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Cloud Solutions in Global Health Solutions

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Abstract: ***Digital innovations and their applications in healthcare have changed the current scenario of delivering healthcare services and storing data. Cloud computing is one such technological adjunct that has the capability of storing vast volumes of medical data, which can be accessed anytime through the internet from anywhere. Today, all smart devices and health-related apps designed for lifestyle changes and monitoring of medical problems utilise cloud-based programs. These applications result in positive reinforcement for inculcating regular monitoring and counselling. The paper critically discusses and summarizes the cloud-aided performance and applications in health and research. Moreover, it outlines the integration of cloud technology in handling drug theft and counterfeiting. The paper explores misconfigurations and the associated risks of current technology to comprehend its future scope and applications.***

Keywords: Cloud Computing, Electronic Records, Imaging, Nudging, Robotics, Telemedicine.

I. INTRODUCTION

Cloud computing is one of the most beneficial solutions to digital problems. It is an abstracted, virtualised, dynamically scalable network which manages power storage platforms and services for instant delivery through the internet [1]. It is a combination of both hardware and software that serves enormous purposes. It offers various applications, including data storage, servers, databases, networking, and software. Cloud-based applications are developed fundamentally on Internet technologies like Hypertext Preprocessor (PHP), which is a scripting language for web applications, AJAX (Asynchronous JavaScript and XML) web browser technologies, HTML, Cascading Style Sheets (CSS) [2]. The primary disadvantage of the healthcare delivery system is its economic inefficiency, which poses a challenge in providing quality healthcare in remote areas. Cloud computing presents an excellent opportunity to address the limitations faced by healthcare systems. This system primarily comprises three services: Software-as-a-Service (SaaS), Infrastructure-as-a-Service (IaaS), and Platform-as-a-Service (PaaS). SaaS is a software that enables consumers to use the provider's application services through a web browser, without requiring downloads or installations. Moreover, users are not liable for hardware or software updates. Cyberattacks and network issues influence the performance of SaaS. PaaS enables the creation of customised web applications that can be used without requiring any additional tools or skills. Infrastructure as a service (IaaS) allows users to rent computing resources, including storage, networks, and other necessary components, which can be utilised to run software such as operating systems and applications.

The providers of IaaS manage servers, hard drives, networking, virtualisation, and storage. The healthcare system has increasingly become data-oriented and a collaborative endeavour. The term “Cloud Computing” is described by the National Institute of Standards and Technology (NIST) as a model for enabling omnipresent, agreeable instant access to a divided pool of configurable computing resources [1]. As cloud services utilise uncomplicated, popular, systematised components, they have become an easy and accessible tool for users. It is an essential collection of information, various functions, applications, and infrastructure that can be accessed by any user and healthcare organisation worldwide. The fields of clinical and biomedical research have witnessed a significant transformation in healthcare data management systems. The need for massive data analytics and breakthroughs in the healthcare field is crucial for a real-time, innovative health information management system. Cloud-based technologies, such as electronic medical records, mobile apps, patient portals, and devices with IoT, as well as big data analytics, are used in healthcare systems to resolve key challenges.

Accessing healthcare is a significant issue in parts of the country that are inaccessible and for patients who are preoccupied. Virtual care solutions are gaining popularity as patients’ negligence in following the drug dosage can be easily tracked and monitored, avoiding unnecessary hospitalisation. Many medical suppliers and pharmaceutical apps keep track of automatic order refills, making it convenient for patients.

Theft and drug misuse, suspicious and illicit medications require monitoring by the supply chain. With the use of artificial intelligence in the healthcare environment, doctors can reinforce data with innovative, machine-based analytics for evaluation. Each healthcare professional has the burden of maintaining their medical records in compliance with the Health Insurance Portability and Accountability Act (HIPAA). Cloud-based solutions enable access to security technologies and reduce institutional accountability. Moreover, having a single electronic health record will

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reduce fluctuations in decision-making and standardise treatment protocols, irrespective of the care provider.
The recent advances in cloud computing have transformed healthcare by improving performance and storage at a better cost, robust security, hybrid infrastructure and seamless integration [3].

II. APPLICATIONS

Cloud computing has various applications in healthcare, including telemedicine, medical imaging, hospital management, and therapeutics. Its applications include mobile apps, patient portals, electronic medical records, etc., as shown in Figure 1 [4].

A. Imaging and Medical Record

Data-Important information can be gathered by image processing, sharing workflows, archiving, PACS (picture archiving and communication system), and thereby forecasting healthcare consequences, predicting epidemics outbreaks, real-time decision making, discovering trends, interoperability, increased scalability [5]. Cloud-based PACS simplifies the exchange of DICOM images between care providers. It comprises the identity and health of the patient, based on demographic and personal characteristics. Treatment plan, lab test and radiograph reports are everyday necessities of health data management. They provide accurate information and analysis that one can use to their advantage to diagnose a disease and administer emergency treatment without wasting time on lengthy laboratory tests.

B. Data Access in Actual Time

Health data management systems require real-time data access for quality patient care. Client-server-based management enables physicians to access and modify patient records in real-time. Any client can access the required information about their medical records at any time with just one click. Considering the timeline of events, data correlation can be done. End-to-end support brings higher patient satisfaction scores by delivering better care at home.

C. Patient Monitoring

Patients can now track their medical data that hospitals or third-party cloud service providers maintain. Platforms based on consumer perception show that a convenient system is required. A comprehensive data asset is maintained, which can now be accessed by patients for monitoring purposes. It creates transparency and convenient use of the networking system.

D. Telemedicine

It involves the use of electronic communications and software to provide clinical services to patients without an in-person visit. Telemedicine technology is frequently used for follow-up visits, management of chronic conditions, medication management, specialist consultations, and a range of other clinical services that can be provided remotely via secure video and audio connections, such as cancer monitoring. The easy access to healthcare through mobile applications is rapid and saves the time and energy of both parties involved. It connects to remote places, allowing for easy access to the necessary treatment. The interconnectivity works remarkably towards improving health situations in remote areas, in particular.

E. Efficiency

It increases the efficiency of the healthcare infrastructure involved while reducing costs. It can manage large amounts of data and simultaneously provide services according to user compliance. Every system involving cloud computing should be efficient enough to offer multiple, diversified services related to healthcare, management, and better compliance.

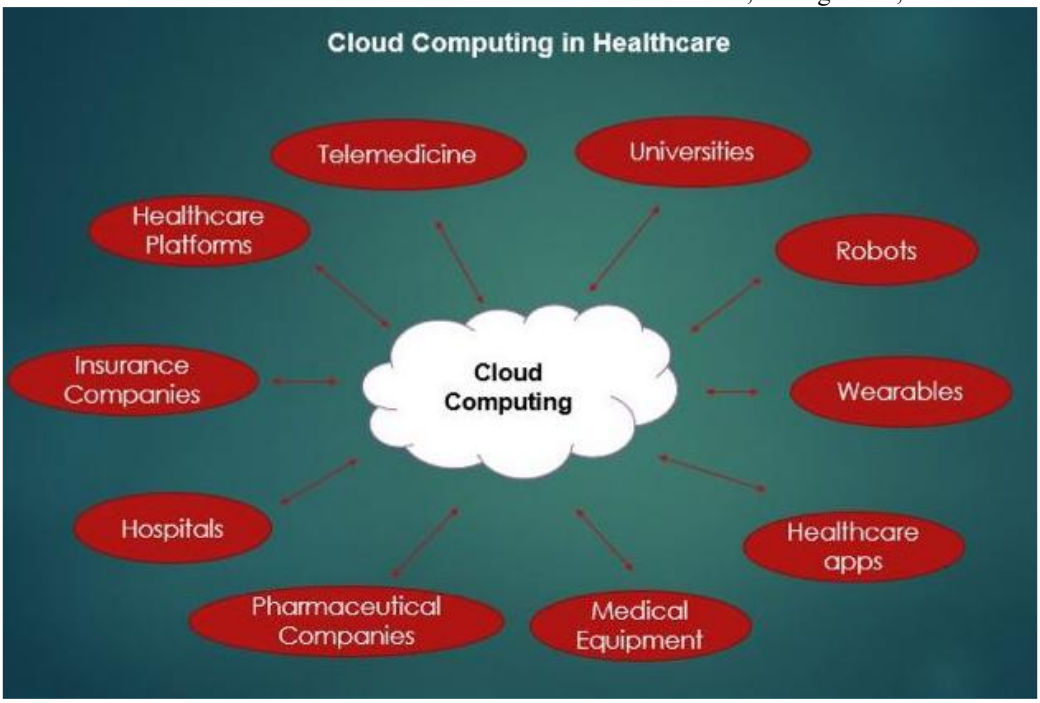

Figure 1: Cloud applications in healthcare [4]

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III. KEY BENEFITS

Salient features of cloud computing are many, but a few crucial advantages are as follows (shown in Figure 2)-

A. Reduced costs

Cloud computing services reduce the financial burden by lowering hardware costs, thereby further cutting labour and maintenance costs. The vendor takes care of the hardware needs, their repair and replacement. Moreover, cloud software applications are accessible via an internet connection, allowing users to access them from anywhere, thereby enabling flexibility at work. Cloud computing will cost less than supercomputers.

B. Security and Privacy

A cloud host is a person who can carefully monitor security, which is more reliable than a conventional networking system. Protecting the data requires powerful security laws. According to security standard rules, the Accountability Act. - Cloud conditions maintain secure health data using encryption and decryption, including unique encryption, as well as public and private key encryption.

C. Flexibility

The pliability offered by cloud services to the overall healthcare system, versus hosting on a regional server, is met immediately by cloud services. The stress-free environment it provides is beneficial. One can work from any location and obtain the required information quickly. The flexibility has enabled the service provider to enhance its operational capabilities and deliver a high-quality service to users.

D. Scalability

The most promising feature of the network is that it helps reduce work pressure. The overall performance increased through effective design and complex execution, as well as huge systems such as databases, which is very important. There is a decrease in investment in manpower, which in turn saves money, and working quality is not hampered.
The rising demand for medical and healthcare IoT devices has led to an increased volume of data. Cloud computing systems are replacing a significant portion of the workforce. The complex system ensures the critical management and storage of data and information related to healthcare.

E. Mutual Performance

An extensive range of cloud providers imparts a variety of services. For example, high-resolution images provide storage and analysis. The services are made easy by integrating data among cloud service providers. It reduces the risk of duplicate tests and prescriptions. The lab reports, the availability of programmed medicine, and the expenditure of treatment are all stored in cloud computing systems to ensure smooth operation.

F. Independence and Program Execution

Different databases, such as SQL, Oracle, and MySQL, can be easily installed on a mobile phone. Numerous documents and applications will be in one form and can be exchanged and collaborated on. Many networking organisations want an independent cloud computing system that only the individual can operate.

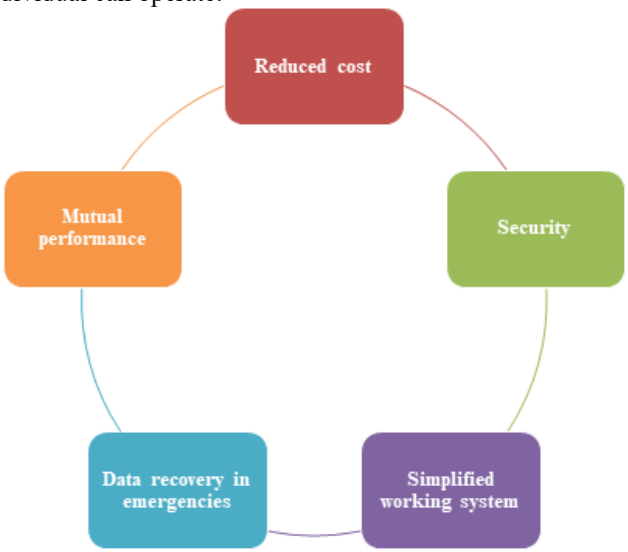

Figure 2: Key benefits of Cloud Technology

G. Exploration

The expertise to search through a vast amount of information and data about millions of users in a database is included in a cloud-based electronic health record environment, categorised into four areas: clinical data, insurance and financial data, data about drugs, usable researchers, patient behaviour, and emotional data. The web browser should include a diversified network to facilitate a simplified working system. Healthcare information fed into the system can be cross-checked for any minor errors that can be instantly corrected, thereby reducing the dependency on manual processes and increasing the reliance on cloud computing.

H. Structure

The cloud infrastructure comprises tasks performed at different levels. This makes the work more exclusive and distinct. Hardware malware does not result in data loss, as networked backup is always available. In the event of emergencies, such as natural disasters or power outages, business disruption can occur, but data can still be quickly recovered. The cloud architecture provides high security and faster data recovery.

IV. LIMITATIONS

Despite the benefits claimed by cloud vendors in providing optimal medical services and care, several drawbacks exist to its implementation.

A. Internet Connectivity

Consistent network connectivity is essential for optimal computing performance. For hassle-free operations, a wider bandwidth can provide the correct amount and speed of internet required. The internet connection will regulate and monitor the overall performance of the cloud service system. Therefore, organizations should have contingency plan to avoid business disruptions—high network bandwidth results in inflated costs.

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It requires a significant investment and the best technology for smooth operation. A start-up needs a substantial number of investors, and additionally, a suitable infrastructure is necessary for establishing the networking system. The quality and quantity of performance depend on work efficiency, which in turn depends on the capital invested.

B. Vendor Lock In

Sometimes organizations witness technical incompatibility and additional cost while transferring their resources from one vendor to another [6]. It becomes a challenging task to manage the diversity of functions among different vendors and expect the same level of quality from each. The applications are easily transferred from one cloud provider to another. Vendor lock-in challenges data portability. The transportation of a networking system can be a real problem that requires addressing. Eradication of vendor lock-in can be a helpful tool, unless other applications have been discovered.

C. Limited Control

The cloud system is wholly owned, directed, and supervised by the service provider, limiting the function and execution of services by the cloud user within a cloud framework. This may hinder the user's work capacity, and they may find it one-sided, which could jeopardise the relationship between the user and provider. The service provider monitors the cloud networking system. As a consumer, the customer has minimal control and will not have access to key administrative tasks. It will be monotonous and have no interconnections between the parties.

D. Security

When acquiring cloud technology, one should be well-informed that all sensitive information of the organisation will be transmitted to a third party, i.e., the cloud service provider. It is the most significant limitation, but can be overcome by implementing encryption and security hardware and applications [7].

E. Interoperability

Developing these complex web services is a fundamental task now. It delays the work process; handling every step systematically may take longer. One may jeopardise sensitive information during the transfer. All platforms should follow a similar pattern of technology, which may be very difficult to implement.

F. Cloud Downtime

Technical problems, including reboots, network outages, and downtime, will hamper cloud operations. This, in turn, will slow down and hinder business operations. Long-term power cuts in remote areas, loss of infrastructure due to natural calamities, and a lack of a proper platform to integrate the system. Hacking may cause severe data loss and require significant time, effort, and resources to recover the information.

V. DISCUSSION

Even though Cloud computing is a new technology, all the required patient particulars provided are accessible throughout the world, it encounters analytical hindrances in meeting one of the health industry's most significant demands [8]. We are all aware that contributing to security systems is mandatory due to their fundamental attributes, such as remote data storage, deficiency in networking systems, acceleration, and sharing of gigantic infrastructure. It is believed that merging the discussed technology can support healthcare authorities in providing a more precise, robust, and customised treatment arrangement. According to several survey studies, the major impelling force that motivates organisations to adopt cloud-based systems is economic benefits. Administrations will not need expensive infrastructure; instead, they can simply pay for the services they receive and expand into additional areas or sections. The expansibility of clouds enables changes in response to customer expectations, resulting in sustained progress. The agility of clouds makes health information systems very mobile, because it allows users to ask for the required service without any initial action towards service preparation [9]. Undoubtedly, quality has become the primary foundation of modern healthcare organisations.

VI. FUTURE SCOPE OF CLOUD APPLICATIONS IN HEALTHCARE

The healthcare industry has leveraged cloud computing technology; however, newer fields are yet to be explored for further opportunities and prospects. Moreover, information technology developers must monitor the associated risks.IT engineers have to be more vigilant of the various types of misconfigurations that can creep in, since this can result in a breach of personal credentials and
hack admin privileges [10]. Although Machine Learning algorithms can be utilised to analyse security challenges in data processing, compromised applications will result in erroneous machine learning. Healthcare-related IoT devices and wearables are gaining popularity due to technological advancements in healthcare. IT and security teams need to have the right tools in place to analyse the threat landscape [11]. Sound cognitive and technical skills, along with frequent technology updates, are essential for the sustainability of digital transformation. The paradigm shift to digitalisation has made patient work more precise and comfortable, but it has incurred additional costs. To recoup the investment cost, clinicians tend to use digital aids and technology more frequently than otherwise indicated. Federal law plays a vital role in checking mismanagement [12].

A. Robotics:

During the unprecedented times of the COVID-19 pandemic, when there was a significant crisis of healthcare professionals, robotic systems were used for disinfection to stop the spread of infection and thereby minimise the exposure of healthcare workers. They can be used 24 hours a day, therefore keeping the limited workforce safe. Robots are being introduced into hospitals and elderly care facilities to deliver supplies and assist in surgeries. Cloud computing providers will process information and address security risks associated with the design and building of robots. Since a robot is an Internet of Things (IoT) device, if it malfunctions or fails, IT developers would be called in to help troubleshoot and resolve the issue.

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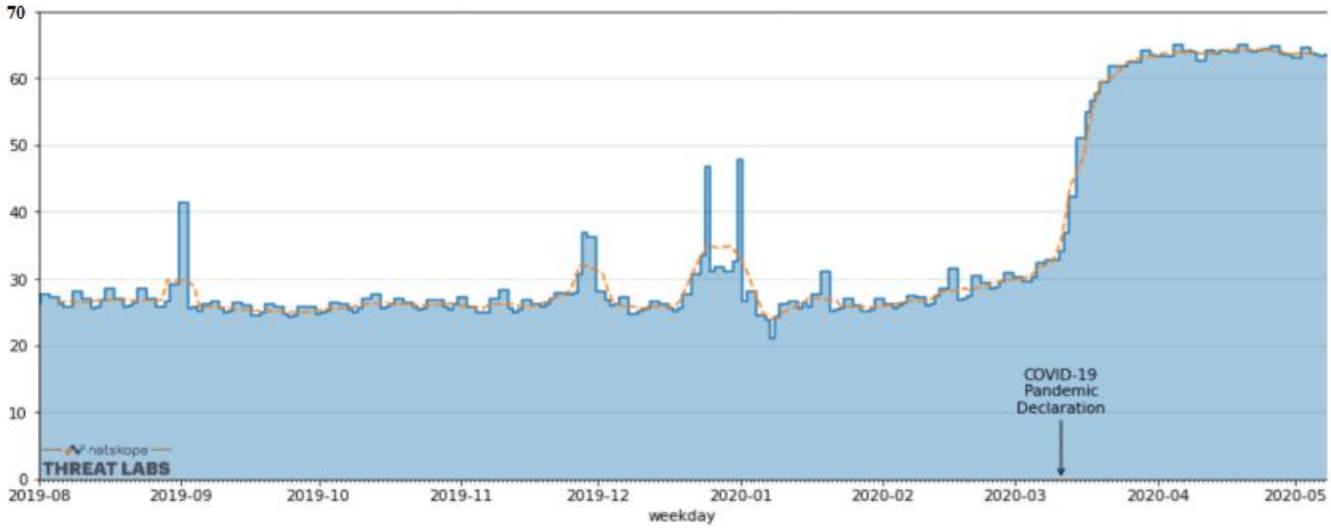

Figure 3: Accelerated Cloud transition during the COVID-19 pandemic [13]

B. Nudging

It has been instrumental in driving digital transformation in the healthcare industry by facilitating informed decision-making. It includes reminding people of their doctor's appointments, helping patients make healthier food choices, and many more. The cloud transition in recent years, particularly during the coronavirus pandemic, has been significantly exponential as depicted in Figure 3 [13]. That means an AI or a robot could be programmed or reprogrammed to encourage healthy lifestyle choices. On the contrary, its misuse can amplify mental health issues. Information Technology (IT) developers must understand the risks involved.

C. Telemedicine

Cloud-based telemedicine is a boon for residents of remote areas, who are often unable to travel due to its benefits. Virtual care technology enables long-distance counselling, advice, reminder setting, and intervention. Such services, however, are often disrupted by network noise or bandwidth issues, as the distribution of information occurs via electronic media and telecommunication technologies. Since the failure is technology-related, IT developers need to troubleshoot and resolve it.

VII. CONCLUSION

Cloud computing offers numerous benefits in data entry and storage, particularly in healthcare organisations and relevant studies. Several articles and resources have noted the successful application of cloud computing in bioinformatics research. Although the cloud computing framework is regarded as a potential internet-based computing platform, the notable security concerns it faces are noteworthy. However, the benefits and advantages of cloud computing far outweigh the risks and threats. Meeting security necessities is increasingly challenging without a significant investment in infrastructure and manpower. The absence of skill, cognition and proficiency of users is another challenge. So cloud

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