of organizational readiness have included leadership, resources, and organizational policies (Korst et al. 2011; Lee et al. 2007; Zheng et al. 2009), as well as

economic decisions (Fontaine et al. 2010b; Huang et al. 2014; Patel et al. 2011; Pevnick et al. 2012), improved operational efficiency (Fontaine et al. 2010b; Ross et al. 2010), competition (Vest et al. 2010), and workflow (Ross et al. 2010; Rudin et al. 2009; Unertl et al. 2012).

Technical factors affecting HIE include the information technology needed to access an HIE, such as an EHR (Patel et al. 2011), and issues of interoperability (Edwards et al. 2010; Fontaine et al. 2010a; Fontaine et al. 2010b). Patient confidentiality and security of patients' PHI is an issue that involves technical solutions, regulations from state and federal authorities, and organizational policies and procedures. Security of PHI is a major concern among providers (Edwards et al. 2010; Fontaine et al. 2010a; Fontaine et al. 2010b; Pevnick et al. 2012; Rudin et al. 2009). Of the studies reviewed, technical factors were only considered for their effect on adoption, but not usage.

A major technical issue is that there does not yet exist a single standardized terminology and data communication protocol in support of HIT systems interoperability (Edwards et al. 2010). The development of a common ontology for electronically communicating clinical information is beset with complication and difficulty as terminology between medical practices differs. Since HIE is about information retrieval and transmission between disparate systems possibly using different data models, mapping becomes a non-trivial issue. Although one of the functions of an HIE is to provide a translation, or mapping, between coding schemes, concerns of interoperability have been expressed as a barrier to adoption (Fontaine et al. 2010a; Fontaine et al. 2010b).

Patient confidentiality and security of PHI is a socio-technical issue influenced by federal and state regulation, organizational policies and procedures, and technological solutions that is a

major issue in the adoption of HIEs (Fontaine et al. 2010a; Fontaine et al. 2010b; Pevnick et al. 2012; Rudin et al. 2009), as are the economics of security (Huang et al. 2014).

It has been argued that patient confidentiality as covered by the Health Insurance Portability and Accountability Act of 1996 (HIPAA) and the HITECH act are insufficient in protecting the rights of patients (Kam 2012). Indeed, such is the concern among patients about their PHI that in one study 12.3% of U.S. adults reported withholding medical information from healthcare professionals to protect their privacy (Agaku et al. 2014). There are mixed results as to the extent patient confidentiality and PHI security influence decisions to adopt and use HIT. Some studies show it ranks low among barriers to the adoption of HIT systems (Singh et al. 2012; Wright et al. 2010), or will decline after implementation (Ludwick et al. 2009). Other research indicate that it is a more serious barrier (Adler-Milstein et al. 2013; Pevnick et al. 2012). An analysis of these studies seems to indicate that there is far greater concern about patient confidentiality and PHI security prior to adoption than after implementation. While there is no shortage of publications lamenting the seriousness of patient confidentiality and PHI security, often with prescriptive solutions, there are very few rigorous academic studies examining this issue. One notable exception is a study of the effect of state privacy regulation on the diffusion of EHRs in hospitals (Miller et al. 2009). In this study, researchers concluded that state privacy regulations restricting hospital release of health information reduces aggregate EHR adoption by more than 24%. They present evidence that suggests this is due to the suppression of network externalities. This finding is of particular importance to the study of HIEs as its success will be strongly influenced by network externalities given the very nature of HIE. No study was located that examined this effect among ambulatory clinics. Additionally, there is little evidence of competitive concern (Pevnick et al. 2012).

Table 2.2. Relevant HIE studies on adoption and usage.

Citation	Goals/Purpose	Methods	Key Findings	Map
(Adler-Milstein et al. 2014)	Are current policy efforts addressing key barriers to HIE participation by hospitals?	Secondary analysis of American Hospital Association's IT Supplement.	Majority of hospitals do not engage in HIE. Some types of hospitals feel they are better off not participating. Stronger policies and incentives may be needed to convince organizations to electronically share patient health data.	A
(Huang et al. 2014)	Determining optimal level of security investment by healthcare organizations using HIEs.	Economic decision analysis and mathematical modeling.	With smaller providers it is highly unlikely that their optimal investment would reach the level necessary to capture the business benefit from the HIE they belong to. The result is that larger member organizations invest enough for all to enjoy the business benefit that a HIE brings, while smaller providers "underinvest" and cover their own risks.	A, C
(Adler-Milstein et al. 2013)	To determine what types of stakeholders are participating in HIEs, and what types of data are being exchanged. What are the barriers to using HIEs?	National survey of 119 operational HIEs as of July 1, 2012.	Despite increase in the number of HIE efforts, participating hospitals and ambulatory clinics, significant challenges remain. These include – sustainability of business model, funding, lack of features in HIE technologies, inadequate participation of stakeholders.	D, E, F
(Vest et al. 2013)	Identify the strengths and weaknesses of organizational models to achieve exchange.	Interview of state and national policy experts. N = 17. Analyzed using general inductive and comparative approach.	Identified challenges with the regional health information organization (RHIO) model of facilitating exchange including: economics, organizational issues, and geography. RHIO contrasted against Direct, enterprise HIE, and vendor-mediated exchange. HIE is a difficult undertaking due to political and economic reasons.	A
(Yaraghi et al. 2013)	Study of interlinked network effects between two physician groups.	Model development and statistical analysis. Testing on 1060 physicians over 32 months.	Interlinked effects stronger than intragroup. Primary care physician influence stronger on specialists than vice versa.	D
(Gold et al. 2012)	Examination of market and regulatory forces influencing provisions laid out by the HITECH act of 2009.	Expert opinion and analysis of EHR and HIE adoption issues as envisioned and incentivized by HITECH.	Identification of key drivers and challenges in the adoption of EHRs and HIEs, as well as issues important to providers. Discussion of HITECH progress and measures of success.	A

Citation	Goals/Purpose	Methods	Key Findings	Map
(Pevnick et al. 2012)	Understanding of perceived costs and benefits to provider organizations for joining an HIE.	18 semi-structured interviews with 10 healthcare organizations (networks, hospitals and associations) participating in Long Beach Health Network.	Transcripts thematically coded and aggregated. No respondent expected HIE to result in a net financial benefit. Many expressed concerns about data security. Little evidence of organizational concern regarding loss of patients to other organizations.	B, C
(Unertl et al. 2012)	Understanding of how HIE fits into clinical workflows.	Ethnographic qualitative study of six emergency departments.	User and role-specific customization to accommodate differences in workflow needs, may increase the adoption and usage of HIE.	E
(Vest et al. 2012)	Sought to examine factors associated with HIE usage during ambulatory care visits to safety-net clinics.	Secondary analysis of centralized HIE database. Includes patient encounters between January 2006 and June 2009 inclusive.	Odds of HIE access higher for patients recently visiting emergency department. System use may be more related to an organization's usage policy. HIE integration with EHRs may be a better fit for clinical workflow than standalone HIE access.	D, E
(Vest et al. 2011b)	Determine the key factors associated with HIE usage (none, basic, and novel usage – classification based on the interface screens accessed when providing care).	Secondary analysis of patient-level clinical dataset from an emergency room in an operational HIE in TX. Encounters occurred from January 2006 through June 2009.	Actual usage of HIE is very low in emergency rooms. Degradation of use occurred over time. Odds of usage lower when time constraints increased. Novel usage was seen in familiar patients or patient revisits and in cases of prior hospitalizations; Complexity of the patient's condition and HIE usage was partially supported.	D
(Korst et al. 2011)	Development of readiness metrics for quality improvement in hospitals participating in an HIE.	On-line survey of 68 hospitals. Data analyzed using principal component and factor analysis.	Three domains from analysis are: quality improvement leadership, hospital resources, and compatible hospital policies. Most important factor predicting HIE success was organizational leadership traits that foster a culture of quality improvement.	E
(Patel et al. 2011)	To characterize physician attitudes and preferences toward HIE, and identity factors the influence interest.	Survey of 144 physicians in 2009, descriptive statistics.	68% of physicians indicated interest in using HIE in their practice. Most expected HIE to improve provider communication, coordination and continuity of care, and efficiency. Potential barriers to adopting and using include startup costs and available resources. A majority reported that technical assistance and financial incentives would positively influence their decision to adopt and use HIE.	A, B, C

Citation	Goals/Purpose	Methods	Key Findings	Map
(Fontaine et al. 2010a)	Understanding motivating factors for primary care practices to participate in HIEs.	Systematic literature review of publications from 1990 through September 2008.	Only benefit reliably documented were those regarding efficiency. Barriers include cost, privacy, liability, organizational characteristics (lack of strategic plan, misaligned incentives), and technical issues (lack of interoperability and lack of IT training and support).	A, B, C
(Fontaine et al. 2010b)	Examine factors that motivate or prevent small primary care practices from participating in an HIE.	Survey and interviews of nine primary care practices in Minnesota with fewer than 20 physicians. Data collected in late 2008 and early 2009.	No practice was fully involved with an HIE and most did not have HIE as part of its short-term strategic plans. External motivators for HIE included state and federal mandates, payer incentives, and increasing expectations for quality reporting. Internal motivators were anticipated cost savings, quality, patient safety, and efficiency. The most frequently cited barriers were lack of interoperability, cost, lack of buy-in for a shared HIE vision, security and privacy, and limited technical infrastructure and support.	A, B, C
(Dixon et al. 2010)	To develop a framework for evaluating costs, effort, and value of HIEs.	Literature review and survey of 23 HIEs to assess usefulness of framework.	Model assess measures for data (volume, use, and effort), implementation (architecture, costs), policies, and technology (cost, choices, characteristics). Respondents indicated framework contained useful measures for current and future HIE evaluation.	D, E, F
(Edwards et al. 2010)	What are the barriers to healthcare information systems interoperability?	Literature review of research through 2009.	Major barriers include, need for standards (particularly terminology standards), security and privacy concerns, economic loss to competitors, and complex and costly system interfaces.	A, C
(Ross et al. 2010)	Determine desired functions of HIE and potential motivators, barriers, and facilitators of adoption in small-to-medium primary care practices.	Case study of nine practices. Five used paper records and four were participating in an HIE.	Practices were motivated to adopt HIE to improve the quality and efficiency of care. The greatest facilitator of HIE adoption would be technical assistance and support during and after implementation. Financial incentives were also valued. Trust in HIE partners was a major issue, and practices with rich professional and social networks appeared to be especially favorable settings for HIE adoption.	A, B, C
(Vest 2010)	Examine the technological, organizational, and environmental factors for the adoption and usage of HIEs.	Secondary analysis of survey data from two databases for 4830 hospitals. Surveys were from 2007 through 2009.	Many factors associated with adoption were unassociated with use, and vice versa. Non-profit status, public hospitals, more live and operational applications, more emergency room visits, network membership, and the presence of physician portals all increased hospitals' odds of HIE adoption. Competition decreased odds of use.	A, B, C, D

Citation	Goals/Purpose	Methods	Key Findings	Map
(Wright et al. 2010)	Assess physician attitudes toward HIE and willingness to pay to participate in an HIE.	Survey and analysis of 1043 respondents in 2007.	Most respondents indicated that HIE would reduce costs, improve quality, and save time. Most were somewhat or very concerned about privacy. Just over half indicated willingness to pay an unspecified amount to participate in an HIE. Primary care physicians and those in larger practices tended to have more positive attitudes toward HIE.	A, D
(Rudin et al. 2009)	Examine the decision making process in selecting technical architecture and vendors by key stakeholders in HIE	Semi-structured interviews with fourteen stakeholders in 3 Massachusetts communities.	Key factors considered in decision making (fully centralized vs. peer-to-peer vs. hybrid architecture) include: performance concerns (workflow integration), technical complexity, security concerns, quality of care, alignment with strategic goals, trust among participants, and desire for independence.	A, B, C
(Melvin 2009)	Testimony before congressional subcommittee on health record sharing between Veterans Administration (VA) and the Department of Defense (DOD).	Government Accountability Office (GAO) describes achievements and challenges for EHR interoperability.	Using interoperable health IT is a complex goal that requires the involvement of multiple stakeholders and numerous activities taking place over an expanse of time. Departments have agreed to use certain vocabulary and messaging standards. Challenges have included inadequate accountability, poor planning, and lack of tangible goals.	E, F

Table 2.3. Relevant HIT studies on adoption and usage.

Citation	Goals/Purpose	Methods	Key Findings	Map
(Abbott et al. 2014)	Examination of barriers and facilitators to successful HIT implementations. Identification of gaps in HIT implementation literature.	A literature review resulting in six best practices that were applied to two HIT implementation studies to assess their applicability.	Diversity of settings precludes "one size fits all" approach to HIT implementation. Best practices can be adapted to improve implementation.	E, F
(Bhakoo et al. 2013)	Institutional environment examination of inter-organizational systems in a healthcare supply chain.	Theory-building case study using the three tiers of manufacturer, distributor, and hospital. Data collected from early 2007 to mid-2008.	Study shows how different institutional pressures manifest across different tiers in the supply chain. Also, how a differential mix of endogenous and institutional pressures lead to mixed organizational responses.	D
(Novak et al. 2013)	Understanding work adaptations to HIT implementation (barcode medication administration).	Two qualitative studies of in-patient settings using observation and ethnographic fieldwork.	Collisions in frames during implementation of new technology result in adaptations at the individual and organization level. Adaptations found to be a means of evolving both the work routines and the technology.	E
(Avgar et al. 2012)	Examination of organizational structures and processes affecting HIT adoption.	Development of a framework based on management research literature.	Highlights specific organizational barriers and enablers at different stages of adoption (investment, implementation, and use), and at different levels of decision-making (strategic, operational, and front-line).	B
(Bradley et al. 2012)	Understanding of the antecedents and consequences of IT governance on hospital performance.	Empirical testing of survey data from 164 CIOs of U.S. hospitals.	IT governance influences the technology's contribution to hospital performance as measured by market responsiveness, external relationship management, and operational IT effectiveness.	D, E
(Callaway et al. 2012)	Examination of the determinants of adoption of IT by primary healthcare clinics	Secondary analysis of HIMSS 2006 database for seven types of clinics, and the U.S. County Health Rankings.	Adoption probabilities vary by clinic type. Geographic location was significant to adoption likelihood, as was state. Health IT is diffusing at a faster rate over time.	A

Citation	Goals/Purpose	Methods	Key Findings	Map
(Currie 2012)	Examining institutional isomorphism in healthcare. Longitudinal analysis of government policy to modernize healthcare using IT	140 interviews at 10 UK hospitals and document analysis of government reports and websites, and other sources in the UK.	Although early adopters of EHR desire to improve performance, coercive, mimetic, and normative forces come into play. Institutional isomorphism was revealed in the health field where established clinical routines, norms, and behaviors were not amenable to top-down policy changes to bring about abrupt institutional change.	D, E
(Singh et al. 2012)	National assessment of EHR adoption in rural primary care offices.	Mail survey to 5200 primary care offices. Conducted in 2007-2008.	Perceived barriers to EHR adoption greater, and perceived benefits less, by offices without EHRs compared to barriers and benefits experienced by those offices with EHRs.	B, C, E, F
(Ash et al. 2011)	Investigation of the facilitators and barriers to a clinical decision support system by independent physicians in a community setting.	Interviews and observations of 27 clinicians in nine clinics.	Facilitators and barriers analyzed for eight dimensions: 1) hardware and software, 2) clinical content, 3) human computer interaction, 4) people, 5) workflow and communication, 6) internal organizational features, 7) external rules and regulations, and 8) measurement and metrics.	D, E, F
(Lluch 2011)	Identify and categorize organizational barriers to the use of HIT.	Systematic literature review covering 79 articles.	Five main headings (Structure of organizations, tasks, people policies, incentives, and information and decision processes) and 10 subcategories identified for categorizing barriers. Incentives for overcoming barriers discussed.	E
PwC Health Research Institute (2011)	Understanding of security and privacy concerns, challenges, and implications in a HIT environment.	Survey of more than 600 healthcare professionals and executives	Four security and privacy challenges are identified and discussed: EHR access and data sharing control, requirements for business associates, secondary data use, and virtual touch points like social media.	C, F
(McAlearney et al. 2010)	Synthesis of best practices for ambulatory EHR system implementation, emphasizing strategies that maximize physician adoption and usage.	Extensive literature review and interviews with 47 informants at six sites.	Good versus great approaches to implementation categorized. “Great” included a focus on optimization and improvement over time, and included explicit considerations of improved data capture and quality of care.	B, E

Citation	Goals/Purpose	Methods	Key Findings	Map
(Carayon et al. 2009)	Evaluation of EHR implementation in small family clinic.	Longitudinal design with surveys, interviews, and work analysis pre and post implementation.	Time spent by physicians per patient did not change. Increases of computer use by clinical and office staff offset by time savings of manual chores. Qualitative and quantitative methods provided complementary information.	E
(Jensen et al. 2009)	Illustrate use of combining institutional theory with sense-making theory using an empirical study of an EHR implementation.	Theoretical development illustrated from a qualitative, interpretive case study of an EHR	Findings address the phenomenon of implementing EHRs at three levels: the organizational field, the organizational/group, and the individual/socio cognitive level. Evidence of a strong human agency by showing how doctors enact their work practices and shape the use of the EHR system. Theory able to link macro-states that 'frame' the behavior of individual actors with the situated actions and interpretations of the individual actors that (re)construct macro-states.	D, E
(Jha et al. 2009)	Estimate of EHR adoption by U.S. acute care hospitals.	National survey of U.S. acute care hospitals in 2008. 2,952 hospitals responded.	Based on a 63% response rate, only 1.5% of U.S. hospitals have a comprehensive EHR, and 7.6% have a basic EHR. Larger hospitals and teaching hospitals were more likely to have an EHR. Capital requirements and high maintenance costs cited as barriers more so by non-adopters.	B, E
(Miller et al. 2009)	Quantification of effect of state privacy regulation on diffusion of EMRs.	Secondary analysis of the 2005 HIMSS Analytics Database.	Claims that state privacy regulation restricting hospital release of health information reduces aggregate EMR adoption by hospitals by more than 24%. Evidence presented suggests that this is due to the suppression of network externalities.	A, D
(Zheng et al. 2009)	Assessment of the organizational readiness and pre-implementation planning for EHR in an ambulatory practice.	Strategy development based on experience and case study of an EHR implementation in an ambulatory clinic at a university health center.	Discussion of the organizational readiness assessment, pre-implementation planning, and key technology considerations for this type of practice. A research-based formative evaluation designed to ensure an implementation's long-term success is presented and discussed.	B
(DesRoches et al. 2008)	Assessment of physician adoption of EHRs in ambulatory care settings.	National survey in late 2007 and early 2008 of 2758 physicians.	4% reported having a fully functional EHR, and 13 % reported having a basic system. Adoption varied by practice type and geographical location. Users of EHRs reported positive effects on quality measures and high levels of satisfaction. Financial barriers viewed as having greatest effect on decisions about the adoption of EHRs.	A, B, D, E

Citation	Goals/Purpose	Methods	Key Findings	Map
(Hagen et al. 2008)	A Congressional Budget Office report on the costs and benefits of HIT.		"But many providers, especially primary care physicians in small practices, might gain relatively little from implementing such a system because their practice would be too small to benefit from the efficiencies it would create."	
(Leu et al. 2008)	To describe how HIT functions within an ambulatory clinical context.	Interviews and comparative analysis in 2007 of eight organizations with over 400 sites.	Systematic characterization of clinical context identified six primary clinical domains, including inter-clinic coordination. Participants suggested that underlying workflows for these domains must be fully operational to ensure successful deployment of HIT.	A, B, D, E
(Harrison et al. 2007)	Understanding of interactions and consequences between HIT and the organization's sociotechnical environment.	Development of conceptual model: Interactive Sociotechnical Analysis. Illustrated with cases from published research.	Five types of sociotechnical interaction presented: 1) New HIT changes existing social system, 2) Technical & physical infrastructures mediate HIT use, 3) Social system mediates HIT use, 4) HIT-in-use changes social system, and 5) HIT-social system interactions engender HIT redesign. Comparison against other models.	B, E
(Lee et al. 2007)	Examine RFID adoption decisions by 126 hospitals. Majority were in some stage of evaluation and only four actively using RFID.	Survey of hospital executives. Structural model development, and statistical analysis methods used.	The three categories of factors posited: technology push, need pull, and presence of champions are strengthened or weakened by organizational readiness.	B, C, E, F
(Anderson et al. 2006a)	Assess current level of IT use by primary care physicians in the U.S.	Web-based survey with 1,665 usable responses. Analysis of four types of systems: EHR, e-prescribing, decision support, and electronic communication	Perceived benefits related to quality and efficiency. Notable barriers were lack of financial support, vendor's inability to deliver acceptable products, difficulty proving quantifiable benefits, lack of strategic plan, and considerable investment in IT applications.	A, B, C, E, F
(Fonkych et al. 2005)	Examination of factors and characteristics of HIT adoption in healthcare.	Literature review and analysis of secondary data and archival databases.	Factors that influence HIT adoption in in-patient and ambulatory clinics. Small ambulatory practices are slow adopters of EHR. Managed care seems to be important for ambulatory EHR adoption.	B, C

Citation	Goals/Purpose	Methods	Key Findings	Map
(Zheng et al. 2005)	Assess adoption of a clinical reminder system among residents in an urban teaching hospital.	Longitudinal, correlational study using quantitative and qualitative analysis of 41 medical residents across 10 months in 2002.	Quantitative analysis delineates three types of user adoption behavior: light, moderate and heavy usage. Qualitative analysis reveals that clinicians of distinct types tend to exhibit views of the system consistent with their demonstrated adoption behavior.	B, C

Table 2.4. Non-health IT relevant studies on adoption and usage.

Citation	Goals/Purpose	Methods	Key Findings	Map
(Schooley et al. 2010)	How to manage IT collaboration of multi-organizational services	Framework development.	Timely responses rely heavily on data exchanged via shared IT systems, inter-organizational relationships, and governance mechanisms for collaboration.	D
(Wang et al. 2009)	To understand how organizations contribute to and benefit from community learning	Model development and empirical examination.	Roles of different players contributed to community learning at different stages of adoption.	A, D
(Baker 2012)	Description of the technology-organization-environment framework.	Literature review	Book chapter describing the technology-organization-environment framework. Examination of different ways in which the framework has been adapted for various contexts.	A, B, C, D, E, F
(Grandon et al. 2004)	Examination of determinant factors of strategic value and adoption of electronic commerce.	Model development and empirical test. Survey in spring 2002 with 100 respondents. Statistical analysis.	Confirmatory factor analysis corroborated organizational support, managerial productivity, and decision aids as significant in the perception of strategic value. For adoption, perceived usefulness, perceived ease of use, compatibility, and external pressure were found to be statistically significant.	A, B, D
(Kuan et al. 2001)	Understanding factors affecting small business adoption of EDI.	Statistical testing of technology-organization-environment framework.	Framework is a useful approach for examining factors affecting adoption decisions. Perceptions of indirect benefits by small firms different than by large firms. Differences between adopters and non-adopters noted.	A, B, C
(Premkumar et al. 1999)	Identify the state of various information and communication technologies and factors of adoption in small businesses in rural communities	Model with 10 variables under the three categories of innovation, organizational, and environmental characteristics. Collection using structured interviews with 78 responses.	Multivariate discriminant analysis used for predicting adoption of information and communication technologies. Analysis indicated that relative advantage, top management support, organizational size, IT expertise, external pressure, and competitive pressure are important determinants of adoption.	A, B
(Thong 1999)	Development of integrated model of IS adoption in small businesses.	Survey and theory development.	Small businesses with certain CEO, innovation, and organizational characteristics are more likely to adopt IS. Extent of adoption is mainly determined by organizational characteristics.	B, E

1.5 Studies of Outcomes and Value

There are a number of studies from other fields germane to our research on HIEs. These include studies of technological innovations in general, and information systems adoption and usage in other fields, such as electronic data interchange (EDI) and supply chain management.

The growth of HIEs since HITECH was enacted has been driven primarily by the Meaningful Use (MU) program set up by the act and administered by ONC. Meant to bootstrap the healthcare industry's use of IT solutions, MU pays hospitals and providers for demonstrating meaningful use of IT, including the electronic transfer of clinical health information facilitated by HIEs (HealthIT 2010b). Federal funding was also made available to states to either develop their own HIE or to fund a third-party provider. Since this funding is limited in duration, a major concern going forward is the financial viability of HIEs. One study showed that lack of funding is of much greater concern by those HIEs in the planning stage compared to those that are operational and that 74% of HIE efforts report struggling to develop a sustainable business model (Adler-Milstein et al. 2013).

Table 2.5. HIE specific studies relevant to outcomes.

Citation	Goals/Purpose	Methods	Key Findings
(Feldman et al. 2013)	Examine value of HIE for uncompensated care cost recovery.	Case study of three organizations (Social Security Administration, an HIE, and a health care system) covering period from August 2009 to July 2010.	HIEs valuable for uncompensated care cost recovery. Findings suggest value propositions are recursive driven by organizational factors requiring support of technical and governance actions.
(Campion Jr et al. 2012)	Examine the effect on Push vs Pull HIE on physician usage and satisfaction. (Push is a point-to-point data transmission, and pull refers to multisource data aggregation.)	Survey of 99 physicians whose practices were provided HIE services by HEALTHeLINK or Rochester RHIO	Physicians are more satisfied with push HIE than pull HIE. HIE impact on the physician practices was assessed using perceived improvements in the following areas: • Privacy and security of personal health information • Quality and safety of care • Communication with other providers • Administrative efficiency • Access to accurate information • Access to complete information • Access to timely information • Ordering potentially redundant tests
(Frisse et al. 2012)	Examine the financial effect of HIE use in emergency departments (ED).	Archival study of EDs across a 13 month period (Jan. 2007 through Dec. 2008) in Memphis drawn from a Tennessee Hospital Assoc. database.	HIE access was associated with a net cost savings of $1.07 million over the 13 month period examined. Hospital admission reductions accounted for 97.6% of total cost reduction.
(Kern et al. 2012)	Assess the effect of HIE on ambulatory quality (15 measures of clinical quality)	Retrospective cohort study of 138 primary physicians in small group practices in New York State.	Comparison of physician-users and non-users of a HIE portal showed modest, yet significant improvements (7% absolute improvement and 12% relative improvement) in ambulatory care quality.
(Herwehe et al. 2012)	Assessment of using Louisiana Public HIE (LaPHIE) for real time clinical messaging for HIV/AIDS cases.	HIE usage analysis between February 2009 and end of January 2011.	LaPHIE alerts medical providers when individuals with HIV/AIDS who have not received HIV care for >12 months are seen at any ambulatory or inpatient facility in an integrated delivery network. LaPHIE successfully reduces critical missed opportunities to intervene with individuals not in care.

Citation	Goals/Purpose	Methods	Key Findings
(Feldman et al. 2011)	Investigate blended value propositions for collaboration in HIEs.	Case study of a HIT prototype between Social Security Administration and Beth Israel Deaconess Medical Center.	Documents technical (inter-operability and establishment of standards), business (perceived value of the initiative) and socio-organizational (leadership, managing expectations, alignment with organizational mission) factors in creating a blended value proposition for HIT collaboration.
(Fontaine et al. 2010a)	Understand motivating factors for primary care clinics to participate in HIEs and the value they derive from it.	Systematic literature review of publications through September 2008.	A positive return on investment has not been documented. The only benefit reliably documented were those regarding efficiency.
(Afilalo et al. 2007)	Assess effect of Internet communication (email and Web portal) on continuity of care.	Randomized controlled trial of 23 family practices and 2022 emergency department (ED) visits.	Compared to notifications by postal mail, the email notification and Web portal access resulted in higher rates of information receipt, more useful information, better knowledge of ED visits, and improved continuity of care.
(Walker et al. 2005)	Assess value of HIE between providers, labs, pharmacies, payers, and others.	Literature review, expert panel assessment, and analytical framework development.	Projects cost savings to overall healthcare system in 10 year time frame. Little discussion on other benefits. Little assessment of value at the organizational level.

Table 2.6. HIT studies relevant to outcomes.

Citation	Goals/Purpose	Methods	Key Findings
(Bassi et al. 2013)	To explore how key components of economic evaluations have been included in evaluations of health information systems.	Literature review of published papers from January 2000 to June 2012 that included an economic evaluation of a health information system.	33 papers selected that analyzed eight different types of health information systems including one HIE. In terms of value for money, 23 reported positive findings, eight were inconclusive, and two reported negative results.
(Kern et al. 2013)	To determine the effect of EHRs on ambulatory quality in a community-based setting by comparing providers using an EHR against those who did not.	Included all general internists, pediatricians and family medicine physicians who: were members of the Taconic Independent Practice Association, had patients in a data set of claims aggregated across five health plans, and had at least 30 patients per measure for at least one of nine quality measures selected by the health plans.	Positive association between EHRs and ambulatory quality in a community-based setting. EHR use was associated with significantly higher quality of care for four of the measures: hemoglobin A1c testing in diabetes, breast cancer screening, chlamydia screening, and colorectal cancer screening.
(Meyerhoefer et al. 2013)	Investigation of outpatient EHR integration with hospital EHR, and effects on physician productivity and health outcomes.	Mixed methods; interviews at two OB/GYN outpatient practices, and regression model testing.	Installation and use of EHR over a four year period led to a reduction in productivity, a reduction in negative health outcomes, and influenced clinical practice norms.
(Litwin et al. 2012)	Theorize likely sources of measurement error when performing HIT performance analysis.	Review of management literature in application of HIT performance studies.	Focus on seven issues likely biasing downward the effect of HIT. These are: negative self-selection, omitted or unobserved variables, mismeasured contextual variables, mismeasured HIT variables, lack of attention to adoption-implementation stage being examined, too short of a time horizon, and inappropriate units of analysis. Specific recommendations to address these issues are discussed.
(Das et al. 2011)	Analysis of different categories of IT investment in healthcare.	Analysis of state database on hospitals at the organizational level. Data spanned 26 years.	Communications IT had the most economic value effect on hospital productivity, followed by transactional support IT, and then administrative IT. Patient management IT had a minimal economic value effect.

Citation	Goals/Purpose	Methods	Key Findings
(Setia et al. 2011)	To investigate the effects of IT assimilation and use on the financial performance of hospitals.	Statistical analysis of archival data on 272 hospitals in California.	Longevity of IT application architecture, i.e. years of experience with business IT systems, was found to have positive, significant impact on financial performance of hospitals. However, the assimilation effects manifest differently when examining clinical process vs. business process domains.
(Baker et al. 2008)	Investigates how IT assets are related to each other and to hospitals' productivity.	Framework development and empirical testing of archival data in HIMSS Analytic Database for 2006 and 2007.	Framework relating IT hardware, systems, and spending to productivity. Indications that on-site IT personnel play a key role in improving hospital productivity, and is preferable to outsourcing.
(Hagen et al. 2008)	A Congressional Budget Office report on the costs and benefits of HIT.	Literature review and expert opinion.	Evidence on the benefits of adopting HIT; the costs of implementing HIT; possible factor to explain the low rates of HIT adoption; and the federal role in implementing HIT.
(Menachemi et al. 2008)	To explore the relationship between IT adoption and quality of care in acute-care hospitals.	Statistical analysis of primary and secondary data.	Hospitals that adopted a greater number of IT applications were significantly more likely to have desirable quality outcomes.
(Mongan et al. 2008)	Essay on approaches to reducing medical expenditures.	Analysis of public proposals for medical cost savings.	Recommendations include: 1) modification of payment reimbursement, 2) implement effectiveness review bodies, 3) maximize support for EHR with decision-support, 4) enhance the standardization of healthcare transactions, 5) support end-of-life quality improvements, and 6) provide support for prevention programs.
(Devaraj et al. 2003)	Tests the proposition that IT impact is from actual use of IT, and not the investment in IT.	Field study and longitudinal analysis of archival records and logs in six hospitals.	Evidence that investments in technologies have positive payoffs when actual usage is considered. Study suggests lagged effect of payoff from investment.

3 THEORIES AND HYPOTHESES

The EOT framework was developed from research on technology innovation and diffusion to give context to the process by which organizations adopt and implement technological innovation (Tornatzky et al. 1990). The three elements described by Tornatzky and Fleischer are the environmental context, organizational context, and technological context.

The environmental context is considered the arena in which an organization conducts its business. This includes its industry, competitors, vendors, and the government. The environment presents both constraints and opportunities for technological innovation. Innovation related information plus human and financial resources can come from any of the players in the environment. However, the same players can constrain innovation activity through government policies and regulations, capital availability, and restrictions on information flow (Tornatzky et al. 1990). We consider the major influences of government, patients, information exchange affiliates, and peers.

The organizational context as defined by Tornatzky and Fleischer (1990) consists of the descriptive elements of an organization (size, structure, resources, etc.), informal linkages, internal communication, transactions, and decisions. Also considered are mechanisms key to boundary-spanning linking structures in the organization's orientation to the external task environment, the integration within the organization, and the cost of increased information processing for decision making (Galbraith 1973). One need for linking structures is the need for task coordination communication (Allen 1986). In the HIE context, communication for care coordination is critical.

The technological context describes both the internal and external technologies relevant to the organization. This includes current practices, processes, and equipment, as well as the pool of available technologies external to the organization. It is considered separately from the rest of the environment in order to focus attention on how features of the technologies themselves can influence the processes of adoption and usage (Tornatzky et al. 1990).

The EOT framework has been used to examine the factors of adoption for open systems (Chau et al. 1997), EDI (Kuan et al. 2001), RFID use in healthcare (Lee et al. 2007), inter-organizational systems (Grover 1993), as well as adoption of information systems by small businesses (Kuan et al. 2001; Thong 1999). Using the EOT framework, we draw on a number of theories in hypothesizing the factors affecting the processes of adoption and usage. We consider environmental factors through the lens of the institutional approach (DiMaggio et al. 1983; Powell et al. 1991; Scott 2014), organizational factors from an ambidexterity lens that categorizes decisions and actions as either explorative or exploitative (March 1991), and technological factors are considered using resource dependency theory (Pfeffer et al. 2003; Ulrich et al. 1984), and an integrated three-perspective theory (Parks et al. 2011), consisting of the institutional approach, the resource-based view (RBV) of the firm (Barney 1991; Penrose 1959), and ethical responsibility (Culnan et al. 2009; Mason et al. 1995; Smith et al. 1999). The research model is shown in Figure 2.

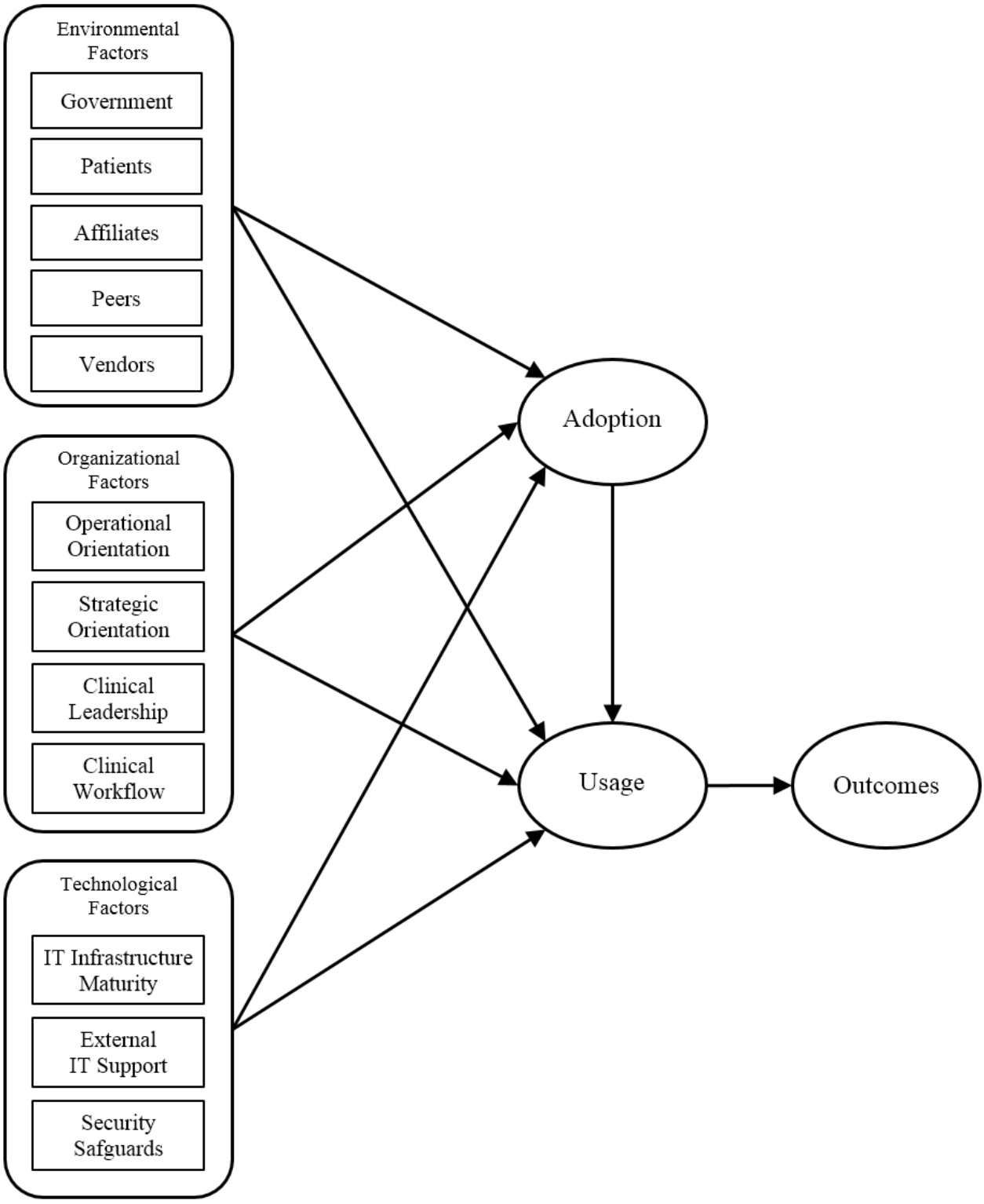

Figure 3.1. Research model using the Environmental-Organizational-Technological framework.

1.6 Environmental Factors

The need to consider environmental influences on organizational decisions and behavior may seem obvious and easily asserted (Downey et al. 1975). Though researchers have classified environmental factors according to levels of specificity, immediacy, and relevance to the organizational phenomena of interest (Beard et al. 1988; Child 1972; McKelvey 1982), consideration of environmental factors that are contextually relevant present challenges. Considering components of a task environment, Dill (1958) outlined four major factors: (i) customers, (ii) resources, (iii) competitors, and (iv) regulatory groups. Aldrich (1979) considered essential features of relations between organizations and environment by focusing on the processes of variation, selection, retention, and struggle. According to Aldrich, the environment is more than just elements, but a concentration of resources, power, political domination, and other organizations. A codification of environmental dimensions consistent with the population-ecology and resource-dependence conceptualization of the interaction of organization and environment considers *munificence* (capacity), *complexity* (homogeneity-heterogeneity, concentration-dispersion), and *dynamism* (stability-instability, turbulence) as a means to build both descriptive and normative theory about organization-environment relationships (Dess et al. 1984). It is from these perspectives that we consider five influential factors.

We examine five factors based on the literature and current developments. These are: government agencies, patients, information exchange affiliates, professional peers, and vendors. 'Government' consists of the federal and state agencies with oversight or jurisdiction over healthcare entities. 'Patients' are the subpopulation cared for by the focus organizations. 'Affiliates' are the healthcare organizations with which a focus organization exchanges patient information. 'Peers' are all other healthcare professionals with whom the focal organization has

contact. This may include members in professional associations, competitors, and others. 'Vendors' are those providing EMR and other HIT systems, particularly those participating in a coalition to provide an interoperable service between members systems. The following subsections define these entities and hypothesize their association with HIE adoption and usage.

1.6.1 Government Measures

Ambulatory clinics face significant influence in the form of mandates and financial incentives from government to adopt and implement HIE. Influence from government entities primarily comes from federal and state agencies. The Department of Health and Human Services (HHS) is the primary federal agency charged with administrating, overseeing and enforcing the rules, regulations, and incentives defined by the federal government. Additionally, CMS administers the Meaningful Use program that financially incentivizes healthcare organizations to use HIT and HIE. Furthermore, each state has its own regulatory environment and may administer incentive programs for the use of HIT, some of which may be federally funded. State public health agencies may also mandate or promote electronic reporting for public health surveillance. We may find that mandates and incentives affect adoption and usage differently. Mandates may have more effect on adoption where incentives may be more important to use.

The Meaningful Use program, designed in part to entice healthcare providers to electronically exchange patient health information, has already influenced a number of healthcare organizations to adopt and use HIE (Fontaine et al. 2010b; Patel et al. 2011; Ross et al. 2010). As such, we expect to find that government financial incentives are positively associated with ambulatory clinics adoption and use HIE. Another financial incentive that is influencing healthcare providers is the favorable reimbursement rates for those that adopt the

value-based reimbursement model being implemented by CMS. This model requires the use of HIT for information sharing and reporting (Fontaine et al. 2010b; Ross et al. 2010). We believe that the pressure to move toward value-based reimbursement by CMS, the largest payer in the U.S., and influential on private payer policy, will positively influence ambulatory clinics to adopt this reimbursement model. Given government mandates and associated financial incentives, we hypothesize,

H1a: Greater government measures is associated with higher adoption of HIE by ambulatory clinics.

H1b: Greater government measures is associated with higher use of HIE by ambulatory clinics.

1.6.2 Patient Preference

Patient use of IT for healthcare management is growing (McMullan 2006; Rai et al. 2013). In addition to using the Internet to search for health related information, healthcare providers are increasingly offering patients electronic access to their medical records through Internet portals, particularly those providers seeking to meet Meaningful Use requirements (Neuner et al. 2014). As patient use of IT for managing their health and medical needs grows in sophistication, so too will the complexity of information management needed to meet patient expectations. HIEs provide the functionality to coalesce, summarize, and present medical information to patients. Furthermore, with the development of patient-centered medical home in support of coordinated care and value-based reimbursement models (Williams et al. 2012), ambulatory clinics may come under greater pressure from patients for access to their medical

information than other healthcare organizations, particularly since most primary-care physicians work in small practice settings (Kane et al. 2013). As such, we hypothesize,

H2a: Greater patient preference is associated with higher adoption of HIE by ambulatory clinics.

H2b: Greater patient preference is associated with higher use of HIE by ambulatory clinics.

1.6.3 Affiliate Participation

Ambulatory clinics interact with hospitals, laboratories, specialists, pharmacies, care facilities, and others in providing clinical care to patients. Affiliates are defined here as those healthcare organizations with which the focal organization exchanges patient health information in the clinical care of their patients. Clinics routinely send and receive patient health information to and from these affiliates. Those affiliates using HIE, especially larger hospitals, that are in a dominant position relative to the clinic may exert pressure on the clinic to use HIE. With ambulatory clinics likely in a less dominant relationship with hospitals, and perhaps other affiliates, we expect to find coercive pressure from affiliates that use HIE.

As organizations learn from affiliated organizations that have adopted an innovation, they are more likely to be behave similarly (Burt 1987). This social effect has been examined for HIE and found to be strong as expected in the professional culture of healthcare (Lichtenstein et al. 2010). Even if coercive pressure is not experienced by a clinic from affiliates, they may experience normative pressure, particularly as the number of affiliates using HIE grows. These influences are even more pronounced when integration between organizations is seen as beneficial (Ugrin 2009). As such, we hypothesize,

H3a: Greater affiliate participation is associated with higher adoption of HIE by ambulatory clinics.

H3b: Greater affiliate participation is associated with higher use of HIE by ambulatory clinics.

1.6.4 Peer Pressure

Shared norms stemming from professionalization among members of a network have the potential to influence organizational behavior (DiMaggio et al. 1983). Two important aspects of professionalization are: the legitimization afforded by formal education as a cognitive base, and the growth and elaboration of professional organizations across which new models rapidly diffuse (DiMaggio et al. 1983). Both of these aspects are arguably prevalent in healthcare.

As noted above, peers, as defined here, are the other healthcare professional organizations with which the focal organization has contact and not considered an affiliate. This may include members in professional associations, competitors, and others.

As organizations learn from peers about their use of HIE as a result of professionalization and other peer contact, so might their motivation for using HIE increase. It has been suggested that small business knowledge about an innovation and its benefits does not translate into adoption in part due to the complexity of knowledge transfer and organizational learning needed to adopt and use the innovation (Parker et al. 2007). As peers realize benefits and experience success in their use of HIE they become mediating institutions in the transfer of knowledge (Attewell 1992). As a result, organizational knowledge about HIE grows, as possibly does their desire to mimic the success of peers. Hence, we hypothesize,

H4a: Greater peer pressure is associated with higher adoption of HIE by ambulatory clinics.

H4b: Greater peer pressure is associated with higher use of HIE by ambulatory clinics.

1.6.5 Vendor Pressure

The number of hospitals and healthcare systems acquiring and using EHRs is growing (McCann 2014b; Wood 2013), as is the number of vendors providing EHR solutions (ONC 2014). In addition, vendor coalitions to provide interoperability between their products have taken root (Zina Mou 2014). Several major EHR vendors (Allscripts, Athenahealth, Cerner, Epic, Greenway, and McKesson) are members, along with several healthcare systems (CVS Caremark, UnitedHealth Group, Walgreens, Surescripts, and Kaiser Permanente), and others in one of two coalitions – Carequality and CommonWell Health Alliance – designed to provide a common HIE interoperability framework between EHR systems (CareQuality 2014; CommonWell 2014; Zina Mou 2014). In addition, the two coalitions are in discussions about how to make interoperability work between them (Zina Mou 2014). The rise of these two coalitions with the goal of providing its members with interoperability solutions will position vendors with product offerings that include HIE. As such, we hypothesize,

H5a: Greater vendor pressure is associated with higher adoption of HIE by ambulatory clinics.

H5b: Greater vendor pressure is associated with higher use of HIE by ambulatory clinics.

1.7 Organizational Factors

We consider organizational factors of ambulatory clinics through the lens of ambidexterity as adopted by organizational theorists (Cao et al. 2009; Gibson et al. 2004; Gupta et al. 2006; He et al. 2004; Lubatkin et al. 2006; March 1991). The human trait of ambidexterity referring to equally competent use of both hands was adopted as a metaphor by researchers to explain the dynamics of organizational knowledge-processing classified as either explorative or exploitative. The theory of classifying decisions and actions as explorative or exploitative arose within a theory of learning. According to March (1991), exploration is about searching for new possibilities and knowledge with the goal of discovering new ways to address an issue, solve a problem, or interact in the environment. Whereas exploitation is about variance reduction and improved efficiency through the application of existing competencies or the refinement of existing technologies. The choices made within the context of these two categorizations is greatly influenced by the dynamic between organizational disposition and environmental variation. On one hand is the scope and intensity of environmental influences driven by various forces (e.g. the market, regulatory, competition, etc.), and on the other is the response to the environmental turbulence as determined by organizational disposition. This organizational disposition arises from the organization's strategy, resources, top management, and other characteristics that together form and influence decisions and actions in response to the environment. This disposition may also be dynamic as an organization cycles through, or switches between, the two dispositions of exploitation and exploration. It is through this lens that we consider the focal organization's orientation toward HIE.

There exists conceptual ambiguity as to whether ambidexterity concerns relative balance between the two activities or their combined effect, or both (Cao et al. 2009). As such, the

construct has been operationalized in different ways (He et al. 2004; Lubatkin et al. 2006). Cao et al. (2009) argued that the balance between the two activities versus the combination of the two are conceptually distinct dimensions with different causal mechanisms. Their research indicated that high levels of both dimensions provide synergistic effects that positively affect organizational performance. Furthermore, they find that the balance dimension is more influential to resource constrained organizations, and the combination dimension more beneficial to those with access to internal or external resources. With ambulatory clinics likely resource constrained, at least for internal resources, we would expect the balance dimension to be of greater influence in our context.

In addition to the two issues above is one of temporality. How ambidexterity plays over time expands the conceptualization of this multifaceted construct. In developing a typology for ambidexterity's conceptualizations, antecedents, and outcomes, Simsek et al. (2009) proposed a temporal dimension and a structural dimension. The first dimension considers the extent to which ambidexterity is pursued simultaneously versus sequentially over time. This allows for capturing the organizational capabilities needed to support the simultaneous pursuit of exploration and exploitation and those needed to implement switching between the two. The structural dimension considers whether ambidexterity is realized within an independent organizational unit independent or within interdependent units. Juxtaposing these two dimensions in a two-by-two representation depicts four ambidexterity types. Of interest to our research here is the type the authors label as *cyclical ambidexterity*.

Cyclical ambidexterity occurs in organizations that engage in long periods of exploitation with occasional or sporadic episodes of exploration. This concept is grounded in the literature on punctuated equilibrium (Gersick 1991). In this model, ambidexterity is not obtained structurally

from separate organizational units, but by sequential allocation of resources that switch between exploitation and exploration. Simsek et al. (2009) describe the punctuated equilibrium model as placing heavy emphasis on exploration. Though infrequent, this change is needed for altering the ingrained structures developed and solidified during long periods of exploitation and incremental change. From this perspective, "The changes accompanying exploration are radical and competence-destroying in nature (Simsek et al. 2009)." The switching of emphasis between exploitation and exploration, also known as cycling (Raisch et al. 2009), in an independent organizational unit involve changes in formal structures and routines, practices and procedures, and resource allocation.

This model aptly fits that of small organizations who are not structurally organized for ambidexterity and operate for extended periods of time in an exploitative frame. These organizations cycle into an explorative frame as driven by factors that will lower costs and improve efficiency. In our context, ambulatory clinics using procedures of sending and receiving patient health information that involve manual methods (e.g. fax) and may require hours or days to complete are faced with HIE technology that improves efficiency and lowers the cost of this process. HIE as a disrupter to long established methods of exchanging patient information requires a clinic to shift from an exploitative orientation into an explorative frame to consider and act upon this new technology.

1.7.1 Orientation toward HIE

We define orientation toward HIE as a generalized organizational disposition that is influenced by (i) planned strategy for the use of HIE, and or (ii) a focus on cost and efficiency. We believe these two important key factors likely influence the adoption and usage of HIE by

ambulatory clinics. Strategic intent has been a significant determinant of IT adoption and usage in general (Chen et al. 2010; Ives et al. 1984; Leidner et al. 2011; Piccoli et al. 2005), and HIT adoption and usage in particular (Anderson et al. 2006b; Baker et al. 2008; Cao et al. 2012; Raghupathi et al. 2002). Clinics may consider HIE as a strategic tool rather than just an automation or administrative tool. That is, as a tool towards the attainment of new services and revenue as enabled by HIE versus using it solely for automating a process.

HIE provides the means by which healthcare organizations can efficiently send and receive patient health information in the course of clinical care. HIE also enables cost savings by lowering the resources and time need to send and receive patient health information compared to existing methods; primarily faxing and waiting for responses. Whereas setting goals and having plans is an exploratory orientation, an organization that focuses on operational efficiency demonstrates an exploitative orientation.

Being operationally or strategically focused defines a clinic's orientation toward HIE. A focus on cost control and efficiency has been found to be a significant determinant of HIT adoption in healthcare organizations (Bardhan et al. 2013; Chaudhry et al. 2006). Whereas, strategic goals and planning were determined to be important for sustainable HIE success (Fontaine et al. 2010a; Rudin et al. 2009; Zheng et al. 2009), and poor planning and lack of tangible goals were found to present challenges to exchanging electronic health records (Melvin 2009). Being operationally focused is an exploitative position as it concerns selection, refinement, implementation, and efficiency. Planning strategically requires an explorative disposition in that it involves innovation, flexibility, search, and risk taking. As such, we hypothesize,

H6a: A greater exploitative (operational) orientation is associated with higher adoption of HIE by ambulatory clinics.

H6b: A greater exploitative (operational) orientation is associated with higher use of HIE by ambulatory clinics.

And,

H7a: A greater explorative (strategic) orientation is associated with higher adoption of HIE by ambulatory clinics.

H7b: A greater explorative (strategic) orientation is associated with higher use of HIE by ambulatory clinics.

The processes of IT adoption and usage can also be viewed through the lens of ambidexterity; the ability to balance, or switch between, both an exploitative and explorative orientation (Cao et al. 2009). Juxtaposing a clinic's orientation toward HIE against the processes of adoption and usage provides insight into the organizational factors driving the decisions of ambulatory clinics. Those organizations with both an exploitative (operational) and explorative (strategic) orientation demonstrate ambidexterity.

1.7.2 Clinical Leadership

Key to effective organizational ambidexterity is leadership (Raisch et al. 2008). Successful leadership depends upon collaborative behavior in the adoption and assimilation of IT (Miranda et al. 2001; Poon et al. 2004; Schuster et al. 2003). Collaborative behavior depends on the quantity and quality of information exchanged with an emphasis on joint decision making,

and has been found to have a positive effect on both exploitation and exploration in small- to medium-sized organizations (Lubatkin et al. 2006).

In addition, it is well understood that the predisposition of the top management team towards IT, as well as their understanding of the potential of IT, is a predictor of successful IT implementation that accelerates adoption and assimilation of IT in organizations (Armstrong et al. 1999; Liang et al. 2007; Thong et al. 1995). Moreover, in addition to mere support, management's active engagement in critical IT projects has been found to be important to their success (Blake et al. 2010; Korst et al. 2011; Martin et al. 2007). For instance, Blake et al. (2010) found that leadership supporting a spirit of collaboration lead to the success of an HIT implementation. In the HIE context, Korst et al. (2011) found that the most important factor predicting HIE success was organizational leadership traits that foster a culture of quality improvement.

Smaller ambulatory clinics are more likely to be owned and operated by physicians (Kane et al. 2013). Even in those clinics managed by non-clinicians, it is the clinical leadership who are the likely decision-makers regarding the adoption and assimilation of clinical HIT systems. This group is, in essence, the top management team of the clinic; certainly as it pertains to clinical HIT systems. In such an organization where ambidexterity plays an important role, as argued above, we believe that strong clinical leadership traits in support of HIE, as well as clinical leadership traits that support ambidexterity, are vital to success in ambulatory clinics. Hence, we hypothesize,

H8a: Stronger clinical leadership is associated with higher adoption of HIE by ambulatory clinics.

H8b: Stronger clinical leadership is associated with higher use of HIE by ambulatory clinics.

1.7.3 Clinical Workflow

It has long been reported in the information systems literature that process-awareness and process-design is critical to successful IT strategy (Grover et al. 2005; Silvius et al. 2013), and IT systems implementation (Kohlbacher 2010; Patas et al. 2012; Tarafdar et al. 2007). Indeed, over time information systems have evolved from a focus on functionality to a focus on workflow (Sheth et al. 1996; Weber et al. 2008) as IT often enables process automation (Nissen et al. 2000; Scheer et al. 2004). For information systems to be successfully adopted and utilized, organizations need to redesign their key business processes so that they can take advantage of the capabilities offered by advanced IT systems (Al-Mashari et al. 1999; Venkatraman 1994). Such process-oriented systems are developed to provide the right functionality at the right time to the right persons.

Understanding clinical workflow is necessary for the successful adoption of HIT (Dadam et al. 2000). Research shows that clinicians heavily consider the effect of EHRs on workflow (Bowens et al. 2010). Consequently, clinical workflow has increasingly become a topic of research for HIT adoption (Aarts et al. 2007; Niazkhani et al. 2009). Addressing issues that interfere or impede clinical workflow before, during, and after HIT implementation is a major focus by clinicians in the process of adoption and usage of HIT (Leu et al. 2008) that has been recognized as important to small ambulatory practices (Lorenzi et al. 2009).

Workflow has been identified as a major issue to the adoption and usage HIE (Ross et al. 2010; Unertl et al. 2012). In their study of small-to-medium sized family practices, Ross et al.

(2010) found that some practices were open to reengineering workflows with HIE adoption, but most wanted HIE to complement their existing workflows. Unertl et al. (2012) identified two general role-based HIE usage models related to workflow and concluded that role-specific customization to accommodate differences in workflow needs may increase the adoption of HIE.

Ambulatory clinics may be rigid in their use of existing methods for exchanging health information. For instance, their use of a fax machine. The introduction of HIE in this setting might pose a level of concern about clinical workflow disruption as to engender resistance to the adoption and or use of HIE. The ability of ambulatory clinics to integrate HIE into their clinical workflow is, therefore, critical to its success. Hence, we hypothesize,

H9a: Compatibility or adaptability of clinical workflow is associated with higher likelihood of adopting HIE in ambulatory clinics.

H9b: Compatibility or adaptability of clinical workflow is associated with higher likelihood of using HIE in ambulatory clinics.

1.8 Technological Factors

Since IT competencies are a determining factor of success toward IT adoption and usage by small organizations (Caldeira et al. 2003), we consider the effect of three technological factors critical to the adoption and usage of HIE by ambulatory clinics: IT infrastructure maturity, external IT support, and electronic security and privacy. These factors are critical in consideration of an inter-organizational system (IOS), like HIE. An IOS can be characterized as a higher-order system in that it is predicated on the interconnectedness of existing IT systems. In order to build this higher-order IOS, a level of organizational ITI maturity must either exist or be developed. An IOS links external entities so by its very nature will require some level of external

IT support. This is compounded when organizational knowledge and skill to adopt and implement an IOS is limited, as is likely with smaller organizations. Information security is also an inherent factor in IOS as data are exposed outside the control of an organization. This, too, is compounded as the sensitivity of healthcare data are great and their protection paramount to patient trust, as well as the extent of government regulation to ensure its security.

1.8.1 IT Infrastructure Maturity

An organization's IT capability derives from underlying strengths in IT infrastructure (ITI), human IT resources, and IT-enabled intangibles (Bharadwaj 2000). ITI has been characterized simply as computers, software, data, and communication networks that are integrated and interconnected (Rockart et al. 1996), or more broadly as a set of shared, tangible IT resources forming a foundation for business applications (Duncan 1995). ITI as a construct has been viewed as consisting of both the technical infrastructure and the human IT resources, which consist of the knowledge, skills, and competencies required to effectively manage the technical infrastructure (Byrd et al. 2000). Combined, this ITI provides organizational applications, services, and capabilities that, over time, evolve (mature) to provide improved organizational performance (Bharadwaj 2000) as organizations seek to derive value from their IT investments (Kumar 2004). We consider ITI as described by Byrd and Turner.

The concept of information systems maturity dates back to the 1970s with proposals for measuring four stages of growth, thereby providing insight into an organization's IT infrastructure, its effect on business value, and its potential for growth (Gibson et al. 1974; Nolan 1973). Since then, various maturity models have been developed for assessing information systems technology and processes. In healthcare, there are several process focused maturity

models. Examples include, the U.K.'s National Health Service (NHS) Infrastructure Maturity Model to provide a scoring of key performance indicators relevant to ITI capabilities (National Health Service 2014), a picture archiving and communication systems (PACS) maturity model for assessing adopting of medical imaging technology (van de Wetering et al. 2009), a maturity model for telemedicine implementation (Van Dyk et al. 2012), and a HIT maturity model focused on assisting CIOs and senior IT management in hospitals in enhancing their IT organizational capabilities (IVI 2013). Specific to ambulatory clinics, Healthcare Information and Management Systems Society (HIMSS) has developed the Ambulatory EMR Adoption Model (A-EMRAM), a framework designed to help stakeholders focus on EHR usage metrics needed for achieving higher levels of access, quality, efficiency, and safety (HIMSS 2014).

The nature and context of this study calls for consideration of a properly scoped measure of ITI maturity. In addition to adopting a view of ITI as described by Byrd and Turner (2000), we consider the A-EMRAM framework in developing a measure appropriate to ITI maturity in ambulatory clinics. This includes the types and level of usage of existing IT systems and a measure of the knowledge and IT capabilities possessed by the organization.

Development of an IOS capability, like HIE, requires a certain level of ITI capability and investment to realize the higher-order process capabilities afforded by the technology (Rai et al. 2006). That is to say, a certain level of ITI maturity must exist in order to implement an HIE capability. Non-existent or low levels of ITI may present a formidable barrier to resource-challenged ambulatory clinics. Hence, we hypothesize,

H10a: A greater level of ITI maturity is associated with higher adoption of HIE for ambulatory clinics.

H10b: A greater level of ITI maturity is associated with higher use of HIE for ambulatory clinics.

1.8.2 External IT Support

External IT support refers to the availability or active engagement of an outside organization to provide services or products relative to the evaluation, adoption, implementation, and or operation of an information system. External IT support might be sought because of a lack or unavailability of internal resources (Cohen et al. 1990; Damanpour 1991). External support has long been identified as a major factor in the adoption of information systems (DeLone 1981; DeLone 1988), particularly among small- to medium-sized organizations (Premkumar et al. 1999; Thong et al. 1996; Zinatelli et al. 1996).

Ambulatory clinics may seek HIT support from consultants, vendors, service providers, parent organizations, professional associations, and government sponsored support groups. Examples of the latter include states office of health information technology (OHIT) designed to promote and support HIT, and the regional extension centers (RECs) funded under the HITECH Act to assist healthcare organizations, primarily smaller physician offices and clinics, with the selection, adoption, and implementation of EHR systems and HIE (HealthIT 2010a).

In considering the adoption of HIE, ambulatory clinics might not have the knowledge and resources needed to make an informed decision or be successful in its implementation. Because of the obstacles in developing or acquiring the requisite skills and knowledge, these clinics may postpone or forgo adoption. As such, we believe the availability of external resources to support HIE efforts play a critical role in its adoption. Hence, we hypothesize,

H11a: A greater level of external IT support is associated with higher adoption of HIE for ambulatory clinics.

H11b: A greater level of external IT support is associated with higher use of HIE for ambulatory clinics.

1.8.3 Information Security Safeguards

Issues of information security have long been considered by IS practitioners and scholars alike (Conway et al. 1972; Huang et al. 2010; Loch et al. 1992; Ware 1984; Whitman 2003). In an increasingly digitized world where organizations increasingly rely on IT to achieve their missions, information security has become even more critical (Bélanger et al. 2011; Greenaway et al. 2005). Concerns about, and publicity of, a range of digital threats from viruses to information theft have led organizations to be aware of, and attentive to information security safeguards (Liu et al. 2012; Panko 2009). In healthcare, advancements in sensing, computing, and electronic communications have given rapid rise to the capture, storing, and electronic transmission of patient health information as not previously known. Consumers already concerned about privacy and security of personal and financial information now face similar issues in healthcare.

To examine the safeguarding of information at an organizational level, we adopt the organizational privacy response (OPR) model, a three element theoretical perspective (Parks et al. 2011). Based on the work by Greenway and Chan (2005) who developed a typology of organizational privacy behavior, and incorporating ethical responsibility, Parks et al. developed a model that identifies four major types of responses to mitigate information privacy issues in

healthcare: technical safeguards, human safeguards, physical safeguards, and organizational processes.

Studies show mixed results of the effect of information security issues on adoption of HIT. Some find that it ranks low as a barrier to adoption (Singh et al. 2012; Wright et al. 2010), or will decline after implementation (Ludwick et al. 2009). While others have found that it is a more serious barrier (Adler-Milstein et al. 2013; Pevnick et al. 2012). An analysis of these studies indicates that there is far greater concern about information security issues prior to adoption than after implementation. As such, those practices and clinics that have considered or implemented information security safeguards are better positioned for implementing HIE. Hence, we hypothesize,

H12a: Greater information security safeguards is associated with greater adoption of HIE by ambulatory clinics.

H12b: Greater information security safeguards is associated with the use of HIE by ambulatory clinics.

1.9 Usage and Outcomes

As documented in a meta-analysis by Kohli et al. (2003), academic literature is replete with studies examining the relationship between IT investments and organizational performance. However, empirical studies support the proposition that it is the actual usage of IT, and not the investment, that leads to improved performance (Burton-Jones et al. 2006; Devaraj et al. 2003; Zhu et al. 2005). We adopt this proposition in our consideration of the effect of HIE usage on outcomes.

Prior studies have identified a number of outcomes affected by HIE usage including quality of care (Kern et al. 2012), efficiency (Fontaine et al. 2010a), and follow-up notifications

(Herwehe et al. 2012). Quality issues have included continuity-of-care (Afilalo et al. 2007), and a reduction in redundant test ordering (Campion Jr et al. 2012). Studies on EHR usage also report improvement in quality of care (Kern et al. 2013; Menachemi et al. 2008; Meyerhoefer et al. 2013) and efficiency (Das et al. 2011) thereby affirming the use of these measures in evaluating HIT. In addition to quality and efficiency, other outcome measures examined include: privacy and security of PHI, communication with other providers, and information quality measures including access to accurate, complete, and timely information (Campion Jr et al. 2012). Our literature review did not find any report of a positive financial return-on-investment from HIE, as also previously reported (Fontaine et al. 2010a). This is not unexpected considering HIE usage is arguably in its infancy.

A survey of 99 physicians whose practices used a common HIE revealed that the physicians were more satisfied with push HIE than pull HIE (Campion Jr et al. 2012). That is, directed exchange, most similar to faxing, was seen as more useful than querying an HIE for information. Of course, this study was cross-sectional and involved a young HIE that might not yet have the full capabilities or data repository to satisfy meaningful queries. However, it revealed that this difference in HIE type is germane to examining HIE usage.

Though HIE usage is nascent, it has been shown to provide value for a number of outcomes. Ambulatory clinics might realize value in a number of areas including: improved quality of care; a reduction in errors and risk; improved coordination with other care providers; more efficient inter-organizational communication; reduced administrative costs; and improved patient and clinician satisfaction. Information quality positively affects outcomes (Hartono et al. 2010). Quality of care, risk reduction, and patient safety are improved when information quality improves (Waegemann et al. 2002). Access to accurate, complete, and timelier information also

leads to increased engagement between providers and patients which further improves patient outcomes (Waldo 2003). Improved care coordination using HIE can also affect quality and safety (Frisse et al. 2012) and reduce the administrative cost of care coordination (Mongan et al. 2008). Administrative costs associated with the sending and receiving of patient information are positively affected as processes are made more efficient, reducing the time spent by clinicians and administrators in performing these tasks. Furthermore, improvement in all of these areas is expected to positively affect patient and clinician satisfaction. Our study considers the effect from HIE usage inside and outside of a healthcare system. We define "inside a healthcare system" as being within an overarching organization structure operating under common policy, procedures, and possibly using common IT, but not necessarily common ownership. "Outside a healthcare system" refers to entities not under the umbrella of focal's healthcare system, if any.

The outcome categories measured are:

- Satisfaction (patient and provider satisfaction, overall satisfaction with quality of care and care coordination)
- Information quality (accuracy, completeness, and timeliness)
- Administrative and operational efficiency (including cost reduction).

Hence, we hypothesize,

H13a: Greater HIE usage inside a healthcare system is associated with greater outcomes by ambulatory clinics.

H13b: Greater HIE usage outside a healthcare system is associated with greater outcomes by ambulatory clinics.

Prior research has shown that payoff in IT investments has a lagged effect (Devaraj et al. 2003; Peffers et al. 1996), and that cross-sectional studies conducted soon after an application is installed may fail to find benefits (Peffers et al. 1996). However, clinical outcomes may show lag effects of less than six months after changes in processes and workflow are implemented (Dickinson 1986; Joiner et al. 1996).

Because HIE is a nascent technology, particularly among ambulatory clinics, financial value is not addressed in this study, despite its potential for such. For instance, HIE has been shown useful in recovering uncompensated cost of care (Feldman et al. 2013). Additionally, it has been estimated that a national implementation of fully standardized information exchange between providers and other healthcare organizations would result in a savings of approximately 5% of the annual cost spent on healthcare in the U.S. (Walker et al. 2005). As performance-based reimbursement models are adopted by payers, the improved quality afforded by HIEs will likely affect financial value.

To test these hypotheses we developed a survey based on literature, professional opinion, and a pilot study. We then recruited administrators and clinical leaders in Illinois ambulatory practices and clinics to participate in our Web-based survey. The research design and results are presented in the following two chapters.

4 RESEARCH METHOD

1.10 Research Design

Chapter three setup the constructs that operationalize the conceptual model. The model is composed of three components: i) factors associated with adoption and usage of HIE, ii) adoption and usage of HIE and, iii) value of outcomes from usage of HIE. This theoretical model is based on an environmental-organizational-technological framework. Each of these three components draws on HIE, HIT, and IS literature and theory in defining the model's constructs. The study aims to understand how these aspects pertain to ambulatory clinics' adoption and usage of HIE, and the resulting value that arises from HIE usage, in three phases. Phase One consisted of qualitative interviews, focus groups, and the author's observations from participation in a HIE project with the Illinois Office of Health Information Technology (OHIT). The information distilled from Phase One led to the development of a Web-based survey comprising Phase Two. In this phase, a pilot survey with healthcare professionals led to refinement of the final survey, recruitment of participants, and collection of survey results. Phase Three is qualitative in nature and involved interviews with healthcare professionals to interpret and understand some of the findings from the survey.

1.11 Study Participants and Recruitment

This study draws from a population of healthcare providers and clinics in the state of Illinois. The target respondents were clinical and administrative leaders. We partnered with the two Illinois-based health IT regional extension centers (REC) for sending recruitment letters to ambulatory clinics. Health IT RECs were established in each state with funding from the 2009

Health Information Technology for Economic and Clinical Health (HITECH) Act. Their mission is to provide outreach and education to healthcare providers and organizations for implementing HIT and HIE solutions. As such, the constituents of Illinois' HITRECs are comprised of the vary practices and clinics that are the target of this study. Chicago Health IT REC (CHITREC), hosted by Northwestern University, primarily serves the Chicagoland area. Illinois Health IT REC (IL-HITREC), hosted by Northern Illinois University, serves the remainder of the state. Both RECs agreed to multiple mass emailings to their constituents in recruitment of survey participants. CHITREC also sent recruitment letters via fax to a list of constituents using fax as their preferred method of communication. Additionally, a list of Illinois rural health clinics was obtained from the Illinois Department of Public Health Web site and used to develop an additional list of potential respondents who were sent recruitment letters via fax and email by the author and graduate assistants. As incentive, a $15 gift card was offered to participants who completed the survey.

1.12 Data Collection

The Web-based survey was created using Qualtrics software made available online by the University of Illinois at Chicago. Access to the survey was made available to respondents via a hyperlink within the invitation email or provided URL Web address in the recruitment letter sent via fax. Recruitment emails and faxes were sent during February and March 2015. The survey remained available to respondents until early April 2015. The survey instrument, recruitment letter, and statement of informed consent (Appendix B) was submitted to the UIC Office for the Protection of Research Subjects (OPRS), the university's Institutional Review Board, with application for exempt status. After one revision approval from OPRS was granted. The full

recruitment letter and statement of informed consent were made available to potential participants via hyperlinks in the recruitment emails, and Web address on the recruitment faxes.

The primary constituency of CHITREC and IL-HITREC are small- and mid-sized practices and clinics that seek education and assistance in evaluating and implementing health information systems. Indeed, nearly half of the valid response were from clinics with less than 10 providers. Approximately 68% of responses were from IL-HITREC constituents across the state, 27% from CHITREC constituents in the Chicagoland area, and 5% from other statewide recruitment. Of the 2,949 recruitment emails and faxes sent, 383 completed the survey for an overall response rate of 13%. Survey responses were exported from Qualtrics in the form of a CSV file and imported into Excel for data cleansing and initial analysis.

1.13 Dataset Analysis

In general, answers to questions were on a five-point Likert scale. The questions from the survey used in this study are shown in Appendix A. The measurement item names and descriptions are given in appendix C. The calculation of scores for adoption and usage, both inside and outside a healthcare system, for the three groups – hospitals, clinics, other healthcare facilities – required a two-step procedure.

First, from the five categories available for indicating a clinic's stage of adoption or usage for each of seven data types, a value was assigned as shown in table 4.1. A respondent answer of 1 or 2 ("not capable, not planning" or "capable, not planning") is assigned a value of zero (0) to indicate that adoption had not occurred. An answer of 3 (planning, evaluation, or trial) indicates adoption but no usage, whereas an answer of 4 or 5 indicates not only adoption, but usage. As such, an answer of 3, 4, or 5 was assigned a value of one (1) to indicate that the

practice is adopting, or has adopted, electronic exchange. The value calculated for usage is weighted. An answer of 4 is given a value of one (1), and an answer of 5 is given a value of two (2). That is, a clinic that is entirely, or almost entirely electronically exchanging clinical patient data (rarely using other methods), is weighted higher than those using both electronic and other methods (e.g. fax, mail, etc.).

Table 4.1. Adoption and usage values for respondent indicated categories.

Indicated Answer	Category	Adoption Indicator	Usage Indicator
1	Not capable and not planning electronic exchange	0	0
2	Capable, but not planning electronic exchange	0	0
3	Engaged in planning, evaluation, or trial	1	0
4	Using electronic and other methods for exchange	1	1
5	Entirely, or mostly, using electronic exchange	1	2

The second step summed the scores for adoption and for usage for the seven data types. This produced an adoption score with a value ranging from 0 to 7, and a usage score from 0 to 14. This resulted in an adoption and usage score for both the “inside a healthcare system” and “outside a healthcare system” category for each of the three groups (hospitals, clinics, and other), for a total of 12 scores. These 12 scores are then used to form the four dependent (endogenous) variables (Adoption Inside, Adoption Outside, Usage Inside, and Usage Outside) in the structural model; one each from hospital, clinic, and other.

The survey cases were initially screened for completeness. All incomplete cases were dropped as there was insufficient reporting to be useful. Cases were then sorted by ‘number of providers at location’. Consistent with research goals, clinics with 100 or fewer providers were selected for further analysis, yielding a dataset of 326 cases. These cases were then imported into

SPSS (version 21) for developing descriptives and outlier detection. After pruning for outliers, the final dataset contained 321 cases.

We choose partial least squares structural equation modeling (PLS-SEM) to analyze our dataset. PLS is an ordinary least squares (OLS) regression-based technique. As such, the method focuses on the prediction of a set of relationships that maximizes the explained variance in the dependent variables. In addition, the PLS-SEM method exhibits a higher level of statistical power than other methods (Hair et al. 2011; Reinartz et al. 2009). The focus of PLS-SEM is, therefore, more on prediction than explanation, making it more suitable for exploratory research (Hair Jr et al. 2013). PLS places minimal restrictions on sample size, residual distributions, data distribution normality, model complexity, and can process formative constructs (Chin et al. 2003). Since our research is exploratory in nature, our model contains formative constructs, and our sample size would not meet the minimum requirements in a covariance-based (CB) SEM model given its complexity, we chose to use PLS-SEM for our analysis. For its ease of use and extensive reporting capability, SmartPLS version 3 (Ringle et al. 2015) was chosen as the software package for analyzing the structural model.

A two-step approach to modeling was employed that analyzes the two conceptually distinct measurement models and structural model (Anderson et al. 1988). The measurement model, also referred to as a factor model, specifies the relationships among the measured, or observed, variables underlying latent variables. The structural model describes the relationship among the latent variables (Schumacker et al. 2010). The assessment of the measurement model involves convergent validity for reflective latent variables, weights and significance for formative latent variables, and discriminant validity. The structural model is assessed by its path

coefficients and their significance, and the explained variance (R^2 values) of its endogenous variables.

1.14 Validity and Reliability

This section provides an assessment of the measurement model's convergent and discriminant validities (i.e. legitimacy), and their reliability (i.e. accuracy) scores. All predictor variables are reflective in nature, save one. ITI Maturity is a formative variable, as are the adoption and usage variables, and discussed separately as criteria for assessment of formative variables is different than that for reflective variables. Assessment was made with the measurement models in the context of the structural model.

1.14.1 Convergent and discriminant validity

Latent variable item loadings (outer-loadings in PLS parlance) along with average variance extracted (AVE) are used for examining convergent validity. Assessment of discriminant validity is made by comparing AVE, latent variable loadings (inner-loadings in PLS), and cross-loadings, as well as using the heterotrait-monotrait (HTMT) ratio of correlations based on the multitrait-multimethod matrix recently suggested as a method for evaluating PLS-SEM discriminant validity (Henseler et al. 2015). HTMT provides a quick and easy method to assess discriminant validity and is touted as overcoming the shortcomings of other methods. AVE, loadings, cross-loadings, and HTMT are reported in SmartPLS 3.

The measurement model of latent variables was made in the context of the structural model. The outer-loadings of the reflective latent variables to the measured items, along with AVE, are examined. The outer-loadings, also called indicator reliability, should be statistically

significant and, ideally, report a loading of 0.707 or higher (Hair Jr et al. 2013). A loading of 0.707 squared is 0.5, or 50%. As such, outer-loadings below .707 are candidates for removal, but may be retained for theoretical reasons. AVE is the grand mean of the squared loadings of the indicators. As such, AVE is the communality of the construct and any value below 0.5 indicates that, on average, more error remains in the items than variance explained by the construct (Chin 2010).

Five measurement items fell well below the threshold of 0.707 and were removed from consideration. All but five of the 41 remaining reflective items loaded onto their respective constructs at 0.707 or higher. The five below this threshold were close in value and deemed theoretically important and were retained. Appendix D shows the measurement item loadings onto their respective constructs.

For discriminant validity two assessments are made. The AVE is compared with the square of the correlations among the constructs as shown in Table 4.2. The squaring of construct correlations allows comparing the percentage of variance explained by a latent variable to the percentage of variance shared with other variables. Best practice is that the percentage of variance explained by a construct should be larger than its shared variance with another construct (Hair Jr et al. 2013). The correlation between the latent variables along with the square root of the AVE is shown in Appendix E.

Table 4.3 shows the HTMT ratios. Some authors suggest a threshold level below 0.9 confirms discriminant validity (Gold et al. 2001; Teo et al. 2008), whereas some suggest a more conservative value of 0.85 (Clark et al. 1995; Markus 2012). Only one relationship between constructs fails to be confirmed; that of patients with peers reported as 0.90. Using the more conservative 0.85 ratio for HTMT suggest a potential discriminant issue between the exploitative

orientation and explorative orientation constructs, workflow and external IT support, and the satisfaction construct with both information quality and operational efficiency.

1.14.2 Reliability

Assessments of reliability scores, a measure of internal consistency, were made by examining a composite reliability (CR) as developed by Werts, Linn, and Jöreskog (1974). This approach takes into account the different weights of the indicators, is not sensitive to the number of items in the scale, and is considered a closer approximation than other methods under the assumption that the parameter estimates are accurate (Chin 2010). For exploratory purposes, values as low as 0.60 to 0.70 are considered acceptable (Chin 1998; Nunnally et al. 1994). The scores shown in table 4.2 are only applicable to reflective constructs.

Table 4.2. Squared correlations among reflective constructs with average variance extracted and composite reliability.

CR	AVE		Govrn	Patnts	Affil	Peers	Vndrs	Exploi Orient	Explor Orient	Clin Ldrsh	Work Flow	Ext IT Sup	Sec Safgrd	Satisf	Info Qlty	Oper Effic
0.84	0.64	Government	1.00													
0.87	0.69	Patients	0.10	1.00												
0.87	0.68	Affiliates	0.10	0.47	1.00											
0.91	0.83	Peers	0.06	0.33	0.36	1.00										
0.91	0.84	Vendor	0.22	0.18	0.15	0.21	1.00									
0.88	0.71	Exploitative Orient.	0.10	0.34	0.38	0.30	0.17	1.00								
0.88	0.72	Explorative Orient.	0.13	0.39	0.39	0.28	0.24	0.49	1.00							
0.88	0.71	Clinical Leadership	0.25	0.18	0.19	0.12	0.14	0.30	0.27	1.00						
0.84	0.57	Workflow	0.18	0.38	0.38	0.16	0.09	0.36	0.29	0.34	1.00					
0.82	0.60	Ext IT Sup	0.11	0.30	0.25	0.17	0.09	0.30	0.28	0.22	0.36	1.00				
0.78	0.64	Security Safeguards	0.28	0.02	0.06	0.01	0.05	0.08	0.07	0.20	0.16	0.08	1.00			
0.89	0.67	Satisfaction	0.17	0.45	0.46	0.39	0.23	0.45	0.42	0.26	0.37	0.31	0.05	1.00		
0.85	0.65	Info Quality	0.11	0.28	0.27	0.25	0.14	0.30	0.29	0.16	0.23	0.17	0.01	0.48	1.00	
0.81	0.59	Operational Efficny.	0.07	0.33	0.30	0.24	0.15	0.30	0.27	0.16	0.29	0.18	0.01	0.43	0.26	1.00

Table 4.3. Heterotrait-Monotrait (HTMT) ratio of correlations.

	Govrn	Patnts	Affil	Peers	Vndrs	Exploi Orient	Explor Orient	Clin Ldrsh	Work Flow	Ext IT Sup	Sec Safgrd	Satisf	Info Qlty	Oper Effic
Government														
Patients	0.41													
Affiliates	0.39	0.90												
Peers	0.32	0.74	0.77											
Vendor	0.61	0.54	0.48	0.56										
Exploitative Orient.	0.41	0.75	0.77	0.69	0.50									
Explorative Orient.	0.47	0.80	0.77	0.66	0.60	0.87								
Clinical Leadership	0.66	0.54	0.54	0.43	0.46	0.69	0.66							
Workflow	0.58	0.82	0.80	0.52	0.38	0.78	0.69	0.75						
External IT Sup	0.47	0.77	0.68	0.56	0.39	0.75	0.72	0.65	0.85					
Security Safeguards	0.94	0.25	0.36	0.14	0.36	0.43	0.46	0.74	0.69	0.49				
Satisfaction	0.52	0.84	0.83	0.77	0.58	0.82	0.79	0.62	0.76	0.75	0.35			
Info Quality	0.39	0.68	0.67	0.64	0.47	0.69	0.66	0.47	0.61	0.56	0.26	0.85		
Operational Efficiency	0.37	0.81	0.76	0.69	0.53	0.75	0.72	0.54	0.76	0.62	0.27	0.87	0.73	

1.14.3 Formative variables

Whereas reflective variables capture aspects of a common dimension, formative variables are multidimensional with each measurement item contributing to its definition. i.e. The measurement items "cause" the state of the variable (Chin 1998). The objective to using a formative construct is to obtain weights that create the best score such that it maximally correlates with neighboring constructs. As such, PLS formative indicators are inwardly directed to maximize the structural portion of the model (Chin 2010).

The statistical evaluation criteria for reflective measures cannot be transferred to formative measurement models. Formative measures represent independent contributions and thus do not necessarily covary. Furthermore, formative measures are assumed to be error free, which means the internal consistency and reliability concept is inappropriate (Diamantopoulos 2006; Edwards et al. 2000). That is to say, the linear combination of the measurement items makes up all of the construct's variance. Additionally, convergent and discriminant validity criteria for reflective models are not appropriate. Instead, content validity is theoretically defined and the weights, their significance, and collinearity are used for their assessment (Hair Jr et al. 2013).

High correlations are not expected between items in a formative construct as they are considered independent contributors to the makeup of the construct. To assess, multi-collinearity is considered by examining the variance inflation factor (VIF) score, the reciprocal of tolerance. Tolerance represents the amount of variance of one formative indicator not explained by the other indicators (Hair Jr et al. 2013). This is computed in a two-step procedure. First, a given formative indicator, x, is regressed on the remaining indicators. The proportion of variance

explained by the other indicators is R^2x. The tolerance is then 1 – R^2x. Taking the reciprocal produces the VIF, a term derived from the degree in which the standard error has been increased due to the presence of collinearity. In particular, the square root of VIF. For example, a VIF of 4 would indicate that the standard error had doubled due to collinearity ($\sqrt{4} = 2$). A VIF of 5 or higher is considered indicative of a collinearity problem (Hair et al. 2011).

Another criterion for assessment of formative constructs is the significance and relevance of the formative indicators. PLS-SEM treats the formative latent variable as a dependent variable and the measurement indicators as independent variables to calculate a score in the context of the structural model. The indicator scores, or outer weights, provide their relative contribution to the construct. Along with the indictor's significance, the relevance of the indication can be assessed. Whereas the outer weight provides the relative contribution of an item, the outer loading provides the absolute contribution.

One predictor construct, ITI Maturity, and the four adoption and usage constructs are formative in nature. Appendix F shows the measurement item weights and VIF for the formative constructs. Since the theoretical definition of a construct is dependent on its measurement items, the absolute contribution (zero-order correlation or loading) must be considered in conjunction with the significance of an item's relative contribution (i.e. weight) (Cenfetelli et al. 2009). Unlike reflective models where measurement items may be dropped to improve a constructs validity, all the items in our reflective constructs are retained for theoretical adherence to its definition.

5 RESULTS

1.15 Descriptive Statistics

It was expected from the target population that the majority of respondents would be from small- to medium-sized practices and clinics. From the sample set we see this holds true. Respondents included providers (physicians, advanced practice nurses, and physician assistants), clinic administrators, and staff. Two indicators of organizational size here are the number of providers at the practice or clinic, and the number of clinic locations. Descriptive statistics of clinics in our sample is presented in Table 5.1. Nearly half of the respondent clinics (148/319, 46.4%) had less than 10 providers, one-third with 10 to 19 providers (106/319, 33.2%), with the remaining clinics having 20 or more providers (65/319, 20.4%). One-third of the respondent clinics (104/320, 32.5%) were single-location clinics, one-fourth (79/320, 24.7%) that operate with two locations, and only a small fraction (11/320, 3.4%) operated with nine or more locations.

In terms of ownership, slightly above half of the respondent clinics were partly or fully owned by a hospital or health system (170/315, 53.9%), and less than half of the clinics (135/315, 42.9%) were wholly owned by providers.

Size and ownership can affect a number of aspects concerning a clinic's operation. Those that are smaller in size or wholly provider owned are more likely resource constrained compared to larger practices or those partially or fully owned by hospitals or healthcare systems. Resources that can affect an organization's capability to adopt and use information technology can include finances, management capabilities, technical knowledge, and more.

Over one-half of the respondent clinics (171/321, 53.3%) are solo primary or specialty practices, and over one-fourth of the respondent clinics (87/321, 27.1%) belong to a primary care group. In addition, the practice specialty of over two-thirds of the respondent clinics (225/321, 69.5%) is either family medicine or pediatrics. The statistics for practice setting and clinic specialty mimic previous surveys.

Construct means and standard deviations are shown in Appendix G.

Table 5.1. Descriptive statistics of survey sample.

	Count	Percentage
Number of providers (N=319)		
From 1 to 4	66	20.7
From 5 to 9	82	25.7
From 10 to 19	106	33.2
20 or more	65	20.4
Number of clinic locations (N=320)		
1	104	32.5
2	79	24.7
From 3 to 5	96	30.0
From 6 to 8	30	9.4
9 or more	11	3.4
Ownership of clinics (N=315)		
Wholly owned by providers	135	42.9
Partially owned by hospital or system	123	39.0
Wholly owned by hospital or system	47	14.9
Do not know	10	3.2
Practice setting (N=321)		
Solo primary care	67	20.9
Solo specialty care	104	32.4
Primary care group	87	27.1
Single specialty group	36	11.2
Multi-specialty group	15	4.7
Other	12	3.7
Practice specialty (N=321)		
Family Medicine	107	32.7
Pediatrics	118	36.8
Urgent care	52	16.2
OB/GYN	15	4.7
Surgical (any)	9	2.8
Internal medicine	3	.9
Behavioral health	8	2.5
Other	11	3.4

1.16 Analysis of Structural Model

Structural equation modeling using PLS was conducted to examine the hypothesized relationships. SmartPLS (version 3) with pair-wise deletion for missing values, and a bias-corrected and accelerated bootstrapping technique (Efron 1987) using 2,000 subsamples for determining significance of all path and loading estimates was used for the analysis. The path coefficients have a standardized value between -1 and +1. Coefficients closer to +1 have a stronger positive relationship, and those closer to -1 have stronger negative relationship. The significance of path coefficients depends on its standard error which was determined using bootstrapping. As such, the bootstrapping 'individual sign change' option was selected to ensure that the bootstrap samples are made consistent with the original sample so as to avoid sign change related problems, such as an inflated standard error (Chernick 2008).

There is potential for common method bias with self-reported data. As such, we implemented remedies to minimize common elements between independent (predictor) and dependent (criterion) variables as suggested by Podsakoff et al. (2003) and implemented by Anderson and Agarwal in their study on the digitization of healthcare (2011). This included assuring respondent confidentiality, providing definitions and context to reduce ambiguity, and using a different item scale format for the independent and dependent variables. Additionally, since this is an organizational level study we believe that social desirability-biased responses will be minimal or non-existent.

To ensure sufficient statistical power, the general recommendation for PLS-SEM is 10 cases per number of predictors for any given variable (Hair Jr et al. 2013). This is in contrast to the rule-of-thumb for CB-SEM to have 5 (or 10) cases minimum per measurement item. The difference is based on PLS-SEM being iteratively calculated versus CB-SEM being

simultaneously calculated. Based on this recommendation, our model with 'usage' variables each having 13 predictors should, at a minimum, have 130 cases to ensure valid results. Our model, with 321 cases, is nearly 2 ½ times this recommendation.

PLS path modeling does not optimize a unique global scalar function (Hair Jr et al. 2013). As such, an index that can provide a global validation of the model, like chi-squared, is not available. The objectives of PLS-SEM and CB-SEM are different. Though a PLS goodness-of-fit measure has been proposed (Tenenhaus et al. 2004) and used as an index for judging PLS path models, simulation studies have shown it not to be suitable for model validation (Henseler et al. 2013). Our objective is in the predictive characteristics for exploratory purposes so we have adopted key criteria for evaluating PLS-SEM that include examining each set of predictors for collinearity, using bootstrapping to assess the significance of path coefficients, evaluation of R^2 values, contingent assessment of heterogeneity, and not using the proposed PLS goodness-of-fit (Hair Jr et al. 2013).

A major emphasis in PLS is on variance explained, with the predictive power of the structural model assessed by the R^2 values of the endogenous constructs (Chin 2010). Significant path coefficients and R^2 values are shown in Figure 5.1 for the structural model. (All path coefficients and R^2 values are shown in Appendix H) Our model explained 42% (R^2=0.42) of variance in HIE adoption and 54% (R^2=0.54) in usage within a healthcare system. For outside a healthcare system, our model explained 39% (R^2=0.39) of variation in HIE adoption and 55% of the variance in HIE usage (R^2=0.55) in which our sample clinics operate in Illinois. Furthermore, our model accounted for 36% variance in a satisfaction score from HIE usage (R^2=0.36), 19% variance in the perceived information quality resulting from HIE (R^2=0.19), and 18% variance in perceived operational efficiency gained (R^2=0.18) as a result of using HIE.

We have hypothesized for each factor that its association with both HIE adoption and usage. Based on our definition of adoption and usage our model includes a path from adoption to usage for both the inside and outside a healthcare system context. As such, there may be mediated effects by adoption to usage for a given factor that need to be accounted for in our assessment. To test whether mediation is occurring in any instance, we followed the technique developed by Preacher and Hayes (2004; 2008), and outlined by Hair et. al. (2013). This first required testing for significant direct effects without the mediating variable (adoption) in the model. Significant path coefficients to HIE usage (direct effect) indicated potential candidates for mediation. Using the full model, we then assessed the significance of the indirect effects. SmartPLS reports standardized coefficients for both indirect effects and total effects (i.e. direct effect + indirect effect) relieving us of multiple-step calculations. The significance of the effects were determined from bootstrapping. For each of the significant direct effects from the unmediated model, assessment of the significance for the indirect effects was made. If the indirect effect was not significant, then mediation is not occurring. Our analysis revealed four significant indirect effects. The next step was to calculate the 'variance accounted for' (VAF) to determine the size of the indirect effect relative to total effects. This indicator for the level of mediation is used as the final assessment with a VAF > 80% indicating full mediation, VAF between 20% and 80% indicating partial mediation, and VAF < 20% indicating no mediation (Hair Jr et al. 2013). Our calculation resulted in all four potential indirect effects being significant and having a VAF that ranged from a low of 30% to a high of 70% indicating partial mediation. These significant indirect effects are occurring for government, ITI maturity, and security safeguards inside a healthcare system, and for affiliates outside a healthcare system. This is discussed further for each variable in section 5.3 below.

Whereas previous studies have used a variety of methods to consider various factors to HIE adoption and usage including principal component and factor analysis (Korst et al. 2011), qualitative analysis with expert opinion (Fontaine et al. 2010b; Gold et al. 2012; Pevnick et al. 2012; Rudin et al. 2009), an ethnographic approach (Unertl et al. 2012), and many relying on analysis from descriptive statistics (Adler-Milstein et al. 2013; Adler-Milstein et al. 2014; Patel et al. 2011; Vest et al. 2013), we believe our study to be the first of its kind in assessing the effects of various factors on HIE adoption and usage using a structural model approach. Indeed, structural modeling has been used for IT adoption studies in healthcare (for example, cloud computing (Ratnam et al. 2014)), but not for HIE.

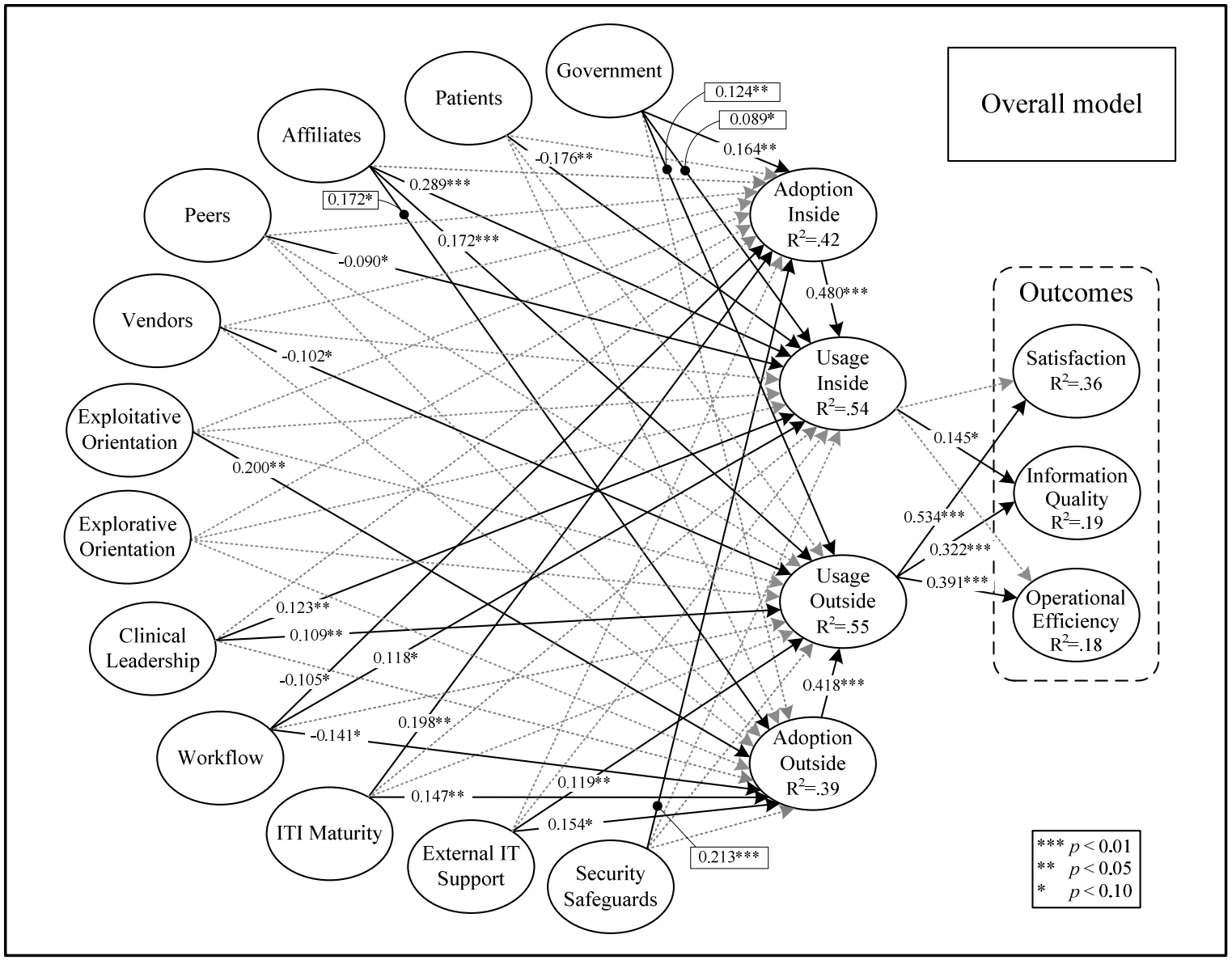

Figure 5.1. Path coefficients and R^2 for overall model.

1.17 Hypothesis Testing

Consideration of the hypotheses is made based on the significant paths of the structural model. Each predictor variable is associated with two adoption and two usage dependent (endogenous) variables. A significant path with the proper sign to any dependent variable is considered support for the given hypothesis. A summary of significant paths and hypotheses supported is given in table 5.2 below. A discussion of the findings is provided in chapter 6.

Environmental factors hypothesized as relating to HIE adoption and usage include government, patients, affiliates, peers, and vendors.

Government influence was hypothesized to be positively related to both adoption and usage of HIE among Illinois ambulatory clinics. We found a significant, positive association between government influence and (i) HIE adoption within a healthcare system (path coefficient = 0.164, $p< .05$), (ii) HIE usage within a healthcare system (path coefficient = 0.089, $p<0.10$), and (iii) HIE usage outside a healthcare system (path coefficient = 0.124, $p< 0.05$). However, our tests indicated significant indirect effects with HIE adoption mediating effects from government to HIE usage inside a healthcare system. As such, the total effect from government to HIE usage inside a healthcare system is stronger than indicated by the path coefficient alone (total effects = 0.168, $p<0.05$). The association between government influence and HIE adoption outside the health network was not statistically significant. Based on three significant path coefficients, we observe government influence in HIE adoption within a healthcare system and HIE usage outside a healthcare system. Taken together, we have support for government influence on HIE adoption and usage among ambulatory clinics. Hence, hypotheses H1a and H1b are supported.

Patient preference was hypothesized to positively relate to both adoption and usage of HIE among Illinois ambulatory clinics. The path between patient preferences and HIE adoption was positive but not significant inside a healthcare system. Contrarily, we found that HIE usage inside was significant but negative (path coefficient = -0.176, $p<0.05$). The path coefficient for HIE adoption inside a healthcare system was notable and positive, but not significant. The difference in sign for HIE in the inside context suggests possible differences between expectations and experiences. For HIE adoption and usage outside a healthcare system the path coefficients were low and not significant. Overall, H2a and H2b are not supported.

Affiliates was hypothesized to be positively related to both adoption and usage among Illinois ambulatory clinics. A positive path was indicated for HIE adoption inside a healthcare system but it was not significant. However, a positive and significant path was indicated for HIE usage for the inside context (path coefficient = 0.289, $p<0.01$). Indeed, the path coefficient for affiliates is the strongest of any factor for HIE usage inside a healthcare system. For HIE outside a healthcare system, both adoption (path coefficient = 0.172, $p<0.05$) and usage (path coefficient = 0.172, $p<0.01$) were significant. Furthermore, a significant indirect effect was indicated for the outside context. As such, the total effect from affiliates to HIE usage outside a healthcare system is higher than indicated by the path coefficient (total effect = 0.243, $p<0.01$). With indication that HIE usage in both contexts, and HIE adoption in the outside context is significantly associated with affiliates, hypotheses H3a and H3b are supported.

Peer influence was hypothesized to be positively related to both adoption and usage among Illinois ambulatory clinics. Surprisingly, this variable did not indicate strong associations with either HIE adoption or usage. The only significant association was with HIE usage inside a healthcare system and it indicated a negative, or inverse, relationship (path coefficient = -0.09,

$p<0.1$), suggesting a slight negative influence by peers in the use of HIE, and possibly HIT in general, inside a healthcare system. Given this evidence, H4a and H4b are not supported.

Vendor influence was hypothesized to positively relate to both adoption and usage among Illinois ambulatory clinics. The associations with HIE adoption and usage inside a healthcare system from vendors are weakly positive but not significant. Contrarily, we found the associations between vendors and HIE adoption and usage outside a healthcare system to be negatively related. For HIE adoption in the outside context, the relationship is not significant. However, vendor association with HIE usage in the outside context is negative and significant (path coefficient = -0.102, $p<0.1$). Given these findings, H5a and H5b are not supported.

The organizational factors hypothesized as relating to HIE adoption and usage for Illinois ambulatory clinics include an exploitative orientation, explorative orientation, clinical leadership, and workflow.

Exploitative Orientation was hypothesized to positively relate to both HIE adoption and usage among Illinois ambulatory clinics. For HIE inside a healthcare system, the associations were not significant. For outside a healthcare system, the relationship with HIE adoption was positive and significant (path coefficient = 0.200, $p<0.05$), suggesting that an organizational focus on operational efficiency is a factor for HIE adoption in this context. Indeed, this relationship indicated the strongest path coefficient of any factor for HIE adoption outside a healthcare system. However, the association between exploitative orientation and HIE usage in the outside context was weak and not significant. With indication that this organizational orientation influences decisions related to adoption, hypothesis H6a is supported. However, hypothesis H6b for usage is not supported.

Explorative Orientation was hypothesized to positively relate to both HIE adoption and usage among Illinois ambulatory clinics. All path coefficients for this factor were weak and not significant suggesting that an organizational orientation for strategic purposes is not influencing HIE adoption and usage. This was the only factor that did not have a significant association of any kind with this dataset. As such, hypotheses H7a and H7b are not supported.

Clinical Leadership was hypothesized to positively relate to both adoption and usage among Illinois ambulatory clinics. Associations with HIE usage for both the inside and outside a healthcare system context were significant, but with HIE adoption in both contexts it was not significant. This finding suggest that adoption decisions are not influenced by this organizational factor, but are strongly influential for actual usage, i.e. patient care. For HIE usage inside a healthcare system, the relationship was positive and significant (path coefficient = 0.123, $p<0.05$). Likewise, for HIE usage outside a healthcare system the relationship with clinical leadership was positive and significant (path coefficient = 0.109, $p<0.05$). These findings do not support hypothesis H8a, but hypothesis H8b is supported.

Clinical *Workflow* compatibility and adaptability was hypothesized to positively relate to HIE adoption and usage among Illinois ambulatory clinics. Surprisingly, adoption of HIE in both the inside and outside a healthcare system context indicated a negative and significant relationship. The association with HIE usage, however, indicated positive path coefficients for both contexts with only usage in the inside context being significant (path coefficient = 0.118, $p<0.10$). The relationship between workflow and HIE adoption inside was negative and significant (path coefficient = -0.105, $p<0.10$), as well as the relationship with HIE adoption in the outside context (path coefficient = -0.141, $p<0.10$). The finding that workflow is inversely compatible or adaptable with HIE adoption but is positively associated with HIE usage suggests

that workflow transformation may occur between these two stages of implementation. As a result of these contrary findings, hypothesis H9a is not supported, and hypothesis H9b is supported.

Technological factors hypothesized as relating to HIE adoption and usage include IT infrastructure maturity, external IT support, and information security safeguards.

IT Infrastructure Maturity was hypothesized to positively relate to both HIE adoption and usage. Its association with HIE adoption inside a healthcare system was positive and significant (path coefficient = 0.198, $p<0.05$), and its association with HIE adoption outside a healthcare system was positive and significant (path coefficient = 0.147, $p<0.10$). However, the indicated path coefficients for both HIE usage contexts was weak and not significant. However, a significant mediating effect was indicated for HIE usage inside a healthcare system. As such, the total effect by ITI maturity on HIE usage in the outside context is significant (total effect = 0.135, $p<0.10$). Taken together, this suggests that ITI maturity is important for HIE adoption decisions and indirectly affects HIE usage. As such, hypotheses H10a and H10b are supported.

External IT Support was hypothesized to positively relate to both HIE adoption and usage. Within a healthcare system, the path coefficients for both adoption and usage were weak and not significant. However, in the context of HIE outside a healthcare system the relationship with HIE adoption indicated positive and significant (path coefficient = 0.154, $p<0.10$), and the relationship with HIE usage also indicated positive and significant (path coefficient = 0.119, $p<0.05$). The difference in significant associations between the two contexts suggests that it is not a factor for HIE within a healthcare system. However, the findings suggest that it is influential for HIE adoption and usage outside a healthcare system. As such, both hypotheses H11a and H11b are supported.

Information *Security Safeguards* for patient information was hypothesized to positively relate to both HIE adoption and usage. The findings indicate that its association with HIE adoption inside a healthcare system was positive and significant (path coefficient = 0.213, $p<0.01$). Indeed, this path coefficient indicated the strongest association of any factor for HIE adoption in the inside context. The path coefficient to HIE usage inside a healthcare system was not significant, but an indirect effect was significant (total effect 0.149, $p<0.05$). Surprisingly, we found that security safeguards had a weak and not significant association with HIE adoption and usage outside a healthcare system. Since a significant effect was indicated for both adoption and usage, hypotheses H12a and H12b are supported.

Outcomes were hypothesized to be positively related to HIE usage both inside and outside a healthcare system. Measures were classified in three categories: satisfaction, information quality, and operational efficiency. For the association between HIE usage inside a healthcare system and outcomes, the path coefficient to information quality was positive and significant (path coefficient = 0.145, $p<0.10$). However, the path coefficients to satisfaction and operational efficiency were weak and not significant. For outcomes related to HIE usage outside a healthcare system, the relationship with satisfaction was positive and significant (path coefficient = 0.534, $p<0.01$), as was information quality (path coefficient = 0.322, $p<0.01$), and operational efficiency (path coefficient = 0.391, $p<0.01$). The strongest relationships reported in our model were from HIE usage outside a healthcare system to satisfaction and operational efficiency. With strong indication of HIE usage associated with outcomes, hypotheses H13a and H13b are supported. The amount of variance explained in the three outcome variables as indicated by the R^2 values was moderately-low. This reflects the intuitive notion that other

factors are influential for the defined outcomes. However, it can be construed that HIE has a sizable effect.

The effect of HIE adoption on usage was not hypothesized as this is a logical association that follows by virtue of our definitions. In the nomological network indicated by our model, HIE adoption indicated strongly with HIE usage inside a healthcare system (path coefficient = 0.480, $p<0.01$), and likewise for HIE adoption with usage outside a healthcare system (path coefficient = 0.418, $p<0.01$).

Table 5.2. Summary of significant path coefficients and hypotheses supported.

	Adoption (a)		Usage (b)	
Variable	Significant Path	Hypothesis Supported	Significant Path	Hypothesis Supported
Government (H1)	Yes	Yes	Yes	Yes
Patients (H2)	No	No	Yes, neg.	No
Affiliates (H3)	Yes	Yes	Yes	Yes
Peers (H4)	No	No	Yes, neg.	No
Vendors (H5)	No	No	Yes, neg.	No
Exploitative Orientation (H6)	Yes	Yes	No	No
Explorative Orientation (H7)	No	No	No	No
Clinical Leadership (H8)	No	No	Yes	Yes
Workflow (H9)	No	No	Yes	Yes
IT Infrastructure Maturity (H10)	Yes	Yes	Yes	Yes
External IT Support (H11)	Yes	Yes	Yes	Yes
Security Safeguards (H12)	Yes	Yes	Yes	Yes
	Usage Inside (a)		Usage Outside (b)	
Outcomes (H13)	Yes	Yes	Yes	Yes

1.18 Subsample Results

Consistent with prior research studies that have confirmed the role of clinic size and ownership in HIT adoption and usage (Kane et al. 2013; Ross et al. 2010), we examined the varying effects of clinic size and ownership on HIE adoption and usage among Illinois ambulatory clinics.

To account for control variables in PLS-SEM requires running separate models for comparison. As such, we performed separate analysis on two primary categories likely to affect results: size of the organization as defined by number of providers, and practice ownership. Each of these two categories were analyzed dichotomously.

Based on our pilot study and previous classification (Kane et al. 2013), we analyzed size based on practices with less than 10 providers, and 10 or more providers. This produced two datasets with 148 and 171 cases, respectively.

Resource availability was a factor for consideration of analysis by ownership. Those practices and clinics partially or wholly owned by a hospital or healthcare system may likely have access to resources critical to technology adoption. As such, we considered practices and clinics that are wholly owned by providers as independent, and those that are partially or wholly owned by a hospital or healthcare system as not independent. This produced two datasets with 135 and 170 cases, respectively.

A comparison of means (independent T-test) was performed with the HIE adoption and usage scores from both the inside and outside a healthcare system context for the two subsets, size and ownership. Levene's test for equality of variances was calculated (Levene 1960) for each group. We found that for each comparison for which there was a statistically significant difference between means, the Levene's test was also significant at $p < 0.001$ indicating that the

null hypothesis of equal variances is rejected and there is a difference between the variances of the two subgroups for each category. As such, the independent samples T-test statistics reported are those calculated for equal variances *not* assumed. A summary of the results is shown in Table 5.3.

Table 5.3. Differences in HIE adoption and usage based on (i) clinic size, and (ii) clinic ownership.

Categories		HIE adoption inside healthcare system (min:1, max:21)	HIE usage inside healthcare system (min:1, max:42)	HIE adoption outside healthcare system (min:1, max:21)	HIE usage outside healthcare system (min:1, max:42)
Size	Clinics with less than 10 providers	16.01 (sd. 5.43) (N=125)	14.58 (sd. 11.02) (N=118)	15.68 (sd. 5.53) (N=122)	13.66 (sd. 9.18) (N=110)
	Clinics with10 or more providers	14.39 (sd. 4.32) (N=164)	13.53 (sd. 9.32) (N=160)	14.53 (sd. 4.10) (N=165)	12.35 (sd. 7.97) (N=161)
	Significant difference	Yes***	No	Yes*	No
Ownership	Independent clinics (owned by providers)	15.30 (sd.5.22) (N=113)	15.51 (sd. 11.34) (N=110)	15.09 (sd. 5.01) (N=113)	14.23 (sd. 9.73) (N=104)
	Not independent (not wholly owned by providers)	14.95 (sd. 4.62) (N=169)	12.87 (sd. 8.85) (N=163)	14.87 (sd. 4.63) (N=166)	12.21 (sd. 7.50) (N=161)
	Significant difference	No	Yes**	No	Yes*
*** p < .01, ** p < .05, * p < .10					

For HIE adoption inside a healthcare system, the mean score for clinics with less than 10 providers ($\mu = 16.01$) was significantly higher ($p<0.01$) than for clinics with 10 or more providers ($\mu = 14.39$). Likewise, for HIE adoption outside a healthcare system, the score was higher for clinics with less than 10 providers ($\mu = 15.68$) compared to clinics with 10 or more providers ($\mu = 14.53$), and the difference was significant ($p<0.10$). There were no significant

difference between the scores for HIE usage in either the inside or outside a healthcare system context.

When we compared HIE adoption and usage scores for clinics based on ownership, we found statistically significant differences for HIE usage scores both inside and outside a healthcare system. Provider-owned independent clinics reported higher HIE usage scores for the inside context ($\mu = 15.51$) as compared to the non-independent clinic group ($\mu = 12.87$), with the difference being significant ($p<0.05$). Similarly, the provider-owned independent clinic group reported higher HIE usage scores for the outside the system context ($\mu = 14.23$) when compared with non-independent clinics ($\mu = 12.21$), also with a significant difference ($p<0.10$). Based on ownership, the HIE adoption scores in both the inside and outside a healthcare system context did not indicate a significant difference between the two groups.

Taken together, our results indicate clinic size to be an important factor for HIE adoption both inside and outside a healthcare system. Whereas, clinic ownership seems to be an important factor in differentiating HIE usage both inside and outside a healthcare system. Based on these preliminary insights, we divided our overall sample into subsamples based on clinic size (number of providers) and ownership. A PLS structural model was reassessed for each of these subsamples, and these results are presented in the next section.

1.18.1 Subsample PLS structural models

Structural models were built and analyzed in SmartPLS for two subsamples in each of the two categories of size and ownership. The significant paths in each of the four subsample models are similar in many ways to the overall model, but there are some notable differences.

Comparison of significant path coefficients and R^2 values between the two groups in each category, as well as with the overall model, are given below.

1.18.1.1 Structural model results by number of providers

For the size category, both models indicate significant paths similar to the overall model. However, the 10-or-more providers model indicates R^2 values higher than either the less-than-10 providers or overall model, and the path coefficients from the 10-or-more usage variables (both inside and outside a healthcare system) are notably different. A summary table is provided below for comparing R^2 values between the two subsamples and the overall model.

Table 5.4. Comparison of R^2 values for the two 'size' subsamples and overall model.

Variable	Less than 10 providers	10 or more providers	Overall
Adoption inside a healthcare system	0.37	0.57	0.42
Usage inside a healthcare system	0.55	0.67	0.54
Adoption outside a healthcare system	0.42	0.51	0.39
Usage outside a healthcare system	0.59	0.64	0.55
Outcome – satisfaction	0.29	0.55	0.36
Outcome – information quality	0.13	0.30	0.19
Outcome – operational efficiency	0.21	0.19	0.18

Most notable is the higher R^2 values for the 10-or-more providers model compared to both the less-than-10 providers model and the overall model with the exception of operational efficiency, which is very similar to the other two. The largest difference is between the two subsamples for adoption inside a healthcare system where the amount of variance explained for the 10-or-more model is 20 points higher than for the less-than-10 model.

For comparison of hypothesized associations between the environmental-organizational-technological factors and HIE adoption and usage we consider each of the 12 factors as shown in figures 5.2 and 5.3.

In the overall model, government influence indicated three significant positive path coefficients. Both the less-than-10 and 10-or-more provider groups indicated two significant positive paths each, though for different variables. The less-than-10 group indicated a stronger relationship between government and HIE adoption inside a healthcare system than the overall model (path coefficient = 0.227, $p<0.05$), as well as a stronger relationship with HIE usage outside a healthcare system (path coefficient = 0.225, $p<0.01$). Neither of these relationships were significant for the 10-or-more model. In contrast, this group indicated a positive and significant association with HIE usage in the inside context that is notably stronger than the overall model (path coefficient = 0.186, $p<0.05$), and a positive and significant path with HIE adoption in the outside context (path coefficient = 0.141, $p<0.10$) that is not significant for either the overall model or the less-than-10 group.

Influence by patients for the less-than-10 group is similar to the overall model with the only significant relationship showing a negative, yet stronger, relationship with HIE usage inside a healthcare system (path coefficient = -0.269, $p<0.05$). Contrarily, the 10-or-more group indicated a positive and significant relationship between patients and HIE adoption outside a healthcare system (path coefficient = 0.161, $p<0.10$). This contrast might be a reflection of clinic demographics or in patient demographics. All other relationships were not significant.

The significant associations for affiliate influence is similar for the two groups and with the overall model. Both groups indicate positive and significant relationships with HIE usage in the inside context with the less-than10 group indicating stronger than the overall model (path

coefficient = 0.389, $p<0.01$). Indeed, this was the strongest path coefficient indicated for affiliates in all the models tested in this study. Both groups also indicated positive and significant relationships with HIE usage outside a healthcare system, again with the less-than-10 group being stronger than the overall model (path coefficient = 0.207, $p<0.05$). In contrast to the overall model, associations with HIE adoption in either the inside or outside a healthcare system contexts was not significant for the two subgroups. With a very similar pattern indicated, the size of the clinic based on number of providers is not a differentiator for influence by affiliates.

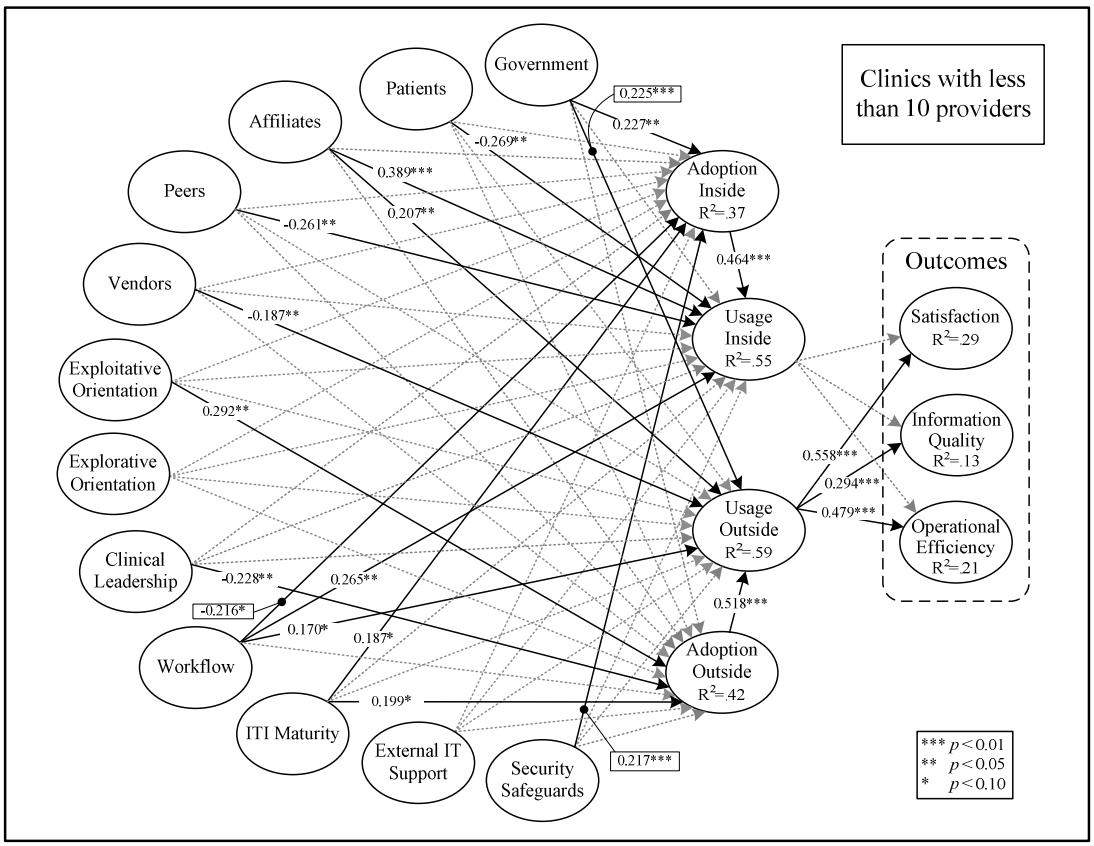

Figure 5.2. Path coefficients and R^2 for Less-than-10 providers.

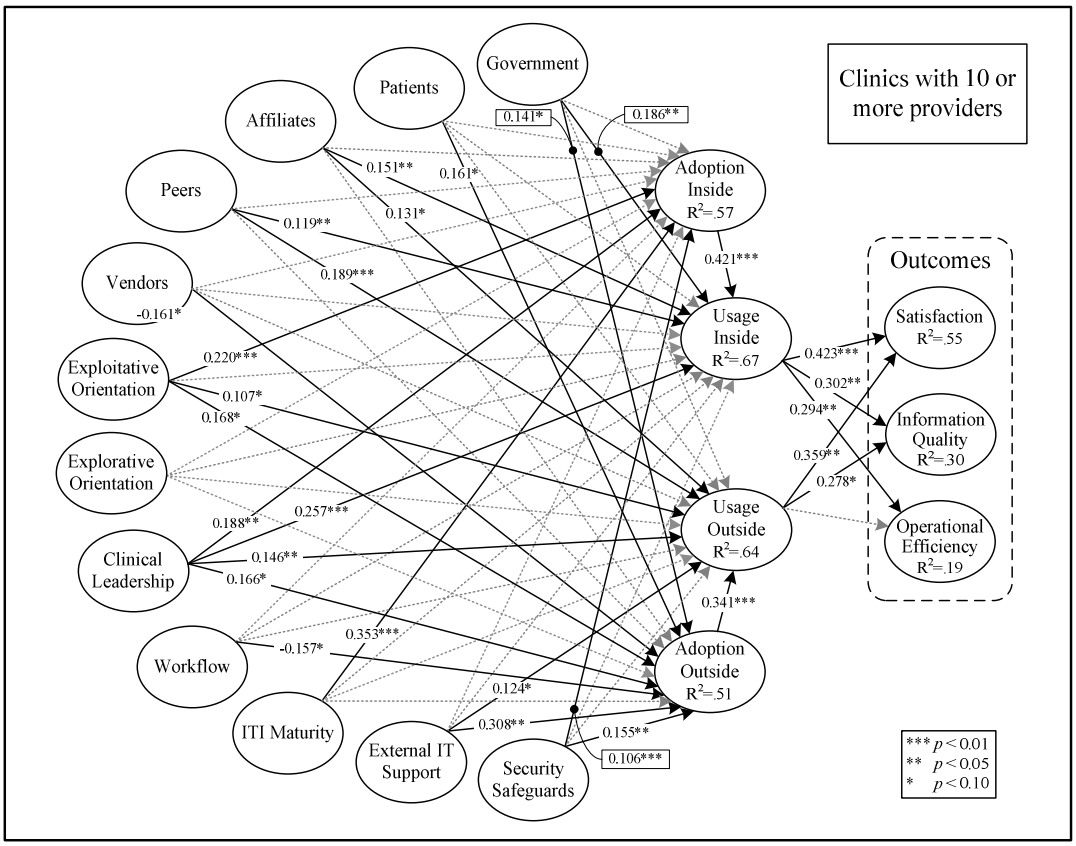

Figure 5.3.Path coefficients and R^2 for 10-or-more providers.

Peer influence associated with HIE usage inside a healthcare system for the less-than-10 group is similar to the overall model indicating a negative, yet stronger, significant relationship (path coefficient = -0.261, $p<0.05$) with no other relationships being significant. Contrarily, the 10-or-more group indicated positive and significant relationships between peers and HIE usage in the inside context (path coefficient = 0.119, $p<0.05$), as well as with HIE usage in the outside context (path coefficient = 0.189, $p<0.01$). Unfavorable peer experience inside a healthcare system may be responsible for the negative relationships indicated by the less-than-10 and overall models. In contrast, the positive association with HIE usage for the 10-or-more group indicates different elements related to peers are at play. For instance, competitive pressure.

Similar relationships are indicated by the models for both subgroups and the overall model for vendors. The less-than-10 group and overall model indicate a negative and significant relationship with HIE usage outside a healthcare system. The 10-or-more group indicates the same negative relationship but it is not significant. However, it indicates a negative and significant relationship between vendors and HIE adoption outside a healthcare system (path coefficient = -0.161, $p<0.05$). Negative vendor influence for both subgroups indicates that the experience is not a function of size for the practices and clinics surveyed.

Organizational factors also show big differences between the less-than-10 and 10-or-more providers groups. For exploitative orientation, both groups indicated a positive and significant relationship with HIE adoption outside a healthcare system similar to the overall model. However, for the 10-or-more group, positive and significant relationships were indicated for HIE adoption inside a healthcare system (path coefficient = 0.220, $p<0.01$), as well as for HIE usage in the outside context (path coefficient = 0.107, $p<0.10$).

As with the overall model, neither model for the two groups indicated a significant association for explorative orientation.

There are very distinct differences for the influence of clinical leadership between the two groups. The less-than-10 model indicated a negative and significant relationship with HIE adoption outside a healthcare system (path coefficient = -0.228, $p<0.05$), with none of the other clinical leadership relationships being significant. In contrast, the 10-or-more model indicated positive and significant associations in all four contexts. That is, for HIE adoption both inside a healthcare system (path coefficient = 0.188, $p<0.05$), and outside a healthcare system (path coefficient = 0.166, $p<0.10$). As well as for HIE usage in the inside context (path coefficient = 0.257, $p<0.01$), and outside context (path coefficient = 0.146, $p<0.05$). Here, the associations with HIE usage is similar to the overall model. This finding is surprising for HIE adoption as it was expected that clinical leadership would play a strong positive role for smaller-sized clinics and less of a role in larger-sized clinics that are more likely to have administrative leaders. Provider demographics may play a role.

Associations with workflow indicate the same sign as the overall model for both groups, but are significant in different contexts. Similar to the overall model, yet stronger, the less-than-10 model indicated a negative and significant relationship with HIE adoption inside a healthcare system (path coefficient = -0.216, $p<0.10$), yet indicated a positive and significant relationship with both HIE usage in the inside context (path coefficient = 0.265, $p<0.05$), and the outside context (path coefficient = 0.170, $p<0.10$). The only significant relationship indicated by the 10-or-more model for workflow was negative with HIE adoption outside a healthcare system (path coefficient = 0.157, $p<0.10$). The negative associations between workflow an HIE adoption by both groups and the overall model contrasted with the positive associations with HIE usage by

the less-than-10 and overall models, further supports the concept that workflow transformation occurs between the stages of adoption and usage as first expressed in section 5.2.

Like the overall model, the less-than-10 model indicated positive and significant relationships between ITI maturity and HIE adoption for both inside and outside a healthcare system with similar magnitude. However, the 10-and-more model indicated a very strong relationship between ITI maturity and HIE adoption inside a healthcare system (path coefficient = 0.353, $p<0.01$), but all other context indicators were not significant for this group. Taken together, this is further evidence that ITI maturity plays in role in HIE adoption decisions.

The less-than-10 providers model did not indicate any significant relationship between external IT support and any of the HIE adoption and usage contexts. However, the 10-or-more model indicated similar to the overall model with the relationship between external IT support and HIE adoption outside a healthcare system being positive and significant (path coefficient = 0.308, $p<0.01$), as well as being positive and significant for HIE usage in the outside context (path coefficient = 0.124, $p<0.10$). The lack of any significant relationship for external IT support in the smaller-sized less-than-10 model is surprising as this group would likely be more resource challenged compared to larger-sized clinic and benefit from external IT support.

The indicated significant relationships for information security safeguards is nearly identical between the overall model and the less-than-10 model with only the path to HIE adoption inside a healthcare system being significant. In addition, the 10-or-more model indicated a positive and significant relationship with HIE adoption outside a healthcare system (path coefficient = 0.155, $p<0.05$). The pattern of security safeguards being significant with HIE adoption but not HIE usage may be reflective of its importance at different stages of

implementation. However, it might indicate that with HIE usage, information security safeguards are seen as lacking.

Significant paths between HIE usage and the three outcome variables are quite different between the two groups. For HIE usage inside a healthcare system, none of the paths were significant for the less-than-10 model, whereas all three were significant for the 10-or-more group. This group's model indicated positive and significant paths for perceptions in satisfaction (path coefficient = 0.423, $p<0.01$), information quality (path coefficient = 0.302, $p<0.05$), and operational efficiency (path coefficient = 0.294, $p<0.05$). The positive and significant paths for all three outcome measures from HIE usage outside a healthcare system indicated by the less-than-10 model are very similar to the overall model. However, the 10-or-more model indicted lower for perceived satisfaction (path coefficient = 0.155, $p<0.05$) compared to either the less-than-10 or overall models, and did not indicate a significant association between HIE usage in the outside context and operational efficiency, the only model analyzed in this study not to indicate a significant path for this association. Overall, HIE usage outside a healthcare system is perceived as more beneficial by smaller-sized clinics. The stronger outcomes for HIE usage inside a healthcare system by larger-sized clinics might be a reflection of demographics with these clinics more likely a member of a healthcare system.

For the size category, three overall observations provide insight into the differences between the two subsamples. 1) The amount of variance explained (R^2) for both HIE adoption and usage inside and outside a healthcare system is greater for the 10-or-more providers subsample compared to the less-than-10 providers subsample. 2) The 10-or-more model indicated 19 positive and significant path coefficients that support hypothesized associations, versus 10 positive and significant path coefficients for the less-than-10 model. In addition, the

10-or-more model indicated two negative and significant path coefficients in opposition to hypothesized relationships, versus five negative and significant path coefficients in the less-than-10 model. 3) Five of the six paths from HIE usage inside and outside a healthcare system to the three outcome categories were significant for the 10-or-more group versus only three significant paths from HIE usage in the outside context, and none from HIE usage inside, for the less-than-10 group. Taken together, these observations suggest that our structural model better explains the 10-or-more subsample than the less-than-10 subsample, and that notable differences exist between clinics based on size.

1.18.1.2 Structural model results by clinic ownership

For the ownership category, both the independent (wholly provider owned) and not-independent models indicate significant paths similar to the overall model, with some notable differences. The models also indicate R^2 values similar to the overall model, also with some notable differences. A summary table is provided below for comparing R^2 values between the two subsamples and the overall model.

Table 5.5. Comparison of R^2 values for the two ownership subgroups and overall model.

Variable	Independent ownership	Not independent ownership	Overall
Adoption inside a healthcare system	0.48	0.48	0.42
Usage inside a healthcare system	0.64	0.49	0.54
Adoption outside a healthcare system	0.49	0.44	0.39
Usage outside a healthcare system	0.59	0.61	0.55
Outcome – satisfaction	0.44	0.32	0.36
Outcome – information quality	0.22	0.21	0.19
Outcome – operational efficiency	0.23	0.16	0.18

In general, the R^2 values for the two subgroups are higher than the overall model with three exceptions, all from the not-independent model. Most notable is the higher R^2 value for usage inside a healthcare system for the independent ownership group.

The measured associations for the hypothesized relationships are shown in figures 5.4 and 5.5. Significant associations for government influence for the independent group is indicated for HIE adoption inside a healthcare system (path coefficient = 0.220, $p<0.05$), as well as with HIE adoption outside a healthcare system (path coefficient = 0.275, $p<0.05$), but not for either HIE usage contexts. The not-independent model only indicated a significant association with HIE usage outside a healthcare system similar to the association in the overall model, but all other associations were not significant. Stronger indication of a government association with HIE adoption by the independent model suggests that wholly provider owned clinics are being influenced by government efforts.

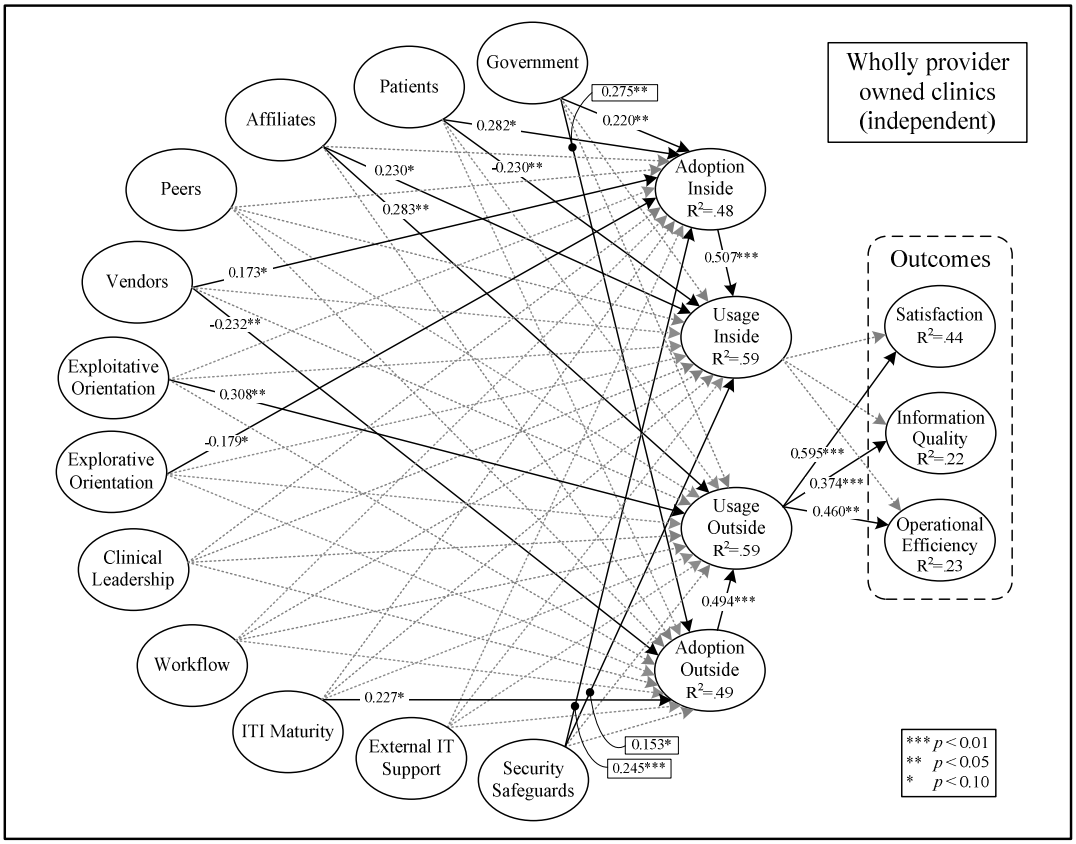

Figure 5.4. Path coefficients and R^2 for Independent clinics.

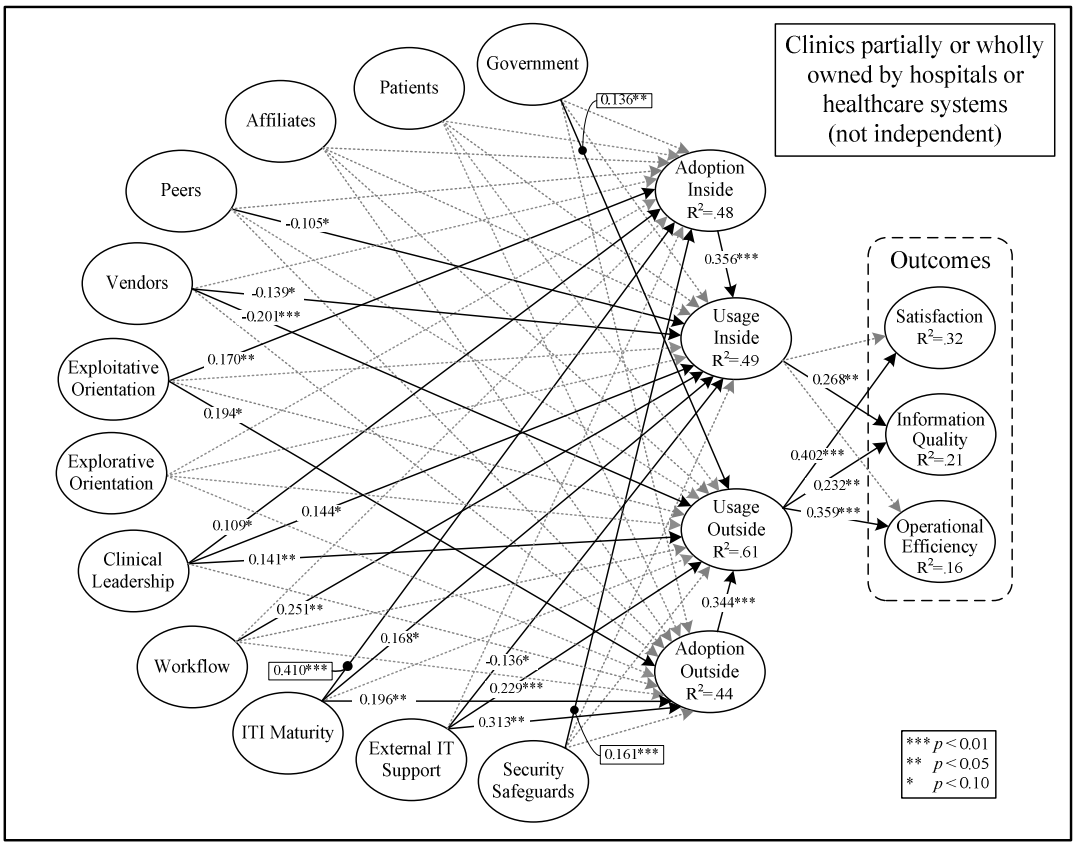

Figure 5.5. Path coefficients and R^2 for Not-Independent clinics.

The association between patient influence and HIE usage inside a healthcare system indicated by the independent model was negative and significant (path coefficient = -0.230, $p<0.05$), as it was in the overall model. However, the independent model also indicated a positive and significant relationship between patients and HIE adoption inside a healthcare system (path coefficient = 0.282, $p<0.10$). The overall model had a notable positive path coefficient for HIE adoption inside as well, but it was not significant. The dichotomy of inverse relationships between HIE adoption and usage inside a healthcare system suggests difference between expectations and experience. The not-independent model did not indicate any significant relationships for patient influence with any of the HIE adoption and usage contexts.

The association of affiliate influence with HIE usage in both the inside and outside a healthcare system context indicated by the independent model was similar to the overall model, although stronger for the independent model with HIE usage in the outside context (path coefficient = 0.283, $p<0.05$). The independent model had notable path coefficients with HIE adoption in both contexts, but neither were significant. Surprisingly, the not-independent model did not indicate any significant relationship for affiliate influence.

Vendor influence indicated mostly negative for the two subgroups as it had in other models. The not-independent model indicated negative and significant relationships with HIE usage both inside a healthcare system (path coefficient = -0.139, $p<0.10$), and outside a healthcare system (path coefficient = -0.201, $p<0.01$). The independent model did not indicate significant paths for HIE usage in either context. However, it indicated a positive and significant relationship with HIE adoption inside a healthcare system (path coefficient = 0.173, $p<0.10$), and a negative and significant relationship with HIE adoption in the outside context (path coefficient = -0.232, $p<0.05$). This is the only model in the study to indicate a positive and significant

vendor relationship. The difference in sign for the two HIE adoption relationships for the independent group contrast potential differences between the inside and outside a healthcare system contexts, and how these contexts can influence the relationships with the hypothesized factors.

Both the independent and not-independent models indicated positive and significant associations between exploitative orientation and HIE adoption outside a healthcare system similar to all other models. Additionally, the not-independent model indicated a positive and significant relationship with HIE adoption inside a healthcare system (path coefficient = 0.170, $p<0.05$). These relationships provide further evidence that an exploitative orientation by organizations is a factor for HIE adoption decisions. The model for independent clinics indicated a negative and significant association between explorative orientation and HIE adoption inside a healthcare system (path coefficient=-0.179,$p<0.10$), the only model in the study to indicate any significant path with explorative orientation.

Another contrasting difference is that of clinical leadership. The independent model did not indicate any significant relationships, whereas the not-independent model indicated three significant relationships. As with the overall model, the not-independent model indicated positive and significant, yet stronger, associations between clinical leadership and HIE usage in both the inside a healthcare system context (path coefficient = 0.144, $p<0.10$), and in the outside context (path coefficient = 0.141, $p<0.05$). Additionally, this model indicated a positive and significant relationship with HIE adoption inside a healthcare system (path coefficient = 0.109, $p<0.10$). This factor also indicated very strongly for the larger-sized 10-or-more model indicating that both size and ownership affect the role clinical leaders play in HIE adoption and usage.

The overall model indicated a negative and significant relationship between workflow and HIE adoption in both the inside and outside contexts. Both the independent and not-independent models indicated weak negative associations for these contexts and neither of them were significant. In contrast, the not-independent model indicated a positive and significant relationship between workflow and HIE usage inside a healthcare system (path coefficient = 0.251, $p<0.05$), as did the overall model. In all models with significant path coefficients for workflow, the relationship with HIE adoption is negative, and the relationship with HIE usage is positive.

ITI maturity as indicated as positive and significant by the overall model for HIE adoption in both contexts. The independent model only indicated significance for ITI maturity with HIE adoption outside a healthcare system (path coefficient = 0.227, $p<0.10$). It was more of a factor with the not-independent group. This model indicated a strong positive and significant relationship with HIE adoption inside a healthcare system (path coefficient = 0.410, $p<0.01$) – the largest path coefficient for any factor indicated by any of the models in this study. Additionally, this model indicated a positive and significant relationship between ITI maturity and HIE usage inside a healthcare system (path coefficient = 0.168, $p<0.10$), as well as with HIE adoption in the outside context (path coefficient = 0.196, $p<0.05$), the only model to indicate a significant association with HIE usage.

Surprisingly, external IT support did not indicate significantly for the independent group, as it had not for the smaller-sized less-than-10 providers model. For the not-independent group, it indicated positive and significant for HIE adoption (path coefficient = 0.313, $p<0.05$), and usage (path coefficient = 0.229, $p<0.01$) outside of a healthcare system, as did the overall model. Contrarily, we found that the not-independent model also indicated a negative and significant

relationship between external IT support and HIE usage *inside* a healthcare system (path coefficient = -0.136, $p<0.10$), the only model to indicate any negative association for external IT support. The not-independent model for clinics partially or wholly owned by hospitals or healthcare systems is also the only model to also indicate a negative and significant association between vendors and HIE usage inside a healthcare system. No other model indicated significantly, either positively or negatively, for these two factors in this context.

The association of information security safeguards with HIE adoption inside a healthcare system indicated positive and significant for both models, similar to the overall model. In addition, the independent model indicated a positive and significant relationship with HIE usage inside a healthcare system (path coefficient = 0.153, $p<0.10$). The only model to indicate a significant relationship with HIE usage.

Significantly indicated outcomes by the not-independent model were similar to the overall model. For this model, HIE usage outside a healthcare system was significantly associated with all three perceived outcome measures: satisfaction (path coefficient = 0.402, $p<0.01$), information quality (path coefficient = 0.232, $p<0.05$), and operational efficiency (path coefficient = 0.359, $p<0.01$). HIE usage inside a healthcare system was only significant with the information quality measure (path coefficient = 0.268, $p<0.05$) for the not-independent model. The independent model did not indicate any significant relationship between HIE usage inside a healthcare system and outcome measures. However, for the HIE usage outside a healthcare system the independent model indicated positive and significant for satisfaction (path coefficient = 0.595, $p<0.01$), information quality (path coefficient = 0.374, $p<0.01$), and operational efficiency (path coefficient = 0.460, $p<0.01$). Indeed, the path coefficient indicated for

satisfaction (0.595) by this model was the highest for any path coefficient in all the models in this study.

Analysis by ownership reveals notable differences in the factors that are significantly related to HIE adoption and usage. The number of significant associations in each group are similar, but the factors themselves are different. The most notable contrast between the two groups is the absence of any significant relationship for patients or affiliates in the not-independent model, and the absence of any significant relationship for peers and workflow in the independent model. These are the only models analyzed in the study to indicate absence of *any* significant association for these factors.

Clinics partially or wholly owned by hospitals or healthcare systems (not-independent) are members of an organization with a larger and more bureaucratic administrative structure with organizational traits that may be responsible for shaping and defining the importance of issues and factors of influence differently than clinics wholly owned by providers. Some of the differences revealed based on ownership are reflective of those seen between subsamples based on size.

1.19 Conclusion

Results were presented for the overall model and related to our hypotheses. We then analyzed the dataset by two different criteria: 1) the number of providers in the practice (size), and 2) clinic ownership. For each of these two categories, we created two subsamples excluding those cases that did not indicate 'number of providers' or ownership status. An independent means comparison was performed for the adoption and usage variables in both the inside and outside a healthcare system contexts for these subsamples. Based on the results, we created and ran separate structural models for each subgroup and presented the findings.

6 Discussion

1.20 Overall Model

Twelve factors within an environmental-organizational-technological framework were hypothesized to relate to the adoption and usage of HIE by small to mid-sized ambulatory clinics in the state of Illinois. These examinations also considered HIE for practices and clinics in the context of both within (inside) a healthcare system, and outside a healthcare system, and the results indicate notable differences. This indicates that the underlying aspects associated with HIE is different in each context, thereby revealing a differentiated understanding of the phenomena. Differences may be caused by any number of reasons. For example, the competitive environment as seen by a healthcare system common for an HIE affiliate and the focal clinic may result in decisions and actions for using HIE (competitive peer pressure) that may be less a factor, if at all, for consideration of HIE with an affiliate outside the healthcare system. Evidence for differences between the contexts is indicated by the relationships between the hypothesized factors and HIE adoption and usage. For HIE adoption there were only two hypothesized factors with significant associations for both contexts: workflow and ITI maturity. Seven significant relationships were indicated for HIE usage inside a healthcare system, and five for HIE usage outside a healthcare system, with only three factors significant for both contexts: government measures, affiliate associations, and clinical leadership.

It is also important to consider the relationship between HIE adoption and usage in this cross-sectional study. We defined adoption as consisting of the planning, evaluation, or trail of HIE absent clinical usage. Adoption, therefore, precedes actual usage for patient care. Indicated significant relationships between factors and HIE usage but not adoption does not indicate that

adoption did not occur. A lack of support for adoption in this scenario might be a reflection of when a factor is influential. Since this is a cross-sectional study, we only capture a slice of the life-cycle. This is not to say that there are non-temporal reasons for significant associations with HIE usage but not adoption. For instance, factors, absent clinical leadership, may be important to the adoption process. Whereas, the significant relationship between clinical leadership and HIE usage indicates that it is important for actual use.

Following our environmental-organizational-technological framework, we expound further on our findings.

1.20.1 Environmental factors

The Meaningful Use program administered by CMS provides financial incentives to motivate healthcare provider organizations to implement and use HIT. Enacted as part of the 2009 HITECH Act, it is unsurprising to find a relationship between government measures and HIE adoption and usage as previously reported (Fontaine et al. 2010b; Patel et al. 2011; Ross et al. 2010). Though our study indicated that government agencies, like regional extension centers and state offices of health IT, play a role, it is the carrot-and-stick of the federal government's incentives and mandates that indicated the strongest. Altogether, government efforts seem to be a factor in motivating ambulatory clinics to adopt and use HIE in the state of Illinois.

As pointed out in chapter 5 results, the significant paths for patient preference that indicated positive for HIE adoption and negative for usage may be a reflection of differences between expectations and experiences. Meaningful Use requirements to provide health information to patients in an electronic form (Neuner et al. 2014), along with a continually increasing tech-savvy population demanding cyber options, may be motivating the development

of patient-centric HIE solutions, particularly inside a healthcare system. However, once implemented the experience by patients using these systems may account for the negative association with HIE usage. This finding is contrary to one report of a positive patient association between HIE and satisfaction (Vest et al. 2011a). The lack of a significant relationship between patients and HIE adoption and usage outside a healthcare system suggests that HIE in its current state for this context is not being influenced by patient expectations and experiences. This could reflect a lower frequency of electronic exchange in this context compared to inside a healthcare system, a difference of data types exchanged in each context, a difference in clinical circumstances for using HIE in each context, or the lack of exchange information in the outside context being made available to patients compared to that made available in patient portals by healthcare systems. A physician we interviewed narrated his experience.

> *"As a part of the meaningful use requirements, we needed to have patients download, transfer and view their health records online. Also, patients needed to electronically communicate with my office. So, when we didn't have enough electronic communication a few days before the deadline, my staff started asking patients to send all their questions by email or the portal just to make sure we met the requirements."*

The effect of affiliates on ambulatory clinics to adopt and use HIE is strongly supported by our models. It reflects the intuitive notion that participants in an organized provider network are influenced by each other, and is certainly supportive of the social influence to use HIE (Lichtenstein et al. 2010). A healthcare system has a defined mission, goals, and objectives. The extent to which these are supported by HIE within the healthcare system could result in pressure (influence) from affiliates within the healthcare system. The significant associations may also be

indicating a correlated relationship among all the players operating under a common policy, to include using common HIT. The relationship between affiliates and both HIE adoption and usage in the outside context supports the notion that networks of providers not under a common umbrella understand the benefits of HIE (Ugrin 2009), and are also influencing each other. As one physician remarked in our post analysis interviews:

> *"When all others in our network use a computer system or software to send us the paperwork, the natural expectation is that we will also send them everything electronically".*

Contrary to our hypothesis (H4), positive peer influence is not indicted by the overall model. In the overall model, the only significant association was negative with HIE usage inside a healthcare system. However, a significant positive association was found between peer influences and HIE usage (inside the system and outside the system) for the larger-sized clinics with 10 or more providers. A negative association between peer influence and HIE usage inside the healthcare system was found for the not-independent clinic subsample, as well as for the smaller-sized clinics (less than 10 providers). Taken together, we note that peer influence seems to spur increased HIE usage within a healthcare system only for larger clinics. In other cases, peer influence from competing clinics and non-affiliated peer clinics inversely influence HIE usage. A possible explanation is that smaller clinics may simply not be able to keep pace with other clinics and might resort to fax or other means to transfer health information.

The rise of vendor coalitions to provide HIT product interoperability solutions (i.e. HIE) (Zina Mou 2014) drove the hypothesis (H5) that vendors positively influence the adoption and usage of HIE. We find the hypothesis partly supported only in the case of independent clinics where we note a significant, positive association between vendor influences and HIE adoption

within a healthcare system. We found a significant negative association between vendor influences and (i) HIE usage outside a healthcare system in our overall model, (ii) HIE usage within and outside a healthcare system for the not-independent clinic subsample, (iii) HIE adoption outside for the larger-sized (10 or more) clinic subsample, and (iv) HIE usage in the outside context for the smaller-sized (less than 10) clinics. These negative associations might, in part, be occurring because HIT vendors are seen as engaging in information blocking strategies to "lock in" customers to protect market share (Lorenzi 2003; Pear 2015), and the positive effect from consortium cooperation is yet to be realized. This later point is supported by a conversation this author had with a representative of the CommonWell Health Alliance at HIMSS15[3] that, though progress is being made, not all members have fully adopted proposed interoperability solutions and none are yet a part of any vendor's product. This was reinforced by a physician we interviewed who stated,

> *"When we signed up for the EMR system, we were told by our vendor that we can easily exchange our data with hospitals and outside entities. Now, they are charging us a fee to set up the system to transfer the data. Depending on whom we transfer to, the fee is going to be different. This was not something we knew upfront."*

Another clinician remarked,

> *"There are additional fees each time I send or get data using the system. When I send to clinics that use same EHR as us, the vendor fee is less, but when we send to others who use a different system, it is higher."*

[3] HIMSS15, April 12-16, 2015, Chicago, IL, a convention produced by the Health Information and Management Systems Society.

Vendor's activities could be discouraging clinics from using HIE to exchange information especially outside a healthcare system where the likelihood is higher that the e is using an EHR from a different vendor.

1.20.2 Organizational factors

Organizational factors hypothesized to influence ambulatory practices and clinics include exploitative and explorative orientation, clinical leadership, and workflow.

The issues that reflect an exploitative orientation in our survey concern operational efficiency, clinical process improvement, and administrative process improvement. This factor indicated a positive and significant relationship with HIE adoption outside a healthcare system, the strongest of any factor for this context. This relationship supports previous findings that a focus on cost control and efficiency has been found to be a significant determinant of HIT adoption in healthcare organizations (Bardhan et al. 2013; Chaudhry et al. 2006). However, despite reports that strategic goals were important for HIE success (Fontaine et al. 2010a; Rudin et al. 2009; Zheng et al. 2009), we did not find any significant positive relationship for explorative orientation suggesting that pursuit of HIE is not being strategically driven, at least for the population surveyed.

Clinical leadership indicated significant positive relationships for HIE usage inside and outside a healthcare system, but not for HIE adoption in either context, for the overall model. This lends support to the finding that leadership that fosters a culture of quality improvement is an important factor in predicting HIE success (Korst et al. 2011). For HIE usage, we found support for clinical leaders who consider HIT important, have a well-defined vision of how HIT can advance the goals of the practice, and have a favorable view toward HIE, as captured in our

survey. Though we did not find an association between clinical leadership and HIE adoption in the overall model, it was indicated by the models based on size. In fact, clinical leadership indicated positive and significant for the 10-or-more model, but negative and significant for the less-than-10 model. It was thought that clinical leaders in smaller-sized practices and clinics with fewer administrative leaders would indicate a strong influence. However, there are several possible explanations including the demographics of the clinical leaders and their attitude toward HIE and HIT. This is supported by a recent ONC report using the 2013 National Ambulatory Medical Care Survey Physician Workflow Survey that states, "Physicians in large and multi-specialty practices had the lowest rates of physicians reporting they would never adopt an EHR", and that, "Solo practice physicians had the highest percentage of physicians who were uncertain about their EHR adoption plans and physicians who did not plan to adopt an EHR" (Heisey-Grove et al. 2014). The survey also indicated that smaller-sized practices have a larger percentage of physicians not adopting EHR due to imminent retirement. As a result of EHR not being adopted, HIE is also not adopted.

Leadership is a critical success factor in the success of information systems projects (Al-Mudhary et al. 2013; Rockart 1982), especially for small and medium sized organizations (Caldeira et al. 2003; Yew Wong 2005). Furthermore, poor leadership puts information systems projects at risk (McLeod et al. 2011; Oz et al. 2000). We expected to find that clinical leadership plays a significant role in HIE projects. The importance of clinical leadership for HIE usage is highlighted by the following statement made by one of the clinicians with whom we talked.

> *"If there is one thing that can make or break a health technology project, it is the senior leadership. It is not enough to simply put a system in place but to actually use it and encourage others to use it so that the clinic on the whole benefits from it."*

We hypothesized that ambulatory clinics whose workflow was compatible or adaptable with using HIE would be positively associated with the adoption and usage of HIE. For usage inside a healthcare system, a significant positive association was indicated. Surprisingly, a significant negative, or inverse, relationship is indicated for both HIE adoption inside and outside a healthcare system. This suggests that clinics are proceeding with adoption regardless of workflow compatibility or adaptability issues, and between the process of adoption and actual usage for patient care find and correct any incompatibilities between workflow and HIE usage. A positive relationship for usage, at least in the inside a healthcare system context, may indicate that workflow issues are resolved by this time. It is also possible that workflow compatibility is a key factor for actual usage and those unable or unwilling to overcome workflow issues have not proceeded past an adoption phase. As commented by one of our interviewees:

> *"When I enable our [EMR] system to transfer health records to other parties, I need to change a number of processes. [That is,] how we have been doing this all along. The nurses, medical assistants, front desk and I all will need to change our old ways of exchanging the records and it is not easy for everyone to change and switch to new way immediately. There are always some initial hiccups, some complaints and all that, but once the new processes set in, we get the hang of it and start doing it more, it goes smoothly."*

1.20.3 Technological factors

The technological factors hypothesized to be associated with HIE adoption and usage include ITI maturity, external IT support, and information security safeguards. In general, we find support for technological factors being associated with HIE adoption (four indicators), and

very little with usage (one indicator). This suggest that these factors are more important up front during the adoption process, but are not relevant to usage. The exception being for external IT support.

An organization's IT capability is a combination of underlying strengths in IT infrastructure (used here in the technical sense), human IT resources, and IT-enabled intangibles. More broadly, an organization's IT infrastructure (ITI) is seen as consisting of the technical infrastructure and human IT resources combined (Bharadwaj 2000). We hypothesized that higher levels of ITI maturity are associated with adoption and usage of HIE. The results from our model support this for HIE adoption in both the inside and outside a healthcare system contexts, and indirectly via mediation for HIE usage for inside a healthcare system. This finding reveals that ITI maturity is a consideration for HIE adoption, and a factor for usage.

External IT support might be sought by a healthcare practice because of a lack, or unavailability, of internal resources (Cohen et al. 1990; Damanpour 1991). The absence of a significant relationship for external IT support with HIE adoption and usage inside a healthcare system suggest that, overall, this is not an issue in this context. However, a significant relationship was indicted with both HIE adoption and usage outside a healthcare system in our overall model suggesting that external IT resources, like regional extension centers (RECs), are important to HIE in this context. However, our analyses based on size and ownership indicated that external IT support is not significant for the smaller-sized (less-than-10) clinics, or the clinics wholly owned by providers (independent). This was surprising as smaller-sized clinics (and smaller-sized business in general), and those without the resources of a larger organizational structure – like that afforded by hospitals and healthcare systems – are more likely to require and seek out external support.

Whereas sufficient internal IT support may be available inside a healthcare system, ambulatory practices and clinics pursuing HIE outside a healthcare system are seeking external IT support, and availing themselves of support availability, such as that available from RECs, state health IT offices, vendors, and others.

The final technological factor considered was information security safeguards. We found a significant relationship between security safeguards and HIE adoption inside a healthcare system. This factor indicated the strongest among all factors for this adoption context. However, there was no significant relationship with HIE usage in either context. These findings support previous reports that information security issues are important to adoption (Adler-Milstein et al. 2013; Pevnick et al. 2012), but decline after implementation (Ludwick et al. 2009). Surprisingly, in light of HIPAA and HITECH security requirements, information security safeguards are not significantly associated with HIE adoption outside a healthcare system. For those practices that use HIE within a healthcare system prior to pursuing HIE outside the healthcare system, this finding might be a reflection of information security preparedness being overestimated upfront compared to later stages. That is, usage of HIE, and perhaps HIT in general, changes the perception of the level of effective information security safeguards in place.

We hypothesized that HIE usage both inside and outside a healthcare system would be positively associated with three outcome constructs: satisfaction, information quality, and operational efficiency. HIE usage inside a healthcare system only indicated a significant association with information quality. The lack of an indicated effect on satisfaction and operational quality suggests that other factors play more of a role in these measures, or that perceptions of influence from HIE usage on these measures has waned. HIE usage outside a healthcare system indicated a significant positive relationship with all three outcome categories.

Only information quality was significant for both usage contexts and supports previous findings of the effect of HIE on information quality measures (Campion Jr et al. 2012; Hartono et al. 2010). The strong support for operational efficiency, and even satisfaction, from HIE outside a healthcare system may in part be a reflection of the inefficiencies of non-electronic exchange methods (e.g. fax, courier, postal mail, etc.) with affiliates outside the provider's healthcare system.

1.21 Clinic Size

Clinics with a small number of providers may be content with their operation and do not necessarily aspire to grow their practice and, like other small businesses, generally lack the resources of larger organizations. These smaller clinics are more likely to resist or delay investments in IT that are not perceived as being essential to their current operation. The demographics of physicians in smaller-sized clinics are that of older providers who typically are less amenable to adopting technology and who have an eye toward retirement. Investing in IT for a changing healthcare environment with a potentially long payback period might not be viewed as financially prudent for this group. Our findings support a 2013 survey that found providers in smaller-sized clinics are more uncertain about adopting HIT, or do not plan to adopt at all, compared to clinics with more providers (Heisey-Grove et al. 2014).

The strength of the association between HIE usage and outcomes, and the strength of the outcome measures (R^2) in our study for smaller-sized clinics compared to larger-sized clinics reveal notable distinctions in the experience of using HIE. The results seem to indicate that larger-sized clinics are more engaged in pursing HIE and are realizing benefits more so than smaller clinics. The smaller-sized clinics indicated a notable distinction between HIE usage and

outcomes inside a healthcare system versus usage and outcomes with HIE partners outside a healthcare system. This phenomenon may be caused by any number of factors including patient demographics, the nature and level of clinic participation within a healthcare system, and the nature of association with HIE partners outside a healthcare system. Vest et al. (2012) reported that the most common type of HIE usage was encounter-based and mostly associated with older and chronically ill patients, and that HIE usage in a retrospective manner was associated mostly with complex patients and those relying on many different providers. A large proportion of the smaller-sized clinics in this study were family practices and pediatric practices. As such, the type of patient fitting their demographic for HIE usage may have affected our results. Additionally, larger clinics may be able to offer services in-house that smaller-sized clinics rely on outside of their clinic. The benefit that HIE brings to these externally provided services might account for the strong association between HIE usage outside a health care system and operational efficiency for the smaller-size clinics compared to no significant relationship for the larger-sized clinics. Expressed theoretically, HIE usage with partners outside a healthcare system for smaller-sized clinics may provide embedded resources in the inter-organizational process as a result of this electronically enhanced boundary-spanning capability that result in improved operational efficiency (Dyer et al. 1998; Sambamurthy et al. 2003). Future research might further explore these phenomena.

We found fewer environmental-organizational-technological factors indicating a significant relationship with the adoption and usage variables for smaller-sized clinics compared to larger-sized clinics. Affiliates and Government indicated a significant and positive relationship with HIE usage for both groups. However, Patients and Peers indicated differently for the two groups. Smaller-sized clinics indicated a negative association, and larger-sized clinics indicated

positive for these two factors, both statistically significant. This suggests that peer influence – supportive or competitive – is not influential in the decision making process to adopt and use HIE for smaller clinics, but is for larger clinics. Competition may be a greater concern for larger-sized clinics, hence a factor for this group. The experience by smaller-clinics, however, may also be influenced by resource constraints. As expressed by a clinic from our interviews,

> *"As a small clinic, we are not in a position to take up every technology that is required to transfer our records to others. Many competing clinics in our area have the ability to link with multiple systems, but we simply don't have that. We sometimes get questions on why we are not transferring records seamlessly the way other clinics do, but we simply don't have that."*

The observed differences for associations from patients were also different for the two groups. Again, resource constraints on smaller-sized clinics may influence their experience and the experience of their patients as expressed in the following comment.

> *"You cannot force the patients to use the system or portal. But our clinic is required to show that certain percentage of patients electronically communicate with us. It is a real challenge for us to manage this. And when the [electronic] traffic goes up, I don't think we are equipped to handle all of that to respond back to them in a timely manner."*

Patient preference concern by larger-sized clinics would fit the narrative that they are more concerned with competition. With greater resources compared to smaller clinics they are better able to focus on patient preferences in their efforts to attract and retain patients.

Having an exploitative orientation toward HIE was indicated by both groups, but was most evident with the larger-sized clinics. Viewing HIE as a cost reduction tool was reinforced by a physician who commented,

"The more we move towards a health information exchange and use it as a primary means to transfer health records, the more time and money we will save, and that will tremendously improve how we deliver healthcare to our patients".

The primary drivers for smaller-sized clinics seem to be the expectations by exchange affiliates, government incentives, and operational efficiency. Additionally, the significant and positive relationship between ITI maturity and HIE adoption suggests that smaller clinics with less ITI maturity are less likely to adopt HIE. For promoters of HIE – such as RECs and vendors – it might prove beneficial to consider an approach that increases small clinics overall ITI maturity in an effort to move them toward adoption and use of HIT and HIE.

1.22 Clinic Ownership

Consideration based on ownership reveals differences between clinics that are wholly provider owned (independent), and those that are partially or wholly owned by a hospital or healthcare system (not-independent). Both groups, similar to the overall model, indicated significant relationships between HIE usage outside a healthcare system and all three outcome measures. However, there is a notable difference in the strength of the coefficients and outcome R^2 measures for Satisfaction and Operational Efficiency. The distinction between HIE usage inside versus outside a healthcare system in both groups and the overall model can indicate several possible phenomena.

It is very possible that the effect of HIE usage compared to other factors influencing outcome measures in each context result in relative differences. Within a healthcare system, certain influencers may be stronger compared to those outside a healthcare system. As such, the effect of HIE usage may be relatively stronger compared to other influencers in the outside

context. Another consideration is that each context will necessarily have differences in the entities with which information is exchanged. For example, information electronically communicated to public health officials inherently falls within the context of organizations outside a healthcare system. So too may be the case for other organizations not within the clinic's healthcare system in which the use of HIE has a pronounced affect. Possible examples include rehabilitation centers and nursing homes. Electronic coordination of patient care with such entities may result in a greater effect on certain measures compared to information exchanged with entities within a healthcare system as reflected in the measures for the Satisfaction construct. Additionally, it might be expected that clinics in the not-independent group would give preference to other healthcare groups within their healthcare system compared to independent clinics. This may account for the statistical significance of the association between HIE usage inside a healthcare system and Information Quality, the only outcome measure to have a significant association with HIE usage in the inside context for either group.

The very distinct differences in the associations between the hypothesized factors and the adoption and usage variables might also reflect different phenomena. For one, there may be life cycle temporal differences between the two groups. The not-independent subgroup can be considered more "corporate" in nature, and as such, their experience with, and extent of, internally exchanging patient clinical information among in-house players is well developed. Similar to small-sized clinics, independent clinics may lack the resources of those owned by a larger organization. Resource constraints can affect when an organization decides to adopt a technology. The data may be reflecting this temporal difference. Surprisingly, the Patient and Affiliate factors in the not-independent group did not indicate a significant association with any of the adoption and usage variables, the only model examined to indicate as such. These two

social constructs may be more influential in earlier or less mature stages than later, leading to measureable differences. The difference between the two groups for associations between Government and adoption and usage variables also supports this view. The independent group indicated significant relationships between the Government construct and HIE usage in both the inside and outside a healthcare system context, possibly indicating early stage adoption for this group. However, for the not-independent group, the Government construct did not indicate significantly with HIE adoption but did indicated significantly with HIE usage outside a healthcare system, possibly indicating a later or more mature stage.

A path analysis shows only eight of the twelve constructs indicating any significant relationship for the independent group, the lowest of all models examined, and that eight of the thirteen (61.5%) significant relationships, also the lowest number among the models, are for adoption. Contrast this with the not-independent group showing ten of twelve constructs having significant associations with adoption and usage variables, and ten of seventeen (58.8%) significant relationships are for HIE usage. Taken together, this further supports a difference in life cycle stage.

The level of IT maturity can also be a relative indicator of life cycle stage as those organizations with lower levels of maturity are more likely to adopt later than those with resources (Cerpa et al. 1998; Venkatesh et al. 2003). An overall lower level of IT maturity for the independent group suggests the two groups are in different stages of adoption. The negative relationship between Explorative Orientation and HIE adoption inside a healthcare system for the independent group shows that these clinics have not previously pursued HIT solutions. In addition, the ITI Maturity construct indicated stronger for the not-independent group further supporting this difference.

1.23 Limitations of the Study

Our study was administered using a Web-based survey, therefore respondents without, or unwilling to, access the survey online have not been included. Our outreach to the target population was primarily through the email lists administered by CHITREC and IL-HITREC, hence, the overwhelming majority of responses came from those who are interested in the services of these regional extension centers. This has resulted in respondents who are interested, seeking, and engaged in using HIT and HIE, primarily through the regional extension centers. A limitation of our study also relates to potential response bias. Though our sample was representative of varied clinics in Illinois, it is possible that clinics that were not actively involved in HIE, or not successful in using HIE, might have avoided participating in our study. Another limitation pertains to a single-respondent answering questions on both the outcomes from HIE and the independent variables. Capturing of objective measures, rather than perceptions of outcomes in future research could help avoid these limitations. Results should also be viewed with the limitation that most of the measures are perceptive in nature. All the measures for the hypothesized factors and outcomes from HIE usage are scale-based measures that capture the perception of respondents who participated in our survey. We did not capture objective measures such as actual number of records exchanged via HIE, or economic or financial outcomes resulting from HIE efforts. Future studies can incorporate more objective measures of HIE.

Our study was also cross-sectional and does not capture longitudinal results. As such, temporal effects might be reflected in the data used in this study that are not readily apparent. Since the process of HIE adoption and usage takes place over a period of time, factors of

influence can be different for clinics based on their stage of adoption and implementation. Furthermore, the nature and extent of the factors themselves can change over time – for example, government incentives and mandates. Our study was also limited to the state of Illinois. The environment in which clinics operate differ by state with clinics in some states more engaged with HIT and HIE than others (HealthIT 2014). As such, our results should not be generalized for other states, nor nationally. Additionally, even though our models indicated moderate to high R^2 values for HIE adoption and usage, other factors not accounted for are undoubtedly affecting the process of HIE adoption and usage. Finally, HIE, and HIT in general, is rapidly evolving in its capabilities and uses. Proliferation and use of the technology, as well as changing provider demographics, will result in changes in the factors of influence upon HIE adoption and usage. Given the limitations of our study, results should be interpreted with caution.

1.24 Conclusion

Advances in health information technology promise to improve patient care and lower the cost of providing that care. Communication of patient clinical information is paramount in the provision of care and is a major reason for consideration of HIT solutions. Information systems interoperability has been a focus for researchers and practitioners in many fields for decades, and is now a focus for healthcare as use of HIT proliferates. The last ten years have witnessed a rapid increase in the use of HIT and this has precipitated the need for exchanging patient health information between HIT systems used for patient care. Electronic health information exchange is a concept that has been promoted and failed in decades past, yet is today proliferating as technical and sustainable business solutions have been implemented.

Research of HIE has expanded since the HITECH Act of 2009 yet few studies have considered what factors are, and are not, influencing the large contingency of providers who work in ambulatory clinics. Seeking to understand this group, we asked the questions of what is influencing ambulatory clinics in the state of Illinois, the effect of these influences on the process of HIE adoption and usage among this group, and what is the effect of HIE usage on outcomes for this group. We considered how environmental, organizational, and technological factors influence ambulatory clinics in the state of Illinois to adopt and use HIE. We also considered the effect of HIE usage on outcomes as measured in three categories: satisfaction, information quality, and operational efficiency. Financial and economic considerations were not made for this nascent technology. This organizational level study has a number of implications for both research and practice.

The contributions of this study extend to both HIE and HIT research, and to the study of adoption and usage of information technology in general. Our study contributes to theory in several ways. First, it advances the state of HIE research by going beyond descriptive and prescriptive studies that dominate HIE research by using second generation statistical techniques to investigate factors of influence in a nomological network to provide deeper insight into the nature of the HIE adoption and implementation process. Indeed, we believe this study to be the first of its kind to use a structural model to investigate HIE phenomena. Second, we introduced the concept of organizational exploitative and explorative orientation, and ITI maturity in consideration of HIE adoption and usage. Third, we introduced an adoption and usage scale that considers categorical stages across seven different data types for three groups of HIE partners in both the context of HIE within a healthcare system and outside a healthcare system. Fourth, we examined specific outcome categories in their relationship to the two HIE usage contexts.

There are also a number of contributions to practice from our research. For clinic leadership and clinicians it demonstrates the value of HIE for clinics, and provides inputs for tactics to promote HIE adoption and use by clinics. For administrators and executive leadership of hospitals and healthcare systems it provides insight into differences between 'clinic HIE adoption and usage', and 'hospital or large system HIE adoption and usage'. It also provides insight into those clinics owned, or partially owned, by hospitals or healthcare systems. These insights can contribute to the tailoring of HIE strategies for clinics in these environments. For health policymakers at state and federal agencies this study provides input to developing coordinated efforts among government, vendors, support structures, healthcare systems, and clinics. It also aids in the promotional and educational efforts for improving HIE adoption and use.

Private group practices, as clinics were once called, have been evolving since they sprouted around 100 years ago (Madison et al. 1988). Ongoing changes in the healthcare market over the years from government programs, payer reform efforts, demographics, and now technology have required ever changing approaches and greater resources for providing patient care. Health information exchange is an important technology vital to the advancement of healthcare, and it is hoped that this research contributes to that endeavor.

CITED LITERATURE

3M-HIS 2013. "Innovating the Language of Health: Meaningful Use and the 3M Healthcare Data Dictionary," in *3M Health Information Systems*: Salt Lake City, UT.

Aarts, J., Ash, J., and Berg, M. 2007. "Extending the understanding of computerized physician order entry: implications for professional collaboration, workflow and quality of care," *International Journal of Medical Informatics* (76), pp S4-S13.

Abbott, P. A., Foster, J., Marin, H. F., and Dykes, P. C. 2014. "Complexity and the Science of Implementation in Health IT-Knowledge Gaps and Future Visions," in *International journal of medical informatics*.

Abramson, E. L., McGinnis, S., Edwards, A., Maniccia, D. M., Moore, J., and Kaushal, R. 2012. "Electronic health record adoption and health information exchange among hospitals in New York State," *Journal of evaluation in clinical practice* (18:6), pp 1156-1162.

Adler-Milstein, J., Bates, D. W., and Jha, A. K. 2011. "A survey of health information exchange organizations in the United States: implications for meaningful use," *Annals of Internal Medicine* (154:10), pp 666-671.

Adler-Milstein, J., Bates, D. W., and Jha, A. K. 2013. "Operational health information exchanges show substantial growth, but long-term funding remains a concern," *Health Affairs* (32:8), pp 1486-1492.

Adler-Milstein, J., and Jha, A. K. 2014. "Health information exchange among US hospitals: who's in, who's out, and why?," in *Healthcare*, Elsevier.

Afilalo, M., Lang, E., Léger, R., Xue, X., Colacone, A., Soucy, N., Vandal, A., Boivin, J.-F., and Unger, B. 2007. "Impact of a standardized communication system on continuity of care between family physicians and the emergency department," *Canadian Journal of Emergency Medicine* (9:2), pp 79-86.

Agaku, I. T., Adisa, A. O., Ayo-Yusuf, O. A., and Connolly, G. N. 2014. "Concern about security and privacy, and perceived control over collection and use of health information are related to withholding of health information from healthcare providers," *Journal of the American Medical Informatics Association* (21), pp 374-378.

Agarwal, R., Gao, G., DesRoches, C., and Jha, A. K. 2010. "Research commentary-The digital transformation of healthcare: current status and the road ahead," *Information Systems Research* (21:4), pp 796-809.

AHRQ 2014. "Trends in Health Information Exchanges," Agency for Healthcare Research and Quality.

Ajami, S., and Bagheri-Tadi, T. 2013. "Barriers for Adopting Electronic Health Records (EHRs) by Physicians," *Acta Informatica Medica* (21:2), p 129.

Al-Mashari, M., and Zairi, M. 1999. "BPR implementation process: an analysis of key success and failure factors," *Business Process Management Journal* (5:1), pp 87-112.

Al-Mudhary, A. S., Imtiaz, M. A., Mirhashemi, M. T., and Ibrahim, R. 2013. "Critical Success Factors of Information Technology Projects," *International Journal of Scial, Human Science and Engineering* (7:12), pp 1547-1551.

Aldrich, H. E. 1979. *Organizations and Environments*, (Prentice-Hall: Englewood Cliffs, NJ.

Allen, T. J. 1986. "Organizational structure, information technology, and R&D productivity," *Engineering Management, IEEE Transactions on* (EM-33:4), pp 212-217.

American Hospital Association 2013. "AHA Annual Survey Information Technology Supplement."

Anderson, C. L., and Agarwal, R. 2011. "The digitization of healthcare: boundary risks, emotion, and consumer willingness to disclose personal health information," *Information Systems Research* (22:3), pp 469-490.

Anderson, J., and Balas, E. A. 2006a. "Computerization of Primary Care in the United States," *International Journal of Healthcare Information Systems and Informatics* (1:3), pp 1-23.

Anderson, J., and Balas, E. A. 2006b. "Computerization of primary care in the United States."

Anderson, J. C., and Gerbing, D. W. 1988. "Structural equation modeling in practice: A review and recommended two-step approach," *Psychological Bulletin* (103:3), pp 411-423.

Angst, C. M. 2009. "Protect my privacy or support the common-good? Ethical questions about electronic health information exchanges," *Journal of business ethics* (90:2), pp 169-178.

Armstrong, C. P., and Sambamurthy, V. 1999. "Information technology assimilation in firms: The influence of senior leadership and IT infrastructures," *Information Systems Research* (10:4), pp 304-327.

Ash, J. S., Sittig, D. F., Wright, A., McMullen, C., Shapiro, M., Bunce, A., and Middleton, B. 2011. "Clinical decision support in small community practice settings: a case study," *Journal of the American Medical Informatics Association* (18:6), pp 879-882.

Attewell, P. 1992. "Technology diffusion and organizational learning: The case of business computing," *Organization Science* (3:1), pp 1-19.

Avgar, A. C., Litwin, A. S., and Pronovost, P. J. 2012. "Drivers and Barriers in Health IT Adoption: A Proposed Framework," *Applied Clinical Informatics* (3:4), p 488.

Bahensky, J. A., Jaana, M., and Ward, M. M. 2008. "Health care information technology in rural America: electronic medical record adoption status in meeting the national agenda," *The Journal of Rural Health* (24:2), pp 101-105.

Baker, J. 2012. "The Technology–Organization–Environment Framework," in *Information Systems Theory*, Springer: New York, pp. 231-245.

Baker, J., Song, J., Jones, D., and Ford, E. W. 2008. "Information Systems and Healthcare XXIX: Information Technology Investments and Returns--Uniqueness in the Healthcare Industry," *Communications of the Association for Information Systems* (23), pp 375-392.

Bardhan, I. R., and Thouin, M. F. 2013. "Health information technology and its impact on the quality and cost of healthcare delivery," *Decision Support Systems* (55:2), pp 438-449.

Barney, J. 1991. "Firm resources and sustained competitive advantage," *Journal of Management* (17:1), pp 99-120.

Bassi, J., and Lau, F. 2013. "Measuring value for money: a scoping review on economic evaluation of health information systems," *Journal of the American Medical Informatics Association* (20:4), pp 792-801.

Beard, D. W., and Dess, G. G. 1988. "Modeling organizational species' interdependence in an ecological community: an input-output approach," *Academy of Management Review* (13:3), pp 362-373.

Bélanger, F., and Crossler, R. E. 2011. "Privacy in the digital age: a review of information privacy research in information systems," *MIS Quarterly* (35:4), pp 1017-1042.

Bhakoo, V., and Choi, T. 2013. "The iron cage exposed: Institutional pressures and heterogeneity across the healthcare supply chain," *Journal of Operations Management* (31:6), pp 432-449.

Bharadwaj, A. S. 2000. "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS quarterly* (24:1), pp 169-196.

Blake, R. T., Massey, A. P., Bala, H., Cummings, J., and Zotos, A. 2010. "Driving health IT implementation success: insights from The Christ Hospital," *Business Horizons* (53:2), pp 131-138.

Bowens, F. M., Frye, P. A., and Jones, W. A. 2010. "Health information technology: integration of clinical workflow into meaningful use of electronic health records," *Perspectives in Health Information Management/AHIMA, American Health Information Management Association* (7:Fall).

Bradley, R. V., Byrd, T. A., Pridmore, J. L., Thrasher, E., Pratt, R. M., and Mbarika, V. W. 2012. "An empirical examination of antecedents and consequences of IT governance in US hospitals," *Journal of Information Technology* (27:2), pp 156-177.

Brailer, D. J. 2007. "From Santa Barbara to Washington: A person's and a nation's journey toward portable health information," *Health Affairs* (26:5), pp w581-w588.

Buntin, M. B., Burke, M. F., Hoaglin, M. C., and Blumenthal, D. 2011. "The benefits of health information technology: a review of the recent literature shows predominantly positive results," *Health Affairs* (30:3), pp 464-471.

Burt, R. S. 1987. "Social Contagion and Innovation: Cohesion versus Structural Equivalence," *American Journal of Sociology* (92:6), pp 1287-1335.

Burton-Jones, A., and Straub Jr., D. W. 2006. "Reconceptualizing system usage: An approach and empirical test," *Information Systems Research* (17:3), pp 228-246.

Byrd, T. A., and Turner, D. E. 2000. "Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct," *Journal of Management Information Systems* (17:1), pp 167-208.

Caldeira, M. M., and Ward, J. M. 2003. "Using resource-based theory to interpret the successful adoption and use of information systems and technology in manufacturing small and medium-sized enterprises," *European Journal of Information Systems* (12:2), pp 127-141.

Callaway, B., and Ghosal, V. 2012. "Adoption and diffusion of health information technology: The case of primary care clinics," CESifo Working Paper: Industrial Organisation.

Campion Jr, T. R., Ancker, J. S., Edwards, A. M., Patel, V. N., Kaushal, R., and Investigators, H. Year. "Push and Pull: Physician Usage of and Satisfaction with Health Information Exchange," AMIA Annual Symposium Proceedings, American Medical Informatics Association2012, pp. 77-84.

Cao, Q., Baker, J., Wetherbe, J., and Gu, V. Year. "Organizational adoption of innovation: Identifying factors that influence RFID adoption in the healthcare industry," ECIS 2012 Proceedings, Barcelona, Spain, 2012.

Cao, Q., Gedajlovic, E., and Zhang, H. 2009. "Unpacking organizational ambidexterity: Dimensions, contingencies, and synergistic effects," *Organization Science* (20:4), pp 781-796.

Carayon, P., Smith, P., Hundt, A. S., Kuruchittham, V., and Li, Q. 2009. "Implementation of an electronic health records system in a small clinic: the viewpoint of clinic staff," *Behaviour & Information Technology* (28:1), pp 5-20.

CareQuality 2014. "Carequality."

Carr, C. M., DiGioia, C. H., Wagner, J., and Saef, S. H. 2013. "Primer in health information exchange for the emergency physician: benefits and barriers," *Southern medical journal* (106:6), pp 374-378.

Cenfetelli, R. T., and Bassellier, G. 2009. "Interpretation of formative measurement in information systems research," *MIS Quarterly* (33:4), pp 689-707.
Cerpa, N., and Verner, J. M. 1998. "Case study: The effect of IS maturity on information systems strategic planning," *Information & Management* (34:4), pp 199-208.
Chau, P. Y., and Tam, K. Y. 1997. "Factors Affecting the Adoption of Open Systems: An Exploratory Study," *MIS Quarterly* (21:1), pp 1-24.
Chaudhry, B., Wang, J., Wu, S., Maglione, M., Mojica, W., Roth, E., Morton, S. C., and Shekelle, P. G. 2006. "Systematic review: impact of health information technology on quality, efficiency, and costs of medical care," *Annals of internal medicine* (144:10), pp 742-752.
Chen, D. Q., Mocker, M., Preston, D. S., and Teubner, A. 2010. "Information systems strategy: reconceptualization, measurement, and implications," *MIS Quarterly* (34:2), pp 233-259.
Chernick, M. R. 2008. *Bootstrap Methods: A guide for practitioners and researchers*, (2nd ed.) John Wiley & Sons: Hoboken, NJ.
Child, J. 1972. "Organizational structure, environment and performance: The role of strategic choice," *Sociology* (6), pp 1-21.
Chin, W. W. 1998. "The partial least squares approach to structural equation modeling," in *Modern Methods for Business Research,* G. A. Marcoulides (ed.), Psychology Press, pp. 295-336.
Chin, W. W. 2010. "How to write up and report PLS analyses," in *Handbook of Partial Least Squares*, Springer, pp. 655-690.
Chin, W. W., Marcolin, B. L., and Newsted, P. R. 2003. "A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study," *Information Systems Research* (14:2), pp 189-217.
Clark, L. A., and Watson, D. 1995. "Constructing validity: Basic issues in objective scale development," *Psychological assessment* (7:3), p 309.
CMS 2014. "The Official Web Site for the Medicare and Medicaid Electronic Health Records (EHR) Incentive Programs."
Cohen, W. M., and Levinthal, D. A. 1990. "Absorptive capacity: a new perspective on learning and innovation," *Administrative Science Quarterly* (35:1), pp 128-152.
CommonWell 2014. "CommonWell Health Alliance."
Conway, R. W., Maxwell, W. L., and Morgan, H. L. 1972. "On the implementation of security measures in information systems," *Communications of the ACM* (15:4), pp 211-220.
Culnan, M. J., and Williams, C. C. 2009. "How Ethics Can Enhance Organizational Privacy: Lessons from the ChoicePoint and TJX Data Breaches," *MIS Quarterly* (33:4), pp 673-687.
Currie, W. L. 2012. "Institutional isomorphism and change: the national programme for IT–10 years on," *Journal of Information Technology* (27:3), pp 236-248.
Dadam, P., Reichert, M., and Kuhn, K. 2000. "Clinical workflows—the killer application for process-oriented information systems?," in *BIS 2000,* W. Abramowicz and M. E. Orlowska (eds.), Springer: London.
Damanpour, F. 1991. "Organizational innovation: A meta-analysis of effects of determinants and moderators," *Academy of management journal* (34:3), pp 555-590.

Das, S., Yaylacicegi, U., and Menon, N. M. 2011. "The effect of information technology investments in healthcare: A longitudinal study of its lag, duration, and economic value," *IEEE Transactions on Engineering Management* (58:1), pp 124-140.

DeLone, W. H. 1981. "Firm size and the characteristics of computer use," *MIS Quarterly* (5:4), pp 65-77.

DeLone, W. H. 1988. "Determinants of success for computer usage in small business," *MIS Quarterly* (12:1), pp 51-61.

DesRoches, C. M., Campbell, E. G., Rao, S. R., Donelan, K., Ferris, T. G., Jha, A., Kaushal, R., Levy, D. E., Rosenbaum, S., and Shields, A. E. 2008. "Electronic health records in ambulatory care—a national survey of physicians," *New England Journal of Medicine* (359:1), pp 50-60.

DesRoches, C. M., Painter, M. W., and Jha, A. K. 2013. "Health Information Technology in the United States: Better Information Systems for Better Care, 2013," Mathematica Policy Research, Harvard School of Public Health, and Robert Wood Johnson Foundation.

Dess, G. G., and Beard, D. W. 1984. "Dimensions of organizational task environments," *Administrative Science Quarterly* (29:1), pp 52-73.

Devaraj, S., and Kohli, R. 2003. "Performance impacts of information technology: is actual usage the missing link?," *Management science* (49:3), pp 273-289.

Diamantopoulos, A. 2006. "The error term in formative measurement models: interpretation and modeling implications," *Journal of Modelling in Management* (1:1), pp 7-17.

Dickinson, J. 1986. "From process to policy: a generic prescription for test over-utilization in the emergency department," *Family Practice Research Journal* (7:1), pp 12-21.

Dill, W. R. 1958. "Environment as an influence on managerial autonomy," *Administrative Science Quarterly* (2), pp 409-443.

DiMaggio, P. J., and Powell, W. W. 1983. "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields," *American Sociological Review* (48:2), pp 147-160.

Dimick, C. 2009. "Complicated game. HISPC privacy and security collaborative hands off three years of work," *Journal of AHIMA* (80:5), pp 20-25.

Dixon, B. E., Zafar, A., and Overhage, J. M. 2010. "A Framework for evaluating the costs, effort, and value of nationwide health information exchange," *Journal of the American Medical Informatics Association* (17:3), pp 295-301.

Dowling Jr, A. F. 1987. "Do hospital staff interfere with computer system implementation?," in *Use and impact of computers in clinical medicine,* J. G. Anderson and S. J. Jay (eds.), Springer: New York, pp. 302-317.

Downey, H. K., Hellriegel, D., and Slocum Jr, J. W. 1975. "Environmental uncertainty: The construct and its application," *Administrative science quarterly* (20:4), pp 613-629.

Duncan, N. 1995. "Capturing IT infrastructure flexibility: A study of resource characteristics and their measure," *Journal of Management Information Systems* (12:2), pp 37-57.

Dyer, J. H., and Singh, H. 1998. "The relational view: Cooperative strategy and sources of interorganizational competitive advantage," *Academy of Management Review* (23:4), pp 660-679.

Edwards, A., Hollin, I., Barry, J., and Kachnowski, S. 2010. "Barriers to cross--institutional health information exchange: a literature review," *Journal of healthcare information management: JHIM* (24:3), p 22.

Edwards, J. R., and Bagozzi, R. P. 2000. "On the nature and direction of relationships between constructs and measures," *Psychological Methods* (5:2), p 155.

Efron, B. 1987. "Better bootstrap confidence intervals," *Journal of the American Statistical Association* (82:397), pp 171-185.

Feldman, S. S., and Horan, T. A. 2011. "The Dynamics of Information Collaboration: A Case Study of Blended IT Value Propositions for Health Information Exchange in Disability Determination," *Journal of the Association for Information Systems* (12:2).

Feldman, S. S., Horan, T. A., and Drew, D. 2013. "Understanding the value proposition of health information exchange: the case of uncompensated care cost recovery," *Health Systems* (2:2), pp 134-146.

Fonkych, K., and Taylor, R. 2005. *The State and Pattern of Health Information Technology Adoption*, (Rand Corporation.

Fontaine, P., Ross, S. E., Zink, T., and Schilling, L. M. 2010a. "Systematic review of health information exchange in primary care practices," *The Journal of the American Board of Family Medicine* (23:5), pp 655-670.

Fontaine, P., Zink, T., Boyle, R. G., and Kralewski, J. 2010b. "Health information exchange: participation by Minnesota primary care practices," *Archives of Internal Medicine* (170:7), pp 622-629.

Ford, E. W., Menachemi, N., Peterson, L. T., and Huerta, T. R. 2009. "Resistance is futile: but it is slowing the pace of EHR adoption nonetheless," *Journal of the American Medical Informatics Association* (16:3), pp 274-281.

Frisse, M. E., Johnson, K. B., Nian, H., Davison, C. L., Gadd, C. S., Unertl, K. M., Turri, P. A., and Chen, Q. 2012. "The financial impact of health information exchange on emergency department care," *Journal of the American Medical Informatics Association* (19:3), pp 328-333.

Frohlich, J., Karp, S., Smith, M. D., and Sujansky, W. 2007. "Retrospective: lessons learned from the Santa Barbara project and their implications for health information exchange," *Health Affairs* (26:5), pp w589-591.

Galbraith, J. R. 1973. *Designing complex organizations*, (Addison-Wesley Longman Publishing Co., Inc.: Boston, MA.

Gersick, C. J. 1991. "Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm," *Academy of Management Review* (16:1), pp 10-36.

Gibson, C. B., and Birkinshaw, J. 2004. "The antecedents, consequences, and mediating role of organizational ambidexterity," *Academy of Management Journal* (47:2), pp 209-226.

Gibson, C. F., and Nolan, R. L. 1974. "Managing the four stages of EDP growth," *Harvard Business Review* (52:1), pp 76-87.

Gladwin, J., Dixon, R., and Wilson, T. 2002. "Rejection of an innovation: health information management training materials in east Africa," *Health Policy and Planning* (17:4), pp 354-361.

Gold, A. H., and Arvind Malhotra, A. H. S. 2001. "Knowledge management: An organizational capabilities perspective," *Journal of Management Information Systems* (18:1), pp 185-214.

Gold, M. R., McLaughlin, C. G., Devers, K. J., Berenson, R. A., and Bovbjerg, R. R. 2012. "Obtaining providers''buy-in' and establishing effective means of information exchange will be critical to HITECH's success," *Health Affairs* (31:3), pp 514-526.

Grandon, E. E., and Pearson, J. M. 2004. "Electronic commerce adoption: an empirical study of small and medium US businesses," *Information & Management* (42:1), pp 197-216.
Greenaway, K. E., and Chan, Y. E. 2005. "Theoretical Explanations for Firms' Information Privacy Behaviors," *Journal of the Association for Information Systems* (6:6), pp 171-189.
Grover, V. 1993. "An Empirically Derived Model for the Adoption of Customer-based Interorganizational Systems*," *Decision Sciences* (24:3), pp 603-640.
Grover, V., and Segars, A. H. 2005. "An empirical evaluation of stages of strategic information systems planning: patterns of process design and effectiveness," *Information & Management* (42:5), pp 761-779.
Gupta, A. K., Smith, K. G., and Shalley, C. E. 2006. "The interplay between exploration and exploitation," *Academy of Management Journal* (49:4), pp 693-706.
Hagemeier, G. 1997. "Uniform standards are basic building blocks for Electronic Data Interchange. Healthcare EDI Coalition," *Journal of healthcare resource management* (15:6), p 26.
Hagen, S., and Richmond, P. 2008. "Evidence on the costs and benefits of health information technology," Congressional Budget Office, Washington D.C.
Hair, J. F., Ringle, C. M., and Sarstedt, M. 2011. "PLS-SEM: Indeed a silver bullet," *The Journal of Marketing Theory and Practice* (19:2), pp 139-152.
Hair Jr, J. F., Hult, G. T. M., Ringle, C., and Sarstedt, M. 2013. *A primer on partial least squares structural equation modeling (PLS-SEM)*, (Sage Publications.
Harrison, M. I., Koppel, R., and Bar-Lev, S. 2007. "Unintended consequences of information technologies in health care—an interactive sociotechnical analysis," *Journal of the American Medical Informatics Association* (14:5), pp 542-549.
Hartono, E., Li, X., Na, K.-S., and Simpson, J. T. 2010. "The role of the quality of shared information in interorganizational systems use," *International Journal of Information Management* (30:5), pp 399-407.
He, Z.-L., and Wong, P.-K. 2004. "Exploration vs. Exploitation: An Empirical Test of the Ambidexterity Hypothesis," *Organization Science* (15:4), pp 481-494.
Health Resources and Services Administration 2012. "What is health information exchange?," U.S. Department of Health and Human Services.
HealthIT 2010a. "Regional Extension Centers (RECS)," Office of the National Coordinator for Health Information Technology.
HealthIT 2010b. "What is Meaningful Use?," in *EHR Incentives & Certification*, Office of the National Coordinator for Health Information Technology.
HealthIT 2012a. "State Health Information Exchange Cooperative Agreement Program," in *State Health Information Exchange.*, Office of the National Coordinator for Health Information Technology.
HealthIT 2012b. "What is HIE?," Office of the National Coordinator for Health Information Technology.
HealthIT 2014. "State HIE Implementation Status," Office of the National Coordinator for Health Information Technology.
Heisey-Grove, D., and Patel, V. 2014. "Physician Motivations for Adoption of Electronic Health Records," Office of the National Coordinator for Health Information Technology.

Henseler, J., Ringle, C., and Sarstedt, M. 2015. "A new criterion for assessing discriminant validity in variance-based structural equation modeling," *Journal of the Academy of Marketing Science* (43:1) 2015/01/01, pp 115-135.

Henseler, J., and Sarstedt, M. 2013. "Goodness-of-fit indices for partial least squares path modeling," *Computational Statistics* (28:2), pp 565-580.

Herwehe, J., Wilbright, W., Abrams, A., Bergson, S., Foxhood, J., Kaiser, M., Smith, L., Xiao, K., Zapata, A., and Magnus, M. 2012. "Implementation of an innovative, integrated electronic medical record (EMR) and public health information exchange for HIV/AIDS," *Journal of the American Medical Informatics Association* (19:3), pp 448-452.

HIMSS 2014. "Ambulatory EMR Adoption Model," HIMSS Analytics.

Holmquest, D. L. 2007. "Another lesson from Santa Barbara," *Health Affairs* (26:5), pp w592-w594.

Huang, C. D., Behara, R. S., and Goo, J. 2014. "Optimal Information Security Investment in a Healthcare Information Exchange: An Economic Analysis," *Decision Support Systems* (InPress).

Huang, D.-L., Rau, P.-L. P., and Salvendy, G. 2010. "Perception of information security," *Behaviour & Information Technology* (29:3), pp 221-232.

Iossifova, A. R., and Meyer-Goldstein, S. 2013. "Impact of standards adoption on healthcare transaction performance: The case of HIPAA," *International Journal of Production Economics* (141:1), pp 277-285.

Ives, B., and Learmonth, G. P. 1984. "The information system as a competitive weapon," *Communications of the ACM* (27:12), pp 1193-1201.

IVI 2013. "Leveraging IT Capabilities to Accelerate Business Value Impact from Electronic Medical Record Adoption," Innovation Value Institute p. 8.

Jensen, T. B., Kjærgaard, A., and Svejvig, P. 2009. "Using institutional theory with sensemaking theory: a case study of information system implementation in healthcare," *Journal of Information Technology* (24:4), pp 343-353.

Jha, A. K., DesRoches, C. M., Campbell, E. G., Donelan, K., Rao, S. R., Ferris, T. G., Shields, A., Rosenbaum, S., and Blumenthal, D. 2009. "Use of electronic health records in US hospitals," *New England Journal of Medicine* (360:16), pp 1628-1638.

Joiner, G. A., Salisbury, D., and Bollin, G. E. 1996. "Utilizing quality assurance as a tool for reducing the risk of nosocomial ventilator-associated pneumonia," *American Journal of Medical Quality* (11:2), pp 100-103.

Joshi, J. K. 2011. "Clinical Value-Add for Health Information Exchange (HIE)," *Internet Journal of Medical Informatics* (6:1).

Kam, R. 2012. "Top 3 issues facing patient privacy," Government Health IT.

Kane, C. K., and Emmons, D. E. 2013. "New Data On Physician Practice Arrangements: Private Practice Remains Strong Despite Shifts Toward Hospital Employment " in *Policy Research Perspectives,* A. M. Association (ed.): Chicago.

Kaplan, B., and Harris-Salamone, K. D. 2009. "Health IT success and failure: recommendations from literature and an AMIA workshop," *Journal of the American Medical Informatics Association* (16:3), pp 291-299.

Kern, L., Wilcox, A., Shapiro, J., Yoon-Flannery, K., Abramson, E., Barron, Y., and Kaushal, R. 2011. "Community-based health information technology alliances: potential predictors of early sustainability," *The American journal of managed care* (17:4), pp 290-295.

Kern, L. M., Barrón, Y., Dhopeshwarkar, R. V., Edwards, A., and Kaushal, R. 2013. "Electronic health records and ambulatory quality of care," *Journal of General Internal Medicine* (28:4), pp 496-503.

Kern, L. M., Barrón, Y., Dhopeshwarkar, R. V., and Kaushal, R. 2012. "Health information exchange and ambulatory quality of care," *Applied clinical informatics* (3:2), pp 197-209.

Kim, K. K., McGraw, D., Mamo, L., and Ohno-Machado, L. 2013. "Development of a privacy and security policy framework for a multistate comparative effectiveness research network," *Medical care* (51), pp S66-S72.

Kohlbacher, M. 2010. "The effects of process orientation: a literature review," *Business Process Management Journal* (16:1), pp 135-152.

Kohli, R., and Devaraj, S. 2003. "Measuring information technology payoff: A meta-analysis of structural variables in firm-level empirical research," *Information Systems Research* (14:2), pp 127-145.

Korst, L. M., Aydin, C. E., Signer, J. M., and Fink, A. 2011. "Hospital readiness for health information exchange: Development of metrics associated with successful collaboration for quality improvement," *International journal of medical informatics* (80:8), pp e178-e188.

Kuan, K. K., and Chau, P. Y. 2001. "A perception-based model for EDI adoption in small businesses using a technology–organization–environment framework," *Information & Management* (38:8), pp 507-521.

Kumar, R. L. 2004. "A framework for assessing the business value of information technology infrastructures," *Journal of Management Information Systems* (21:2), pp 11-32.

Lau, F. 2011. "Benefits of Health Information Technology—Are We There Yet?," *iHealth Connections* (1:2), pp 148-150.

Lee, C.-P., and Shim, J. P. 2007. "An exploratory study of radio frequency identification (RFID) adoption in the healthcare industry," *European Journal of Information Systems* (16:6), pp 712-724.

Leidner, D. E., Lo, J., and Preston, D. 2011. "An empirical investigation of the relationship of IS strategy with firm performance," *The Journal of Strategic Information Systems* (20:4), pp 419-437.

Leu, M. G., Cheung, M., Webster, T. R., Curry, L., Bradley, E. H., Fifield, J., and Burstin, H. 2008. "Centers speak up: the clinical context for health information technology in the ambulatory care setting," *Journal of General Internal Medicine* (23:4), pp 372-378.

Levene, H. 1960. "Robust tests for equality of variances," in *Contributions to probability and statistics: Essays in honor of Harold Hotelling,* I. Olkin, S. G. Ghurye, W. Hoeffding, W. G. Madow and H. B. Mann (eds.), Standford University Press: Standford, CA, pp. 278-292.

Liang, H., Saraf, N., Hu, Q., and Xue, Y. 2007. "Assimilation of Enterprise Systems: The Effect of Institutional Pressures and the Mediating Role of Top Management," *MIS Quarterly* (31:1), pp 59-87.

Liao, J. M., and Chu, D. 2012. "The State of Health Information Exchange," *Journal of Health & Medical Informatics* (3:e102).

Lichtenstein, Y., Shabtai, I., Milstein, I., and Ben-Assuli, O. Year. "Social influence and network effects in the diffusion of a healthcare information exchange system," Proceedings of Mediterranean Conference on Information Systems (MCIS) 20102010, pp. 1-13.

Litwin, A. S., Avgar, A. C., and Pronovost, P. J. 2012. "Measurement error in performance studies of health information technology: Lessons from the management literature," *Applied Clinical Informatics* (3:2), pp 210-220.
Liu, C.-H., Chung, Y.-F., Chen, T.-S., and Wang, S.-D. 2012. "The enhancement of security in healthcare information systems," *Journal of Medical Systems* (36:3), pp 1673-1688.
Lluch, M. 2011. "Healthcare professionals' organisational barriers to health information technologies—A literature review," *International Journal of Medical Informatics* (80:12), pp 849-862.
Loch, K. D., Carr, H. H., and Warkentin, M. E. 1992. "Threats to information systems: today's reality, yesterday's understanding," *MIS Quarterly* (16:2), pp 173-186.
Lorenzi, N. M. 2003. "Strategies for creating successful local health information infrastructure initiatives.," Vanderbilt University, Nashville, TN.
Lorenzi, N. M., Kouroubali, A., Detmer, D. E., and Bloomrosen, M. 2009. "How to successfully select and implement electronic health records (EHR) in small ambulatory practice settings," *BMC Medical Informatics and Decision Making* (9:1), p 15.
Lubatkin, M. H., Simsek, Z., Ling, Y., and Veiga, J. F. 2006. "Ambidexterity and Performance in Small-to Medium-Sized Firms: The Pivotal Role of Top Management Team Behavioral Integration," *Journal of Management* (32:5), pp 646-672.
Ludwick, D. A., and Doucette, J. 2009. "Adopting electronic medical records in primary care: lessons learned from health information systems implementation experience in seven countries," *International journal of medical informatics* (78:1), pp 22-31.
Madison, D. L., and Konrad, T. R. 1988. "Large medical group-practice organizations and employed physicians: A relationship in transition," *The Milbank Quarterly* (66:2), pp 240-282.
Manos, D. 2014. "Interoperability beyond doom or gloom," Healthcare IT News.
March, J. G. 1991. "Exploration and Exploitation in Organizational Learning," *Organization Science* (2:1), pp 71-87.
Markus, K. A. 2012. "Principles and Practice of Structural Equation Modeling by Rex B. Kline," *Structural Equation Modeling: A Multidisciplinary Journal* (19:3), pp 509-512.
Martin, T. N., and Huq, Z. 2007. "Realigning top management's strategic change actions for ERP implementation: how specializing on just cultural and environmental contextual factors could improve success," *Journal of Change Management* (7:2), pp 121-142.
Mason, R. O., Mason, F. M., and Culnan, M. J. 1995. *Ethics of Information Management*, (Sage Publications, Inc.
McAlearney, A. S., Song, P. H., Robbins, J., Hirsch, A., Jorina, M., Kowalczyk, N., and Chisolm, D. 2010. "Moving from good to great in ambulatory electronic health record implementation," *Journal for Healthcare Quality* (32:5), pp 41-50.
McCann, E. 2014a. "HIE market scales to new heights," Healthcare IT News.
McCann, E. 2014b. "Hospitals in EMR buying frenzy," Healthcare IT News.
McDonald, C. 2009. "Protecting patients in health information exchange: a defense of the HIPAA privacy rule," *Health Affairs* (28:2), pp 447-449.
McGraw, D., Dempsey, J. X., Harris, L., and Goldman, J. 2009. "Privacy as an enabler, not an impediment: building trust into health information exchange," *Health Affairs* (28:2), pp 416-427.
McKelvey, B. 1982. *Organizational systematics--taxonomy, evolution, classification*, (Univ of California Press.

McLeod, L., and MacDonell, S. G. 2011. "Factors that affect software systems development project outcomes: A survey of research," *ACM Computing Surveys (CSUR)* (43:4), p 24.

McMullan, M. 2006. "Patients using the Internet to obtain health information: how this affects the patient–health professional relationship," *Patient Education and Counseling* (63:1), pp 24-28.

Melvin, V. C. 2009. "Information Technology. Challenges Remain for VA's Sharing of Electronic Health Records with DOD," Government Accounntability Office, Washington D.C.

Menachemi, N., Chukmaitov, A., Saunders, C., and Brooks, R. G. 2008. "Hospital quality of care: does information technology matter? The relationship between information technology adoption and quality of care," *Health care management review* (33:1), pp 51-59.

Meyerhoefer, C. D., Deily, M. E., Sherer, S. A., Shin-Yi Chou, L. P., Sheinberg, M., and Levick, D. 2013. "The Impact of Electronic Health Record Adoption and Integration on Physician Productivity and Health Outcomes."

Miller, A. R., and Tucker, C. 2009. "Privacy protection and technology diffusion: The case of electronic medical records," *Management Science* (55:7), pp 1077-1093.

Minnesota Office of Health Information Technology 2014. "Health Information Technology Ambulatory Clinic Survey," Minnesota Department of Health.

Miranda, D., Fields, W., and Lund, K. 2001. "Lessons learned during 15 years of clinical information system experience," *Computers in Nursing* (19:4), pp 147-151.

Mongan, J. J., Ferris, T. G., and Lee, T. H. 2008. "Options for slowing the growth of health care costs," *New England Journal of Medicine* (358:14), pp 1509-1514.

National Center for Health Statistics 2011. "Physician Workflow Supplement 2011," in *National Ambulatory Medial Care Survey*, Centers for Disease Control and Prevention.

National Center for Health Statistics 2012. "National Electronic Health Records Survey," in *National Ambulatory Medial Care Survey*, Centers for Disease Control and Prevention.

National Health Service 2014. "NHS Infrastructure Maturity Model (NIMM)."

Neuner, J., Fedders, M., Caravella, M., Bradford, L., and Schapira, M. 2014. "Meaningful Use and the Patient Portal Patient Enrollment, Use, and Satisfaction With Patient Portals at a Later-Adopting Center," in *American Journal of Medical Quality*.

Niazkhani, Z., Pirnejad, H., Berg, M., and Aarts, J. 2009. "The impact of computerized provider order entry systems on inpatient clinical workflow: a literature review," *Journal of the American Medical Informatics Association* (16:4), pp 539-549.

Nissen, M., Kamel, M., and Sengupta, K. 2000. "Integrated analysis and design of knowledge systems and processes," *Knowledge Management and Virtual Organizations* (13:1), pp 24-43.

Nolan, R. L. 1973. "Managing the computer resource: a stage hypothesis," *Communications of the ACM* (16:7), pp 399-405.

Novak, L. L., Holden, R. J., Anders, S. H., Hong, J. Y., and Karsh, B.-T. 2013. "Using a sociotechnical framework to understand adaptations in health IT implementation," *International journal of medical informatics* (82:12), pp e331-e344.

Nunnally, J. C., and Bernstein, I. H. 1994. *Psychometric Theory*, (3rd ed.) McGraw-Hill: New York

ONC 2014. "Certified Health IT Product List," HealthIT.gov.

Oz, E., and Sosik, J. J. 2000. "Why information systems projects are abandoned: a leadership and communication theory and exploratory study," *The Journal of Computer Information Systems* (41:1), p 66.

Panko, R. 2009. *Corporate Computer and Network Security*, (2nd ed.) Prentice Hall: Upper Saddle River, NJ.

Parker, C. M., and Castleman, T. 2007. "New directions for research on SME-eBusiness: insights from an analysis of journal articles from 2003 to 2006," *Journal of Information Systems & Small Business* (1:1/2), pp 21-40.

Parks, R., Chu, C., Xu, H., and Adams, L. Year. "Understanding the Drivers and Outcomes of Healthcare Organizational Privacy Responses," Thirty Second International Conference on Information Systems, Shanghai, China, 2011.

Patas, J., Bartenschlager, J., and Goeken, M. Year. "Resource-Based View in Empirical IT Business Value Research--An Evidence-Based Literature Review," System Science (HICSS), 2012 45th Hawaii International Conference on, IEEE2012, pp. 5062-5071.

Patel, V., Abramson, E. L., Edwards, A., Malhotra, S., and Kaushal, R. 2011. "Physicians' potential use and preferences related to health information exchange," *International Journal of Medical Informatics* (80:3), pp 171-180.

Pear, R. 2015. "Tech Rivalries Impede Digital Medical Record Sharing," May 26, 2015 (available at http://www.nytimes.com/2015/05/27/us/electronic-medical-record-sharing-is-hurt-by-business-rivalries.html?_r=0).

Peffers, K., and Dos Santos, B. L. 1996. "Performance effects of innovative IT applications over time," *Engineering Management, IEEE Transactions on* (43:4), pp 381-392.

Penrose, E. T. 1959. *The Theory of the Growth of the Firm*, (Oxford University Press: Oxford.

Pevnick, J. M., Claver, M., Dobalian, A., Asch, S. M., Stutman, H. R., Tomines, A., and Fu Jr, P. 2012. "Provider stakeholders' perceived benefit from a nascent health information exchange: A qualitative analysis," *Journal of medical systems* (36:2), pp 601-613.

Pfeffer, J., and Salancik, G. R. 2003. *The external control of organizations: A resource dependence perspective*, (Stanford University Press: Stanford, California.

Piccoli, G., and Ives, B. 2005. "Review: IT-dependent strategic initiatives and sustained competitive advantage: a review and synthesis of the literature," *MIS Quarterly* (29:4), pp 747-776.

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., and Podsakoff, N. P. 2003. "Common method biases in behavioral research: a critical review of the literature and recommended remedies," *Journal of Applied Psychology* (88:5), pp 879-903.

Poon, E. G., Blumenthal, D., Jaggi, T., Honour, M. M., Bates, D. W., and Kaushal, R. 2004. "Overcoming barriers to adopting and implementing computerized physician order entry systems in US hospitals," *Health Affairs* (23:4), pp 184-190.

Powell, W. W., and DiMaggio, P. J. 1991. *The New Institutionalism in Organizational Analysis*, (University of Chicago Press: Chicago.

Preacher, K. J., and Hayes, A. F. 2004. "SPSS and SAS procedures for estimating indirect effects in simple mediation models," *Behavior Research Methods,Iinstruments, & Computers* (36:4), pp 717-731.

Preacher, K. J., and Hayes, A. F. 2008. "Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models," *Behavior Research Methods* (40:3), pp 879-891.

Premkumar, G., and Roberts, M. 1999. "Adoption of new information technologies in rural small businesses," *Omega* (27:4), pp 467-484.
PwC 2011. "Old data learns new tricks: Managing patient security and privacy on a new data-sharing playground," PwC Health Research Institute, p. 38.
Raghupathi, W., and Tan, J. 2002. "Strategic IT applications in health care," *Communications of the ACM* (45:12), pp 56-61.
Rai, A., Chen, L., Pye, J., and Baird, A. 2013. "Understanding determinants of consumer mobile health usage intentions, assimilation, and channel preferences," *Journal of Medical Internet Research* (15:8).
Rai, A., Patnayakuni, R., and Seth, N. 2006. "Firm performance impacts of digitally enabled supply chain integration capabilities," *MIS quarterly* (30:2), pp 225-246.
Raisch, S., and Birkinshaw, J. 2008. "Organizational ambidexterity: Antecedents, outcomes, and moderators," *Journal of Management* (34:3), pp 375-409.
Raisch, S., Birkinshaw, J., Probst, G., and Tushman, M. L. 2009. "Organizational ambidexterity: Balancing exploitation and exploration for sustained performance," *Organization Science* (20:4), pp 685-695.
Raths, D. 2008. "Setting the standards stage. If health information exchange is to get to the next level, formulating standards will be an absolute key," *Healthcare informatics: the business magazine for information and communication systems* (25:3), p 34.
Ratnam, K. A., Dominic, P., and Ramayah, T. 2014. "A structural equation modeling approach for the adoption of cloud computing to enhance the Malaysian healthcare sector," *Journal of Medical Systems* (38:8), pp 1-14.
Reardon, J. L., and Davidson, E. 2007. "An organizational learning perspective on the assimilation of electronic medical records among small physician practices," *European Journal of Information Systems* (16:6), pp 681-694.
Reinartz, W., Haenlein, M., and Henseler, J. 2009. "An empirical comparison of the efficacy of covariance-based and variance-based SEM," *International Journal of Research in Marketing* (26:4), pp 332-344.
Ringle, C. M., Wende, S., and Becker, J.-M. 2015. "SmartPLS 3," SmartPLS GmbH: Boenningstedt.
Rockart, J. F. 1982. *The changing role of the information systems executive: a critical success factors perspective*, (Massachusetts Institute of Technology Boston.
Rockart, J. F., Earl, M. J., and Ross, J. W. 1996. "Eight imperatives for the new IT organization," *Sloan Management Review* (38:1), pp 43-55.
Rogers, E. M. 2003. *Diffusion of Innovations*, (5th ed.) Simon and Schuster: New York.
Ross, S. E., Schilling, L. M., Fernald, D. H., Davidson, A. J., and West, D. R. 2010. "Health information exchange in small-to-medium sized family medicine practices: Motivators, barriers, and potential facilitators of adoption," *International Journal of Medical Informatics* (79:2), pp 123-129.
Rudin, R. S., Simon, S. R., Volk, L. A., Tripathi, M., and Bates, D. 2009. "Understanding the decisions and values of stakeholders in health information exchanges: experiences from Massachusetts," *American Journal of Public Health* (99:5), pp 950-955.
Sambamurthy, V., Bharadwaj, A., and Grover, V. 2003. "Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms," *MIS Quarterly* (27:2), pp 237-263.

Scheer, A.-W., Abolhassan, F., Jost, W., and Kirchmer, M. 2004. *Business Process Automation*, (Springer: Berlin.

Schooley, B., Horan, T., and Marich, M. 2010. "Managing IT Collaboration in Multi-Organizational Time-Critical Services," *MIS Quarterly Executive* (9:3), pp 147-161.

Schumacker, R. E., and Lomax, R. G. 2010. *A beginner's guide to structural equation modeling*, (3rd ed.) Routledge - Taylor & Francis Group: New York.

Schuster, D. M., Hall, S. E., Couse, C. B., Swayngim, D. S., and Kohatsu, K. Y. 2003. "Involving users in the implementation of an imaging order entry system," *Journal of the American Medical Informatics Association* (10:4), pp 315-321.

Scott, W. R. 2014. *Institutions and Organizations: Ideas, Interests, and Identities*, (4th ed.) Sage Publications: Thousand Oaks, CA.

Setia, P., Setia, M., Krishnan, R., and Sambamurthy, V. 2011. "The Effects of the Assimilation and Use of IT Applications on Financial Performance in Healthcare Organizations," *Journal of the Association for Information Systems* (12:3), pp 274-298.

Shakib, S., Knight, E., Endo, J., and Lau, L. M. Year. "An Application to Integrate the Logistical and Technical Aspects of Data Dictionary Support to Multiple Healthcare Systems," Proceedings of the AMIA Symposium, American Medical Informatics Association2002, p. 1163.

Sheth, A., Georgakopoulos, D., Joosten, S. M., Rusinkiewicz, M., Scacchi, W., Wileden, J., and Wolf, A. L. 1996. "Report from the NSF workshop on workflow and process automation in information systems," *ACM SiGMOD Record* (25:4), pp 55-67.

Silvius, A., and Stoop, J. Year. "The Relationship between the Process of Strategic Information Systems Planning and Its Success: An Explorative Study," System Sciences (HICSS), 2013 46th Hawaii International Conference on, IEEE2013, pp. 4495-4501.

Simsek, Z., Heavey, C., Veiga, J. F., and Souder, D. 2009. "A typology for aligning organizational ambidexterity's conceptualizations, antecedents, and outcomes," *Journal of Management Studies* (46:5), pp 864-894.

Singh, R., Lichter, M. I., Danzo, A., Taylor, J., and Rosenthal, T. 2012. "The adoption and use of health information technology in rural areas: results of a national survey," *The Journal of Rural Health* (28:1), pp 16-27.

Smith, H. J., and Hasnas, J. 1999. "Ethics and information systems: the corporate domain," *MIS Quarterly* (23:1), pp 109-127.

Tarafdar, M., and Gordon, S. R. 2007. "Understanding the influence of information systems competencies on process innovation: A resource-based view," *The Journal of Strategic Information Systems* (16:4), pp 353-392.

Tenenhaus, M., Amato, S., and Esposito Vinzi, V. Year. "A global goodness-of-fit index for PLS structural equation modelling," Proceedings of the XLII SIS scientific meeting, CLEUP Padova2004, pp. 739-742.

Teo, T. S., Srivastava, S. C., and Jiang, L. 2008. "Trust and electronic government success: An empirical study," *Journal of Management Information Systems* (25:3), pp 99-132.

Thong, J. Y. 1999. "An integrated model of information systems adoption in small businesses," *Journal of Management Information Systems* (15:4), pp 187-214.

Thong, J. Y., and Yap, C.-S. 1995. "CEO characteristics, organizational characteristics and information technology adoption in small businesses," *Omega* (23:4), pp 429-442.

Thong, J. Y., Yap, C.-S., and Raman, K. 1996. "Top management support, external expertise and information systems implementation in small businesses," *Information systems research* (7:2), pp 248-267.

Tornatzky, L. G., and Fleischer, M. 1990. *Processes of Technological Innovation*, (Lexington Books: Lexington, Massachusetts.

Ugrin, J. C. 2009. "The Effect of System Characteristics, Stage of Adoption, and Experience on Institutional Explanations for ERP Systems Choice," *Accounting Horizons* (23:4), pp 365-389.

Ulrich, D., and Barney, J. B. 1984. "Perspectives in organizations: resource dependence, efficiency, and population," *Academy of Management Review* (9:3), pp 471-481.

Unertl, K. M., Johnson, K. B., and Lorenzi, N. M. 2012. "Health information exchange technology on the front lines of healthcare: workflow factors and patterns of use," *Journal of the American Medical Informatics Association* (19:3), pp 392-400.

ValenceHealth 2013. "Models of Value-Based Reimbursement," Valence Health.

van de Wetering, R., and Batenburg, R. 2009. "A PACS maturity model: a systematic meta-analytic review on maturation and evolvability of PACS in the hospital enterprise," *International Journal of Medical Informatics* (78:2), pp 127-140.

Van Dyk, L., Fortuin, J., and Schutte, C. Year. "A maturity model for telemedicine implementation," The Fourth International Conference on eHealth, Telemedicine, and Social Medicine, Valencia, Spain, 2012, pp. 78-84.

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. 2003. "User acceptance of information technology: Toward a unified view," *MIS quarterly* (27:3), pp 425-478.

Venkatraman, N. 1994. "IT-enabled business transformation: from automation to business scope redefinition," *Sloan Management Review* (35:2), pp 73-87.

Vest, J., and Miller, T. 2011a. "The association between health information exchange and measures of patient satisfaction," *Applied Clinical Informatics* (2:4), pp 447-459.

Vest, J. R. 2010. "More than just a question of technology: Factors related to hospitals' adoption and implementation of health information exchange," *International Journal of Medical Informatics* (79:12), pp 797-806.

Vest, J. R., Campion Jr, T. R., and Kaushal, R. 2013. "Challenges, Alternatives, and Paths to Sustainability for Health Information Exchange Efforts," *Journal of Medical Systems* (37:6), pp 1-8.

Vest, J. R., and Gamm, L. D. 2010. "Health information exchange: persistent challenges and new strategies," *Journal of the American Medical Informatics Association* (17:3), pp 288-294.

Vest, J. R., Gamm, L. D., Ohsfeldt, R. L., Zhao, H., and Jasperson, J. S. 2012. "Factors associated with health information exchange system usage in a safety-net ambulatory care clinic setting," *Journal of medical systems* (36:4), pp 2455-2461.

Vest, J. R., Zhao, H., Jaspserson, J., Gamm, L. D., and Ohsfeldt, R. L. 2011b. "Factors motivating and affecting health information exchange usage," *Journal of the American Medical Informatics Association* (18:2), pp 143-149.

Waegemann, C. P., Tessier, C., Barbash, A., Blumenfeld, B. H., Borden, J., Brinson, R., Robert, M., Cooper, T., Elkin, P., and Fitzmaurice, J. 2002. "Healthcare documentation: A report on information capture and report generation," Medical Records Institute, Newton, Massachusettes.

Walczuch, R., Van Braven, G., and Lundgren, H. 2000. "Internet adoption barriers for small firms in the Netherlands," *European Management Journal* (18:5), pp 561-572.

Waldo, B. H. 2003. "Connecting for Compliance: Improving Satisfaction and Care Coordination by Extending the Home Care Record to the Physician," *Home Healthcare Nurse* (21:10), pp 674-679.
Walker, J., Pan, E., Johnston, D., Adler-Milstein, J., Bates, D. W., and Middleton, B. 2005. "The value of health care information exchange and interoperability," *Health Affairs* (24:W5), pp 10-18.
Wang, P., and Ramiller, N. C. 2009. "Community Learning in Information Technology Innovation," *MIS quarterly* (33:4), pp 709-734.
Ware, W. H. 1984. "Information systems security and privacy," *Communications of the ACM* (27:4), pp 315-321.
Warner, D. 2012. "Untangling HIE: patchwork regulations, standards complicate health information exchange," *Journal of AHIMA* (83:5), p 40.
Weber, B., Reichert, M., and Rinderle-Ma, S. 2008. "Change patterns and change support features–enhancing flexibility in process-aware information systems," *Data & Knowledge Engineering* (66:3), pp 438-466.
Werts, C. E., Linn, R. L., and Jöreskog, K. G. 1974. "Intraclass reliability estimates: Testing structural assumptions," *Educational and Psychological Measurement* (34:1), pp 25-33.
Whitman, M. E. 2003. "Enemy at the gate: threats to information security," *Communications of the ACM* (46:8), pp 91-95.
Williams, C., Mostashari, F., Mertz, K., Hogin, E., and Atwal, P. 2012. "From the Office of the National Coordinator: the strategy for advancing the exchange of health information," *Health affairs* (31:3), pp 527-536.
Wood, D. 2013. "EHR Adoption Report: The Latest Trends," AMN Healthcare.
Wright, A., Soran, C., Jenter, C. A., Volk, L. A., Bates, D. W., and Simon, S. R. 2010. "Physician attitudes toward health information exchange: results of a statewide survey," *Journal of the American Medical Informatics Association* (17:1), pp 66-70.
Yaraghi, N., Du, A. Y., Sharman, R., Gopal, R. D., and Ramesh, R. 2013. "Network effects in health information exchange growth," *ACM Transactions on Management Information Systems* (4:1), p 26.
Yew Wong, K. 2005. "Critical success factors for implementing knowledge management in small and medium enterprises," *Industrial Management & Data Systems* (105:3), pp 261-279.
Zheng, K., McGrath, D., Hamilton, A., Tanner, C., White, M., and Pohl, J. M. 2009. "A case study in ambulatory practices," *Journal of Decision Systems* (18:1), pp 117-140.
Zheng, K., Padman, R., Johnson, M. P., and Diamond, H. S. 2005. "Understanding technology adoption in clinical care: clinician adoption behavior of a point-of-care reminder system," *International Journal of Medical Informatics* (74:7), pp 535-543.
Zhu, K., and Kraemer, K. L. 2005. "Post-adoption variations in usage and value of e-business by organizations: cross-country evidence from the retail industry," *Information Systems Research* (16:1), pp 61-84.
Zina Mou, h. 2014. "Group of Electronic Health Record Vendors To Become Officially Interoperable," in *Pharma & Healthcare*, Forbes.com.
Zinatelli, N., Cragg, P., and Cavaye, A. 1996. "End user computing sophistication and success in small firms," *European Journal of Information Systems* (5:3), pp 172-181.

Appendix A. Survey question references used in study.

Question	Source
Adoption and Usage	
Adoption and Usage – Repeated for Hospitals, Clinics, and Other facilities, for both inside and outside a healthcare system. *Enter one of the following codes as applicable for electronic exchange of patient information.* (1 = Not capable and not planning on electronic exchange; 2 = Capable but not planning on electronic exchange; 3 = Engaged in planning, evaluation, or trial of electronical exchange; 4 = Electronically exchanging these data, but also using other methods; 5 = Entirely, or mostly, engaged in electronic exchange of these data.	
Patient demographics	(Minnesota Office of Health Information Technology 2014; National Center for Health Statistics 2012)
Referrals	Ibid.
Clinical orders	Ibid.
Clinical/Summary care records (any format)	Ibid.
Medication history and/or physician notes	Ibid.
Lab results	Ibid.
Radiology results	Ibid.
Government Influence Extent to which the following factors have influenced your clinic's decision to adopt or implement a Health Information Exchange (HIE) solution? Likert: 1=No Influence, 5=Very Strong Influence	
Government Regulations (e.g. HITECH act, Meeting Meaningful Use etc.)	(National Center for Health Statistics 2011; Patel et al. 2011)
Government incentives (e.g. Financial and other incentives)	Ibid.
Governmental efforts through agencies like State-level Offices of Health IT, Regional Health Information Organizations, Regional Extension Centers, etc.	Ibid.
Patient Influence Likert: 1=Strongly Disagree, 5=Strongly Agree	
Our patients like electronic access to their health records and other clinical information.	(Minnesota Office of Health Information Technology 2014; National Center for Health Statistics 2012)
Our patients prefer electronic exchange of their health information between our clinic and hospitals, specialists, or other clinics.	Ibid.
Our patients encourage electronic transfer of their orders to	Ibid.

Question	Source
labs and/or pharmacies.	
Affiliates Likert: 1=Strongly Disagree, 5=Strongly Agree	
Most of the specialists and other clinics we work with prefer electronic exchange of health information.	(National Center for Health Statistics 2011)
Most of the hospitals we work with prefer electronic exchange of health information.	Ibid.
Many health facilities we work with (e.g. labs, pharmacies, other centers etc.) prefer electronic exchange of health information.	Ibid.
Peers Extent to which the following factors have influenced your clinic's decision to adopt or implement a Health Information Exchange (HIE) solution? Likert: 1=No Influence, 5=Very Strong Influence	
Peer clinics operating in your health network.	(National Center for Health Statistics 2011; Premkumar et al. 1999)
Competing clinics in your local area.	Ibid.
Vendors Extent to which the following factors have influenced your clinic's decision to adopt or implement a Health Information Exchange (HIE) solution? Likert: 1=No Influence, 5=Very Strong Influence	
Our clinic's Health IT/EMR vendor(s).	(American Hospital Association 2013; Premkumar et al. 1999)
Primary provider of your IT services.	Ibid.
Orientation toward HIE Over the last five years we have engaged in Health Information Technology projects to, Likert: 1=Strongly Disagree, 5=Strongly Agree	
Extend the range of services offered to our patients.	(Chen et al. 2010; Grandon et al. 2004; Leidner et al. 2011; Patel et al. 2011)
Enhance the clinical care offered by our clinicians and staff.	Ibid.
Expand our clinic's outreach to new patients.	Ibid.
Improve operational efficiency.	Ibid.
Improve clinical processes.	Ibid.
Improve administrative processes (e.g. patient check-in, billing, etc.)	Ibid.
Clinical Leadership Likert: 1=Strongly Disagree, 5=Strongly Agree	

Question	Source
Our clinical leadership considers the use of HIT (like EHR) important.	(Grandon et al. 2004; National Center for Health Statistics 2011)
Our clinical leadership has a well-defined vision of how HIT will advance the goals our clinic.	Ibid.
Our clinical leadership has a favorable view toward Health Information Exchange (HIE).	Ibid.
Clinical Workflow Likert: 1=Strongly Disagree, 5=Strongly Agree	
Use of electronic exchange methods for patient information easily fit into our clinical workflow.	(National Center for Health Statistics 2011)
Use of electronic exchange methods for patient information is compatible with our clinical workflow.	Ibid.
Our clinical workflow can easily adapt to electronic exchange methods for patient information.	Ibid.
Our clinical workflow allows for use of health information technology.	Ibid.
Information Technology Infrastructure (ITI) Maturity Likert: 1=Strongly Disagree, 5=Strongly Agree	
Our clinicians are quite knowledgeable about the health IT systems that we have.	(American Hospital Association 2013; Bharadwaj 2000)
Our staff (non-clinicians) are quite knowledgeable about health IT systems that we have.	Ibid.
Our clinic's information technology infrastructure is compatible with HIE.	Ibid.
Employees at our clinic are electronically connected to most other employees (e.g. email, instant messaging, etc.).	Ibid.
External IT Support Likert: 1=Strongly Disagree, 5=Strongly Agree	
We have easy access to vendors and agencies for technical support pertaining to health information technologies.	(Minnesota Office of Health Information Technology 2014; Premkumar et al. 1999)
We have easy access to vendors and agencies who provide training for health information technologies.	Ibid.
IT support is readily available to use from external sources when we need it.	Ibid.
Information Security Safeguards Likert: 1=None at all, 5=Extraordinary amount, 9=Do not know	
What level of technical safeguards exist in your practice or	(American Hospital

Question	Source
clinic for controlling access to patients' health information?	Association 2013; Edwards et al. 2010; Fontaine, Ross, et al. 2010; Fontaine, Zink, et al 2010; Wright et al. 2010)
To what degree has your practice or clinic put policies and procedures in place for safeguarding patient health information?	Ibid.
Demographics	
How many providers (physicians, nurse practitioners, and physician assistants) are associated with this clinic location?	(Minnesota Office of Health Information Technology 2014)
What is the ownership of your clinic or group? • Wholly physician/provider owned • Partially owned by a hospital, healthcare system, HMO, etc. • Wholly owned by a hospital, healthcare system, HMO, etc. • Do not know	Ibid.

Appendix B. Recruitment email, letter, and statement of consent.

Invitation email

Dear Health Practice Leader,

Take a 15-minute survey and receive a $15 gift card, plus receive an exclusive report on Exploiting Health Information Exchange for Your Clinic's Future.

Enter this URL into a browser to begin: http://bit.ly/1w7bCob

Your input is valuable and may help policy and decision makers better understand practices such as yours.

The Center for Healthcare Information Management and Systems (CHIMS) at the University of Illinois at Chicago, the Illinois Health Information Technology Regional Extension Center (IL-HITREC), and the Chicago Health Information Technology Regional Extension Center (CHITREC) request your participation. Read the complete survey invitation letter here: http://bit.ly/1Nl7UfV

Your participation is greatly appreciated,

John Pendergrass
jpender2@uic.edu

Dr. Ranganathan
ranga@uic.edu

Full recruitment letter posted online

Dear Health Practice Leader,

The Center for Healthcare Information Management and Systems (CHIMS) at the University of Illinois at Chicago (UIC) in conjunction with both Chicago Health Information Technology Regional Extension Center (CHITREC) and Illinois Health Information Technology Regional Extension Center (IL-HITREC), are requesting your participation in a study about **the influences affecting decisions of small providers and clinics regarding health information exchange (HIE)** in the state of Illinois.

The majority of physicians in the United States work for small practices or clinics yet little is understood about the factors that influence their decisions regarding healthcare information technology. Meaningful Use, Accountable Care, and other incentive programs requiring coordination of patient care and use of Electronic Medical Records is changing how practitioners operate. A key component in these models is the sharing, or exchange, of clinical patient information. Your participation in this research will help lead to an understanding of the influences affecting the decisions by small practices and clinics regarding HIE.

If you agree to participate, we ask that you complete a survey at the link below. It is estimated that the survey will take about 15 minutes to complete. The survey is anonymous and no identifiable individual or organizational information is required. You can withdraw from the survey at any time without consequence. Upon completion of the survey, you will be presented the opportunity to receive an executive report resulting from this study, as well as a $15 gift card as a token of our appreciation (limited to one per practice). Contact information needed to receive the report or gift card will be collected separately and not be associated with the survey.

The results of this study may be published. Confidentiality will be maintained to the degree permitted by the technology used. Your participation in this research study is completely voluntary. Your participation in this online survey involves risks similar to a person's everyday use of the Internet. Although it is impossible to completely guarantee that electronic data will not be accessed by unauthorized personnel, we expect such risk to be

very minimal. You can withdraw from the survey at any time. For additional details, please read the Statement of Consent at this link,

https://drive.google.com/file/d/0B6cm232Zo_tDclVhaGdIVEJjYTQ/view?usp=sharing

If you have questions about this study, please contact John Pendergrass at jpender2@uic.edu, or Dr. Ranganathan at ranga@uic.edu.

If you have questions about your rights as a participant in this study, you may call the Office for the Protection of Research Subjects (OPRS) at 1-866-789-6215 (toll-free) or 312-996-1711, or e-mail OPRS at uicirb@uic.edu.

Your participation is greatly appreciated,

John Pendergrass, CHIMS, UIC
Dr. Ranganathan, CHIMS, UIC

Informed Consent for Participation in Research

Why am I being asked?

You are being asked to answer questions on behalf of your organization because of your position within the organization. Your organization has been identified as a healthcare clinic, the subject of this study. This research is being conducted by John C. Pendergrass, PhD Candidate, Department of Information and Decision Sciences, at the University of Illinois at Chicago. Please read this form and ask any questions you may have before agreeing to be in the research.

Your participation in this research is voluntary. If you decide to participate, you are free to withdraw at any time.

What is the purpose of this research?

Over the last 10 years healthcare has seen a rapid rise in the use of information technology. Recent programs such as Meaningful Use and Accountable Care further incentivize the use of health information technology. The meaningful use of Electronic Medical Records as part of the Medicare and Medicaid incentive program under the Health Information Technology for Economic and Clinical Health (HITECH) act of 2009, and the creation of accountable care organizations (ACOs) under the Patient Protection and Affordable Care Act (ACA) of 2010, are enabled by health information technology. Key to the goals of these new paradigms is exchanging (sharing) patient clinical information between different healthcare providers and facilities. Enabling this exchange of patient information are electronic Health Information Exchanges (HIEs).

HIEs have been adopted by over half of the hospitals in the United States and are increasingly used to transmit and receive patient clinical information to providers, laboratories, pharmacies, health reporting agencies, and others. Though many larger clinics, especially those part of a larger health system, are increasingly adopting HIE, what is not known is the posture of smaller clinics, often physician-owned, on adopting and using HIE.

The objectives of the research are to:

- Understand the extent of ambulatory healthcare practice and clinic adoption and use of HIE
- Examine the outcomes that result from using HIE by this group
- Understand the environmental, organizational, and technological factors leading to decisions to adopt and use HIE.

We expect the number of research participants in this study to be approximately 400.

What procedures are involved?

If you agree to participate in this research, we would ask you to answer questions in an online survey to explain your clinic's posture toward HIE. This is an organizational level survey. There are no questions asking for

personal information. This survey will take approximately 15 minutes of your time and must be completed in one session.

What are the potential risks and discomforts?

Risks and discomforts associated with this survey are expected to be very minimal. Questions are related to how your practice or clinic approaches and uses, or does not use, electronic HIE. Confidentiality will be maintained to the degree permitted by the technology used. Your participation in this online survey involves risks similar to a person's everyday use of the Internet.

Are there benefits to taking part in the research?

You will not directly benefit from participating in this research. You may, upon completion of this survey, select to receive an executive report resulting from this study, as well as a gift card as a token of appreciation.

What about privacy and confidentiality?

The only people who will know that you have participated are members of the research team. No information about you, or provided by you during the research, will be disclosed to others without your written permission, except:

- If necessary to protect your rights or welfare (for example, if you are injured and need emergency care or when the UIC Institutional Review Board monitors the research or consent process), or
- If required by law.

When the results of the research are published or discussed in conferences, no information will be included that would reveal your identity or the identity of your practice or clinic.

Any information that is obtained in connection with this study that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. No identifiable information, such as your IP address, will be collected from you during the completion of the survey. All survey responses will be stored on a secured server. Although it is impossible to completely guarantee that electronic data may not be accessed by unauthorized personnel, we expect such risk to be very minimal. Confidentiality will be maintained to the degree permitted by the technology used. Your participation in this online survey involves risks similar to a person's everyday use of the Internet.

What are the costs for participating in this research?

There is no cost to you for participating in this study.

Will I be reimbursed for any of my expenses or paid for my participation in this research?

You will not be directly compensated for participating in this study. However, you can select to receive an executive report resulting from this study, as well as a gift card as a token of our appreciation.

If you do choose to request the executive report or gift card, you will be taken to a separate page to submit your email or postal address. All contact information will be kept in a separate file from survey results and so cannot be used to connect you with specific survey responses. However, email and postal addresses are personally identifiable information and will indicate that you have participated in the study. Your email or postal address will only be used to send you the requested executive report and gift card. Your contact information will not be shared with anyone other than the research team or agents needed to distribute the report and gift card.

Can I withdraw or be removed from the study?

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind by exiting your Internet browser. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so.

You must complete the entire survey in order to request the executive report and gift card.

Who should I contact if I have questions?

The research is conducted by John C. Pendergrass, PhD Candidate, Department of Information and Decision Sciences, at the University of Illinois at Chicago. Should you have any questions about the study please

contact Mr. Pendergrass at jpender2@uic.edu. This research is being supervised by Dr. C Ranganathan at University of Illinois at Chicago. You may contact Dr. Ranganathan at ranga@uic.edu or 312-996-2847.

If you feel you have not been treated according to the descriptions in this form, or you have any questions about your rights as a research subject, you may call the Office for the Protection of Research Subjects (OPRS) at 312-996-1711 (local) or 1-866-789-6215 (toll-free) or e-mail OPRS at uicirb@uic.edu.

You may use your browser's print function to print this informed consent for future reference.

Appendix C. Construct and measurement item descriptions.

Construct	Measurement Item	Description
Government	EnGov1	Influence from government regulations (e.g. HITECH act, Meeting Meaningful Use etc.).
	EnGov2	Influence from government incentives (e.g. Financial and other incentives).
	EnGov3	Influence from governmental efforts through agencies (like Regional Extension Centers, etc.).
Patients	EnPtn1	Patients like electronic access to their health records and other clinical information.
	EnPtn2	Patients prefer electronic exchange of their health information between our clinic and other providers.
	EnPtn3	Patients encourage electronic transfer of their orders to labs and/or pharmacies.
Affiliates	EnAff1	Affiliated specialists and clinics prefer electronic exchange of health information.
	EnAff2	Affiliated hospitals prefer electronic exchange of health information.
	EnAff3	Affiliated facilities (e.g. labs, pharmacies, etc.) prefer electronic exchange of health information.
Peers	EnPr1	Extent to which peer clinics in health network have influenced decision to implement HIE.
	EnPr2	Extent to which competing clinics in local area have influenced decision to implement HIE.
Vendors	EnVen1	Extent to which clinic's health IT/EMR vendor has influenced decision to implement HIE.
	EnVen2	Extent to which clinic's provider of IT services has influenced decision to implement HIE.
Exploitative Orientation	OrEplo1	Engaged in HIT project to improve operational efficiency in last 5 years.
	OrEplo2	Engaged in HIT project to improve clinical processes in last 5 years.
	OrEplo3	Engaged in HIT project to improve administrative processes in last 5 years.
Explorative Orientation	OrEplr1	Engaged in HIT project to extend range of services offered to patients in last 5 years.
	OrEplr2	Engaged in HIT project to enhance clinical care offered by clinicians and staff in last 5 years.
	OrEplr3	Engaged in HIT project to expand clinical outreach to new patients in last 5 years.
Clinical Leadership	OrLdr1	Clinical leadership considers the use of HIT (like EHR) important.
	OrLdr2	Clinical leadership has a well-defined vision of how HIT will advance the goals of the clinic.
	OrLdr3	Clinical leadership has a favorable view toward Health Information Exchange
Workflow	OrWkfl1	Use of electronic exchange methods for patient information easily fits into clinical workflow.
	OrWkfl2	Use of electronic exchange methods for patient information is compatible with clinical workflow.
	OrWkfl3	Clinical workflow can easily adapt to electronic exchange methods.
	OrWkfl4	Our clinical workflow allows for use of health information technology.
IT Infrastructure Maturity	TeITIM1	Clinicians are quite knowledgeable about clinic's existing health IT systems.
	TeITIM2	Clinic staff (non-clinicians) are quite knowledgeable about existing health IT systems.

Construct	Measurement Item	Description
	TeITIM3	Clinic's information technology infrastructure is compatible with HIE.
	TeITIM4	Employees at clinic are electronically connected to most other employees (e.g. email, etc.).
External IT Support	TeSup1	Easy access to vendors and agencies for HIT technical support.
	TeSup2	Easy access to vendors and agencies for HIT training.
	TeSup3	Availability of IT support from external sources when needed.
Security Safeguards	TeSec1	Level of technical safeguards for accessing patient's health information.
	TeSec2	Level of policies and procedures in place for safeguarding patient health information.
Adoption Inside	AdptClinic_In	HIE adoption score for electronic exchange with clinics in focal's healthcare system.
	AdptHosp_In	HIE adoption score for electronic exchange with hospitals in focal's healthcare system.
	AdptOther_In	HIE adoption score for electronic exchange with other healthcare facilities in focal's healthcare system.
Adoption Outside	AdptClinic_Out	HIE adoption score for electronic exchange with clinics outside focal's healthcare system.
	AdptHosp_Out	HIE adoption score for electronic exchange with hospitals outside focal's healthcare system.
	AdptOther_Out	HIE adoption score for electronic exchange with other healthcare facilities outside focal's healthcare system.
Usage Inside	UseClinic_In	HIE usage score for electronic exchange with clinics in focal's healthcare system.
	UseHosp_In	HIE usage score for electronic exchange with hospitals in focal's healthcare system.
	UseOther_In	HIE usage score for electronic exchange with other healthcare facilities in focal's healthcare system.
Usage Outside	UseClinic_Out	HIE usage score for electronic exchange with clinics outside focal's healthcare system.
	UseHosp_Out	HIE usage score for electronic exchange with hospitals outside focal's healthcare system.
	UseOther_Out	HIE usage score for electronic exchange with other healthcare facilities outside focal's healthcare system.
Satisfaction	Outcome1	Perceived improved coordination of patient care.
	Outcome2	Perceived improved quality of care for patients.
	Outcome9	Perceived improved patient satisfaction.
	Outcome10	Perceived improved clinician satisfaction.
Information Quality	Outcome3	Perceived improved information accuracy for clinicians.
	Outcome4	Perception of more timely information for clinicians.
	Outcome5	Perception of more complete information for clinicians.
Operational Efficiency	Outcome6	Perceived reduction in administrative and operational costs to exchange patient information.
	Outcome7	Perceived reduction in paperwork.
	Outcome8	Perception of better compliance with regulatory requirements.

Appendix D. Reflective constructs – measurement item loadings.

	Govrn	Patients	Affil	Peers	Vendrs	Exploi Orient	Explor Orient	Clinical Leadrsh	Work flow	Ext IT Sup	Sec Safgrds
EnGov1	**.836**										
EnGov2	**.789**										
EnGov3	**.767**										
EnPtn1		**.842**									
EnPtn2		**.888**									
EnPtn3		**.747**									
EnAff1			**.847**								
EnAff2			**.879**								
EnAff3			**.748**								
EnPr1				**.918**							
EnPr2				**.906**							
EnVen1					**.885**						
EnVen2					**.946**						
OrEplo1						**.817**					
OrEplo2						**.778**					
OrEplo3						**.887**					
OrEplr1							**.874**				
OrEplr2							**.778**				
OrEplr3							**.887**				
OrLdr1								**.849**			
OrLdr2								**.891**			
OrLdr3								**.781**			
OrWkfl1									**.714**		
OrWkfl2									**.801**		
OrWkfl3									**.719**		
OrWkfl4									**.773**		
TeSup1										**.719**	
TeSup2										**.787**	
TeSup3										**.805**	
TeSec1											**.882**
TeSec2											**.778**

Appendix E. Square root of average variance extracted (diagonal) and correlation between latent variables .

	Govrn	Patnts	Affil	Peers	Vndrs	Exploi Orient	Explor Orient	Clin Ldrsh	Work Flow	Ext IT Sup	Sec Safgrd	Satisf	Info Qlty	Oper Effic
Government	0.798													
Patients	0.312	0.828												
Affiliates	0.315	0.683	0.827											
Peers	0.249	0.578	0.603	0.912										
Vendor	0.468	0.429	0.391	0.453	0.916									
Exploitative Orient.	0.315	0.586	0.615	0.550	0.417	0.841								
Explorative Orient.	0.361	0.626	0.622	0.533	0.488	0.700	0.848							
Clinical Leadership	0.504	0.422	0.439	0.340	0.374	0.548	0.524	0.842						
Workflow	0.426	0.616	0.614	0.405	0.307	0.596	0.538	0.583	0.753					
Ext IT Sup	0.332	0.544	0.495	0.408	0.300	0.548	0.525	0.468	0.601	0.771				
Security Safeguards	0.528	0.154	0.240	0.081	0.232	0.282	0.261	0.447	0.398	0.276	0.800			
Satisfaction	0.408	0.668	0.675	0.628	0.476	0.671	0.645	0.509	0.605	0.558	0.215	0.821		
Info Quality	0.331	0.526	0.515	0.504	0.369	0.546	0.534	0.397	0.482	0.413	0.111	0.690	0.805	
Operational Efficny.	0.260	0.574	0.551	0.492	0.385	0.551	0.524	0.405	0.538	0.423	0.091	0.659	0.513	0.765

Appendix F. Formative constructs – loadings, weights, and variance inflation factor (VIF).

Construct -Measurement item	Loading	Relative Weight	VIF
ITI Maturity			
TeITIM1	0.858***	0.598***	1.28
TeITIM2	0.440***	0.120*	1.18
TeITIM3	0.521***	0.312***	1.15
TeITIM4	0.653***	0.416***	1.14
Adoption Inside			
AdptClinic_In	0.905***	0.407***	2.45
AdptHosp_In	0.909***	0.335***	2.73
AdptOther_In	0.896***	0.385***	2.27
Adoption Outside			
AdptClinic_Out	0.891***	0.301***	2.68
AdptHosp_Out	0.887***	0.419***	2.18
AdptOther_Out	0.884***	0.417***	2.08
Usage Inside			
UseClinic_In	0.886***	0.267*	3.05
UseHosp_In	0.983***	0.645***	3.01
UseOther_In	0.862***	0.175*	2.90
Usage Outside			
UseClinic_Out	0.951***	0.517***	2.92
UseHosp_Out	0.851***	0.212*	2.49
UseOther_Out	0.905***	0.372***	2.57
Satisfaction			
Outcome1	0.833***	0.326***	1.89
Outcome2	0.831***	0.313***	1.91
Outcome9	0.811***	0.289***	1.85
Outcome10	0.808***	0.289***	1.84
Information Quality			
Outcome3	0.880***	0.598***	1.43
Outcome4	0.821***	0.315***	1.88
Outcome5	0.704***	0.307***	1.51
Operational Efficiency			
Outcome6	0.659***	0.352***	1.24
Outcome7	0.805***	0.392***	1.49
Outcome8	0.821***	0.552***	1.28
*** p < .01, ** p < .05, * p < .10			

Appendix G. Construct means and standard deviations.

Construct (min=1, max=5)*		Overall	By Clinic Size		By Ownership	
			Less-than-10	10-or-more	Indepen.	Not-Indep.
Government	Mean	3.36	3.43	3.29	3.42	3.28
	Std. Dev.	0.72	0.81	0.62	0.76	0.65
	N	321	148	171	135	170
Patients	Mean	3.10	2.99	3.21	3.03	3.26
	Std. Dev.	0.83	0.96	0.69	0.89	0.67
	N	321	148	171	135	170
Affiliates	Mean	3.01	2.95	3.07	2.94	3.15
	Std. Dev.	0.83	0.97	0.68	0.95	0.61
	N	320	148	170	135	169
Peers	Mean	3.43	3.31	3.55	3.23	3.65
	Std. Dev.	1.01	1.18	0.82	1.17	0.76
	N	321	148	171	135	170
Vendors	Mean	3.38	3.38	3.38	3.21	3.53
	Std. Dev.	0.97	1.07	0.88	1.06	0.84
	N	319	146	171	135	169
Exploitative Orientation	Mean	3.01	2.99	3.05	2.91	3.13
	Std. Dev.	0.84	0.96	0.72	0.95	0.68
	N	321	148	171	135	170
Explorative Orientation	Mean	3.23	3.16	3.30	3.11	3.33
	Std. Dev.	0.90	1.06	0.73	1.04	0.74
	N	321	148	171	135	170
Clinical Leadership	Mean	3.26	3.30	3.22	3.30	3.22
	Std. Dev.	0.82	0.91	0.75	0.90	0.72
	N	321	148	171	135	170
Workflow	Mean	3.26	3.28	3.25	3.32	3.26
	Std. Dev.	0.66	0.73	0.58	0.74	0.55
	N	321	148	171	135	170
ITI Maturity	Mean	3.59	3.62	3.57	3.60	3.58
	Std. Dev.	0.57	0.62	0.52	0.64	0.48
	N	316	144	170	134	166
External IT Support	Mean	3.36	3.33	3.41	3.37	3.41
	Std. Dev.	0.69	0.80	0.57	0.79	0.58
	N	319	146	171	134	170
Security Safeguards	Mean	3.86	3.99	3.73	3.96	3.76
	Std. Dev.	0.67	0.73	0.58	0.70	0.62
	N	321	148	171	135	170

* except as noted

Appendix G continued.

Construct (min=1, max=5)*		Overall	By Clinic Size		By Ownership	
			Less-than-10	10-or-more	Indepen.	Not-Indep.
Adoption Inside (0,21)	Mean	15.09	16.01	14.39	15.30	14.95
	Std. Dev.	4.89	5.43	4.32	5.21	4.62
	N	289	125	164	113	169
Usage Inside (0,42)	Mean	13.97	14.58	13.53	15.51	12.87
	Std. Dev.	10.07	11.02	9.32	11.34	8.85
	N	278	118	160	110	163
Adoption Outside (0,21)	Mean	15.04	15.68	14.53	15.09	14.87
	Std. Dev.	4.79	5.53	4.10	5.01	4.63
	N	288	122	165	113	166
Usage Outside (0,42)	Mean	12.88	13.66	12.35	14.23	12.21
	Std. Dev.	8.49	9.18	7.97	9.73	7.50
	N	271	110	161	104	161
Outcome - Satisfaction	Mean	3.01	2.98	3.05	2.94	3.12
	Std. Dev.	0.86	1.01	0.70	1.02	0.70
	N	318	147	169	135	170
Outcome - Information Quality	Mean	3.28	3.16	3.41	3.17	3.43
	Std. Dev.	0.87	1.00	0.71	1.03	0.68
	N	317	147	168	134	170
Outcome - Operational Efficiency	Mean	3.12	3.03	3.22	3.06	3.24
	Std. Dev.	0.93	1.02	0.83	1.07	0.78
	N	317	146	169	135	169

* except as noted

Appendix H. Structural model path coefficients and coefficients of determination (R^2).

		Inside Healthcare System		Outside Healthcare System	
		Adoption	Usage	Adoption	Usage
Environmental	Government	0.164**	0.089*	0.110	0.124**
	Patients	0.121	-0.176**	0.050	0.046
	Affiliates	0.067	0.289***	0.172*	0.172***
	Peers	-0.002	-0.090*	0.024	-0.007
	Vendor	0.077	0.009	-0.023	-0.102*
Organizational	Exploitative Orientation	0.090	-0.037	0.200**	-0.020
	Explorative Orientation	-0.035	-0.049	0.087	-0.018
	Clinical Leadership	0.077	0.123**	-0.025	0.109**
	Workflow	-0.105*	0.118*	-0.141*	0.048
Technological	ITI Maturity	0.198**	0.040	0.147*	0.017
	External IT Support	0.043	0.006	0.154*	0.119**
	Security Safeguards	0.213***	0.046	0.072	0.041
	R^2	0.42	0.54	0.39	0.55
	Adoption Inside → Usage Inside		0.480***		
	Adoption Outside → Usage Outside				0.418***
Outcomes			Satisfaction	Information Quality	Operational Efficiency
	Usage Inside		0.092	0.145*	0.052
	Usage Outside		0.534***	0.322***	0.391***
	R^2		0.36	0.19	0.18
*** p < .01, ** p < .05, * p < .10					

VITA

Name:	John C. Pendergrass
Education:	Ph.D., Management Information Systems, 2015 Information and Decision Sciences, College of Business University of Illinois at Chicago
	M.S., Information Systems, 2007 College of Computing and Digital Media DePaul University
	B.S., Computer Science, 1989 Computer and Information Sciences University of Alabama at Birmingham
Appointments:	Visiting Assistant Professor, 2015-2016 Operations Management & Information Systems Dept. Northern Illinois University
Publications:	Pendergrass, J.C., Heart, K., Ranganathan, C., & Venkatakrishnan, V.N. (2014). A Threat Table Based Assessment of Information Security in Telemedicine. *International Journal of Health Information Systems and Informatics, 9(4)*, 20-31.
	Pendergrass, J. C., and Ranganathan, C. (2014). A Framework to Improve Coordinated Action toward the Adoption and Implementation of Health Information Exchanges. *System Sciences (HICSS), 2014 47th Hawaii International Conference on*, IEEE2014, 2686-2692.
	Pendergrass, J.C., Heart, K., Ranganathan, C., & Venkatakrishnan, V.N. (2013). A Threat Table Based Approach to Telemedicine Security. *Transactions of the International Conference on Health Information Technology Advancement*, *Paper 38*. http://scholarworks.wmich.edu/ichita_transactions/38
Fellowship:	Integrative Graduate Education and Research Traineeship Program (IGERT), National Science Foundation, 2013 – 2015.

Conferences & Workshops:	Pendergrass, J.C. (2015). Adoption of Health Information Exchange by Small Clinics: An Institutional Perspective. Emergent research presentation at *Americas Conference on Information Systems (AMCIS),* Puerto Rico.
	Pendergrass, J.C. (2014). Information Security Assessment in Telemedicine. Presentation at Third Franco-American Workshop on CyberSecurity December 8-10, 2014, Lyon, France.
	Pendergrass, J.C. (2014). Environmental, Organizational, and Technological Factors of Adoption and Usage of Health Information Exchanges Among Small Ambulatory Clinics. Poster presentation at *OCIS Doctoral Consortium, Academy of Management*, Philadelphia, PA.
	Pendergrass, J.C. (2012, December). Sharing Personal Health Information via Health Information Exchanges: A Conceptual Model of Patient Willingness. Poster presentation at *ICIS Workshop on Information Security and Privacy 2012*, Orlando, Florida.
Teaching Experience:	Visiting Assistant Professor, Northern Illinois University, 2015 – 2016 Database Management for Business (fall), Project Management (spring).
	Teaching Assistant, University of Illinois at Chicago, 2011 – 2013 Intro MIS, Business Systems Analysis & Design, Business Systems Project, Advanced Systems Analysis & Design Project, Introduction Operations Management.
	Adjunct Instructor, Argosy University, Chicago, IL, 2010 (two terms) Information Systems Management (MBA program).
	Adjunct Instructor, Alabama Industrial Development & Training, 1999 C Programming and Design.
Research Experience:	Research Assistant, University of Illinois at Chicago, 2013 Project with Illinois Health Information Exchange.
Pedagogical Training:	Foundations of College Teaching, 2014 Graduate College, University of Illinois at Chicago
	Organizational Communication & Information Systems (OCIS) Doctoral Consortium, 2014, Academy of Management, Philadelphia, PA

Professional:	Web master, 2012
Service:	Americas Conference on Information Systems (AMCIS), Chicago, IL
Professional Affiliations:	Association for Information Systems (AIS) Institute for Operations Research and the Management Sciences (INFORMS) Healthcare Information and Management Systems Society (HIMSS)
Industry Experience:	IT Manager (part-time), 2012 – current World Relief, Chicago, IL Senior Project Manager, 2008 – 2009 ACS INC., Oak Brook, IL Senior Project Manager, 2003 – 2007 Fidelity National Information Services, Chicago, IL Director, Information Technology, 1996 – 2002 MACH Americas, Montgomery, AL Manager, Development and Support, 1987 – 1996 BellSouth, Inc., Birmingham, AL
Volunteer Work:	Radio Reader, 2009 – 2010 The Chicago Lighthouse, Chicago, IL Project Manager, 2008 Taproot Foundation, Chicago, IL