

Critical Factors Influencing Electronic Health Record (EHR) Adoption in U.S. Hospitals: An Empirical Analysis Using the Technology-Organization-Environment (TOE) Framework

Abstract

There is a growing agreement that electronic health record (EHR) can play a key role in improving healthcare quality and efficiency. Despite the benefits associated with the use of EHR, the adoption of EHR is low in the United States. The main aim of this study is to identify the critical factors affecting the hospitals' adoption of EHR. This study identifies seven critical factors that are key to the adoption of EHR by using the technology, organization, and environment (TOE) framework. Moreover, we propose a research framework that provides future research opportunities that can offer further insights into the study of adoption of EHR.

Keywords: Electronic Health Record (EHR), Health Quality, Technology, Organization, Environment, TOE framework

Introduction

Even though the United States (US) healthcare industry is one of the largest industries in the entire world, it is the most inefficient industry across the globe [11]. Several studies suggest that patient safety is often compromised due to a lack of proper medical management. The report "To Err is Human," published by the Institute of Medicine of the US estimated that between 44000 and 98000 lives are lost annually in the United States due to medical error [16]. Other research has also shown that there is a substantial financial loss and increase in mortality rate due to medical errors such as adverse drug events [33]. The result of these studies has emphasized the importance for better medical management by both policymakers and health organizations.

With the advent of Information technology (IT) it was anticipated that IT would transform the quality and efficiency of health care by reducing medical errors and costs [21]. Electronic health records (EHR), one of the critical components of health information technology, was anticipated to play a pivotal role in improving healthcare quality and efficiency [24]. Electronic health records are the real-time health records of patients. Healthcare Information and Management Systems Society (HIMSS) defines EHR as a “longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting” (HIMSS). Further U.S. Department of Health & Human Services (HHS) defines EHR as “An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization” (NLM). A lot of initiatives were taken by the US government to promote the EHR with the hope that EHR will transform health care by providing better health care, improved efficiency, lowered health costs, and better clinical decisions. In 2004, the President of the US signed an executive order to have interoperable electronic health records for most of Americans by 2014 [8]. The main thrust came from the Health Information Technology for Economics and Clinical Health (HITECH) Act of 2009 to promote the adoption and meaningful use of EHR. This act allocated around \$19.2 billion in incentives for healthcare organizations and healthcare professionals to adopt HER [14]. Recently Blumenthal studied the importance of IT in healthcare and emphasized that IT is the lifeline of the healthcare system and it is impossible for any healthcare organization and physicians to deliver high-quality care without information technology [6]. Further, a number of studies have shown the benefits of EHR on outcomes such as quality, efficiency, and cost [13][38]. Despite the availability of the technology for more than 30 years and the benefits

associated with the use of EHR, the adoption of EHR is low in the United States [20]. In important research, analyzed earlier studies done on EHR adoption and found that 23.9 % percent of physicians use EHR and only 5% of hospitals use basic HER [39]. Furthermore, in another study, found that only 1.5% of US hospitals have comprehensive EHR systems and 7.6% of US hospitals have basic EHR systems [26].

Moreover, analysis of studies related to EHR suggests that there is indeed a gap in the adoption of EHR and attempts should be made to understand the reasons behind these gaps [19]. In the past, there have been limited studies that have focused on understanding the factors affecting EHR adoption among hospitals. A few notable studies include Kazley and Ozcan (2007) who studied the organizational and environmental factors affecting the EHR adoption and Angst et al. (2010) who studied the EMR adoption using the social contagion and diffusion theory. However, none of these theories are comprehensive in nature. For example, Kazley and Ozcan (2007) did not include the technological context in their study. Angst et al.(2010) used EMR and EHR interchangeably in their study limiting the generality of the study as EMR and EHR are two distinct things. Prior research suggests that no significant work has examined the influence of Technological, Organizational, and Environmental factors on EHR adoption in US hospitals simultaneously [10]. Considering the above facts, the main aim of this study is to fill this gap by using standard EHR definition and investigate the adoption of EHR in hospitals with the following research questions:

- 1. What are hospitals' technological, organizational, and environmental context factors that Influence the adoption of EHR?***
- 2. How do hospitals' technological factors, organizational factors, and environmental factors influence EHR adoption?***

Theoretical background

Innovations are adopted by organizations to sustain or enhance their performance to stay ahead of the competition [3]. In the literature of innovation, numerous definitions have been provided to conceptualize innovation [22]. Damanpour and Evan (1984) defined innovation as the introduction of a new product, new service, or change in the process of production or service operation of the firm. EHR is also a new system that will bring change in the way services are provided by the hospitals to the patients. Based on above argument, the adoption of an EHR system by hospitals will be considered as innovation in this paper. Researchers have studied the contextual factors that can influence the adoption of innovation by the organization [32]. Damanpour (1987) suggested that adoption of innovation is strongly influenced by the characteristics of individuals, organization and the environment. Tornatzky and Fleischer (1990) developed a framework to study the influence of technological context, organizational context, and environmental context on the adoption of innovation. The focus of this paper is to study the contextual factors that in turn influence the adoption of EHR systems in hospitals. Technology, organization and environment framework is appropriate and are used for this study.

Technological, Organizational, and Environment Context

Technology-Organization-Environment (TOE) framework has three dimensions within the context of the organization. These three dimensions explain the adoption and implementation of innovation in the organization. The three dimensions of the TOE framework are technological context, organizational context, and environmental context. Technological context refers to technologies that are relevant to the organizations [29]. It also includes the availability of technologies and technology characteristics. There are a number of factors identified by the

researchers that influence the adoption of technology by the organizations [40]. The majority of the studies have suggested that characteristics of technology such as “compatibility” have significant impact on the adoption of technology in the organization. Both in Information System (IS) and health care literature, compatibility has been identified as an important factor that influences the adoption of technology in the organization [30]. Another factor that has been a major concern is security and privacy of the data, which also influence the adoption of EHR [4].

Further, the study done by Kimberly and Evanisko suggests that the characteristics of an organization are also important factors that impact the adoption of technology [28]. They argued that an organization’s characteristics either help or motivate the process of innovation and size is one of the important factors that influence the adoption of technology. Other than size, researchers have identified other determinants such as top management and human resource readiness [12][5].

For the environmental dimension, Tornatzky and Fleischer (1990) identified certain aspect of environment such as competitive intensity, market uncertainty and government which influence the process of adoption of innovation. No firm is insulated from the external environment and external pressure has a significant impact on the adoption of innovation. The external environment for the firm can be in the shape of government regulation, competition pressure, suppliers, or customers. These external forces can aid or hinder the process of adoption of innovation in the organizations.

Research model and development of Hypothesis

In this study, a research model is proposed based on theoretical background information and findings of the literature review (Fig 1). Variables from the technology, organization, and environment (TOE) model are used as predictors for this research.

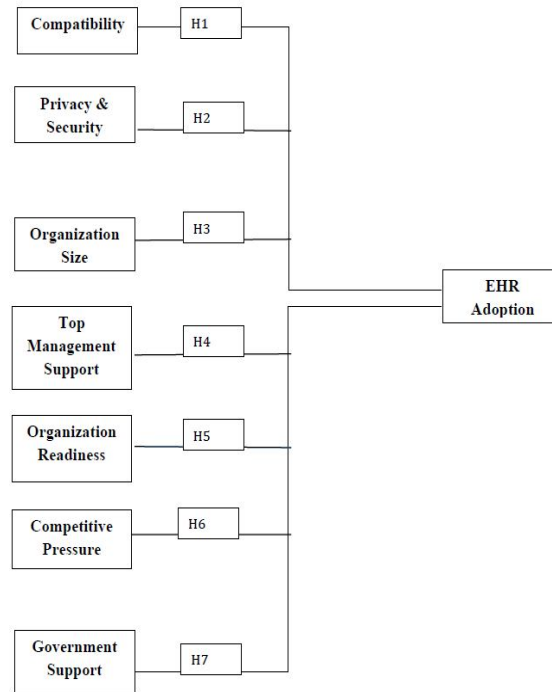


Figure: 1
Research Framework for EHR Adoption using TOE

Technology Context

Compatibility

Compatibility is “the degree to which an innovation is perceived as being consistent with existing values, past experience, and need of receiver,” [10]. Tornatzky & Klein (1982) further added that the values are associated with normative and the need of the receiver is associated with practical compatibility. In this paper, compatibility implies the practical compatibility of the EHR System. EHR is not a standalone system and it has various functionalities such as clinical documentation, test and image results, computerized provider entry systems and decision support system. It has been well established that many of the hospitals have some functionalities such as medicine list, laboratory reports and decision support system [36]. If EHR system is compatible with existing functionalities of hospitals, then hospitals will be more inclined to embrace the EHR system.

The innovation literature also suggests that compatibility is positively associated with innovation adoption [17]. In health care also, compatibility is recognized as important factor that influences adoption of technology. For example, compatibility has strongly influenced the adoption of EPI and RFID (in health care organizations [42]). The above arguments lead to following hypotheses:

Hypothesis 1 (H1): Higher the compatibility of EHR system, the greater will be the adoption of EHR in hospitals.

Privacy and Security Concern

Privacy and security concern in health care refer to unauthorized access to patient data, loss and theft of data. In EHR, the data of patient is stored in central server and it has to be exchanged over internet, which can result in loss or theft of data [37]. It has been argued that protected security and privacy framework is required for EHR system, otherwise the breach of security can have dire consequences both for hospitals and patients [1]. Privacy and security concern have been identified as one of the major obstacles in adoption of EHR [15]. Heir et al. (2005) in their study found that 35-40% of physicians have listed security concerns as a barrier to adoption of EHR and the same concern has been echoed by other researchers [18]. Thakkar and Davis (2006) conducted a nationwide study of US hospitals and found that the top risk associated with EHR systems were privacy and security of data.

Few studies in healthcare setting have studied the adoption of technology in hospitals such as the adoption of RFID and cloud computing and these studies have also suggested that privacy and security concerns influence the adoption of technology [25]. The above arguments lead to the following hypotheses:

Hypothesis 2 (H2): Proper security and privacy protection will positively influence the adoption of EHR in hospitals.

Organizational Context

Size

It has been argued that the adoption of technology is highly influenced by structural characteristics of the organization and size is one of the variables that influence the adoption rate [18]. Damanpour (1992) did a meta-analysis to understand the relationship between the size of a firm and innovation and indicate that there is a relationship between the size of the firm and the innovation. In IS literature also, it has been shown that technology adoption is impacted by the firm size [31]. Tornatzky and Fleischer (1990) also indicated that organizational characteristics such as lack of resources have an impact on technology adoption. Size of organization means availability of resources such as number of employees and budget [2]. They argued that resources of organization are important factors that influence innovation and organizations with large number of resources have an impact on innovation. Large organizations have more resources and enjoy economies of scale that facilitate the adoption of innovation on the other hand studied small firms and found that small firms deal with "Resource Poverty". They argued that small firms have few financial resources, technology experts, and others lack resources, which hinders the adoption of information technology in small organizations [31]. In the context of EHR, there is general agreement that it has the potential to save cost in the long run still EHR is still a big cost burden for hospitals. There is a cost associated not only with technology infrastructure but also with consultation, training and maintenance of the system [34]. In an important study conducted at 280 bed acute care hospital with 16 satellite clinic and 400 physicians, it was estimated that the cost of implementation of EHR, which lasted for 7 years, was around \$19 million [35]. Furthermore, another study found that the initial average cost of implementation of HER is \$44,000 for full time provider [27]. In

addition to that, the study suggested that there will be additional cost of \$8500 per year for full time provider. In light of above findings, it can be argued that EHR implementation requires huge number of resources such as financial resources. As large firms have more resources in terms of financial and human expertise, and they can enjoy economies of scale and large hospitals are more likely to adopt EHR. The above arguments lead to the following hypothesis:

Hypothesis 3 (H3): Larger hospitals are more likely to adopt EHR implementation in comparison to small hospitals.

Top Management Support

Although there is no clear understanding of the role played by top management in the innovation process, it has been quite clear in innovation literature that the role of organizational management is very crucial for innovation adoption in the organization [43]. The top management is crucial for developing and sustaining the organization's culture towards innovation [23]. They argued that top management with less orientation toward innovation will fail to develop processes necessary for innovation. Previous studies have shown that upper management is vested with more power as they control resources and implement the policies in response to the external environment [7]. IS literature also suggests the influence of top management on technology adoption. For example, studies have shown the influence of top management on the use and adoption of new information systems and the adoption of inter-organizational systems [2]. Cao et al. (2014) did a case study at one of the healthcare organizations in the US to understand the impact of contextual factors on patient tracking RFID adoption. They found that the role of top management was instrumental not only during RFIP project initiation but also during implementation. They argued that one of the factors in the success of RFID applications in the organization was the support of top management. EHR implementation impacts every aspect of hospitals (clinical

and administrative) and the involvement of top management is inevitable in EHR adoption, and this leads to the following hypothesis:

Hypothesis 4 (H4): Top management support will positively affect the adoption of EHR in the hospitals.

Organization Readiness

The level of both financial and technological resources of the organization is considered as organization readiness [7]. Organization readiness for this paper is limited to the “level of sophistication of IT usage” that implies employees' readiness for the adoption of technology. Venkatesh et al. (2012) in their study found that “effort expectancy and facilitating condition” have an influence on the use of technology. They argued that the ease of technology and support available for the use of technology influences both the intention and use of technology among employees. Implementation of EHR will require workflow change and clinician will have to adjust their workflow processes. Previous research has argued that physicians are reluctant in EHR adoption because it requires more time to adjust to EHR [41]. Physicians' negative attitudes towards EHR due to the perception of learning difficulty and time-consuming will hinder EHR adoption. So, it can be argued that organization readiness is a critical factor that influences the adoption of technology. The above arguments lead to the following hypothesis:

Hypothesis 5 (H5): Organization readiness will have a positive influence on the adoption of EHR by the hospitals.

Environmental Context

Competitive pressure

Porter & Miller (1985) argued that Information technology (IT) has the power to change the game of competition and it can generate competitive advantage for the firms. Bakos & Treacy in their

study listed several examples which show that IT has helped the companies to achieve advantage [9]. They also concluded that IT creates opportunities for the firms, which in turn helps the firms within an industry to outperform other firms. Other researchers have also identified a number of advantages of IT such as first mover advantage. Powell & Dent-Micallef (1997) suggested that IT creates an advantage for firms if the firm focuses on both external and internal applications of IT. Given that if hospitals focus on both internal and external applications of EHR then EHR will create a competitive advantage for the hospitals.

Powell & Dent-Micallef (1997) also analyzed earlier IT research and proposed that IT generates value for organizations by increasing efficiencies and firms that do not implement IT will be at a competitive disadvantage. Johnston & Vitale (1988) argued that IT creates internal and inter-organizational efficiency and these efficiencies will provide the organization a competitive advantage. Moreover, it has been suggested that organizations tend to implement the IT system when competitors are adopting the IT [39]. Thus, the following hypothesis is formulated:

Hypothesis 6 (H6): Competitive pressure will positively affect the adoption of EHR by hospitals.

Government Support

Government policies have a significant influence on the adoption of technology by the firm since government has the power to give financial incentives and tax breaks to promote the adoption of technology. In health care also, federal and state governments are implementing policies to promote EHR systems in hospitals. This is evident from the executive order by President Bush in 2004 and the HITECH Act of 2009 that call for universal EHR adoption in the US. Further Jha et al. (2009) indicated that favorable policies from the government such as additional reimbursement

for Health Information Technology use and financial incentives will encourage hospitals to implement EHR.

Another area where government policies can have a profound effect is health information exchanges. EHR system requires the electronic transfer of patient data from one hospital to another hospital and lack of health information exchange hampers the interoperability of data. Few studies have suggested that slow growth of health information exchange have a negative effect on EHR adoption. Health information requires a nationwide infrastructure and government policy in promoting health information exchange will help the hospitals to consider the implementation of an EHR System. These leads to the following hypothesis:

Hypothesis 7 (H7): Government Support will positively influence the adoption of EHR in hospitals.

Implications for research and future direction

This study will further the understanding of EHR adoption among hospitals. To the best of our knowledge, this study is the first study to use innovation theory and technology, organization, and environment framework to empirically test the factors influencing EHR adoption. This study will also help policymakers and administration of healthcare organization to identify the determinants of EHR adoption and the impact of these determinants on EHR adoption. This will help them to modify their program and policies that in turn will promote EHR adoption in hospitals. Moreover, this study provides avenues for future research. For example, research suggests that social capital is the key factor in the performance of an organization. Thus, future research can investigate the role of social capital among hospital staff and the adoption of EHR.

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