Electronic health cloud as service to improve collaboration in healthcare organizations

Shady Gomaa Abdulaziz¹, Norizan Mohd Yasin², Zeinab AlGamal³, Asmaa Hateem¹, and Kalaimagal Ramakrishnan⁴

¹Taif University, United Arab of Emirates
²Department of Information Systems, Faculty of Computer Science and Information Systems University of Malaya, Malaysia
³University of Madinah, United Arab of Emirates
⁴Foundation in Science, Faculty of Science, University of Nottingham Malaysia, Malaysia

Email:
¹safaga_diadora@hotmail.com; ²norizan@um.edu.my; ³zeinab.algamal@gmail.com, ⁴asou.rashid79@gmail.com; ⁵Kalaimagal.Ramakrishnan@nottingham.edu.my

Abstract. There are many factors contributing to lack of collaboration which relates to teamwork and partnership in healthcare organization such as low awareness level in technology use, computer literacy, absence of e-health cloud, poor health information systems, decentralized systems, language barriers, difficulty to manage and control large amounts of data, work independently and time factor. Among medical staffs it is important to be able to share information and knowledge in patient treatments by having a better implementation of the electronic health cloud as service can improve and enhance the collaboration. This research was conducted using mixed method approach combining observations, questionnaires and interviews used to determine the level of collaboration among medical staff in e-health cloud environment.

1. Introduction

Healthcare organizations such as hospitals, the use of healthcare information systems (HISs) are important to provide and share information and knowledge among the staffs relating to patient care as to improve patients healthcare [1],[2]. Complexity of the HISs in the healthcare industry has caused many healthcare organization considering changing from normal HISs to state of art cloud-based technologies [3]. This is because cloud computing can offers solutions by incorporating new technologies and use of new forms of IT outsourcing [4] where patients’ information is accessible via a secure authentication. Critical activities like storing and sharing information-based HISs is important for hospitals and these activities can be supported by the adoption of cloud computing. Hospitals demand for cloud solutions as it provides greater support in data sharing and accessibility [3]; therefore many healthcare organizations that adopts some types of cloud services in order to meet their needs and to improve quality of services [5].

Providing quality patient care yet controlling operating costs can be a challenge [6],[7] In many developing countries these technologies were found unable to accommodate and perform effectively plus it’s difficult to be adapted and deployed due to difficulties that include storage capacity, system integration, high operating cost, system maintenance, complexity, compatibility and insufficient IT
infrastructure [8], [9]. In addition, the slow rate of e-health systems adoption in the developing countries are affected by human, staff, technology, organization and finance [10]-[13], [9], [14].

These challenges need to be addressed and there is an urgent need to look for alternatives which calls for use of new technologies so healthcare organizations like hospitals can move forward in providing quality patient care; hence calling for the adoption of cloud computing [15-16]. As a new technology cloud computing services minimize the intervention of the users hence relieving the users such as staffs of the hospital to have to know the technicality of the systems allowing them to have more focus on their primary duty in patients care. This technology provides the advantages of increasing the storage capacity and adding new capability on the existing healthcare system and minimizing the need for technical knowledge of the users [3],[17]-[18], ability to solve fragmentation and isolation problem of healthcare information system [15] and elasticity to scale up the IT services [19]-[20]. Collaboration over the cloud between physicians, patients, and the hospital is very important to improve patients' quality of service [3],[8] to provide proper and fast treatment to patients [1] and mutual benefits[21] to collaborate within health organizations [19], [22].

Cloud computing includes three layers [23] as shown in Figure 1. The first one provides computation and storage capacity (Infrastructure of Service (IaaS)); second, software development tools and application execution environment (Platform as a Service (PaaS)); and finally cloud computing applications (Software as a Service (SaaS)). In addition, data storage (Data as a Service (DaaS)) and communication capability (Communication as a Service (CaaS)) [26].

![Cloud Computing Environment](image)

**Figure 1. Cloud Computing Environment**

The focus of this paper is to investigate the staffs in the hospital in terms of their collaboration based on a newly develop and implemented system using the architecture of cloud computing. The system is known as e-health cloud system (eHaaS).

2. System Development

The design and development of eHaaS is made recent by having the important system feature for stakeholders (healthcare personnel) as the users based on the current cloud computing technology architecture and access by mobile application and clicks on the application tabs as shown in Figure 2. The eHaaS was used by doctors in hospitals in Arab Saudi to share patients’ information and medical knowledge. The system is design and developed using the model and features of SAAS that offer better access, flexible, ubiquity, less risks and costs.

This application built to address the shortcomings and needs in any medical organization which is looking to achieve the cost-efficiencies and flexibility promised by new paradigm, it is important to have the right partner and tools to help with their journey.
Figure 2. Architecture of the e-health cloud system (eHaaS)

The current local HISs system used has e-health web portal as the front end and Software as a service (SaaS) to provide application for the system. The eHaaS suggest to configure the web portal for end users and able to navigate the current system and the central databases. Communication is made possible between the middleware and the current system. Access to database is via current local HISs system and cloud central database where authorised user can can retrieve, update and receive medical information from the cloud’s central database through this web page with some degree of restrictions which depends on the end user’s privileges. Each collaborating hospitals allow its administrator and doctors to have different view of the patient’s record in the database. Figure 3 shows the overview of eHaaS.

Figure 3. Overview of the eHaaS

3. Methodology
Based on quantitative data collection techniques, this research used surveys and questionnaires to determine the levels of collaboration. Three government hospitals in Saudi Arabia were chosen as case study. The questions asked were as follows: Q1 Awareness of cloud computing service, Q2 Plan for...
adoption of cloud computing service Q3 Services to support of cloud deployment, Q4 Benefits of eHealth services using cloud, Q5 plan for future cloud deployments support Q6 Accessibility of cloud services for external users Q7 Awareness of clinical context by cloud service provider, Q8 Patient encouragement to develop their health record Q9 Prioritize the benefits of cloud computing adoption in electronic health system Q10 Which external users can access the cloud services.

The eHaaS system was tested for its usability using System Usability Scales (SUS) measurement developed by Brooke (1996) based on effectiveness, efficiency and satisfaction [30]. A total of two hundred respondents who are also the users of eHaaS that include physicians, nurse, pharmacist, administrator and receptionists took the usability survey based on the SUS. The higher the score of the SUS scores, the higher the level of satisfaction based on 100.00 scale where a score of 70 are passable (Bangor, et al., 2009). Collected data analysis in this research indicate a score of 35 as minimum and 92.5 as the maximum score of SUS. In addition, the survey on SUS in this study returns a score of 71.7 indicating a high level of acceptance of eHaaS as shown in Figure 4.

4. Results and Discussion
The study done has shown that a system like eHaaS that is built based on cloud computing architecture. This indicate the feature of cloud computing help to improve and enhance collaboration among personnel in the hospitals. In addition, eHaaS is found to be easy to use and that it improved the activates in the healthcare. By having a midpoint of 3.0 in the SUS scores indicate that the overall satisfaction of eHaaS is high, and that the user interface is clearly usable. In this context, Figure 5 shows the comparison between pre- and post-implementation of the eHaaS regarding the collaboration level among medical staff within the selected healthcare organizations.
Figure 5. Mean level of the collaboration among medical staff within the selected healthcare organization.

The previous figure presented the result of the mean level of the collaboration among medical staff within the selected healthcare organizations. The overall mean level of the post implementation of the eHaaS is 3.5 and the overall mean level pre-implementation of the eHaaS was 1.98. Sharing information and knowledge help to develop skills in patient care in providing quality treatment as shown is using eHaaS.

5. Conclusion
In this paper, an attempt was made to improve and enhance teamwork between personnel in healthcare organizations like hospitals by designing and implementing a complete robust and efficient cloud-based HISs system. The research done has shown that the collaboration has been improve by enabling services to be provided via cloud computing architecture designed. This kind of cloud computing architecture system will help to make collaboration and teamwork among healthcare like hospitals easier and convenience to improve initiatives to provide quality health care.

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