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Relationship Between Information System Success Model Dimensions and Electronic Health Records Use

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This is to certify that the doctoral dissertation by

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Walden University
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Abstract

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MSN, Walden University, 2010

BSN, Liberty University, 2008

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

The rise in the use of electronic health records (EHRs) in health care facilities necessitates a standardized tool for evaluating their effectiveness. Delone and McLean's information system success model (ISSM) was the theoretical foundation, which consists of seven dimensions namely system, information, service qualities, user satisfaction, use, system usefulness, and net benefits. The purpose of this study was to examine EHRs' efficiency and identify ISSM dimensions that influenced net benefits, the dependent variable. The research questions examined the relationship between dimensions of ISSM and the dimensions that affect net benefits. Participants were recruited using purposeful sampling via social media and email and accessed the survey through a link provided. Two hundred and one registered nurses who worked at least 20 hours per week in acute and primary care settings completed the survey consisting of 60 items. Data were analyzed with SPSS version 27 for Pearson correlation and multiple linear regression. Results indicated a significant positive relationship between dimensions (r = .036 - .816, p < .05). From the regression analysis, information quality [B = .223, 95% CI (.070, .376), p < .05], user satisfaction [B = .281, 95% CI (.138, .424), p < .05], and system usefulness [B = .433, 95% CI (.348, .518), p < .05] were positive predictors of net benefits. Service and system qualities and use did not predict net benefits. This study promotes positive social change by validating the survey tool for U.S. health care. Recommendations for future studies include exploring how nursing practice setting influence nurse users' view of EHRs' efficiency.

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Dedication

I dedicate this achievement to my Lord and Savior, who has helped me achieve this dream, many years in the making. Special shoutout to my husband, Godwin Oshegbo, my biggest cheerleader, and my children, Makarios, Evangel, and Basileus Oshegbo. Thank you all for your patience during this process. It was not an easy journey, but it was worth it.

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I want to express my thanks to members of the Walden University faculty and support services. I echo the sentiment of Dr. Walter McCollum, ex-Walden University Faculty member, that we have been given the tools to succeed as students in this great institution. My deepest appreciation to Dr. Janice Long, whose mentorship and support have helped me reach this point in the dissertation process. Thank you, Dr. Diane Whitehead, for your expert counsel. Thanks to Dr. Kelly Fisher for the feedback on making this product a quality one.

Special thanks to the entire Kingdom Center Ministries family for the prayers and to my extended family for always checking in on my progress. Thank you, Tina Denmark, a friend that sticks closer than a sister, for always being there and checking to see how you can assist. To my friends and aunties, Oghenemine Edebiri, Mrs. Edna Edewor, Dr. Clara Agbedia, and the list goes on. I appreciate you all.

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Chapter 1: Introduction to the Study

Health care has been lacking in technology adoption compared to other industries like finance and manufacturing. Health care technology is a need considering the numerous benefits of electronic health records (EHR) such as long-term cost reduction, improvement in quality of patient care, reduction in medication error, and decrease in performance of unnecessary and duplicate testing (Crosson et al., 2012; Lee & Dowd, 2013). These underlying benefits of health care technology led to the passage of the Health Information Technology for Economic and Clinical Health (HITECH) Act in 2009 to promote healthcare technology adoption by providing incentives to adopters (Crosson et al., 2012). However, there is a lack of standardized validation measures of EHR efficiency and success (Messeri et al., 2013). Considering the cost associated with EHR implementation and ongoing maintenance (Messeri et al., 2013), having a standardized tool to evaluate system performance and efficiency is needed. I used a validated tool developed using the Delone and McLean information system success model (ISSM), which provides a comprehensive and objective measure of EHRs' success (Ebnehoseini et al., 2019), in this study to assist hospital leadership and policymakers in their decision-making process on variables that registered nurses identified as contributing to return on investment of EHR implementation. This chapter focuses on the background information, purpose, theoretical framework, and definition of relevant terms.

Background

The passage of the HITECH Act stimulated the adoption of technology in health care. As the health care industry witnessed the rise in technology adoption, studies have examined how its use impact specific aspects of the industry, such as measuring the quality of patient care and user satisfaction.

Research has shown that users are more active in the implementation phase of EHR adoption compared to the analysis and design phase (Safdari et al., 2014). Additionally, teamwork and management support are key factors that influence users' participation. Researchers have also found that continuous use and task repetition resulted in users' perception of EHR system efficiency (Meulendijk et al., 2016). Though the evaluation of EHR efficiency is a measure of success (Makam et al., 2013), the complexity and users' variety compounds evaluation of the comprehensive EHR systems (Bossen et al., 2013). What is needed is a global view of the impact on providers and consumers. Additionally, although studies have examined factors that impact EHR efficiency, examining efficiency should not be limited to any specific phase in the life cycle of system implementation.

The challenge with EHR evaluation has been finding tools and benchmarks for evaluating efficiency and effectiveness that provides the balance in the measurement of the impact of technology on patients, users, and the financial return on investment (Bossen et al., 2013). Some older studies have examined EHRs' effectiveness especially in the United States (Ammenwerth, et al., 2003; Venkatesh & Davis, 2000). Additionally, assumptions about success with EHR implementation, use, and overall benefits are based

on use cases and study outcomes in the retail and finance industries (Agha, 2014; Lee & Dowd, 2013). To that end, Ebnehoseini et al. (2019) designed a tool based on the seven dimensions of ISSM to evaluate the success rate of technology implementation and use based on users' experience. But given the limited studies on the comprehensive evaluation of the EHRs efficiency in the United States, I conducted this study to examine EHR efficiency based on dimensions of the Delone and McLean ISSM.

Problem Statement

Critical factors in evaluating EHRs' efficiency are user's acceptance and impact of system use on clinical practice and patient care delivery (Hsiao et al., 2011). The evaluation of EHR efficiency should be based on the end-user's perception of system usability and effectiveness (Beuscart-Zéphir et al., 2001). Additionally, the financial investment associated with EHR implementation necessitates a process for comprehensive evaluation of system effectiveness and efficiency (Bossen et al., 2013). Although EHR evaluation is attributed as a measure of system success (Makam et al., 2013), finding the standardized tool to comprehensively measure EHR system efficiency has been a challenge.

Purpose of the Study

The purpose of this quantitative study was to examine EHRs' efficiency based on domains of Delone and McLean ISSM (Delone & McLean, 2003; Urbach & Mueller, 2011). The secondary purpose was to determine whether the domains of the ISSM predicted user satisfaction with the EHR system. The study population was registered nurses only. The key variables in this study were system quality, information quality,

service quality, system use, usefulness, user satisfaction, and net benefits. The intended dependent variable was user satisfaction but was revised to net benefits in the statistical analysis process. More details on the revision are provided in Chapter 3.

Research Questions and Hypotheses

The research questions and hypotheses for this study were:

1. What is the relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction, and net benefits?

$H_0$1: There is no relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction, and net benefit.

H_a1: There is a relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction, and net benefits.

2. What are the domains of ISSM that predict net benefits?

$H_0$2: The domains (system quality, information quality, service quality, system use, usefulness, and net benefits) of the ISSM do not predict net benefits

H_a2: The domains (system quality, information quality, service quality, system use, usefulness, and net benefits) of the ISSM predict net benefits

Theoretical Framework for the Study

The theoretical framework for this study was the Delone and McLean ISSM. This model consists of seven dimensions: system quality, information quality, service quality, system use, system usefulness, user satisfaction, and net benefits (Delone & McLean, 2003). The ISSM was developed in 1992 based on seminal review to identify a comprehensive framework to evaluate technology efficiency and was updated in 2003 to

include a seventh dimension (Delone & McLean, 2003; Urbach & Mueller, 2011). The dimensions in this framework provided the variables in this study. Additionally, the framework's structure lends itself to a quantitative study approach, making it suitable for the study. Lastly, this model has been widely used in studies evaluating the success of e-commerce, knowledge management, e-government, and health information systems in both developed and developing countries (Ojo, 2017).

Nature of the Study

This was a quantitative study using a survey questionnaire for data collection. This study design allowed for objective measures of the study variables. The questionnaire was designed by Ebnehoseini et al. (2019) based on ISSM dimensions by incorporating all seven dimensions in the model. Permission was obtained from the authors for use of the questionnaire. The independent variables were system quality, information quality, service quality, system use, usefulness, and user satisfaction. The dependent variable was net benefits. Data were collected from registered nurses who had a minimum of 6 months of experience with the use of comprehensive EHRs post system implementation. Data collection was done with the questionnaire placed online. Multiple regression analysis was conducted using SPSS software.

Definitions

The definitions for the ISSM dimensions were extracted from the article by Urbach and Mueller (2011).

Basic electronic health record (EHR): Defined as the adoption of 10 essential functions in at least one major clinical unit of the hospital: patient demographics,

physician notes, nursing assessments, patient problem lists, patient medication lists, discharge summaries, laboratory reports, radiologic reports, diagnostic test results, and order entry for medications (DesRoches et al., 2010).

Comprehensive electronic health records (EHRs): Defined as the implementation of all basic functional along with fourteen additional functions (i.e., electronic clinical information, computerized provider order entry, results management, and decision support) across all major clinical units in the hospital (DesRoches et al., 2010; Krousel-Wood et al., 2018).

Efficiency: Described as the relationship between resource input (capital and labor) and health outcomes (Palmer & Torgerson, 1999).

Information quality: The desirable characteristics of the system outputs (Urbach & Mueller, 2011).

Intention to use: Belief about the likelihood to use the information (Urbach & Mueller, 2011).

Net benefits: The extent to which information systems contribute to the success of individuals, groups, organizations, industries, and nations (Urbach & Mueller, 2011).

Service quality: The quality of the support that system users receive from the information systems department and information technology (IT) support personnel (Urbach & Mueller, 2011).

System use: The degree and manner in which staff and customers utilize the capabilities of an information system (Urbach & Mueller, 2011).

System quality: The desirable characteristics of an information system (Urbach & Mueller, 2011).

User satisfaction: Users' level of satisfaction with reports and support services (Urbach & Mueller, 2011).

Assumptions

Several assumptions were made in this study. It was assumed that the study sample was representative of the general population. This was achieved by using a purposeful sampling technique with homogeneous subjects (Etikan et al., 2016). Furthermore, user satisfaction was posited as a measure of EHRs success; therefore, it was assumed that the survey instrument would capture the variables that contributed to EHRs success since all questions in the survey instrument were based on dimensions of ISSM, which predicts technology success from users' perspective (Ebnehoseini et al., 2019). Lastly, it was assumed that participants would answer all survey questions honestly. This was achieved by collecting data using anonymized and voluntary participation via an online survey tool (SurveyMonkey). The use of virtual human computer assessment increases the likelihood of honest disclosure (Lucas et al., 2014).

Scope and Delimitations

The scope of this study was limited to registered nurses who work in acute health care facilities or outpatient clinic settings, have used comprehensive EHRs for at least 6 months post-implementation, and worked at least 20 hours per week. The study excluded registered nurses who had less than 6 months of experience with the use of comprehensive EHRs and worked less than 20 hours per week. Data collection was done

using a survey questionnaire that incorporated the seven dimensions of ISSM. To mitigate the challenges of face-to-face participant recruitment, data collection was done through an online survey using SurveyMonkey. The study sample excluded health care professionals who were not registered nurses. Finally, study variables were limited to domains of ISSM since it has been demonstrated as an objective model for comprehensive evaluation of technology success.

Limitations

Study limitations could result from methodology and study design (Simon & Goes, 2013). There were several potential limitations of this study, including the sample and sampling technique. This was a correlational study with a population limited to registered nurses. Additionally, the use of purposeful sampling limited the generalizability. There was also an anticipated low survey response rate. The survey questionnaire had not been widely used, and since the survey instrument uses a Likert scale, responses were limited to available selections. Lastly, the data analysis process posed some challenges. I used the services of the methodologists at the university's center for research quality to mitigate this challenge.

Significance

The evaluation of technology should include not only the technology but the interaction between the technology and users (Ammenwerth et al., 2003). Although evaluation should be done across stages of the life cycle of system development, the complexity of health technology evaluation project has posed challenges with identifying a clear definition of health technology success and standardized criteria for its evaluation

(Ammenwerth et al., 2003). The use of the Delone and McLean model provides a comprehensive model for evaluating EHR efficiency. This study promotes positive social change by validating that the ISSM was not only a comprehensive model but an objective measure of EHRs system success (see Ebnehoseini et al., 2019). Additionally, findings from this study provide information that can assist hospital leadership and policymakers in their decision-making process when considering the adoption of new EHRs to take into consideration variables that impact technology use and efficiency.

Summary

Although the e-commerce industry has witnessed more advances than the health care industry, EHR adoption and use has expanded rapidly since the passage of the HITECH Act in 2009 (Crosson et al., 2012). However, the primary challenge is the lack of a standardized tool to evaluate the effectiveness of EHR. Considering the cost and resources associated with EHR implementation, it is worthwhile to evaluate efficiency and effectiveness and impact on patient, users, and return on investment (Bossen et al., 2013; Messeri et al., 2013).

This study utilized the Delone and McLean ISSM framework from which the variables in this study were derived. The study intended to examine the relationship between dimensions of ISSM and domains of ISSM that predict user satisfaction since all dimensions of the ISSM dimensions are interdependent (Delone & McLean, 2003). Data collection was done using survey questionnaire that encompassed all dimensions of ISSM to evaluate EHR efficiency. The study sample was registered nurses. This chapter

provided a broad overview of the study including background and study scope. Chapter 2 provides an in-depth review of literature related to the study.

Chapter 2: Literature Review

The 2009 HITECH Act, a reaffirmation of the 2004 goal of universal EHR adoption, was enacted to incentivize health care providers and hospital facilities to adopt EHR technology (Crosson et al., 2012). But given the complexity and challenges associated with implementing an EHR system, efficiency and effectiveness are critical components of such an information system (Safdari et al., 2014). EHR system efficiency evaluation is necessary because it informs system providers, hospital administration, and policy and decision-making regarding healthcare technology (Ammenwerth et al., 2003). Given the limited studies on the comprehensive evaluation of the EHR efficiency, I examined nurses' view of EHR efficiency based on dimensions of the Delone and McLean's ISSM in this study. This chapter focuses on the literature search strategy, discussion of the theoretical framework, literature review of key variables, and a summary of literature findings and gaps.

Literature Search Strategy

The focus of the literature review was to identify relevant articles for studies conducted within the past 5 to 10 years. To search the literature, I used an iterative process with key terms including *electronic health record*, *electronic health record, healthcare technology*, *ehr efficiency*, *ehr evaluation*, *Delone and McLean*, *ISSM*, and *IS success model*. Databases searched included EBSCO, Academic Search Complete, CINAHL, and Medline Combined Search, which I accessed from Walden University Library. I focused on finding peer-reviewed publications for studies conducted within and outside the United States. Other search parameters included English language

publications and full-text studies. The search was expanded to include studies outside the United States due to the limited number of studies with a theoretical framework centered on comprehensive EHRs evaluation in health care in the United States. I also expanded the search to include articles beyond 10-year time frame with the goal of identifying additional U.S.-based studies. I reviewed the citations in relevant articles to find additional sources for the literature review. I reviewed approximately 80 articles, 90% of which were peer reviewed. The literature review included 36 of these articles. I stopped reviewing the literature when I reached saturation. When reviewing the literature on the theoretical framework, I searched for the original seminal presentation from the development of the framework, which was dated past the 10-year timeline.

Theoretical Foundation

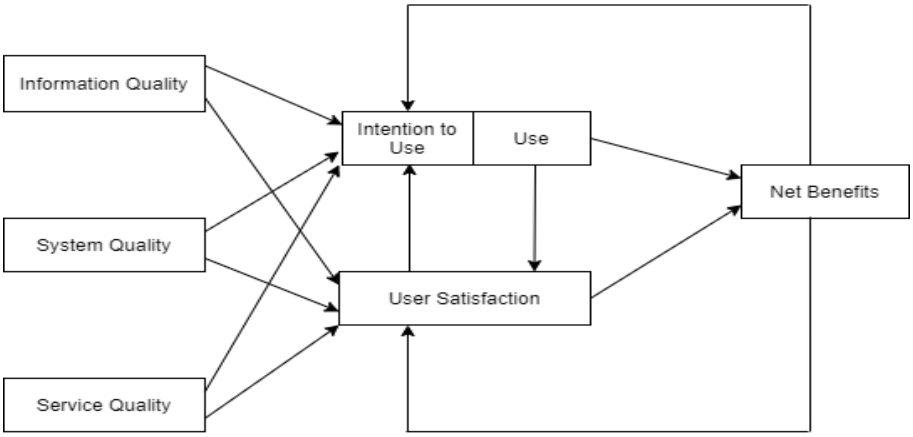
Several frameworks have been applied in studies related to evaluation and outcome of health care technology. The technology acceptance model (TAM) has been used to study intention to use and actual usage of technology (Davis, 1993; Ward, 2013). Rogers's diffusion of innovation theory consists of five attributes of perceived advantages, compatibility, complexity, trialability, and observability which influence the adoption or rejection of technology innovations (Rogers, 2003; Ward, 2013). The human, organization, and technology-fit (HOT-fit) model was developed to provide a comprehensive evaluation of technology (Yusof et al., 2008). HOT-fit consists of three factors that are further broken down to dimension namely technology factor (system quality, information quality, service quality), human factor (system development, system

use), organization factor (structure, environment), and the overall impact as net benefit. The HOT-fit model adopted several dimensions from Delone and McLean's ISSM.

The theoretical foundation for this study is Delone and McLean's ISSM (Figure 1). ISSM was first developed in 1992 based on seminal review and the need to identify consolidated and standardized categories to measure information system success (Delone & McLean, 2003; Urbach & Mueller, 2011). Delone and McLean argued that the lack of a standardized measure did not provide a foundation to conduct studies that allowed for comparison of outcomes across similar studies. The initial model consisted of six dimensions—system quality, information quality, information use, user satisfaction, individual impact, and organizational impact—and each dimension contained variables that allowed for measures of information success. In 2003, the ISSM was updated based on several research and recommendation to reflect seven dimensions namely system quality, information quality, service quality, system use, usefulness, user's satisfaction, and net benefits (Delone & McLean, 2003). Delone and McLean posited that the dimensions should be considered as interdependent variables when evaluating information systems success. For this study I used the updated ISSM containing seven dimensions.

Figure 1

Updated Delone and McLean Information Systems Success Model



Explanation of Delone & McLean ISSM

This section focuses on the updated ISSM containing seven dimensions for measuring information system success and effectiveness. The initial model consisted of six dimensions (Delone & McLean, 2003) and was updated to include a seventh dimension (Petter et al., 2013). The headers and explanations were synthesized from the both the original and updated publications of ISSM:

1. System quality: examines the overall quality of the information system based on user's characteristics. Some of the measures to evaluate system quality include ease of access, system functionality, reliability, response time, flexibility, integration, and importance
2. Information quality: data entered in the information system is expected to generate information that assist in the clinical decision-making process. Therefore, critical elements of this dimension include accuracy, precision, currency, timeliness, sufficiency, understandability, and conciseness. The

assumption is that quality information translates to improved patient care outcome.

3. Service quality: Service quality measures the quality of support provided by the information systems department and IT support staff to users. Some key attributes of this dimension include accuracy, reliability, empathy of the support staff.
4. System use: System use measures the use of the information system full functionality for the intended purpose to achieve expected outcome. Some variables to consider in this dimension include amount, frequency, appropriateness, and purpose of use. System use has been widely studied as a dependent variable.
5. Intention to use: This measures user's relationship with information systems in the intended environment for intended purpose. Studies have shown that user's attitude to technology has predicted intention to use the system. A strong variable in this dimension is self-efficacy. self-efficacy refers to user's confidence with their ability to use the system as intended. Since self-efficacy predicts the success of several dimensions, it is recommended that proper training and support should be offered to users.
6. User satisfaction: This dimension measures user's satisfaction based on interaction with the information system. The assumption is that the less difficulty a task, the higher the level of satisfaction. This variable has been frequently studied to identify its relationship and user's attitude towards

technology and ease of task. Delone and McLean also hypothesized that user's expectation is a measure of user's satisfaction especially during the system development stage.

7. Net benefits: This dimension is measured by the extent to which technology use impact individual, organization, or industry success. Variables to measure this dimension include increased productivity, improved patient outcome, and at organization level, could be cost saving. The decision on level of measure net benefit depends on the system under evaluation.

The ISSM assumes that information, system and service quality affect users' satisfaction and use/intention to use. User satisfaction and use have mediating effect on each other. Delone and McLean noted that user satisfaction, intention to use, and use influence net benefit. However, in the current health care environment of mandatory use, intention to use/use should not be a variable under consideration in clinical system evaluation (Garcia-Smith & Effken, 2013). DeLeon and McLean further surmised that the dimension of users' satisfaction should be studied long with use/intention to use. Studies have found statistical significance between system use and individual impact/net benefit. Although the dimensions in the model show associations among the dimensions, the causal associations between the dimensions are dependent on the outcome of research studies. Based on the framework, the research questions and hypotheses were:

1. What is the relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction and net benefits?

$H_0$1: There is no relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction, and net benefits.

H_a1: There is a relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction and net benefits.

2. What are the domains in ISSM that predict net benefits?

   $H_0$2: The domains (system quality, information quality, service quality, system use, usefulness, and net benefits) of the ISSM do not predict net benefits.

   H_a2: The domains (system quality, information quality, service quality, system use, usefulness, and net benefits) of the ISSM predict net benefits.

Relevant Literature Related to Theoretical Foundation

Since the inception of ISSM in 1992, research studies have examined and validated the dimensions especially in e-commerce and the management information systems domains (Delone & McLean, 2003; Petter et al., 2013). However, few healthcare related studies have adopted all dimensions of ISSM in the comprehensive evaluation of EHR. This section includes review of health care studies that have utilized dimensions of ISSM.

Evaluation of EHR Among Healthcare Professionals Using ISSM

Several studies have evaluated the effect of ISSM quality and service dimensions on user satisfaction using quantitative and mixed method approaches. In a mixed-method study to evaluate interdisciplinary professionals' satisfaction shortly after implementation of EHR systems in Denmark using four constructs of information quality, system quality,

service quality, and use from ISSM, there was an increase in users' satisfaction especially among physicians and physiotherapists, the two group of users who expressed concern about system performance prior to implementation (Bossen et al., 2013). In a pre and post evaluation study of EHR implementation in three public Korean hospitals using ISSM, users' satisfaction score increased post EHR implementation (Cho et al., 2015). Both studies included the ISSM quality dimensions and noted significant impact on user satisfaction but only the study by Cho et al. (2015) included the influence of user satisfaction on net benefits and found a positive correlation. A study to evaluate EMR implementation in selected hospitals in Ethiopia demonstrated congruent findings as Cho et al. and additional findings that user satisfaction influenced use, use did not influence user satisfaction, and use and user satisfactions significantly influenced net benefit (Tilahun & Fritz, 2015).

Some studies utilized multiple models to minimize the possibility of excluding other factors that may impact the measure of information system success (Nassar et al., 2015; Yusof et al., 2008). A mixed method study among healthcare workers in Jordan evaluated EHR success using the theoretical models of ISSM and the balanced scorecard and found a causal relationship between variables in both models pertaining to EHR success (Nassar et al., 2015). The HOT-fit framework is based on ISSM and the IT-Organization Fit Models and includes six dimensions from ISSM (Yusof, 2015). Using the HOT-fit framework to evaluate a critical care information system adoption in a Malaysian healthcare facility, Yusof found that technical factors (ISSM quality dimensions) positively influenced EHR adoption while organizational factors (structure

and environment) negatively impacted implementation and use (Yusof, 2015). Both studies by Nassar et al. and Yusof showed positive correlations between ISSM dimensions and EHR success evaluation. Another quantitative study that utilized the end-user computing satisfaction model and a survey instrument that included ISSM dimensions of information and system qualities, and support found that all dimensions from ISSM positively influenced end-user satisfaction (Aggelidis & Chatzoglou, 2012).

In a post implementation EHR survey of primary care practices in the United States using constructs of system quality, user satisfaction and individual impact from the ISSM, the positive perception of system quality and IT support impacted user satisfaction, ease of use, and subsequently improved clinical practice (Messeri, et al., 2013). On the contrary, a post implementation study of physician satisfaction with EHR in a Government hospital in Kingdom of Saudi Arabia using the ISSM found low physicians' satisfaction especially with information and system qualities (Alharthi et al., 2014). The study to explore users' satisfaction with health information systems based on ISSM in selected hospitals in Isfahan, Iran, found statistical differences in satisfaction score based on type of HIS systems and facility (Saghaeiannejad-Isfahani et al., 2014).

Fewer studies evaluating IS success have incorporated all dimensions of ISSM. The quantitative study to evaluate HIS in selected teaching hospitals in Nigeria included all dimensions of ISSM and found that the ISSM quality dimensions influenced system use and user satisfaction although user satisfaction did not translate to positive net benefit (Ojo, 2017). The quantitative study to develop a questionnaire tool for evaluation of health information system success rate in selected hospitals in Iran based on all

dimensions of ISSM found a correlation between all dimensions of ISSM (Ebnehoseini et al., 2019).

Evaluation of EHR Among Nurses Using ISSM

The TAM has been used in combination with ISSM to examine EHR effectiveness. In a quantitative study to identify factors that influenced HIS adoption among nurses using the TAM and ISSM, the ISSM quality dimensions (system, information, service), perceived usefulness, and perceived ease of use positively influenced EHR adoption (Lu et al., 2012). Garcia-Smith and Effken developed the theoretical framework of clinical ISSM to evaluate information success among selected nurses in the United States using factors from three theoretical framework of ISSM, the extended TAM2, and unified theory of acceptance and use of technology theory (Garcia-Smith & Effken, 2013). They found that system performance, information quality, and facilitating condition had the greatest influences on nurses' satisfaction while information quality and social influence impacted use dependency. Additionally, nurses' satisfaction had greater influence on net benefit. A descriptive, cross-sectional study among Jordanian hospital nurse using the ISSM framework and a validated survey tool developed (see Otieno, et al., 2007) found a high level of satisfaction with EHRs use among nurses (Tubaishat, 2017). The quantitative study to explore nurses view of EMRs use, quality, and user satisfaction in selected hospitals in Turkey found a significant relationship among all three variables with highest correlation between quality and user satisfaction (Top & Gider, 2012). In a follow up study to validate survey instrument (see Otieno et al., 2008) to measure nurses' view of EMRs use, quality, and user satisfaction

in selected Turkish health system, they found that there was a positive correlation of EHR use on patient care, safety, and work quality, but nurses expressed less confidence in information quality (Top et al., 2015).

Several of the studies reviewed used quantitative approach (Cho et al., 2015; Tilahun & Fritz, 2015) and some used mixed methods (Bossen et al., 2013; Nassar et al., 2015). None of the studies used a qualitative approach. Additionally, fewer studies included all dimensions of ISSM (Ebnehoseini et al., 2019; Ojo, 2017). Bossen et al. (2013) did not include the dimension of intention to use because system use was mandatory. This is congruent with Garcia-Smith and Effken (2013) position that variables of intention to use would not provide any significant outcome in a mandatory use environment. Although several studies have examined constructs in ISSM, there is a dearth in instruments that measure all constructs in ISSM related to EHR evaluation studies (Messeri et al., 2013). ISSM provides a comprehensive framework that has been validated for EHR evaluation (Ebnehoseini et al., 2019; Lu et al., 2012; Messeri, et al., 2013; Ojo, 2017). The aim of this study was to examine the relationship between all dimensions of ISSM and impact on EHR effectiveness. This study utilized the questionnaire developed by Ebnehoseini et al. (2019) since it addressed all dimensions in ISSM and provided a comprehensive and objective approach to EHR evaluation.

Relevant Literature Related to Current Study

The theoretical framework for this study was the updated Delone & McLean ISSM which consists of seven dimensions of system quality, information quality, service quality, system use, usefulness, user satisfaction, and net benefits (Delone & McLean,

2003). This section explored other studies that have examined some or all of the variables associated with ISSM.

Studies have examined the relationship between system usability, quality, and user's satisfaction among nurses. A cross-sectional study on EHRs usability among nurses in Korea using the stratified view of health IT usability evaluation framework examined system usability among nurses with focus on nurses' perception of usefulness, usable and satisfaction with EHR system and found a high level of satisfaction with system use but lower satisfaction with data accuracy (Cho et al., 2016). Similar outcome on usability was noted in the cross-sectional study to examine the effect of EHR adoption and work environment on system usability and patient care quality among nurses in the United States found a positive relationship between comprehensive EHR adoption and patient care quality and that work environment had a greater impact on patient care quality and safety (Kutney-Lee et al., 2019). Both studies demonstrated positive attitude of nurses towards EHR adoption.

Some studies have examined physician satisfaction with EHRs from implementation to post-implementation. A study examining the effect of EHR adoption on United States physicians' satisfaction and continuation of use of EHR using the unified theory of acceptance and use of technology theory and Chen Model of intention to continue to use self-service technology included variables of performance expectancy, effort expectancy, social influences, facilitating conditions, user satisfaction, and continuation of use, found statistical significance between all the variables and physician satisfaction with EHR use (Wright & Marvel, 2012). A qualitative study that used the

diffusion of innovation theory to examine factors that influenced the implementation of EMRs among family physicians in Toronto concluded that problematic implementation led to dissatisfaction with the system, lack of standard workflow, and lack of improvement in patient care (Greiver et al., 2011).

The TAM has been widely used in the study of EHR adoption and acceptance. TAM consists of two variables of perceived usefulness and perceived ease of use (King & He, 2006). The study in a Taiwanese hospital using the extended TAM derived from the original TAM and Yusof et al.'s HOT-fit frameworks evaluated physicians' adoption of EHR and found that management support, system quality, perceived usefulness, and perceived ease of use influence acceptance (Chen & Hsiao, 2012). Another quantitative study on the relationship between intention to use and EHR adoption decision among primary health care clinics in Taiwan using multiple theoretical frameworks including TAM found that intention to use and perceived usefulness were major factors that influenced EHR adoption decision (Iqbal et al., 2013). The quantitative cross-sectional study to measure how variables in TAM influenced nurses and doctors' intention to use technology identified that the variable of perceived ease of use had the greatest influence on decision to use technology (Ketikidis et al., 2012). The quantitative study to examine how TAM influence EMR implementation in Isfahan, Iran found a positive correlation among variables of perceived usefulness, perceived ease of usefulness, and behavioral intention to use (Tavakoli et al., 2013). These studies using TAM provided similar outcomes because the variables associated with the model primarily examined decisions to adopt and use technology.

Studies have examined the relationship between experience and efficiency, and net benefits of technology adoption. In a study on EHRs usability among selected physician and pharmacist providers in Amsterdam to evaluate the effect of experience on efficiency using data collected during the intervention arm of a randomized clinical control trial, they found that task repetition and experience led to increase in efficiency (Meulendijk et al., 2016). Finding in another study also identified that experience improved efficiency and system usage (Lin et al. (2016). In consideration of the cost associated with EHRs implementation, a study to evaluate the cost savings from EHR implementation among physician practices in Massachusetts did not find any immediate cost saving but projected long-term cost savings with continued system use (Adler-Milstein et al., 2013).

Several theoretical frameworks have been used in study related to EHR adoption and evaluation. The popular TAM was primarily used in quantitative approach. The diffusion of innovation model can be used in either quantitative or qualitative approaches. Considering the financial and personnel resources involved in the adoption, implementation, and ongoing upgrade maintenance of EHR, there are limited studies on comprehensive evaluation of EHR especially among nurses. This is further evidenced by the dearth of studies evaluating technology adoption within the healthcare industry in the United States. The findings from this study would contribute to the body of knowledge on nurses' perspective of technology efficiency.

Summary and Conclusions

EHR are almost indispensable in current healthcare environment whether at basic or comprehensive implementation state. The ISSM has been widely used in e-commerce for evaluation of technology and has been used in several quantitative studies for comprehensive evaluation of EHR for efficiency and effectiveness. Studies have utilized some of the dimensions of ISSM with fewer studies exploring all dimensions in the model. The variables of use/intention to use and net benefit were not frequently measured. Evaluation of use/intention to use in a mandatory use environment like nursing does not provide an unbiased outcome. (Bossen et al., 2013; Garcia-Smith & Effken, 2013). With net benefit as a projected long-term outcome of EHRs implementation, it is unclear what a suitable time frame would be to accurately measure this factor (Adler-Milstein et al., 2013; Bossen et al., 2013). Studies that utilized mixed methods with the ISSM adopted multiple frameworks to adjust for the qualitative aspect of the study. There were even fewer studies related to nursing and EHR evaluation in the United States.

For this quantitative study, I included all dimensions of ISSM with the goal of contributing to the limited body of knowledge on EHR evaluation among nurses in the United States using the study questionnaire developed by Ebnehoseini et al., (2019). The structure of the ISSM framework leans towards a quantitative study and allows for flexibility in choosing dimensions that apply to study hypothesis. The next chapter focused on in-depth discussion of study methodology and data collection process.

Chapter 3: Research Method

The purpose of this quantitative study was to examine EHRs' efficiency based on domains of Delone and McLean's ISSM (Delone & McLean, 2003; Urbach & Mueller, 2011). The secondary purpose was to determine whether the domains of the ISSM predict net benefits with the EHR system, after changing the original dependent variable of user satisfaction. The rise in EHR adoption, use, and cost associated with implementation necessitates that it is evaluated for effectiveness. To accomplish a comprehensive evaluation of this technology, the ISSM, which has been tried and tested in the e-commerce industry was used. This chapter focuses on the research design, research methodology including target population, sample size, recruitment strategy, data collection process and instrumentation, and steps for ethical protection of participants.

Research Design and Rationale

This was a correlational quantitative study. The correlational research approach is used to examine the relationship between and among variables for co-variance, and the result from this approach allows for the generation of hypotheses (Sousa et al., 2007). The independent variables were system quality, information quality, service quality, system use, usefulness, and user satisfaction, and the dependent variable was net benefits. For this study I examined the relationship between variables in the study and no intervention was necessary as the study leveraged participants' experiences with EHR implementation and use.

Questionnaires were distributed through SurveyMonkey to collect data from registered nurses using either email message or recruitment flyer containing a link to the

survey. For the initial proposal, the first page was designed to include the introduction of the study and the ethical approval. The next page would contain the screening questions to determine participant eligibility to complete the questionnaire. The third page would contain instructions on using the Likert scale to answer the actual survey questions. Basic demographic data excluding any unique identifying information were collected (Appendix B).

One anticipated constraint in this survey study was attrition rate due to the length of the survey questions. The survey instrument sought to capture responses related to seven dimensions of the ISSM. Although the questions were relatively straight forward, the plan was to use online group networking to broadcast survey to obtain enough usable responses for data analysis. Studies have shown there is no significant difference in result from using the traditional versus online recruitment methods (Brandon et al., 2014). Another constraint was that the use of SurveyMonkey for the data collection required paid subscription as the free version was limited to 10 questions.

Methodology

Population

The study population for this study were registered nurses who provide direct patient care or were in administrative roles and interacted with the EHR for managerial duties. The estimated sample size was 145 respondents. Sampling a subset of the target population using survey saves time and cost usually associated with studying the target population and allows for generalization of findings (Rahi, 2017). Furthermore, using the internet as a means of survey distribution reduces cost of printing and mailing. Concerns

related to online survey distribution include lack of personalization and/or personal relationship with study participants, threat of junk mail, and concerns about internet security (Anseel et al., 2010). Further, though the use of incentive has been known to influence survey response rate, this may not apply to non-managerial working professionals. Rather, the perceived relevance of the survey topic to their work has greater influence on the survey response rate (Anseel et al., 2010).

Considering concerns related to attrition and survey response, the targeted sample was 200 participants with the goal of getting a 70% response rate, which was considered acceptable and would minimize the effect of response bias (Keeney et al., 2010). Finally, the recommendations for improving survey response rate were taken into consideration when distributing the survey for this study. I used social media to solicit for participation of registered nurses. Additionally, a link to the survey was sent to registered nurses with publicly available email address through SurveyMonkey.

Sampling and Sampling Procedures

The primary sampling strategy was nonprobability purposeful sampling technique. Snowball sampling was used as a secondary approach to leverages groups and social network for participant recruitment (Etikan & Bala, 2017). The characteristics for participant selection was based on the inclusion criteria making the target population homogenous. Nonprobability sampling technique is more cost effective and may allow for faster data collection (Etikan, et al., 2016). Exclusion criteria ensured that participants were appropriate for the study (Martin & Bridgmon, 2012). The inclusion criteria for participant selection were

1. Registered nurses who use EHR for direct patient care
2. Registered nurses who have been using EHR for more than 6 months
3. Registered nurses who work in acute health setting or ambulatory clinics with comprehensive EHR

The exclusion criteria were

1. Registered nurses with less than 6 months of EHR experience
2. Registered nurses who work in skilled nursing facilities

The sample size was calculated using G*Power software version 3.1.9.6 for multiple regression resulting in 145 respondents. The anticipated effect size was 0.15 (medium). The desired statistical power level was 0.8 with 6 predictors and probability level of 0.05 (Table 1). The a priori analysis assists the researcher with correctly rejecting the false null hypothesis and accepting the alternate hypothesis. The alpha level selection for the power analysis influences the risk of making a type 1 or type II error during decision to reject or accept the null hypothesis (Martin & Bridgmon, 2012). The more stringent alpha level reduces the probability of making a type I error. An alpha level of 0.05 was selected for this analysis resulting in a five percent chance of rejecting a true null hypothesis. A power level of 0.8 was used reflecting an 80% chance of correctly rejecting the false null hypothesis (Martin & Bridgmon, 2012).

Table 1

*G*Power Analysis Output for Liner Multiple Regression*

F tests -	Linear multiple regression: Fixed model,	R^2 increase
Analysis:	A priori: Compute required	sample size
Input:	Effect size f^2	= 0.0989011
	α err prob	= 0.05
	Power (1-β err prob)	= 0.8
	Number of tested predictors	= 6
	Total number of predictors	= 6
Output:	Noncentrality parameter	= 14.3406595
	Critical F	= 2.1648927
	Numerator df	= 6
	Denominator df	= 138
	Total sample size	= 145
	Actual power	= 0.8027786

Recruitment, Participation, and Data Collection

Participants' recruitment occurred online through social media solicitation for registered nurses. Questionnaires were distributed through SurveyMonkey to collect data from registered nurses. Participants accessed survey by clicking the link in the recruitment flyer or email message containing a link to the survey. For the initial proposal, the first page would include the introduction of the study and the ethical approval. The next page would contain the screening questions to determine participant eligibility to complete the questionnaire. First level of screening question to recruit participants who meet the inclusion criteria would include nursing degree qualification

and type of facility where participant works. Once participants answered these questions, met the study inclusion criteria, and agreed to the informed consent, access would be granted to the full survey. This would take participants to the third page which would contain instructions on using the Likert scale to answer the actual survey questions. Basic demographic information included gender, age range, years of nursing experience, highest level of education, years of experience working with EHRs, and employment status with current healthcare facility (Appendix B). Demographic data excluded any unique personalized identifying information.

As part of the informed consent, participants were notified of the purpose of the study and were required to consent electronically to participate in the study or participant could opt out in which case, the survey was terminated if the participation agreement was declined. Although the expectation was that participants would answer all questions in the survey, they also had the options to end the survey at any time. All survey questions were structured with five-point Likert scale options. At the conclusion of the survey, participant had the option to add a comment. Since this was not an experimental study, data was collected at a single point with no follow up requirement. To maintain confidentiality, participants name, email or IP addresses were not included with the data import to eliminate incidence of linking survey response to specific participant (see Gill et al., 2013). This process of confidentiality was maintained with the use of SurveyMonkey.

Instrumentation and Operationalization of Constructs

The instrument for this study was developed by Ebnehoseini et al. based on the seven dimensions of ISSM, to evaluate EHR success from the user's perspective (Ebnehoseini et al., 2019). Although several studies have incorporated dimensions of ISSM in EHR evaluation, there are dearth of studies related to comprehensive evaluation in healthcare sector that included all dimensions of ISSM. Therefore, this tool was deemed appropriate as it accounted for all variables in the study. Written permission to use the survey questionnaire was obtained from Dr. Ebnehoseini (Appendix A). The instrument development was tested in a large acute psychiatric teaching hospital in Iran. The questionnaire has two sections. The first section consists of user's characteristics and the second section include 60 questions on a 5-point Likert scale ranging from 1 (*completely disagree*) to 5 (*completely agree*) that address the 7 dimensions of ISSM (Table 2; Ebnehoseini et al., 2019). Sample included 125 participants and approximately 50% were nurses. The instrument was validated by a panel of experts and the Content Validity Index was 0.85, the content validity ratio was 0.86, and the overall Cronbach's alpha value was 0.93. The *p* value of 0.01 showed positive significant relationship among all dimensions of ISSM (Ebnehoseini et al., 2019).

Table 2

Dimensions and Evaluation Measures

Dimensions	Evaluation Measures (Number of questions)
System Quality	Adaptability (*n* = 1) Reliability (*n* = 1) Availability (*n* = 6) Usability (*n* = 6)
Information Quality	Security (*n* = 3) Ease of understanding (*n* = 3) Completeness (*n* = 2) Personalization (*n* = 1) Relevance (*n* = 1)
Service Quality	Responsiveness (*n* = 4) Assurance (*n* = 4) Empathy (*n* = 4)
Satisfaction	Evaluation Measure was dimension (*n* = 4)
System Use	Evaluation Measure was equal to dimension (*n* = 1)
System Usefulness	Evaluation Measure was equal to dimension (*n* = 4)
Net Benefits	Evaluation Measure was equal to dimension (*n* = 18)

For the study, the intended independent variables were system quality, information quality, service quality, system use, usefulness, and net benefits. The intended dependent variable was user satisfaction. The operational definitions for variables in this study were derived from the article by Urbach and Mueller (2011). The variables for evaluating each dimension were measured on a 5-point Likert scale ranging from 1 (*strongly disagree/absolutely inappropriate/never*) to 5 (*strongly agree/absolutely appropriate/always*) and covered 16 evaluation measures from the 7 dimensions of ISSM. Questionnaire consisted of 60 questions. The survey response was considered usable if all 60 questions related to the ISSM dimensions were answered.

Data Analysis

Survey responses in SurveyMonkey was downloaded in Excel spreadsheet format excluding participants identifiable information like email and IP addresses. All responses related to the ISSM domains must be answered to utilize response from any participant. Incomplete ISSM variable responses negated the ability to utilize participant's response. ISSM success rate was calculated using the following formula (Ebnehoseini et al., 2019):

- Maximum success rate of evaluation measures, dimensions, and total dimensions by each user = number of questions* 5 (maximum score for each question on a 1-5-point Likert scale)
- The acquired rate of success of evaluation measures, dimensions, and total dimensions by each user = sum of the acquired score for each question on a 1-5-point Likert scale by each user
- Success Rate = (The acquired rate of EHRs success of evaluation measures, dimensions, and total dimensions by each user/Maximum EHRs success rate of evaluation measures, dimensions, and total dimensions by each user)*100

The intended research questions and hypotheses for this study were developed from the ISSM framework:

1. What is the relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction and net benefits?

   $H_0$1: There is no relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction and net benefit.

H_a1: There is a relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction and net benefits.

2. What are the domains in ISSM that predict user's satisfaction?

$H_0 2$: The domains (system quality, information quality, service quality, system use, usefulness, and net benefits) of the ISSM do not predict the user's satisfaction

$H_a 2$: The domains (system quality, information quality, service quality, system use, usefulness, and net benefits) of the ISSM predict the user's satisfaction

Pearson correlation and multiple regression statistical analysis were done using IBM SPSS (Version 27) predictive analytics software. Multiple regression analysis examines the relationship between two or more independent variables to a dependent variable (Martin & Bridgmon, 2012). The effect size (0.15), power level (0.8), and alpha level (0.05) were taken into consideration when accepting or rejecting the null hypothesis (Martin & Bridgmon, 2012). No covariates and/or confounding variables were identified for the study. I tested the reliability of the study instrument by running a Cronbach alpha on the participants' responses.

Justification for Revision to Research Method

During the IRB review and approval stage, modifications were made to the proposed recruitment, participation, and data collection processes. After the initial IRB approval, follow up request was made to IRB to include additional data collection

method. During the data analysis phase, one of the research questions was revised to align with ISSM.

Recruitment, Participation, and Data Collection

Participants' recruitment occurred online through social media solicitation for registered nurses. Electronic recruitment flyer containing the link to the survey was posted online. Survey response was collected through SurveyMonkey. The recruitment flyer provided a brief overview of the study and inclusion criteria. At the bottom of the recruitment flyer, a link to the survey was provided. Once a participant accessed the link, the first page included the introduction of the study and the ethical approval. The next step required participant to accept or decline participation in the study The third step contained the screening questions to determine participant eligibility to complete the questionnaire. Once a participant answered these questions, met the study inclusion criteria, participant could proceed to the full survey. Screening questions included gender, age, highest level of education, years of nursing experience, employment status with current healthcare facility. Demographic data excluded any unique identifying information.

Due to the very low response rate after about four months into recruitment, I submitted an amendment to IRB to include additional recruitment approaches using snowball sampling approach and sending survey link via email to nurses in states where email addresses were publicly available. This request was approved by IRB and the recruitment strategies were implemented.

Revision to Research Question

During the data analysis process, the assumption of homoscedasticity was not met. Critical review of the research variables showed that use, system usefulness, and user satisfaction were contributors to net benefits. After consultation with dissertation chair and committee member, I received approval to change the dependent variable from user satisfaction to net benefits and therefore revised the research question to "What are the domains of ISSM that predict net benefits?"

Threats to Validity

For this study, a perceived threat to external validity was the participant selection. To minimize this risk, nonprobability sampling approach using homogenous participants was used. While this ensures homogeneity of the sample, it improves the chance of participation by eligibility participants (Etikan et al., 2016). The perceived threat to internal validity was the survey instrument. The currently proposed questionnaire has only been tested at the time of development (Ebnehoseini et al., 2019). To minimize the validity threat, no change was made to questions that measured the key variables under study. The proposal was to modify the demographic data from the original survey to include two segments with some in the prescreening questions and the rest in the actual demographic section. Prescreening questions would include job title, type of facility (not unit), type of patient unit/setting where you carry out your primary duties, EHRs applications used by facility, years of EHRs use. However, final version included just the basic demographic data (Appendix B). Additionally, some of the demographic questions from the original questionnaire were modified to reflect the language and cultural trend

applicable in the current environment of study. For the demographic, selections for sex/gender identification included an option for ‘other’ and number of hours worked was modified to ‘per week’ instead of ‘per month’ (Appendix B)

Ethical Procedures

Ethical considerations consistent with Walden University requirement for confidentiality was taken into consideration. Participant solicitation was done through SurveyMonkey therefore permission from any specific healthcare organization institutional review board (IRB) was not necessary. Permission was obtained from the Walden University IRB and approval was received with approval number 01-21-21-0131937, before data collection began. The recruitment cover letter/consent form clearly indicated the voluntary nature of participation in the study and option to exit survey at any point in time.

Downloaded survey response was stored in a secured device along with backup on a flash drive. While demographic information was requested during the survey, data collated for all participants were reported in de-identified format. Participants had the option of taking the survey at the convenience of their home thereby minimizing relationship risk and conflict of interest. All survey data were collected confidentially and anonymously since I had no physical interaction with participants due to the medium of data collection.

Summary

The non-experimental quantitative study explored the relationship between the independent variables and dependent variables using dimensions from ISSM. Study sample were registered nurses involved in direct patient care or in administrative roles that use EHRs regularly. Projected sample size was 145 participants based on G*power calculation with effect size of 0.8. Sampling strategy was nonprobability purposeful sampling with snowball sampling as a secondary approach. Participant solicitation was done online using social media. Survey responses were collected using SurveyMonkey. Participation in study was voluntary and participants could exit survey at any point. Data analysis for Pearson correlation and multiple regression analysis was done using IBM SPSS (Version 27) predictive analytics software. The analysis was intended to provide data on the strength of the relationship between the variables and identify which variables positively contributed to user satisfaction but was revised to dependent variable was revised to net benefits. Chapter 4 focused on the discussion of result of the study including the data collection, result analysis and summary of findings from the data analysis.

Chapter 4: Results

The purpose of this study was to examine EHR efficiency based on domains of the ISSM (Delone & McLean, 2003; Urbach & Mueller, 2011). The secondary purpose was to determine whether the domains of the ISSM predict net benefits with the EHR system. The research questions were designed to determine the relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction and net benefits as well as the domains in ISSM that predict net benefits. All variables used in the analysis of this study were obtained from the results of 201 ISSM questionnaire responses.

Data Collection

Data collection was completed over a 6-month period from mid-February to mid-August 2021. Recruitment was initially through social media platforms of Facebook and LinkedIn. Due to the very low response rate after four months into recruitment, I submitted an amendment to IRB to include additional recruitment approach like emailing recruitment flyer to nurses, sending survey link via email to nurses in states where email addresses were publicly available, and using a snowball method for participant recruitment. Once IRB approved the request, I sent out an email blast with the survey link to nurses in the states of Florida and Nebraska through SurveyMonkey. This resulted in an increase in response rate. I was able to exceed the targeted number of respondents, which was initially 145 respondents, to reach a total of 201 completed survey responses.

A total of 466 participants responded to the survey using the SurveyMonkey link provided. Of the 466 participants, 89 respondents (19.10%) declined to participate in the

study, 176 participants (37.8%) did not complete the survey, and 201 participants completed the survey for a response rate of 100% based on the participant recruitment target number of 145. Only the 201 completed survey responses were included in the final data analysis.

To address external validity, survey responses were from registered nurses who met the study inclusion criteria using nonprobability sampling. The survey was available to all registered nurses in the United States since social media was the initial preference for participant recruitment. Nurses working less than 20 hours per week were excluded depending on response to survey question on number of hours worked per week. Any nurse who chose to click on the survey link and met the inclusion criteria had a chance of participating in the survey by completing all questions. According to the U.S. Bureau of Labor Statistics, in 2020, 13% of registered nurses were males and about 87% were females. For this study, 82% identified as female and about 17% identified as male. Although the study sample was homogeneous, nurse participants were limited by practice environment; therefore, the study findings may be reflective of the view of nurses working in acute care and primary care settings but cannot be generalized as reflecting the view of the general registered nurse population.

Results of Analysis

Statistical Analysis

To approach the research questions for this study, data were analyzed using IBM SPSS (Version 27) predictive analytics software. Only completed questionnaire responses were included in the analysis. Negative worded items in the questionnaire were reversed

prior to compiling total values for responses for each dimension of the model. Descriptive statistics were calculated for the demographic section of the questionnaire and included frequency and percentage. A Pearson correlation coefficient was completed to assess the relationship between the variables in the model. Multiple regression analysis was conducted to identify the independent variables that predicted net benefits. The Cronbach alpha was calculated to measure the internal consistency of the study instrument.

Descriptive Statistics Analysis

A total of 201 completed survey responses were used for the analysis. Of the total participants, 82% (*n* = 165) identified as female, 17% (*n* = 34) identified as male, and 1% (*n* = 2) identified as other. Age analysis showed that 8% (*n* = 16), 13 females and three males, were 18–29 years old, 22% (*n* = 44) 33 females, nine males and two others, were 30–39 years old; 31% (*n* = 63), 55 females and eight males, were 40–50 years old; and 39% (*n* = 78) participants, 64 females and 14 males, were over 50 years old. About 50% (*n* = 100) of participants had a bachelor's degree, followed by 35% (*n* = 71) with a master's degree or higher and 15% (*n* = 30) of participants had associate degree. Participants comprised of nurses, 35% (*n* = 71) with greater than 25 years of nursing experience, 8% (*n* = 16) had less than 5 years of nursing experience, and 56% (*n* = 114) had between 5 and 25 years of nursing experience. Analysis of work status showed that 84% (*n* = 169) of participants, 137 females and 32 males, worked more than 35 hours per week and 16% (*n* = 32) participants, 28 females, two males, and two identifying as other, worked 20–35 hours per week.

Assumptions of Multiple Regression Analysis

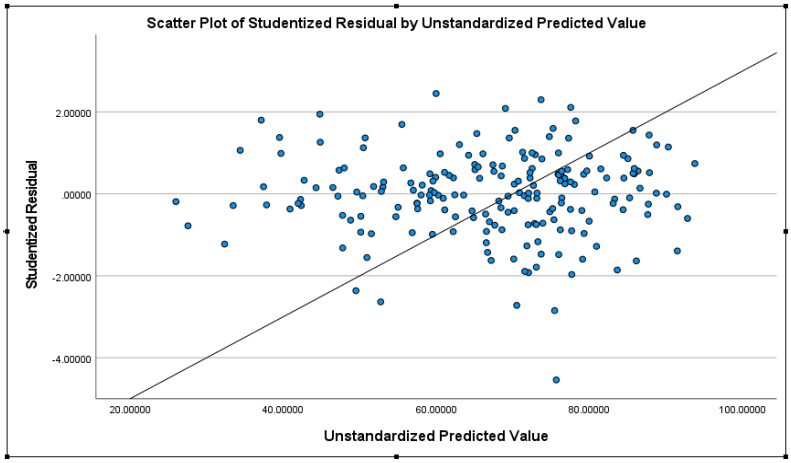
There are several assumptions associated with multiple regression analysis (Osborne & Waters, 2002). For this study, the assumptions in the following sections were addressed.

Assumption 1

There was a linear relationship between the dependent and independent variables. Testing of this assumption was done with a scatterplot of the studentized residuals (SRE_1) against the (unstandardized) predicted values (PRE_1), which showed a linear relationship between the variables (Figure 2).

Figure 2

Scatter Plot of SRE_1 by PRE_1



Assumption 2

There was no multicollinearity in the data. This assumption was tested by inspection of the correlation coefficients and tolerance/variance inflation factor (VIF) values. Net benefits and system usefulness were highly correlated with $r = 0.816$ and all other correlation scores were below $r < 0.8$ (Table 3).

Table 3

Pearson Correlations

		Net benefits	System quality	Information quality	Service quality	User satisfaction	System use	System usefulness
Pearson correlation	Net benefit	1.000	.642	.677	.571	.710	.036	.816
	System quality	.642	1.000	.770	.622	.628	.167	.641
	Information quality	.677	.770	1.000	.603	.626	.176	.639
	Service quality	.571	.622	.603	1.000	.617	.019	.558
	User satisfaction	.710	.628	.626	.617	1.000	-.042	.657
	System use	.036	.167	.176	.019	-.042	1.000	.109
	System usefulness	.816	.641	.639	.558	.657	.109	1.000

Further testing for multicollinearity was done using the tolerance and VIF values. The VIF scores were all below 10 and the tolerance scores were above 0.2 (Table 4).

Table 4

Coefficients Showing the VIF and Tolerance Scores

	Unstandardized coefficients		Standardized coefficients	Collinearity	
Model 1	B	SE	β	Tolerance	VIF
(constant)	3.996	5.226			
Service quality	.020	.081	.016	.337	2.967
Information quality	.223	.078	.180	.346	2.892
Service quality	.016	.054	.015	.508	1.970
User satisfaction	.281	.073	.219	.425	2.354
System use	-.054	.042	-.049	.909	1.100
System usefulness	.433	.043	.545	.456	2.194

Assumption 3

The values of the residuals were independent. This assumption was tested using the Durbin-Watson statistics, with the value of 1.962 (Table 5).

Table 5

Durbin-Watson Test

Model summary[b]										
				Change statistics						
Model	*R*	R^2	Adjusted R^2	SE of estimate	R^2 change	F change	df1	df2	Sig. F change	Durbin-Watson
1	.859[a]	.738	.730	8.61621	.738	91.160	6	194	.000	1.962

a. Predictors: (Constant), system usefulness, system use, service quality, information quality, user satisfaction, system quality

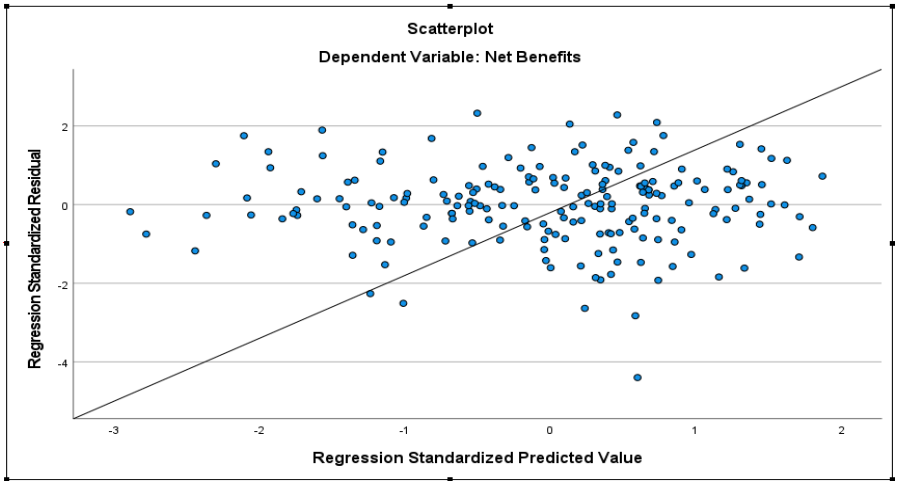
b. Dependent variable: net benefits

Assumption 4

Test for homoscedasticity, which assumes that variation across the values of the independent variables is similar was met. This was first tested by plotting the standardized residual versus the predicted values. The plot showed there was homoscedasticity as shown in Figure 3.

Figure 3

Scatterplot of Standardized Residual versus the Predicted Values



Further testing for homoscedasticity was done using the Breush-Pegan test with a $p > 0.05$ as shown in Table 6, supporting the assumption of homogeneity of variance in the model.

Table 6

ANOVA Analysis for Breush-Pegan Test

ANOVA[a]						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	175444.335	6	29240.723	1.552	.163[b]
	Residual	3654364.188	194	18836.929		
	Total	3829808.523	200			

a. Dependent variable: sqres
b. Predictors: (Constant), system usefulness, system use, service quality, information quality, user satisfaction, system quality

Assumption 5

The values of the residuals were normally distributed. This was tested using the histogram with superimposed normal curve (Figure 4) and a Q-Q Plot (Figure 5). Skewness for the dependent variable was -.656 and kurtosis was 1.894 for the studentized residual.

Figure 4

Histogram

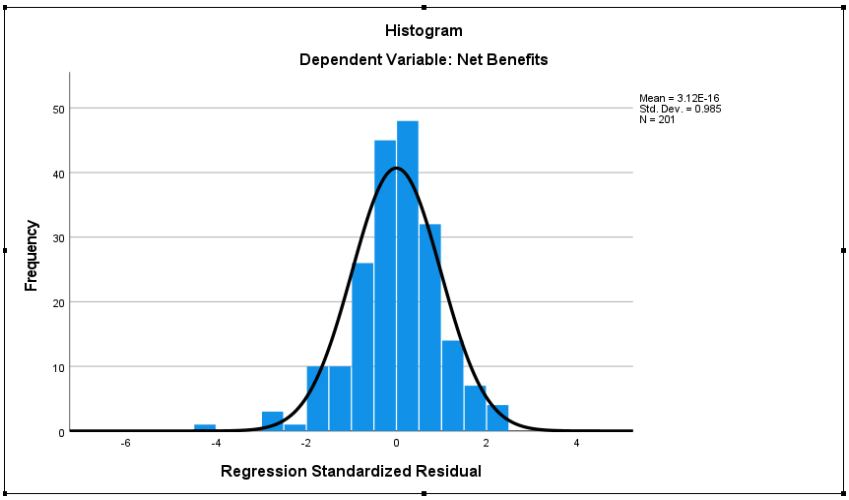
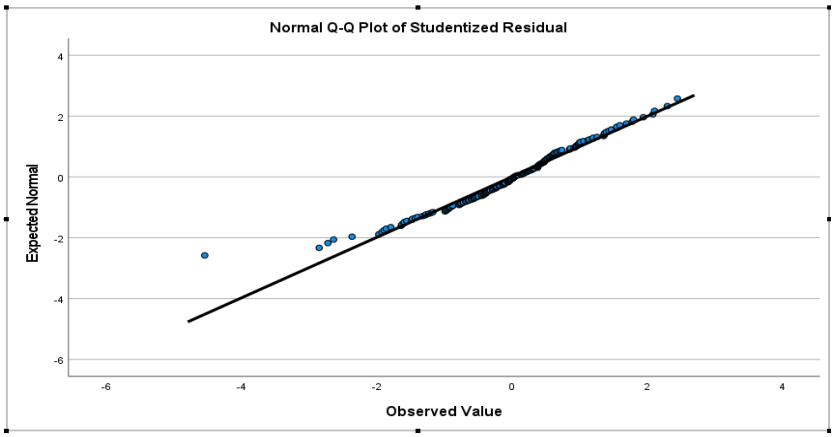


Figure 5

Q-Q Plot of Studentized Residual



Assumption 6

Test for outliers/influential cases. This assumption was tested using the Cook's Distance statistic. The Cook's Distance statistics values were all under 1. Therefore, this assumption was met.

Reliability

The Cronbach alpha value for the instrument was between .173 – .954 for the different dimensions. The Cronbach alpha value was satisfactory among five dimensions of system quality, information quality, service quality, system usefulness, and net benefits with range of .829–.954. The value for user satisfaction was low at .173, when all questions in the dimensions were evaluated and jumped to > .80 when the low performing question was excluded. Since the dimension of system use had only one question, the Cronbach's alpha was not calculated.

Statistical Analysis

Nurses' view of each variable was calculated using the mean scores of participants responses as shown in Table 7. The high mean (SD) score of 91.64 (15.159) associated with system use is reflective of response to frequency of EHR use. Scores indicate how positively nurses view each dimension with the highest possible score of 100. Mean score range was 65.92 – 91.64 with standard deviation range of 12.885 – 20.855.

Table 7

Descriptive Statistics

	Mean	*SD*	*N*
Net benefits	67.1365	16.58434	201
System quality	74.8543	12.99384	201
Information quality	72.1727	13.36325	201
Service quality	67.05	15.959	201
User satisfaction	65.92	12.885	201
System use	91.64	15.159	201
System usefulness	71.24	20.855	201

Research Question 1

Research Question 1 was "What is the relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction and net benefits?" To approach the research question, correlation analysis was conducted to examine the relationship between the various variables in the model. The analysis showed a positive and significant correlation between user satisfaction, system quality, information quality, service quality, system usefulness, and net benefits with $p < .05$ (Table 8). The highest level of positive correlation and significance was between system usefulness and net benefits ($r = .816$, $p < .05$). However, there was negative and non-significant correlation between system use and user satisfaction ($r = -.042$, $p > .05$). This meant that with increasing system use, user satisfaction decreased. There were weak positive and non-significant correlation between system use and service quality ($r = .019$, $p > .05$), system use and system usefulness ($r = .109$, $p > .05$), system use and net benefits ($r = .036$, $p > .05$). Based on the analysis result, the null hypothesis that there was no

relationship between system quality, information quality, service quality, system use, usefulness, user satisfaction and net benefits, was rejected.

Table 8

Pearson Correlations

		Net benefits	System quality	Information quality	Service quality	User satisfaction	System use	System usefulness
Pearson correlation	Net benefit	1.000	.642	.677	.571	.710	.036	.816
	System quality	.642	1.000	.770	.622	.628	.167	.641
	Information quality	.677	.770	1.000	.603	.626	.176	.639
	Service quality	.571	.622	.603	1.000	.617	.019	.558
	User satisfaction	.710	.628	.626	.617	1.000	-.042	.657
	System use	.036	.167	.176	.019	-.042	1.000	.109
	System usefulness	.816	.641	.639	.558	.657	.109	1.000
Sig. (1 tailed)	Net benefit		.000	.000	.000	.000	.308	.000
	System quality	.000		.000	.000	.000	.009	.000
	Information quality	.000	.000		.000	.000	.006	.000
	Service quality	.000	.000	.000		.000	.393	.000
	User satisfaction	.000	.000	.000	.000		.275	.000
	System use	.308	.009	.006	.393	.275		.062
	System usefulness	.000	.000	.000	.000	.000	.062	

Research Question 2

Research Question 2 was “What are the domains in ISSM that predict net benefits?” To approach the research question, a multiple linear regression analysis was conducted to evaluate the predictors of net benefits from system quality, information quality, service quality, system use, usefulness, and user satisfaction. From the results of the multiple linear regression analysis, system quality, service quality, and system use were not statistically significant predictors of the model ($p > .05$). However, the results of the multiple linear regression analysis showed that information quality, user satisfaction,

and system usefulness were positive and statistically significant predictors of net benefits ($p < .05$). See Table 9.

Table 9

Coefficients

	Unstandardized coefficients		Standardized coefficients			95% CI		Correlations		
Model 1	B	SE	β	*t*	Sig.	Lower bound	Upper bound	Zero order	Partial	Part
(constant)	3.996	5.226		.765	.445	-6.310	14.302			
Service quality	.020	.081	.016	.247	.805	-.139	.179	.642	.009	2.967
Information quality	.223	.078	.180	2.877	.004	.070	.376	.677	.106	2.892
Service quality	.016	.054	.015	.294	.769	-.090	.121	.571	.011	1.970
User satisfaction	.281	.073	.219	3.878	.000	.138	.424	.710	.142	2.354
System use	-.054	.042	-.049	-1.271	.205	-.137	.030	.036	-.047	1.100
System usefulness	.433	.043	.545	10.007	.000	.348	.518	.816	.368	2.194

Controlling for user satisfaction and system usefulness, the regression coefficient [B = .223, 95% CI (.070, .376), $p < .05$] associated with information quality suggests that with each additional unit of information quality, net benefits increased by approximately .223. The confidence interval associated with the regression analysis did not contain 0, which meant that the null hypothesis, there is no association between information quality and net benefits was rejected.

Controlling for information quality and system usefulness, the regression coefficient [B = .281, 95% CI (.138, .424), $p < .05$] associated with user satisfaction suggests that with each additional unit of user satisfaction, net benefits increased by approximately .281. The confidence interval associated with the regression analysis does not contain 0, which meant that the null hypothesis, there is no association between user satisfaction and net benefit was rejected.

Controlling for information quality and user satisfaction, the regression coefficient [B = .433, 95% CI (.348, .518), $p < .05$] associated with system usefulness

suggests that with each additional unit of system usefulness, net benefits increased by approximately .433. The confidence interval associated with the regression analysis does not contain 0, which meant that the null hypothesis, indicating there is no association between system usefulness and net benefits was rejected.

Results also showed that 85.9% of the variance in net benefits could be accounted for by the six predictors collectively, $F(6,194) = 91.160$, $p < .05$ (Table 5). Further, Cohen's effect size value ($f^2 = 2.82$) suggested a high practical significance.

Summary

Descriptive analysis of the 201 participants included 82% (n = 165) who identified as female, 39% (n = 78) of participants were over age 50 years and about 50% (n = 100) had a bachelor's degree. 35% (n = 71) of participants had greater than 25 years of nursing experience, and 84% (n = 169) of participants work more than 35 hours per week.

The correlation analysis to examine the relationship between the variables showed positive and significant relationship between user satisfaction, system quality, information quality, service quality, system usefulness, and net benefits (p <.05) with the highest positive correlation between system usefulness and net benefits. System use had the weakest correlation with other variables in the model. There was a negative correlation between system use and user satisfaction. For the multiple linear regression analysis to evaluate the prediction of net benefits from system quality, information quality, service quality, system use, system usefulness, and user satisfaction, three of six independent variables, information quality, user satisfaction, and system usefulness, were

statistically significant and positive predictors of net benefits. Chapter 5 focused on further discussion of findings from statistical analysis, limitations of this study, and recommendations for practice and future research.

Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this study was to examine EHR efficiency based on domains in the ISSM (Delone & McLean, 2003) and whether the domains predicted net benefits with the EHR system. The ISSM has been used in previous studies for comprehensive evaluation of technology especially in the commerce industry. However, with limited studies on the comprehensive evaluation of EHR efficiency, this study aimed to examine EHR efficiency based on dimensions of the Delone and McLean's ISSM.

The correlation analysis to examine the relationship between the variables showed positive and significant relationship between user satisfaction, system quality, information quality, service quality, system usefulness, and net benefits ($p < .05$) with the highest positive correlation between system usefulness and net benefits ($r = .816$, $p < .05$). However, there was a negative correlation between system use and user satisfaction ($r = -.042$, $p > .05$). System use had the weakest correlation with other variables in the model. For the multiple linear regression analysis to evaluate the prediction of net benefits from system quality, information quality, service quality, system use, system usefulness, and user satisfaction, three of six independent variables, information quality, user satisfaction, and system usefulness, were statistically significant and positive predictors of net benefits.

Interpretation of the Findings

The correlation analysis showed a positive and statistically significant relationship between user satisfaction, system quality, information quality, service quality, system usefulness, and net benefits ($p < .05$) with the highest positive correlation between system

usefulness and net benefits. The variable of system use had the weakest correlation with the other variables in the dimension. The correlation findings are consistent with the results of previous studies that found a positive correlation between all dimensions of the ISSM (Ebnehoseini et al., 2019; Yusof et al., 2008). Although system use did not show statistical significance in this study, this finding was congruent with research suggesting that measuring intention to use/use in a mandatory use environment like nursing does not provide an unbiased outcome (Garcia-Smith & Effken, 2013). In the United States, system use is mandatory. The decision on whether to use EHR during clinical practice in the United States is not within the scope of the nurses' decision-making process, making use mandatory regardless of the nurses' perceptions of the value of the EHR system.

The linear regression analysis found that information quality, user satisfaction and system usefulness positively and significantly contributed to net benefits. This aligned with the studies that showed that user satisfaction positively predicted net benefits (Cho et al., 2015; Garcia-Smith & Effken, 2013). Comparison of the findings in this study to the theoretical framework, the ISSM (Petter et al., 2013), took into consideration the assumptions of the model that user satisfaction, intention to use, and use influence net benefits. Findings from this study showed that user satisfaction and system usefulness significantly and positively contributed to net benefits. The variable of use did not contribute significantly to net benefits, which aligned with the finding that measuring the variable of intention to use/use in a mandatory use environment is not meaningful (Garcia-Smith & Effken, 2013).

The ISSM also assumes that system, information, and service qualities contribute to user satisfaction and user satisfaction influence net benefits. In this study, information quality was the only variable that contributed significantly to net benefits. Service and system qualities did not contribute to net benefits. This finding aligned with the finding that the influences of variables like service quality and system quality are strong before and up to about three months after EHR adoption and weaken over time as users get more comfortable with the technology especially with ongoing use (Venkatesh & Davis, 2000).

Limitations of the Study

Study participants were limited to nurses who work in acute care setting and ambulatory clinic setting. Though findings from this study may be generalized to nurses who work in similar setting, it may not necessarily reflect the viewpoint of the overall nursing population since other clinical settings like skilled facility workers were excluded. The Cronbach alpha test showed a high level of external validity with value > .80 for five of the six dimensions evaluated. However, the variable of user satisfaction had very low alpha when all questions in the dimensions were evaluated and jumped to > .80 when the low performing question was excluded. The instrument was generally effective with measuring the variables. The internal validity of the instrument was not tested.

Recommendations

Findings from this study showed that information quality, system usefulness, and user satisfaction were significant and positive contributors to net benefits. EHR use has witnessed exponential growth in the United States within the last decade. Although there

was no clear standard defining when to evaluate net benefits from time of implementation of EHR, now is as good a time considering that most system implemented should be within more than 2 years post implementation. Recommendations for future research is to consider including nurses across clinical practice setting and compare how the practice setting influence EHRs' efficiency.

Implications

One impact to positive social change is that hospital management can be informed about the variables that significantly contribute to net benefits when considering adoption of a new EHR system and during EHR system upgrade. Findings from this study showed that nurses place emphasis on information quality, system usefulness, and user satisfaction. Nurses are at the forefront of EHR use. In the era of big data, information quality is a useful variable. Finally, adopting an objective and valid tool to evaluate EHR efficiency provides a way to continually evaluate system for improvement.

Conclusion

Nurses are the largest users of technology in health care. Therefore, their opinion matters when considering adopting a new system. Nurses' opinions are especially valuable since wider scale EHR use in the United States has risen within the last decade largely due to the HITECH Act. An understanding of what nurses consider as valuable in any EHR system should be taken into consideration when adopting or looking to switch to a new technology system in health care. Lastly, this study showed that the ISSM is a good framework to evaluate EHR efficiency among nurses.

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Appendix A: Letter of Permission to Use Survey Tool

From: Zahra Ebnehoseini <[redacted]>
Sent: Thursday, October 17, 2019 6:45 AM
To: Gloria Oshegbo <[redacted]>
Cc: Mahmoud Tara <[redacted]>
Subject: RE: Request

Dear Gloria,
Thank you for your interest in our study. We are happy to send you the questionnaire. Please find it attached.
We are in the process of preparing a new publication based on the contents of this questionnaire. As such, this is intended to serve as your personal information or research use only, and we kindly request that you do not publish this or share it with anyone else without our consent. However, you are welcome to use it in your research (with reference to our work) without sharing the questionnaire itself.
Please do not hesitate to ask me any question regarding the questionnaire. We look forwards to your news on your research publication (using the questionnaire).

Good luck on your research,

Zahra Ebnehoseini,
Ph.D. of Medical Informatics
Psychiatry and Behavioral Sciences Research Center

From: Gloria Oshegbo [mailto:[redacted]
Sent: Thursday, October 17, 2019 3:48 AM
To: Mahmoud Tara <[redacted]>; Zahra Ebnehoseini <[redacted]>
Subject: Re: Request

Dear Dr. Ebnehoseini,
I am following up to see if you have had time to review my request. I look forward to your response.

Regards,

Gloria Oshegbo

From: Mahmoud Tara <[redacted]>
Sent: Tuesday, October 8, 2019 1:20 AM
To: Zahra Ebnehoseini <[redacted]>
Cc: Gloria Oshegbo <[redacted]>
Subject: RE: Request

Dear Dr. Ebnhoseini,
Please review the below request and see how we can help.

Regards,

Mahmood

From: Gloria Oshegbo <[redacted]>
Sent: سه شنبه, 16 مهر 1398 04:55 ق.ظ
To: Mahmoud Tara <[redacted]>
Subject: Request

Hi Tara,

My name is Gloria Oshegbo and I am a PhD student at Walden University, USA. I came across your study on 'Determining the Hospital Information System (HIS) Success Rate: Development of a New Instrument and Case Study'. I would like to know the steps to get approval for the use of the questionnaire you developed for this study.

Thank you for your kind consideration.

Regards,
Gloria Oshegbo

Appendix B: Demographic Information

Please answer the following demographic information. All information you provide will be held confidential and anonymous.

1. What is your sex?
    - female
    - male
    - Other
2. What is your age?
    - 18-29 years
    - 30-39 years
    - 40-50 years
    - >50 years
3. What is your highest education level?
    - Associate degree
    - Bachelor's degree
    - Master's degree and higher
4. How many years have you worked in this hospital or other health care organizations altogether?
    - <5
    - 5-10
    - 10-15
    - 15-20
    - 20-25
    - >25
5. How many hours per week do you usually work?
    - < 20 hours
    - 20-35 hours
    - > 35 hours