Literature Review

Cloud Computing for building effective information system in healthcare

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1.0 Introduction

Healthcare is undergoing a digital transformation, with information systems playing a pivotal role in improving patient care, streamlining operations, and enhancing decision-making processes (Wager et al., 2021). Cloud technology has developed contributing numerous advantages for building effective information systems in healthcare (Rai et al., 2022). The aim of this literature review is to provide an overview of the role of cloud computing in the development and implementation of effective information systems in healthcare. The review synthesises key findings from academic research to highlight the benefits, challenges, and future prospects of cloud-based solutions in the healthcare sector. The review also highlights the possible impact of cloud computing on data security, interoperability, scalability, and cost-efficiency in healthcare information systems.

2.0 Background

Information Technology (IT) and cloud computing have become integral components of the healthcare sector, changing the way healthcare is provided, managed, and optimised. Advancements in Information and Communication Technologies are increasingly influencing the healthcare sector. Embracing this advancement opens up fresh prospects and unveils unanticipated use cases, offering potential advantages to the healthcare industry. Consequently, there is potential for improvement in the quality of medical services and a decrease in healthcare expenditures, even amidst rising demands associated with an aging population (Aceto et al., 2018). Cloud computing refers to the utilisation of cloud-based services and infrastructure to process healthcare information and applications. It offers healthcare organisations the flexibility to scale resources as needed, reducing

infrastructure costs, and enabling remote access to critical patient information. Furthermore, cloud computing enhances data security, disaster recovery, and collaborative research efforts while supporting innovations in telemedicine and data analytics for improved patient care and outcomes (Rai et al., 2022).

3.0 Search Strategy

A systematic method for reviewing the literature using the Google Scholar search engine was adopted. Specific keywords like "healthcare," "information systems," "cloud computing," and "current trends" to identify the most pertinent literature were employed. Given the extensive number of relevant publications, the review of the latest publications and related references were prioritised.

4.0 Benefits of Cloud Computing

4.1 Accessibility and Real-time Updates

One of the paramount benefits of cloud computing in healthcare is improved accessibility to electronic health records. Healthcare providers can securely access patient data from anywhere with an internet connection, allowing for seamless collaboration among professionals across different locations (Rajabion et al., 2019). Real-time updates ensure that patient information remains current, enabling healthcare practitioners to make informed decisions promptly (Sharma et al., 2023). This accessibility not only streamlines patient care but also plays a crucial role in emergency situations, where quick access to medical records can be life-saving.

4.2 Data Centralisation and Integration

Cloud-based solutions facilitate the centralisation and integration of healthcare data. By storing electronic health records in the cloud, healthcare organisations can

consolidate information from various sources, including hospitals, clinics, laboratories, and pharmacies. This data centralisation enhances care coordination and ensures that a comprehensive patient history is readily available to authorised personnel. It reduces duplication of tests, minimises errors, and leads to more effective and efficient healthcare delivery (Dang et al., 2019; Aceto et al., 2020).

4.3 Patient Engagement and Remote Monitoring

Cloud computing extends its capabilities to support telehealth services and remote patient monitoring. These tools allow patients to dynamically join in their care by enabling virtual consultations with healthcare providers. Remote patient monitoring devices collect real-time health data, allowing healthcare teams to proactively intervene when necessary (Chung & Park, 2019). This not only enhances patient engagement but also expands healthcare access to individuals in remote areas or those with chronic conditions.

4.4 Advanced Data Analytics and Predictive Modeling

Cloud resources provide the computational power required for advanced data analytics and predictive modeling in healthcare. By harnessing the cloud, healthcare organisations can analyse vast datasets to identify trends and patterns (Sunyaev et al., 2020). Predictive models can assist in early disease detection, population health management, and forecasting disease outbreaks. These insights improve clinical decision-making, enabling healthcare providers to deliver more precise and personalised care, ultimately leading to better patient outcomes (Al-Jaroodi et al., 2020).

4.5 Data Security and Compliance

Data security is principal requirement in healthcare, because of the sensitive patient information. Cloud solutions provide robust security methods, with encryption, access controls, and audit trails, safeguarding the protection of patient data (Shabbir et al., 2021). Moreover, cloud providers often fulfill with stringent regulations, such as Health Insurance Portability and Accountability Act (HIPAA) the federal law of United States, to support healthcare organisations in maintaining regulatory compliance. The cloud's security features mitigate the risk of data breaches and unauthorised access.

4.6 Data Backup and Disaster Recovery

Cloud computing provides reliable data backup and disaster recovery solutions. Electronic health records are backed up in multiple data centers, reducing the risk of data loss due to natural disasters or system failures. In the event of an emergency, healthcare organisations can quickly restore critical patient information, ensuring uninterrupted healthcare services (Gupta & Singh, 2023).

4.7 Cost Efficiency and Scalability

Cloud computing provides cost effective solutions by removing the need for extensive on-premises infrastructure. Healthcare organisations can reduce capital expenses, as cloud providers operate on a pay-as-you-go model (Usak et al., 2020). Scalability is another key benefit, allowing healthcare providers to adjust IT resources to meet changing patient demands. This flexibility ensures that healthcare organisations can handle fluctuations in data volume and computing needs efficiently (Al-Jaroodi et al., 2022).

5.0 Challenges and Concerns

5.1 Data security

While cloud computing offers numerous benefits in healthcare, it is equally vital to address the challenges and concerns related with its adoption. These concerns often revolve around data security, regulatory compliance, and the potential for service interruptions, emphasising the need for a balanced approach to cloud implementation in healthcare (Agapito et al., 2023; Cresswell et al., 2022). Careful planning, robust security measures, and adherence to industry-specific regulations are essential to harness the full potential of cloud technology while mitigating its associated risks (Chenthara et al., 2019; Azeez & Van der Vyver, 2019; Paul et al., 2023).

The analysis of healthcare data breaches by Seh et al. (2020) indicates that electronic health data is highly vulnerable, with attackers frequently targeting it. Their analyses reveal that healthcare records are compromised by various attack types, including hacking, theft/loss, internal disclosure, and improper data disposal. Healthcare related data breaches are notably more costly than average breaches, especially in developed countries, and the analysis suggests that the breach incidents and their associated costs will continue to rise. Consequently, prioritising preventive measures is crucial for researchers, security experts, and healthcare organisations.

5.2 Interoperability

The interoperability challenge in cloud computing within the healthcare sector is a significant concern. It is the capability of various healthcare systems, applications, and platforms to work synchronously and interchange information flawlessly.

Achieving interoperability and remaining compliant with regulations is complex while using cloud solutions (Vilakazi & Adebesin, 2023).

5.3 Vendor Lock-In

The potential risks of dependency on cloud service providers that some cloud service providers may use proprietary formats or technologies, making it difficult for healthcare organisations to switch providers without significant data migration efforts (Gao & Sunyaev, 2019).

5.4 Data Privacy

Szigetvári, G., & Mesko, B. (2023), had reviewed the collaboration of technology giants' like Amazon, Google (and Alphabet), Microsoft, NVIDIA, IBM, Apple, and Samsung with healthcare companies, aiming to highlight the privacy implications and technological advantages of such partnerships. The tech companies are motivated to move into the healthcare market as patients and medical professionals increasingly turn to technology for health data access and analysis. To access the healthcare data, tech giants are work together with healthcare institutions that possess this data.

6.0 Tackling the challenges

Vilakazi & Adebesin (2023) had reviewed the strategies to mitigate **cybersecurity threats** in health care data. Ensuring data security and privacy in healthcare cloud environments involves a combination of technical safeguards, organisational policies, and compliance with regulatory frameworks.

Blockchain technology offers a robust solution for securing patient records and transactions. By providing a decentralised and immutable ledger, blockchain ensures the reliability and confidentiality of healthcare data (Jabbar et al., 2020).

Sharma & Sehrawal (2020) proposes a hybrid multi-criteria **decision making** method **for cloud adoption** requiring a clearly defined adoption strategy and involving varying stakeholder perspectives in decision –making. Al-Marsy et al. (2021) identifies three critical dimensions for adopting cloud computing in health information system: financial performance and cost, IT operational excellence and DevOps, and security, governance, and compliance. They also provide guidance to healthcare executive management, in making informed decisions about cloud computing adoption, recognising the need for holistic evaluation due to the critical nature of healthcare data.

The National Health Service (NHS) in the United Kingdom utilises cloud services that align with the 'Government Cloud First Policy.' Public sector entities are encouraged to adhere to these Cloud Principles, which seek to find a harmonious equilibrium between swift technology deployment, associated costs and resources, and risk mitigation. Teams are empowered to influence cloud services from international or global providers, with due diligence carried out following the guidance provided by the Information Commissioner's Office (ICO, 2023) and the National Cyber Security Centre (NCSC) (Cloud Security Guidance, 2018).

NHS Cloud exit strategy discusses the importance of having an exit plan when using cloud computing services, particularly in the context of healthcare organisations. It highlights the risks associated with relying on proprietary cloud services and the need for a structured approach to minimise migration risks. It also emphasises the

significance of planning for data migration, security, management, personnel, and business continuity during the exit process and outlines best practices for creating a cloud exit plan. It also discusses the challenges and considerations when moving applications between different cloud providers or from the cloud back to on-premises infrastructure.

7.0 Future of computing in healthcare

Ur Rasool et al. (2023) had explored the emerging field of **quantum computing** and its effect on healthcare. Quantum computing enhances healthcare by concentrating on areas like drug discovery, personalised medicine, DNA sequencing, medical imaging, and operational optimisation.

The integration of **edge computing** with cloud solutions for real-time data processing at the source provides decentralised processing of data at or near the source of data generation, such as medical devices, sensors, or patient wearables, rather than relying on a centralised cloud-based system. This approach offers several advantages in the healthcare industry: real-time data processing, data security, reliability even with disrupted network connectivity. Edge devices can screen and process data locally, and selectively passing only pertinent information to the cloud for further analysis and long-term storage, which reduces cloud resource usage and associated costs (Bhowmik & Banerjee, 2023).

Artificial Intelligence (AI) and Machine Learning are poised to be game-changers in healthcare. These technologies can analyse vast amounts of data, from patient records to medical images, to identify patterns and make predictions. AI-powered diagnostic tools can assist healthcare professionals in early disease detection and treatment planning. Moreover, AI-driven chatbots and virtual assistants will improve

patient engagement by providing instant medical advice and monitoring (Sun et al., 2020; Gill et al., 2019).

8.0 Conclusion

Cloud computing is reshaping the healthcare industry by providing scalable, cost-effective, and flexible solutions for building effective information systems. While it offers numerous benefits, healthcare organisations must also address challenges related to security, interoperability, and regulatory compliance. As technology continues to evolve, cloud computing will likely remain a central component of healthcare information systems, supporting improved patient care and healthcare delivery. Further research and collaboration among stakeholders are essential to maximise the potential of cloud computing in healthcare.

9.0 References

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