Integrate the Healthcare Services in Iraq by using Cloud Computing

Hussein Muzahim Aziz Basi

Abstract—Health Information System (HIS) is considered one of the most important sector that is related to human's lives. The HIS benefit from integrating Information and Communication Technologies (ICT's) with the health domain to develop an electronic health (e-health) system. The e-health system can be improved by adapting the cloud computing recourses to manage, monitor, and exchange the Patient Health Record (PHR) among the health care's facilities. The aim of this work is to enhance the health quality of service in Iraq, by integrating the health care facilities with the cloud computing recourses. The collaboration between healthcare facilities is an opportunity offered by the cloud computing to provide availability and interoperability. The framework will improve the efficiency for the medical staff to look up after the patient to improve the diagnosis process and treatments.

Index Terms— Cloud Computing, Deployment Models, e-health, Health Information System (HIS), Information and Communication Technology (ICT), Interaction relationship, Patient Health Record (PHR)

1 Introduction

Health Information System (HIS) is design for the healthcare sector to manage the patient's time and to improve the medical process by integrating many health services process like; making appointments, provide medical results, and transferring information to other specialists [1]. Traditionally, the patient will get observation and the prescriptions will be recorded in a document based papers. With the recent advances in Computer and Communication Technologies in the health domain. The paper-based system will be converted to electronic-based system. The patients Documents Health Records (DHR) will be transferred to electronic Patient Health Records (PHR) [2]. Integrating the healthcare with ICT will provide electronic health (e-health) system. The e-health will develop a sufficient electronic exchange of health related information between paramedics, to enables medical staff to look up after the patient's medical record quickly. E- health will also improve the efficiency and effectiveness of healthcare services by flow the administrative procedure, diagnosis process, decision making, discharge summaries report, laboratory results test, pharmacy, sharing information, monitoring the public health, improving the health research and education [3],[4],[5].

Saving and exchanging, the PHR it become an important issues in health sector. Patients could need treatments at different healthcare and the information should be available at the right moment. The patient's information could be located and store at different location, therefore cloud computing could be a promising technique. Healthcare sector can take advantage of cloud computing recourse and bring tremendous benefits to improve the patient quality of service and reduce overall healthcare costs [6].

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Cloud computing can be a sufficient techniques in containing healthcare integration, and optimizing resources with lower cost technology. Cloud computing technology will provide high availability of resources that are needed for certain operation at anytime and anywhere [7]. The healthcare system will be more efficiently and effectively, that allow to access and exchange the patient health record (PHR) [8].

To improve the effectiveness of the quality of the healthcare service in Iraq, a framework is proposed. The proposed framework is consider to monitor the patient's information, where the PHR can be store at different healthcare location and it will be retrieved and integrated in a single window. The framework will provides an integration to the healthcare facilities that distributed over the country. The healthcare facilities will be able to communicate and the PHR will be available and accessible by any healthcare facilities according to their need. The system is also can be used to check the availability of a paramedics, the required services at different times and for different cases. The interface information window will make the interoperability and integration possible.

2 Overview of Cloud Computing and cloud deployment Models

Cloud computing technology provide flexibilities and availabilities to the user's applications by combining different computing resources and services like, networks, servers, and data storages that can be shared with minimal management [6]. Cloud computing has three different service layers [6], [9], [10], as shown in Figure 1:

1. Software as a Service (SaaS): The users do not have any knowledge about the infrastructure and platforms where the user's applications are running. The users can access the applications without the concerns of installation and maintenance.
2. Platform as a Service (PaaS): The users do not have any knowledge on how much processing unit, memory, and storage are needed for their applications. The service providers will be responsible about the platform that

include software, hardware, operating system, server, and development tools.

3. Infrastructure as a Service (IaaS): The users will deploy and run both operating systems and applications. As the users will not take any responsibility on deployment, administration, and maintenance to the system.

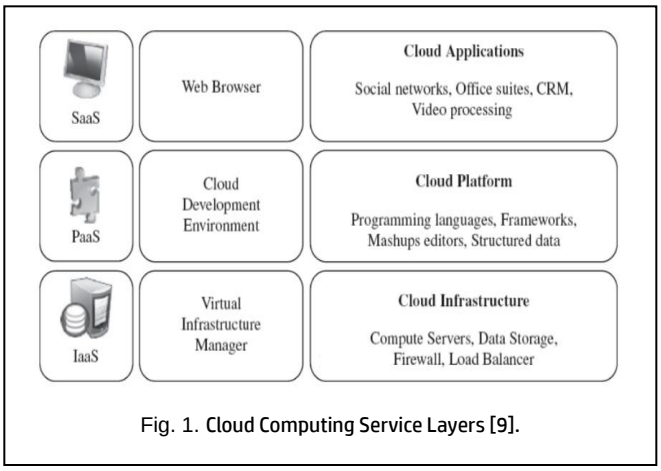

Fig. 1. Cloud Computing Service Layers [9].

Cloud computing can be operate on different infrastructure based on the deployment models that been proposed by NIST (National Institute of Standards and Technology). The cloud will be allow to operate on one or more of the following infrastructure [11], [12]:

- **Private Cloud**: Private cloud infrastructure is provisioned for exclusive use by a single organization. It may be owned, managed, and operated by the organization or by a third party, or may be hosted or outsourced to a hosting company.
- **Community Cloud**: Community cloud infrastructure is provisioned for exclusive use by a specific community of users from organizations that have shared the same mission, policy, and security requirements, rather than serving a single organization as does on a private cloud.
- **Public Cloud**: Public cloud infrastructure will make the computing resources available to the public over the existing networks.
- **Hybrid Cloud**: Hybrid cloud infrastructure is a composition of two or more cloud infrastructures (private, community, or public) that remain unique entities, and they are bounded together by standardized or proprieties technology that enables the user's applications and their data portably.

3 THE PROPOSEFD OF HEALTH SERVICES OVER THE CLOUD

One of the most important issue that are related to human life is health. Combing the health sector with the Information and Communication Technologies (ICT's), will allow the e-health products, services and processes to have a positive impacts on the healthcare quality of services. The e-health will improve the availability of the clinical data and that will increase the efficiency by reducing the medical costs, waiting times and errors [13].

The computer based system is not been introduced widely in the healthcare sector in Iraq, as the healthcare system is still useing a paper based documents to record the patients information. The document paper that began as a personal record, maintained either by local hospital or family clinic to keep track of an individual's health over a lifetime [14]. Unfortunately, the communications between hospitals and clinics are still used the traditional way by producing the official's letter to obtained information or services from another hospital.

The computer-based technology will be considered by using the computing resources to communicate between healthcare facilities over the cloud. The patients will be guided in appropriate way through a window interface, which allow the paramedics to access the patient's information at any healthcare facilities within the country.

The idea been obtained from [7], where Oana-Sorina Lupşe et al., proposed a private cloud infrastructure for e-health system, where all PHR are stored in a private cloud and allow all the departments staff within the same hospital to access and share the PHR when it is needed. A private cloud infrastructure is considered in their work to eliminate the drawback of cloud computing that been represented by weak security and to ensure that the patient's data and the communication between departments, can be done in a secure way.

Their work is been extended to serve the healthcare sector in Iraq, which allow the urgent patients medical information to be accessed and shared among different healthcare facilities that are located at different regions and states. In this situation, the system will provide the availability, accessibility, flexibility, and mobility movement to the patient's records through the cloud infrastructure within the country.

3.1 Health Cloud Model

Cloud computing is an excellent infrastructure that can easily adapt to the healthcare system and their application. The healthcare facilities are located at different regain or states, where the PHR are stored and distributed over these facilities. Cloud computing will play an important roles for allowing communications, and collaboration between these healthcare facilities [8].

To integrate all the healthcare facilities within the country and to identify the level of access, a hybrid cloud is going to be considered in this study. The composition of private and public cloud are going to be used to serve the purpose of the propose system;

- **Public cloud**: The public cloud will allow the online access to; book an appointments, patient's appointments scheduling, laboratory test checking, drugs collection from the pharmacy, etc.
- **Private cloud:** The private cloud will allow the hospitals and the departments within the hospitals and the related clinic to exchange the PHR among them.

The patients could be examined or get treatments by another healthcare facilities. Therefore, the healthcare will communicate through a private cloud to the local data centre that hold the PHR. In this case, the availability and accessibility of PHR can be store and retrieved from any healthcare facilities within the country if it's required, as shown in Figure 2.

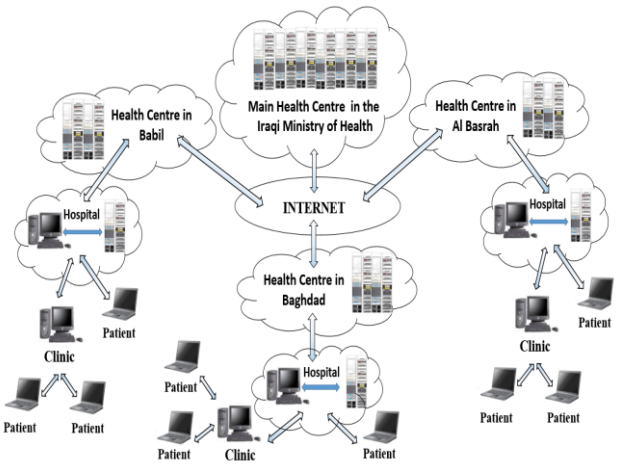

Fig. 2. An Overview of Distributing the Health Facilities over the cloud.

3.2 Categorise of E-Health

The PHR are distributed according to the region or states, while the communication mechanism been set according to the type of access to the health system. As two level been identify to access the system on the cloud (public and private) and depends according to their related use. In this section, the inter-relation system are going to be defined to identify the types of interaction that are need to be set between the patients and healthcare facilities and among the specialist. Therefore, the e-health system will be categorise into five different interaction relationship:

- **Clinic - to - Patient (C2P) Interaction:** It is an interaction between clinic and patients. The aim is to deliver clinic services to patients in efficient and reliable way by making an online services, which are related to booking appointment, check patients status, and accessing information.
- **Hospital - to - Patient (H2P) Interaction:** It is an interaction between hospital and patients. The aim is to deliver hospital services to patients in efficient and reliable way by making an urgent online appointment, check patients status, and accessing information.
- **Hospital - to - Hospital (H2H) Interaction:** It is an interaction to integrated services between two hospitals that are located in different cities or states or regions. The aim is to exchange information between Hospitals to deliver an online cooperation and communication effectively.
- **Hospital - to - Clinic (H2C) Interaction:** It is an interaction services between hospitals and clinics, where the clinics are registered under the local hospitals. The aim is to exchange information between hospital and the registered clinics to deliver online information that are related to patient's status for urgent services.
- **Clinic - to - Clinic (C2C) Interaction:** It is an interaction and integrated services between clinics. The aim is to exchange information between clinics for different specialities to deliver online cooperation and information that are related to patient's status.

3.3 Accessing Patients Information

Until now, the hospital in Iraq are following the traditional procedures for recording the patient's information in a documents paper. The documents paper will be kept and used locally within the hospital. In case, the patients been admitted to another hospital, in this situation the patient will redo all the diagnoses and laboratory test checking as the hospital don't have the PHR for the particular patient. To make the patient information accessible by the healthcare facilities, an online interface application will be design and implemented to make the availability, integration, and interoperability possible [15].

Cloud services can help the healthcare sectors to provide data availability and accessibility to the PHR that will communicate with other computing system resources in the cloud. Interoperability is another important factors to exchange information among different healthcare. The online web interface window will be used to make the patient's information available and accessible.

The interface window will view the patient's personal information, medical report, laboratory test, treatments, type of drugs been taken, etc. The interface window will be able to integrate and combine different reports from different hospitals and view the PHR in a single window, as shown in Figure 3.

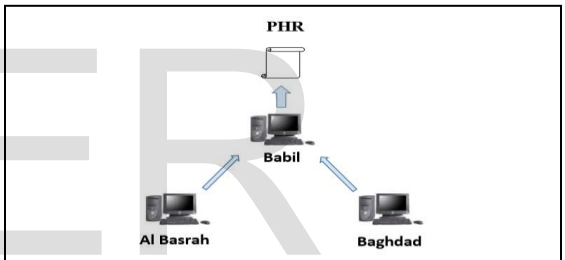

Fig. 3. Intergrated the patient Health Records (PHR).

The interface window will view all the medical history that are related to the patient. The Personal Interface Window, will show all the personal information details, as shown in Figure 4. The underline information will link to another interface window for checking purpose. The information could be needed by the paramedics to study the family history (as an example, the parents name link, is to allow the paramedics to check the family health history disease, where information could be located in another healthcare facilities centre, etc.).

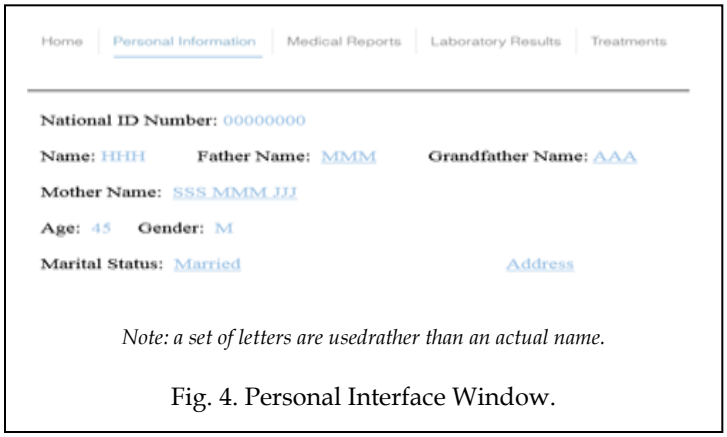

Fig. 4. Personal Interface Window.

The medical report window, as it's shown in Figure 5, is an example of the patient medical history, as it can be seen from that, the patient did a general checking and an operation in different hospitals that are located at different states. The numbers under the paramedic ID, it will link to the paramedic details information. Under the location section, it can show that, where the hospitals been located and can access these location through the link as well. The paramedic can view the medical report by clicking on the purpose of visiting the hospital and can view the previous diagnose that been done by another paramedic. While the information that related to the medicine and treatment also can been viewed in different window as well.

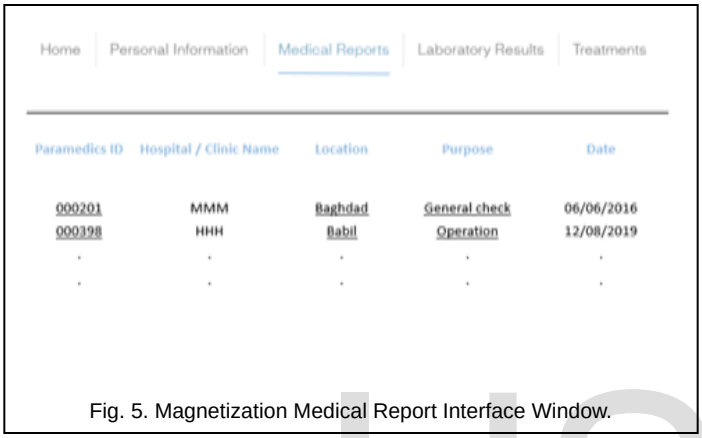

Fig. 5. Magnetization Medical Report Interface Window.

4 Conclusion

The proposed of e-health system over the cloud for the Iraqi health sector is considered in this study. Traditionally, the interaction between the hospital departments, and patients will take place in the hospital building or through an official letters to be addressed to another healthcare facilities or units.

With the availabilities of computing resources and networks infrastructure, it is now possible to move forward to e-health system in Iraq. Integrating the health system with the cloud system is to make ensure that, the PHR are available and accessible. The benefit of integrating the healthcare facilities with the cloud computing, will enhance the healthcare services, reduce the management cost and network infrastructure services. As such service will be transferred to the service provider, where the service provider will be responsible for maintaining and upgrading.

Enabling communication and exchange information between different healthcare facilities is a key outcome of e-health system over the cloud, and this can be done through the hybrid cloud. Hybrid cloud will allow the two way communication level between the patients and the paramedics or between the paramedics and medical staff for decision making and services. The patient's information can be viewed or retrieved or shared by different healthcare over the cloud, where the paramedics can study the patient's medical history (if it's necessary) to provide an accurate diagnosis and treatments.

References

[1] M. Malliarou, and S. Zyga,"Advantages of Information Systems in Health Services," *The Sport Management International Journal Choregia*, vol. 5, no. 2, pp. 43-53, Jan. 2009.

[2] K. Häyrinen, K. Saranto, and P. Nykänen," Definition, Structure, Content, Use and Impacts of Electronic Health Records: A Review of the Research Literature," *International Journal of Medical Informatics*, vol. 77, no. 5, pp. 291-304, May 2008.

[3] M. Botha, A. Botha, and M. Herselman," The Benefits and Challenges of e-Health Applications: A Content Analysis of the South African Context," *The International Conference on Computer Science, Computer Engineering, and Social Media (CSCESM '14)*, pp. 1-12, Dec. 2014, doi: 10.13140/2.1.4051.1042.

[4] S. Ouma, and M. E. Herselman,"E-health in Rural Areas: Case of Developing Countries," *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, vol. 2, no. 4, pp. 304-310, March 2008.

[5] D. G. Katehakis, A. Kouroubali, and I. Fundulaki," Towards the Development of a National eHealth Interoperability Framework to Address Public Health Challenges in Greece," *First International Workshop on Semantic Web Technologies for Health Data Management (SWH '18)*, pp. 1-9, Oct. 2018, doi: 10.1007/978-3-319-51020-0_2

[6] C. T. Si Xue, and F. T. Wee Xin,"Benefits and Challenges of the Adoption on Cloud Computing in Business," *International Journal on Cloud Computing: Services and Architecture*, vol. 6, no. 6, pp. 1-15, Dec. 2016.

[7] O.-S. Lupşe, M. M. Vida, and L. Stoicu-Tivadar," Cloud Computing and Interoperability in Healthcare Information Systems," *The First International Conference on Intelligent Systems and Applications (INTELLI '12)*, pp. 81-85, May 2012.

[8] S. P. Ahuja, S. Mani, and J. Zambrano," A Survey of the State of Cloud Computing in Healthcare," *Network and Communication Technologies*, vol. 1, no. 2, pp. 12-19, Sept. 2012.

[9] I. Ashraf,"An Overview of Service Models of Cloud Computing," *International Journal of Multidisciplinary and Current Research*, vol. 2, no. 4, pp. 779-783, Aug. 2014.

[10] K. Kavitha," Study on Cloud Computing Model and its Benefits, Challenges," *International Journal of Innovative Research in Computer*, vol. 2, issue 1, pp. 2423- 2431, Jan. 2014.

[11] National Institute of Standards and Technology," NIST Cloud Computing Reference Architecture," Special Publication 500-292, Sept. 2011.

[12] National Institute of Standards and Technology," The NIST Definition of Cloud Computing," Special Publication 800-145, Sept. 2011.

[13] P. Kierkegaard," Interoperability after Deployment: Persistent Challenges and Regional Strategies in Denmark," *International Journal for Quality in Health Care*, vol. 27, no. 2, pp. 147-153, Apr. 2015.

[14] P. C. Tang, D. Fafchamps, E. H. Shortliffe," Traditional Medical Records as a Source of Clinical Data in the Outpatient setting," *Proceedings Annual Symposium on Computer Applications in Medical Care*, pp. 575-579, 1994.

[15] A. Aguilar,"Semantic Interoperability in the Context of e-Health," *Digital Enterprise Research Institute*. Galway, Ireland: National University of Ireland, pp.1-3, 2005.