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Review Paper

A Simplified Review of Cloud Computing in the Healthcare System

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Abstract: One of the key drivers of the health information revolution in the healthcare industry is cloud computing. Cloud computing makes it possible for anyone to exchange digitized health records globally. This technology fosters innovation and enhances safety in the healthcare industry. The use of this technology makes communication with the health matrix possible on a global scale. For many years, cloud computing has been used in the healthcare industry and has developed along with changes in the business. Through a network connection, this technology creates universally usable hardware for a range of healthcare applications. Doctors can provide their patients with health advice and communicate their daily health routines, often maintaining the health of their bodies and brains. By using videoconferencing, psychologists and psychiatrists may create a pleasant environment for their patients. The necessity for cloud computing in healthcare is covered in this essay. The large key is that the benefits, drawbacks, and difficulties of cloud computing for the healthcare sector are noted. Finally, it discusses the important uses of cloud computing in the field of healthcare. Increasingly, healthcare providers are giving Internet of Things (IoT)-equipped devices to patients, and by connecting these devices to the cloud systems of hospitals, patient data is promptly sent to their physicians. Because of this, cloud computing enhances efficiency and multiplies the methods for streamlining healthcare delivery. These fast-evolving technologies include Big Data analytics, artificial intelligence, and the Internet of Medical Things. It increases interoperability, increases resource availability, and lowers costs.

Keywords: Cloud computing, Cloud system, Healthcare organizations, Electronic health records, Security and privacy, HIPAA, e-Health, Health Monitoring, Telemedicine

1. Introduction

In the healthcare sector, cloud computing has emerged as a game-changing technology that is revolutionizing how healthcare organizations manage and use massive volumes of data. Cloud computing has paved the path for better collaboration, improved data protection, more intelligent analytics, and increased access to healthcare services by providing scalable and affordable solutions. This introduction gives a general overview of cloud computing in healthcare, emphasizing its potential advantages and importance in changing the system.

Every day, the healthcare industry generates enormous amounts of data, from electronic health records [1] and medical imaging to genomic data and patient monitoring data. The traditional approaches to data management and storage cannot keep up with the rising demands, resulting in inefficiencies, data silos, and restricted accessibility. With its capacity to deliver on-demand access to pooled computing resources over the internet, cloud computing offers a workable solution to these problems. The potential of cloud computing to facilitate seamless data processing, sharing, and interoperability among healthcare providers are two of its main benefits. Healthcare Practitioners can access and exchange data in real-time by centralizing patient information on cloud-based systems, facilitating collaborative treatment, strengthening care coordination, and ultimately improving patient outcomes. Through this enhanced information flow, fewer tests are repeated, accurate diagnoses are made, and better-informed treatment choices can be made. Additionally, cloud computing provides strong data security and privacy protections, solving issues with the digitization of healthcare data. To protect private patient data from unauthorized access, breaches and natural catastrophes, cloud service providers put strict security standards in place. These include encryption, access controls, and routine data backups. To guarantee patient privacy and data safety, compliance with industry laws, such as the Health Insurance Portability and Accountability Act [2], is another essential component of cloud computing in healthcare [3]. The use of cloud computing also creates new opportunities for utilizing advanced analytics and machine learning techniques to gain insightful knowledge from massive healthcare datasets. Predictive analytics, disease surveillance, population health management, personalized medicine, and clinical decision support systems [4] can all benefit from these insights, enhancing patient classification, healthcare delivery, and treatment outcomes. With on-premises infrastructure, it would be difficult to execute sophisticated algorithms and analyze large datasets efficiently. The scalability and computational power of the cloud make this possible. The growth of

healthcare services outside of the conventional brick-and-mortar setting is another benefit of cloud computing. Solutions for telemedicine and remote patient monitoring use the cloud to link medical staff with patients in far-off locations, enabling virtual consultations, remote diagnostics, and continuous vital sign monitoring. This technologically driven strategy removes geographic constraints, expands access to healthcare, and improves patient convenience, especially for people with limited mobility or those residing in underdeveloped areas.

Although using cloud computing in healthcare has many advantages, some issues need to be resolved. Robust governance frameworks must take data privacy, security breaches, and regulatory compliance into careful account. To reduce the risks associated with vendor lock-in [5], healthcare organizations must evaluate the dependability, reputation, and observation of cloud service providers, ensure data portability, and develop unambiguous data ownership agreements.

In summary, cloud computing has revolutionized the healthcare sector by offering scalable and affordable options for data processing, management, and storage. Data sharing has been revolutionized, security measures have been improved, powerful analytics have been made possible, and access to healthcare services has been expanded. To fully take advantage of cloud computing while protecting patient privacy and data, rigorous planning, compliance with legal standards, and thorough security processes are needed.

2. Related works

2.1 "Cloud Computing and Healthcare: A Comprehensive Survey" (2019)

The uses of cloud computing in healthcare are comprehensively covered in this survey report. It talks about the drawbacks and advantages of employing cloud technologies in several areas of healthcare, like telemedicine, remote patient monitoring, and data analytics. The report also discusses privacy and security issues related to healthcare's embrace of the cloud. The paper may not provide a thorough review of every facet of cloud computing in healthcare due to the length and scope restrictions inherent in academic studies. It might not go into great detail on particular technological matters or interoperability issues or give special insights into particular healthcare domains.

2.2 "A Framework for a Cloud-Based Electronic Health Records System for Developing Countries" (2020)

In this research, a framework for a cloud-based electronic health records system that can store, retrieve, and update patient medical records is suggested. This system would be useful in poor nations. In the context of a health institution moving from paper-based patient record documentation to an EHR system, the architecture enables different medical stakeholders and patients to access the EHR system via a web portal and a range of devices. Strong infrastructure and sufficient internet access are prerequisites for cloud-based solutions. However, developing nations may experience resource constraints such as constrained bandwidth, erratic power supplies, or a lack of technical competence. The proposed approach may be difficult to implement in practice

since the study may not fully address these resource limitations.

2.3 "Cloud-Based Multilayer Telemedicine Architecture: A Case Study" (2019)

This study examines how cloud computing and telemedicine might work together. It draws attention to the role that cloud infrastructure plays in telemedicine services' scalability and accessibility, thereby improving access to healthcare for rural and underserved people. This study covers cloud-enabled telemedicine platform case studies and actual implementations.

2.4 "Security and Privacy in IoT-Cloud-Based e-Health Systems—A Comprehensive Review" (2020)

The use of intelligent techniques in health care and its progress over time, notably the integration of Internet of Things (IoT) devices and cloud computing, are explored in this paper through research projects conducted from 2017 to 2020. To protect patient data in the cloud environment, it examines several security measures, including encryption, access controls, and authentication.

2.5 "A cloud solution for medical image processing." (2014)

This paper examines the difficulties and benefits of cloud computing as they relate to medical image processing. This research also presents cloud-based tools and techniques for processing medical images. A system for processing medical images is finally offered, based on Eucalyptus cloud architecture, software, and an improved evolutionary algorithm for resource allocation. Medical image processing methods and cloud computing technology are both constantly developing fields. This study may not take into account the latest advances in machine learning, deep learning and image processing technologies that have emerged over recent years.

2.6 "Security Challenges in Healthcare Cloud Computing: A Systematic Review" (2016)

This article explicitly discusses how cloud technologies can facilitate data interchange among diverse healthcare systems and stakeholders because interoperability is a recurring concern in the healthcare industry. This study used a systematic review to look into the security issues with cloud computing. It primarily focuses on healthcare cloud computing security and conducted a systematic review of 210 full-text articles from 2000 to 2015. Medical image processing methods and cloud computing technology are both constantly developing fields. This study may not cover the latest advances in machine learning and algorithms for processing images which have been introduced over the last few years. The paper's focus on medical image processing in the cloud may limit a broader understanding of the challenges and opportunities in the entire healthcare ecosystem. It may not address other critical aspects such as data integration, interoperability, and clinical decision-making. support, or telemedicine, which are relevant to the broader field of healthcare informatics.

2.7 "Opportunities and Challenges of Cloud Computing to Improve Health" (2011)

To assess the advantages and disadvantages of this computing model, this article explores the idea and its current application in the field of health care from the perspectives of management, technology, security, and law. Also covered is the use of strategic planning by a health organization to choose its course, strategy, and distribution of resources after deciding to switch from conventional to cloud-based health services. Given the broad nature of the paper, it may provide a generalized overview of the opportunities and challenges, which could vary depending on the specific context, organization size, infrastructure, and regulatory requirements. The paper may not extensively cover the technical aspects of cloud computing implementation in healthcare. It might not address specific concerns related to integration, interoperability, data migration, or system architecture, which are critical considerations in practical implementations.

2.8 "Cloud Computing-Based Medical Health Monitoring IoT System Design" (2021)

The design of the IoT system for monitoring medical health that is based on cloud computing is mostly covered in this paper. Through the medical terminal, users can gather their own physiological signs both inside and outside of their homes. Through the mobile GSM-TD communication network, these signs and data are sent to the background health platform system. Through the web or WAP website, users can also access their own past health records and the recommendations of health advisers.

2.9 "e-Health Cloud: Opportunities and Challenges" (2012)

The term "e-Health Cloud" is introduced in this paper, along with many of its components, as well as a proposal to create an e-health environment and an explanation of many of the obstacles that must be overcome for the e-Health Cloud to be successful. It also discusses many potential solutions to problems like security and privacy. Due to the broad nature of the topic, the paper may provide a generalized overview of the opportunities and challenges of e-health cloud computing. It may not account for the specific context, regional variations, or organizational requirements that can influence the implementation and outcomes of e-health cloud solutions.

2.10 "A review of the hybrid cloud approach for sharing health information and management" (2017)

This paper focuses on determining which health information is appropriate and helpful to share for diabetes patients with type 2 while several stakeholders are concerned for different purposes and cloud-based solutions are to be found, i.e., auspicious and bright solutions that can be achieved, and to share the health information, it allows the patients to share data where they want to have a deep understanding of the area, and to identify knowledge on specific research, a literature review paper is drafted.

3. Cloud Computing

The act of using and storing software and data online rather than on a computer's hard drive is the simplest definition of cloud computing. The best definition of cloud computing is "an information technology service model where computing services (both hardware and software) in a virtual environment are delivered to customers over a network in a self-service manner, independent of device and location." Customers who use cloud computing do not own the infrastructure; instead, they rent it from another provider.
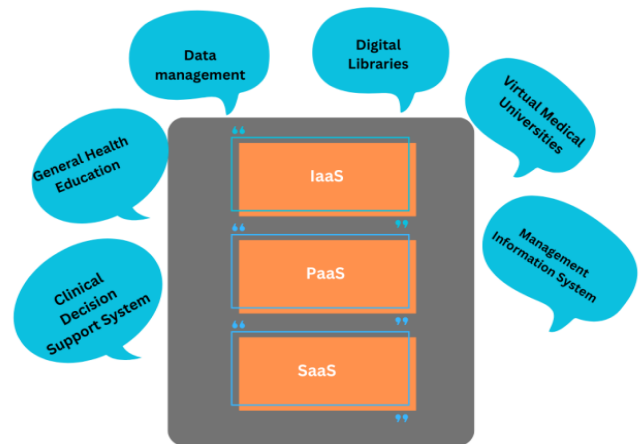

Fig.: 1 Cloud-Driven Healthcare System

On-demand, self-service, extensive network access, resource pooling, and quick elasticity are the main features of cloud computing and cloud services. More people are using cloud computing due to its benefits and ease of processing. The US National Cloud computing service models include infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS) [6]. Users can access processing, storage, networks, and other computer infrastructure resources through infrastructure as a service (IaaS).

Platform as a Service (PaaS) enables customers to deploy applications created using specific programming tools and frameworks categorized by the Institute of Standards and Technology on the cloud infrastructure. Users can access applications operating on cloud infrastructure from different end-user perspectives by using software-as-a-service (SaaS) devices (usually using a web browser).

4. Cloud Computing in Healthcare

The use of cloud computing in the medical field has increased recently. The need for cloud technology in the healthcare industry is growing daily. The need to give the best medical treatment at the lowest possible cost has intensified competition among the many healthcare providers, which has resulted in the healthcare environment evolving more quickly than ever before.

To provide better services for less money, hospitals, physicians, research clinics, and other commercial and public healthcare organizations are always seeking new solutions. If these cloud computing technologies are properly applied, they can solve every issue the healthcare sector is now facing. Thus, the newest cloud technologies provide the healthcare

industry with the potential to enhance patient care, modernize operational infrastructure, facilitate information sharing, and save costs. Therefore, a doctor may access his patients' records using cloud computing in healthcare, even if they are far away. Therefore, it can be demonstrated that using cloud technology in healthcare is beneficial for people all over the world.

5. Benefits of cloud computing for Healthcare

The healthcare industry produces a lot of data every day. For clinicians and patients to safely access these data remotely, time is required.

With the use of health cloud computing, enterprises may do away with restrictions while improving patient outcomes. For healthcare providers, cloud computing lowers operating costs and offers customized care.

The use of cloud technologies also contributes to effective workflows and enhanced service. Patients also get quicker responses from the healthcare sector at the same time. Healthcare information is accessible because of cloud solutions. [7] It enables people to monitor their health more effectively.

Using cloud computing technologies, doctors and other healthcare professionals provide top-notch solutions. Utilizing cloud-based services and technology always enables faster and more accurate access to all the vital data for healthcare service providers and the patient's history. It is quickly processed utilizing user-friendly cloud technologies to produce concise, easily accessible information that enables analysts to assess and provide suggested treatment. The necessity of reducing waiting times for patients and healthcare professionals alike is both a boost to independent health consultation and seamless support over the Internet [8]. Long-standing conventional systems in healthcare have witnessed some recent demands for digital change. Patients can now receive individualized care when needed through wearable technology and virtual medicine. Demand for cloud-based technology has emerged due to the rise and desire for interoperability across electronic health record technology platforms, which offers several customers secure, quick, and affordable solutions [9] Applications.

The major application of cloud computing is to store medical records online. Because of the most recent HIPAA modification, cloud healthcare service providers are now liable for HIPAA compliance on behalf of the healthcare organizations they support. Thus, data encryption and safe backup of data, including a person's health information, are included. Next, it is determined if the data can be recovered quickly. Finally, security may be increased by employing permission-based and secured databases.

Sometimes, two or more healthcare organizations will need a person's health information. In that situation, the implementation of health information on a person may be easily synchronized and shared at the same time thanks to cloud technology. Consequently, this supports the idea that

doctors may offer patients better medical treatment. Thus, the patient's information is easily accessible thanks to the use of cloud technology.

6. Downsides of Cloud Computing in Healthcare

Cloud computing offers numerous benefits in terms of scalability,cost-efficiency, and accessibility. There are also concerns and fears associated with its implementation in the healthcare industry. Healthcare organizations are increasingly adopting cloud computing to improve efficiency, reduce costs, and improve patient care. However, there are some fears associated with cloud computing in healthcare, including

6.1 Data Security and privacy issues:
According to [10], healthcare data is some of the most sensitive data in the world, and organizations are understandably concerned about the security of their data in the cloud. Cloud providers have a responsibility to protect their customers' data, and they have several security measures in place to do so. However, there is always the risk of a data breach, and organizations need to carefully evaluate the security of any cloud provider before they adopt their services. Improper access controls, weak authentication mechanisms, or insufficient user management practices can result in unauthorized access to sensitive patient information. Healthcare organizations must implement robust access controls and regularly review and update user privileges.

6.2 Compliance:
Healthcare organizations are subject to some regulations, including HIPAA [2], which require them to protect the privacy and security of patient data. Cloud providers must also comply with these regulations, and they have many measures in place to do so. Healthcare businesses need to establish legally enforceable contracts that guarantee data protection and thoroughly evaluate the compliance procedures of possible cloud providers.

6.3 Vendor lock-in:
When an organization adopts a cloud-based solution, it may become locked into it. This can happen if the organization's data is stored in a proprietary format or if the organization is dependent on the cloud provider for support.

The lack of adaptability may weaken the organization's bargaining position in the future and restrict its capacity to respond to shifting technical environments or unanticipated provider problems. Organizations should carefully evaluate the terms of any cloud contract to make sure that they are not locked into a particular solution.

6.4 Performance:
Cloud computing can be a good solution for organizations that need to scale their IT resources up or down quickly. However, organizations need to make sure that the cloud provider they choose can meet their performance requirements. Even slight delays in medical emergencies might affect patient outcomes. To retain the speed needed for

medical decision-making, cloud providers must offer low-latency solutions. Organizations should test the performance of any cloud-based solution before they adopt it.

6.5 Cultural Barriers to Change

Because of worries about employee training requirements and disruption to workflow, the healthcare industry has historically been reluctant about implementing new technologies in this field of work. Healthcare personnel who are accustomed to the current procedures may be reluctant to adopt cloud based solutions. Clear communication, training, and change management techniques can assist in overcoming this cultural resistance.

6.6 Budgetary Issues:

While using the cloud can save money by eliminating the need for on-premises equipment, there may be a risk of rising expenditures in the long run. Budgeting for healthcare businesses may not be compatible with cloud provider subscription models and anticipated price increases. Businesses must evaluate the entire cost of ownership over time, taking into account subscription fees, data transfer expenses, and prospective consumption growth.

6.7 Integrating and being interoperable

Healthcare facilities frequently use antiquated software and systems, which may not function properly with cloud alternatives. Compatibility problems and potential disruptions to established workflows must be resolved before data can be moved to the cloud. This integration problem might make adoption and implementation more difficult, which would disrupt the continuity of patient care. Organization must do a timely maintenance of their system for the proper integration of the softwares for proper workflow.

6.8 Owning and managing data

Giving up direct control of data to outside suppliers is common when using cloud storage. In the event that the cloud provider has problems or changes its conditions, this raises questions regarding the capacity to access, alter, or retrieve data. Without direct access to patient records, healthcare organizations may feel exposed, which could affect professional judgment and treatment planning. Thus healthcare organizations should make a contract with a reliable and trustworthy cloud provider and to carefully evaluate their terms and conditions.

6.9 Reliability

For prompt and efficient healthcare delivery, uninterrupted access to patient data is essential. Critical procedures can be delayed and patient care can be disrupted by cloud service disruptions. Healthcare organizations are concerned about cloud service providers' capacity to ensure high availability, particularly in times of crisis. Disaster recovery plans, redundant data centers, and communication protocols can all help to lessen the effects of outage.

6.10 Lack of Expertise

Healthcare personnel could lack the particular knowledge and abilities needed to successfully implementing cloud computing. Expertise is necessary for maintaining updates, assuring security of the critical data and configuring cloud systems timely. To ensure a seamless transfer of data and continuous operations, organizations may need to spend money on training or hire specialized personnel.

A strategic strategy is needed to strike a balance between these worries and the potential advantages of cloud computing. Healthcare organizations can confidently navigate the complexities of cloud adoption while safeguarding patient data and quality of care by addressing security with robust encryption, compliance with legal requirements, creating redundancy for reliability, ensuring interoperability, and investing in training and expertise.

7. Conclusion and Future Scope

Our lives are quickly and dramatically changing as a result of cloud computing. Everywhere on the globe, the use of cloud computing technology is growing daily. As was said above, there are several reasons why cloud technologies are used in the healthcare sector. Medical professionals may efficiently communicate with their patients and assess their health conditions at a reasonable cost with the use of cloud computing technologies. The use of cloud technologies in the healthcare sector will usher in a new era in the field of healthcare. There may be some concerns about data safety and other issues, but just as all problems have a solution, humans will also solve them one day. By utilizing this technology, any segment of society may receive healthcare. It is important to keep in mind that cloud computing is still a developing technology, which suggests that the services it provides in the future will exceed our expectations or go far beyond our wildest dreams.

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