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Organizational Complexity and Hospitals' Adoption of Electronic Medical Records for Closed-loop Medication Therapy Management

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Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

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Abstract

Over 700,000 adverse drug events (ADEs) result in emergency hospital visits annually, and many of these ADEs are preventable through the use of health information technology in hospitals. However, only 12.6% of U.S. hospitals have developed the capacity to adopt closed-loop electronic medical records (EMR). Organizational complexity may be a major factor influencing hospitals' adoption of closed-loop EMR. This quantitative study explored how organizational complexity influenced hospitals' adoption of closed-loop EMR. Diffusion of innovation theory was the foundation for this study. Logistic regression was used to establish possible relationships between organizational complexity and hospitals' adoption of EMR for closed-loop medication therapy management. Secondary data from Health Information and Management Systems Society were examined to explore the relationship between organization complexity and hospitals' adoption of EMR for closed-loop medication therapy. The research questions explored whether vendor selection strategy, structural complexity, and management structure influence hospitals' adoption of EMR for closed-loop medication therapy management. The results indicated that all three variables, vendor selection strategy, structural complexity, and management structure, are statistically significant predictors of hospitals' adoption of EMR for closed-loop medication therapy management. Results from this study may promote positive social change by enhancing hospitals' adoption of EMR for closed-loop medication therapy management, which may therefore help improve the quality, efficiency, and safety of health care delivery in U.S. hospitals.

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Dedication

This work is dedicated to my wife-Angela Adu Siaw and my three children-Abigail Adu Siaw, Angel Adu Siaw, and Ebenezer Adu Siaw (Jnr).

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My sincere thanks go first and foremost to the Almighty God whose mercy and blessings I cannot count. He has been my provider, guide and protector. To God be the Glory! During this work, I have come across numerous people who have been the source of encouragement and support; my classmates, tutors, and friends. To you all I say thanks. I am also thankful to HIMSS Analytics for making the data available to me for this study. My thanks go to my wife and children who sacrifice their time and supported me throughout this journey.

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Chapter 1: Introduction to the Study

Introduction

Quality, efficiency, and patient safety related to medication management in healthcare delivery pose a significant problem in the United States (National Coordinator for Health IT [ONC], 2013). Medication management encompasses the processes of ordering by physicians, dispensing by pharmacists, and administration by nurses, usually operating in different parts of the organization. Deficits in communication and information transfer among providers within an organization have been identified to play a significant role in medication errors (Budnitz, Lovegrove, Shehab, & Richards, 2011). Over 700,000 adverse drug events (ADEs) result in emergency hospital visits every year (Center for Disease Control and Prevention [CDC], 2014), and many of these ADEs are preventable through the use of health information technology in hospitals.

Health information technology to improve medication safety usually centers on the electronic medical records (EMR), which is the platform for automation of medication-related processes within the inpatient facility. EMR with closed loop medication management (closed-loop EMR) provides functional integration of computerized physician order entry (CPOE), pharmacy dispensing, and bar coding for medication administration (BCMA) to support the five rights of medication administration (right patient, right drug, right dose, right route, and right time). Closed-loop EMR has been demonstrated to substantially reduce prescribing errors and medication administration errors in inpatient settings (Franklin, O'Grady, Donyai, Jacklin, & Barber, 2007; Poon et al., 2010). Despite its benefits, hospitals' adoption of

closed-loop EMR has been relatively slow Health Information and Management Systems Society (HIMSS, 2012). As of late 2011, only 12.6% of U.S. hospitals had adopted capabilities for closed-loop EMR. By focusing on organizational complexity and adoption of EMR for closed-loop medication therapy management, this study was an attempt to add to the knowledge needed to promote the adoption of EMR for closed-loop medication therapy management and to improve medication safety. The findings from this study may help raise awareness to organizational factors that impact the adoption of EMR for closed-loop medication therapy management. Knowing how organizational factors influence the adoption of EMR for closed-loop medication therapy management will help administrators to adopt strategies that may promote the adoption of EMR for closed-loop medication therapy management. This study may promote positive social change by furthering understanding of organizational factors related to hospitals' adoption of EMR for closed-loop medication therapy management, which can significantly reduce medication errors and improve patient safety in U.S. hospitals (Poon et al., 2010).

This chapter provides a summary of the study and its significance to healthcare delivery. The synopsis of the methodology used in the study, the theoretical base for the research, and the assumptions, limitations, and delimitations of the study are addressed. The hypotheses tested in the study are also discussed in this chapter. Finally, the operational definitions of the variables used in the study are addressed. Details of the methodology will be provided in Chapter 3.

Background

It is estimated that over 1.5 million preventable ADEs occur every year in the United States (Aspden, Wolcott, & Bootman, 2007). The majority of available literature supports a positive association between health Information Technology (HIT) and quality and safety of healthcare delivery in the United States (ONC, 2013).

There has been a debate and studies by researchers on how to improve quality and safety of healthcare delivery in the United State since the Publication titled To Err is Human by IOM (1999) and the enactment of the American Recovery and Reinvestment Act [ARRA] (2009). Appari et al. (2012) focused on the nature of the relationship between HIT and medication administration quality in U.S. hospitals. Franklin et al. (2007) provided insight into closed-loop electronic prescribing and administration on medication errors. DesRoches et al. (2013) provided a statistical review of the growth and extent of adoption of Electronic health records (EHR) from 2009 to 2012. Pedersen, Schneider, and Scheckelhoff (2015) provided information on the extent of adoption and growth of HIT between 2008 and 2012. The researchers provided information on the extent of adoption, growth, and the increasing role of the pharmacist in drug therapy management with the use of EMR, but they did not report on closed-loop EMR.

Organizational culture, strategic and management perception play critical role in the adoption of innovation. Corporate behavior and structural relationships are factors that influence an organization's readiness to adopt an innovation (Angst, Agarwal, Sambamurthy, & Kelley, 2010). Lluch (2011) provided information on a literature review focused on organizational barriers to information technology. Cresswell and Sheikh

(2013) provided an interpretive analysis of how organizational issues influence adoption of health information technology innovation. Both Lluch and Cresswell and Sheikh cited organizational factors as possible barriers to HIT adoption, but they did not address the nature of the relationship between organizational complexity and the adoption of closed-loop EMR.

When organizations decide to adopt innovation, management generally select one of three main strategies. Ford et al. (2010) provided information on vendor selection strategies and how that may influence future expansion. According to Ford et al., a majority of U.S. hospitals have adopted a single vendor selection strategy. Those using a best of suite approach have a higher proportion of implementation than those employing other strategies; however, the researchers did not comment on how vendor selection strategy would influence the adoption of closed-loop EMR. Spaulding, Furukawa, Raghu, and Vinze. (2013) provided information on the sequence of processes leading to the adoption of closed-loop EMR. Baird, Furukawa, Rahman, and Schneller, (2014) provided information on how the corporate governance practices impact the adoption of HIT within integrated delivery systems. However, these studies did not focus on the relationships between organizational complexity and adoption of closed-loop EMR. The literature review provided evidence that there is the need to investigate how organizational complexity influences the adoption of EMR for closed-loop medication therapy management. In particular, there is the need in the literature to examine how technological complexity, structural complexity, and management structure

simultaneously influence the adoption of EMR for closed-loop medication therapy management.

Problem Statement

There is a problem with the quality, efficiency, and patient safety in healthcare delivery in the United States, mainly related to medication therapy management (ONC, 2013). Over 700,000 ADEs result in emergency hospital visits annually (CDC, 2014), and many of these ADEs are preventable through the use of health information technology in hospitals. Medication errors are reduced substantially with the use of closed-loop EMR (Poon et al., 2010). However, only 12.6% of U.S. hospitals have developed the capacity to adopt closed-loop EMR (HIMSS, 2012). Management's perception of innovation has a direct correlation to the organization's readiness to adopt innovation such as EMR (Boonstra & Broekhuis, 2010). In addition, the adoption of EMR is influenced by the complexity of the organization and external relationship (Angst et al., 2010)

Organizational complexity may be a major factor influencing hospitals' adoption of closed-loop EMR. Competing for the locus of control and organizational structure can be a significant determinant of adoption of innovation because the leader's attitude towards change impacts its success or failure. Furthermore, multiple vendors can be a barrier to the integration of EMR applications due to different software standards (Cresswell & Sheikh, 2013). Given these issues, it is unclear whether organizational complexity and vendor selection is related to the adoption of closed-loop EMR. Thus, in this study, I examined the influence of organizational complexity on the adoption of

closed-loop EMR in U.S. hospitals. By focusing on organizational complexity (technological, structural, and management structure), this study adds to the knowledge needed to promote the adoption of EMR for closed-loop medication therapy management and improve medication safety. This study addressed a gap in the literature by focusing specifically on the influence of organization complexity (technological complexity, structural complexity, and management structure) on hospitals' adoption of EMR for closed-loop medication therapy. This project is unique because it provides insight into organizational factors that may influence hospitals' adoption of EMR for closed-loop medication therapy management. Understanding the relationship between organizational complexity and hospitals' adoption of EMR for closed-loop medication therapy may have a positive social change by guiding stakeholders to adopt closed-loop EMR.

Purpose of the Study

The goal of this study was to examine the relationship between organizational complexity and hospitals' adoption of EMR for closed-loop medication therapy management. In this study, I focused on three aspects of organizational complexity: technological complexity, structural complexity, and management structure.

The technological complexity (vendor selection strategies: single vendor, best of breed, or best of suite), structural complexity (number of units and differentiation), and management structure (presence or absence of Chief Medical Information Officer (CMIO) were examined to determine their relationship to hospitals' adoption of EMR for closed-loop medication therapy management. These characteristics and strategies are

essential to understanding why some organizations adopt EMR for closed-loop medication therapy management while others do not.

A regression analysis was used to examine the relationships between organizational complexity and hospitals' adoption of EMR for closed-loop medication therapy management. Regression analysis was used in the study because this technique allowed me to determine the relationship between the adoption of EMR for closed-loop medication therapy management and organizational complexity, controlling for other hospital and area characteristics.

Research Questions and Hypotheses

In this study, I examined three research questions about the relationship between organizational complexity and hospitals' adoption of EMR for closed-loop medication therapy management as measured by HIMSS Analytics EMR adoption model (EMRAM):

Research Question 1 (RQ1): Is there a correlation between hospitals' technological complexity (vendor selection strategy) and adoption of EMR for closed-loop medication therapy management?

$H1_a$: There is a positive correlation between technological complexity (single-vendor, Best of Breed [BoB], and Best of Suite [BoS]) and hospitals' adoption of EMR for closed-loop medication therapy management.

$H1_0$: There is no correlation between technological complexity (single-vendor, BoB, and BoS) and hospitals' adoption of EMR for closed-loop medication therapy management.

Research Question 2 (RQ2): Is there a correlation between hospitals' structural complexity and adoption of EMR for closed-loop medication therapy management?

$H2_a$: There is a positive correlation between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management.

$H2_0$: There is no correlation between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management.

Research Question 3 (RQ3): Is there a correlation between hospitals' management structure and adoption of EMR for closed-loop medication therapy management?

$H3_a$: There is a correlation between management structure and hospitals' adoption of EMR for closed-loop medication therapy management.

$H3_0$: There is no correlation between management structure and hospitals' adoption of EMR for closed-loop medication therapy management.

Theoretical Framework of the Study

The theoretical base for this study was Rogers' (1970) diffusion of innovation (DOI). In this theory, Rogers sought to explain the elements and characteristics that influence adoption of innovation. Rogers described how the five main elements (relative advantage, compatibility, complexity of new approach, observability, and testability) contribute to influence adoption of innovation or a new approach. Per Rogers, organizations will adopt innovation if they perceive the innovation as better than the existing approach. Organizations are also more likely to adopt innovation if it is compatible with the organization's structure, experience, values, and potential needs.

Perceived complexity for the use of the innovation can create a barrier that can inhibit its adoption. Per Rogers, reducing these obstacles will improve chances of adoption. Because the theory explains how elements and characteristics of organizations influence innovation, the DOI framework has been used extensively in the study of innovation.

Healthcare organizations have inherent complex organizational structures because of the diverse professionals who must come together to form the healthcare team (Dooley, 2002). However, organizations may deal with the complexity through different organizational structures, such as decentralization, centralization, or multiple channels of authority. Rogers' (1970) DOI theory provides guidance on how organizational complexity may influence innovation. The theory provides the theoretical framework to gain an understanding of how organizational complexity may influence the adoption of integrated systems. This theory may provide significant insights into how organizational complexity may influence adoption of EMR for closed-loop medication therapy management.

Research Design and Rationale

This research is a quantitative substantially study of the influence of organizational complexity on hospitals' adoption of EMR for closed-loop medication therapy management. Quantitative research is grounded in the positivist/postpositivist tradition (Creswell, 2009). The philosophical worldview proposed in this study is positivist/postpositivism. The deterministic philosophy assumes that the world is influenced by causes and that the researcher can identify the causes by testing their influence on an outcome (Creswell, 2009). In other words, the world is governed by laws,

which can be tested to understand the world better (Creswell, 2009). In this study, I used the deterministic philosophy of this tradition to test the influence of organizational complexity on hospitals' adoption of EMR for closed-loop medication therapy management.

A qualitative design was not used because qualitative designs are often used to explore or develop theory, or where statistical analyses are not appropriate for the problem (Creswell, 2013). Qualitative designs take the form of case study, narrative studies, phenomenological research, ethnographic research, or grounded theory research. The intent of this study does not fall into any of the qualitative inquiries. This study is a descriptive quantitative rather than causative quantitative study because no treatment was performed on any of the participants and the independent variable was not manipulated.

Definitions

Adoption: How organizations or individuals decide to acquire and use innovation. The process of adoption is usually preceded by the identification of a need and a search for solution (Damanpour & Schneider, 2006).

Best of Breed (BoB): Vendor selection approach where the managers of the organization source for applications from multiple vendors and integrate them into their HIT system (Ford, Menachemi, Huerta, & Yu, 2010).

Best of Suite (*BoS):* A vendor selection approach where the managers of an organization select a hybrid of single vendor and a BoB approach (Ford et al., 2010). The leaders of the organization choose a single vendor to develop the platform for the health

information technology (HIT) platform; then suitable applications from multiple vendors are integrated on the HIT platform.

Closed-loop EMR: Stage 5 of the HIMSS analytics adoption model (EMRAM). At the closed-loop, electronic medical administration records and other identification technologies such as bar coding and radio frequency identification (RFID) are integrated with CPOE and pharmacy systems to support medication administration (HIMSS, 2012).

Computerized practitioner/physician order entry (CPOE): The process of entering medication orders or instruction by the practitioner/physician electronically. The provider enters the medication order directly into the computer, which is then transmitted to the pharmacy (Agency for Healthcare Research and Quality [AHRQ], 2014).

Electronic health records (EHR): Healthcare records that have been formatted to allow for computer processing (HIMSS, 2012). They include, among others, the personal health record and clinical data (Spiranovic, Matthews, Scanlan, & Kirkby, 2016).

Electronic medical records (EMR): The local electronic health records in the hospital (HIMSS, 2012). EMR is a computerized medical information system that is used to collect medical records and stores and displays the information for the hospitals' authorized users. EMR is the electronic version of the traditional paper chart that is used to record patients' medical history. It consists of the patients' demographics and health information, and it is secured for use by authorized staff of the hospital.

EMR adoption model (*EMRAM):* A model developed by HIMSS Analytics to assess the level of EMR adoption in hospitals (HIMSS, 2012). HIMSS Analytics has broken down the adoption and implementation of EMR into seven stages. HIMSS

Analytics uses an algorithm to score the hospitals. Stage 5 of the EMRAM is the level of closed-loop medication administration; at this stage, the hospital has integrated its CPOE with the pharmacy to support medication administration.

Health Information Technology for Economic and Clinical Health (HITECH) Act: This act was passed in 2009 to stimulate the adoption of EHR and support health information technology in the United States. The HITECH Act provides financial incentives to hospitals and clinical practices that demonstrate meaningful use of EHR.

Meaningful use: A section of the HITECH provision that requires providers to show that they are using certified EHR to measure and improve quality of care (Department of Health and Human Services [HHS], 2015). Incentives are offered to providers who meet the criteria.

Single vendor selection: A vendor selection approach is where the managers of the organization contract with a single vendor for most of the organization's HIT needs (Ford et al, 2010).

Assumptions

The data from HIMSS are grouped in stages of implementation from Stage 1 to 7, according to the EMRAM developed by HIMSS Analytics to assess the status of EMR implementation in a care delivery organization. It is assumed that all hospitals designated as Stage 4 have implemented at least all stages from 1 to 4. Because I was not able to determine whether all units of the hospitals have implemented all the stages from 1 to 4, I was conservative in stating that at least one unit in the hospital has implemented Stage 4

on the EMRAM. It was also assumed that respondents to the HIMSS Analytic survey answered the questionnaire honestly.

Scope and Delimitations

This study was designed to analyze the influence of vendor selection strategies, structure complexity, and management structure on hospitals' adoption of EMR for closed-loop medication therapy management in nonfederal U.S. hospitals. The scope of the study is limited to this sample unit because of the curiosity to understand how organizational complexity will influence hospitals' adoption of EMR for closed-loop medication therapy management, the importance of this unit in care delivery in the United States, and the availability of data for this analysis. The numeric secondary data from HIMSS data as well as the quantitative study design reduce the scope of this study from opinions or reflections made by human observers. Because quality assurance (activities that occur before data collection) and quality control (activities that take place during and after data collection) are critical to data integrity, secondary data from HIMSS are appropriate for this study. The use of well-trained data collection personnel by HIMSS significantly reduces error in the data. The archival data from HIMSS, which were used for this study, were collected at a single point in time, thus reducing the affect that time or proximal or longitudinal conditions can affect data integrity.

Limitations

Data used for the analysis were derived from HIMSS data, from the HIMSS Analytics Database. Even though HIMSS is a comprehensive survey, HIMSS does not state whether all units of the hospital have attained the stage of implementation.

Responses from the survey were numerically coded to allow for statistical analysis; this operationalization further limits the ability to consider in-depth interpretation of data. Specifically, given variables were anchored with semantic phrases (i.e., adoption of EMR for closed-loop medication therapy management), and additional meaning was not investigated during the data analysis phase.

Use of archival data limits the study to information that has been gleaned from the historical source. I abdicated control over the data collection process and assumed the data to be relevant and valid; that is, without error. As such, source data were rigorously scrutinized to ensure fidelity with the true data.

It was not possible to consider how long it took for hospitals of interest to reach their implementation stage because HIMSS does not provide individual commencement dates. Furthermore, because secondary data were used for this study, the survey questions were not solely designed to answer relevant questions of this study. This limitation was minimized because the purpose for the data collection by HIMSS is in alignment with this study. HIMSS also provided detailed descriptions of all variables in the database, which made it possible to operationalize the variables for accurate measurement and analysis.

Significance of the Study

This study is expected to fill a gap in the literature by focusing specifically on the influence of organization complexity (vendor selection, structural complexity, and management structure) on hospitals' adoption of EMR for closed-loop medication therapy management. This project is unique because it provides insight into

organizational factors such as vendor selection strategies, which may influence hospitals' adoption of EMR for closed-loop medication therapy management. Findings from this study are expected to help raise awareness to organizational factors that impact the adoption of EMR for closed-loop medication therapy management.

Recent policy initiatives have focused on expanding hospitals' adoption of HIT to improve medication safety. The American Recovery and Reinvestment Act of 2009 (ARRA) was passed to stimulate the adoption of EHRs, including functionalities supporting closed-loop medication management, with the goal to improve patient safety, quality of care, and efficiency in healthcare delivery in the United States (ONC, 2013). This study could promote positive social change by furthering the understanding of organizational factors related to hospital adoption of EMR for closed-loop medication therapy management, which can significantly reduce medication errors and improve patient safety in U.S. hospitals (Poon et al., 2010).

Summary

This chapter provided an introduction to the study, the background to the problem that stimulated this study, the theoretical framework for this study, and the purpose of this study. The measurement of the stages of EMR adoption was based on HIMSS EMRAM.

HIT is widely believed to hold the key to improve the quality of care in United States hospitals and reduce cost. The HITECH Act of 2009 was passed to provide substantial funding to encourage hospitals and clinical practices to adopt EHR and EMR. Even though there has been improvement in EMR adoption, integration of the HIT system to enable EMR for closed-loop medication therapy management is limited.

Understanding how organizational complexity influences the adoption of EMR for closed-loop medication therapy management might help raise awareness to organizational factors that impact the adoption of EMR for closed-loop medication therapy management.

In this study, I examined the elements of organizational complexity that influence the adoption of EMR for closed-loop medication therapy management. Understanding of these factors and how they influence adoption of EMR for closed-loop medication therapy management might help stimulate the adoption process. This study is expected to fill a gap and add to the scholarly literature. The finding of this study could help managers to choose the appropriate strategy for the adoption of EMR for closed-loop medication therapy management.

Chapter 2 provides the literature review, which revealed the gap in the literature and prompted the need for this study. Chapter 2 also provides details of what is known and the gap in the literature that needs to be filled.

Chapter 2: Literature Review

Introduction

Most studies have revealed that healthcare delivery in the United States is disintegrated resulting in duplication, omission of therapy, and medication errors. For instance, the ONC (2013) acknowledged that there is a problem with the quality, efficiency, and patient safety in healthcare delivery in the United States, particularly related to medication therapy management. It is estimated that over 1.5 million preventable ADEs occur every year in the United States (Food and Drug Administration, 2014). Recent policy initiatives have focused on expanding hospitals' adoption of HIT to improve medication safety. The HITECH Act (2009) was passed to stimulate the adoption of EHRs, including functionalities supporting closed-loop medication therapy management (in the closed-loop medication therapy environment, electronic medication administration records are integrated with the CPOE and pharmacy to enhance medication administration), with the goal to improve patient safety, quality of care, and efficiency in healthcare delivery in the United States (ONC, 2013). The passing of the HITECH Act has resulted in some increases in the adoption of EMR, but hospital adoption of EMR for closed-loop medication therapy management is relatively slow (HIMSS, 2012). As can be noted from the literature, adoption of EMR for closed-loop medication therapy may be influenced by organizational factors, and for the objectives of the HITECH to be achieved, policymakers need to understand how various elements influence the adoption of EMR.

The purpose of this chapter is to review relevant literature that established the need for this study. In the chapter, I discuss relevant theory and the problem that stimulated this study. Consideration of the literature revealed a significant gap in factors that influence the adoption of EMR for closed-loop medication therapy management. The historical background to hospitals' adoption of EMR will first be reviewed. The conditions that motivated the introduction of Health IT and studies on elements that influence the innovation of IT and adoption are examined. Secondly, vendor selection strategies, structural complexity, management structure, and EMR adoption are debated. Thirdly, components that influence vendor selection, structural complexity, and management structures that influence the adoption of EMR for closed-loop medication therapy are reviewed. Finally, what is known and unknown is summarized as well as the contribution of this study to positive change and scholarly literature.

Library Search Strategy

The literature search was performed primarily by a digital search of scholarly databases such as the Journal of American Medical Association, MEDLINE, Medscape, ProQuest, CINAHL, PsycINFO, and Walden University's library database. The search was performed by using key words like *EMR, health information, electronic medical records, adoption of EMR, adoption of innovation, barriers to EMR adoption, EMR and management structure*, and *EMR and vendor selection*.

Theoretical Foundation

Diffusion of Innovation **(DOI) Theory**

The theoretical base for this study was Rogers' (1970) DOI. This theory describes the elements and characteristics that influence adoption of innovation. In this theory, Rogers explained how the five main elements (relative advantage, compatibility, complexity of new approach, observability, and testability) contribute to influence the adoption of innovation or new approach. According to Rogers, organizations will adopt innovation if they perceive the innovation as better than the existing approach. Organizations are also more likely to adopt an innovation if it is compatible with the organization's structure, past experiences, values, and potential needs. Perceived complexity for the use of the innovation can create a barrier that can inhibit its adoption. According to Rogers, reducing such obstacles will improve chances of adoption. Because the theory explains how elements and characteristics of organizations influence innovation, the DOI framework has been used extensively in the study of innovation.

Rogers (1970) noted in the DOI theory that the willingness to adopt innovation is determined by five main characteristics: (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) testability. Per Rogers, an organization is more likely to adopt an innovation if it perceives the innovation to have an advantage over the existing idea. Rogers also highlighted in the DOI theory that if the innovation is consistent with the values of the organization, it is more likely to be adopted. For an incompatible innovation to be adopted, the existing value system must be changed. As can be expected, if the innovation is perceived to be complex or difficult to implement,

organizations are more likely to avoid it. Rogers further pointed out that an organization will adopt an innovation if it can try the innovation on a limited basis. Finally, if the desired outcome of the innovation is clearly visible, then the organization is more likely to adopt the innovation.

DOI Theory and Health IT Adoption

The DOI theory provides insight for understanding the processes of innovation adoption, implementation, and diffusion and has been applied in the study of innovation in service organizations in general (Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004) and hospital IT adoption (Hameed, Counsell, & Swift, 2012; Putzer & Park, 2010; Thakur, Hsu, & Fontenot, 2012). This theory has been applied in many innovation types of research in service organizations and hospital IT innovation because the theory provides insight into how the elements and characteristics of service organizations in general and hospitals in particular influence IT adoption. For example, Greenhalgh et al. (2004) used the DOI as the theoretical framework to study the diffusion of innovation in service organizations. Likewise, Putzer et al. (2010), Hameed et al. (2012), and Thakur et al. (2012) applied the DOI theory to study IT adoption in health organizations.

DOI Theory and Organizational Complexity

Healthcare organizations have inherent complex organizational structures because of the diverse professionals who must come together to form the healthcare team (Dooley, 2002). However, organizations may deal with the complexity through various organizational structures such as decentralization, centralization, or multiple channels of authority. Rogers' (1970) DOI theory provides guidance on how organizational

complexity may influence innovation. The theory provides the theoretical framework to gain an understanding of how organizational complexity may influence the adoption of integrated systems. This theory may provide significant insights into how organizational complexity may influence the adoption of EMR for closed-loop medication therapy management.

This theory, therefore, shows that organizational complexity may influence the adoption of EMR for closed-loop medication therapy management. As can be deduced from the effect of trialability on innovation, the vendor selection strategy may affect the adoption of EMR for closed-loop medication therapy. For example, if the vendor selection strategy allows for limited experimentation, an organization is more likely to adopt EMR. Per Rogers (1970), characteristics for innovation and structural complexity may influence the adoption of EMR for closed-loop medication therapy management. This is because the structural complexity of the organization has an effect on how the innovation will be seen as compatible or incompatible to existing values. Furthermore, in accordance to the characteristics of DOI that influence innovation, management structure may influence the innovation of EMR for closed-loop medication therapy management. The perceived relative advantage that may be measured in terms of convenience, social prestige, and importance is significantly influenced by management structure.

In conclusion, the DOI theory is a suitable framework to understand why some hospitals adopt innovation and others do not. This theory was particularly selected for this study because the focus of this study is on how organizational complexity influences the adoption of EMR for closed-loop medication therapy management. DOI theory is

applicable to this study because DOI focuses on the elements that influence the adoption, implementation, and diffusion of innovation process. It is therefore not surprising that much scholarly research on innovation in healthcare uses DOI theory as the theoretical framework. The DOI theory may therefore help to understand whether organizational complexity explains why some hospitals have adopted EMR for closed-loop medication therapy while others have not.

Adoption of Electronic Medical Records (EMR) for Closed-Loop Medication Therapy Management

HIT to improve medication safety usually centers on the EMR, which is the platform for automation of medication-related processes within the inpatient facility. The terms EMR and EHR are often used interchangeably; however, they are not the same. The International Organization for Standardization (ISO) Technical Committee 215 defined EHR as a healthcare record that is formatted to enable computer processing (HIMSS, 2012). The ISO (2009) clarified that local EHR, which are the legal electronic health records in the hospital, is EMR. The shared EHR, on the other hand, is the enterprise EMR for multiple provider access for both inpatients and outpatients whilst integrated care EHR (ICEHR) enables stakeholders to share medical information from multiple enterprise providers.

EMR is believed by most stakeholders to hold the key to improve the quality of healthcare and control cost in the United States. EMR with closed-loop medication therapy management (closed-loop EMR) provides functional integration of CPOE,

pharmacy dispensing, and BCMA to support the five rights of medication administration (right patient, right drug, right dose, right route, and right time).

HIMSS Analytics has developed the EMRAM to assess the status of EMR implementation in healthcare delivery organizations (HIMSS, 2012). The model uses an algorithm to score care organization from 0 to 7 in the implementation stages. At Stage 0, there is no installation of EMR, and at Stage 7 (the final stage), there is complete integrated EMR, which allows data warehousing and data sharing. Stage 5 is the closed-loop medication administration environment. At this stage, there is an implementation of the electronic medication administration record (EMAR) as well as the use of other health technology such as bar coding or Radio-Frequency Identification. These technologies are integrated with CPOE and pharmacy to minimize medication errors and improve patient safety. The closed-loop EMR is crucial because the integration of the pharmacy with the other units supports the five rights (right patient, right drug, right dose, right route, and right time) to enhance patient safety processes (HIMSS, 2012).

The adoption of EMR for closed-loop medication therapy is very important because research has shown that this stage of EMR adoption significantly improves quality measures (Appari, Carian, Johnson, & Anthony, 2012). Closed-loop EMR has been demonstrated to substantially reduce prescribing errors and medication administration errors in inpatient settings (Franklin et al., 2007; Poon et al., 2010). Appari et al. (2012) demonstrated that hospitals implementing EMAR, a component of closed-loop, performed better on 10 of 11 process performance measures than nonadopters. In

contrast, hospitals implementing only CPOE performed better in only two of the 11 process performance measures than nonadopters.

In a nationwide survey, Pedersen et al. (2015) observed in the stratified random sample of 1,435 pharmacy directors that 44.8% of hospitals use some form of coding to manage medication dispensing. The researchers also acknowledged that pharmacists have a positive impact on healthcare delivery with the adoption of HIT. Despite this finding, over 21% of medications orders are not reviewed by pharmacists (Pedersen et al., 2015). Furthermore, hospital adoption of closed-loop EMR has been relatively slow (HIMSS, 2012). As of late 2011, only 12.6% of U.S. hospitals had adopted capabilities for closed-loop EMR. Organizational complexity may be an important factor influencing the hospital adoption of EMR for closed-loop medication therapy management.

The adoption of EMR is a process that involves diverse stakeholders with different interests and measurements for success. The adoption of EMR is, therefore, influenced by several factors. Angst et al. (2010) noted that EMR adoption is influenced by corporate behavior and structural relationships. Angst et al. also acknowledged that EMR is a capital-intensive project, and managers want to see evidence of benefit from early adopters before commitment. Police, Foster, and Wong (2011) found that technological problems were among the significant barriers to adoption of HIT by physician practice organizations. Although researchers have identified various elements that facilitate or hinder the adoption of information technology by healthcare professionals, Gagnon et al. (2012) noted that there is a lack of consensus on how these elements influence the adoption of information technology. As expected, hospitals are

more likely to adopt information technology to gain a competitive advantage over their competitors.

For these reasons, a healthcare organization's environment greatly influences the leadership's willingness to adopt IT innovation. Often, hospitals managers turn to adopt the actions of others within their environment. Organizational complexity will therefore theoretically influence the hospital's adoption of EMR for closed-loop medication therapy management.

Technological Complexity (Vendor Selection)

Management first and foremost makes a strategic decision to adopt technology and then chooses the vendor selection strategy that aligns with the organization's values and financial position. Researchers have generally acknowledged that organizations adopt technology when it is perceived to be more efficient and aligns with the values of the organization (Boonstra & Broekhuis, 2010; Gagnon et al., 2012). For instance, Gagnon et al. (2012) noted that technology is acceptable if it is perceived to have a relative advantage over the existing processes. It is reasonable to assume that management will adopt EMR if it views EMR to be in the strategic interest of the organization. Then it will adopt a vendor selection strategy that is suitable for the organization's financial and strategic position.

Vendor selection strategy is the approach that organizations select to adopt innovations. The management carefully chooses the approach that aligns with the organization's short and long-term strategy. Organizations mainly choose one of three main strategies: single-vendor, BoB, or BoS (Menachemi, Shin, Ford, & Yu, 2011). In

single-vendor selection, the organization frees itself from the burden of sourcing for applications and maintaining large IT staff. In the BoB approach, the organization selects the IT products they deem appropriate for their needs. A major disadvantage of this strategy is that the organization must maintain highly skilled IT staff. In addition, Hyvonon (2003) noted that BoB vendors are small companies that are prone to going out of business. The BoS approach is a hybrid of single-vendor selection and BoB. The intent of BoS is to maximize the benefits of single-vendor and BoB. Hyvonon also acknowledged that the maximization of the benefits of single-vendor selection and the BoB in BoS approach make implementation much easier.

The findings of earlier researchers on the choice of vendor selection strategy and the rate of adoption of innovation have motivated other researchers to study the elements that affect the selection of a particular strategy. Menachemi et al. (2011) analyzed data from the American Hospital Association and HIMSS to determine the relationship between the vendor selection strategy and environmental market condition. They concluded that complexity was a significant predictor of the vendor selection strategy. However, they failed to analyze how elements of technological complexity influence the adoption process. In addition, Ford et al. (2010) demonstrated that the vendor selection strategy has influence on the success of the adoption process.

Single Vendor Selection

In the single vendor approach, the organization contracts with a single vendor for most of the organization's HIT needs. Most researchers agree that this approach simplifies the innovation adoption process. In addition, Hyvonon (2003) noted that single

vendor selection strategy enables organizations to cut down on high skill IT staff. In a recent study, Ford, Menachemi, Huerta, and Yu (2010) also found that single vendor selection simplifies the transaction process. However, Ford et al. also acknowledged that single vendor selection requires massive initial capital and structural adjustment which are not practicable for some organizations. Likewise, Jamoom, Patel, Furukawa, and King (2014) reiterated that financial cost and productivity significantly influence the decision to adopt EHR. Despite some drawback, earlier studies found system integration to be less complex because it is done by one vendor (Light, Holland, & Wills, 2001).

Recent studies support these earlier findings; however, environmental characteristics also play a significant role in the selection strategy. Managers of hospitals in an environment of low munificence are more likely to choose a single vendor selection strategy (Menachemi, Shin, Ford, & Yu, 2011). The selection strategy is not determined solely by the environment. The financial position of the hospital may also influence the selection because of higher upfront investment. However, the simplicity of implementation makes this approach suitable to many hospitals. Despite these appealing conditions, Ford, Menachemi, and Huerta (2010) noted that a single vendor's inability to update and develop the software can put the hospital at risk in the adoption of EMR. The simplicity and centralized nature of the single vendor selection approach seem to be more appealing on the face value; however, it is more complex than is seems. For example, the massive infrastructure needed to initiate single vendor IT approach demands extensive capital which may cause some organization to avoid this strategy

Best of Breed (BoB)

Organizations which do not have the massive financial resources needed to overhaul the system to initial adoption, as well as organizations which do not want extensive policy change, lean more towards BoB. The BoB strategy may also be chosen to meet the diverse needs of the specialization and differentiation within the organization (Scott & Davis, 2007). In a hospital environment where several professionals with different interests must come together as a team, the BoB may lower resistance between differentiation. The less resistance from staff may be explained by the inherent sense of ownership in the BoB strategy. The lower resistance is because the applications are chosen in accordance with the desires and recommendations of the department staff. For instance, Hermann (2010) noted that BoB approach requires relatively lower investment and faces fewer resistance from staff. In an earlier study, Kara (as cited by Aspen et. al., 2007) acknowledged that the BoB approach enables organizations to take advantage of the most appropriate applications on the market on incremental basis. This process allows organizations to progressively improve their adoption process without putting too much strain on their finances. Light, Holland, and Wills (2001) noted that the risk of a vendor falling out of business is also distributed among multiple vendors; however, they also pointed out that implementation is more complicated. Likewise, Ford, Menachemi, Huerta, and Yu (2010) has emphasized that the BoB approach demands the hiring of highly skilled IT staff. This can be expected because the BoB approach requires that the IT staff of the organization must have the ability to integrated the diverse applications to meet the needs of the organization.

Organizations and their stakeholders are mindful that any investment made has the potential to fail or succeed. It therefore makes economic sense to adopt innovation, if it can be tested on a smaller scale. Some organizations may deliberately choose the BoB approach in order to measure their viability in stages. Ford, et al. (2010) acknowledged that the flexibility and relatively less intensive re-engineering needed for BoB strategy makes it attractive to some organizations. Nonetheless Ford, et al. (2010) also pointed out that most of the applications in BoB are in isolated silos. Likewise, Hoehn (2010) concluded that integration of applications across platforms in BoB is harder.

Best of Suite (BoS)

The BoS selection strategy theoretically maximizes the benefits of single-vendor selection and BoB. It enables the organization to integrate the appropriate application into the single vendor platform. The main advantage of this strategy is that disruption to the work process is minimal because most of their core applications are retained. The hospital can then source for appropriate applications to meet the various departments' need. Leavitt (2009) acknowledged that integrating such suitable applications onto certified core system will enhance the hospitals' compliance with meaningful use. The potential to demonstrate compliance is vital to the hospital because Federal incentive and penalty are based on compliance to the meaningful use. Earlier study by Hong and Kim (2002) showed efficient implementation processes which are simpler and less disruptive.

It is unclear what impact the vendor selection strategy will have in the long-term EMR adoption for closed-loop medication therapy management. Ford, Menachemi, Huerta, and Yu (2013) determined that the vendor selection strategy had significant

impact on the HIT adoption process in the earlier stages but failed to establish a long-term link. In this study, Ford et. al. (2013) used merged data from American Hospital Association (2007) and HIMSS Analytics data in their analysis, and logistic regression was used to determine any association between the vendor selection strategy (single vendor, BoB, and BoS) on the level of IT adoption process. The researchers analyzed data from 1,814 hospitals and concluded that organizations using BoS strategy were more efficient than those using either single vendor or BoB. Ford et al. (2013) did not find significant difference between those using a single vendor or BoB; however, they did not consider how structural complexity or management structure might have impacted on the adoption process. It is therefore unclear what impact organizational complexity will have on the EMR for closed-loop medication therapy management.

Structural Complexity (Number of Units and Differentiation)

Healthcare organizations are made up of various professionals with different interest who must come together to work as a team to accomplish the desired outcome of stakeholders. The structural complexity (number of units and differentiation) of the organization is likely to influence re-engineering and any extensive change in policy. Damanpour (2001) believes that the presence of specialist in complex organizations leads to knowledge which is needed for innovation. It therefore suggests that complexity measured as the number of units and differentiation may lead to adoption of EMR.

The structures within organizations may have an influence on change processes such as an introduction of new ideas and approach. Organizational culture and internal structure of the organization has a significant influence on the adoption of EMR

(Kralewski, Dowd, Zink, & Gans, 2010). Organizational cultures which promote harmony and teamwork among units and departments are more likely to adopt EMR. On the other hand, organizations with weak relationship among units and departments will find it harder to adopt EMR for closed-loop medication therapy management. It is therefore theoretically sound to presume that structural complexity poses greater challenges to the adoption of EMR for closed-loop medication therapy management.

Kazley and Ozcan (2007) demonstrated that EMR adoption is significantly associated with the size, system affiliation, and location of the hospital. Likewise, in a systematic literature review, Boonstra, Versluis, and Vos (2014) noted that large, urban, not-for-profit, and teaching hospitals are more likely to implement EHR. They searched relevant databases such as EBSCO, Cochrane, and Web of Knowledge for literature on hospitals EHR implementation. Of the 364 articles, which were initially identified by Boonstra et al. (2014), the researchers analyzed 21 articles which met their criteria. They focused on factors which influence the progress of EHR implementation. Even though the systematic review of the literature revealed that size, location, and affiliation have influence of hospitals' adoption and implementation of EHR, it is unclear how structural complexity impacts on the adoption of EMR. This study ie expected to fill the gap by focusing of the influence of structural complexity on EMR for closed-loop medication therapy management.

Management Structure (Presence or Absence of CMIO)

The adoption of innovation to a large extent and EMR for closed-loop medication therapy management in particular requires champions who will secure buy-in from

stakeholders to gain support for the success of the adoption. Leveiss, Kremsdorf, and Mohaideen (2006) demonstrated that physician champions are critical to the success of EMR adoption. They acknowledged that the clinical background of the Champion is more important to the champion's effectiveness than his or her background in health informatics. Likewise, Ludwick and Doucette (2009) emphasized that physician champion is critical to the success of Electronic medical records adoption process. In addition, social influence (Zheng, Padman, Krackhardt, & Johnson, 2010) and advance buy-in from physicians (McAlearney et al., 2010) play significant role in Physician adoption of EMR. In contrast, Smith, Saunders, Stuckhardt, and McGinnis (2013) noted that physicians are often at odds with the CMIO and poses a barrier to the adoption process. In addition, Kralewski, Dowd, Zink, and Gans (2010) contended that effective conceptualization of the new EMR environment is equally important as physician championship. A systematic review suggests that physician perception that EMR systems erode physician professional relevance is a significant barrier to EMR adoption (Police, Foster, & Wong, 2010). Likewise, Boonstra and Broekhuis (2010) agrees that physicians fear of lack of autonomy, and lack of support from management (Vishwanath &Scamurra, 2007) is a significant barrier to adoption of EMR. It is reasonable to assume that the presence of CMIO in the management structure may have a positive influence on the adoption process but further investigation is needed.

The corporate governance structure is generally developed to align with business strategy to increase efficiency and improve performance. The complex interaction between highly specialized professionals and autonomy in the healthcare industry makes

governance relatively more complex. Baird, Furukawa, Rahman, and Schneller (2014) demonstrated that centralization of IT decision rights might delay IT innovation. However, centralized IT decision rights were not significantly associated with CPOE adoption (Baird et al., 2014). Baird et al. (2014) observed mixed results for various clinical support applications within the integrated delivery system. For example, BCMA was significantly associated with centralized IT decision rights whereas RFID was not significantly associated with centralized IT decision rights. There is the need for further investigation to determine if other elements account for the mixed results.

A systematic review of the literature revealed that EMR adoption is a change process which requires a change in the organizational culture in order to minimize resistance to the adoption process (Boonstra & Broekhuis, 2010). In addition, Boonstra, Versluis, and Vos (2014) also pointed out that organizational culture which promotes collaboration positively impacts on the EMR adoption process. Furthermore, Garland, Bickman, and Chorpita (2010) noted that adoption is a complex process and decision makers ought to acknowledge that change within the organization is necessary. This assertion is not surprising because collaboration will result in increased trust and lower resistance to the adoption process. It is reasonable to assume that the presence of CMIO in the management structure may have a positive influence on the adoption process but further investigation is needed. This study fills the gap by focusing on the influence of the presence of CMIO on the adoption of EMR for closed-loop medication therapy management.

Summary and Conclusion

The literature review provided evidence that there is a need to investigate how organizational complexity influences the adoption of EMR for closed-loop medication therapy management. There is evidence that hospitals which adopt eMAR and CPOE which are components of closed-loop medication therapy perform better on medication quality measures (Appari, Carian, Johnson, &Anthony, 2012). Furthermore, Franklin, O'Grady, Jacklin, and Barber (2007), noted that closed-loop medication environment reduced both prescribing errors and medication administration errors. There is however, a gap in the literature to examine how technological complexity, structural complexity and management structure simultaneously influence the adoption of EMR for closed-loop medication therapy management. There is the need to further investigate how the vendor selection strategy selected by the hospital will influence the adoption of EMR for closed-loop medication therapy management. The literature is unclear on how the vendor selection strategy affects the adoption of EMR for closed-loop medication therapy management.

The literature is also inconclusive on how structural complexity impacts on the adoption of EMR for closed-loop medication therapy management. Whereas the literature acknowledged that structural complexity has influence on adoption of EMR, it failed to conclusively identify the direction of the influence. Further investigation of the influence of this component is needed in the literature. The literature also identified mixed results in the influence of management structure (presence of CMIO) on the adoption of EMR.

There is therefore the need to study how management structure (presence of CMIO) influences the adoption of EMR for closed-loop medication therapy management.

This study will fill a gap in the literature by focusing specifically on the influence of organization complexity (Technological complexity, Structural complexity, and Management structure) on hospitals' adoption of EMR for closed-loop medication therapy management. This project is unique because it provides insight into organizational factors which may influence hospitals' adoption of EMR for closed-loop medication therapy management. Findings from this study will help raise awareness to organizational factors which impact the adoption of EMR for closed-loop medication therapy management.

Recent policy initiatives have focused on expanding hospital adoption of health information technology to improve medication safety. The HITECH act (2009) was passed to stimulate the adoption of electronic health records, including functionalities supporting closed-loop medication management, with the goal to improve patient safety, quality of care, and efficiency in healthcare delivery in the US (ONC, 2013). This study is expected to promote positive social change by furthering understanding of organizational factors related to hospitals' adoption of EMR for closed-loop medication therapy management which could significantly reduce medication errors and improve patient safety in US hospitals (Poon et al., 2010).

The components which influence the adoption process as well as the control variable such as size, location and affiliation which were used to test the hypotheses will

be presented in chapter 3. Details of the methodology and explanation of the variable will also be addressed in chapter 3.

Chapter 3: Research Method

Introduction

The purpose of this study was to examine the relationship between organizational complexity and hospitals' adoption of EMR for closed-loop medication therapy management. In this study, I focused on three aspects of organizational complexity: technological complexity, structural complexity, and management structure. The technological complexity (vendor selection strategies: single vendor, BoS), structural complexity (number of units and differentiation), and management structure (presence or absence of CMIO) were examined to determine their relationship to hospitals' adoption of EMR for closed-loop medication therapy management.

This chapter delineates the methodology used for the study. Hypotheses developed from the literature review to test the model are presented. Secondly, the research design, data source, sample frame, and measurements are described. Issues of reliability and validity are addressed. Finally, data analysis and statistical processes are explained.

Research Design and Rationale

This research was a descriptive quantitative study of the influence of organizational complexity on hospitals' adoption of EMR for closed-loop medication therapy management. Quantitative research is grounded in the positivist/postpositivist tradition (Creswell, 2009). The philosophical worldview proposed in this study was positivist/postpositivism. The deterministic philosophy assumes that the world is influenced by causes and that the researcher can identify the causes by testing their

influence on an outcome (Creswell, 2009). In other words, the world is governed by laws, which can be tested to understand the world better (Creswell, 2009). In this study, I used the deterministic philosophy of this tradition to test the influence of organizational complexity on hospitals' adoption of EMR for closed-loop medication therapy management.

A qualitative design was not employed because qualitative designs are often used to explore, develop theory, or where statistical analyses are not appropriate for the problem (Creswell, 2013). Qualitative designs take the form of case study, narrative studies, phenomenological research, ethnographic research, or grounded theory research. The intent of this study does not fall into any of the qualitative inquiries. This study was a descriptive quantitative rather than causative quantitative study because no treatment was performed on any of the participants and the independent variables were not manipulated.

Sampling and Sampling Procedures

Archival data were obtained from a data warehouse maintained by HIMSS Analytics. Direct connection with subjects did not occur; rather, data were accessed electronically and processed in accordance with IRB protocol. Archival data collection is often used in contemporary research when primary data collection is not possible or excessively burdensome to the researcher or participant. For this study, data on the topic were available, but had yet to be analyzed. Accordingly, analyzing archival data is not only appropriate, it judiciously simplifies the process. That is, the act of collecting data via archival data effectively utilizes Ockham's razor, which means law of parsimony. The theory is a problem-solving principle attributed to William of Ockham (Stanovich, 2007).

According to Stanovich (2007), the term "entities must not be multiplied beyond necessity" was formulated to coalesce Ockham's principals (p. 19). Thus, collecting primary data when archival data are available would run counter to this principal (Stanovich, 2007).

Sample of Hospitals

The 2012 HIMSS Analytics Database provides detailed historic data about hospitals and their usage of IT as well as healthcare delivery networks (HIMSS, 2012). The database includes a complete integrated healthcare delivery system plus, which is an intelligence tool that profiles hospitals and their integrated delivery system IT use. The 2012 HIMSS Analytics Database (HAD) includes demographic and IT data from about 40,000 facilities. This is made up of 5,467 hospitals, 2,332 subacute care facilities, 28,041 ambulatory facilities, and 184 free standing data centers. The HIMSS data also include market share and purchasing plans for over 100 software applications and technologies.

HIMSS has developed EMRAM to assess the status of EMR adoption and implementation in the healthcare delivery organizations. The 2012 HIMSS data have used algorithms to score over 5,300 hospitals in the United States. The states were grouped into six regions prior to the survey of the hospitals by HIMSS.

Power Analysis

A formal power analysis was conducted to determine the appropriate sample size for the study. Given that multiple regression with three predictors was used to test each of the three hypotheses, a sample size of approximately 77 data points was needed to obtain

80% power (see Figure 1). Specifically, with power set at 80%, effect size set at .15 (medium), and alpha set at .05, approximately 77 data points are needed to find a significant relationship if one exists in the population.

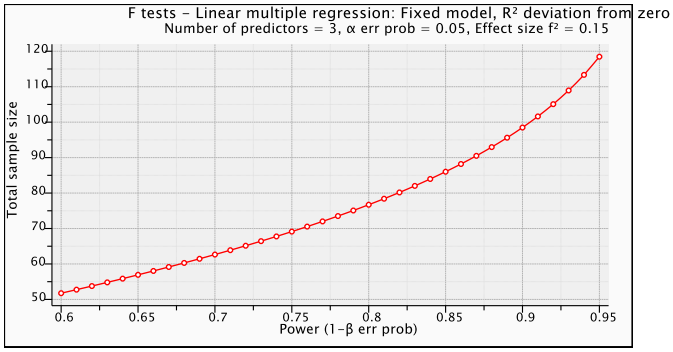

Figure 1. Power plot depicting power as a function of sample size.

Archival Data

The data I used for this quantitative correlational study were archival, and consist of data from 2012 HIMSS, obtained from HAD (see Appendix A). The HAD includes detailed information about hospitals' adoption of EMR functionality to support medication management. HIMSS Analytics developed an EMRAM score that categorizes hospitals' extent of adoption into seven stages (HIMSS, 2012). EMRAM Stage 5 reflects the adoption of HIT for closed-loop medication management, and this measurement was used as the dependent variable in this study. Information on organizational complexity

(technological complexity, structural complexity, and management structure) and other hospital and area characteristics were also derived from the HAD.

Data validity was assumed given that internal institutional review occurs regularly and that data collection processes and procedures are managed by the specified institution. Given that only indirect access of data occurred, primary data validation was not possible. Further, reliability of data was also assumed, meaning that the internal consistencies of constructs were assumed to be appropriately evaluated by the institution managing the data.

Instrumentation and Operationalization of Constructs

Operationalization of Constructs

In total, three predictor variables, one dependent variable, and three control variables were specified in this study. The three predictor variables and dependent variable are scaled at the categorical level while the control variables are scaled at the nominal level. A detailed description of each variable is provided including a definition of the variable, scale characteristics, and score range.

The independent variables for organizational complexity (technological complexity, structural complexity, and management structure) influence hospitals' adoption of EMR for closed-loop medication therapy management.

Technological Complexity

The internal and external environments of hospitals force managers to select a strategy to adopt innovation. Greater technological complexity may be a barrier to the adoption of innovations. Hospitals have adopted three main vendor-selection strategies in

EMR adoption (Menachemi et al., 2011). These are single vendor selection, BoB, and BoS. Single-vendor selection is defined as the approach of contracting a single vendor for all (or most) of the hospitals' IT needs for EMR adoption for closed-loop medication therapy management. The BoB vendor selection is defined as the vendor selection approach where hospitals choose the application from multiple vendors based on what they deem to be appropriate for their needs. The BoS vendor selection is defined as the vendor selection approach, which is practically a hybrid of single vendor selection and BoB. The intent of this approach is to maximize the benefits of single vendor and BoB. Accordingly, the variable is scaled at the ordinal level.

Technological complexity is operationalized as a categorical variable: The lowest complexity is single vendor, which is operationalized from single vendor strategy. The middle level of complexity has some standardization of vendors based on the suite (grouping of applications). The highest level of complexity is the selection of multiple vendors for specific needs, which is operationalized as BoB. The categorical variable equals 1 if single vendor, equals 2 if BoS, and equals 3 if BoB. Technological complexity was measured relative to BoB strategy. The variable is scaled at the ordinal level.

Structural Complexity

Structural complexity may be defined by the number of differentiations, specializations, or job functions (Damanpour, 1996). Greater structural complexity may be a barrier to the adoption of innovations. The level of structural complexity is often measured by the number of units or functional services. The degree of complexity is therefore indicated by the number of units in the hospital. Structural complexity is

operationalized by the number of clinical users (e.g., physicians and nurses) employed by the hospital. This is represented by the number of physicians employed and intensive care beds. The structural complexity of the hospitals was measured by the number of physician and intensive care beds in the hospitals. As these are continuous variables, no dummy coding was performed.

Management Structure

The management structure of hospital organization is rather complex by the nature of the highly-varied specializations. According to Dooley (2002), individual members within the organization can optimize the innovation process without regard to other units when optimization is not a function of integration. However, when integration of the various units (as is the case with closed-loop medication therapy management), independent adoption by units fails to optimize successful adoption. The management structure, therefore, has a profound influence on the adoption of EMR for closed-loop medication therapy management. For instance, physician champion was found to be key in the success of CPOE adoption (Metzger & Fortin, 2003). The presence of a CMIO will therefore theoretically enhance the adoption of EMR for closed-loop medication therapy management. The CMIO is the leader in the hospitals' management structure who oversees decisions for the adoption of closed-loop systems. The CMIO variable was operationalized based on whether the hospital reported having CMIO position or not. The CMIO variable is a binary variable equal to 1 if the hospital has CMIO and equal to 0 if the hospital does not have CMIO.

Adoption of EMR

The dependent variable is adoption of EMR for closed-loop medication therapy management. The literature review revealed that the adoption of EMR is a process that is decided by various units with diverse interests. Hospitals' adoption of EMR for closed-loop medication therapy management is therefore influenced by organizational complexity. Hospitals that have reached Stage 5 and above of HIMSS EMRAM have adopted closed-loop for medication therapy management. Hospitals that have reached Stages 1 to 4 of HIMSS EMRAM have not adopted EMR for closed-loop medication therapy management. Hospitals that have adopted EMR for closed-loop medication therapy management equals 1 while hospitals that have not adopted EMR for closed-loop medication therapy management equals 0. The variable is scaled at the nominal level, meaning that no mathematical relationship between coded values is assumed.

Control Variables

The size of hospitals significantly influences their adoption of innovation. According to the HIMSS Analytics report of 2012, there is a positive correlation between the size and EMRAM score of hospitals (HIMSS, 2012). DesRoches et al. (2013) observed a similar relationship between size and adoption of EMR but also pointed out that location and teaching status are important elements that influence the adoption of EMR. These findings support Damanpour's (1996) earlier assertion of a positive relationship between size and innovation. The size of a hospital may be operationalized by various measurements such as bed size, number of operating beds, and number of outpatients. For this study, size was operationalized by the number of beds in the

hospital. In addition, hospital characteristics, such as ownership type (for-profit, not-for-profit), teaching status (teaching, nonteaching hospitals) as well as hospital location (rural, nonrural) have a significant association with the adoption of innovation. These characteristics were therefore the controls for this study.

Data Analysis

This studywas an analysis of secondary data from 2012 HIMSS data from HIMSS analytics database (HAD). Regression analysis is a statistical method used to study the relationship between a single criterion variable and one predictor variable. Data analyses were conducted using the Statistical Package for the Social Sciences (SPSS, 23.0) software program. SPSS provides the means to statistically analyze the data through direct imputation of data. Results are presented in Chapter 4.

In this study, I examined three research questions about the relationship between organizational complexity and hospitals' adoption of EMR for closed-loop medication therapy management as measured by HIMSS Analytics EMRAM:

RQ1: Is there a correlation between hospitals' technological complexity (vendor selection strategy) and adoption of EMR for closed-loop medication therapy management?

$H1_a$: There is a positive correlation between technological complexity (single-vendor, BoB, and BoS), and hospitals' adoption of EMR for closed-loop medication therapy management.

$H1_0$: There is no correlation between technological complexity (single-vendor, BoB, and BoS), and hospitals' adoption of EMR for closed-loop medication therapy management.

RQ2: Is there a correlation between hospitals' structural complexity and adoption of EMR for closed-loop medication therapy management?

$H2_a$: There is positive correlation between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management.

$H2_0$: There is no correlation between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management.

RQ3: Is there a correlation between hospitals' management structure and adoption of EMR for closed-loop medication therapy management?

$H3_a$: There is correlation between management structure and hospitals' adoption of EMR for closed-loop medication therapy management.

$H3_0$: There is no correlation between management structure and hospitals' adoption of EMR for closed-loop medication therapy management.

Univariate and logistic regression analysis was used to determine any possible association between specified predictor variables and adoption of EMR for closed-loop medication therapy management, controlling for other hospital and area characteristics. Variables to be controlled for are: Hospital size (number of beds); Ownership type (for profit, non-profit), Teaching status (teaching, non-teaching), and Hospital location (rural, non-rural).

Three univariate logistic regression analyses were used to test each of the hypotheses respectively. Each predictor variable is scaled at the ordinal level while the dependent variable is scaled at the nominal level. Significance of a logistic regression model was determined by calculating a log-likelihood and comparing the model with predictors to the null model using chi square goodness of fit tests (Tabachnick & Fidell, 2007).

A final logistic regression analysis was used to test the overall model that included the control variables. For the logistic regression analysis, a two-step process was used. Two-step binary logistic regression where step 1 included the relevant predictor variables, and step 2 added the covariates of for profit status, teaching status, rural status, and number of staffed beds to the regression. This technique allows one to control for the effects of covariates on the predictor variables. Model 1 contained three predictor variables, while model 2 contained the three predictor variables and the control variables. The criterion variable was adoption of EMR for closed-loop medication therapy management.

Logistic regression is an inferential technique that is used to predict categorical criterion variables from both continuous and categorical predictor variables. In addition to testing overall model fit with chi square goodness of fit tests, and significance of individual predictors with the Wald test, odds ratios can be computed that determine the odds of being in one of the categories of the criterion variable when a predictor variable score increases by one unit. Odds ratios above 1.0 indicate an increased chance and odds ratios below 1.0 indicate a decreased chance of being in a category of the DV. Logistic

regression is sensitive to outliers and multicollinearity between predictors; however, unlike multiple regression, the assumption of normality does not need to be met.

The prediction equation for a logistic regression with two predictors is: $Y' = (e^{A +B1X1 + B2X2})/(1 + e^{A + B1X1 + B2X2})$. Significance of coefficients is determined using Wald's test: $W_j = (B_j^2)/SEB_j^2$. Significance of a model is determined by calculating a log-likelihood and comparing the model with predictors to the null model using chi square goodness of fit tests (Tabachnick & Fidell, 2007).

Process or Procedures

Institutional review board (IRB) permission to conduct this investigation will be sought prior to commencement of this study. This will be done by filling and submitting the appropriate form for authorization to undertake this study. Permission for the use of the 2012 HIMSS data will be requested by filling the appropriate application form for authorization to use the database for this study (Make sure to attach the permission in the Appendix below). Microsoft access application will be used to access the target hospitals' data from HIMSS data.

Methodological Assumptions, Limitations, and Delimitations

Methodological Assumptions

The data from HIMSS is grouped in stages of implementation from stage 1 to 7 according to the EMR adoption model (EMRAM) developed by HIMSS analytics to assess the status of EMR implementation in Care delivery organization. It is assumed that all hospitals designated as stage 4 have implemented at least all stages from 1 to 4. Because I am not able to determine whether all units of the hospitals have implemented

all the stages from 1 to 4, I will be conservative in stating that at least one unit in the hospital has implemented stage 4 on the EMR adoption model.

Limitations

Data used for the analysis will be derived from HIMSS data, from HIMSS analytics Database. Even though the data from HIMSS is a comprehensive survey, HIMSS does not state whether all units of the hospital have attained the stage of implementation. Responses from the survey were numerically coded to allow for statistical analysis; this operationalization further limits the ability to consider in-depth interpretation of data. Specifically, given variables were anchored with semantic phrases (i.e., adoption of EMR for closed-loop medication therapy management), additional meaning will not be investigated during the data analysis phrase.

Use of archival data limits the study to information that has been gleaned from the historical source. Control over the data collection process has been abdicated by the researcher and assumed to be relevant and valid; that is, without error. As such, source data will be rigorously scrutinized to ensure fidelity with the true data.

It is not possible to consider how long it took for hospitals of interest to reach their implementation stage because HIMSS does not provide individual commencement dates. Furthermore, because secondary data will be used for this study, the survey questions cannot be solely designed to answer relevant questions of this study. This limitation will be minimized because the purpose for the data collection by HIMSS is in alignment with this study. HIMSS can also provide detailed description of all variables in

the database which made it possible to operationalized the variables for accurate measurement and analysis.

The design of the study will consider the influence of vendor selection strategy, structural complexity and management structure on hospitals' adoption of EMR for closed-loop medication therapy management. The finding of this study cannot be extended to other elements of organizational complexities, however the extensive database from HIMSS for this study has the advantage of generating new insight from previous studies and unexpected discoveries.

Delimitations

This study is designed to analyze the influence of vendor selection strategies, structure complexity, and management structure on hospitals' adoption of EMR for closed-loop medication therapy management in non-federal U.S. hospitals. The scope of the study is limited to this sample unit because of the curiosity to understand how organizational complexity will influence hospitals' adoption of EMR for closed-loop medication therapy management, the importance of this unit in care delivery in the United States, and the availability of data for this analysis. The numeric secondary data from HIMSS data as well as the quantitative study design reduce the scope of this study from opinions or reflections made by human observers. Because quality assurance (activities that take place before data collection) and quality control (activities that take place during and after data collection) are critical to data integrity, secondary data from HIMSS is appropriate for this study. The use of well-trained data collection personnel by HIMSS greatly reduces error in the data. The archival data from HIMSS, which will be used for

this study, was collected at a single point in time, thus reducing the affect that time or proximal or longitudinal conditions can affect data integrity.

Reliability and Validity

Reliability

Reliability is consistency in the measurement of construct or variable each time the variable is measured with the instrument (Frankfort-Nachmias & Nachmias, 2008). The data used for this study will be obtained from HIMSS data which is a comprehensive data source used in similar scholarly research and published in scholarly literature. Furthermore, the consistency of the instrument used in HIMSS Analytics survey is documented in scholarly literature. The reliability of the instrument is therefore assumed.

Validity

Validity is degree to which the researcher measures what he or she intends to measure. Because constructs are not measured directly there is the possibility of threat to validity. Even though it was not possible to eliminate all possible threat to validity, such threats were minimal and validity assumed because all measurements used in this study are those used in the literature for similar scholarly research. Furthermore, variable and constructs used in this study for operationalization were drawn from cited literature and have been used for similar purposes.

Ethical Procedures

Secondary data from the HIMSS Analytics Database were used for this study. There was no direct contact with participants. IRB permission was obtained for the use of the data for the study. The IRB approval number for this study is 11-18-16-0306074.

Permission to access and analyze the data was granted by HIMSS Analytics for this study. All possible efforts were made to code data to ensure that data were actually anonymous. The data will be kept no longer than the period necessary for the research and stored on encrypted hard drive to prevent unauthorized access.

Summary

This chapter explained the post-positivist, descriptive quantitative study to answer the research questions to address the research purpose. This will be achieved by testing the hypotheses developed from the literature review and expectations from theories. The purpose of this study is to examine the relationship between organizational complexity and hospitals' adoption of EMR for closed-loop medication therapy management. The research questions and hypotheses to test the model were presented. The constructs were operationalized to measurable variables from cited literature which used them for similar purposes. The source of secondary data to be used for the study was identified. The independent, dependent, and control variables were stated and explained. Issues of validity and reliability as well as ethical issues were addressed. Logistic regression was identified as the primary statistical procedure to test the significance of the hypotheses developed from the research questions to address the study purpose.

Chapter 4: Results

Introduction

An estimated 1.5 million preventable ADEs occur every year in the United States (IOM, 2007). Deficits in communication and information transfer among providers within an organization have been identified to play a significant role in such medication errors (Budnitz et al., 2011). Though the majority of available literature supports a positive association between HIT and quality and safety of healthcare delivery in the United States, these metrics of quality, efficiency, and patient safety in healthcare delivery remain problematic, mostly in terms of medication management (ONC, 2013). Of the numerous ADEs encountered each year, many are preventable through the adequate use of HIT in hospitals (ONC, 2013). In particular, Poon et al. (2010) found that medication errors are reduced substantially with the use of closed-loop EMR. Management's perception of innovation has a direct correlation to the organization's readiness to adopt innovation such as EMR (Boonstra & Broekhuis, 2010). In addition, the adoption of EMR is influenced by corporate behavior (Angst et al., 2010).

Based on this information, organizational complexity may be a major factor influencing hospitals' adoption of closed-loop EMR. Furthermore, multiple vendors can be a barrier to integration of EMR applications due to different software standards (Cresswell & Sheikh, 2013). Given these issues, it is unclear whether organizational complexity and vendor selection are related to the adoption of closed-loop EMR. Thus, this study was conducted to examine the influence of organizational complexity on the

adoption of closed-loop EMR in US hospitals using the following three research questions:

RQ1: Is there a correlation between hospitals' technological complexity (vendor selection strategy) and adoption of EMR for closed-loop medication therapy management?

$H1_a$: There is a positive correlation between technological complexity (single-vendor, BoB, and BoS), and hospitals' adoption of EMR for closed-loop medication therapy management.

$H1_0$: There is no correlation between technological complexity (single-vendor, BoB, and BoS), and hospitals' adoption of EMR for closed-loop medication therapy management.

RQ2: Is there a correlation between hospitals' structural complexity and adoption of EMR for closed-loop medication therapy management?

$H2_a$: There is a positive correlation between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management.

$H2_0$: There is no correlation between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management.

RQ3: Is there a correlation between hospitals' management structure and adoption of EMR for closed-loop medication therapy management?

$H3_a$: There is correlation between management structure and hospitals' adoption of EMR for closed-loop medication therapy management.

$H3_0$: There is no correlation between management structure and hospitals' adoption of EMR for closed-loop medication therapy management.

In this chapter, I focus on three aspects of organizational complexity: technological complexity, structural complexity, and management structure. The chapter begins with an explanation of data cleaning procedures and a description of the resulting sample. Through regression analyses, the interconnectedness among the variables of interest was assessed next. Following the presentation of these detailed analyses, the findings are reviewed in a summary of the chapter.

Data Cleaning

Prior to use in analysis, data were cleaned to remove outliers, as logistic regression tends to be very sensitive to such data points (Tabachnick & Fidell, 2007). To identify outliers, Tabachnick and Fidell's (2007) convention was used, which classifies continuous variable values more than 3.29 standard deviations from the mean of that variable as outlying values. To measure the distance from the sample mean in terms of standard deviations, standardized scores were created for the three continuous variables of (a) number of physicians, (b) number of intensive care beds, and (c) number of staffed beds. Outliers on these values were not mutually exclusive, as each hospital could have outliers on one, two, or all three of these values, and many did exhibit this tendency to be outlying in more than one measure. IBM SPSS software, student version 23 was used for the analyses.

An examination of standardized values for each hospital determined that there were 105 hospitals with outliers on the number of physicians, 77 with outliers on the

number of intensive care beds, and 84 with outliers on the number of staffed beds. All of these outliers were on the higher end of the value, meaning that overly large hospitals could have potentially had a disproportionate influence on regression outcomes and were removed based on their lack of fit with the rest of the sample. Based on these outliers, 215 observations were removed from the data set in a list-wise fashion, and final analyses were conducted on a sample of 5,252 hospitals.

Description of the Sample

After data cleaning procedures, the final sample of 5,252 was assessed to describe the composition of the full sample in terms of type, technological complexity, adoption, management structure, and structural complexity. Hospital type, technological complexity, adoption, and management structure were assessed in terms of frequencies and percentages, while structural complexity was measured in continuous variables, and are thus presented using means and standard deviations. These descriptive data can be used to determine the applicability of the findings to other settings based on the identification of populations with similar demographic representation.

As seen in Table 1, not all hospitals fell into the three categories of interest, and those not classified into one or more of these categories were considered “other” for the following analyses. The largest portion of the sample consisted of single vendor hospitals (2,076, 39.5%), with 38.0% (n = 1,994) using closed loop adoption practices. While a majority of the sample was of a management structure not including CMIOs (3,792, 72.2%), the remaining 27.8% had a CMIO. Based on these demographic features, all hospital features were considered sufficiently represented in the data, as Tabachnick and

Fidell (2007) suggested that no fewer than 30 cases should be in any group. In addition, many of the smaller groups, such as teaching hospitals, could also be for profit or rural in addition to their status as any of the other classifications.

Table 1
Frequencies and Percentages for Nominal Descriptive Data (N = 5,252)

Demographic	*N*	%
Hospital type		
For profit	1,238	23.6
Teaching	133	2.5
Rural	1,171	22.3
Technological complexity		
Single vendor	2,076	39.5
Best of suite (BoS)	1,746	33.2
Best of breed (BoB)	460	8.8
Other	970	18.5
Adoption		
Closed loop EMR	1,994	38.0
Less than closed loop EMR	3,258	62.0
Management structure		
Chief medical information officer (CMIO)	1,460	27.8
No CMIO	3,792	72.2

Hospitals in the final sample had between zero and 1,097 physicians, where the average number was approximately 116. However, the number of physicians widely varied, as evidenced by the relatively high standard deviation (*SD* = 203.64). This sample consisted of hospitals with between zero and 100 intensive care beds, and an average of approximately 10 intensive care beds (*SD* = 13.30). The number of staffed beds also varied from two to 664, with approximately 122 on average (*SD* = 127.31). Table 2 displays these descriptive data prior to rounding.

Table 2
Means and Standard Deviations for Continuous Descriptive Data (N = 5,252)

Demographic	Min.	Max.	*Mean*	*StdDev*
Number of physicians	0	1,097	115.87	203.64
Number of intensive care beds	0	100	9.51	13.30
Number of staffed beds	2	664	122.29	127.31

Data Analysis

Research Question 1

Is there a correlation between hospitals' technological complexity (vendor selection strategy) and adoption of EMR for closed-loop medication therapy management?

$H1_a$: There is a positive correlation between technological complexity (single-vendor, BoB, and BoS), and hospitals' adoption of EMR for closed-loop medication therapy management.

$H1_0$: There is no correlation between technological complexity (single-vendor, BoB, and BoS), and hospitals' adoption of EMR for closed-loop medication therapy management.

To answer Research Question 1 and determine whether there is a positive correlation between technological complexity and adoption of EMR for closed-loop medication therapy management, a binary logistic regression was conducted. Because these three selection strategies were represented by a categorical variable that did not compose all possible categories of technological complexity, dummy coding was used, where the reference category included best of breed and other. The resulting regression was a two-step binary logistic regression where Step 1 included the relevant predictor

variables, including the two-aforementioned dummy coded categories of technological complexity, and Step 2 added the covariates of for profit status, teaching status, rural status, and number of staffed beds to the regression.

The results of Step 1 indicated that technological complexity significantly predicted the adoption of EMR for closed-loop medication therapy management ($\chi^2(2) = 101.64$, $p < .001$. This step indicated that information from these variables allowed hospitals' adoption of EMR for closed-loop medication therapy treatment to be correctly predicted for 62.0% of the sampled hospitals. Step 2 of the analysis included the covariates alongside the predictor variables and was also significant ($\chi^2(6) = \chi^2(6) = 473.03$, $p < .001$. These results suggested that a logit combination of the covariates and factors of technological complexity could accurately predict the adoption of EMR for closed-loop medication therapy treatment in 65.7% of the sampled hospitals. By examining both of these percentages, the difference of 3.7 indicated that the covariates allowed 3.7% more of the hospitals to be accurately predicted than the independent variables alone.

Based on the significance of the overall regression, individual predictors were assessed for their individual significance and influence on adoption. The *SE* measures the accuracy of prediction. The Wald test determines the significance of the predictor variables, and the *p*-value (*P*) is the significance value. Variables are significant when $p < 0.05$. In Step 2, results indicated that each of the facets of technological complexity were significantly predictive of adoption ($p \leq .001$ for all). For each of these predictors, there was a positive relationship, which is evidenced by the positive beta coefficient (*B)* and

OR greater than 1. *B* is the unstandardized regression weight, and it is used to predict event occurrence, and *OR* measures the probability of occurrence; that is, the likelihood of occurrence for every 1 unit increase in the predictor variable. The 95% CI is also reported, which indicates 95% certainty of the prediction.

Because these predictors were binary, this can be interpreted to mean that hospitals in each of the technological complexity groups entered in Step 2 were more likely to adopt than those in the BoB/other group, which consisted of hospitals that did not use single-vendor or BoS selection strategies. Hospitals in the single-vendor selection strategy group were most likely to adopt, while BoS hospitals were still more likely to adopt than BoB/other hospitals, but not as likely as single-vendor hospitals. These findings indicate that the null hypothesis can be rejected in favor of the alternative, and can be found in Table 3.

Table 3
Logistic Regression Analysis of Technological Complexity on Adoption (N = 5252)

						CI (95%)	
Source	*B*	S.E.	Wald	*p*	O.R.	Lower	Upper
Step 1							
Single vendor	0.73	0.073	98.17	.000	2.07	1.79	2.39
Best of suite	0.42	0.077	29.72	.000	1.52	1.31	1.77
Step 2							
Single vendor	0.72	0.08	89.74	.000	2.06	1.77	2.39
Best of suite	0.45	0.08	30.12	.000	1.56	1.33	1.83
For profit	-0.99	0.08	155.54	.000	0.37	0.32	0.43
Teaching	-0.59	0.19	9.40	.002	0.55	0.38	0.81
Rural	-0.62	0.08	55.22	.000	0.54	0.46	0.64
Number of staffed beds	0.00	0.00	67.86	.000	1.00	1.00	1.00

Note. Step 1: $\chi^2(2) = 101.64$, $p < .001$, Step 2: $\chi^2(6) = 473.03$, $p < .001$.

Research Question 2

Is there a correlation between hospitals' structural complexity and adoption of EMR for closed-loop medication therapy management?

$H2_a$: There is positive correlation between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management.

$H2_0$: There is no correlation between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management.

To answer Research Question 2 and determine whether there is a positive correlation between structural complexity and adoption of EMR for closed-loop medication therapy management, a second binary logistic regression was conducted. As all of the structural complexity variables were continuous, no dummy coding was required for the Step 1 predictors in this analysis. As in Research Question 1, this binary logistic regression consisted of Step 1, which included the independent variables (i.e., the number of physicians and the number of intensive care beds), and Step 2, consisting of the addition of covariates of for profit status, teaching status, rural status, and number of staffed beds.

The results of Step 1 indicated that the independent variables of structural complexity were significantly predictive of adoption of EMR for closed-loop medication therapy management $\chi^2(2) = 198.10$, $p < .001$, where adoption of EMR for closed-loop medication therapy treatment was correctly predicted for 62.9% of the sampled hospitals. Step 2 of this analysis included the relevant predictor variables (i.e., number of staffed beds, number of physicians, and number of intensive care beds) and was also significant

$\chi^2(6) = 425.62$, $p < .001$. These results suggested that a logit combination of the covariates and three main factors of structural complexity could accurately predict the adoption of EMR for closed-loop medication therapy treatment in 64.6% of the sampled hospitals. The difference between these proportions of correctly predicted hospitals indicated that the structural complexity predictors allowed 1.7% more of the hospitals to be accurately predicted than the covariates alone.

Based on the significance of the overall regression, individual predictors were assessed for their individual significance and influence on adoption. In Step 2, results indicated that each of the facets of structural complexity were significantly predictive of adoption ($p < .001$ for all) even when controlling for the covariates. For each of these predictors, a positive relationship occurred, as evidenced by the positive *B* and OR higher than 1. For these continuous variables, the OR indicated how much of an increase in likelihood corresponded with each unit increase in the predictor. For the number of physicians, each additional physician in a hospital corresponded with an increase by a factor of 1.00 in the odds of adopting EMR for closed-loop medication therapy management. Similarly, each additional intensive care bed in a hospital corresponded with an increase by a factor of 1.01 in the odds of closed-loop adoption. Thus, more structurally complex hospitals are more likely to adopt EMR for closed-loop medication therapy management. These findings indicate that the null hypothesis can be rejected in favor of the alternative and can be found in Table 4.

Table 4
Logistic Regression Analysis of Structural Complexity on Adoption (N=5252)

Source	*B*	S.E.	Wald	*p*	O.R.	CI (95%) Lower	CI (95%) Upper
Step 1							
Number of physicians	0.00	0.00	33.10	.000	1.00	1.00	1.00
Number of intensive care beds	0.02	0.00	92.32	.000	1.02	1.02	1.03
Step 2							
Number of physicians	0.00	0.00	18.50	.000	1.00	1.00	1.00
Number of intensive care beds	0.01	0.00	20.68	.000	1.01	1.01	1.02
For profit	-1.01	0.08	168.97	.000	0.36	0.31	0.42
Teaching	-0.67	0.20	11.91	.001	0.51	0.35	0.75
Rural	-0.54	0.08	42.76	.000	0.58	0.50	0.69
Number of staffed beds	0.00	0.00	6.13	.013	1.00	1.00	1.00

Note. Step 1: $\chi^2(2) = 198.10$, $p < .001$, Step 2: $\chi^2(6) = 425.62$, $p < .001$.

Research Question 3

Is there a correlation between hospitals' management structure and adoption of EMR for closed-loop medication therapy management?

$H3_a$: There is a correlation between management structure and hospitals' adoption of EMR for closed-loop medication therapy management.

$H3_0$: There is no correlation between management structure and hospitals' adoption of EMR for closed-loop medication therapy management.

To answer Research Question 3 and determine whether there is a correlation between management structure and adoption of EMR for closed-loop medication therapy management, the third and final binary logistic regression was conducted. As the use of a chief medical information officer was binary (i.e., yes versus no), dummy coding was used where 1 = chief medical information officer employed, and 0 = no chief medical information officer employed. As in the previous research questions, this binary logistic

regression consisted of a Step 1, which included the independent variable (i.e., management structure) and a Step 2 in which covariates were added to the regression.

The results of Step 1 indicated that management structure was significantly predictive of adoption of EMR for closed-loop medication therapy management $\chi^2(1) = 136.55$, $p < .001$, where adoption of EMR for closed-loop medication therapy treatment was correctly predicted for 62.4% of the sampled hospitals. Step 2 of this analysis included the covariates, and was also significant $\chi^2(5) = 437.03$, $p < .001$. These results suggested that a logit combination of the covariates and single factor of management structure (i.e., CMIO versus none) could accurately predict adoption of EMR for closed-loop medication therapy treatment in 65.0% of the sampled hospitals. The difference between these proportions of correctly predicted hospitals indicated that inclusion of the covariates allowed 2.6% more of the hospitals to be accurately predicted than the independent variable alone.

Based on the significance of the overall regression, the employment of a CMIO assessed was assessed for its individual significance and influence on adoption. In Step 2, results indicated that employment of a CMIO was significantly predictive of adoption ($p < .001$). For this predictor, there was a positive relationship, which is evidenced by the positive *B* and OR greater than one. Because this was a binary variable, the OR indicated how much of an increase in likelihood corresponded with the employment of a CMIO. Results indicated that hospitals with a CMIO are 1.64 times more likely to adopt EMR for closed-loop medication therapy management than those without a CMIO. These

findings indicate that the null hypothesis can be rejected in favor of the alternative and can be found in Table 5.

Table 5
Logistic Regression Analysis of Management Structure on Adoption (N = 5252)

Source	*B*	S.E.	Wald	*p*	O.R.	CI (95%) Lower	CI (95%) Upper
Step 1							
Chief medical information officer	0.73	0.06	136.45	.000	2.08	1.84	2.35
Step 2							
Chief medical information officer	0.50	0.07	56.82	.000	1.64	1.44	1.87
For profit	-0.96	0.08	150.39	.000	0.38	0.33	0.45
Teaching	-0.60	0.19	9.75	.002	0.55	0.38	0.80
Rural	-0.53	0.08	41.87	.000	0.59	0.50	0.69
Number of staffed beds	0.00	0.00	53.98	.000	1.00	1.00	1.00

Note. Step 1: $\chi^2(1) = 136.55$, $p < .001$, Step 2: $\chi^2(5) = 437.03$, $p < .001$.

Summary

The results chapter included the findings associated with the guiding research questions, as well as a description of the final sample, and how this final sample was achieved through removal of outliers from archival data. The research questions are analyzed in the order they are presented, with detail for how each variable must be represented in the binary logistic regressions conducted for each. Results showed that all three null hypotheses could be rejected, indicating that technological complexity, structural complexity, and management structure all corresponded with the adoption of closed-loop EMR. Further examination detailed these relationships, indicating that single-vendor and BoS hospitals were all more likely to adopt closed-loop EMR than BoB/Other hospitals. Similarly, more structurally complex hospitals were also more

likely to adopt closed-loop EMR, and hospitals with a CMIO were much more likely to adopt than those without. Chapter 5 will expound upon these findings, and include a synthesis of the outcomes in terms of the relevant literature. This chapter will also list limitations of the study and suggestions aimed at improving future research in light of these limitations.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

Quality, efficiency, and patient safety related to medication management in health care delivery pose a significant problem in the United States (ONC, 2013). Medication management encompasses the processes of ordering by physicians, dispensing by pharmacists, and administration by nurses usually operating in different parts of the organization. Researchers have identified deficits in communication and information transfer among providers within an organization to play a significant role in medication errors (Budnitz et al., 2011). More than 700,000 ADEs result in emergency hospital visits every year (CDC, 2014), and many of these ADEs are preventable through the use of health information technology in hospitals.

A problem exists regarding the quality, efficiency, and patient safety in health care delivery in the United States, mainly related to medication management (ONC, 2013). Problems in medication management are reduced substantially with the use of closed-loop EMR (Poon et al., 2010). However, only 12.6% of U.S. hospitals have developed the capacity to adopt a closed-loop EMR (HIMSS, 2012). Management's perception of innovation has a direct correlation to the organization's readiness to adopt innovation, such as EMR (Boonstra & Broekhuis, 2010). In addition, the adoption of EMR is influenced by complexity of the organization and external association (Angst et al., 2010). Therefore, the purpose of this study was to examine the elements of organizational complexity that influence the adoption of EMR for closed-loop medication therapy management. The focus was to explore how technological complexity (vendor

selection strategy), structural complexity (differentiation), and management structure (presence or absence of CMIO) influence hospitals' adoption of EMR for closed-loop medication therapy management. The outcome variable was whether a hospital adopts EMR for closed-loop medication therapy or not. I retrieved the archival data for the study from HIMSS Analytics.

I conducted the study to provide managers and policymakers the ability to predict whether a hospital might adopt EMR for closed-loop medication therapy management based on organizational complexity. The results showed that all the three-predictor variables (technological complexity, structural complexity, and management structure) significantly predict a hospital's adoption of EMR for closed-loop medication therapy management. This finding indicates organizational complexity significantly predicts whether a hospital will adopt EMR for closed-loop medication therapy or not.

Interpretation and Discussion of the Findings

Technological Complexity and Adoption of EMR for Closed-Loop Medication Therapy Management

The first research question asked whether a correlation exists between hospitals' technological complexity (vendor selection strategy) and adoption of EMR for closed-loop medication therapy management. The proposed hypothesis to answer that question allowed me to examine whether a positive correlation existed between technological complexity (single-vendor, BoB, and BoS), and hospitals' adoption of EMR for closed-loop medication therapy management. The results support this hypothesis, indicating that technological complexity can significantly predict hospitals' adoption of EMR for closed-

loop medication therapy management. This is similar to previously reported research, wherein researchers determined that the vendor selection strategy had influenced the success of adoption process within various hospitals (Ford et al., 2010). This had previously gone unreported, with many researchers choosing to focus on other concepts, such as vendor selection and market conditions or the environment, and failing to analyze how technological complexity influenced adoption processes within hospitals looking for EMR closed-loop medication therapy management (Menachemi et al., 2011). The results from the logistic regression analysis suggest increased technological complexity negatively influences adoption of innovation. Therefore, managers should select less technologically complex strategies when negotiating for innovation contracts.

Analyses of the individual predictor variables and control variables also presented interesting findings. The findings of the individual vendor selection strategies indicated hospitals that select the single vendor strategy are more likely to adopt EMR for closed-loop medication therapy than hospitals that adopt BoS, which are more likely than hospital that choose BoB (including other strategies). Previous researchers regarding the adoption of EMR for closed-loop medication therapy were split on the concept of vendor selection strategies, specifically of single vendor selection. While some previous researchers suggested an inherent inability of single vendors to update and develop software existed, thus putting the hospital at risk in the adoption of EMR (Ford et al., 2010), other researchers asserted single vendor was a more beneficial route because system integration was reported to be less complex (Light et al., 2001). In more recent studies, researchers have also indicated single vendor was not as risky of a move, citing

low munificent hospitals (Menachemi et al., 2011). As such, the findings of the current study may align with the assertions of Light et al. (2001), who posited that the simplicity of single vendor strategy makes implementation easier and smoother. Therefore, less technological complexity promotes adoption in contrast to researchers who suggested that single vendor (a less technological complex strategy) inhibits innovation. This finding is consistent with DOI theory, in which Rogers (1970) noted perceived complexity creates barriers to innovation and inhibits adoption.

I also observed that even though hospitals that chose BoS (more technological complex than single vendor, but less complex than BoB strategy) were less likely to adopt EMR for closed-loop medication therapy management than hospitals that chose single vendor, they were more likely to adopt EMR for closed-loop medication therapy management than hospitals that chose BoB strategy. This finding is consistent with Hong and Kim (2002), who demonstrated the BoS strategy showed efficient implementation processes that are more simple and less disruptive. The somewhat high adoption rate of BoS strategy in comparison to BoB could be attributed to the fact that integration of suitable applications onto a certified core system will enhance the hospital's compliance with meaningful use. For example, a hospital that has a certified platform from a single vendor can integrate with other suitable applications to be compliant with meaningful use (Light et al., 2001; Menachemi et al., 2011).

The results for the individual predictors indicated hospitals that chose less technologically complex strategy are more likely to adopt EMR for medication therapy than more a technologically complex strategy. Research suggests BoB turn to have

application in isolated silos (Ford et al., 2010; Hoehn, 2010). Hospitals that chose a more technologically complex strategy, such as BoB, could potentially face problems with integration, resulting in lower adoption of EMR for closed-loop. Even though some researchers suggested low resistance with the use of technologically complex strategies, such as BoS or BoB, the problems associated with integration make technologically complex strategies less effective (Ford et al., 2010). Managers are therefore more likely to achieve better outcomes by choosing a less technologically complex strategy (i.e., single vendor selection).

Structural Complexity and Adoption of EMR for Closed-Loop Medication Therapy Management

The second research question asked whether a correlation existed between hospitals' structural complexity and adoption of EMR for closed-loop medication therapy management. The hypothesis proposed allowed me to examine whether a positive correlation existed between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management. The findings of this study support the hypothesis, wherein I found a significant correlation between structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management. The results from this study suggest structural complexity will like help the adoption of EMR for closed-loop. Per Rogers (1970), compatible organizational structure will promote innovation. Because I found that increased structural complexity resulted in higher adoption of EMR for closed-loop medication therapy, a potential exists that there may be

more highly-skilled employees, such as IT personnel, who can advance the adoption process because of the structural complexity.

Analysis of the individual variable for structural complexity indicated a positive correlation existed between the number of physicians and hospitals' adoption of EMR for closed-loop medication therapy management. A positive correlation also existed between the number of intensive care beds and hospitals' adoption of EMR for closed-loop. The results indicated increased structural complexity leads to higher EMR adoption for closed-loop medication therapy management. This is consistent with previous researchers, such as Boonstra et al. (2014) and Kazley and Ozcan (2007), who asserted larger hospitals with more units and various specialties are more prone to innovation adoption than smaller hospitals with limited facilities. The results indicate as the structure of the hospital becomes complex, it becomes more likely for the hospital to adopt EMR for closed-loop medication therapy management. Damanpour (2001) and Kralewski et al. (2010) reported similar findings in their earlier studies, asserting the internal structure of organizations influences the adoption of innovation. It is possible that as the structure of the organization becomes complex, there are more technologically savvy employees to advance the adoption process. Additionally, a more structurally complex hospital can hire skilled IT personnel to advance the adoption process. Structurally complex hospitals also have more specialized units, which may include an IT department to advance the integration and implementation process. Policy makers need to provide incentives and other initiatives to help smaller and less structurally complex hospitals adopt EMR for closed-loop medication therapy management.

Management Structure and Adoption of EMR for Closed-Loop Medication Therapy Management

The third research question asked whether a correlation existed between hospitals' management structure and adoption of EMR for closed-loop medication therapy management. The hypothesis proposed to answer this question allowed me to examine whether a correlation existed between management structure and hospitals' adoption of EMR for closed-loop medication therapy management. The results from the study support this hypothesis, indicating hospitals that have the CMIO position in the management structure are more likely to adopt EMR for closed-loop than those without the CMIO position. Boonstra and Broekhuis (2010) and Police et al. (2010) asserted centralizing decision-making and providing leadership for IT projects can potentially improve innovation. This is consistent with Rogers' DOI theory, which posits the elements of an organization that inhibit change will hurt adoption of innovation, whereas the elements that promote change will promote adoption of innovation. Accordingly, this is not surprising because physician champions have been demonstrated to be key to successful EMR adoption (Leveiss et al., 2006; Ludwick & Doucette, 2009). The inclusion of CMIO in the management structure may provide the assurance to the physicians and other health care professionals that their professional autonomy is preserved. Thus, the inclusion of CMIO secures the buy-in needed for collaboration to move the project forward with less resistance (McAlearney et al., 2010). Managers may institute the position of CMIO in the management structure to spur the adoption of innovation and EMR for closed-loop medication therapy management.

Limitations

Multiple limitations were reported during the study. First and foremost, this study was limited to nonfederal hospitals, which may affect the generalizability of the findings. Specifically, the findings may not be generalized to federal hospitals. Nevertheless, this study was relevant because of the 5564 registered hospitals in the United States, only 212 are federal government hospitals (AHA, 2017). The survey was self-reported, and I assumed participants truthfully responded to the questions. However, no independent verification existed.

Potential selection bias existed because the hospitals surveyed in the archival data used for the study were not randomly selected, thus posing threat to internal validity. Furthermore, the survey was only conducted on nonfederal hospitals, making the findings potentially not generalizable to all hospitals. However, skilled personnel at HIMSS collected, managed, and stored the data, which has been used extensively in similar research and published in scholarly journals.

Another limitation to this study was that because the design was nonexperimental, I did not perform any manipulation of the variable, and causal inference cannot therefore be made. I indirectly made measurements for the analysis using constructs. I used a limited number of variables to capture the constructs as it was impractical to use all possible variables to operationalize the constructs. It is possible that the variables did not adequately capture the constructs. However, other researchers have extensively used the variables for the analysis in similar scholarly research.

Recommendations for Further Research

Further research is recommended to determine the relationship between adoption of EMR and the order of implementation among the various units of the hospitals. It is possible that the order in which the adoption is implemented may also have influence on the adoption process. I recommend future researchers look at how organizational complexity influences adoption in federal hospitals in comparison to nonfederal hospitals, in that unique differences exist between federal hospitals and nonfederal hospitals. By examining this difference, future researchers have the potential to provide more insight regarding the influence of organizational complexity and adoption of EMR for closed-loop. Finally, the relationship between EMR for closed-loop and other variables to capture the constructs for structural complexity and technological complexity deserves further investigation. For instance, future researchers may look at how centralization and decentralization influence adoption of EMR and how the sequence of adoption in the departments influence adoption. This study was a cross-sectional study; therefore, I recommend a longitudinal study for future researchers to determine how organizational complexity influences the diffusion of the adoption process.

Implications and Social Impact

This research study adds to the knowledge needed for managers and policy makers to make decisions that have community and nationwide social implications as the results provided insight regarding vendor selection strategy, which affects adoption rate of EMR for closed-loop medication therapy management. The quality of health care delivery in the United States can be improved through the use of EMR for closed loop

medication management (Franklin et al., 2007; Poon et al., 2010). The findings of this study may guide policy makers and managers to choose the appropriate strategy to advance adoption of EMR to improve the quality and safety of health care delivery in the United States. Results from this study suggests that even though a single vendor approach tends to be more capital intensive, hospitals choosing this strategy are more likely to achieve the goal to reach the EMR for closed-loop (Stage 5 of the EMRAM). The research findings also provided insight into management structures, which may positively influence the adoption of EMR for closed-loop medication therapy management. The results of the study suggested the presence of the CMIO position in the management structure positively influenced the adoption of EMR for closed-loop medication therapy management. The majority of the sampled hospitals used in the study did not have CMIO in their management structure. As such, the results of this study may guide hospitals in structuring their management to enhance adoption of EMR, which will have positive social change implications on the population.

The research further demonstrated that structural complexity promotes adoption of EMR for closed-loop medication therapy management. Smaller hospitals and rural hospitals that have less structural complexity face unique challenges, which hurt their adoption of EMR for closed-loop medication therapy management. The insight gained from this study may guide policy makers to come up with incentives and measures to assist such entities to adopt EMR for closed-loop medication therapy to improve health care delivery throughout the United States. In conclusion, the findings of this study may help hospitals to adopt health IT in general and EMR for closed-loop medication therapy,

in particular. This finding may therefore help improve the quality and safety of health care delivery. Managers, however, should determine which vendor selection strategy best suits their unique setting. Policy makers should also consider the unique challenges of smaller and rural hospitals when enacting laws to promote HIT.

Conclusion

Researchers have identified deficits in communication and information transfer among providers within an organization to play a significant role in medication errors (Budnitz et al., 2011) and a problem still exists with the quality, efficiency, and patient safety in health care delivery in the United States, mainly related to medication management (ONC, 2013). Problems in medication management can be reduced substantially with the use of closed-loop EMR (Poon et al., 2010). However, only 12.6% of U.S. hospitals have developed the capacity to adopt closed-loop EMR (HIMSS, 2012). As such, the purpose of the study was to examine the elements of organizational complexity that influence the adoption of EMR for closed-loop medication therapy management. I focused on how technological complexity (vendor selection strategy), structural complexity (differentiation), and management structure (presence or absence of CMIO) influenced hospitals' adoption of EMR for closed-loop medication therapy management. I found positive correlations between technological complexity (single-vendor, BoB, and BoS), and hospitals' adoption of EMR for closed-loop medication therapy management and structural complexity and hospitals' adoption of EMR for closed-loop medication therapy management. In addition, the results revealed hospitals that have the CMIO position in the management structure are more likely to adopt EMR

for closed-loop than those without the CMIO position. Based on the findings of the study, I recommend future researchers determine the relationship between adoption of EMR and the order of implementation among the various units of the hospitals, how organizational complexity influences adoption in federal hospitals in comparison to nonfederal hospitals, and how organizational complexity influences the diffusion of the adoption process.

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Appendix A: Permission Letter from HIMSS Analytics

You now have access to the Dorenfest Institute

Inbox x

(a) foundation@himss.org Aug 10

to me

Dear Ebenezer Adu,

<P>
You have been granted access to the The Dorenfest Institute for Health Information Technology Research and Education.
You will be able to access the databases from 8/10/2016 until 2/10/2017.
</P>
<P>
This on-line tool can be accessed by visiting:
http://apps.himss.org/dorenfestinstitute/login.aspx
User Name: eadu2
Password: KJ23kkwwg
</P>
Questions should be forwarded to (312) 664-4467 or foundation@himss.org.