

Opportunity and Implementation of Cloud Computing in Indian Health Sector

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Abstract:-In this paper I am dealing with the effectiveness of cloud computing technologies in health care information systems. Health care, like other service operation, requires consistent and systematic innovation in order to remain cost effective, efficient and timely to provide high-quality services. The health care industry is generally considered a slow in adoption of technology. In the last few years, expectations about patient privacy information, medical services, data retention and health care provider availability have risen dramatically. For solving such kind of issues I suggest the electronic health care systems using cloud computing techniques. Cloud technology reduces the time delay and more time can be spared for patient care. In this paper I discuss the cloud computing evolution, how can the health care industries use the cloud computing and improves the service to patient in India, challenges of cloud in health care and benefits of cloud techniques in health care industries.

Keywords: EMR, PHR, IAAS, SAAS, PAAS, HIS, PACS, HER

1. Introduction

Advanced technology has entered in human lives so much that it has started to become an essential part of human life today. Cellular phones have brought a revolutionary change in the lifestyle the way we are living. We continuously look to social media to inform our personal development and business decisions to the world over network. We always look for immediate access to information anytime, anywhere in today's world. The ever growing expectations and rapid changes in technology pose a challenge to traditional approaches for information technology. A new approach is required to free individuals and organizations from the constraints of traditional Information Technology. Cloud computing is a new paradigm. In Cloud, IT resources and services are abstracted from the underlying infrastructure and provided on-demand and at scale in a multi-tenant environment.

Clouds are a large pool of easily usable and accessible virtualized resources (e.g.; hardware, development platforms and/or services). These resources can be dynamically re-configured to adjust to a variable load (scale) for optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized Service Level Agreements [11].

1.1. Cloud Service Environments

Cloud includes several types of service models (i.e., IaaS, PaaS, and SaaS) as discussed below.

- **Infrastructure as a Service (IaaS)**

The cloud user outsources the equipment used to support operations, including storage, hardware, servers and networking components. The provider owns the equipment and is responsible for housing, running, and maintaining it. The user typically pays on a per-use basis. The user does not require managing or controlling the underlying Cloud infrastructure, but

has control over operating systems, applications and programming frameworks.

- **Platform as a Service (PaaS)**

The development tools are hosted in the cloud and accessed through a browser. With PaaS, developers can develop Web applications without installing any tools or software on their systems, and then deploy those applications without any specialized administrative skills. The user does not require managing or controlling the underlying infrastructure, but has control over deployed applications.

- **Software as a Service (SaaS)**

SaaS enables users to access applications running on a Cloud infrastructure from various end-user devices (generally through a web browser). The user does not require managing or controlling the underlying Cloud infrastructure or individual application capabilities other than limited user-specific application settings.

1.2 Cloud Deployment Environments

Deployment of the cloud is generally dependent on the functional requirement and organizations operational environment. Mostly deployment of a cloud can be done in the following ways:

- **Private Clouds**

Private Clouds are operated only for single organization. They may be managed by the organization itself or by a third party, and they may reside on-premises or off it. For example, Microsoft Azure enables users to build the foundation for a private cloud infrastructure using Windows Server and System Center family of products with the Dynamic Data Center Toolkit.

- **Public Clouds**

Public Clouds are open to the general public or a large industry group and are owned and managed by a Cloud service provider. For example, the Amazon Elastic Compute Cloud (EC2) provides users a facility

to rent virtual computers on which to run their own applications. EC2 executes within Amazon's network infrastructure and data centers and allows customers to pay only for what they have used with no minimum fee.

- **Hybrid Clouds**

Hybrid Clouds combine two or more clouds (private, public or community) that remain unique entities but are bound together by technology that enables data and application portability. An organization provides and manages some resources within its own data center and has others provided externally. For example, IBM collaborates with Juniper Networks to provide a hybrid cloud infrastructure to enterprises to seamlessly extend their private clouds to remote servers in a secure public cloud. [12]

- **Community Clouds**

In Community Clouds the cloud infrastructure is shared by several organizations with common interests (e.g. mission, security requirements, policy and compliance considerations). For example, the Google GovCloud provides the Los Angeles City Council with a segregated data environment to store its applications and data that are accessible only to the city's agencies. They may be managed by the organizations or a third party and may reside on-premises or off it.

2. Challenges in Healthcare

In India, the healthcare sector is facing momentous pressures to lower the costs associated with providing healthcare, adopt new systems that support Electronic Medical Records (EMR) and share data speedily and securely with other healthcare and government agencies. Reducing service time for patient care is another aspect in the fight to keep costs low and lessen delay in getting back results from a laboratory. India is also facing the problem of population aging. These make the deficiency of health care and medical resources more and more evident and severe. The contradiction between per person level of medical resources and the growing demand from people for health care is rapidly increasing. The challenges faced in the field of medical and health care such as the aging of the population, the increase of chronic patients, the rising medical expenses and the needs to improve the quality of medical services are common around the world today. In order to solve them, information technology must be deployed to this field. India doesn't have a strong law where the Hospital Workflow's remain constant. Each hospital has its own rule and patients are bound to abide by them. We need to establish common rules of how Hospitals treat patients and the rights patients have to access their Health data. The must dealt challenges of health sector in India are;

1. Rural versus Urban Imbalance

India spends negligible around 4.2% share of its national GDP towards healthcare goods and services [2]. There are wide gaps between the rural and urban populations in its healthcare system which worsen the problem. A majority of the population still lives in rural areas and has no or limited access to hospitals and clinical services. Consequently, the

rural population mostly relies on alternative medicine and government programmes in rural health clinics. In major cities across India, we have some of the best hospitals in the world in terms of adoption of technology and provision of high quality of healthcare services. However, the scenario is completely different in rural hospitals, which lack even basic infrastructure, let alone high end technological infrastructure.

The doctors, nurses, administrators and other personnel working in the rural hospitals are not exposed to technology at all, as opposed to their counterparts in the major cities. In contrast, the urban centers have numerous private hospitals and clinics which provide quality healthcare. These centers have better doctors, access to preventive medicine and quality clinics which are a result of better profitability for investors compared to the less profitable rural areas. There is a need for sustained efforts from both the Government and private sector to create uniformity in healthcare technology adoption.

2. Need for Effective Payment System

Besides the rural-urban divide, another key driver of India's healthcare landscape is the high out-of-pocket expenditure (roughly more than 70%). This means that most Indian patients pay for their hospital treatments and doctors' consultations through cash after care with no payment arrangements. According to the World Bank and National Commission's report on Macroeconomics, only 5% of Indians are covered by health insurance policies [3]. The good news is that the penetration of the health insurance market has been increasing over the years; it has been one of the fastest-growing segments of business in India.

The Indian government plays an important role in running several safety net health insurance programmes for the high risk population group and actively regulates the private insurance markets. Currently there are a handful of such programmes including the Community Health Insurance programme for the population below poverty line and Life Insurance Company (LIC) policy for senior citizens. All these plans are monitored and controlled by the government run General Insurance Corporation, which is designed for people to pay upfront cash and then get reimbursed by filing a claim. There are additional plans offered to government employees, and a handful of private companies sell private health insurance to the public [3].

3. Basic Primary Healthcare and Infrastructure Cost

India faces a serious growing need to fix its basic health concerns in the areas of HIV, malaria, tuberculosis, diarrhea etc. Children less than five year age are born underweight and few of them die before reaching to their fifth birthday. In 2014, Infant mortality rate was 42 per 1000 live births [13]. Miserably, only a small percentage of the population has access to quality sanitation. There should a law to regulate the cost of basic Health Services across the country. For example, for a first consultation, the Doctor fee or the Hospital charge should be same across the country. This will help more people approaching bigger/better facilities to ensure they receive the best consultation and there is no competition among Hospitals or for Doctors.

For primary healthcare, the Indian government spends only about 30% of the country's total healthcare budget [4]. This is just a fraction of what the US and the UK spend every year. One solution to this problem is by standardizing diagnostic procedures, building rural clinics and developing streamlined computerized health systems. The need for skilled medical graduates continues to grow, especially in rural areas which fail to attract new graduates because of financial reasons. To take advantage of technology investments now and in the future, hospitals need an integrated computerized network that helps health service providers to collaborate and communicate effectively. However healthcare providers tend to avoid modernizing their IT infrastructure, because of lack of funds and a tendency to avoid capital expenditure on new technology.

4. Ill-equipped Medical Sector

The medical equipment sector is the smallest piece of India's healthcare industry. However, it is one of the fastest growing sectors in the country like the health insurance marketplace. Till date, the industry has faced a number of regulatory challenges which has prevented its growth and development. Recently, the government has been positive on clearing regulatory hurdles related to the import export of medical devices, and has set a few standards around clinical trials.

5. Confidentiality of Health Data

As patient data will reside at a location distant from their own facility, there is a concern about the possibility that sensitive data could be lost, misused, or fall into the wrong hands. Technology vendors have to build robust security and disaster recovery features into the cloud technology, to ensure that all administrative and clinical data is securely and safely maintained.

Providers are often unwilling to make investments in cloud-based initiatives. Hence it is important to take the entire ecosystem into confidence, before embarking on any large-scale cloud initiative.

Cloud computing is usually accessible to many different customers. If the provider fails to separate the resources, it could cause very serious security risks. For example, a customer requests to delete data stored in the virtual infrastructure; as with most operating systems, this may not result in true erasing of the data immediately. The data are still stored on the disk but are just not available [7]. In the multiple tenancies environment, hardware resources are reused by other customers. In this case, a third party could have access to another customer's "deleted" data. This presents a higher risk to the cloud customers than with dedicated hardware. If the malicious insider is a system administrator, then he or she could use his or her privileges to steal critical data.

6. Skilled or Trained User Requirements

Training of the users also can be a significant challenge because of the digital and geographical divide. Training of the users should be tailored according to the needs of the users and should take into account their educational background, aptitude, and pace of learning. Training may

also be required to conduct in the local language. India is having an advantage in the IT sector at the global stage in the form of skilled IT people. Due to the countries geographic diversities the training still remains a big challenge for the success of any big project.

7. Lack of Willingness to Change

Implementing the cloud computing solution involves drastic changes in the operations to be followed by the healthcare providers. Healthcare facilities have been dependent on legacy systems and processes, many of which are obsolete and are not efficient. The infrastructure needs to be upgraded to match the technological pace. Moreover healthcare stakeholders have traditionally been very resistant to change. Hence healthcare organizations require a significant amount of support from their technology partners, to manage the change and ensure a smooth transition to the new system and processes.

3. Healthcare on Cloud

Today, large IT companies are coming with various kinds of healthcare solutions and services such as telemedicine, electronic medical records, medical imaging and patient management that can be implemented or integrated by healthcare providers, payers and customers over a cloud.

Their primary focus would be to offer IaaS to their internal stakeholders. This will help healthcare organizations to reduce costs and increase its efficiency in provisioning, orchestrating and managing the applications and the infrastructure.

Renowned world class software companies have heavily invested in the cloud, extending their new offerings for medical records services, such as Microsoft's HealthVault, Oracle's Exalogic Elastic Cloud and Amazon Web Services (AWS), promising an explosion in the storage of personal health information online. For example, the AWS plays host to a collection of health care IT offerings, such as Salt Lake City-based Spearstone's health care data storage application, and DiskAgent uses Amazon Simple Storage Service (Amazon S3) as its scalable storage infrastructure [1]. As the cloud adoption in healthcare evolves, we expect a major chunk of healthcare services to move into cloud. This would let healthcare players to focus on providing cost effective and efficient healthcare services. Service providers play a major role in adoption of cloud in any industry and healthcare is no exception.

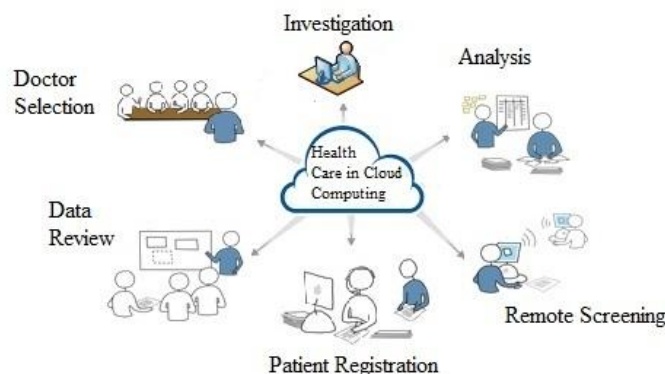


Figure 1. Cloud Based Health Service

Figure 1 depicts cloud based general healthcare service model. This Model could be used as a base to deliver various required services to the healthcare industry. Successful implementation of these cloud services can improve the traditional healthcare system and mitigate management overhead and cost of IT infrastructure.

1. Patient Registration

In the first stage when the patient enters in the clinic or hospital, his/her case registration would be carried out. If the patient is already under treatment then than his/her data would be retrieved from the database. As we know, In India patients have to face various problems during case registration in the large hospitals. Here, the Use of Adhaar Card will enforce common registration process and brings ease of managing patient's demographic data.

2. Doctor Selection

Cloud Healthcare service will provide a significant benefit of doctor selection from the list of doctors serving in the cloud health care, best suit to the patient's diagnosis. This service enables the patient to get the best clinical treatment from the expert doctor. In India, especially in remote locations patient doesn't have any choice and selection of doctor because of the scarcity of doctors and infrastructure issues. This cloud service overcomes the burden of the patients from paying the high consultation fees of reputed doctors located in urban areas.

3. Data Management and Review

Health care centres have to store and maintain every byte of data about human resource, account files and patient medical records including patient history, diagnosis, treatment, dietary information etc. Cloud data storage and maintenance frameworks like HDFS, Hive, HBase etc offer a cost effective solution to the problem with increased security and ease of management [5]. Use of advanced data management and cloud data storage technique helps to retrieve patient's present and past data with a single click. This will help the doctors to provide the required treatment to the patient after reviewing the patient's past and latest laboratory reports. In India, Centralized Drug Database looks immature, plays a very crucial role in building up a strong Health Delivery System. Central Drug database is a must for a successful cloud technology to play a bigger role in building up India's Health System.

4. Investigation

This service provides a platform to the medical practitioners and pharmacist to apply their innovative ideas and investigate new medicines/drugs while ensuring its efficiency and no side effects. This process requires massive computing resources to identify the potential compounds for drug from a numerous possible chemical structures. With the IaaS cloud pharmacist and medical practitioners can now borrow the computational infrastructure to analyze the huge biological data without establishing well equipped laboratory and making big investment. Pharmaceutical companies can start to improve research and drug development to discover newer, cheaper and more effective

treatment practice and medicines as vast amount of health critical data is accessible in the cloud. Ultimately, all these new investigation will add a value to the health care sector.

5. Analysis

Healthcare sector uses information systems for the better information flow within and outside the organization. Properly managed information helps to generate the advice upon the analysis of patient illness record. Doctors as well as patients may use these systems for the further diagnosis and medication purpose with various medical tests. Doctors use the system to provide better patient care; customers use it for querying service; hospital administration will use this information to manage the human resource, billing and finance. Top management will use this system for decision making and forecasting purpose. Use of advanced data analysis model in the cloud health care makes the task easy for doctors to take a better decision for the patient's.

6. Remote Screening

Information and communication technologies have brought a revolutionary change by supporting and providing patient care services beyond the medical centres. Telemedicine technologies like telesurgery, audio/video conferencing and teleradiology bring a new model for collaboration and communication between various healthcare stakeholders [6]. Telehealth care services not only allow patients to get clinical treatment without leaving their place but also help medical specialists to share their expert opinion to deal with complex medical cases. Cloud based software make possible, the doctor to patient and doctor to doctor interaction as well as to facilitate the transmission and archiving of medical images without being at the same place. Patient medical information can be shared in real time across the geographical boundaries for getting a medical advice. Medical experts can retrieve the archived patient files at their own time and place. In India, majority of people resides in rural area and living under poverty line. Economically they can't afford to consume such advanced medical treatment. Clouds Remote Screening service, will save the patients' travelling cost and time as patient doesn't need to travel particular place to get expert medical opinion for their treatment. Medical specialists can save their time by reducing the unnecessary visits of patients through successful adoption of this model.

Above cloud based health care model can be customized to integrate new services for the better health care service to the society. Healthcare service providers need to maximize their investments in IT assets, operations, training and management of their solutions to support the cost economics that drive healthcare.

4. Advantages of Cloud Technology

1. Transforming Service Delivery

Cloud can enable service providers to rapidly and cost-effectively integrate their applications and operations capabilities into a set of cloud services that can be deployed to customers, be it providers, governments, payers, or patients, using a wide range of network connections (fixed

and mobile). Cloud transforms the economics of IT from capital intensive to pay as you go model based on anytime, anywhere IT services. Service level agreements guarantee the capabilities needed, when needed. Costs are tiered and metered to accurately reflect requirements and usage. All applications, including legacy, run more efficiently and sustainably with greater utilization of the underlying infrastructure.

2. Improve Data Management and Reduce Operating Risks

Cloud protects sensitive information through automated policy enforcement. Cloud accelerates business by allowing healthcare organizations to transform ideas into new services, with greater speed. This allows healthcare providers to scale up their operations, and launch new services quickly and easily. Cloud can provide nearly limitless scalability, enabling businesses to grow, without the investment in time and resource intensive technology infrastructure. Hospitals and physicians are starting to see cloud-based medical records and medical image archiving services coming on line. The objective is to offload a burdensome task from hospital IT departments and allow them to focus on supporting other imperatives such as EMR adoption and improved clinical support systems.

3. Brings Efficient IT resources to the Healthcare Providers

Healthcare organizations of all sizes, across all geographies, can access information technology resources, which were out of reach previously. Smaller hospitals, medical practices and laboratories typically do not have internal IT staff to maintain and service in-house infrastructure for mission-critical applications such as Electronic Health Records (EHR). Therefore, eliminating the new infrastructure cost and the IT maintenance burdens can remove many obstacles to EHR adoption [9,10]. From an IT management's point of view, cloud computing can increase the scalability, flexibility and cost effectiveness of infrastructure. Hospitals and other healthcare providers can enter new markets, respond more quickly to changing customer needs, collaborate more effectively to drive innovation and business value, and execute on strategies that might not have been cost-effective in the past.

4. Resolves the Fund issues

EMR, HIS (Hospital Information Systems), PACS (Picture Archiving and Communication System) and other advanced clinical applications are creating a critical need for more data storage, resulting in the expansion of the range of healthcare services and increased IT spending. The cloud will be the foundation for connected health to support a range of complex, disparate, and mission-critical applications by ensuring that users have access to the data and applications they need on demand and from any location. The cloud helps the hospitals and healthcare providers to use the applications, hardware and services on a pay per use model, which allows them to avoid heavy capital expenditure on buying and deploying expensive technology.

For example, Amazon charges only US \$0.1 per hour for 1.0-GHz × 86 instruction set architecture “slices” of EC2. Amazon S3 charges US \$0.12 to \$0.15 per gigabyte-month, with additional bandwidth charges of US \$0.10 to \$0.15 per gigabyte to move data into and out of AWS over the Internet [8]. An organization can have a cost effective and on-premise IT solution through cloud computing without purchasing or evaluating hardware or software, or recruiting technical IT staff to maintain and service in-house infrastructure. With this, the organization can focus on critical operations without incurring additional costs with regard to IT staffing and training.

5. Promotes Green Computing Campaign

Today, leaders of every country talks about reducing Carbon Emission, Global Warming and Green Computing in their global meets. Cloud computing has advantages for so called Green Computing concept. The efficient use of computer resources help the environment and promote energy saving. Usage of readymade computing resources configured to an organization's needs certainly helps it to reduce electricity expenses. While it saves on electricity, it also saves on resources required to cool off computers and other components. This reduces the emission of dangerous materials into the environment.

6. Research Enhancement

Many pharmacology vendors have started to adopt the cloud environment to improve research and drug development. The explosion of data from next generation sequencing as well as the growing importance of biologics in the research process is making cloud-based computing an inevitable part of R&D. Currently, pharma firms do not have the capacity to run large datasets, especially DNA sequencing; as the size of the data can overpower their computers. Commercial cloud providers have developed pharma specific clinical research cloud services with the goal of lowering the cost and development of new drugs.

7. Telemedicine

Artificial Intelligence is the next generation super power technology. Combination of extensive resource efficiency of cloud and Artificial Intelligence will change the face of health sector. Latest mobile technologies and intelligent medical devices, telemedicine has grown to include not only tele-consultations and telesurgeries, but also health record exchange, video-conferencing and home monitoring. Cloud computing and the related ease of services deployment and data storage is an enabler for telemedicine.

8. Security Relief

Strong encryption with key management is one of the core mechanisms that cloud computing uses to guard against data loss and theft. Cloud service provider ensures users of their data security through proper and strong implementation of encryption, data access and authorization algorithms.

Conclusion

Cloud technology mitigates the need to invest in IT infrastructure, by providing access to hardware, computing

resources, applications and services on a per use model, which dramatically brings down the cost and simplifies the adoption of technology. Cloud computing for healthcare will need to have the highest level of availability and offer the highest level of security in order to gain acceptance in the marketplace. Medical information systems is playing an important role in supporting doctors and nurses, enhancing the quality of medical services, reducing the medical expenses, and improving the care of chronic patients. Hence, there might be a need to create a specific cloud for Healthcare that specifically addresses the security and availability requirements for healthcare.

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