

# Role of Cloud Computing for Improvement in Healthcare Services



Puja Shashi

**Abstract:** Cloud helps in offering on-demand latest technology that helps in deploying, accessing and using network-accessed information along with various applications and resources. Nowadays electronic health records are maintained by many hospitals that want to undergo a change in their legacy system. This type of transformation has helped physicians, nurses and also administrative staff access the desired record whenever needed. They believe that this may change the complete face of health information technology. However, lack of security and privacy are two important concerns that may provide hazards when choosing cloud solutions for various health-related factors. This problem can be avoided to some extent by evaluating cloud technology in an effective manner before its complete adoption. This paper uses four major aspects i.e., technology, security, legal and management for finding different types of challenges of this computing model. When any health services want to migrate from traditional to cloud-based health services then they can do different types of strategic planning for determining strategy, allocated resources and direction for maintaining a cloud environment in their organization.

**Keywords** Electronic health record (1), Cloud computing (2), Health care(1), quality improvement (3)

## I. INTRODUCTION

According to many researchers, cloud computing is not new technology we may call it a model that delivers computing resources anywhere and anytime(4). Some common examples of non-healthcare applications are Microsoft Hotmail and computing, usage in the health care sector, advantage and disadvantages and what type of strategic planning should be done by an organization for moving from the traditional approach to cloud approach. Google Docs and some examples of healthcare applications are Microsoft HealthVault and PHI. Though they provide some advantages such as elimination of an upfront commitment by users on-demand availability of huge computing resources and pay-as-you-go. Cloud computing applications industry, business, transportation, education and national security are reported in various journals (4-7) In order to provide high-quality services continuous and systematic innovation is required by health care or with any other service operation.

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There are many advantages of cloud computing in improving health care services that may also change the face of information technology (IT) (8-13). For example, it is believed by Schweitzer(10), Haughton(11), and Kabachinski (12) that electronic health record (EHR) startup expenses can be reduced by cloud computing, and thus adoption can be encouraged. Research done by Rosenthal et al shows that the biomedical informatics community, especially consortiums that share data and applications, can take advantage of the new computing paradigm (13). As indicated in the paper by Anderson et al, problems related to data handling, complexity and unavailability of computation resources are some major issues in the biomedical field. However different types of informatics innovations show that cloud computing can overcome these difficulties with ease. (15-21).

Though healthcare sector can be benefitted a lot from cloud computing services, in spite of that certain legal, technical and managerial issues needs to be taken care of. The main objective of this paper is to define the concept of cloud approach.

## II. CLOUD COMPUTING

### A. New Economic Computing Model

Definition, properties and characteristics of cloud computing is a developing attribute. More than 20 definition was studied by Vaquero et al (22) and he tried to give exact definition that contains the important characteristics of cloud computing. Following are some important points related to the definition of cloud computing (22).

Clouds can be defined as a huge resource of virtualized resources that can be accessed. Re-configuration of these resources can be done in dynamic manner so that resource can be utilized in optimum manner. This is based on pay as you go model where services can be provided to customer by the help of strong level service agreements.

There are three models based from service point of view that include: software, platform and infrastructure.

- (1) Software as a service (SaaS): IN these various types of application services are provided by cloud service provider through the internet.
- (2) Platform as a Service(PaaS): In this development platform are provided by cloud provider that can be accessed with the help of any browser. There is no need of installing any tools in ones machine. Various types of web application can be developed by developer that can be further deployed with the help of administrative skills.



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(3) Infrastructure as a service (IaaS): In this various supporting software such as storage, hardware, servers and networking components are provided to user. In this Cloud provider is the main owner of all the equipment along with their maintenance also.

In order to deploy above mentioned model of cloud computing, the US National Institute of Standards and Technology (NIST) listed four different methodology (1,26)

(1) Public cloud: In this cloud service provider (CSP) such as Amazon elastic compute cloud(EC2) provides the required resource to general public on pay as you go basis. Virtual computer are rented to customers where they can run their own application.

(2) Private cloud : Cloud service is provided to single organization. For example Microsoft Azure help

customers in building private cloud infrastructure with the help of windows server.

(3) Community cloud : In this many organization share the same cloud infrastructure, for example policy, security requirement, goals and objectives etc. Google GovtCloud is the best example.

(4) Hybrid cloud : It is the combination of public, private or community cloud. Some resources are managed by organization themselves. For example IBM is merged with Juniper network in order to provide hybrid cloud infrastructure that enhances private cloud service to remote server within secure public cloud(27). Fig 1.

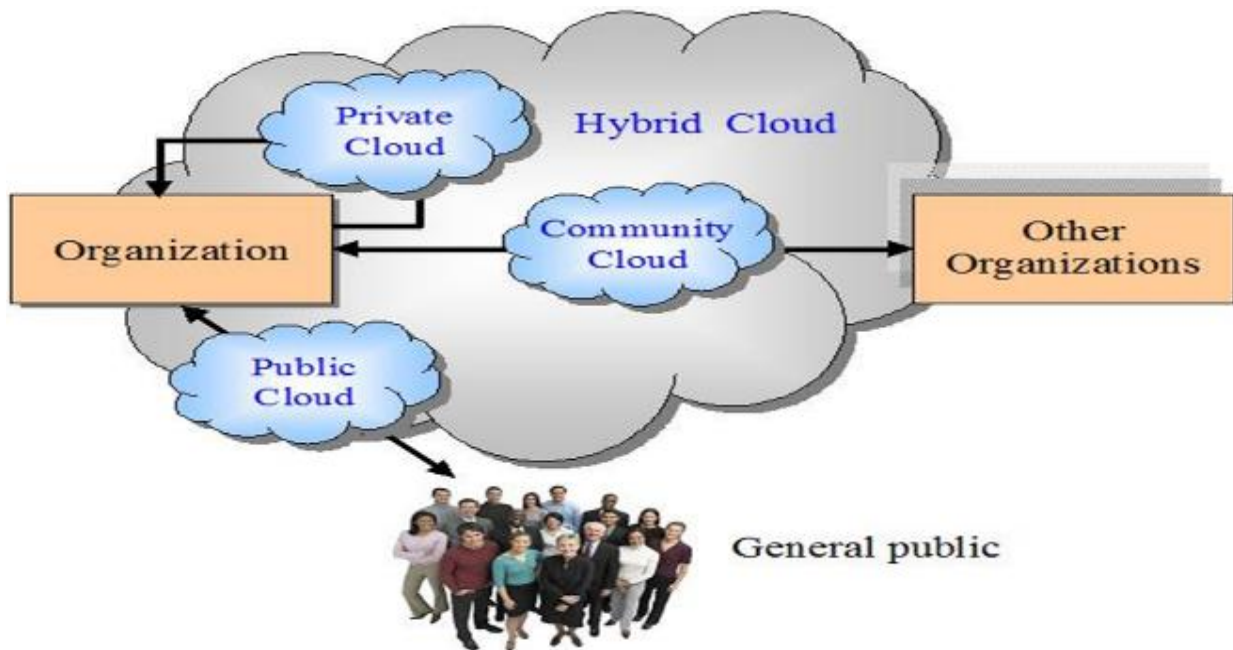


Fig 1: Cloud Deployment Model (Courtesy: Google)

### B. Status And Adoption Of Cloud Computing

In an attempt to improve health care services many research are done that illustrate the potential benefit of improving the health care services (28-35). Among them, it was proposed by Rolim et al for collecting all vital information of patient automatically based on cloud platformcloud with the help of sensor connected to inherited medical devices.. After this data is further delivered to cloud medical center for further storage, processing and distribution. Most important advantage is removing manual collection work and reduce the possibility of typing errors that further makes the deployment process easy(36). Protocol related to cloud computing management system was described by Nkosi and Mekuria that helps in providing security and multimedia sensor signal processing to mobile devices as a service. Mobile health services are now delivered using security algorithm and heavier multimedia. This will help in efficient utilization of mobile devices which will further helps in efficient delivery of health facility to rural community(37). cloud initiative in persistent manner was reported by Rao et al called Dhatri, which that helps in giving knowledge of the power of cloud computing and wireless technologies in order to help physicians to read health information of patient that can be accessed from anywhere and at any time(38).

Koufi et al described a cloud-based prototype emergency medical system for the Greek National Health Service combining the emergency system with personal health record systems to provide physicians with easy and immediate access to patient. Application of cloud computing in bioinformatics research are published in numerous articles and resources (15-21, 40,41). For example, fundamental of colorectal cancer imaging analysis and research for clinical use was proposed by Avila-Garcia et al (18). Amazon's EC2 service with 100 nodes to assemble a full human genome with 140 million individual reads requiring alignment using a sequence search and alignment by hashing (SSAHA) algorithm were used by Bateman and Wood (19). Kudtarkar et al also used Amazon's EC2. The impact of G-quadruplexes on Affymetrix arrays was evaluated by Memom et al (21) using this service. Generic testing model was developed by The Laboratory for Personalized Medicine of the Center for Biomedical Informatics at Harvard Medical School that helps in managing huge amount of data in limited time (41).

Many world class software companies have spent huge amount in cloud services so that they can offer something with better application to medical services for example huge investment in cloud is also done by many companies so that they can extend offerings in medical fields in many a

**C. Challenges And Computing Opportunities In Health Cloud Computing**

More than 70% of chief information officer said that cloud computing is very useful in near future according to current research (47,48). According to Mark Beccue total number of people going to mobile cloud applications will rise drastically by 2022. Many manager and expert in health

sector organization also trust that cloud computing approach may change health care sector drastically.

It is important that before adopting cloud computing it should be evaluated rigorously. Systematic study and impact of cloud computing on health care IT in terms of its opportunities and challenges

Rigorous evaluation of cloud computing should be performed before adopting in mass scale. Systematic study on impact of cloud computing on health care are done by some research paper. These research paper also explain about various opportunities and challenge

Aspect	Opportunities	Challenges
Management	Infrastructure cost is less	Lack of trust by health care professionals
	On-demand availability of computing resources.	Organizational inertia
	Pay as you go	Loss of governance Uncertain provider’s compliance
Technology	Reducing the maintenance burden of IT.	Resource exhaustion issues
	Flexibility and scalability of infrastructure	Unpredictable performance
	Green computing advantage	Data lock-in Data transfer bottlenecks
Security	Data protection resource availability.	Separation failure
	Advanced data security by enhancing replication of data	Public management interface issues
	Dynamically scaled defensive resources strengthen resilience	Poor encryption key management Privilege abuse
Legal	Providing customer data and privacy commitments by the provider.	Data jurisdiction issues
	Enabling construction of the trusted platform	Privacy issues
	Fostering of regulations by the government for data and privacy protection	

**III. MANAGEMENT-RELATED ASPECT**

**A. Opportunity**

An important advantage of cloud computing is low cost and accessibility. For example, Amazon takes the only US \$0.1 per hour for 1.0 GHzX86 instructions set architecture “slices” of EC2.(51). Hence in this way, any company’s rigorous IT solution can be cost-effective through cloud computing without purchasing hardware or software or without maintaining IT staff that are needed for in-house infrastructure maintenance (20,40,51). In this way, any company can focus on the critical task without giving extra cost in terms of training and staffing IT staff. Cloud computing also helps in maintaining speed while maintaining important features (such as rapid elasticity, access to health resources in a unique manner etc. as the a result as the demand increases or decreases, health care service providers do not have to adjust their infrastructure in order to accept the changes.

**B. Challenges**

The most important challenge includes lack of data security trust, users’ privacy, Governance loss and uncertainty in provider compliance. In a cloud environment, the most important factor is trust (52). when any type of sensitive or mission-critical applications are shifted to the cloud then sometimes cloud provider may not provide guarantee of security effectiveness and privacy control(53). In some

cases, even a strong service level agreement may not offer a commitment to allow the client to audit its data.

**IV. TECHNOLOGY ASPECT**

**A. Opportunity**

Mostly there is a lack of IT staff who are responsible for maintaining in house infrastructure in smaller hospital and medical practices. Also there may be a lack of mission critical application such as EHRs. In this way EHR adoption can be made feasible by curtailing the new infrastructure cost and burden for It maintenance (10,55). Cloud computing can increase flexibility, scalability and infrastructure cost effectiveness from an IT management point of view.

**B. Challenges**

Some major issues cresting problem in cloud computing are resource exhaustion, unpredictability of performance, data deadlock, problem in data transmission and various errors in large scale distributed cloud systems. Two key features of cloud computing are less cost and on demand availability of resources.





Now a days since the market is becoming overflooded with cloud provider who sometime overcommit computational resources such as CPU, storage space, application etc. for attracting clients. However, the market is becoming over crowded with large providers. Hence instead of providing quality services, quantity services will be provided. For example limiting access to resources, supplying outdated hardware or software, implementing outdated CPU technology and so on. Cloud provide may not give auditing permission to customer and sometime are unable to provide virtual architecture. This result in unpredictable performance in the service (57). Hence customer expectation may not match with provider delivery and hence end user may get deprived of high-quality service.

## V. SECURITY ASPECT

### A. Opportunity

Maybe the strongest resistance to the relinquishment of pall computing in health IT centers relates to data security (58). Nonetheless, compared with locally housed data, this model isn't inescapably less secure. In some cases, it generally improves security because pall providers (eg, Microsoft, Google, Amazon) are ready to devote huge coffers to working security issues that a lot of guests can not go, in discrepancy to the destruction of the numerous medical records and legal documents within the Japan9.0 magnitude earthquake or the New Orleans Hurricane Katrina disaster.

All kinds of security measures, similar as in tackle, software, mortal coffers, and operation costs, are cheaper when enforced on a large scale. Utmost pall providers replicate druggies' data in multiple locales. This increases data redundancy and independence from system failure and provides A position of disaster recovery. In addition, a pall provider always has the power to stoutly reallocate security coffers for filtering, business shaping, or encryption so as to extend support for protective measures (eg, against distributed denial-of- service attacks). The capability to stoutly gauge protective coffers on demand has egregious advantages for adaptability (54).

### B. Challenges

There are numerous data security pitfalls in the use of IT, similar as hacker attacks, network breaks, natural disasters, separation failure, public operation interface, poor encryption crucial operation, and honor abuse. Specific pitfalls to pall computing are separation failure, public operation interface, poor encryption crucial operation, and honor abuse.

Cloud computation is generally accessible to numerous different customers. However, it could beget veritably serious security pitfalls, If the provider fails to separate the coffers. For illustration, a client requests to cancel data stored in the virtual structure; as with utmost operating systems, this may not affect in true erasing of the data

incontinently. The data are still stored on the fragment but are just not available (54). In the multiple vacancy's terrain, tackle coffers are reused by other guests. In this case, a third party could have access to another client's "deleted" data. This presents an advanced threat to the pall guests than with devoted tackle.

## VI. LEGAL ASPECTS

### A. Opportunity

Data and sequestration protection are essential to erecting the client trust demanded for cloud computing to reach its full potential. However, druggies would be better suitable to assess the affiliated pitfalls they face, If the providers borrow better and clearer programs and practices. Fortunately, numerous main providers have commitments to develop stylish programs and practices to cover guests' data and sequestration (59-61). Besides providers commitments to this protection, some associations, similar as the Cloud Security Alliance, have developed a comprehensive companion to deal with security and sequestration issues (62). The Trusted Computing Group a not-for- profit association, suggests a set of tackle and software technologies to enable the construction of trusted platforms. Governments also play a critical part by fostering wide agreement regulations for both druggies and providers (63-66)

### B. Challenges

The use of cloud computation presents numerous legal issues similar as contract law, intellectual property rights, data governance, and sequestration (67-71). Among them, data governance and sequestration issues are major enterprises.

In the cloud, physical warehouses could be extensively distributed across multiple authorities, each of which may have different laws regarding data security, sequestration, operation, and intellectual property (). For illustration, the US Health Insurance Portability and Responsibility Act (HIPAA) (63) restricts companies from telling particular health data to nonaffiliated third parties, and the Uniting and Strengthening America by Furnishing Appropriate Tools Needed to Block and Obstruct Terrorism ( Loyalist) Act (72) gives the US government the right to demand data if it declares conditions as being an exigency or necessary to motherland security. Also, the Canadian Personal Information Protection and Electronic Documents Act (PIPEDA) (64) limits the powers of associations to collect, use, or expose particular information in the course of marketable conditioning. Still, a provider may, without notice to a stoner, move the stoner's information from governance to governance. Data in the pall may have further than one legal position at the same time, with differing legal consequences

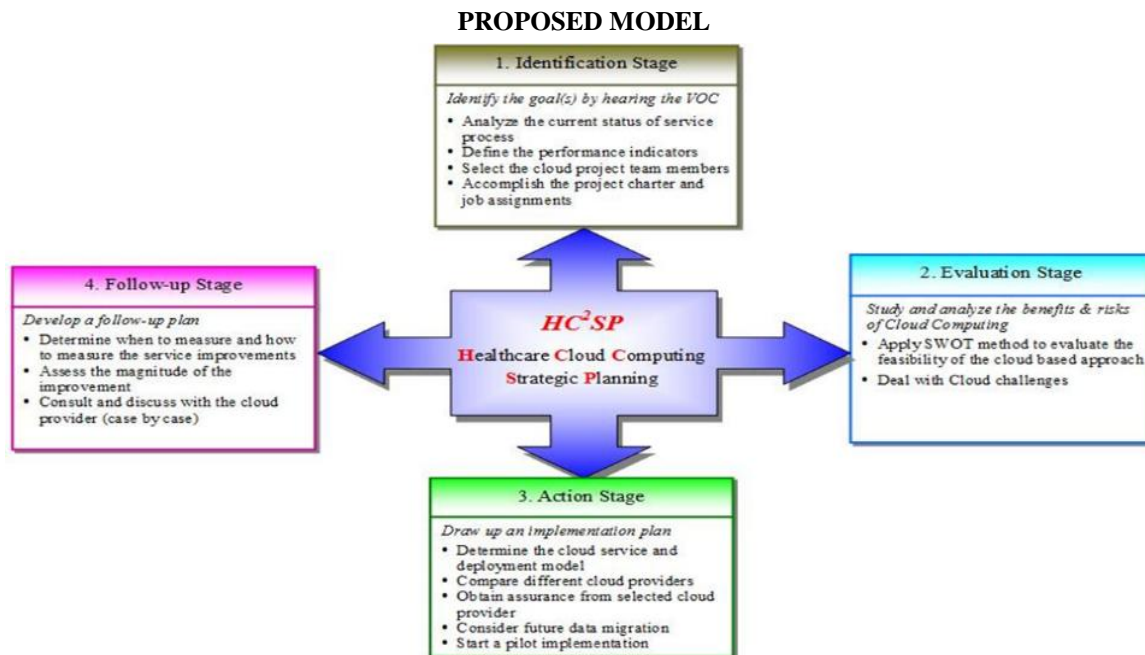


Figure 2. Health care cloud computing strategic planning (HC<sup>2</sup>SP) model (SWOT = strengths, weaknesses, opportunities, and threats; VOC = voice of customer)

**Stage 1: Identification**

In this HC2SP model, the first stage is to dissect the current status of the health association’s service process and identify the abecedarian ideal of service enhancement by hearing the voice of the client or the cases. The root causes analysis system can be applied to dissect the problems of the current service process. A typical scale of causes would be expressed as follows (80)

Problem# 1 The process of patient admission to, or discharge from, hospital is too long. Why? There's too important indistinguishable charting. Why? The paper-grounded charting system is hamstrung. Why? There's lack of automated information systems similar as EHR/ EMR. Why? It involves a lot of over-frontal IT investments and conservation.

The objective identification and its compass must be clarified so as to serve the end druggies (cases) more efficiently and effectively. In addition, the strategic planning platoon has to define health care service quality pointers and explain their purpose as well as the use of each index. This stage of the model provides the strategic planning platoon with a well- defined compass for the service problem being faced.

**Stage 2: Evaluation**

Next stage of the model is to estimate the openings and challenges of adopting cloud computing. ENISA (54), the Cloud Security Alliance (62), and NIST (53) have developed comprehensive attendants to estimate the benefits and pitfalls of adopting cloud computing. An authorized customer can also apply a strengths, weakness and threats (SWOT) analysis to estimate the feasibility of the cloud-oriented approach.

Likewise, the customer needs to assess styles to handle the linked issues. Numerous references are available for this purpose (51,53,62,71,82,83). For example, Armbrust et al (51) report 10 major obstacles for cloud computation. Each

hindrance is paired with openings (results), ranging from straightforward product development to major exploration systems. Buyya and Ranjan (82) bandy several cloud computational operational issues, similar as data transfer backups, participated logging, and confederation of distributed clusters. They also give farther references to handle the banded issues. In addition, Kuo et al (83) propose an XML- grounded middleman to conquer data cinch-in problems.

Furthermore, the user needs to assess methods to handle the identified issues. Many references are available for this purpose (51,53,62,71 ,82,83). For example, Armbrust et al (51) report 10 major obstacles for cloud computing. Each obstacle is paired with opportunities (solutions), ranging from straightforward product development to major research projects. Buyya and Ranjan (82) discuss several cloud-federated management issues, such as data transfer bottlenecks, shared logging, and federation of distributed clusters. They also provide further references to handle the discussed issues. In addition, Kuo et al (83) propose an XML-based mediator to conquer data lock-in problems.

**Stage 3: Action**

Once the new computing model is evaluated, adopting new services or not will be decided by the organization. Implementation plan should be drawn, if the final answer is yes. 5 step plan is proposed in this paper as follows:

**Step 1: Determine The Cloud Deployment Model**

As mentioned above, there are three service model of cloud computing (SaaS, PaaS and IaaS) and there are three deployment models (private, public and hybrid). They have their own advantage and disadvantage (55). Hence different factors should be considered while adopting service or deployment models.

## Step 2: Compare Different Cloud Providers

Choosing a proper cloud provider is the most important part of the implementation plan. Different providers may offer different service models, pricing schemes, audit procedures, and privacy and security policies. The organization has to compare different offerings. Also, it needs to evaluate the provider's reputation and performance before it signs a contract.

## Step 3: Assurance Given By Preferred Cloud Provider

Before providing service to any organization, cloud provider should give assurance to any company regarding security, legal aspect and confidentiality. Pay as you use, fast elasticity, data availability, support in troubleshooting and transparency in operation are some major factors covered. This helps in achieving three major network security goals such as data confidentiality, data integrity and data availability (54). One most important point in this is geographic access to data should be limited according to contract mentioned in service level agreements.

## Step 4: Future Data Migration Consideration

In this step when provider stops the google health services then organization takes their data back from cloud to in house (2). There may be decrease in service quality, or some dispute in SLA. Important part of the plan of this step may be data availability (84).

## Step 5: Start A Pilot Implementation

If some company is not used to any cloud environment, then pilot implementation is the best possible way (75,77).

## Stage 4: Follow-Up

This is the last stage of cloud computing implementation. In this stage required improvement of services can be measured. After fixing the target, improvement limit can be measured by performance related indicators (80). If it doesn't match the required criteria then health sector needs to study impact of aim achievement. In this organization may also consult with cloud provider if any problem is from their side. Chances are there that organization may decide once again to shift from cloud to in-house IT environment.

## VII. DISCUSSION AND CONCLUSION

Cloud computing helps in providing more relaxation, that may be less expensive and, in this way, providing IT services to end users may be more efficient. Thus, potential opportunity of research in health care services increases. However adopting new health care model may be very challenging. Securing the data and legal related issues are the powerful hindrance to adopt cloud computing in IT field of health care center. However some cloud service provider such as Microsoft, Google, Amazon try to provide best practices and policies for securing and safeguarding customer data (59-61). Some different and trusted computing group such as cloud security alliance have designed detailed technologies related to hardware and software to boost reliable cloud application.

Proper planning such as finance, manpower, tradition and culture of an organization should be taken into consideration by any organization when they wants to move their service into cloud. This paper provides required planning for

potential user and organization those who wants to shift to cloud. New model introduced in this paper includes 4 stages such as identification, evaluation action and lats but not the least to follow up.

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