Challenges of Migrating EHR Systems to Cloud

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Abstract

The purpose of this study is to investigate the critical success factors impacting the implementation of cloud based EHR systems. Studies on cloud based EHR systems are scarce. In this study, I investigate the success factors of cloud computing and EHR system separately to come up with the critical factors for a cloud based EHR system. I have also provided information about tackling each factor such as, the change management, data security, cost and Interoperability during and after implementation of cloud based EHR system for long term success.

I. 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). According to the International Organization of Standardization (ISO) EHR is "*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).

EHR systems have many advantages, including:

- Digitalization of health care records

- Improve health quality

- Interoperability

- Cost reduction

- Patient's satisfaction

- Efficient Workflow

(Menachemi & Collum, 2011; Rose et al., 2014; Thakkar & Davis, 2006; Hayrinen et al., 2008)

The EHR systems have shown positive results after implementation, which are visible through various studies. A study conducted by Rose et al. (2014) involved interviewing the patients before and after the implementation of EHR. The study shows that better communication and interaction with the doctors, nurses, and patients with the help of EHR has increased the satisfaction at a significant rate among patients and hospital staff (Rose et al., 2014). The study also shows a significant reduction in the time consumed by each patient at clinic leading

to an increase in efficiency and productivity of the clinic staff. Enhancement is seen in the follow-up and test results with the help of EHR and a significant reduction in medical errors by the clinic staff is noted which leads to improvement in the quality of care and better clinical decision support (Rose et al., 2014). In another study, Menachemi and Collum (2011) review the literature of EHR and found that EHR can help to reduce serious medication errors by 55% when patient data is digitalized and this digitalized data is used with clinical decision support system can reduce the errors by 83% (Menachemi & Collum, 2011). Using the data from American Hospital Association, Thakkar & Davis (2006) selected 1,000 hospitals randomly and showed that there is a large correlation between the medical staff's work efficiency, time management and the size of hospital.

The EHR system creates a platform for the meaningful use of the patient records. Meaningful use includes analyzing the patients' record for more details and trends which can help to further learn about diseases and their symptoms (Blumenthal & Tavenner, 2010). By analyzing the patient data, 82% of clinics reported improvement in care. There was a 63% reduction in readmission rate and 62% improvement in overall health outcomes (Rossi, 2015). However, due to the limitations of the system and infrastructure, the clinics are not ready for full integration of EHR system. 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 center (REC) registered physicians are currently using EHR systems and 75.5% of the hospitals in the U.S. have basic EHR systems (Health IT; Charles et al., 2015). With all the physicians using and recording data in EHR system, the data will keep on piling up. However, analyzing the data will not be possible because of the unintegrated information system. The health care sector is planning to increase their spending by 65% on analytics which would analyze the EHR data 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). Cloud computing can easily eliminate most of this spending as Cloud computing is directly related with all these technological areas. Due to limited knowledge about Cloud computing and many misconceptions, clinics ignore the option of the Cloud based EHR system. In this paper I have investigated the critical success factors that affect the implementation of Cloud based EHR systems. Cloud based EHR systems are not given much attention in the literature studies. I thus aim to contribute to the body of the knowledge on EHR systems implementation and Cloud computing.

II.   Cloud Computing

Cloud computing is made up of hardware and software through networks which are resourced pooled within an infrastructure to meet the on time demand services. Cloud computing must have five essential characteristics which are:

1. On demand self-service: A user gets access automatically with the help of the network to Cloud computing at any time without requiring human interaction with the service provider. In other words the user performs all the actions needed to acquire the service itself, instead of going through an IT department.

2. Ubiquitous network access: A user can access cloud computing from any location and any device with the standard mechanism by connecting to the network. So the user can work from his/her workstation, laptop or smartphone providing flexibility as well as mobility.

3. Resource pooling: Cloud computing has the capability to serve multiple users

with different needs at the same time without any changes visible to the client or to the back end. The resources are dynamically assigned to the users demands.

4. Rapid elasticity: The service and performance of Cloud computing can be easily increased or decreased based on the need of the user. So the users can increase or decrease the data storage capabilities as well as computing power whenever required.

5. Measured service: Cloud computing resource usage can be measured, controlled and reported (billed) providing transparency for both the provider and consumer of the utilized services. For example: electricity, municipality water, and IT services are charged as per usage metrics that is pay per use

(Bhatt, 2011; Srinivas, et al., 2012; Armbrust, 2010)

Cloud computing provides three types of services:

1. Software as a service (SaaS): It is software or applications which are hosted by the vendors or service providers and made available to customers through the network, mostly through the Internet. Some applications are free to the users whereas some applications charge daily, weekly, monthly or yearly service fees. Examples of SaaS include Web based email services, Google apps and Microsoft Office 360.

2. Platform as a Service (PaaS): Provides a platform to the customers to run, manage and deploy applications and software in the Cloud without building or managing the infrastructure for Cloud computing. A Cloud provider hosts hardware and software in their own infrastructure which frees the use for having in-house hardware and infrastructure. Examples of PaaS providers are Microsoft Azure and Heroku.

3. 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 an IP address with which the users can develop their own applications and systems. Users have the flexibility of choosing their own operating system (systems), applications and software. IaaS essentially provides cloud infrastructure to the users. Examples of IaaS are Amazon web services, Savvis and Rackspace.

(Bhatt, 2011; Srinivas, et al., 2012; Armbrust, 2010).

There are four types of cloud computing deployments:

1. Private Clouds are set up for the sole use of organizations which are owned, managed and deployed by the organization or 3rd party.

2. Public Clouds are set up for the use of the general public. They are managed by the organization or business.

3. Community Clouds are set up for the exclusive use of a community or group or organization and they are run and deployed by the organization or 3rd party on behalf of a community.

4. Hybrid Cloud is a combination of private and public clouds which are separate entities, but due to the need of owners, they are connected over the Internet for transferring data and running applications.

(Bhatt, 2011; Srinivas, et al., 2012; Armbrust, 2010).

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 user 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 (LaBerta, 2012). Clouds are very compatible with next generation architecture so the new innovation and advancement in technology can be easily integrated. Many businesses as well as organizations which lack the basic infrastructure for implementing information systems can take the advantage of the cloud computing. (Daley, 2008; Chao et al. 2014)

III. Critical success factors of Cloud based EHR system:

Implementing Cloud based EHR systems is not an easy task. Below, we will 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:

1. Change Management:

Implementation of EHR system would lead to a tremendous amount of change in the work-flow of clinics and many people resist it (Chao et al., 2014). The reason behind this resistance includes perceived risks and habits. The consequences of resistance can lead to delay in implementation time, decrease in efficiency, increase in cost and success of the implementation (Chao et al., 2014; Boonstra & Broekhuis, 2010). Adel Aladwani 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)

2. 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 (Hoang & Dat, 2015; Ali et al., 2015).

3. Government Policies:

When using Cloud based EHR systems, data is 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).

4. 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 implementation is low in cost compared to traditional 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 occur 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. It is expected that the ROI will be very good 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 (Ambinder, 2005; Boonstra & Broekhuis, 2010; Aita, 2008).

5. 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).

6. 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, which leads some users to quit their jobs. (Huser et al., 2010; Nasserh et al., 2015)

7. Interoperability and compatible with other system:

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, 2015).

IV. 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. This research examines the critical success factors of Cloud based EHR. However, current research on EHR cloud computing is still scarce. This research extends the current literature by presenting critical factors that lead to success in Cloud based EHR system. These factors are change management, data security, government policies, cost, customization, user friendly application, interoperability and compatibility with other systems.

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