Literature Based Study On Cloud Computing For Health And Sustainability In View Of Covid19

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Abstract: **The modern age of technology is trending with digitalization and reshaping the business around the world. Advancement of new technologies and innovations are transforming businesses in numerous ways and creating a whole new business computational ecosystem. Most often professionals are across the globe are talking about terms like digitization, Industry 4.0, Big Data, Block chain Technologies, cloud computing, 3D Printing, Machine Learning, Automation, Artificial Intelligence (AI), Internet of Things (IoT), Data mining etc. Amidst, all the major advanced technologies mentioned above, Cloud Computing, is one of the fast emerging into a large scale computing system with seamless access to virtually limitless resources. Just to apprise how the computing systems works before cloud computing ;technically to elucidate, Server-That was the past, back in the days say 20 years ago every company used to have its own server. In computing, a server is a computer program or a device that provides functionality for other programs or devices. A server is basically a very large computer (just like a mainframe) with its own set of hardware which includes a sophisticated processor capable of handling huge workloads from the office clients. On top of these servers the Operating System (OS) was installed and the applications were placed on these OS. The server will contain all the database of that particular organization and all the concerned in that organization will have access to that data stored in that server through WAN (Wide Area Network) or LAN (Local Area Network). The data stored in these servers can be anything ranging from stock record, records of all transactions or even application or email service. Typical servers are Database servers, CatLog server, File Servers, Print Servers, Sound Server, Media Server, Mail Server, Proxy servers, Web servers, Game Servers, Application servers etc. Hence, to maintain such server facility and proper functionality, it's becoming daunting task for small and big companies too. As such huge investment, technical expertise, IT infrastructure, vendors, manpower, security , licensing, overall maintenance cost shall gradually become untenable. Then come "Revolutionizing Computing systems called 'Cloud computing" which is supposed to be totally changed scenario of computational systems. Since it is cheap, no need to hire professional IT to maintain server, no wastage of money on acquiring server OS licensing, user friendly. Hence, it could be sustained in small and big companies/enterprises easily. Coronavirus, now declared as pandemic, is causing widespread shutdown and chaos. The rapid spread and global impact of COVID-19 can make people feel helpless and scared as the novel coronavirus escalates and forces them to change many aspects of their respective lives. It is clear that the world needs a quick & safe solution right now to combat further spread of coronavirus . What then is the best solution to this health crisis? This is where technologies such as cloud computing, AI & machine learning come into play. It will be very interesting to see how cloud computing will address and contribute towards these issues in the healthcare system & industry. The purpose of this paper is to explore the current state, status and trends of cloud computing in health system in view of covid-19.**

Key words: **Healthcare; Cloud; Computing; Security; Pandemic; Covid-19; Digitalization; Sustainability;**
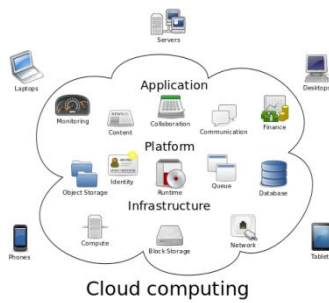
INTRODUCTION

Brief History : Reference to the phrase " Cloud Computing" appeared as early in 1996, with the first known mention in a **Compaq**internal document. The cloud symbol was used to present network of computing equipment in the original **APRANET** by as early as 1977 and the **CSNET**by 1981-both predecessors to the internet itself . The word 'cloud' was used as a metaphor for the internet and standardized cloud -like shape was used to denote a network on **telephony** schematics & also used to refer platform for **distributed computing** as early as 1993, when Apple spin-off General Magic and **AT&T** used it in described their (paired) **Telescript** and PersonaLink technologies. However, its background history also reflects some relationship with grid computing and other technologies such as utility computing, clustering, virtualization systems and Hight performance computing (HPC- i.e computing power, memory, multi-core processors, clusters, graphic processing units). Cloud computing was popularized with **Amazon.com** releasing its **Elastic Compute Cloud** product in 2006.

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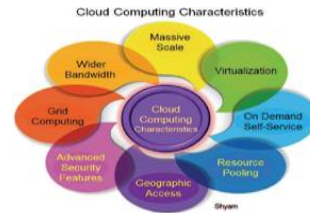
Cloud computing

Definition: Cloud computing is the delivery of computing services like cloud based storage, database management software, analytics and moreover the net (or cloud). Cloud computing is the practice of using a network of remote servers hosted on the internet to store, manage, and process data, rather than a local server or a personal computer.

How Cloud Computing works : In a cloud computing system, there is significant workload shift. Local computers no longer have to do all the heavy lifting when it comes to running applications. The network of computers that make up the cloud handles them instead. Hardware & software demands on the user's side decrease. The only things the user's computer needs to be able to run is the cloud computing system's interface software, which can be as simple as a Web Browser, and the cloud's network takes care of the rest.Examples- e-mail account with a web-based email service like G-mail, Outlook etc. Instead of running an e-mail program on computer, if log into a web e-mail account remotely via web browser, the software store account that doesn't exist on that computer- it is on the service's on computer   cloud . This is one kind of cloud computing .It is also seen that due to scarcity of storage space   on hard drive using of G-drive, Microsoft drive, Mega drive etc, these are also cloud storage devices. This is another kind of cloud computing where storing of data in the cloud done (servers of cloud providers instead of data in server of hard drive).This is what happens in cloud computing wherein all data or application that may run is stored in cloud provider's server and since there is not a single server rather there is group of interconnected servers the same data is mirrored in all the servers which make the date much more secure and safe in case of the servers goes down.

Main characteristic of Cloud computing :

Cloud computing is a model for enabling ubiquitous, convenient, on demand network access to a shared poll of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can rapidly provisioned and released with minimal management effort or service provider interaction. This cloud computing model is composed of eight (08) essential characteristics as depicted in the diagram .

Types of cloud services : Iaas, PaaS, SaaS (Service Models)

Most cloud computing services fall into three broad categories.These are also known as cloud computing stack, because they build on top of one another : **A.Infrastructures as a Service (IaaS)** : Moving down the stack, we get to the fundamental building blocks for cloud services IaaS is composed of highly automated and scalable computer resources , complemented by cloud storage and network capability which can be self provisioned, metered and available on demand. This service provides the infrastructure like Servers, Operating System, Virtual Machines, Networks and storage on rent basis. Examples -Amazon Web Service, Microsoft Azure etc.**B. Platform as a Service (PaaS)**: PaaS function at a lower level than SaaS, typically providing a platform on which software can be developed and deployed. This service is used in developing, testing and maintaining software. PaaS is same as IaaS but also provides the additional tools like DBMS, BI service etc. PaaS provides abstract much of the work of dealing with servers and give clients an environment in which the operating system and server software as well as the underlying server hardware and network infrastructure are taken care of, leaving users free to focus on the business side of scalability, and the application development of their product or service. Examples -Heroku, Google App Engine and Red Hat's Open Shift.

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Software as a Service (SaaS). SaaS is the most familiar form of cloud service for consumers. SaaS moves the task of managing software and its deployment to third party service. Among the most familiar SaaS application for business are customer relationship management application like Salesforce, productivity software suites like Google Apps, and store solution brothers like Box and Dropbox. Use of SaaS application tends to reduce cost of software ownership by removing the need for technical staff to managerial, install, manage, and upgrade software, as well as reduce the cost of licensing software. SaaS application are usually provided on a subscription model. Eg. Google Application, Salesforce.

Top Cloud Computing Companies :

Amazon Web Service (AWS), Microsoft Azure, Google Cloud Platform, Adobe, Vmware, IBM, Red Hat, Rackspace, Oracle Cloud, SAP etc.

Advantages of Cloud computing :

    a. Flexibility of operations
    b. Reduced cost
    c. Impowered productivity
    d. Reliability and Security of data
    e. Speed of Operations
    f. Boost performance

Penetrations , Roles, Functions, Benefit& Modelsof cloud computing in healthcare system:

The healthcare industry has traditionally been considered to be slow adopter of technology in India . Many belonging to healthcare environment have not yet adopted advance technology in their environment. Most of the application and focus has been on Hospital Information Management System (HIMS), Picture Archival Communication system (PACS), Laboratory Management System (LMS), Inventory Management System (IMS), Online Billing System (OBS) for payment and reimbursement and digitization of medical records etc. These modules are not yet implemented in a form of centralized system or only partial digitization occurred due to shortage of IT budgets etc, lack of infrastructure and manpower . Investment in IT infrastructure complete with other priorities like radiological, pathological, microbiological equipment'setc& its' penetration upto rural India will can bring only sustainability and life to all in such erupted crisis .However, developing countries like India , penetration of could computing in healthcare domain has started with emerging technologies such as mobile computing & cloud computing. Large of volume of data is collected, stored, processed and retried in patient digital multimedia data called Electronic Health Records (EHRs) etc.

Cloud transformation models :

Public cloud : The public cloud is deployed in public domain and it provides services on software application, storage, and other services. It has unlimited storage space, huge infrastructure, high speed public internet bandwidth, ownership, hosting, operation and maintenance is entirely with third party service providers . Service offered mainly by public cloud are for all clients of small, medium and enterprise organizations and networks . Eg. Elastic Cloud computing by Amazon, App Engine by Google, BlueCloud by IBM and Azure Services platform by Windows.

Community Cloud : Community Cloud is for collaborative group of people which is managed either internally or by third party. It is deployed either inside the organization or deployed externally. Ownership rely with group of people or may have been hired from outside under mutual consent by both parties . Cost is slightly higher than public cloud but cheaper than private cloud. Mostly, community cloud can be shared by all the govt.institution or partners or member of a similar group or community .

Hybrid Cloud : Hybrid cloud is a fusion of public cloud and private cloud. It has flexibility and has an advantage of multiple deployment models. In this model, both public & private locations are used to deploy hybrid cloud. Eg. IT organization uses it for scaling cloud size by connecting existing clouds available in different geographical region. Prominent features of hybrid cloud are like optimal utilization, data center consolidation, risk transfer and 24X7 availability and security.

Private Cloud : Private cloud is a cloud which is managed by single organization and restricted for outside organization. It is deployed, hosted and managed solely by internally or any outsourced third party. Depending on use, users are charged on the basis of per Gigabyte (Gb) or Per terabyte (Tb) usage. Data sharing has limited sharing due to usage of VPN, MPLS configuration, network security having its own firewall policies etc. Private cloud has provision of customization, strict security measures, comparatively better deployment than other models and reliability. It is less elastic in nature . Examples – Amazon Virtual Private Cloud (Amazon VPC), Microsoft Private, IBM SmartCloud Foundation etc.

Cloud computing in healthcare system :

Obtaining and analyzing healthcare data is a critical factor in getting ahead of and slowing the spread of disease, which is the case with the current Covid-19. To address such issue and create a platform to visualize and analyze Covid-19 in the healthcare works and spread a real-time feed of information ;

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here **cloud computing** is quickly evolving technology as fast, secure, and near real-time access to clinical and operations by enabling advance care for patients and can ultimately slow the spread of disease.

Applications of cloud computing in healthcare system:

Telemedicine: Cloud storage is a data storage service that can be used for storing/sharing patients data during tele-consultation, Tele-followup and Tele-education programme. Telemedicine system comprises video conferencing, medical consultation called telemedicine software which facilitates to record heartbeat, ECG, pulse rate, Blood glucose, Pathological slides, X-Ray scanner and Dermatology camera. Software deployed in cloud permits real-time collaboration via software based video conferencing, patient data exchange , telemedicine during virtual OPD or Tele-OPD. Through this data can be acquired, accessed from removed based location like community health center via cloud center & internet high speed broadband. Doctors at super specialist clinic could to connected to cloud database and give consultation by telemedicine software.

Cloud based 12 Lead ECG for Tele-Cardiology: Cloud based 12 Lead ECG based telemedicine service as compared with the traditional ECG tele-medicine can realize interoperability across various mobile and fixed devices. It greatly enhance the convenience of ECG interpretation and the efficiency of tele-consultation, as it enable cardiologist to interpret ECG ubiquitously, to access patient's current and past ECG records across hospital via centralized cloud database and to provide pre-hospital diagnosis in time.

Video cloud services for tele-medicine and telehealth services : It enables video conferencing from the device, location and network of choice and avoid investing in additional infrastructure through existing telemedicine cart, smartphone, tablet, PC or Mac and video cloud testing etc.

Clinical Research : Medical research is based on the data collected from the different patient from time to time. These data can be archived in any application software with database software as backend. Data can be made available to the researcher for clinical research from the centralized cloud archive.

Electronic Medical Record: Hospitals and physicians are started a cloud-based medical record and medical image archive services online. The objective is to offload a burdensome task from hospital IT department and allows them to focus on supporting other imperatives such as EMR adoption and improved clinical support system.

Collaboration Solutions : Cloud based physician collaboration solutions such as video conferencing physician visits, extending such offering to a mobile environment for rural telehealth or disaster response is becoming more real with broader wireless broadband and smartphone adoption .Hence, cloud technology supports in collaboration and team based care delivery and the ability to use applications based on business model requirement and a common set of clinical information **.**

Bid Data: Healthcare organization are turning into cloud computing to save cost of storing hardware locally, cloud can hold big data sets for EHRs (Electronic Health Records), radiology images and genomic data for clinical trials. Even attempting to share EHRs among facilities in various geographic areas without benefits of cloud storage could delay patient's treatment .

Health information Exchange : Health information exchange (HIE) help healthcare organization to share data in large scale proprietary of EHR systems and can now accelerate the deployment of HIE via a linkage to a strategic cloud implementation.

Medical Imaging : Medical imaging includes storage, sharing and computation of images, cloud based picture archival and communication. Also provides flexible radiology round the clock and thus help the patient by sharing the information among group of medical doctors for expert opinions.

Mobile cloud computing : Mobile cloud computing integrates cloud computing into mobile environment and overcome mobile devices limitations in terms of storage, security and privacy issues and these limitation & challenges are overcome by incorporating advanced technologies like high speed broadband like 3G,4G, Wifi&Wimax connectivity and can be used to improve more patient outcome with quality services .**11.Medical Transcription:** One of the most enabled technology withaudio file transcribing systemrapidly used in healthcare **.**

Discourse of health risk issue & SWOT analysis : Some cloud security has been assessed by identifying/gathering risk based on some literary study . These are appended here as under :-

Table 1. Possible risks in cloud computing in healthcare

Risk A	Policies and changes
Risk B	Legal, Ethical and Privacy laws
Risk C	Failure of cloud access tool / communication media etc
Risk D	Flooding attacks by virus/malware program used by hackers

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Risk E	Distributed denial of service (DDoS)
Risk F	Cloud bankrupt/change in ownership
Risk G	Technical failure/Downtime
Risk H	Access of data by unauthorized users/third party
Risk I	Cloud based privacy and security
Risk J	IP & Post scanning

SWOT Analysis :The acronym SWOT stands for Strength, Weaknesses, Opportunities and Threats. SWOT analysis is an efficient way to find the strength and weakness of any organization capability and has been used very extensively in various organizations for decision making process/resolution. In view of healthcare system, this SWOT could be represented as below :

Table 2. SWOT analysis in healthcare.

STRENGTH	WEAKNESS
Cost effectiveness, Innovative, Flexible, Cost reduction	High speed internet, integrated with local
Energy Saving, Better control, Ability to expand	Software, Lack of commitment to control QoS, Legal, Ethical and Privacy Laws etc.
OPPORTUNITY	THREAT
Latest technology, Minimum investment, adaptive to future requirement	Data security, Loss of connectivity, Integration with another platform is hard/risky, Lack of standard

CONCLUSION :

Healthcare consumerism is an underlying trend that ultimately making cloud adoption essential to provider success. According to MarketsandMarkets, the global adoption of cloud service in healthcare will grow from $3.73 billion in 2015 to nearly $ 9.5 billion by 2020. Such predications are no longer surprising as cloud is a topic nearly every IT strategy meeting. Importantly, test driving cloud today will form an essential foundation for the future of healthcare industry . This cloud application can transform the healthcare system from capital intensive to pay per usage model. Envisioning a futuristic technology, were we can simply enter out health concern and symptoms alongwith details, insurance details, get advice from a physician in real-time and electronically receive prescriptions, order medicines online with automated payment either by insurance company or self and have them delivered at our doorstep- all this without an appointment , visiting a healthcare facility or a pharmacy or have to leave the comfort at home during a infirmity, with increasing and evolving adoption of **cloud computing this** scenario is becoming a reality .Globally, the healthcare cloud computing market is expected to grow at a compound annual growth rate of 20%, exceeding USD 15.5 billion by 2024. Cloud computing offers immense potential to transform the healthcare landscape by redefining systems, processes, and informatics, enabling innovation, drawing insights from monumental data sets, lowering cost and increasing efficiency and personalization, while adhering to high standards of security, privacy and compliance .Therefore, adoption of cloud computing & implementation for the best practices, deployment and use of it will hopefully generate a future growth & sustainability of the cloud -based systems adoption, despite of all odds.

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