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Implications for adopting cloud computing in e-Health

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ABSTRACT

Context: Cloud computing is an emerging and growing field in an IT industry. Cost minimization, fast processing, easy accessibility and scalability are found to be the main attracting features of cloud computing. Cloud computing is known to be as robust authentication and enhanced security provider technology and it is increasing its scope in many sensitive areas like health sectors where data privacy and security hold the key position. Some of the issues when applying cloud solution is; trust of the new system, data confidentiality, security, storage and most importantly data sharing between different data centers locating in different geographical locations.

Objectives: The aim of this thesis is to explore the limitations and find the opportunities and barriers between cloud computing and e-Health and finally suggest guidelines for adoption of cloud computing in an e-Health based sectors based on associates concerns. In the context of this research work, the authors have studied issues involved in the deployment of cloud computing, associates concerns and factors regarding adoption of cloud computing in e-Health and finally suggestion of future of cloud computing in e-Health.

Methods: In order to identify and to get a deeper understanding of those issues, the author performed literature review, conducted interview with health care personnel and cloud computing associates and finally backed up with a web-based survey from the associates of cloud computing and e-Health.

Results: Finally after the completion of entire analysis authors purposed suitable deployment model and guidelines for adoption of cloud computing in e-Health.

Conclusions: Authors concluded that most people's concerns can be due to lack of knowledge about cloud computing and the trust of vendor. However, authors also observed that people are facing problems with data security, data integrity and too much dependency to the technology and vendors.

Keywords: Cloud computing, e-Health, cloud and health care

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ACRONYMS

CAPEX: Capital Investments
CIA: Confidentiality, Integrity and Availability
D2D: Doctor to Doctor
D2N: Doctor to Nurse
EHR: Electronic Health Record
EMR: Electronic Medical Record
HIPPA: Health insurance Portability and Accountability Act
IaaS: Infrastructure as a Service
ICT: Information and Communication Technology
IT: information technology
ITU: International Tele communication Union
NIST: National Institute of Standards and Technology
OPEX: Operating Expenditure
PaaS: Platform as a Service
P2D: Patient to Doctor
P2N: Patient to Nurse
SaaS: Software as a Service
SLA: Service Level Agreement
SP: Service Provider
WHO: World Health Organization

1. INTRODUCTION

In this chapter, authors describe background information about cloud computing and e-Health. Authors then continued with related work, aim of the thesis, research questions, expected outcomes and finally, authors presented the summary of all chapters.

1.1 Background

As today, world can be considered as an IT world. Since, everything is revolving around the development of IT, its role and scope is increasing day by day. Every day, there are new innovations evolving in the field of IT to make people life easier and effective. Among them, cloud computing is one of the future generation of computing, characterized by three entities- software, hardware and network, which is spreading its usefulness in every field (Manish et al. 2009). Scholars defined cloud computing in their own way according to their requirements and effectiveness of their business (Maria, 2009). In cloud computing the services are offered 'just-in-time' over the internet in very cost-effective and flexible manner. While increasing the productivity, cloud computing mainly intends to reduce the implementation, maintenance cost and complexity (Maria, 2009). Cloud computing enables the organization to scale up or down their services, whenever needed to optimize their resources. 58 % of private sector IT executives hope that "Cloud Computing" would bring a great revolution to the IT field and 47 % say they are already on it or actively exploring it (West, 2010).

According to National Institute of Standards and Technology (Peter et al., 2009) "*Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction*". Every definition of the cloud is based on three important factors; Characteristics, Delivery models, and Deployment methods.

World health organization (WHO) defines e-Health as the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, surveillance, literature and health education, knowledge and research (e-Health Resolution, 2005). E-Health applies an advantage of e-Commerce to medical technology like telemedicine. E-Health supplies medical service like D2D (Doctor to Doctor), D2N (Doctor to Nurse), P2D (Patient to Doctor) and P2N (Patient to Nurse) to patients and clinic. If it fully applies these advantages of e-Commerce to health sector, patients and then, clinic receives an effective and convenient medical service like cost reduction, time and storage space (Byung et al. 2007)

Increased use of e-Health services requires a legal and ethical environment that ensures data privacy, security and confidentiality. While exchanging the medical data or patient health history, there must be the respect for human rights and privacy within health personal or between countries (Report by the Secretariat, 2005).

Cloud computing in e-Health

In a medical setting, the cloud offers the potential of easy access to electronic medical records. Quick access to a person's medical history could speed up treatment, help to avoid complications, and even saves lives (Gottlieb, 2005). In addition, the cloud could make it easier for the patients to locate and keep track of their own medical history. However, on the other hand, patient also wants privacy and guarantees that their health information is secure.

Before cloud computing can be fully adopted as a structure for health, IT vendors must gain the trust of a concerned society by demonstrating that they meet Health Insurance Portability and Accountability Act (HIPAA) regulation and minimize all areas of risks (Osterhaus, 2010).

1.2 Related Work

As cloud computing is a new research area, there are only few researchers worked in the field of cloud computing and e-Health until now. Lejiang et al. (2010) developed a new intelligent management system based on cloud computing and the paper is mainly aimed to present defects of traditional hospital management system. Authors concluded that, by achieving optimized patient flow and strong information technology, cloud computing would improve the efficiency in use of medical records. According to Gottlieb et al. (2005), quick access to electronic health records would help doctors to know about patient medical history and current prescription medications in case of emergency. Ajay et al. (2011), proposed tight similarities between generic government functioning and the service oriented cloud approach. Ashish (2010), proposed model based framework to implement cloud computing and discussed how to overcome the e-Service problems faced by developing countries. Hans et al. (2010) discussed about general problems of current e-health systems and provided a technical solution for the protection of privacy-sensitive data and usability of e-health cloud systems. Osterhaus (2010), explained about cloud computing technologies and their impact on healthcare and implications for privacy and the collection of medical records. All the above authors described the defects in traditional hospital management system, current problems in e-Health and how cloud computing act as an idle solution to face challenges in e-Health like quick medical diagnosis for fast treatment, collecting medical records and maintain privacy etc.

1.3 Motivation

Cloud computing has many features like scalability, data storage, reduce in cost and sharing of resources. Because of these features, all other fields are implementing cloud computing in their work to make it efficient and effective in both cost and processing wise. But still, the health sector is hesitating to implement cloud computing, even though it can get many benefits from cloud computing. So authors want to identify the concerns delaying the adoption of cloud computing in health care through associate's perspectives.

1.4 Aims and Objectives

This thesis aims to suggest guidelines for adoption of cloud computing in e-Health based on associates (health care personnel and cloud computing) concerns i.e. privacy concerns, security concerns, availability, efficiency and cost factor.

To meet the aim, there are certain objectives presented. They are

- To find the current state of art of cloud computing and issues involved in deployment of cloud computing.
- Identify and analyze the factors influencing cloud computing technology
- Identify and analyze the associates (health care personnel and cloud computing) opinions on the factors involved in the adoption of cloud computing in e-Health.

1.5 Research Questions

RQ1. What is the current state of art of cloud computing and the issues involved in the deployment of cloud computing?

RQ2. What are the associates concerns and factors regarding adoption of cloud computing in e-Health?

RQ3. What is the future of cloud computing in e-Health?

1.6 Research Methodology

The purpose of this research is to explore and describe best practices but not to explain and generalize the results. RQ1 answered through literature review and interviews. From literature review, authors came through the concerns like privacy concerns, security concerns, availability, efficiency and cost factor involved in the deployment of cloud computing. Based on these facts, the authors conducted in-depth semi- structured interviews following with online survey with associates (working in health sector and cloud computing) regarding adoption of cloud computing in e-Health (RQ2). The respondents were interviewed about their perspectives toward each of the services i.e. e-Health and cloud computing, their advantages, disadvantages, challenges and concerns about adoption of cloud computing in e-Health based on trust, privacy, security, cost issue etc. RQ1 and RQ2 produce the associates concerns and factors in detail. Based on these facts, authors will propose some guidelines for adopting cloud computing in e-Health in the future (RQ3).

1.7 Research Expected Outcome

By achieving the answers from the associates, authors are able to propose guidelines for adopting cloud computing in e-Health. This research work will provide following outcomes.

- Brief and important information about cloud computing with a focus on issues involved in adoption of cloud computing.
- The associates perception and concerns about cloud computing adoption in e-Health are identified.
- The research will help to propose guidelines for adopting cloud computing in e-Health. These guidelines will be helpful for health care authorities in future to adopt cloud computing in e-Health.

1.8 Relation between research questions and objectives

The below figure, Figure 1 explains, how the research questions and objectives are related. It also explains how the objectives are connected to the research question in-order to achieve the aim and guidelines for adoption of cloud computing in e-Health.

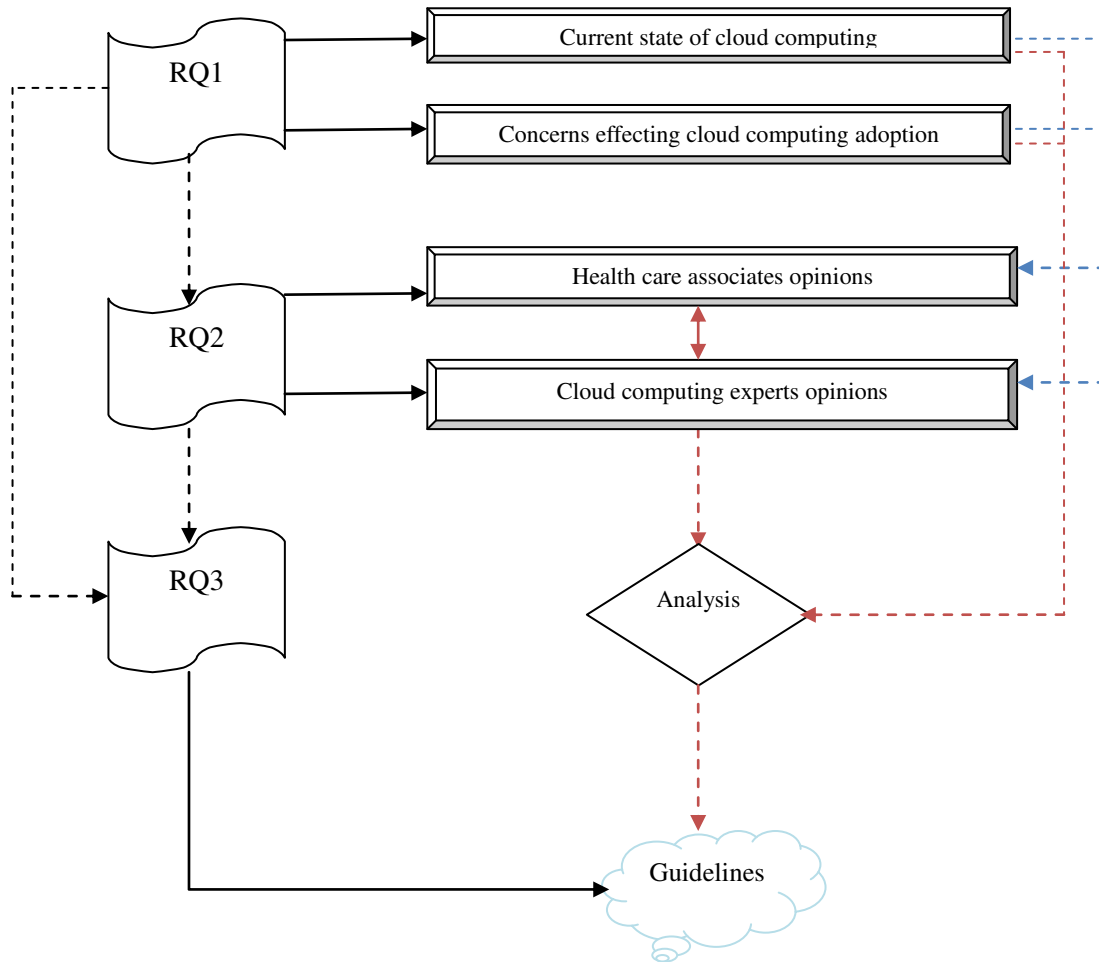


Figure 1: Relationship between research questions and objectives

1.9 Thesis Structure

The overall structure of the thesis is illustrated here with different chapters and their contents.

Chapter No1: This chapter consists of introduction and background of cloud computing and e-Health. Moreover, it consists of related work, research questions, aims and objectives, relation between research questions, objectives, and research outcome.

Chapter No2: This theoretical part consists of detailed background information of cloud computing and e-Health.

Chapter No3: This research methodology part consists of methods, which are used in our research. Here authors describe literature review, interviews and online survey.

Chapter No4: The empirical findings chapter consists of empirical data that were obtained through the interviews and survey conduction.

Chapter No5: In analysis chapter, authors present analysis of the data which were obtained from the empirical findings.

Chapter No6: In discussion and validity threats, authors had discussed the results of our research and present different validity threats related to our research.

Chapter No7: Epilogue chapter consisting of conclusions about this research study, guidelines for adopting cloud computing in e-Health and future work.

2. THEORETICAL BACKGROUND

In this section, authors describe background information about cloud computing and e-Health. Authors presented key definitions and concepts for easy understanding of reader. First, start with cloud computing definition, and then characteristics models, methods for deploying and concerns. Authors also describe start with e-Health definitions, advantages, barriers. Finally, potential application of cloud computing for health care.

2.1 What is cloud computing?

“Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” (Peter et al. 2009).

Cloud computing refers both hardware and applications, which are being delivered through services. These services marked as Software as a Service (SaaS). Cloud is a combination of hardware and software. When we made these clouds as pay-as-you-go manner then it is called public cloud. If we have internal data-centers then it called private cloud and it is not available for public.

2.2 Cloud computing overview model

The figure 2 shows visual model of cloud computing definition and this model is composed of five essential characteristics, three service models, and four deployment models.

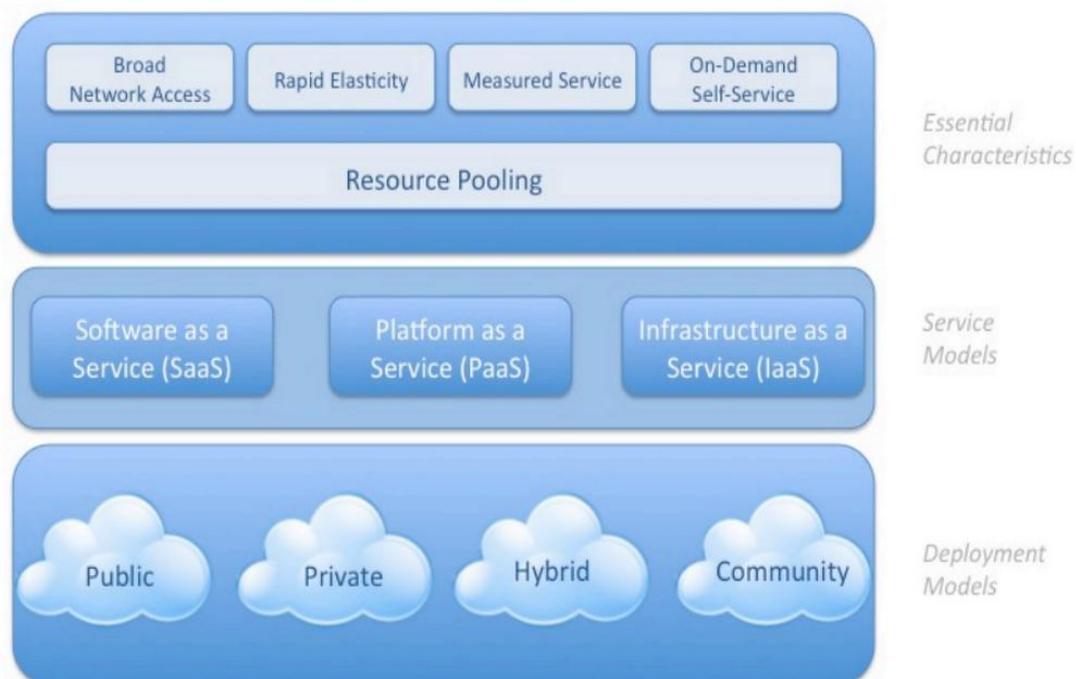


Figure 2: Cloud computing overview model (NIST)

2.2.1 Essential characteristics

There are five essential characteristics of cloud computing. Those are listed below (Peter et al. 2009).

2.2.1.1 On demand self –service

Consumer can increase or decrease computing capabilities like servers, networks or storage as require without need of human interaction. It will help consumer to concentrate more on business to get good results.

2.2.1.2 Broad network access

Consumer can access the applications using heterogeneous (thin or thick) client platforms like mobile phones, laptops, PDAs. We will use standard mechanisms for accessing these applications.

2.2.1.3 Resource pooling

Dependant on consumer demand, different virtual and physical resources (networks, storage, processing, bandwidth and virtual machines) dynamically assign or reassigns to the specific application. These resources will assign to the applications based on multi-tenant model i.e. computer resources are pooled to serve multiple consumers. Consumer does not know the exact location where the data is stored but consumer may have a choice to choose the location of data center where he wants to store the data by specifying country, state or location of data center.

2.2.1.4 Rapid elasticity

Consumer has the ability to increase the resources whenever the demand is high and he is also able to reduce the resources like servers, virtual machines if the demand is less. For example, one website has more traffic in weekends and less in weekdays then we can use the resources rapidly and elastically.

2.2.1.5 Measured service

Cloud systems can automatically measure the usage of resources by the type of service (storage, bandwidth, processing etc) provided and usage resources are monitored, controlled and reported by both consumer and cloud provider.

2.2.2 Delivery Models

Figure 3 shows the abstract layers of cloud service model. It maps the three service models with different security measures at various cloud operational levels.

2.2.2.1 Software as a Service (SaaS)

Software-as-a-Service sometimes refers as “on-demand software”. This service provides software and associated data centrally, and easily access by the end users through thin client interface such as a web browser. Cloud provider rent software’s to the end user as a service. Software delivers to the consumers in “one-to-many” basis. Cloud provider maintains service level agreements to manage servers, operating systems, storage, individual

applications as well as networks in infrastructure. Consumers do not require handling any upgrades or changes to the software and do not need to manage any servers, networks, operating systems as well as individual applications (Peter et al. 2009).

2.2.2.2 Platform as a Service (PaaS)

There is a capability that customer can deploy any type of application to the cloud infrastructure using any programming language and tools that are supported by the provider. The customer does not need to manage or control the cloud infrastructure including storage, networks, application, or operating systems but customer has control over the applications hosted configurations. Customer has a choice to use any type of operating systems and programming tools. In PaaS, we use multi-tenant architecture; by using this, multiple concurrent users can use the same development application (Peter et al. 2009).

2.2.2.3 Infrastructure as a Service (IaaS)

This service provides storage, provision processing, networks and other resources to the customer, where customer can deploys and run the arbitrary software like operating systems and applications. Customer does not manage or control the cloud infrastructure but the customer has control over operating systems, storage, applications and limited control on networking components. In IaaS, resources are distributed as a service. Customer does not need to buy servers, software, datacenter space and network equipment but he can use all these services for rent from cloud infrastructure as pay-as-you-use basis (Peter et al. 2009).

2.2.3 Deployment models

Clouds are classified into four models based on their infrastructure and these are distinguished by their architecture and functionality (Peter et al. 2009).

2.2.3.1 Private Cloud

Private cloud is operated for specific organization and it may be managed by the organization or third party. SLA's are based on mutual understanding of cloud provider and the organization.

2.2.3.2 Public Cloud

Public cloud is owned by specific cloud service provider. This public cloud infrastructure is available for large organizations and public. SLA's are same to all the customers those who are using public cloud.

2.2.3.3 Community Cloud

This cloud is shared by a group of organizations and supports a specific community that has shared concerns. This may be managed by organizations or third party.

2.2.3.4 Hybrid Cloud

This cloud is a combination of private and public cloud. These clouds are bound together by standardized technology that enables data and application portability.

2.3 Cloud Computing Benefits

Cloud computing benefits can be categorized under Technical, Users, Infrastructural, Companies and Environmental aspects and they are as follows:

2.3.1 Technical Advantages

Following are the technical advantages of cloud computing (Weiss, 2007).

a. Power Management: From the aspect of power management, it is easier to manage virtual server as compared to physical server.

b. Scalability: It is the one of the main positive aspects of cloud computing. If there is peak load or high traffic for a site, cloud can handle easily without need of any additional hardware infrastructure or equipments and without disturbing user's normal work.

c. Data Storage: There are various data centers spread throughout the world and it makes easy for the businesses to choose the datacenter as per their convenience to get fast and easy access of services with unlimited data storage.

d. Trouble shooting and Backup (Disaster) recovery: Hardware failure can also be easily traced out and rectified with ease. Similarly, the assessment of data can be done anytime and is highly beneficial for the IT industry in reducing workloads and whenever data needs to be recovered.

e. Efficiency and reliability: To find efficiencies many organizations are moving towards cloud and backup is another significant advantage to the cloud and it maintains backup for all remote sites and branch offices. It will remove many challenges like bandwidth allocation, security and disaster recovery (corevault, 2011). Applications in cloud are so vital and these are available and reliable for all services. One of the cloud industry executive stated that (Michael. H, 2010) “Any business leader worried about the security and reliability of their data in the cloud should remember that they’ve been trusting, saving, and storing their personal financial assets in an external, virtual banking cloud for years.”

2.3.2 User’s Advantages

When coming to users advantages, cost reduction is the major advantage (Weiss, 2007).

Cost Reduction: The consumer does not need to take the stress of updating the software and hardware as they can get the latest and updated resources and services relatively in less time. The consumers do not need to worry about the configuration of the system, storage capacity and capability while using the local system because these all handled and maintained by the cloud provider from where they will buy the services.

2.3.3 Companies Advantages

Similarly, when come to the advantages for companies there is one: cost (Weiss, 2007).

Cost Reduction: It is the main advantage or main reason why organizations are going to apply cloud solutions as it saves the cost involved in building infrastructure and setting up a data centre i.e. both (CAPEX and OPEX). Even a small-scale business can adopt or go into the cloud. This allows a company to concentrate more on improvements of their core competencies. It certainly helps to be more advantageous in longer run.

2.3.4 Environment Advantages

It's Green: Cloud computing share the resources that is very good in the context of environment or going green as it reduce many power-hungry carbon footprints data centers and reduces the need of more electric power for maintaining datacenters. The work of continuous running servers within the organization is reduced if we start using cloud computing (David, 2009).

2.4 Limitations of Cloud Computing

Following are some limitations of cloud computing.

2.4.1 Data segregation:

As data of many users are stored in same data center and same server or same hard disks it will raise the question from the users about the problem of mismatch i.e. how cloud securely isolate users and differentiate the memory and storage of each users as this failure could lead to leakage of information from one customer to another (Victor, 2010).

2.4.2 Deletion of data

Many consumers' data will be stored in same data center, server and hard disk. After completion of their task with cloud if the consumer want to cancel the contract and withdraw the SLA from the provider and want to delete his data i.e. completely remove from the cloud but it is very hard to do since deletion of data can only be done by erasing entirely, repeatedly re-writing the disk sectors with random data, and possibly formatting the server's hard disk which is not possible to do so there always remain the threat of recovering the erased data or if it is not perfectly overwritten or overlapped with random data then there will remain the chance of leaking information out (Victor, 2010).

2.4.3 The Offline cloud

As cloud computing is fully dependent upon internet connection. If the customer has a problem with internet connection then he/she is unable to access the application or data from internet (Victor, 2010).

2.4.4 Privacy

Privacy is one of the major issues in cloud as it needs high degree of trust among the users and it is fundamental human right not to privilege granted by authority (Weiss, 2007). Users are always concerned about their data so to overcome this issue provider should assure the users in following points (John, 2010):

- Employees are aware of their responsibilities related to the confidentiality, integrity, availability of data and information systems.
- The confidential and/or personal client data including system access credentials are protected (e.g. encrypted) from unauthorized interception.

2.4.5 Data Lock-In

Customers once stored their data in one data center and gone through SLA of one provider, then they cannot easily extract their data and programs from other providers. This concern about the difficulty of extracting data from the cloud prevents some organizations from adopting cloud computing. Data lock-in or customer lock-in is beneficial to cloud computing

providers but users will suffer if price increases, reliability problems, or even when the providers are going out of business (Michael, 2009).

2.4.6 Data Confidentiality and Auditability

This aspect concerns customer's worries that data kept in a public cloud is exposed to more attacks and could be intercepted by a third party to compromise data integrity in the absence of adequate security (Mather et al. 2009). Similarly, Auditability could be added as an additional layer providing facilities arguably more secure than those built into the applications themselves (Michael, 2009).

2.4.7 Network

For the proper utilization of cloud computing application/services there is a need of high speed internet connection. Lack of speed and high bandwidth are the causes for not accessing the cloud services, so still there are a lot of questions regarding the cloud computing. Similarly, network failures can result in loss to the company by causing extensive time delays (Weiss, 2007). It is possible in the countries like Sweden where there is high internet connection speed but in other countries where there is the problem of continuous supply of high speed of internet connection, this is a big issue in such places.

2.4.8 Software Licensing

Many cloud providers relied heavily on open source software because the licensing model for commercial software is not a good match to Utility Computing (Michael, 2009). Users first pay for the software and then pay for annual maintenance.

2.4.9 Security

If you are adopting cloud then the data which you store in data center is not under your direct control and it will be stored somewhere, where you cannot get physical access to it. Moreover, with the potential to leave your information will be exposed in some cases. Cloud computing providers support encryption and rudimentary identity management but still people do not want to place secrets in to the cloud (David, 2009).

2.4.10 Control

Control means that when you leverage a cloud computing provider, you are giving up control of all your data and file to them, so now you are at control of provider who could cause you a bunch of trouble like shutting down the account if you accidentally violate some policy or in case your provider go out of business if the services are no longer profitable. You need to address these considerations into the case for cloud computing (David, 2009).

2.5 SERVICE LEVEL AGREEMENT

A Service Level Agreement (SLA) is in general a legal binding agreement in the mutual understanding and acceptance about a service between a client who is buying the service and a Service Provider (SP). It is the serious issue to consider as it records a common understanding about services, priorities, responsibilities, guarantees, and warranties between the cloud provider and the costumers. Failure to follow the agreement is usually followed by huge penalty's, which should also mention in the agreement (David, 2009; Weiss, 2007). According to SLA information zone (SLA-zone, 2009), a regular SLA usually includes:

Service delivered - It describes the services, how they are delivered and the possible or unexpected disturbance within the time frame or system. This information should be very

detailed and accurate so we will get the information about what exactly is going to be delivered.

Performance- Performance of the system is measured by monitoring and measuring the services, which was offered whether it is as per the contract or not.

Problem management- It explained how the unplanned or unexpected incidents can be occurred and how to solve and prevent them from future occurrence of such events.

Customer duties- It explains relationship the customer and provider has and also the responsibilities that the customer has to follow and bear in the service delivery process.

Warrant & remedies - It covers topics such as service quality, third party claims and exclusions.

Security - It is the most critical feature of any SLA where it is defined of which security approaches must be followed and respected.

Disaster recovery- It is usually included in the security section and sometimes also in the problem management area.

Termination – Termination at end of initial term after the contract period expires or if either the customer or provider violates the contract or not satisfied with the performance.

Creating a good SLA is not a trivial task, but a task that is of utter importance when buying and providing services and also errors in SLAs could enforce legal penalties.

2.6 Service providers

This following are the top 10 cloud computing providers of 2011 who are dominating the cloud computing field (Search cloud computing, 2011)

- Amazon (aws.amazon.com)
- Rack space (rackspacecloud.com)
- Sales force (salesforce.com)
- Google (Google App Engine)
- Microsoft (Windows Azure)
- Joint (joyent.com)
- Gorged (gogrid.com)
- Terre mark (terremark.com)
- Savvis (savvis.com)
- Verizon (verizonbusiness.com)

2.7 What is e-Health?

2.7.1 History and definitions

There are many definitions stated for e-Health until now but still there is no consensus on one common definition because of its ubiquitous and dynamic nature. The term e-Health and Health informatics are most widely used with different meanings and purposes. The International Tele communication Union (ITU) stated that these two e-Health and health informatics are used interchangeably (ITU, 2008).

“A new term needed to describe the combined use of electronic communication and information technology in the health sector. The use in the health sector of digital data -

transmitted, stored and retrieved electronically – for clinical, educational and administrative purposes, both at the local site and at a distance” (Mitchell, 1999).

World health organization defined e-Health as “use of information and communications technologies (ICT) in support of health and health-related fields, including health-care services, health surveillance, health literature, health education, knowledge and research” (WHO), has the potential to greatly improve health service efficiency, expand or scale up treatment delivery to thousands of patients in developing countries, and improve patient outcomes. (Edworthy, 2001)

2.7.2 Key e-Health technologies

Electronic medical record (EMR): This is an electronic health care information record, which stores patient information with full interoperability with in the enterprise. It connects different medical and technical departments. All information and services regarding patients will be stored in patient health record and EMR will give secure and more integrated interaction between departments. EMR will operate different functionality with in the hospital and as it follows. (Haux, 2006)

- (a) Patient management system is used for bed management, patient follow-up while hospitalized and for making appointments.
- (b) Pharmacy management system manages drugs automatically and it notifies some possible negative complications of some drugs prescribed.
- (c) Laboratory management system manages the laboratory requests and stores the reports automatically in electronic health record.
- (d) Radiology information system manages radiology requests and stores the results directly in electronic health record.
- (e) Billing and insurance system helps to issue bills and finalizes costs accounts of patients.
- (f) Staff management system manages schedules for physicians and clinical teams.

Computerized physician order entry: It is a process of electronic entry of physicians’ orders and directions for treatment of patients. These orders are communicated through EMR to medical employees.

Telemedicine: This technology allows physicians to offer health care at distance through advanced electronic communications. Treatment involves remote examination, automated forwarding results of examination and analysis, conducting operations and other medical applications (Majid, 2008).

Multipurpose smart card: It contains an integrated circuit to store, retrieve and transfer the data. Some countries are already using smart cards to store the patient health records.

Picture archiving and communication systems: This digital system enables to examine the digital images more than one physician through computer network. This system mainly aims to replace the manual imaging system that depends on radiological films. This digital system overcomes the loss of images and it reduces the cost of taking images second time. (Majid, 2008)

Electronic health records (EHR): This is a national wide system, enables to store the patient records electronically and provide information for decision support and performance quality. EHR has mainly two goals: one is linking health organizations to share the patient data and another is establishing proper communication between patients, physicians, healthcare providers and health planners (Majid, 2008).

2.7.3 National strategy for e-Health

Condition to be fulfilled before implementing ICT in the health care services (e-Health): (National strategy for e-Health, 2006)

- a) Legislation and other regulation should be updated or modified as per the development of ICT maintaining full protection of personal privacy.
- b) National information structure for the health care services should be created for a common information and technical structure.
- c) Facilitate interoperable, supportive ICT systems and most importantly, information and services should be easily access across organizational boundaries for both staff and the citizens.
- d) National technical health care infrastructure should be further developed with a view to create secure electronic communication system capable of linking care units and supporting advanced medical devices.

2.7.4 The main players in the field of e-health

In contrast to the traditional health sectors, e-health solutions require co-ordination with different players whose cultures, objectives and traditions are different. Following are the groups of players whose role, responsibility and constraints will play a vital role in the field of e-Health so it has to be respected, mobilized and coordinated: (Jean, 2008)

- United Nations agencies and other international bodies dealing with health, telecommunications and trade
- Academic and research institutions
- Local health professionals and their associations
- Consumers, patients and their associations
- Donors
- Non-governmental organizations
- The private sector, including foundations and industries related to health and ICTs
- The media

2.8 Advantages of e-Health

Physicians observed potential advantages for e-Health by implementing IT. A recent survey of U.S. primary care physician found that almost 75% indicated that these applications could reduce errors; 70% perceived IT as potentially increasing their productivity; over 60% indicated that IT tools have the potential to reduce costs and help patients assume more responsibility (Anderson, 2006).

There are many advantages using e-Health to health care. One key example is Electronic Health Records (EHRs). Before EHRs came into use, we used paper based system to record patient health data. These paper based system may have errors while entering the patient records into papers. Coming to EHRs, data store electronically and it is more simpler and efficient way of data storing (Häyrinen, 2008). Grogan stated that there is an evidence to suggest that EHRs provide more complete and error free methods for storing patient data

(Grogan, 2006). Mullner and Chung worked in the field of e-Health and they stated that "*paper records contain too many errors and inefficiencies, and they hinder the communication between health care providers*" (Mullner et al. 2006). From this statement, authors got another advantage: ease of communication. All patient data are stored in single location and doctors can easily access the patient health data from electronic records. If the patient is moving to another hospital then these electronic health records are easily transmitted to new hospital within a small delay. The e-Health becomes a tool for improved and faster sharing of health records. This sharing of information may effect to reduce chronic disease management costs, mediation costs and wellness program costs (Majid, 2008).

By using e-Health, there are benefits to physicians, patients, management and ancillary departments (Majid, 2008).

Benefits to physicians: Physicians have total control over patient ordering process (drug-drug, drug-food, or allergy). Physician's orders are placed electronically, which avoid wrong elucidation of hand wrote orders. And e-Health reduces the time of locating and reading patient health charts for physicians.

Benefits to Patients: Patients are the most beneficial group from e-Health. E-Health improves the interdisciplinary communication towards patient health because it avoids the prescription errors from hand written orders. E-Health plays a vital role in medication safety.

Benefits to ancillary departments: Pharmacists and nurses now use much more time on clinical care and less time to go through the orders from physicians. And all resources in ancillary departments are freed up from administrative tasks and have more time to afford higher care value.

Benefits to management: e-Health helps to move the information around the organization instantly and it reduces the time for medication delivery. E-Health helps to standardize the health care process. On national level, we can combine the health data and information from different health organizations and offer secure results to the patients.

2.9 Barriers to e-Health

The followings are the main barriers to the deployment and adoption of e-Health.

2.9.1 Ethical Barriers

If we design an information system for one of category of professionals and it leads to considerable risk because it is ignoring the interests and goals of others. This is the especially case in medical information systems, but more so, in management information systems (Fessler et al. 2001).

2.9.2 Technical Barriers

If the technology innovation increases there will probably be increase in misuse of technology. As it is same to the e-Health and its security implications, which are widely discussed but still it remain as main threat and concern for all e-Health stakeholders. Key security issues in e-Health are not new but as same as any threats to information security i.e. follow CIA (Confidentiality, Integrity and Availability) model (Whitman, 2007). Infrastructure of e-Health is only focused on patients and their data but we must also have to keep record of who is gaining access in the patient data in given time.

2.9.3 Legal Barriers

Legal Barriers refers to the legal concerns faced by healthcare organizations when adopting e-Health solutions. The main problem faced by healthcare organizations in regards to this barrier is enforcing privacy of data (David, 2005 & Audie, 2007). As healthcare organizations are a patient centric industry, it is more important to ensure that the law of privacy is followed while adopting e-Health solutions. Privacy laws may differ from country to country but its main goal is to protect the rights of an individual. The main difficulty is to ensure that only authorized medical personnel have access to patient data, which is relevant to their day-to-day work (Robeznieks, 2005). Furthermore, there is another problem to define who have the access rights on the data and how to differentiate the group as per the access rights. Every individual organization, e.g. hospitals and clinics manage their own access rights internally however e-Health brings about the possibility for cross communication of patient data between health care facilities and the health person, which, is the main problem to manage and ensure privacy laws that are still not formally established. There are many legal barriers to IT adoption in the U.S. There are various laws related to fraud and abuse, mistrust, federal income tax, intellectual property, liability and state licensing to demolished or minimized the uncertainty of health care in implementing IT (U.S. Government Accountability Office (GAO), 2004). For example in the case of the physician self-referral law and the anti-kickback law present barriers to hospitals that would like to pay for electronic software for affiliated physicians.

2.9.4 Operational Barriers

This area of concern relates to the interoperability of systems which e-Health aims to provide (John, 2009). First, a system has to be developed with an interface allowing existing computer system to communicate with new system, which e-Health will introduce. Second, there must be a common standard electronic language to cross communicate between different healthcare organization about the medical data, such as patient records and hospital internal record. There must be formal agreement on what the best method to communicate such data between organizations (Hill et al. 2007).

2.9.5 Cost/Benefit Barriers

As the name suggest it is the barrier related to the cost in implementing e-Health solutions, whether it is feasible in-terms of cost wise i.e. do the benefit of e-Health outweigh the cost required to implement e-Health. From the technical side, the implementation of e-Health solutions is clearly advantageous in comparison with past methods such as the paper-based record keeping systems but from the healthcare organization side these benefits may not outweigh the cost of implementing e-Health solutions. The cost of implementing e-Health solutions can be tens of thousands of dollars and this does not even include the requirement of hiring teams of IT professionals to support and maintain the software throughout its life cycle (Mearian, 2010).

2.10 Cloud Computing in Health Care

Organizations can spend substantial amounts of money on information technology (IT) projects that eventually fail. This can happen when services do not correspond to the needs of their users (Wilson, 2004). So, World Health Organization (WHO) in its 58th World Health Assembly (World Health Organization, 2005), urges its members to draw or design a long-term strategies like building closer collaboration with the other stakeholders, trying to reach the communities by mobilizing the staff and collaborating with local health service providers, develop the infrastructure for information and communication technologies,

establish centers for excellence for e-Health best practice, and establish national public-health information systems.

Organization that handles private consumer information, such as law firms and hospitals, need to be cautious about cloud computing because of security and client privacy. People have started to become comfortable with online applications and data storage. The level of expectations in regards to quick and easy information is increasing day by day. In medical setting, the cloud offers the potential of easy access to electronic medical records. Quick access to a person's medical history could speed up treatment, help avoid complications, and even save lives (Gottlieb, 2005). In addition, the cloud could make it easier for patients to locate and keep track of their own medical history. However, on the other hand, society wants privacy and guarantees that their health information is secure; Americans have conflicting values in regards the use of cloud computing for health information. The use of cloud applications in health care introduces another potential place for security breaches and patient's privacy is always in vulnerable or in risks of being exposed, similarly it also adds complications to current privacy policies.

Currently the technical, legal, economic and security details of the cloud remain undefined (Nelson, 2009). Data in the cloud can be stored and processed on servers residing in countries all over the world. The development and acceptance of cloud computing for health care organizations depends upon the privacy and ownership issues. Health organization can create policies for how their data is managed locally and by an outsourced data center; however, they are unable to create policies that will influence how data is handled in the cloud. Before cloud computing can be fully adopted as a structure for Health, IT vendors must gain the trust of a concerned society by demonstrating that they meet Health Insurance Portability and Accountability Act (HIPAA) regulation and minimize all areas of risk (Osterhaus, 2010)

For the successful implementation of health IT in the cloud without government regulating policies, the following six risks have to be addressed properly (Rubin, 2010). They are defined following.

Regulatory Risk: It includes activities such as encrypting data and preventing from unauthorized access, maintaining the data privacy and confidentiality which are basic and foremost requirement of Health Insurance Portability and Accountability Acts (HIPAA). Every act should be followed of HIPAA (Rubin, 2010).

Intellectual Property Risk: It is the risk of unauthorized use and exploitation of other works or patent. The Health IT vendor wants to own the software themselves as they are IT companies. They are naturally and legitimately have rights to expand the basket of ownership of their own whereas the customer wants to own any content that makes its way through the software which is rarely controversy. The solution of these controversies is combination of cross licenses and having each party own what it provides or controls (Rubin, 2010).

Enforcement Risk: Vendor ability to enforce its rights and force to perform under the agreement to maintain the proper coordination between the applicable law and dispute resolution mechanism with termination rights (Rubin, 2010).

Performance Risk: The customer want to be assured from all applicable laws and regulation, defect free workmanship and materials, performance of your system. Similarly, your company does not violate third party intellectual property rights. The customer wants to protect their data against latent defects (Rubin, 2010).

Business Continuity Risk: It is an overlooked issue where customer can end the agreement before the actual date due to the fear of major interruptions. Similarly, customer can continue the protection of business minimal problems (Rubin, 2010).

Liability Risk: This is a huge issue, users need assurance from vendors that there won't be any general breaches of the agreement and if there will be any, user will get required compliances with applicable law. Similarly in the case of user, that they will not break the rules and regulation of the agreements. So in the mutual understanding of vendor and users decrease the liability risk (Rubin, 2010).

3. RESEARCH METHODOLOGY

There are different types of research approaches (Creswell, 2002). These are qualitative, quantitative and mixed approaches. Based on research one had to select proper methodology and to be familiar with how it will be useful for our research before following it.

According to Creswell (2002), A qualitative research gives the complex, detailed understanding of the issue which can be established by talking directly to people, going to their place of work and allowing them to tell the stories unencumbered by what we expect to find or what we have read in the literature review. While quantitative approach is one in which the investigator primarily uses post positivist claims for developing knowledge i.e. cause and effect thinking, reduction to specific variables and hypothesis and questions, use of

measurements and observations and the test of theories, employees strategies of enquiry such as experiments and surveys and collects data on predetermined instruments that yield statistical data. Authors performed qualitative interviews and online survey to find both the current state and concerns of cloud computing in e-Health which need to be explored. It has to be explored rather than uses predetermined information from the literature or rely on results from other research studies.

Authors choose exploratory studies to find what is happening with the hope of getting new insights in the field of cloud computing and e-Health and also find the scope of implications for adopting cloud computing in e-Health. There are three principal ways of conducting exploratory research (Saunders et al. 2009):

- a. A search of the Literature
- b. Talking to experts in the subject (one-to-one Interview)
- c. Conducting focus group interviews

Of the three principle ways, authors followed first two; literature review and more importantly talking to experts in the subject (conducting one-to-one interviews) with associates related to both cloud computing and health personnel. In order to obtain detailed information, in-depth semi-structured interviews were conducted with associates working in cloud computing and in e-Health. This was followed by survey among the related associates to support and get enough dimensions and perspective about subject matter. The respondents were interviewed about their perspective towards each of the services i.e. e-Health and cloud computing in terms of advantages, disadvantages, challenges, scope regarding trust, security, cost and agility.

3.1 Literature Review

It is the most important phase and step in every research as it plays a key role in the overall research process. Literature review helps in defining the undefined problem, that researcher intends to solve during his research work (Reed, 1998). Authors choose literature review for our research work for two main reasons. First, because the problem, which authors intend to solve, can be defined in a better way and second, more areas of concern from the other related research can be identified.

Concerning information, literature review was performed at the initial phase. authors deeply study about cloud computing and e-Health, their current working methods and what will be the situation or condition if one is used to help other and come through the new area of interest “implications for adopting cloud computing in e-Health”. To explore this, authors

adopt a systematic approach to search available literature on this topic. Authors searched databases such as ACM (Association for Computing Machinery), IEEE (Institute of Electrical and Electronics Engineer), In spec (Ei Village 2) and found relevant information from journals, eBooks, research reports, articles etc., relevant information and articles. Additionally, manual searched was also performed using Google and Google Scholar.

After obtaining sufficient articles and information, authors found that interview method was the best to explore the people perspectives on this issue.

3.2 Interviews

Interview is one of the data collection technique used in qualitative research approach (Hove et al. 2005). According to Creswell (2002) interview is the most important data collection method used in ethnographic studies. Interviews are of different types. These include structured, unstructured and semi-structured (Gordon et al. 2006). However, authors will follow semi-structured interview for our research work. It helps us to rise interesting points in what the interviewee tells us. Semi-structured interview is a technique where there are some predetermined topics and questions along with some space for the interesting topics from their side (Gordon et al. 2006). This technique is used to collect qualitative data by asking open-ended questions to respondents to know their opinion on a particular subject (Semi structure interview). Overall, the questions will be divided into groups in which some questions would directly focus on the research questions while others are related to the topic that gives a broader representation of the topic. Authors choose this technique because it is very crucial for answering the research questions while keeping in mind not to impose on the respondent for answering a specific problem rather it is to let them towards a fair discussion about their experience so that it will possible to relate these insights to our problem or goal at hand.

3.2.1 Source of Data Collection

Each interview lasted for an average of 45 minutes. It was conducted at the interviewee's convenient site, time and mode of interview i.e. some interviews are conducted face to face, some in phone while most of them through Skype conference using software called Call-Graph to record the conference for the validity of the information. Call-graph is completely free for personal and business use and it has no time limit for interview. This call-graph ideally suits phone interviews as authors can record both Skype P2P and Skype Out/Skype In calls (Call-Graph, 2011).

The purpose of our research along with the reason for the interview was prepared and a set of brief documentation was sent before hand to the interviewees to update themselves in some of the issues. They were asked about their awareness, knowledge, previous use of cloud computing, e-health services, the brighter side of cloud computing and its future prospects.

3.2.2 Population of the Interview

There were two target groups, one who are familiar with cloud computing and its features and other are those who are linked or are working in e-Health and know something about cloud computing. They include IT-architects, business development manager, executive consultant, chief technical officer (CTO), program manager, business consultant, CEO and other persons who are either linked with cloud computing or e-Health. The respondents were interviewed about their perspective toward each of the services i.e. e-Health and cloud computing, their advantages, disadvantages, challenges, scope regarding trust, security, cost and agility perspective.

Authors got some associates contacts from our colleagues who had already done the research in cloud computing and contacted them through email. Seminar conducted by Telecom City, Karlskrona helped us to find some more contacts from Logica.

3.2.3 Interview Question Formation

Before designing our questionnaires, authors had gone through literature review and come with some initial draft of questions. However, after series of discussions between ourselves and with the supervisor again helped us to refine our questions. Authors mapped each interview question with our research questions and after numerous iterations of work; authors finally were able to come up with a set of error free questions under the strict guidance and supervision of the supervisor.

3.2.4 Interview Process

The researchers took turns while conducting the interviews. One researcher would hold the conversation while the other took notes and occasionally asked for missing information. The interviews were recorded and transcribed. Based on the transcriptions, case reports were written for each interview and reviewed by both researchers, which after completion send to the respective respondents for the approval of their view and for the validation of our work.

3.3 Online survey

“Survey is a well-known technique to collect demographic data and user’s opinions” (Preece et al. 2002).

Authors designed an online survey in order to collect the associate’s (cloud computing and health care employees) perspective about the cloud computing and e-Health focusing on security, trust, cost, agility, and issues involved in the deployment of cloud computing in e-Health. The survey comprised of three different types of questions i.e. open ended, closed ended and scaling questions. Those were designed to get concrete and discrete opinions of the associates.

3.3.1 Source of Data Collection

Authors used university site (BTH “its learning”) for conducting the online survey. Its learning is a web portal for BTH students, where teachers and students shares information and updates about current lectures. In its learning we can also keep any number of survey questions and it is very convenient for collecting, analyzing and organizing the data. From its learning one can generate excel/html result sheet so that survey findings easily analyzed.

3.3.2 Population of the survey

The population of this study focused on cloud computing and e-Health associates concerns. They include senior engineer, IT- architects, software engineer, general manager, CCO and all other person who are directly or indirectly involved in cloud computing and e-Health.

Authors searched the population or source of contacts with the help of the associates involved in our interview. Because of their help, authors were able to contact other associates working in IT related areas and hospitals by sending our survey link via email.

3.3.3 Designing Survey Questionnaire

Prior to finalizing the survey questionnaires, authors had gone through series of vigorous reviews of the questionnaires with colleagues who have ideas in the topic and with the supervisor, Dr. Jenny Lundberg. Authors therefore made some changes in our survey questions. This has been done by keeping view of the research questions in mind and finally come up with set of error free questions, under the strict guidance and supervision of the supervisor.

Authors performed our survey from 15th June, 2011 to 15th July, 2011 which took about four weeks to complete. The results from the survey were collected and analyzed later.

3.4 Literature Sources

There are usually two kinds of data in research, one is primary and another is secondary data (Dawson, 2002 & Saunders et al. 2009). In our research, authors are using both.

3.4.1 Primary Data

Data that are taken directly by the researcher by himself/herself are called primary data. (Dawson, 2002 & Saunders et al. 2009). In this research primary data means qualitative data that will be obtained by interviews and survey. It shows the originality and new findings. The detailed findings of interview and survey can be found in chapter 4.

3.4.2 Secondary Data

The already existing data from other researchers and scientific authors are called secondary data (Dawson, 2002 & Saunders et al. 2009). Research books, reports, journal articles and websites of reliable authors and organizations are the sources of secondary data. Anyone cannot use the data from such source directly without giving proper references.

4. EMPIRICAL FINDINGS OF DATA

4.1 Interviews

This chapter describes the data gathered from semi-structured interviews.

4.1.1 Brief introduction of interviewees

A total of twelve associates in cloud computing and e-Health were conducted over Skype, face to face and email. However due to online problems, some of the interviews were not completed. Eventually, based on complete and clear responses, authors were able to select eight out of twelve respondents. The table below presents a summary profile about interviewees, his/her position, company and responsibilities.

Interviewee	Organization	Current Position	Responsibilities	Area of interest	Country
Patrick Koch	Care Stream	Cloud services	Developing services and platforms	e-Health and cloud computing	Belgium
Peter Svensson	Blekinge Hospital	IT-Architect	Maintaining relationships between systems	E-Health	Sweden
Anne Mansson	Logica	Business Development Manager	Developing software	Cloud computing	Sweden
Monica Claeson	IBM	Executive Consultant	Business Deployment Cloud Tiger Team	Cloud computing	Sweden
Lennert Ericsson	Center for e-Health in Collaboration	Chief Technical Officer	Technical expert groups in architecture management	e-Health	Sweden
Ulf Daneklev	Logica	Business Consultant	Architect, project manager	Cloud computing	Sweden
Daniel Gustafson	Logica	Technical adviser for cloud services	To help and assist the customers	Cloud computing	Sweden
Jesus Escandon	Tyeca Technologies AB	CEO	Accountant, Manager and Programmer	Cloud computing	Sweden

Table 1: Brief introduction of interviewees

Authors choose two target groups for the interviews. The first group were the ones who are expert and have enough in the field cloud computing while the other group were those who expert in e-Health and have some knowledge and interest in cloud computing. These include IT- architects, business development manager, executive consultant, chief technical officer

(CTO), program manager, business consultant, CEO and other persons who are linked with either cloud computing or e-Health. The respondents were interviewed about their perspective toward each of the services in e-Health and cloud computing, their advantages and disadvantages, challenges and scope regarding trust, security and cost perspectives.

4.1.2 Interview Findings

4.1.2.1 Interview No. 1

Interview was conducted with Patrick Koch on 10th June 2011. This was Skype recorded interview. Patrick Koch is responsible for cloud services in care stream. Care stream provides solutions for better patient care. It is a dynamic company with over hundred years of leadership in medical and dental imaging. His responsibility is to develop services and platforms according to the requirement of customers.

In Patrick's opinion, e-Health is adopting internet and web tool technologies into the health care industry. He mentioned that it is very important to have security in health care so the vendor needs to develop and to ensure the privacy and security of data. Patrick told, "We maintain multiple measures and different levels of infrastructure for data centers and nobody can gain access into those datacenter without specific authorization."

Respondent identified security and privacy as the main challenges in adoption of cloud computing in e-Health and vendor needs to persuade the customers that data in cloud is safe. He also told that availability of low cost internet in some countries is another challenge. He further added that privacy of the patient is most important and if hospitals are to store patients data in cloud then we have to take sign the concerned documents. He told that cloud SLA's are very crucial for any organization.

Respondent mentioned that the important benefits of adopting cloud computing are cost effectiveness and easy access to data between multiple hospitals. Besides, he mentioned that all have the same level of benefits for instance in Google docs, you can update, share and collaborate data between multiple users remotely with latest update.

He personally prefers public cloud as a better tool to store all data if we adopt cloud computing for storing patient and health data.

4.1.2.2 Interview No. 2

Authors interviewed Peter Svensson on 25th April 2011 at Wamo center, Karlskrona. Peter Svensson is IT-Architect at Blekinge Hospital. His responsibility is to maintain relationship between systems but does not have any direct experience in security. According to his knowledge cloud computing technology is yet to be adopted in Sweden. However, he revealed that he has some knowledge about cloud computing.

He said that security setups in Swedish hospitals are increasing and we are building security systems like authentication, smart cards and national level security. Regarding the patient records security, he believed that it is very important to ensure the patient security in health care. He also said that if a popular and a well-known politician visit to health care, it is very important to secure his or her personal data from the outside media.

He mentioned that they are handling patient health records in own hospitals and there are many legal aspects to share the data. He extended that we do not know where the data will be store in cloud.

Regarding benefits for e-Health if we adopt cloud computing, he said that reduction of cost is one advantage but it will not be a big step for patients. He also mentioned that sharing of data among different hospitals is another advantage.

In interviewees opinion about laws regarding where to store data if we adopt cloud computing is major challenge. He also told us that there are more challenges like availability of the internet and control on SLA's and in his opinion private cloud is good to store patient and health data.

In Peter Svensson's opinion the adoption of cloud computing will take nearly five to ten years because of legal issues and security problems.

4.1.2.3 Interview No. 3

Authors interviewed Anne Mansson on 13th May 2011 through Skype. Anne Mansson is Business Development Manager at Logica. She is responsible for developing software. Logica is an organization which provides cloud services to the customers.

The main benefits to the organization using cloud are scalability and efficiency of the data. She further added that cost reduction, increased speed, higher reliability and sufficient storage of data are the other features.

She mentioned that storing all data in cloud is not safe. As an example, she said "if you keep your server in Amazon and if something happened to your data, who is responsible?" Would Amazon care? Probably Amazon does not care. So her opinion was related to trust issue and she cannot trust the cloud services fully so she recommended that not to store sensitive and important data in cloud.

She mentioned that SLA's have very vital role in the sense if you have critical application then you really need to have the good SLA's with public provider. She further added that these SLA's will play great role to build trust from the customer. Besides, the security of the data, SLAs and patients trust run parallel to one other i.e. good SLAs give enough security that makes better services and consequently leads to more trust of the customers.

Regarding the deployment models she said that public cloud is for non-critical applications and private cloud is a good idea if you have the internal company and using traditional hardware. We can provide different SLAs to different customers and can guarantee data integrity. She mentioned Logica as a cloud service broker; the end customers will get different cloud applications directly from broker and broker is responsible for maintaining all applications.

She told that there are many challenges which come with adopting cloud computing in e-Health. Among these, some of them are security of data, data sharing and most importantly trust of the patient. Similarly, legal issues which can play a vital role in the adoption of cloud computing in health sector. She added that as health data are secret information, confidential between patients and the doctors, putting these in cloud arises a question of its availability and reliability because we do not know where these data is stored and who is operating it.

She mentioned the major advantage of cloud computing that e-Health can benefit from is sharing the data between different health organizations when going from one place to another, from one county to another. Currently, if we visit a hospital, our data recorded and stored in their databases. However, when we need to visit a hospital, our records are inaccessible in their data systems. In such scenario, we are likely to go through all the processes from the very beginning. This is both costly and time consuming. Such delays in

health care may put a patient's life at risk. Similarly, fast processing and scalability are other major advantages of cloud and thus help minimize risk of losing patients life.

In her opinion hybrid cloud is best deployment model to store patient and health data. In addition, she agreed that there is possibility for adopting cloud computing in e-Health in future, if hospital work with one of the cloud provider and setup a private cloud within the hospital to share the data.

4.1.2.4 Interview no. 4

Authors interviewed Monica Claeson on 25th May 2011 through Skype. Monica Claeson is an executive consultant at IBM. She is responsible for business deployment cloud tiger team.

She told that IBM is using cloud computing and they are adopting it to reduce cost, increase flexibility and reduce risk. She added that cloud computing is beneficial to organization in terms of cost reduction, increase speed, higher reliability and sufficient storage of data.

She stated that there are lot of security issues when it comes to cloud, for e.g. in sharing data storage, we would have ensure that data has not leak between application using same databases. She added that it is very effective if we think about scalability and efficiency.

Regarding storing all data in cloud, she told that it is safe and secure but it depends on which cloud you use. For instance, private cloud with trusted vendor is highly secured.

She told that SLAs should be given emphasize because there are extremely important in cloud. Because SLAs and security stick together, it affects security factors greatly. Bad SLA affects security in a bad way while good SLAs with trusted vendor have better security. However, vendors must have to prove that they could handle SLAs effectively.

She told about benefits and challenges with different deployment models. She started with public cloud, the main benefit is lower price and challenges are security, reliability and flexibility. Private cloud is more secure but not as economical as public. Further, hybrid cloud benefits from being able to communicate among the clouds but challenges are how to set up these from economical aspects.

She told that there are many challenges such as maturity, knowledge, security, reliability, legal issue that arises while adopting cloud computing in e-Health. However, the most important one is the issues of trust i.e. information is not in wrong hand or misused. Legislation issues and data security are other important issues to be solved or quarantined before fully implementing cloud computing in e-Health. She further added that if vendor can demonstrate in front of the patients and other hospital staffs about their security measures and to restrict from unauthorized users they could gain the trust of those people.

She told that cost reduction and gaining access to data from anywhere are the major advantages of cloud computing that e-Health can benefit from. As the resources are shared there is ultimately the reduction in price, then hospital can concentrate on their proper health service and leave the job of IT to the trusted vendor with one IT officer to monitor it which saves lot of money spend in IT infrastructure. Moreover, she stated that "reaching the information in convenient way via internet is an advantage i.e. when I travel out of the country and if I need medical checkup I can reach to my file if needed that will be the good advantage."

In her opinion cloud computing has big role in the foreseeable future but it will take long time than we wish or expect.

4.1.2.5 Interview No. 5

Authors interviewed Lennert Ericsson on 25th May 2011 through Skype conference using software called Call Graph and our interview lasts for nearly 45 minutes. Lennert Ericsson is Chief Technical Officer (CTO) at Center for e-Health in Collaboration. He is responsible for three technical expert groups in architecture management.

He mentioned that costs for maintaining data centers do not affect the setup because it is Swedish law that states the demands.

Regarding challenges in adoption of cloud computing he told that “we are waiting the legal checks for where to store data, what are the disaster recovery functions available and what SLA’s we get”. Besides, he added that it is still problem with security and if we get contract from Google or Amazon and if we got any problem in our system, we do not know whom we have to call in order to fix the problem.

He also stated that economy of the scale is the one major benefit from cloud computing to e-Health. Similarly, in order to use cloud all legal issues have to be fulfilled especially at SLA levels, disaster recovery and data storage places.

In his opinion private cloud is safe to store patient and health records because of security demands and he added that unless all these legal obstacles are resolved it is possible to adopt cloud in e-Health.

4.1.2.6 Interview No. 6

The interview was conducted with Ulf Daneklev on 20th May 2011 at Ronneby Library through a Skype conference using software called Call Graph, interview last long for nearly 50 minutes. Deneklev is currently working in Logica as a Business Consultant and Program Manager. He also had worked with Government of cloud services. He is being familiar with cloud from last 6 months.

Following the adoption of cloud computing, organizations can get several benefits such as the possibility of sharing of stored space, application and hardware between clients; get cost benefit, speed, reliability and efficient storage of data depending upon the organizational goal and area of interest.

He sees that the major up-sight of cloud computing is scalability and efficiency in terms of payment for what is used or in the number of transactions achieved in a fast and effective manner. There is always room for scaling up and down the server capacity without letting the customer know or feel and without the services being interrupted which help to run the process effectively. Although cloud has numerous advance security features but still we cannot store all data in cloud structure. We have to depend on other infrastructure such as private cloud because it can be store data without any security breach.

In his opinion there are many challenges to be looked upon in cloud computing. Among these, security and integration are the two recent alarming issues. In sharing data storage, we should have to ensure that data are not leaked between applications using same databases. Data encryption can be one basic step to protect our servers and data from unauthorized accession. Additionally, SLAs play vital role both for provider and customer as it will be a central thing for regulating and controlling delivery of the services.

As per the respondent there are many challenges which have to be solved before adopting cloud computing in e-Health. These are data confidentiality, legislation issue and data

security. Because e-Health stores patients and hospital data which needs to be confidential within their reach. Storing these data outside of country violates law. He told that with proper communication and explanation about the system enhances patients trust within the organization.

On the contrary, he also highlighted some of the advantages of cloud computing that e-Health can benefit from. For instance, application consolidation, which is strictly a cloud issue combine services from different providers and what the user does not want to buy i.e. different services and application from different providers. Another important aspect of cloud that must be considered is its scalability. Similarly data sharing and data storage are also the aspects which e-Health could benefit from.

When asked about the deployment method, he explained about three main deployment methods i.e. public, private and hybrid cloud. Amongst these, public cloud is preferred over others because of its low cost and scalability on services. Nevertheless, it has security issue at hand. Because it is free for public and mainly used for general experimentation, anybody can get access and retrieve the required information. On the contrary, private cloud is more secure than public cloud because data and information are not shared other organizations you have greater access and control over your data. However, scalability and costs remain the main challenges in private cloud. The cost would be higher than in public cloud because it requires certain level of dedicated hardware and software. Weighing the pros and cons of public and private cloud in terms of scalability and security results in choosing hybrid cloud as it balances both the challenges effectively. To sum up, he preferred private cloud for storing patient and health data.

Finally, he told that he sees a bright future for adopting cloud computing in e-Health due to its scalability and cutting cost but challenges such as interoperability issues and Legislation issues have to be taken into consideration and some of the standard rules and models have to be fulfilled.

4.1.2.7 Interview No. 7

The interview was conducted with Daniel Gustafson on 24th May 2011 at Ronneby. Gustafson is working as technical advisor for cloud services and mobility services in Logica. His role and responsibilities are to help the customers within the questions regarding cloud, setup a strategy for mobility within the company when it comes to wireless email and applications in cloud.

When we asked about the adoption of cloud computing and its benefit to their organization he replied that this company sets up cloud services and sells cloud applications but not using for its self. He explained cloud services to be better than the current services due to its data storage, scalability and centralize services.

He gave his opinion about security, scalability and efficiency in cloud computing. He said that security is one issue in cloud computing which people made it. For him security within cloud is just as good as any other data storage in use. Similarly, scalability and efficiency are the primary reasons why people are using cloud and in most cases, we pay more than what we use. When further enquired with him about the safe and security of data to store in cloud he told that we must have to save data in multi cloud, which means we have to store in at least two data centers. He also highlighted that cost of the data storage is not a biggest issue but maintained that security is the main issues while using multi cloud. Finally, he ended the statement saying that he does not believe all the data should be in cloud and many applications are not built for cloud. He clearly stated that we must have to trust the cloud provider. If we cannot trust then we should abstain from using it.

According to his view, there are many challenges in cloud computing. However, he focused more on security and access points. One of the challenge is about storing the information outside own country due to the cost effectiveness. For instance, cheaper to store in other country like in India but organizations or end users want to have more control over their own data. There are different transfer rules, legal rules and different SLAs to store data in data centers. With the passage of time, people start to adopt with it and stop raising question for its credibility. When asked about the role and effectiveness of SLA's in cloud, he replied in a positive manner saying that SLAs are big issue, and big cloud providers like Amazon, Rack-space already made some SLAs, which they will not change as per the demands and needs of public customers. However, SLAs in private cloud are discussable and modifiable according to customers' needs and demands.

He told that we could not predict the challenges that arise because of adopting cloud computing in e-Health in future because cloud computing will not use all the security measures what we are using today. He opined the possibility of managing own health record and cloud is just a new way to gain access the health data. His response about inability of storing health records in cloud because of legal bindings and due consideration from the government is needed. However, he did not ruled out the possibility of implementing any application in cloud and keep the storage center in same hospital or any other place. Cloud could be beneficial both to the health sector and to patients. He is supportive to the adoption of new technology in e-Health saying that doctors can access health records data anywhere from the world.

The respondent highlighted the benefits of public cloud as cheap, easy to access, easy to setup service and easy to get out of the service whereas he explained SLAs and security as the main challenges. Similarly, he mentioned the benefits of private cloud as: SLAs are discussable, private cloud can be setup very easily and work for corporate organizations where as he explained higher cost, longer terms and difficulty to come out of the contract as the main problems with private cloud. He further highlights about the hybrid cloud saying it is the best option for cloud as some information in public is cheap and some in private but its main drawback is lack of communication. He mentioned that "we cannot say anything regarding the deployment method preferred to store health data since it depends on the data that we store in cloud".

4.1.2.8 Interview No. 8

The interview was conducted with Jose de Jesus Scanlon on 5th May 2011 through Skype. Jesus is working as CEO in Tyeca Technologies AB, Geek Lab IT Support and Kyne Solutions. He explained his role and responsibilities as accountant, manager, programmer in his organization.

His organization use cloud computing and the reason behind adopting it is to get some services that are hosted in different companies so they do not need to create those services by themselves. Similarly, cost reduction is another reason because after using cloud services there is no need of someone to monitor the services regularly not only the software, hardware part but also servers running with application.

He mentioned cost is the main aspect that many companies looking towards cloud since if we have to buy all services and application by ourselves it is costly and later also need to be updated, same for hardware part and server configuration too. He mentioned that speed of the system and network speed play a vital role in the adoption of cloud computing but it depends on the geographical location and off-course how much we pay for the connection. Similarly he also explained the importance of reliability and efficient storage of data since this is an issue which is concerned to both the users and the company which gives services to

see how they have built their services. So speed, reliability and efficient storage of data depend on how much money we spend (investing) in companies for connection.

Security is the issue which will always remain attached with any software or system so is the case with cloud computing since no system can be 100% secure. Once the system data storage is fixed and in later stage if there is a need of another server it will effect the system performance similarly if the workload or traffic decrease then there will be the waste of the new added server but in cloud computing there is the scalability option to overcome this problem and we pay for how much we use, customer does not have to bare the tension of this and can only concentrate on their efficient work which also increase the overall efficiency of the organization. He even said that it is not safe to store all data in cloud structure. Safe and secure of data depends on the security of the network, location of the server and services and users knowledge.

Jesus identified knowledge; level of expertise of user's (education of the users) and technology are the major challenges in cloud computing since there are still some services which cannot operate through our network service. There are still the issues of bandwidth i.e. the amount of information can send or received by the user.

He pointed some of the major security issues in cloud computing as security breach, hackers, and finally reliability and trust issues (Putting sensitive information in cloud lead to security problems in both provider and customer then there come the issues of reliability and trust). Due to the above reasons he predicts that it will take 2-3 years for a company to adopt cloud with fully secure system once they are assured by that.

He said that SLA's mainly focus on scalability, support that user can gets and how information is managed. Similarly there must be mentioned, how information is treated when users start to pay for the services. Respondent elaborate that security regarding information and data is more or less same between the providers but only difference is the agreement among provider and users (owner of that information).

In his opinion it is not a good solution to adopt cloud computing in e-Health because if we want to adopt cloud services in hospital they have to do with their own cloud. He also explained trust of the patient and associates, security of the data can be solved by persuading the customers by the vendors before fully adopting cloud computing in e-Health. Since it is the case of very sensitive and important data, they are always little uneasy, uncomfortable and always confuse as their data/information is physically out of their sight, do not know who and how they operate and manage it.

As per the respondent major advantages of cloud computing that e-Health can benefit from are: cost reduction (we can get services more cheaply because if we have an external company managing everything and we just pay what we use, no salary, less people, less investment in resources, services), scalability, fast processing and finally data availability (In the sense that data can be easily accessible with the permission of the patient if required anywhere around the world).

He explained public cloud as less secure but with little more flexible in SLA, companies normally used public cloud to test different configuration and different security measures and once they are sure about its safety they finally launch their applications in private cloud. Since if anything happen there is less risk and they do not care about it. Similarly he explained private cloud has high security with strict SLA but still risk is there and they cannot guarantee 100% secure. Vendors have to prepare the users to use cloud services by giving proper education to their users with the services.

In his opinion private cloud is safe for storing patient records and other hospital into the cloud because only the health person (doctor and nurses) and the group of people whom patient allowed can get the access to their health and other record. Doctor cannot leak the information besides him or person outside hospital likes insurance company and even not to the doctor who is not related to this issue.

Most of the big companies and hospital are just moving to online applications and some are still in local applications so it will surely take a longer time to adopt new technology as it is the case of sensitive data and also the case with people's trust with this cloud services. Similarly if the legal issue and confidence of the customer over vendor is sorted out then adoption of cloud computing will evolve rapidly.

4.2 Survey Findings

Authors had sent our survey question to 25 respondents. Until the end of the survey, authors received a total of 12 responses. These responses include both partially and completely filled survey. From those 12 responses, Authors selected 10 completely answered responses to analyze our results. It may be noted here that, from the survey authors are going to support the interview findings and also know the associate perspective regarding issues of cloud computing and the concerns for the adopting cloud computing in e-Health. These are later use to answer our research questions. Finally, authors come across some new findings in survey regarding cloud computing and e-Health. Authors used university site (BTH, its learning) to perform online survey.

Q.No1: What are the characteristics of cloud computing in your opinion?

Authors identified and summarized the opinions given by the respondents from the survey. As per the respondent, the characteristics of cloud computing are high availability, cost effective model, short time to market, self service, automated, economies of scale, standardized, clear model for payment, Pay per use/user/tick, low risk, quick start-up, operational expenditure, can be accessed anytime anywhere with internet connectivity, dynamic power on-demand, robustness, multi-tenant environment (not necessarily), infrastructure scalability, Infrastructure as a Service, security, standardized, optimized, scalable, self service delivered IT-service and distributed computer with thin client.

From the response of the respondents, authors find that automated/easy to use/fast processing have the high value in cloud computing as 6 out of 10 respondents mentioned it. 4 out of 10 respondents addresses reduce cost i.e. both OPEX and COPEX and pay per use are the next mostly important characteristics of cloud computing. Similarly, 3 out of 10 respondents mentioned that scalability is main characteristic and 2 out of 10 addressed with availability and data storage are the other important characteristics of cloud computing. There are also other characteristics come from the respondents. Those are low risk, distributed computer with thin client, security, short time to market.

Q.No2: In your opinion what are the issues involved in deployment of cloud computing?

Authors identified and summarized the issues involved in deployment of cloud computing from the survey. Those are hard to migrate data, dependencies to local systems, lack of knowledge, security, legacy issues, integration, bandwidth, end users and company agreements related the information owner, system availability, single sign on, integration with legacy systems, cloud computing can actually help to build the thin client of the existing web application, which can result in giving limited functionality of the application,

legal aspects in form of storing health data outside Sweden, compatibility, dependency, lack of knowledge, national laws and initial investment.

There are many issues raised in the deployment of cloud computing by the respondent among them security is the mostly addressed by 5 respondents out of 10, after that there comes the legal issue by 4 respondents. Similarly, 3 out of 10 respondents mentioned lack of knowledge, dependencies to the system and availability are the others issues. Some of them mentioned hard to migrate data, Integration, bandwidth or network, SLAs, single sign in, Initial investment are the other issues.

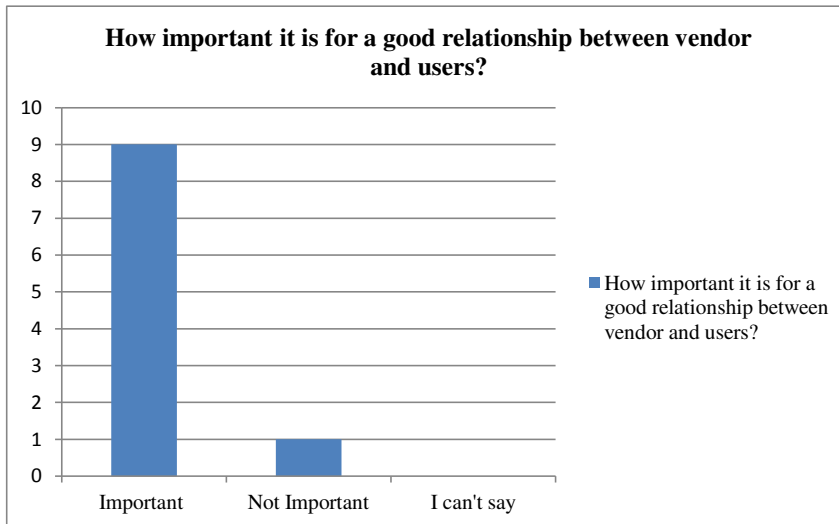


Figure 3 – Q.No3: What is your opinion over the SLA provided by the cloud computing vendors? How important it is for a good relationship between vendor and users?

Q.No3: What is your opinion over the SLA provided by the cloud computing vendors? How important it is for a good relationship between vendor and users?

From the survey, respondents had given different opinions about SLA's and answer for the importance of SLA's in relationship between vendor and users is presented in Figure 3. 9 out of 10 respondents point that SLA's are extremely important but there will be implications when service delivered through many vendors. And one respondent answered like trust is the main concern and SLA's are very hard to understand. He raised some questions about trust and guarantee access about functionality and server availability like "can you trust your cloud supplier as much as you do to your internal IT? Do they guarantee access to functionality or server availability? Do they guarantee end-to-end access? How are the response times?" One respondent answered like SLA's are establishing rights and obligations between client and provider. 2 out of 10 respondents answered that most of the vendors have unclear SLA's but IBM providing clear SLA's. One of the respondents answered like "Service Level Agreements are important between the client and service provider since the hardware resource utility for a cloud application or a platform and much more are managed by the service provider and the client has to accept the terms and conditions and has to get convinced by the limitations of cloud application."

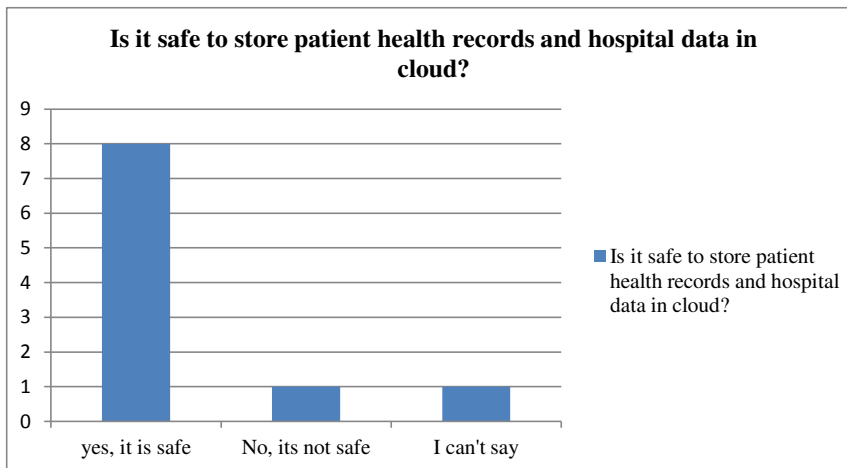


Figure 4 – Q.No4: Is it safe to store patient health records and hospital data into cloud? Why or Why not?

Q.No4: Is it safe to store patient health records and hospital data into cloud? Why or Why not?

Respondents given different opinions for this question and authors summarized the given opinions below and presented in Figure 4. 8 out of 10 respondents given that it is safe to store patient health records in cloud and 5 out of 10 mentioned that we must have trusted vendor in order to store the patient health records in cloud. While mentioning about trusted vendor one respondent raised some questions like “Who audit the vendor? What is their track record of keeping SLA? Continue of the development of products?” One out of 10 suggested that we can built a national community private cloud for storing patient health data. One out of 10 respondents compared the hospital data with bank data and he explained that “it is secured just like your bank account and you do not need to worry about the security”. One respondent told that we must need social acceptance before storing the patient data in cloud. Similarly, one out of 10 given that “I cannot give a straight answer because it depends on the type of implementation, in general aspects security of the data still a big problem, so just for this consideration if the implementation is not in a high security environment then it will be not recommended”. Another respondent mentioned that “it is not safe to store data, that’s why we haven’t really looked into this”. He added that encryption of data in cloud have to be carefully looked into.

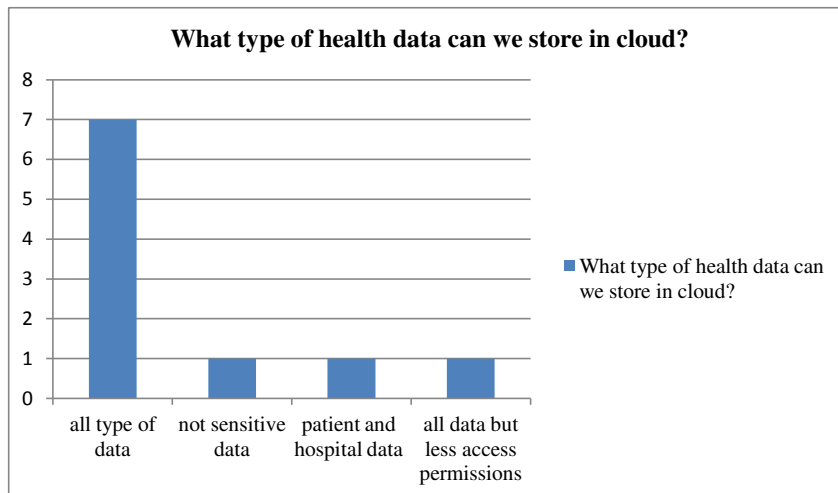


Figure 5 – Q.No5: What type of health data can we store in cloud? (Video tutorials, X-rays, personal data, Health records or specify if any)

Q.No5: What type of health data can we store in cloud? (Video tutorials, X-rays, personal data, Health records or specify if any)

The respondents were asked about the type of health data which we can store in cloud and summary of the answers are presented in Figure 5. Authors found that 7 out of 10 respondents answered that we can store any type of data like video tutorials, x-rays, personal data, health records or any hospital data. one of the respondent answered that we cannot store sensitive information like personal details, hospital economic data etc. another respondent answered that we can store health records because it would be shared with patients and non health data produced at hospital, for example economic data, project data, CAD drawings from property management. Another respondent stated that “X-rays, Personal data and all the data and content related stuff. Video files can also be stored but the accessibility may be low (Since the data/application is on cloud and since it is commonly shared by multiple users (multi-tenant), data streaming for video file may be slow). Moreover the service provider of the cloud will definitely put some constraints over such kinds of files since it is a shared environment.”

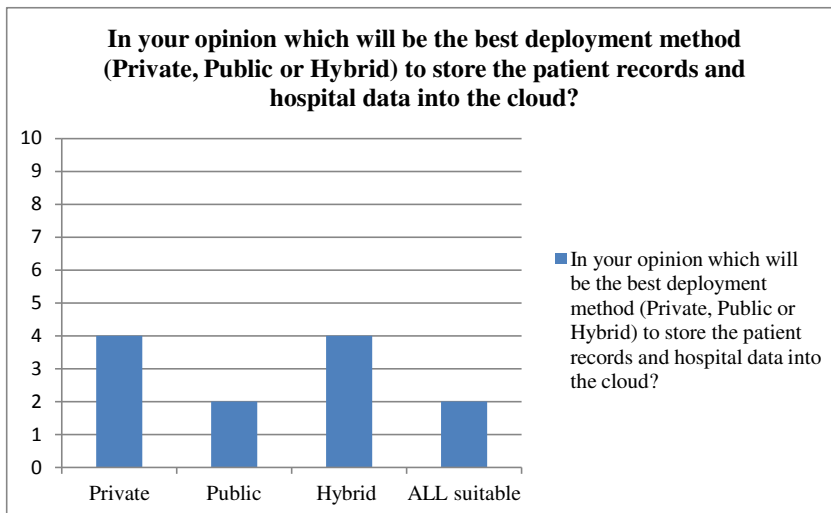


Figure 6 – Q.No6: In your opinion which will be the best deployment method (Private, Public or Hybrid) to store the patient records and hospital data into the cloud? And why?

Q.No6: In your opinion which will be the best deployment method (Private, Public or Hybrid) to store the patient records and hospital data into the cloud? And why?

The respondents were asked about the best deployment method to store the patient records and health data into the cloud. Respondents suggested different models and all are presented in Figure 6. The responses came for this question is 4 out of 10 respondents answered that private cloud is best suitable for storing health records because you can not show any personal information by law. 4 out of 10 respondents answered with hybrid cloud. One respondent answered with private or hybrid cloud and another with hybrid or public cloud. 2 out of 10 respondents go with public cloud because such cloud platform internally provides record level security for group of users who do not have access to confidential records. 2 out of 10 respondents say that all three deployment methods are relevant and one of them explained that “every method have their advantages and disadvantages. Importantly you will have to consider the sensitivity and if it is a huge amount of data and huge number of users going to access the data like more than ten thousand users then better opt to private. If the number of users are less and has less sensitivity of data public approach can be implemented. Hybrid depends on the requirement. Some data cannot be kept in cloud, some data needs to be moved to cloud so mixture of on-premises and cloud computing can be implemented” and another respondent had given that selection of deployment method depends on maturity of workloads, trusted vendors and national laws about the data storage i.e. where data could be stored.

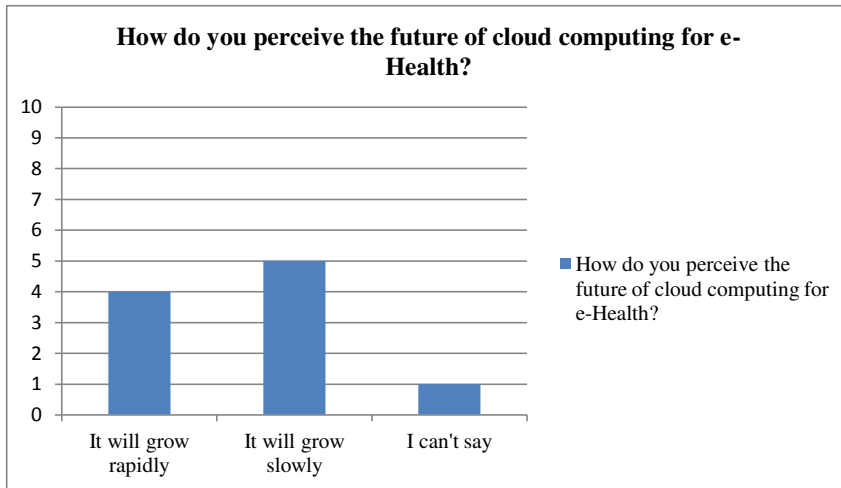


Figure 7 – Q.No7: How do you perceive the future of cloud computing in e-Health?

Q.No7: How do you perceive the future of cloud computing in e-Health?

Authors identified and summarized the future of cloud computing in e-Health from the response of respondents and presented in Figure 7. Almost all respondents hoping that e-Health will use cloud computing advantages to produce better results. Since 9 out of 10 respondents gave positive opinions about future of cloud computing in e-Health. 4 out 9 mentioned that it will grow rapidly but 5 out of 9 mentioned that it will grow slow because of legal, security and privacy aspects. One of the respondent stated that “in a few years e-health will definitely adopt cloud at a significant amount to improve services and build new type of features that do not exist today”. Some of them had given their opinions about the future as e-Health will definitely be in cloud but it won’t adopt cloud as rapidly as other sectors because of legal, security and privacy aspects. One of the respondents stated that “cloud computing is booming irrespective of domain. So e-Health can have a good future through cloud computing”. one of 10 respondents stated that “cloud can only be useful to store the data or content and generate reports (not medical reports) related to patient information, number of visits to a hospital, history of diseases, copies of medical reports etc. But as per my knowledge cloud is NOT for a real time processing (diagnosis and treatment) in medical industry”.

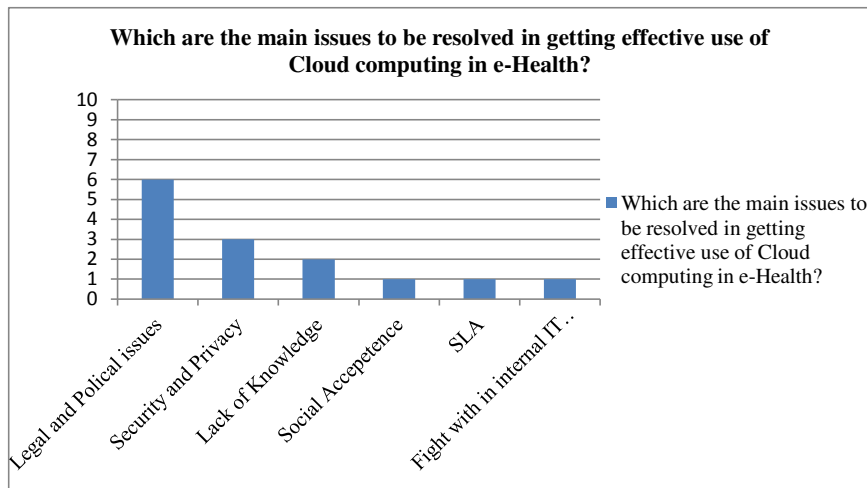


Figure 8 – Q.No8: Which are the main issues to be resolved in getting effective use of Cloud computing in e-Health?

Q.No8: Which are the main issues to be resolved in getting effective use of Cloud computing in e-Health?

Some of the issues identified from the response of respondents are as follows and presented in Figure 8. Many of the respondents mentioned that legal and political issues are the main barriers and they must be resolved in order to get effective use of cloud computing in e-Health. Some of the respondents express their view saying that security and privacy are to be resolved. 6 out of 10 respondents answered with legal and political issues and 3 out of 10 respondents answered with security and privacy. One respondent raised a new issue that “there will be a fight with internal IT department which threatened for their jobs”. One respondent answered that we must have to resolve company agreements related to information owner and another respondent answered with social acceptance is another issue to be resolved for effective use of cloud computing. 2 out of 10 respondents mentioned that lack of knowledge to the doctors and other technical staff regarding the cloud computing resources to be resolved before moving to the cloud.

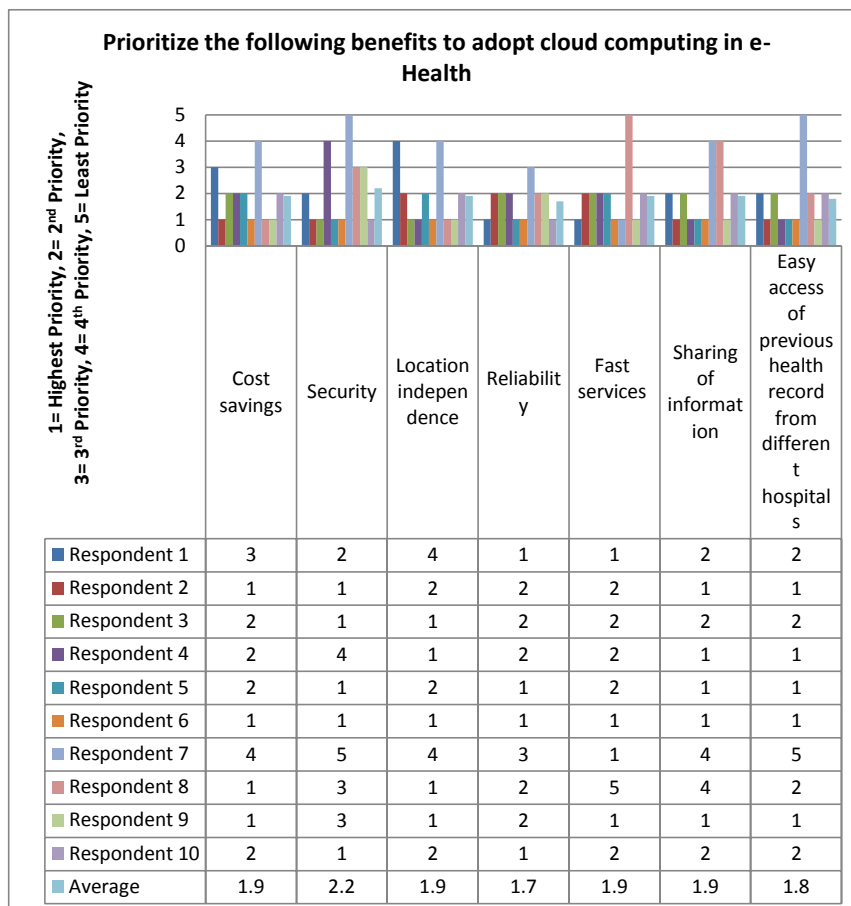


Figure 9– Q.No9: Prioritize the following benefits to adopt cloud computing in e-Health

Q.No9: Prioritize the following benefits to adopt cloud computing in e-Health

The figure 9 shows the priorities given by the respondents for benefits to adopt cloud computing in e-Health. Here total 10 respondents mentioned their priorities and at the end average of total 10 responses were calculated, where 1 denotes the highest priority and 5 as least priority of each benefit. All the benefits of cloud computing are graded after calculating the average score they gain and one which have lowest average are taken as most important benefit and one which have highest as least important. From the above table authors found that reliability as the best benefit if we adopt cloud computing in e-Health as it have average of 1.7 the lowest of all, similarly easy access of previous health records from different hospitals had next priority is the second preferred benefit with average of 1.8. With the average of 1.9 cost savings, location independence, fast services and sharing of information between different hospitals are in the third priorities as benefit. Among all the benefits security is the last benefit if we adopt cloud computing in e-Health with the average of 2.2. In the opinion of respondents security last preference as a benefit.

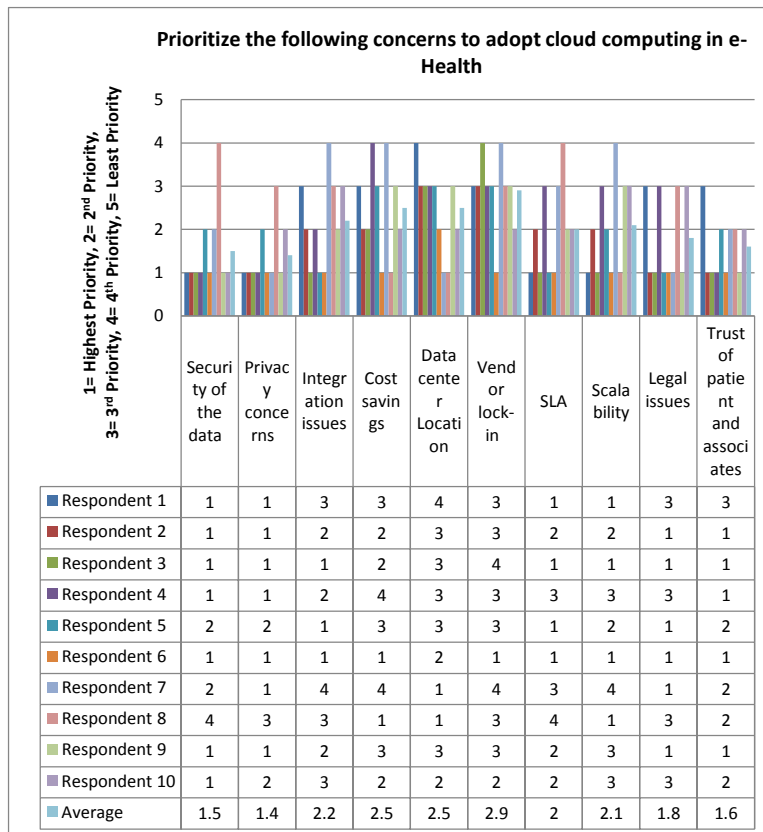


Figure 10– Q.No10: Prioritize the following concerns to adopt cloud computing in e-Health

Q.No10: Prioritize the following concerns to adopt cloud computing in e-Health

The figure 10 shows the priorities given by the respondents for different issues to be resolved before adopting cloud computing in e-Health. Here total 10 respondents mentioned their priorities and at the end average of total 10 responses were calculated, where 1 denotes the highest priority and 5 as least priority of each issues. All the issues are ranked based on the average score which is calculated from the priority given by respondents and one which have lowest average are taken as most important issue and one with highest average as least important. From the above table authors found that privacy, security and trust of the patient and associates are the main issues to be resolved before adopting cloud computing in e-Health with their average score of 1.4, 1.5 and 1.6 respectively. After this there come the legal issues with average score of 1.8 and SLA, scalability and integration are the other concerned issues with an average score of 2, 2.1, and 2.2 respectively. Respondents give minimum care when comes the issues of cost savings and datacenter location as they both

have the average score of 2.5 and vendor lock-in as the least concerned come under adoption of cloud computing in e-Health with the average score of 2.9.

Respondents had mainly identified that security, privacy, sharing information between different hospitals and trust of the patient and associates are the main concerns to adopt cloud computing in e-Health. Cost savings, datacenter location are not important in e-Health and again SLAs has vital role because these will develop good communication between vendor and hospital associates. Scalability and integration, both are important in adoption of cloud computing in e-Health.

5. ANALYSIS OF EMPIRICAL DATA

In this chapter authors presented analysis of all literature review, interviews and the survey findings. Authors come up with some of the benefits and issues of cloud computing and the main benefits and issues in adoption of cloud computing in e-Health.

5.1 Benefits of cloud computing

Following are the benefits of cloud computing through the interviews and survey's and many of the benefits are same as in literature review. Respondents explained how these are beneficial to the organization and many of respondents given same benefits with cloud computing. Authors asked question number 1 and 2 (APPENDIX A) and question number 4 and 5 (APPENDIX B) in interview to get the benefits of cloud computing and in survey, and also question number 11 and 12 (APPENDIX C).

5.1.1 Cost reduction

Literature review (section 2.3.2 and section 2.3.3) and empirical findings (section 4) are analyzed and find, cost reduction is the main benefit of cloud computing and many companies are adopting cloud computing to reduce their company's expenditure. For example, if company want to buy all services and applications by themselves, in later stages there must be a need of updating all applications, services, servers and hardware, that will cost more. If companies adopt cloud computing, they do not need to take the stress of updating the software and hardware as they can get the latest and updated resources and services relatively in less time. The consumer does not need to worry about the configuration of the system, storage capacity and capability while using the local system because all these handled and maintained by the cloud provider. Similarly, one of the respondents told that cost reduction is the main reason for adopting cloud because after using cloud service there is no need of someone to monitor the services regularly not only the software, hardware part but also the servers running with application.

5.1.2 Scalability

From literature review (section 2.3.1) and empirical finding (section 4), scalability is another major benefit from cloud computing and many of the respondents answered that scalability is the one of the main positive aspects of cloud computing because cloud can handle high traffic easily by scaling up the additional hardware infrastructure or equipments without disturbing user's normal work. It will reduce the cost of additional servers those are not being in use because if the servers are not in use then these are automatically released from the application, it will reduce the total cost because cloud computing follows "Pay-as-You- Go" model.

5.1.3 Data storage

As described in literature review (section 2.3.1) and many of the respondent mentioned in empirical findings (section 4) that cloud computing is very effective when it comes to data storage. There are various data center spread throughout the world and organizations can store large amount of data in datacenters as per their convenience to get fast and easy access of services. One of the respondents mentioned that storing data in cloud is cheaper than traditional storing of data. Many of the respondents suggested that it will be good to store the data in more than one cloud because if we have a problem with one cloud then we can access the data from another cloud and they also explained the problem occurred in Amazon EC2

i.e., server down in data center because of this many of the websites gone offline for days. Still cloud storage is better than any other. One of the respondent told that cost of the data storing is not a biggest issue but security is the main issues while using multi cloud. While another respondent said that, it is not safe to store all data in cloud structure.

5.1.4 Sharing of resources

Sharing of resources is one of the main benefits of cloud computing. If the company is established worldwide then the adoption of cloud computing can be beneficial to the company in the form of using storage, applications, hardware and centralized resources remotely so that the company can eventually reduce their expenditure.

5.1.5 Efficiency and Reliability

As described in literature review (section 2.3.1) and empirical finding (section 4), efficiency and reliability are the benefits of cloud computing. One respondent mentioned that adoption of cloud computing in organization will increase the efficiency and reliability of the applications since this is an issue, which is concerned to both the users and the company. The network and system speed will play a vital role in adoption but it also depends on geographical location and off-course how much we pay for the connection. Respondents also mentioned that vendors provide their services to the organizations 24X7 manner so that if customers got any problem with the applications or services then vendor will respond immediately to fix the problems. As per the respondents cloud computing provides good, reliable services and applications so many of organizations are moving towards cloud.

5.2 Issues in cloud computing

Following are the issues and challenges of cloud computing raised from the interviews and survey and most of the issues are found to be same in literature review, interviews and survey but there are also some new issues addressed by the respondents. In interview (APPENDIX A) authors had asked question number 3, 4, 4.a, 5, 6 and 7 questions and similarly, in survey (APPENDIX C) authors asked question number 6, 7, 8 and 12 questions to formulate the overall issues.

5.2.1 Data Storage

As discussed in literature review data segregation and data lock-in are the important aspects of data storage (section 2.4.1 and section 2.4.5). From interviews and survey authors define that cloud has many advanced security features but still all data cannot be stored in cloud because it depends on trusted vendor and deployment model we are adopting. One of the respondents explained that system can be accessed from outside the firewall as it is delivered through internet then it leads to data leakage. Most of the respondents highlighted concern about the location of data storage and safety. For removing issues like data loss or unavailability of cloud, save the data in multi cloud i.e. at least we have to store in two datacenters ignoring the slight increase of cost since data security is more important than cost in many cases.

5.2.2 Data Security

From literature review (section 2.4.4, section 2.4.6, section 2.4.8 and section 2.4.9), privacy, confidentiality, software licensing and security of the data are the most alarming issues in cloud computing. From interviews and survey respondents mentioned that data encryption can be one basic step to protect our servers and data from unauthorized persons. One

respondent expressed his view about the security like it's an issue in cloud computing but it's not big issue as people making it and he concluded that security with in cloud is just as good as any other data storage now using. Most of the respondents had pointed security breach and hacking the data are the major security issues in cloud computing. Similarly, another respondent highlighted the issue of being able to gain the access of the system from outside the firewall since all services are delivered through internet.

5.2.3 SLA

As described in literature review (section 2.5), Service Level Agreements (SLA) play crucial role in adoption of cloud computing as it is the serious issue to consider before recording a common understanding about services, priorities, responsibilities, guarantees, and warranties between the cloud provider and the cloud users. Failure to follow this agreement is usually leads to heavy penalty, which should also be defined in agreement. Respondents also defined SLA in interviews and survey as agreement between end users and service provider. One of the respondents mentioned that SLAs have vital role in cloud computing in the sense that if organization or users have critical application then it is very essential to have good SLA. It will play great role to gain the trust of the customer and to maintain security of the data. SLAs, security and trust of patient run parallel to one other i.e. good SLA's make services good and which leads to more trust of the customers, similarly if there is bad SLA that could affect the security. SLA of public cloud is already designed and it is very hard to modify where as in private cloud SLAs are discussable and changeable.

5.2.4 Reliability and Trust issue

As described in literature review (section 2.4.7) lack of speed, network failure and high bandwidth internet connection cause problem in accessing cloud services can results in loss to the company by causing extensive time delays. From empirical findings, authors confirmed that putting sensitive information in cloud lead to security problems in both provider and customer then there come the issue of reliability and trust. One of the respondents told that speed of the system and network speed play a vital role in the adoption of cloud computing but it depends on the geographical location and the amount we paid for the connection, similarly one respondent express his view said that there are still issues with bandwidth i.e., the amount of information send or received by the costumer. Another respondent suggested that do not trust the cloud services fully and not store sensitive and important data in cloud. Another respondent also mentioned that the customer do not know where data will be stored and how secure it is. And all the data should not be kept in cloud and many applications are not built for cloud so before storing any data or doing any kind of business with cloud providers first of all we must have to trust the cloud provider if we do not trust the provider or do not feel comfortable with them than we should not go into cloud.

5.2.5 Knowledge

One of the respondents in interview mentioned knowledge, level of expertise of user's (education of the users) and technology are the major challenges in cloud computing so vendor have to explain their customers about their system and its working procedure.

5.2.6 Migration of Data

One of the respondents from interview pointed out that migration of current data into cloud as one of the major issue and it is making companies to think many times to go in to cloud. To overcome from this migration issue companies are carrying good security frameworks and having a strong architecture with security promises. To implement very strong governance around IT and overcome these challenges, there is a need for good life cycle management for the execution of different soft code to make it able to move to cloud.

Similarly Integration of old and new data, traditional system and cloud computing are the two recently alarming issues of migration of data.

5.2.7 System availability

As described in literature review (section 2.4.3 and section 2.4.10), There are some of the issues which play a great role in the system availability like offline cloud and control of your whole system. As cloud computing is fully dependent upon an internet connection and if user has a problem with internet connection then he is unable to access the application or data.

5.2.8 Deletion of data

From literature review (section 2.4.2) authors found that the deletion of data is one of the shadowed issue of cloud computing but it play a vital role in the adoption of cloud computing. Many consumers will be stored their data in same data center, server and hard disk. after completion of their task with cloud if the consumer want to cancel the contract and withdraw the SLA from the provider and want to delete his data i.e. completely remove from the cloud, it is very hard to do since deletion of data can only be done by erasing entirely, repeatedly re-writing the disk sectors with random data, and possibly formatting the server's hard disk which is not possible to do so there always remain the threat of recovering the erased data or if it is not perfectly overwritten or overlapped with random data then there will remain the chance of leaking information out.

5.3 Benefits to adopt cloud computing in e-Health

In interview and survey authors asked Question number 9 (b) and 9 respectively to get the benefits to adopt cloud computing in e-Health.

5.3.1 Scalability

As it mentioned in section 5.1.2, scalability is the major benefit to the cloud. From the interviews and survey the respondents answered that scalability is the good benefit to the hospitals if the adoption of cloud computing in e-Health takes place. Hospitals can easily up and down their servers and hardware whenever they need and it will reduce the cost of the unused servers and hardware. Hospitals have to pay what services they used so it will reduce the maintenance of hardware.

5.3.2 Data storage

As described in benefits of cloud computing section 5.1.3, data storage is the main benefit from the adoption of cloud computing. When the respondents were asked about the type of health data can be stored in cloud, many of them answered that we can store any type of hospital data like video tutorials, x-rays, personal data, health records and hospital data. one of the respondent answered that we cannot store sensitive information like personal details, hospital economic data etc. another respondent answered that we can store health records because it would be shared with patients and non health data produced at hospital, for example economic data, project data, CAD drawings from property management. Another respondent stated that "X-rays, personal data and all the data content related stuff can store in cloud. Video files can also be stored but the accessibility may be low (Since the data/application is on cloud and since it is commonly shared by multiple users (multi-tenant), data streaming for video file may be slow). Moreover the service provider of the cloud will definitely put some constraints over such kinds of files since it is a shared environment". Efficient storage of data depends on how much money we spend (investing) in companies for connection. Basically the datacenters of the cloud vendors will be in anywhere in the world and the main problem is storing the patient data outside the home country. Patient

data is very important. For example, if a famous politician comes to health care, it's very important to secure his personal data from media.

5.3.3 Data Sharing and data availability

Data sharing is the major benefit to e-Health from cloud computing if we adopt cloud computing in e-Health. As described in benefit section 5.1.4 about sharing resources, it is the same and here we can share the information between different health organizations while going from one to another either within the Sweden or outside the Sweden. In current system, if we want to go to one hospital to another hospital, we do not have access to the other hospital data. Then doctors should have to check the patient from beginning for his disease or patient have to take papers from that hospital, it is critical process and which is not only costly but also time consuming. Health care is an important field as delay in fraction of section take a life of a person. One of the respondent also stated that "reaching the information in convenient way via internet is advantage i.e., when I travel out of the country and if I need medical checkup I can reach to my file easily". By sharing the data between multiple hospitals, doctors can have easy access to the patient information and give the prescription to the patient based on their old records. Similarly one of the respondents told that "Doctors can access the data from health records anywhere from the world. Maybe it is possible to implement any application in cloud and keep the storage center in same hospital or any other place". Data availability is easily accessing the data remotely with the permission of patient from anywhere in the world.

5.3.4 Reliability and efficiency

Reliability is also one of the benefit for e-Health from cloud computing. As described in section 5.1.5, reliability is totally based on cloud provider who provides services to the customer. Many of respondents told that efficiency is helpful to speed up the services and get the fast results. The fast processing and easy to use have the high values in cloud computing as most of the respondent mentioned it. Automation is another advantage of cloud computing.

5.3.5 Cost reduction

Cost reduction is one of the benefits if we adopt cloud computing in e-Health. Cost reduction is described benefit of cloud computing in section 5.1.1. With the adoption of cloud computing, we can share the resources then ultimately it will reduce the cost. Similarly, hospital now can concentrate on their health service and leave the job of IT to the trusted vendor which saves lot of money to spend on IT infrastructure. With cloud computing, we can get services cheaper because if we have an external company managing everything and we just pay what we use, with less employees, and less investment on resources. Some of them mentioned that reduction of cost is not be a big step for the patients but security of the data and sharing of information between the hospitals is most important benefits for the patients.

5.4 Issues in adopting cloud computing in e-Health

From respondents point of view following are the concerns for adopting cloud computing in e-Health. Authors asked question number 9, 9.a. and 11 from interviews whereas question number 10, 11, 12 and 15 respectively from survey to find the concerns for adopting cloud computing in e-Health. One of the respondent told that we cannot predict the challenges that come in adopting cloud computing in e-Health in future because cloud computing will not use all the security measures what we are using today.

5.4.1 Data Security

As mentioned in section 5.2.2 and section 2.9.2, data security is the main reason for the delay of adopting cloud computing in e-Health. When the interviewees were asked about its impact in e-Health, many of the respondents agreed that security and privacy of the data are the main challenges in adoption of cloud computing in e-Health. To secure the data, vendor has to look and have to be sure that data has not been leaked between applications. Another issue is being able to gain access the system from outside the firewall by hackers or unauthorized users since all is delivered through internet. One respondent told that data security is one of the important issues to be solved or quarantined before adopting cloud computing in e-Health. The security risk can be minimized if the vendor can demonstrate in front of the patient and other hospital staff about their security measure and how it restricts from other unauthorized users. Another respondent stated that security setups in Swedish hospitals are increasing and they are building security systems like authentication, smart cards and national level security. Regarding security of the patient records, respondents believed that it is very important to ensure the patient data in health care and mentioned that we have a security system for patient's journal. Respondent added that if a famous politician comes to health care, it is very important to secure his/her personal data from media. One respondent even told that the data and information are saved just like in our bank account so no need to worry about the security.

5.4.2 Privacy concerns

It is one of the most concerned issues arise in the adoption of cloud computing in e-Health and as described in section 2.9.1, privacy is one of the ethical barrier of adoption of e-Health. One respondent told that trust of patient can be solved with proper communication and explanation about the system like how data is protected, how solution is designed to the clients/patients or people. Respondents further explained trust of the patient and associates, security of the data can be solved by persuading the customers by the vendors before fully adopting cloud computing in e-Health.

5.4.3 Datacenter location

It is one of the major issue in adoption of cloud computing in health sector and many respondents had shown their query on the legislation issue about the datacenter location i.e. we cannot save the health data if the datacenter is outside the origin country. Since e-Health store patient and health data which they surely want to keep confidential within their reach and under the law. One respondent told that we must need social acceptance before storing the patient data in cloud and in order to use cloud all legal issues, that have to be fulfilled especially SLA levels, disaster recovery and data storage places.

5.4.4 SLA

As explained in section 5.2.3, we found that SLA play main role to obtain the trust of the customer and to maintain security of the data. From the interviews and survey response on SLAs, authors found that cloud SLA's are very crucial for any organization. One respondent mentioned that privacy of the patient is most important and we need to ask them to sign the concerned documents before storing the patient data in cloud. Once both the customers and vendor come to common consensus, they will have an agreement which will increase the confidence of the customer over the vendor. SLAs and trust of patient run parallel to each other i.e. good SLAs give enough security which makes service effective and it will lead to more trust of the customers. Issue like vendor lock-in are the main concerned area of people regarding adoption of cloud computing in e-Health but good SLAs will help to minimize this issue.

5.4.5 Data Storage

As mentioned in section 5.2.1, clouds have many advance security features but still we cannot store all data in cloud structure and the organizations have to be sure about the security of data when using different databases. In the case of adoption of cloud computing in e-Health, data storage plays a vital role because patient health records and personnel data cannot be kept in cloud having its datacenter outside the country without the government consideration or approval. Many respondent feels uneasy and uncomfortable when storing their sensitive and important data like health record in cloud as their data/ information is physically out of their sight, do not know who and how they operate and manage it. Regarding storing all data in cloud many respondents believes that it is safe but it depends on which cloud and vendor you are bonding with.

5.4.6 Availability and Reliability

As discussed in the section 5.2.4, putting sensitive information in cloud leads to security problems to customer. Reliability issue in health data is even more vital in the case of cloud computing as it is the key for the trust of the patient over the data. The health data is confidential between patient and the doctor so while putting data in the cloud, it arise a question of its availability and reliability of the data which we do not know where data is stored and who is operating it. Similarly, availability of low cost internet is another issue for adopting cloud computing.

5.4.7. Knowledge

As mentioned in 5.2.5, cloud computing itself is the new field and it needs some time to be familiar with and start to do anything under it. Many organizations are just starting to adopt online applications so they need some time and knowledge to adopt cloud computing. People working in health are lacking in computer knowledge so it will need some knowledge about the technology before adopting. As discussed in 5.2.5, vendor have to give adequate training and workshop to increase the knowledge level of the staff and patient about the cloud computing. Vendor is also need to demonstrate their privacy and security of their system to the patient to increase the trust. One of the respondents expressed his view on the adoption of cloud computing in e-Health saying that it will take at least another 10 years to aware of the technology.

5.5 Deployment model for e-Health

From the interviews and survey, authors found that many of the respondents had explained different deployment models. Authors asked question number 6 and 10 in interview for getting the answers about deployment models and best deployment model for e-Health. In survey, authors had given question 13 for getting information about deployment model.

When asked about the deployment models, respondents explained the benefits and challenges with three deployment models. Firstly public cloud, the main benefit is lower price and challenges are security, reliability and flexibility. Private cloud benefit is more secure and challenge is not as economic as public. Finally, hybrid cloud benefit is to be able to communicate among the clouds and challenge is to set them up. Another respondent answered public cloud as less secure but with little more flexible in SLA, companies normally used public cloud to test different configuration and different security measures. Once they are sure about its safety they finally launch their applications in private cloud. Private cloud has the high security with strict SLA but it cannot guarantee 100% secure.

Organizations must have to trust the vendor and vendor have to prepare the users to use this kind of services and give proper education to their users.

Many of the respondents suggested that private cloud is safe for storing patient records and other hospital data into the cloud because only the health person (doctor and nurses) and the group of people whom patient allowed can get the access to their health and other records. Doctors cannot leak the information besides him or person outside hospital likes insurance company and even not to the doctor who is not related to this issue. Among them one respondent told that private cloud is safe to store patient and health records because of security demands and he added that if all these legal obstacles are ok to resolve then it is possible to adopt cloud in e-Health but one respondent was totally against of choosing deployment method as per him it depends on the data that we want to store in cloud.

6. DISCUSSION AND VALIDITY THREATS

6.1 Discussion

In order to have efficient and significant discussion on benefits and issues of adopting cloud computing in e-Health, authors used literature, interviews and survey. Authors discussed benefits and issues of cloud computing (section 6.1.1 and section 6.1.2) from analysis of empirical data (section 5.1.1 – 5.1.5 and section 5.2.1- 5.2.8 respectively) and also the benefits and issues in adoption of cloud computing in e-Health (section 6.1.3 and section 6.1.4) from analysis portion (section 5.3.1 – 5.3.5 and section 5.4.1 - 5.4.7 respectively). Finally, the best deployment model for e-Health (section 6.1.5) has been presented by using analysis portion (section 5.5).

6.1.1 Benefits of cloud computing

Authors analyzed literature review as well as opinions from the interviews to find benefits of cloud computing. Respondents explained, how cloud computing is beneficial to the organizations. Authors observed that many of the associates mentioned scalability and cost reduction as the major benefits of cloud computing.

After analyzing the associate's opinion, authors came across some of the benefits of cloud computing. Those are reduction of cost, data storage, scalability, network speed and sharing of resources. Many of the respondents told that reduction of cost is main benefit to the organizations from cloud computing. It will reduce the capital investment to the organizations by reducing maintenance costs of hardware. Respondents also mentioned that data storage is the one of the major benefit to the cloud computing. Many of the respondents answered that scalability is one of the main positive aspects of cloud computing because cloud can handle high traffic easily by scaling up the additional hardware infrastructure without disturbing user's normal work. Respondents also mentioned that sharing of the resources worldwide is one of the main benefits of cloud computing and many of them told that network and system speed will plays a vital role. As per the respondents many of organizations are moving towards cloud because of these benefits.

6.1.2 Issues of cloud computing

Authors analyzed literature review as well as opinions from the interviews and survey to find issues of cloud computing. Many of the respondents mentioned that security is the major issue in cloud computing and because of this some of the organizations are still thinking to move to cloud.

After analyzing the responses from the associates, authors identified that data security, data storage, SLAs, reliability and migration of the data are some issues of cloud computing. Many of the respondents mentioned that data security is the major issue in cloud computing and encryption is the one basic step to protect our data and servers from unauthorized persons. Respondents pointed out data storage are another issue that we cannot store all data in cloud because it depends on trusted vendor and deployment model we adopted. And many of them suggested that for removing issue like data loss, we need to store our data in multi cloud i.e. at least we have to store in two data centers. Many of respondents mentioned that SLAs play vital role in cloud computing in the sense that if organization or users have critical application then it is very essential to have good SLA. Reliability is also another issue and it is the key for the trust of the patient over the data, system and vendor over all. One respondent suggested that do not trust the cloud services fully and not store sensitive

and important data in cloud. Some of the respondents mentioned about migration of data from current system to cloud are one issue.

6.1.3 Benefits in adoption cloud computing in e-Health

After analyzing the associate's opinions about benefits of cloud computing, authors observed that there are some benefits in adoption of cloud computing in e-Health too. Authors observed that many of the associates mentioned that sharing the data between different hospitals is the major benefit in adoption of cloud computing in e-Health.

After analyzing the associate's responses, there are some benefits that e-Health can benefit from cloud computing and those are cost reduction, scalability, reliability, efficiency and data storage. Authors identified that if we share the resources, then it will reduce the cost and now hospital can concentrate on their proper health service and leave the job of IT to the trusted vendor with one IT officer to monitor it which saves lot of money spends in IT infrastructure. From the scalability, hospitals can up and down their servers and hardware whenever they need and it will reduce the cost of the unused servers and hardware. Reliability and efficiency will be the good benefits to the e-Health and efficiency is also helpful to speed up the services and get the fast results. About the type of data to store in cloud, authors analyzed the responses of respondents and then mentioned that we can store video tutorials, x-rays, health records and other hospital data in cloud.

According to authors, cloud computing is best for adopt in health care. Health care can produce good results by using benefits of cloud computing. There are still some issues with this technology and these issues are presented in section 6.1.4.

6.1.4 Issues in adoption of cloud computing in e-Health

From the interview and survey authors analyzed that many of the associates highlighted many issues regarding adoption of cloud computing in e-Health among them legal issue about the datacenter location and the trust of patient are the prime concerned.

Authors identified data security, SLA, data availability and privacy of the patients are the other issues found from interviews and survey. There is one new issue evolved recently i.e. knowledge or expertise of the users in cloud computing, as cloud computing itself is the new field in today market it need some knowledge to be familiar with and start to do anything under it since many big organization are still following or just starting to adopt online application so they need some time, training or knowledge to adopt cloud computing. And the respondents highlighted legal issue as the major issue come on the way of adoption of cloud computing in e-Health since without the concern of government or from the approval of politician, we cannot store the data in datacenter i.e. located in different country than its origin. Similarly, as the patient record cannot be accessed without the approval of patient since it includes their social status and medical history, the leakage of these data may bring major problems to them like denying their insurance approval and there is also the fear of social stigma so privacy of patient hold the key. So for the successful adoption of cloud computing, the vendor has to solve the issues raised till now and also the forthcoming one.

6.1.5 Best Deployment model for e-Health

Authors analyzed the opinions from cloud computing and e-Health associates and concluded that private cloud is best deployment model for storing patient and health data because only the health person and the group of people whom patient had allowed can get the access to their health and other record.

Authors identified the benefits and challenges of deployment models from the responses of respondents. About public cloud's benefits, are lower price, flexible SLA's and challenges are less secure, reliability and flexibility. Coming to private cloud, benefits are more secure with strict SLA's and challenge is not economic as public. And finally hybrid cloud has a benefit that able to communicate among the clouds and challenge of hybrid cloud is that setting up the connection. From these three deployment models many of them suggested that private is best deployment model because patient data and health data must be confidential and secure than any other data. If the adoption of cloud computing in e-Health is takes place then private is the best option for storing the data.

6.2 Scenarios

6.2.1 Scenario 1: Data Sharing

Assume a person in one city or even country goes to another city or country for different purpose like study, work, trade or to visit and unfortunately if he/she met with an accident or has serious health problems, then the doctor (health personnel) must try to look his previous medical history before prescribing any medical and medical treatment. Because if he/she has been patient of same disease or other there must be prescription based on old records since there are many crosscutting diseases i.e. one medicine advantage will be disadvantage to another. But in this case he/she does not have any old medical records with him so for getting old records patient called to previous hospital and takes an appointment with the prescribed doctor and made a discussion with him.

The main problem here is, time taking for the appointment with the doctor as per his/her convenience. Time is crucial and every second is important in health field. To maintain the continuity of the medical treatment, there must be a proper means of communication between previous health care personnel (doctor, nurse etc) and the new doctor, nurse.

In the above situation there is plenty of time wasting between transferring data between doctors. If we use cloud computing, then hospital staff store all patient data in cloud then doctors can access the patient data through cloud from anywhere around the globe. To maintain data in cloud, we must have to share medical data or record which includes a chronological documentation of events, diagnosis, action taken, laboratory results etc. So there come the problem of medical record sharing which will be against the patient's trust, ethical issue and if it is across country it is against law but the sharing is mandatory to saves the life of patient and undergoing quick treatment. In this case, if the whole medical records of the patient has been in cloud maintaining the trust, privacy and security issue, it can be easily retrieved and access in time. It will minimize the time consuming process for accessing the data. So that patient can get quick necessary treatment which can save his/ her life. One of the respondents also mentioned about this advantage that "Sharing the data between different health organizations when going from one place to another, from one county to another. Currently, if we visit a hospital, our data recorded and stored in their databases. However, when we need to visit a hospital, our records are inaccessible in their data systems. In such scenario, we are likely to go through all the processes from the very beginning. This is both costly and time consuming. Such delays in health care may put a patient's life at risk" and another respondent mentioned that "data availability throughout the world is the major advantage and it will be beneficial for the fast treatment to the patient".

One of the best solutions to get access to the cloud data maintaining trust, privacy and security issues is through getting permission from the patient himself/herself. By giving the patient (individual) control over their medical data we will achieve better results in both privacy protection and improved quality of this information. To solve the legal issue the data can be kept in hospital own private cloud and the health personnel who want to get access the patient record on the approval of patient himself/herself will be in touch with previous

health personnel and transfer it to his (new hospital) private cloud. After completing the treatment his/ her record is updated by hospital personnel or patient themselves and uploaded to the previous hospital private data.

6.2.2 Scenario 2: Data Storage

Assume the patient was suffering from frequent headaches and was unable to go to the hospital then any one among his/her relatives has to go to hospital to take medicine where the pharmaceutical or doctor may take time to authenticate and it's a problem for the patient to wait for a long time for the medicines.

One of the solution is with cloud computing. Patient can store all his old medical records, prescriptions, X-rays in cloud with authentication. If patient come across above situation then it will be very helpful to access the data from cloud. Patient can also store their every day diet based on doctor prescription and give access to his data to physiotherapist and gym instructor. So that he/she can maintain his body fitness based on suggestions from gym instructor and physiotherapist.

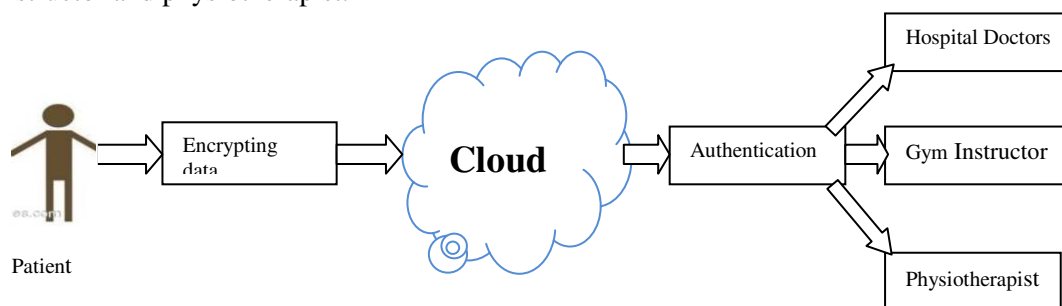


Figure 11: Storing patient data in cloud

Above diagram explains how the patient data (medical prescriptions, x-rays, MRI, health data etc) will be accessed by the hospital doctors, gym instructor and physiotherapist. First patient will store all the data in cloud by encrypting it. Then if anyone want to access the patient data, patient have to give access to the particular person by authenticating himself/herself then only they can get access of those data from cloud. Patient can share the data anywhere around the world. Cloud computing will reduce the time for accessing the data and by using cloud anyone around the world can access the data within minutes.

This proposed solution have got some flaws like if patient have fully right to approve and deny the permission of health personnel to access their health data they may deny the right proposal with the fear of being exposed or shyness and similarly they may also change their record which will eventually leads to the false treatment so to avoid this all, authors proposed the mutual understanding approval to access the data i.e. both the party's, health personnel and patient have to come in common understanding before editing the record or updating the record and secondly patient only have got read only (control) permission over their data so that they cannot modify by their own but can go through their record any time and health personnel when updating the patient record they have to take the permission to update.

6.2.3 Scenario 3: Multi cloud

Assume that, one hospital stored all hospital data in one of the major cloud providers. There was server crash in that cloud and then the hospital end up with the loss of all data. One of

respondents also mentioned that “storing all data in cloud is not safe because if you had kept your server in Amazon and if something happened to your data, who is responsible? Would Amazon care? Probably Amazon does not care”. If the cloud provider goes belly up then also hospital ends up with loss of data.

Assume that Hospital 1 and Hospital 2 are storing their health data in cloud A but Hospital 2 is simultaneously storing the health data in Cloud B ignoring the cost factor. Suddenly there comes the problem in Cloud A and server goes down then Hospital 1 end up with loss of data. But Hospital 2 accessed the health data from Cloud B and continued with their work without interruption. Hospital 2 followed multi cloud technology so it didn't end up with loss of data.

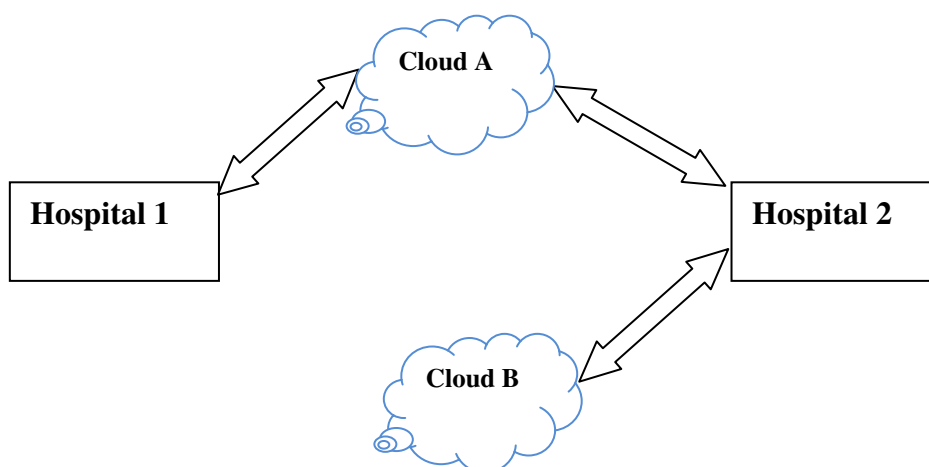


Figure 12: Storing data in Multi Cloud

Multi cloud is the best option for the health data because if cloud is down or provider goes belly up then the hospital can still access their data from the second cloud and continue the work without interruption. One of the respondent mentioned that “we must have to store data multi cloud; at least we have to store in two data centers and cost of the data storing is not a biggest issue but security is the main issues while using multi cloud”. By providing more security features we can stop hacking the health data and personal data.

6.3 Validity Threats

6.3.1 External validity

According to Damm (2007) and Berander (2007) validity that make sure that the results obtained from one research work can be generalized or applied to other research setting as well or not is called external validity.

Selection of wrong sample or selecting a wrong group of people to represent a population can cause threat to external validity as result from such sample size cannot be generalized to whole population. In order to minimize these threats the authors selected interviewees based on having certain knowledge of cloud computing and also having certain knowledge of health care domain. This study was performed to see and analyze the people's perceptions towards the adoption of cloud computing in e-Health so authors selected associates with different expertise in order to have diverse opinion on the subject.

Author's goal was to find and analyze the perspective of the associates in the field of cloud computing and healthcare. The authors believe that the results can be generalized since one of the objectives of qualitative research is to choose a small amount of people which then can give insights to wider range of population (Dawson, 2002).

6.3.2 Internal validity

According to Berander (2007), Damm (2007) and Wohlin et al. (2000) the validity, which mentions that threats to internal validity are influence by the cause and effect relation of the treatment and outcome and it allow the researcher to draw conclusions.

Our research is exploratory in nature and collection of open ended questions. The respondents are free to give their view without being affected by its history, trend and market. The research is designed by keeping the time frame in mind as per the course required and it does not include any cause and effects but only the view of the respondents are counted so it will eliminate the remaining and related risk.

According to Wohlin et al. (2000) selection of the subjects for the research study also affects the internal validity .This threat is eliminated with the selection of interviewees from cloud computing and health care side. All the interviewees were related to the main area of the study in one way or other way.

6.3.3 Conclusion validity

According to Berander (2007) and Wohlin et al. (2000), Conclusion validity is called as the validity process that has been done to carry out the required definite results which are reliable and quite enough to the researchers to lead the on-going research work towards the accurate conclusion.

Interview questions and survey questionnaire were designed and has been sent to supervisor for her feedback. After getting the approval from the supervisor the questions were finalized. Authors were conducted tests in advance with interview questions and as well as survey questions in order to restrict any potential threats to conclusion validity.

According to Wohlin et al. (2000), heterogeneity of subjects cause to potential threat to conclusion validity of the research. The subjects involved in the research from different educational backgrounds and experiences then this situation is called heterogeneity. The authors eradicate this threat by selecting the subjects from cloud computing domain, however some interviewees were selected from e-Health domain. Survey had been sent to associates in cloud computing and as well as health care. This research work mainly aims to find implications for adopting cloud computing in e-Health.

6.3.4 Construct validity

According to Wohlin et al. (2000) and Berander (2007), construct validity is showing the relationship between theory and observation. Evaluation apprehension and mono-operation bias are the threats to construct validity.

The authors eradicated evaluation apprehension threat to construct validity by selecting interviews based on their interest. Before the interview, authors discussed with interviewee and this helped to minimize the threats to construct validity. In survey, authors eliminated the threat to construct validity by not mentioning the respondent's names. Similarly, mono-operation bias threat is eradicated by interviewing eight interviewees in this research study. As well as in survey also authors selected the respondents from both cloud computing and health sector.

7. EPILOGUE

7.1 Research Questions

RQ1. What is the current state of art of cloud computing and the issues involved in the deployment of cloud computing?

The authors answered RQ1 through literature review followed by interviews and survey. Authors had conducted literature review on cloud computing to find the current trends in it and had given significant information about the cloud computing (Section 3.1 – 3.6). The issues involved in deployment of cloud computing are listed from literature review, interview and online survey. In interviews and survey, Associates (cloud computing and e-Health) had given their opinions about different issues in deployment of cloud computing (section 5.2). Some of the issues are data storage i.e. where data is storing, data security i.e. is it safe to store all data in cloud, SLA i.e. agreements between customer and vendor, knowledge about the technology i.e. cloud computing is new technology and only some people know about its working and usage and migration of data i.e. migration of current IT data in to cloud. All these issues came from literature review, interviews as well as survey.

RQ2. What are the Associates concerns and factors regarding adoption of cloud computing in e-Health?

RQ2 was answered by authors in three steps in this thesis work. At first authors carried out a literature review (section 2.4.1 – 2.4.10) and find some concerns regarding cloud computing. Based on the concerns found in literature review authors conducted interviews with associates (both cloud computing and health care) and come-up with some issues involved in adoption of cloud computing in e-Health. Authors made a questionnaire for the online survey based on the results of interview to support the interviews findings. Finally from the interviews and survey authors found issues in adoption of cloud computing in e-Health (section 5.4.1 – 5.4.7).

From the interviews and survey findings, authors identified concerns for adopting cloud computing in e-Health from the associates i.e. both the cloud computing and health care. Some of the main concerns in adoption of cloud computing are listed here. Associates identified that datacenter location is the main issue to adopt cloud computing because as health data is more secure than any other data and data must not leave the original country. Associates mentioned that sharing the patient data between different hospitals will be easy by adopting cloud computing. It is also observed that there are some concerns about security of the data and also the people have fear about their data, where the data will be stored and who are accessing it.

RQ3. What is the future of cloud computing in e-Health?

Authors answered RQ3 by providing definite guidelines (section 7.2) by using literature review (RQ1), interviews and survey (RQ2) conducted with the Associates. RQ3 is answered by results of RQ1 and RQ2.

7.2 Guidelines presented by authors

- **Awareness to the patient and associates about cloud computing**

As cloud computing is a new approach most of the people are still unaware of its features and have certain fears in data confidentiality so they are reluctant to put their data in cloud. People working in health lacked in computer knowledge so before starting to adopt cloud computing vendor have to give adequate training and workshop to increase the knowledge level of the staff and patient about the cloud computing and also need to demonstrate their privacy and security of their system to increase the trust of the patient or users.

- **Secure and flexible SLAs to use patient data**

As SLAs are key elements for the success of any legal contract or agreements so it must be formed with the mutual understanding of both the providers and customers before adopting the cloud services. As it is the case of health data and personnel history the complexities of SLAs make people fear or stop from going into the cloud so there must be the secure and flexible SLA formed by the mutual understanding of vendor and patient which help to remove the risk like data-lock in, security level and the cost issues. Risks like data security and data availability can be resolved by the concept of multi-cloud so it must be listed in the SLAs and discussed with patients. Authors described about multi cloud in scenario 3 (section 6.2.3) i.e. if we had problem with one cloud and access the data from another cloud without disturbing the ongoing work.

- **Gaining the trust of the patient**

As explained in scenario 2 (section 6.2.2) trust of the patient is more important in health care. Moreover it's necessary to prevent any unauthorized access, whenever someone wants to login the system or access the data there must be some form of authentication for patients. The authority has to take the patient approval before accessing their record. The patient should have the ability to view the list of authorities or person who has at-least once went through their records. Patients have to be fully explained and demonstrated about the system performance by the vendor before adopting. These all are done to increase the trust of the patient as patients are the key in health sector and their confidentiality has to be respected.

- **Datacenter Location**

As discussed in scenario 1 (section 6.2.1) storing the patient data in cloud will give easy access from anywhere. And the legal issue of data center location can be resolved with the amendment of law as health data is more precious for both patient and health care personnel. Allow of storing the health data in cloud and sharing the data between different hospitals saves time and cost of re-medical diagnosis and help to do treatment fast. And storing the data in any country where it is cheaper to store helps both vendor and patient to utilize the cloud services cheaply.

- **Long term availability of patient data throughout the world**

In scenario 1 (section 6.2.1), authors discussed about sharing of data between different hospitals, which will save the time and money. Most of the Associates have positive opinion about to store all health data in cloud. In current system, if patient want to move from one hospital then he must have to bring his all paper based health records to the concerned hospital. But if we adopt cloud computing in e-Health, hospitals can share information between them and then doctors can access the patient old health records from the cloud anywhere from the world and give their treatment and prescription based on the old records

and prescriptions. It will be helpful to patients in order to get fast treatment from the doctors and in the health sector every second is important for patient health. Accessing the data remotely will save a lot of time. Another important thing is long-term preservation of health records, it is very important to make sure that the health data must be retrievable.

- **Vendor selection**

Many of the associates identified that selection of a good vendor is the critical step for the health care before adopting cloud computing. Selection of a vendor needs proper planning and analysis and a hospital must have to check the vendor background, services they provided, from how long they are providing the services and customer satisfaction about the vendor. A good vendor will produce secure SLA's to the customer and it will produce a good relationship between the customer and the vendor. If the health sector selected a good vendor, a vendor can produce secure SLA's to secure and share the data between the hospitals.

- **Selecting the best deployment model for e-Health**

Many of the associates mentioned that every deployment model has its own benefits and challenges. Authors analyzed the opinions from associates and concluded that private cloud is the best deployment model for storing patient and health data because only the health person and the group of people whom a patient allowed can get the access to their health and other records. Private cloud is more secure with strict SLA's but still there is no 100% secure and it is more expensive than public cloud. If the health data is stored in private cloud it should have tightly controlled or full of security; if it is stored in public cloud it must be in encrypted form and the decryption rights should be given to the certain group who are related to the data. Associates mentioned that a company normally used public cloud to test different configurations and different security measures and if once they are sure about its safety then they will finally launch their applications in private cloud.

7.3 Steps to implementing cloud

- **Plan and Be Realistic**

The first and most important step before implementing a cloud solution is to be clear, concise and focused before setting any realistic set of goals i.e. why to use cloud computing, what are the advantages of using it and can we be able to achieve all what we thought — do not try to cover all the aspects and try to do too much too soon.

For that a hospital should consult with their key stakeholders both internal and external at the outset of any cloud implementation. This includes legal advisors, CEO of a company, IT director who suggest and ensure full protection if a data breach occurs and confidentiality of both the patient and hospital data.

- **Identify the Data/Application**

Once the objectives have been outlined, there is the problem of storing which data/application to be in the cloud first, for that, a company discuss with available IT experts within the field. Thorough assessments have to be done before an investment to decide which application/data are most suited for the cloud for health data and why, as many of our respondents express their view saying that all desktops (all data) are not safe to keep in cloud and all application are not mean for cloud. One approach is to determine the areas where IT are mostly used and need lots of attention and also giving problem, similarly also to find from where a hospital gain the biggest benefit from the Cloud. Another approach is to first

migrate less 'risky' applications, those that are not holding the confidential and vital information of the health care organization. Migrating such data and application first will give time and opportunities for the coworker within the hospital to be familiar with cloud computing with less fear of the data.

- **Choose the Right cloud vendor**

As it is the case of storing health related data it is the key component to choose the right cloud vendor from so many other vendors for ensuring a successful and long-term relationship between hospital and vendor. As cloud vendors are the service providers who are going to support hospital in maintaining the data privacy and security within the Cloud. Choosing the right vendor as per the need and requirement of the data (privacy, confidentiality) rather than compromising with cost will give good output in patient trust in long term run. So there are many issues to be looked after before selecting any vendor, some of the issues are:

- Is the company registered (licensed) one or approved one from the government authorities?
- From how many years they have been offering cloud services?
- Does the company provide a reliable and secure service? What are their past feedback or portfolio about success and failure cases?
- Does the company provide 24x7 technical supports? What is included in the company's technical support? How many support techs are on the support team?
- Does the company have a good roadmap about their services?
- What is the service level agreement associated with the service?

- **Pilot Program "Implement the Cloud"**

After hospital had selected cloud provider and identified which application they want to migrate first into cloud. They have to just test it with small number of data/ application storing in one server and goes on increasing the size and number of data since it is the case of data confidentiality and people privacy, hospital should not rush to store all data in the cloud. While increasing the size and number of data the performance of the system has to be checked frequently and what will happen when crossed the limit of storing capacity of server and analyze how scalability features of cloud computing handle it efficiently and effectively before getting fully committed. After the pilot program, reassess how the cloud and its features are working and then take the feedback from everyone regarding the performance, security and privacy. Once all are ok with it, it is time to work with cloud provider and begin a broader deployment.

Most and important things to remember from planning to implementation phase is that the Cloud is nothing but just a new way to gain access the data and if adopted over time with careful consideration and planning it will compliment the current IT investment. Every company has to know that cloud implementation should be based on their individual IT needs rather than trying to imitate or follow others.

7.4 Conclusion

Cloud computing is an emerging technology in which every services are available but still there are some limitations which are restricting its usefulness in e-Health. The aim of this thesis was to explore the limitations and find the opportunities and barriers between cloud computing and e-Health and later purpose it in the form of guidelines. Clouds computing solution or data storage are considered as unsecure, illegal and unreliable and that's why it is not progressing as it sound to be. Like any other systems Cloud computing adoption also requires prior understanding of human perceptions; human perception can be changed through series of training, workshop and demonstration of system security to the patient, health care personnel and other stakeholders.

In the context of this research work, the authors have studied the issues involved in the deployment of cloud computing, associates concerns and factors regarding adoption of cloud computing in e-Health and finally the future of cloud computing in e-Health. In order to identify and to get a deeper understanding of those issues, the author performed literature review, conducted one to one interview with associates (both health care personnel and cloud computing) and finally backed up with a web-based survey from the associates for the validation of interview findings.

The issues regarding deployment of cloud computing were collected as presented by the associates in interviews along with the web-based survey finding taken from the associates (see section 5.2.1-5.2.7). Finally all the issues were analyzed and presented.

Similarly for the concern and factor regarding adoption of cloud computing in e-Health, authors followed associate's interview and web-based survey. After analyzing the findings from interviews and survey, authors presented the benefits of cloud computing in e-Health (section 6.1.1), issues of adopting clouding in e-Health (section 6.1.2) and best deployment model for e-Health (section 6.1.3).

The authors, from their understandings of associates opinion explored that there are some definite concerns among the people (patient and healthcare personnel like doctor and Nurses) when it comes to the adoption of cloud computing in e-Health. The authors observed that most of these concerns are based on the Data storage, Trust of patient and Data center location. It was also observed that cost efficiency and ease of use was preferred by the users when they were asked about the cloud computing adoption. The authors noticed that Data storage and reliability of data is an important factor that affects the adoption of cloud computing.

On the basis of interviews and surveys performed, the authors determined that most of these concerns are due to lack of knowledge about cloud computing and the trust of vendor. However the authors also observed that people are facing problems with data security, data integrity and too much dependency over the technology and vendors.

Finally after the completion of the entire analysis author purposed possible good deployment model and guidelines for adoption of cloud computing in e-Health.

7.5 Future work

Cloud computing is a new approach and many person are still unaware of its features. Authors found security of the data, trust of the patient and confidentiality of the patient data are the main issues dominating all other issues coming to adoption of cloud computing in health care. People need to trust the cloud provider and cloud provider must have to show the

capability to build a confidence among the people about privacy and security of data. Therefore, for ensuring security and privacy of data cloud provider must have to design cloud models and architectures to look into important data and information segregation at different layouts. In future, use of experimental platform for showing how cloud computing be useful in health care will fasten the adoption of cloud computing. Authors also believe that in the future by using certain simulation techniques, we can test the security, confidentiality and privacy of the data in cloud.

In this thesis work, definite guidelines have been proposed based on understanding of issues involved for adoption of cloud computing in e-Health. Authors propose these guidelines based on opinions of associates working in health care and cloud computing. Authors considered that these guidelines will be helpful to health care people before adopting cloud computing. If the issue involved in the deployment of cloud computing and the concerns regarding adoption of cloud computing in e-Health can be documented and understood from the associate perspective, there is the possibilities for using this knowledge in the design of future systems.

In survey, authors have mainly focused on associates from cloud computing and e-Health. In future, there is the possibility to investigate in to the prospect of mixed backgrounds i.e. different levels of education, field of expertise.

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APPENDIX

A. Cloud Interview Questions

Interview questions to the cloud computing associates.

Introduction part

- What is your name?
- What is the name of your organization?
- What is your current position in organization?
- What are your roles and responsibilities in organization?

Interview Questions

1. Does your organization use cloud computing? If yes (a) else (b)
 - a. What are the main reasons behind adopting cloud computing?
 - i. How your organization works with cloud?
 - b. What are the reasons behind your delay in adopting cloud computing?
2. How is adoption of cloud computing beneficial to your organization in terms of cost, speed, reliability and efficient storage of data?
 - a. Are there any more benefits for an organization? Mobility,
3. What are the major security issues in cloud computing?
 - a. How will they effect the organization?
4. How effective cloud computing services in regards security, scalability and efficiency?
 - a. Is it safe and secure to store all data in cloud structure? How?
5. What is the role of service level agreements (SLA) in cloud? How will they affect security factors?
6. What are the benefits and challenges with public, private and hybrid clouds?
7. What are the challenges in cloud computing? Are there any implementations to overcome these challenges?
8. What is the future of cloud computing in next 12 months?
9. What are the challenges that come in adopting cloud computing in e-Health?
 - a. What about cost factor, security of data, trust of patient and associates if we use cloud computing in health sector to store patient health records in cloud?
 - b. What are the major advantages of cloud computing that e-Health can benefit from?
10. If we want to adopt cloud computing to store the patient records and other hospital data in to cloud, which deployment method do you prefer, Private, Public or Hybrid Cloud? Why?
11. Is there any future for adopting cloud computing in e-Health?

B. Health Interview Questions

Interview questions to the health care associates.

Introduction part

- What is your name?
- What is the name of your organization?
- What is your current position in organization?
- What is your main Responsibilities or Role in an Organization?

Interview questions

1. How do you define e-Health?
2. How does current e-Health evaluate trust and security issues?
3. What methods are you implementing in your current system to ensure privacy of electronic patient record and healthcare employs?
4. How the cost factor of maintaining datacenters will affect the system?
5. One of the aspects that keep hindering the SMEs from adopting cloud solution is the unavailability (as they can be anywhere) of the data center and the servers, is this the main reasons of delaying Cloud Computing in e-Health and your Organization as well?
6. According to the European Health Organization (EHO) “Data should not leave the original country of collection at any time”, is it the main cause to restrict to put data in the Cloud?
7. What are the challenges that come in adopting cloud computing in e-Health?
8. What about cost factor, security of data, trust of patient and associates if we use cloud computing in health sector to store patient health records in cloud?
9. Do you think there is a need of advanced level of security measures (like cloud SLA) for health care? Why or why not?
10. What are the major advantages of cloud computing that e-Health can benefit from?
11. If we want to adopt cloud computing to store the patient records and other hospital data in to cloud, which deployment method do you prefer, Private, Public or Hybrid Cloud? Why?
12. Is there any future for adopting cloud computing in e-Health?

C. Survey Questions

Survey questions with cloud computing and health care associates.

Introduction part

- Organization name, Country
- Job Title
- Roles and Responsibilities
- Experience in cloud computing

Main survey part

1. What are the characteristics of cloud computing in your opinion?
2. What is the current state of art in cloud computing?
3. In your opinion what are the issues involved in deployment of cloud computing?
4. What is your opinion over the SLA provided by the cloud computing vendors? How important it is for a good relationship between vendor and users?
5. Prioritize the following benefits to adopt cloud computing in e-Health
 - a. Cost savings
 - b. Security
 - c. Location independence
 - d. Reliability
 - e. Scalability
 - f. Fast services (Diagnosis and Treatment)
 - g. Sharing of information and data between different hospital and care givers
 - h. Easy access of previous health record from different hospitals
6. Prioritize the following concerns to adopt cloud computing in e-Health
 - a. Security of the data
 - b. Privacy concerns
 - c. Integration issues
 - d. Cost savings
 - e. Data center location
 - f. Vendor lock-in
 - g. SLA
 - h. Scalability
 - i. Legal issues
 - j. Trust of patient and associates
7. Is it safe to store patient health records and hospital data into cloud? Why or Why not?
8. What type of health data can we store in cloud? (video tutorials, X-rays, personal data, Health records or specify if any)
9. In your opinion which will be the best deployment method (Private, Public or Hybrid) to store the patient records and hospital data into the cloud? And why?
10. How do you perceive the future of cloud computing in e-Health?
11. Which are the main issues to be resolved in getting effective use of Cloud computing in e-Health?

D. Key terms

The following are the key concepts as a basis of this thesis.

Cloud Computing: *“Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction”* (Peter et al, 2009)

Community Cloud: This cloud is shared by a group of organizations and supports a specific community that has shared concerns. This may be managed by organizations or third party (Peter et al. 2009).

Data Center: A data center is a centralized repository on which software and data can be remotely stored instead of hard drive or a server located in user’s premises (John. D. K et al, 2010)

e-Health: *“e-Health as the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, surveillance, literature and health education, knowledge and research”* (WHO)

Electronic Health Records (EHR): Establishing proper communication between patients, physicians, healthcare providers and health planners (Majid, 2008).

Electronic Medical Records (EMR): This is an electronic health care information record, which stores patient information with full interoperability within the enterprise. It connects different medical and technical departments (Haux, 2006)

Hybrid Cloud: The combination of private and public is called hybrid cloud (Peter et al. 2009).

Infrastructure as a Service: Users being able to use servers, storage, network settings on-demand from other providers on a pay-per-use basis (Peter et al. 2009).

Platform as a Service: The customer does not need to manage or control the cloud infrastructure including storage, networks, application, or operating systems but customer has control over the applications hosted configuration (Peter et al. 2009).

Private Cloud: Clouds that are used for specific organization providing more security and it may be managed by the organization or third party (Peter et al. 2009).

Public Cloud: Public cloud is owned by specific cloud service provider. This public cloud infrastructure is available for large organizations and public and can be accessed from anywhere (Peter et al. 2009).

Scalability: Maintaining the storage and traffic load in the peak load or high traffic for a site, cloud can handle easily without need of any additional hardware infrastructure or equipments and without disturbing user's normal work (Weiss, 2007).

Service Level Agreement (SLA): It is in general a legal binding agreement in the mutual understanding and acceptance about a service between a client who is buying the service and a Service Provider (David, 2009).

Service Provider (Vendor): Within the context of cloud computing, the service organization or provider is the business that delivers a cloud computing application “as a service” for a monthly fee.

Software as a Service: This service provides software and associated data centrally. It is easily accessed by the end users through thin client interface such as a web browser (Peter et al. 2009).