

Analysis of the Health Information and Communication System and Cloud Computing

Matija Varga

University of Zagreb, Faculty of Teacher Education, Savska 77, Zagreb, Croatia

Abstract -This paper describes an analysis and shows its use in analysing strengths, weaknesses, opportunities and threats (risks) within the health care system. The aim is further more to show strengths, weaknesses, opportunities and threats when using cloud computing in the health care system. Cloud computing in medicine is an integral part of telemedicine. Based on the information presented in this paper, employees may identify the advantages and disadvantages of using cloud computing. When introducing new information technologies in the health care business the implementers will encounter numerous problems, such as: the complexity of the existing and the new information system, the costs of maintaining and updating the software, the cost of implementing new modules, a way of protecting the existing data in the database and the data that will be collected in the diagnosis. Using the SWOT analysis this paper evaluates the feasibility and possibility of adopting cloud computing in the health sector to improve health services based on samples (examples) from abroad. The intent of cloud computing in medicine is to send data of the patient to the doctor instead of the patient sending it himself/herself.

Keywords- Cloud technologies, cloud computing models, healthcare, electronic health record, information system.

1. Introduction

The goal of this thesis is to determine with the help of SWOT analysis the strengths, weaknesses, opportunities and threats (hazards) of the ministry of health and potential benefit of applied cloud computing while offering health services and/or the benefit of applied cloud computing as the upgrade of electronic health record. Along the wide usage of electronic health record the construction of safe electronic health record's surrounding attracted huge attention in health industry and academic community Chen, YY. et. al (2012) and such fact thus inspired us for this sort of research [2]. Methods applied in the thesis: observation, perception, content analysis, modelling and SWOT analysis. SWOT analysis is used nowadays as unavoidable part of situational analysis with which process of strategy formulation starts due to simplicity, intelligibility and appliance

in all organisations Buble, M. et. al (2005) [1]. SWOT analysis is powerful and it can open up new possibilities in a short period of time from which numerous advantages can be gained. It is used to detect drawbacks of organisation or information system so that the perils can be suppressed and eliminated. With the help of SWOT analysis in this thesis there will be evaluation of impracticability and the possibility of acquisition of cloud computing in the health sector for the improvement of health services based on a sample (example) from thesis: de la Torre-Díez et. al (2013), Kuo, M. H. et. al (2011) and Wessella AM et. al (2013) [3],[8], [14]. For example, the thesis of Wessella AM et al (2013) clearly demonstrates the research of the usage of medicine with patients at primary healthcare with the help of electronic health record on the sample of 20 partners of research Network PPRNet [14]. PPRNet is research Network of primary care on which practical database is accessible for the users of electronic health record. Research has been conducted due to the reason of avoiding potentially unsuitable therapies and due to adverse events' recording. This article is yet another example of successful appliance of electronic health record and it can be concluded that electronic health record can as well be very effective support system in decision making and implementing audit in the primary health care (Wesselli AM et. al, 2013) [14].

An example of appliance of SWOT analysis for determination of strength, weakness, opportunity and threat at implementation of electronic health record systems (system EHR) depicted in the thesis of Spyridonet. al (2012) [13]. Identical analytical method, SWOT analysis will determine strengths, weaknesses, opportunities and threats during implementation of cloud computing into health in Republic of Croatia or some other country which uses certain support program for monitoring patients' illnesses and in outmost case for patients' treatment. Information technology (IT) has an important place in improving the quality of healthcare and patients' security. An essential component represents an electronic record about patient (EHR). EHR represents systematic data acquisition about patients'

health. Electronic records can be divided between integrated health units, which constitute Network. Divided records refer to anamnesis, medicaments and allergies, results of laboratorial analysing, charge data etc.. The usage of EHR system can reduce medical errors and enable more effective interventions Menachemi and Collum (2011); Silow-Carroll et. al (2012); Wessell et. al, (2013) [10], [14]. EHR for administrating clinical data and for classifying the cause of searching for primary healthcare services becomes imperative especially for countries with limited resources and countries turned towards severe austerity measures such as Greece and Croatia. In Croatian health system the implementation of such a system would be useful Spyridonet. al (2012) [13].

Cloud computing is oriented towards employees and other open code users. Cloud computing has been known for some time now and it is used every more often in the area of health, medicine, pharmaceutical companies and numerous other big companies. An example of cloud computing can be observed at the pharmaceutical company Eli Lilly which uses it as a platform for research and development. Cloud computing is used by the organization MedCommon Kuo, M. H. et. al, (2011) as well [8]. There are also attempts of implementing cloud computing into health system in countries such as Italy and Portugal Kuo, M. H. et. al, (2011) [8].

Cloud computing offers new way of approaching electronic data and web applications. Electronic data are no longer placed on employees' personal computer or server which is placed inside the health space rather than on the server which is a part of the cloud, which means that they are available through the Internet when Internet provider is available. Electronic data (which is in the cloud) can be approached through bigger number of computers and mobile technology devices not depending on the location.

In the processes of health computing employees in the ministry of health together with outer co-workers, the computer experts should have a task of determining whether cloud computing has good and not so good or bad sides (strengths, weaknesses) because they constitute competent unity i.e. a system for decision making. The following employees' tasks in the Ministry of health are determining the usage of strength in cloud computing and realization of chances at health computing. Moreover, it is necessary to determine how to bridge bad sides of cloud computing which threaten realization of computing project.

2. Analysis application and possible resistance to ICT

Framework for analysing strength, weakness, opportunities and threats (SWOT) is used by numerous analytics. SWOT analyse can be used by individuals or agencies for strategic planning in any field of biomedicine or field of public health. The technique of SWOT analysis is often used in great number of cases and is one of the successful examples of appliance of SWOT analysis in Thailand where SWOT analysis was used for the assessment of wishes of majority of medicine students whose study lasts five years regarding their future doctor status Woratanarat T. and Woratanarat P. (2012) [15]. The research in Thailand on a sample of 568 medicine students has shown that a big part of surveyors do not want to work in the rural areas in the future. The research has proved significant increase in percentage of those students who would not want to work in rural areas Woratanarat, T. and Woratanarat, P. (2012) [15].

An object of SWOT analysis is cloud computing for the needs of medicine and health. With the help of SWOT analysis, the performance and possibility of comprehension of cloud computing in the health sector is assessed for the improvement of health services.

Apart from the resistance of some employees at the introduction of new informational technology and implementation of program, possible problems of introducing new informational technologies in health are the following: relatively high costs of introducing new technologies, complexity of the existing and new informational system, service costs and costs of updating program support, cost of implementation of new modules, connecting the existing database with newly created database. Ministry of health in most of the cases can compensate the majority of costs caused by the introduction of new informational technology. Ministry of health cooperates with the computing of primary healthcare and actively cooperates and can enable introduction of cloud computing into health system and cover the charges which are caused by introduction of cloud computing.

At the possible implementation of cloud computing a problem during data migration can occur. Moreover, there are dilemmas, nowadays, and a question arises about the maturity of such a model of offering services and whether the model of cloud computing is compatible with high demands which have to be fulfilled in complex and sophisticated IT

surrounding which is in the health system Schweitzer (2012) [12].

3. What is cloud computing

The model of cloud computing can be released very fast in administering any business system at minimum effort invested in administering. The usage of cloud computing services on shore began ten years ago, and in the last several years came into use on board ships, shipping companies and other maritime institutions such as Gardline (marine sciences company), Ristov, P. et. al. (2014) [11]. Through cloud computing there are offered mainly services (applications and data storage) at a long distance via World Wide Web Kuo, M. H. et. al (2011) [8]. Cloud computing enables the usage of additional processors when the demand occurs but processors cannot solve the problems of equal distribution and data storage. Cloud represents one of the possibilities of data storage, which has a lot of potential. The usage of the cloud simplifies some things, however, it still does not utterly suffice the needs of the end users. Mutual cloud is used and controlled by organizations in a group with a similar interest. Members of a group who constitute an organization share resources in the cloud i.e. they share access to data in electronic form and applications in the cloud. In this case a question arises whether data are always accessible when the need occurs or does it depend on hardware and program part of the Internet service provider.

Cloud computing in the health sector has a goal to improve health services. With the help of cloud computing in medicine they try to send data to the doctor in electronic form about the patient and his illness instead of the sole patient what is of course great advantage in some cases for doctors and sole patients. Research in space is the main originator of introducing telemedicine activities. With the telecommunication's connections, the data can be sent to experts (doctors), nowadays, who can help solving patient's health problems in much shorter period of time. Transport of patients can sometimes be risky Kern, J. et. al (2009) [7].

4. Models and characteristics of cloud computing

Models of cloud computing services can be useful for the whole electronic health record. Characteristics of cloud computing are: offering a range of services and resources on demand (anywhere and anytime), enabling the user's payment for the usage of resources of cloud computing, very broad appliance

in the work of various organizations Kuo, M. H. et. al (2011) [8]. All the mentioned characteristics strengthen cloud computing. There are three basic models of cloud computing:

- SaaS (Software as a Service),
- PaaS (Platform as a Service),
- IaaS (Infrastructure as a Service).

Typical examples of SaaS services include applications not only from health but also from various other areas such as: CRM, ERP, projects' administration, insurance, banking, CAD/CAM, text processing, data bases etc..SaaS includes various web applications with functions similar to those in traditional office tools, including Gmail, Google Calendar, Talk, Docs and Sites. Model SaaS is available through widely spread Internet network. In SaaS model there are also included examples such as Google Apps, Google Docs and Salesforce.com.

PaaS services mark research platforms where research tools are placed in the cloud and available through Internet browser. At this service a development of web applications without the installation of necessary tools on personal computer is enabled.

At IaaS models hardware infrastructure like server, Internet equipment, working memory and storage space is delivered Gironet. al, (2013) [4]. Infrastructure at IaaS models enables support at performing operations, enables data storage and components networking (example Amazon EC2).

Three basic models of cloud computing which are applied nowadays are tightly connected because IaaS model cannot function independently without SaaS model and because of that reason application of all three models at once is advisable if decision is brought in the health system about appliance of cloud computing. The cloud in the health system has to function as a private cloud. Except three basic models of cloud computing there is a division of models based on appliance on private, public, combined respectively hybrid and a mutual cloud as well (www.cert.hr/sites/default/files/, 2013) [17].

Private cloud is intended exclusively for private practices. Possibilities (services) in the private cloud can be used only by employees of the organization which is the owner of the cloud. IKT organizations, which introduce services of cloud computing, enable the usage of private clouds more and more because of electronic data protection. Advantages of private clouds as opposed to public clouds can be noticed when the security of electronic data and electronic

infrastructure on the Internet are in question. Organizations, which possess and use private clouds can implement applications and program modules in it and can manage it. Private cloud is most often approached with the help of mobile devices.

Public cloud is open to public and everyone can use it. One of the benefits of public clouds is that they are much bigger than the private ones. Public cloud offers the possibility of renting certain parts. A size of the cloud, which will be rented, is determined by the organization, which requires its services. Only one user can use parts of the public cloud, by placing and saving data thus creating private database.

In the mutual cloud, the infrastructure is divided by two or more organizations, which have identical interest. Infrastructure of the cloud is divided on the grounds of mutual relations, connections and by contract defined and concluded cooperation.

Hybrid or combined form represents a combination of private and public. The structure of hybrid cloud is combined of various different forms (private, mutual or public cloud), which remain unique entities or are mutually connected with standardised or adequate technologies, which enable effective transmission of data or applications. The possibility of expanding private cloud with resources of private can be used for maintenance of service levels so that big burdens could be more easily withstood (www.cert.hr/sites/default/files/, 2013) [17].

Some other deployment models, such as Virtual Private Cloud and Managed Cloud are well known but not widely used. Virtual Private Cloud is a Private Cloud that leverages a Public Cloud infrastructure using advanced network capabilities in an isolated and secured manner. Managed Cloud is a type of private Cloud that is managed by a team of experts in a third-party organization. Managed Cloud includes access to a dedicated, 24 × 7 × 365 support team via phone, chat, online support, and so on to support Cloud servers from the OS up through the application stack (Hajibaba and Gorgin, 2014) [5].

Implementation of cloud computing enables the use of services and exchange of digital information between provider and organizations. Alongside mentioned and depicted models of cloud computing, nowadays, they try to introduce additional two models inside of which would strengthen cloud computing and these are: DaaS (Data as a Service) and AaaS (Analysis as a Service). Inside of cloud computing users can be offered with certain data in digital form and the possibility of collected data analysis with which health system appears stronger.

5. The Method of SWOT analysis for implementing cloud computing

With the help of SWOT analysis performance and possibility of comprehending cloud computing in the health sector for the improvement of health services can be assessed. Architecture of cloud computing could potentially be superior to the traditional design of electronic health record regarding economy, effectiveness and usefulness states Schweitzer (2012) [12]. Main question for program designer of electronic health record in the USA is whether this kind of systems are limited by legislation and monitoring. In the USA challenges of the usage of cloud computing are recognized regarding enabling safety of personal data and patients' privacy. Electronic health record built with a model of cloud computing can enable acceptable privacy and safety of patients' personal data which is possible to reach and with a contract of business associates with which conditions for synchronizing, performance data and divided responsibility are determined Schweitzer (2012) [12].

Table 1. Depiction of SWOT analysis for the estimation of possibilities of cloud computing comprehension

	Strengths:	Weaknesses:
Inner	Applications and data in the cloud, part of IT infrastructure inside of hospitals, health centres or ministry of health is not necessary during the usage of the cloud (e.g. servers and storage media), possibility of reduced outcome of financial means for hardware and software, possibility of creating descriptive menu of all used applications of the cloud computing regarding the needs of the doctor there is no need for the payment of IT experts for the maintenance of the computer equipment, providing cheap	impossibility of data accessing at places where there is no Internet access, lack of experts which will have solution for the protection of patients' electronic data from unauthorised usage and implementation of such a system, there is no proof of successful application of the cloud computing in health centres.

	possibility for a recovery of the system from the damage.	
Outer	Opportunities:	Threats:
	possibility of leading EHR in the cloud, possibility of financial savings anticipated for investing in IT, possibility of accessing data at any time from any place with the access to the Internet, governments have to create a whole range of regulations and laws so that electronic data would be protected in such a system.	safety of electronic data is questionable, places where data will be stored are not strictly defined, infrastructure, which is used, is not the property of a hospital, health centre or ministry of health, a question of ownership of electronic data (database) is set, a question of data secrecy about illnesses of public figures and all the other people, lack of trust of users into such a system, lack of law regulations (for complete appliance of cloud computing in health system
	Positive	Negative

Source: creation of author of the paper

Based on table 1 Kuo, M. H. et. al (2011) the usage of cloud computing in health system strengthens health system and creates new opportunities as for example saving of financial means anticipated for investment in information and communication technology, possibility of data access from anywhere in the world where the access to Internet exists and enables access to health resources at any time [8].

6. Results of analysis

In observed SWOT analysis (table 1) there are more strengths and opportunities than weaknesses, while possible dangers and threats, which exist during the usage of cloud computing need to be neutralized. For example, for protection of electronic data about patients' illnesses before sending data to the cloud it is recommended to put strong data encryption and application of data protection such as the usage of smart-card or base of public keys where chosen users have access only to those parts of patients' electronic health record for which they have authorization. All important data about a patient are

available in electronic health record in real time and include for example list of medical condition, opinion of a medical specialist, laboratory test results, pictures and other. Smart-card is owned by a doctor while a patient owns a health card. Transfer of data from a card into a system and the other way around is possible only with connection of patient's health card and doctor's smart-card and in that manner patient's identification is secured. Some users have access only to those parts of EHR for which they are authorized. Electronic register of authorizations contains authorized persons' data and levels of authorization and is protected with corresponding safety program support for communication via network. Individual databases contained in electronic archives are separated from safety reasons on different servers. Databases, which contain patient's administrative data, are separated from bases, which contain medical data and the main patient's index enables connection of these databases. Only an authorized person, a chosen doctor, can use "keys" from the main patient's index and in this way can find all data stored in different bases which contain administrative and medical data about a person. This example is one way of fulfilling extremely important demands for confidentiality of patient's personal and medical data Mavrincet. al (2013) [9].

Nowadays, there are already rarely organizations in medicinal and pharmaceutical industry which do not use cloud computing. For example, one of the known service providers of cloud computing is Amazon (Amazon's Web Service). Amazon's (AWS) cloud computing uses pharmaceutical company Eli Lilly as a platform for research and development and organization MedCommon, Kuo, M. H. et. al (2011) [8]. Except of the mentioned organizations for improvement of medical services, which are used by patients, medical organizations in countries like Italy and Portugal are working on introducing cloud computing as well Kuo, M. H. et. al (2011) [8]. In the Croatian health system a cheaper system which serves for administrating clinical data and for classification of reasons for searching primary healthcare would be more welcome, because such a system becomes imperative for countries with limited resources and for countries which are turned towards severe austerity measures. An application of such a manner of patient-physician communication is suitable in the country of Thailand as well, where there is a shortage of medical workforce. Woratanarat T. and Woratanarat P. (2012) [15]. If there would be an offer of health information system in the form of cloud computing in Thailand they would probably be keen on the suggestion because they could do their work in greater areas in the future. Inasmuch they

would work in rural areas they would also be able to obtain data with the help of such health data system much faster and consult colleagues who work in greater areas and have met greater sample of patients and different and specific illnesses. When a medical worker has various different patients with different illnesses surely he acquires more experience than the medical worker in smaller rural areas.

7. Conclusion

Sudden changes in medical surrounding have brought to the point that medical documentation is more and more often kept in electronic form, while computing systems for records' preservation about a patient offers numerous advantages HwaJeonget. al (2011) [6].

Based on SWOT analysis it can be concluded that the application of cloud computing is useful for the improvement of service providing in medicine. Moreover, we conclude that it is necessary to work on security of electronic data in the cloud and security from unauthorised access to electronic data. Preferably, health institution which is the user of the cloud computing knows where the server, on which data in electronic form about the patients' illnesses, is stored, for the reason if data about patients' illnesses would get lost it would be easier to determine whose fault it is for the data loss or disclosure of classified information about illnesses of, for example, public figures to the public and to determine who is responsible for such an oversight.

Cloud computing users do not have direct control over the infrastructure in the cloud. Steve Wozniak (2012), furthermore, points out that the content which is in the cloud is leased and that it is not in the legal possession of the user what can sometimes be fatal and states that a lot of problems will appear in the next five years for the users of cloud computing [16]. He states that the user of the cloud does not possess anything and in the majority of cases he signs it concordant with the legal conditions of the service provider he has to respect. If material is stored in the cloud or it is controlled through the cloud computing it is easy to restrict data access to the user. Nowadays, there is hope that a complete transition into the cloud will not occur in the near future because there are IT experts that are not fond of the idea Wozniak (2012) [16].

When a user prefers a service provider in the cloud computing it does not have an affect on informational infrastructural control of the provider anymore, which is dangerous for the sole user. User has to respect regulations of service provider so that the

same would not cancel the account and access to the data.

A recommendation for the organizations which offer numerous services of cloud computing in medicine is that security copies of database work as often as possible and in the shortest possible period of time because momentarily there is not mentioned anywhere if there is a possibility of making security copies of data which are in the cloud (or will be there). So that electronic data about patients' illnesses would be secured before they are sent into the cloud it is recommended to put a severe data encryption and thus owners of the clouds would not misuse data in electronic form and/or send it to the third party (trade). When it comes to cloud computing in medicine it is essential and necessary to introduce two more models and they are: DaaS (Data as a Service) and AaaS (Analysis as a Service). Inside of DaaS model limitations for the access to individual electronic data would have to be created with the purpose of data integrity preservation (unity) and to permit access only to some data of individual users (depending on the need for data). Introduction of AaaS model, which we also recommend for cloud computing, especially in medicine, would serve for chronological monitoring of patients' illnesses and graphical depiction of acquired results about people's illnesses through history.

Cloud computing in medicine can be very effective support system in decision-making and performing revision in the health care of patients. Nowadays, cloud computing and organizations, which enable such services, promise to ensure greater flexibility, lower costs and higher security of electronic data. Cloud computing could be essential in improving the health of patients and can enable fast decision-making of medicine workers based on previously collected data in the cloud anywhere. Cloud computing is promising but it cannot in any way replace all health applications and modules of health information system.

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Corresponding author: Matija Varga,
Institution: University of Zagreb,
 Faculty of Teacher Education, Croatia
E-mail: maavarga@gmail.com