DECISION SCIENCES INSTITUTE
Critical Success Factors Impacting Cloud-Based EHR Systems

Mohammad I. Merhi
Department of Decision Sciences
Judd Leighton School of Business & Economics
Indiana University South Bend
mmerhi@iusb.edu

Sheel Patel
Department of Decision Sciences
Judd Leighton School of Business & Economics
Indiana University South Bend
shapate@iusb.edu

ABSTRACT

The implementation of Electronic Health Record (EHR) systems continues to generate a lot of interest among researchers and practitioners. During implementation many organizations run into problems that affect the success of the project. Cloud-based EHR is a substitute system that solve some of the technical issues that organizations face. Studies on cloud-based EHR systems are scarce. This research in progress investigates the critical success factors impacting the implementation of cloud-based EHR systems. We plan to assess the significance of these factors on implementation and present our results at the conference.

KEYWORDS: Electronic Health Record, Cloud Computing, Success Factors, EHR
                 Implementation, and Could EHR.

INTRODUCTION

Over the last decade, many countries' governments, including the U.S., are investing billions of dollars in the digitalization of the hospital legacy system of recording patient information into Electronic Health Record (EHR) (Hayrinen et al., 2008; Merhi, 2015). According to the International Organization of Standardization (ISO), EHR is defined as "a repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorized users. It contains retrospective, concurrent, and prospective information and its primary purpose is to support continuing, efficient and quality integrated health care" (ISO, 2004). In general, EHR systems contain patients' medical history, diagnoses, medications, treatment plans, immunization dates, allergies, radiology images, laboratory test results among others (Hayrinen et al., 2008). This information is securely stored and only made accessible to authorized users when needed. Authorized users are not only limited to patients, doctors, nurses and laboratories but can also be shared with pharmacies, emergency facilities, specialists and other areas where it is required (Menachemi & Collum, 2011). EHR systems not only share the information between various medical institutions to provide better care but also to help improve the safety,

efficiency and quality of care and to reduce the cost of healthcare (Blumenthal & Tavenner, 2010; McClellan, 2011).

A report from Healthcare IT News states that 96% of the providers say that their infrastructure is not ready for full integration of EHR technologies in their workflow (Rossi, 2015). Over 90% of regional extension centers registered physicians are currently using EHR systems and 75.5% of the hospitals in the U.S. have basic EHR systems (Health IT, 2015; Charles et al., 2015). With all these physicians who are using and recording data in EHR systems, the data will keep on significantly increasing. The health care sector is planning to increase their spending by 65% on analytics in order to analyze the EHR data and make decisions in coming years (Rossi, 2015). Some of the areas where the healthcare sector will be spending the most are data warehouse and data models, real time data analytics applications, data security, IT systems for optimizing data processing and IT infrastructure to optimize data storage (Rossi, 2015). We argue that cloud computing can easily eliminate most of this spending especially those related to storage and infrastructure. Due to limited knowledge about Cloud and many misconceptions, clinics ignore the option of the Cloud based EHR system. In this paper we present the critical success factors that affect the implementation of Cloud based EHR systems and make it a successful project. Current studies in the literature have not explored this area. We thus aim to contribute to the body of the knowledge on EHR systems implementation and Cloud computing.

CLOUD COMPUTING

Cloud computing is made up of hardware and software through networks which are elastic, resourced pooled within an infrastructure to meet the on-time demand services (Armbrust, 2010; Bhatt, 2011; Srinivas, et al., 2012). Cloud computing provides three types of services:
- Software as a service (SaaS): It is software or applications distribution model which are hosted by the vendors or service providers and made available to customers through the network, mostly through the Internet.
- Platform as a Service (PaaS): provides a platform to the customers to run, manage and deploy application and software on Cloud without building or managing the infrastructure for Cloud computing.
- Infrastructure as a Service (IaaS): provides the basic infrastructure of the virtualized pool of outsourced services. Users are provided with the hardware, network connectivity, bandwidth and IP addresses with which the users can develop their own applications and systems. Users have flexibility of choosing their own operating system, applications and software (Armbrust, 2010; Bhatt, 2011; Srinivas, et al., 2012).

Cloud computing offers a wide range of choice and agility to the users; it is built to best suit their needs and the latest trends. The cost of implementing cloud computing is very low as the users does not have to setup new infrastructure, buy new hardware, license software or hire new personnel. Cloud computing provides encapsulated change management, that is a user can integrate his current infrastructure and technology with Cloud computing without making any major modifications in system configuration. Clouds are very compatible with next generation architecture so the new innovation and advancement in technology can be easily integrated Cloud computing, which helps to enhance the performance of the operations. Many businesses as well as organizations which lack the basic infrastructure for implementing information system can take the advantage of the cloud computing to implement information system with lowest cost and latest technology (Daley, 2008; Chao et al. 2014).

CRITICAL SUCCESS FACTORS OF CLOUD BASED EHR SYSTEM

Implementing Cloud based EHR systems is not an easy task. Below, we discuss major critical factors that organizations face and need to take care of when implementing Cloud based EHR systems. Avoiding and solving these problems will eventually lead to success in the Cloud based EHR systems implementation. The critical success factors are:

Change management

Implementation of EHR system would lead to a tremendous amount of change in the workflow of clinic and many people resist it (Chao et al., 2014). The reasons behind resistance include perceived risk and habits. The consequences of resistance can lead to delay in implementation time, decrease in efficiency, increase in cost and less chance of success in the implementation (Chao et al., 2014; Boonstra & Broekhuis, 2010). Aladwani (2001) proposed a process oriented conceptual framework that effectively deals with the change management. The framework has three phases:
- Knowledge gathering, which includes gathering as much information as possible about the resisting groups.
- Strategy implementation which includes creating strategies to communicate with the resisting groups and finding solutions.
- Status evaluation, which requires constant feedback and evaluations of the strategies implemented to make necessary changes, if required.

In addition to the conceptual framework, motivation and incentives are major factors during change management process. (Aladwani, 2001)

Data security

According to a 2014 report from the nonprofit group Identity Theft Resource Center, the Healthcare Sector accounts for 42.5% of all security breaches (Rossi, 2015). The confidential information stored in the EHR systems must be protected from entering the data into storing and retrieving. Storing information in the Cloud requires even extra security. With the Cryptographic approach, the information stored in the Cloud servers as well as the information that is being transferred from the Cloud to the application and from the application to the Cloud are all in the form of encrypted data. Only authorized users of the application can decrypt the information with the help of encryption key, which makes it safe and secure for storing and transferring information in the Cloud (Ali et al., 2015; Hoang & Dat, 2015).

Government policies

When using Cloud based EHR systems, data are stored in cloud servers which are located at different geographical sites from the clinic. Many major Cloud providers have more than one data center in the country as well as in foreign countries. Cloud providers often move their data to different locations. There are legal jurisdictions that restrict this transfer of EHR data. To comply with the national and international jurisdictions, the EHR selection team should discuss all these clauses with the Cloud based EHR system provider before selecting it (Ali et al., 2015; Schweitzer, 2012; Boonstra & Broekhuis, 2010).

Cost

High investment, lack of capital, low return on investment, lack of cost to benefit analysis are some of the major concerns about cost during implementation of EHR system (Boonstra & Broekhuis, 2010). Cloud EHR comes with the major cost saving to EHR implementation. One third of the cost of EHR system implementation is for hardware purchase and Cloud use can eliminate that cost. The U.S. government provides various incentives to the clinics for implementing EHR system and also covers the losses that occurs due to EHR system for a certain time period. It is estimated that Cloud computing can save up to 20% of the cost which is estimated to nearly $7 billion (Boonstra & Broekhuis, 2010). It is expected that the ROI to be high in the long run and have other non-monetary benefits, like satisfaction from the patient and clinic staff, reduction in errors, and many more which cannot be measured (Aita, 2008; Ambinder, 2005; Boonstra & Broekhuis, 2010).

Customization

Customizing the EHR systems based on the needs of the user is very important to increase user productivity and satisfaction. Customization process comes with a great cost as EHR system processes are developed based upon industry standards and best practices. Cloud based EHR system provides certain flexibility for customization, but this is something that EHR selection team should consult and discuss with the Cloud based EHR system provider before selecting EHR system. Many EHR systems do not allow any customizations by the users and so the user has to change the way they do business to be compatible to the new system (Ludwick & Doucette, 2008; Boonstra & Broekhuis, 2010).

User friendly application

User friendliness is a very important characteristic of computer applications because those applications containing more graphics are easier to remember, as well as to use (Ludwick, & Doucette, 2008). While selecting an EHR system for the clinic, the EHR selection team should consider the user friendliness of the application, simplicity of using application, easy to access and navigate, and how it is interacting with the user. If the application is difficult to use, users will resist it or will be frustrated and chance of error increases, leading to quitting the job. (Huser et al., 2010; Nasserh et al., 2015)

Interoperability and compatibility with other systems

EHR systems are implemented to easily maintain and transfer patient records whenever required. But due to the complexity of the structure of the system and database, it is becoming challenging to transfer EHR between different systems. Creating interfaces that are compatible with other systems can help to transfer and read the data, but the cost of developing interfaces are very high and there will be less freedom and right to customize EHR system (Chao et al., 2014).The government can play a major role in solving this problem by providing rules and guidelines for the format of data as well as storage of data. This will create a uniform structure of the data that becomes easily compatible with all the systems (Boonstra & Broekhuis, 2010; Schweitzer, 2012; Boland, 2016).

CONCLUSION

Huge spending in technology by the health care sector will move the EHR system to the Cloud computing platform. In the coming decade, more and more EHR systems will migrate towards

Cloud based EHR systems for compatibility with other systems as well as data analytics. The future of Cloud based EHR system is immeasurable. However, current research on EHR cloud based is still scarce. This research in progress extends the current literature by presenting critical factors that lead to success in Cloud-based EHR system.

After identifying the critical success factors, we aim to quantitatively assess the significance of these factors on implementation. We will happy to share any results we may have when attending the conference in November.

References

Aita, S. (2008). Implementing an EHR with ROI in mind. *Journal of Medical Practice Management*, *23*(4), 244-246.

Aladwani, A. M. (2001). Change management strategies for successful ERP implementation. *Business Process Management Journal*, *7*(3), 266-275.

Ali, M., Khan, S., & Vasilakos, A. (2015). Security in Cloud Computing. *Information Science*, *305*, 357-383.

Ambinder, E. P. (2005). Electronic Health Records. *Journal of Oncology Practice*, *1*(2), 57–63.

Armbrust, M. (2010). A view of cloud computing. *Communications of the ACM*, *53*(4), 50-58.

Bhatt, D. (2011). A Revolution in Information Technology - Cloud Computing. *Journal of Science and Technology*, *9*(2), 107-113.

Blumenthal, D. & Tavenner, M. (2010). The "Meaningful Use" Regulation for Electronic Health Records. *New England Journal of Medicine*, *363*(6), 501-504.

Boland, M. (2016). Big Data, Big Challenges. *Ophthalmology*, *123*(1), 7-8.

Boonstra, A. & Broekhuis, M. (2010). Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC Health Services Research*, *10*(1), 231.

Chao, G., Peng, A., & Gala, C. (2014). Cloud ERP: A new dilemma to modern organisations? *Journal of Computer Information Systems*, *54*(4), 22-30.

Charles, D., Gabriel, M., & Searcy, T. (2015). Adoption of Electronic Health Record Systems among U.S. Non Federal Acute Care Hospitals: 2008-2014. Available online at: https://www.healthit.gov/sites/default/files/data-brief/2014HospitalAdoptionDataBrief.pdf. Accessed on February 29, 2016.

Daley, W. (2008). *Computers are your future*. Upper Saddle River, NJ: Pearson/Prentice Hall.

Hayrinen, K., Saranto, K., & Nykanen, P. (2008). Definition, Structure, Content, Use and Impacts of Electronic Health Records: A Review of the Research Literature. *International Journal of Medical Informatics*, *77*(5), 291-304.

Health IT Quick Stats (2015). Health IT Quick Stats. Available online at: http://dashboard.healthit.gov/quickstats/quickstats.php. Accessed on January 23, 2016.

Hoang, D., Australia, D., & Dat, D. T. (2015). Health Data in Cloud Environments, *Proceedings of the Pacific Asia Conference on Information Systems.*

Huser, V., Narus, S., & Rocha, R. (2010). Evaluation of a flowchart-based EHR query system: A case study of RetroGuide. *Journal of Biomedical Informatics*, *43*(1), 41-50.

ISO/DTR (2014). Health Informatics – Electronic Health Record – Definition, Scope, and Context. Available online at: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=39525

Ludwick, D. & Doucette, J. (2008). Adopting electronic medical records in primary care: Lessons learned from health information systems implementation experience in seven countries. *International Journal of Medical Informatics*, *78*(1), 22-31.

McClellan, M. (2011). Reforming Payments to Healthcare Providers: The Key to Slowing Healthcare Cost Growth While Improving Quality? *Journal of Economic Perspectives*, *25*(2), 69-92.

Menachemi, N. & Collum, T. H. (2011). Benefits and drawbacks of electronic health record systems. *Risk Management and Healthcare Policy*, *4*, 47-55.

Merhi, M. I. (2015). A process model leading to successful implementation of electronic health record systems. *International Journal of Electronic Healthcare*, *8*(2-4), 185-201.

Nasserh Z., A., Elmogy, M., & Elkader, S. (2015). Electronic Health Records: Applications, Techniques and Challenges. *International Journal of Computer Applications*, *119*(4), 38-49.

Rose, D., Richter, L. T., & Kapustin, J. (2014). Patient experiences with electronic medical records: Lessons learned. *Journal of the American Association of Nurse Practitioners*, *26*(12), 674-680.

Rossi, B. (2015). An Inside Look at IT Trends for the Healthcare Market. Available online at: http://www.cdwcommunit.com/wp-content/uploads/2015/06/HealthTechReport_Summer2015.pdf. Accessed on January 20, 2016.

Schweitzer, E. J. (2012). Reconciliation of the cloud computing model with US federal electronic health record regulations. *Journal of the American Medical Informatics Association*, *19*(2), 161-165.

Srinivas, J., Reddy, K. V. S., & Qyser, A. M. (2012). Cloud Computing Basics. *International Journal of Advanced Research in Computer and Communication Engineering*, *1*(5), 343-347.

Thakkar, M. & Davis, D. C. (2006). Risks, Barriers, and Benefits of EHR Systems: A Comparative Study Based on Size of Hospital. *Perspectives in Health Information Management*, *3*(5), 1-19.