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Rangarajan Parthasarathy
University of Illinois at Urbana-Champaign, rparth2@illinois.edu

Justin Kern
University of Illinois at Urbana-Champaign, kern4@illinois.edu

James R. Knight
Ohio State University, james.knight@osu.edu

David K. Wyant
Belmont University, david.wyant@belmont.edu

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Rangarajan Parthasarathy
University of Illinois at Urbana-Champaign
rpartha463@gmail.com, rparth2@illinois.edu

Justin Kern
University of Illinois at Urbana-Champaign
kern4@illinois.edu

James R. Knight
Ohio State University
james.knight@osu.edu

David K. Wyant
Belmont University
david.wyant@belmont.edu

ABSTRACT

Successful Electronic Medical Record (EMR) implementation is expected to help control costs and increase efficiencies in healthcare delivery while also improving the quality of care. EMR is an information technology innovation per research literature. It is therefore important that EMR implementations succeed. A large number of information technology implementations fail resulting in monetary and non-monetary losses. EMR implementations in the United States and around the world have been fraught with problems and delays, resulting in unsuccessful or partially successful implementations. Knowing factors that are associated with successful information technology implementations may help EMR implementations succeed. The goal of this research-in-progress is to investigate whether the factors relative advantage, compatibility and complexity, which have most often been associated with successful information technology implementations in other domains such as e-commerce, are also associated with successful EMR implementations.

Keywords

Electronic Medical Records (EMR), Electronic Health Records (EHR), Healthcare Information Technology Implementations, Diffusion of Innovations Theory, Information Technology Innovation.

INTRODUCTION

The healthcare industry in the United States is a massive undertaking with spending amounting to about 18% of GDP (*www.cms.gov*). In the current scenario of ever escalating healthcare costs, it is hoped that implementations of information technology innovations such as Electronic Medical Records (EMR) and Electronic Health Records (EHR) will help control costs and increase efficiencies in healthcare delivery, while at the same time improving the quality of care (Bates et al., 2003; DesRoches et al., 2008; Häyrinen, Saranto & Nykänen, 2008; Jha et al., 2009; Miller & Sim, 2004). EMR/EHR use has been associated with a multitude of current and potential benefits including reduction in medication errors, diagnosis errors and procedural errors in patient treatment (Dalal & Schnipper, 2016; Goo, Huang & Koo, 2015; Jha & Provonost, 2016; Moja et al., 2016; Murphy et al., 2014; Phansalkar et al., 2013; Singh et al., 2013). For these reasons, successful implementation and use of EMR/EHR is expected to be crucial to healthcare organizations in order to function efficiently and effectively. EMR contains the standard medical and clinical data gathered in one provider's office while EHR contains and shares information from all providers involved in a patient's care. In both, research literature and practitioner literature, the terms EMR and EHR have been used interchangeably, and are hence used interchangeably in this paper also.

Cost of failed information technology implementation projects have amounted to billions of dollars (Brynjolfsson & Hitt, 2003; Dalcher & Genus, 2003; Kagerman, 2005; Menachemi & Collum, 2011; Sumner, 2015). Research literature informs us that 50% to 95% of information technology implementation projects fail (Brynjolfsson & Hitt, 2003; Dalcher & Genus, 2003; Kagerman, 2005; Menachemi & Collum, 2011; Sumner, 2015). Particularly with respect to EMR

implementations, 20-30% of EMR implementations fail within the first year (Palvia, Jacks & Brown, 2015; Sumner, 2015). If information technology implementations such as EMR implementations are important to the future of the healthcare industry in the United States and elsewhere, it is important to ensure that they succeed. Surfacing factors that will contribute to the success of EMR implementations should go a long way in helping them succeed. We develop in this paper a conceptual model for EMR implementation success based on Roger's innovation diffusion theory.

LITERATURE REVIEW

Electronic Medical Records (EMR) and Electronic Health Records (EHR) Implementations

In the United States, laws such as the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 and American Recovery and Reinvestment Act (ARRA) of 2009 govern the implementation and use of EMR. The HITECH act provides incentives to hospitals and doctors for implementation and use of EMR and imposes penalties for non-implementation. However, the act requires EMR implementation to be done in a manner as to be very useful to healthcare providers and healthcare receivers alike, the specifics of which are captured under the "meaningful use" guidelines specified by the government. The meaningful use requirements include the implementation and use of an 'Office of the National Coordinator for Healthcare IT (ONC)-Certified EMR/EHR Technology' (also known as CEHRT) among others. In addition, they require EMR to be implemented in three stages (stage 1, stage 2 and stage 3) with each stage having specific areas of focus with respect to the benefits accruable to healthcare receivers.

Cost reduction and quality improvement in healthcare delivery are expected to result from the use of EMR due to a reduction in the times associated with processing enormous amounts of patient information within and between hospitals, enhancement of the speed and quality of communications between patients and the healthcare providers, and delivery of evidence-based healthcare through the collection and mining of patient data and information (Hillestad et al., 2005; Jardim & Martins, 2016; Sharma et al., 2016). As part of a study by Perera et al. (2011), 511 patients and 46 physicians at St. Joseph's hospital in Ontario, Canada were administered the Health Information Privacy Questionnaire (HIPQ) before and after an extended use of EMR for a period of over six months. This study revealed that more than 90% of the physicians and patients supported the sharing of digital patient records among healthcare professionals while less than 70% agreed on the sharing of de-identified information outside of the healthcare circles. While 58% of patients and 70% of the physicians believed that the benefits of computerization outweighed the risks of loss of confidentiality, a small percentage of them believed computerized records to be more private than paper records.

Stanberry (2011) called EMR a 'silent giant' and discussed factors which are believed to be necessary for increased use of EMR such as cost considerations, privacy and laws/regulations. This study referred to anti-kickback laws, anti-referral laws, malpractice exposure laws and privacy regulations which could hinder the implementation and adoption of EMR. A study by Luchenski et al. (2013) found concerns relating to privacy safeguards and lack of awareness regarding secondary uses, but over 89% of the respondents favored EMR use for personal healthcare. About 62% of the respondents supported the use of EMR for secondary purposes such as planning, policy and health research, and older participants were less favorable towards EMR use. Interestingly, the respondents stated that they would be amenable to the use of EMR if specific criteria to ensure privacy were met.

Applications of the Diffusion of Innovations Theory

Research studies in other domains (e.g., e-commerce implementations, technology implementations) have considered the role of Roger's diffusion of innovation theory (Rogers, 1962) in the successful adoption and implementation of information technology innovations. According to this theory, diffusion is the process by which an innovation is adopted and communicated to members of a social group over time, and the five characteristics of innovations that impact their rate of diffusion are: Relative Advantage, Complexity, Compatibility, Observability and Trialability. Because EMR implementations are considered to be information technology innovations in the realm of healthcare (Crane & Crane, 2006; Dansky, Thompson & Sanner, 2006; Dansky & Dirani, 1998; Dansky et al., 1998; Lee et al., 2016; Lee, 2000), it is appropriate to consider the impact of Roger's factors on EMR implementations. Research studies have either considered only

some of Roger's factors (and not all of them) when developing a research model, or have considered all five of Roger's factors and found only some of them to have statistically significant associations with the dependent variable.

For instance, Grgurović (2014) considered all five of Roger's factors in a research study to explain how the implementation of online learning in a computer lab impacted the process of blended learning in addition to face-to-face classroom learning. This study found relative advantage, compatibility, trialability, and observability to have statistically significant associations with the dependent variable. The innovation under consideration was found to provide a relative advantage in comparison to the system that was in place before it by saving teachers considerable time in certain aspects and providing individualized feedback to the students. The innovation was compatible with the teachers' needs. It could be tested through self-exploration or in training workshops, thereby lending itself to trialability. Its use could be observed by colleagues easily, thereby providing observability. By contrast, Ahmad et al. (2014) considered three of Roger's factors (relative advantage, compatibility and complexity) to examine the determinants of e-commerce adoption among small and medium sized enterprises in Malaysia. They found that the adoption of the innovation was associated with its perceived relative advantage and perceived compatibility, with both being statistically significant elements.

Iacovu, Benbasat and Dexter (1995) found that the most commonly investigated electronic data interchange (EDI) characteristics that promote the adoption of the technology are relative advantage, compatibility and trialability. They point out that relative advantage is the most cited in research literature for EDI adoption. Various research studies have found different combinations of Roger's factors to have statistically significant associations with the study outcomes. However, the factors that have been most often associated with technology implementation success in other domains are relative advantage, compatibility and complexity (Agarwal & Prasad, 1997; Iacovu, Benbasat, & Dexter, 1995; Teng, Grover, & Guttler, 2002; Tornatzky & Klein, 1982; Wu & Wang, 2005). In this study therefore, we propose to investigate the association between the factors relative advantage, compatibility and complexity, and EMR implementation success.

PROPOSED RESEARCH MODEL AND HYPOTHESES

Figure 1 shows the proposed research model. The dependent variable is EMR implementation success. The independent variables are relative advantage offered by EMR, compatibility of EMR with existing systems, and complexity of EMR.

Relative advantage refers to the increased benefits and advantages brought about by the implementation of the technology/innovation/system under consideration in comparison to technology/innovation/system that was in place before it. Therefore, a higher relative advantage offered by a technology/innovation/system will have a positive association with its implementation success. Compatibility refers to how consistent an innovation is with the existing systems and technologies in the organization (more compatibility leads to easier integration with existing technologies). The compatibility of a new technology/innovation/system with existing technology/innovation/system is expected to have a positive association with its implementation success. Complexity refers to the relative difficulty in using the technology/innovation/system under consideration in comparison to its predecessor technology/innovation/system to achieve the same or similar outputs. For this reason, higher complexity generally has a negative association with implementation success.

Based on the above, we propose the following hypotheses:

- H1a: Relative advantage of EMR will positively correlate with EMR implementation success.

- H1b: Compatibility of EMR (with existing systems) will positively correlate with EMR implementation success.

- H1c: Complexity of EMR will correlate negatively with EMR implementation success.
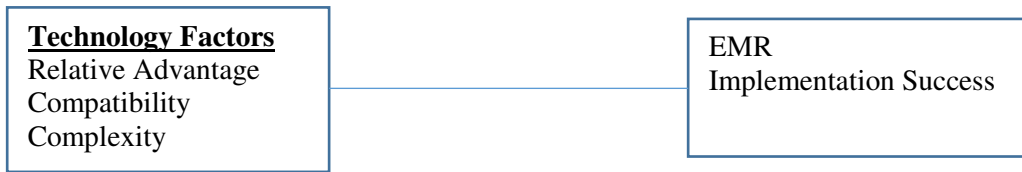
Technology Factors
Relative Advantage
Compatibility
Complexity

EMR
Implementation Success

Figure 1. The Research Model

PROPOSED METHODOLOGY

Items for the dependent and independent variables for this research-in-progress will be determined in due course considering the study and measurement goals. We propose to take this research-in-progress to its logical conclusion through data collection and statistical analyses. Data collection will be done through a survey instrument based on the Likert scale, and a statistically valid sample size will be used for the data collection. The items for the constructs will be borrowed from past studies in research literature. This should help with assuring validity (e.g., face validity, domain validity, and criterion validity) although any additional validity studies needed will be performed. Reliability will be tested by calculating Cronbach's Alpha and/or other suitable measures. The statistical method employed for analysis will depend on the scale and nature of the items, but from a preliminary assessment, Structural Equation Modeling (SEM) appears to be the most appropriate statistical method, due to the existence of latent variables (Hoyle, 1995).

CONCLUSION

This research-in-progress is concerned with investigating whether the factors relative advantage, compatibility and complexity, which have often been associated with successful information technology implementations in the past, are also associated with successful EMR implementations. This study, when taken to its logical conclusion, will add to the existing body of knowledge pertaining to the success factors involved in EMR/EHR implementations. This has important implications for both, academic researchers and practitioners. For academic researchers, the results of this study will reveal whether factors associated with information technology implementations in other domains also impact EMR/EHR implementations. This should create pathways for further investigations and future research. Practitioners will find the results of this study to be important as it will surface factors that are associated with successful EMR/EHR implementations which the practitioners can then use to ensure the practical success of EMR/EHR implementations.

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