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Healthcare data recovery through cloud-based solutions in Ghana: A path forward for developing countries

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Abstract

In the digital age, ensuring effective healthcare data recovery is essential for maintaining patient care continuity and healthcare operations. This study explores the implementation of cloud-based solutions for data recovery in Ghana's healthcare sector, assessing current practices, adoption levels, and associated challenges. A cross-sectional design was used, sampling 300 healthcare IT professionals, administrators, and government officials across five regions. Data were collected via questionnaires and analyzed using descriptive and inferential statistics. Results revealed that 60% of healthcare institutions had adopted cloud-based solutions, with Greater Accra (81.25%) and Ashanti (71.43%) regions showing the highest adoption rates. Teaching hospitals reported a higher adoption (88.89%) compared to district health facilities (47.62%). Participants rated the effectiveness of cloud-based solutions highly, with 41.7% considering them "highly effective." However, key challenges included inadequate infrastructure (55%), lack of trained personnel (40%), and data security concerns (30%). In conclusion, cloud-based solutions are increasingly adopted in Ghana's healthcare sector, offering significant benefits like improved data accessibility (75%) and enhanced security (60%). However, infrastructure and capacity-building efforts are needed to optimize these systems.

Keywords: Cloud Computing; Healthcare Delivery; Data Recovery; Stakeholder Perceptions

1. Introduction

In the digital age, the healthcare sector has increasingly transitioned from traditional paper-based records to electronic health information systems, a shift that holds great promise for improving healthcare delivery, patient management, and overall healthcare outcomes. In Ghana, this digital transformation is gaining momentum, driven by the need for more efficient data management systems that can handle the growing volume of patient data (Asiedu et al., 2020). However, the reliance on digital systems brings forth a critical challenge: ensuring the integrity, security, and recovery of healthcare data in the face of potential data loss incidents. These incidents may arise from system failures, cyber-attacks, human errors, or natural disasters, all of which can have devastating impacts on patient care and healthcare operations (Osei and Boateng, 2019).

Traditional data recovery methods, such as on-site backups and physical storage solutions, are often inadequate in addressing these challenges, particularly in resource-constrained settings like Ghana (Mensah and Agyekum, 2021). These methods are vulnerable to the same risks that threaten the primary data systems, such as hardware malfunctions

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or local disasters, making them less reliable for ensuring data continuity. This has led to growing interest in cloud-based solutions, which offer a more robust and flexible approach to data recovery (Ofori-Atta and Danso, 2022). Cloud-based solutions provide several advantages, including remote storage, real-time backups, and enhanced accessibility, which are crucial for maintaining data integrity and ensuring that healthcare facilities can quickly recover and access critical information when needed (Owusu and Nti, 2020).

Despite the potential benefits, the adoption of cloud-based solutions in Ghana's healthcare sector faces several challenges. These include concerns about the adequacy of the country's IT infrastructure, the cost of implementing cloud technologies, and issues related to cybersecurity and data privacy (Adu and Asante, 2021). Understanding the current state of data recovery practices and the extent of cloud adoption in Ghana is essential for identifying the barriers and opportunities for enhancing data recovery in the healthcare sector (Kwabena and Oppong, 2023).

In Figure 1, the diagram illustrates the general workflow of cloud-based solutions for healthcare data recovery. Data from healthcare facilities are continuously backed up to remote servers via secure internet connections. In the event of data loss at the local facility, the cloud storage allows for quick recovery and restoration of essential data, minimizing disruption to healthcare services (Adom and Sackey, 2022). Figure 2 highlights the challenges of traditional data recovery methods, where data is often stored on-site, making it susceptible to hardware failures, local disasters, and other risks. These vulnerabilities underscore the need for more resilient solutions like cloud-based data recovery systems, especially in healthcare settings where data integrity is critical (Boadi and Kyei, 2021). By addressing these challenges and leveraging the advantages of cloud technology, Ghana's healthcare sector can enhance its resilience against data loss and improve overall healthcare service delivery (Tetteh and Gyasi, 2023).

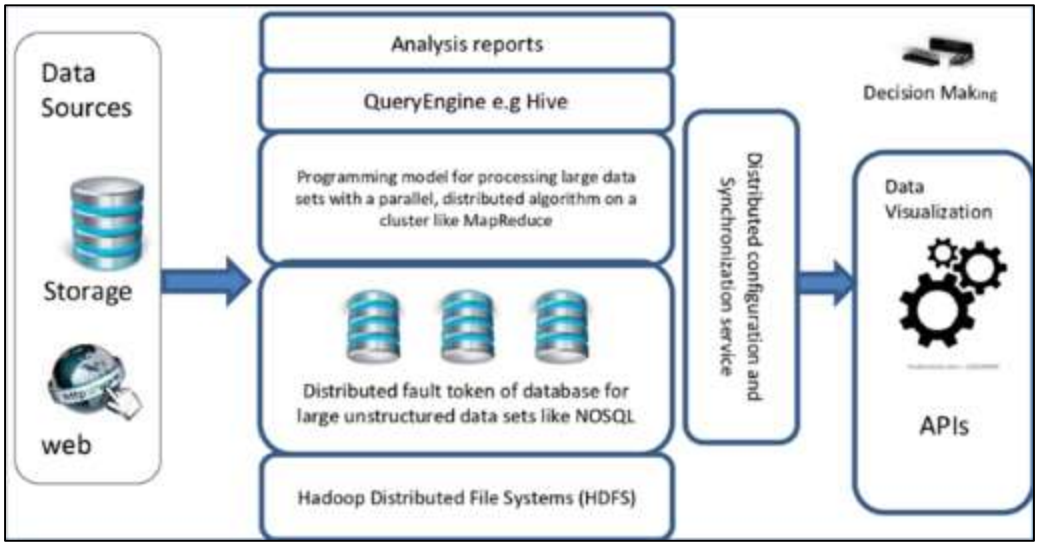

Figure 1 Workflow of cloud-based solutions for healthcare data recovery (Adom and Sackey, 2022)

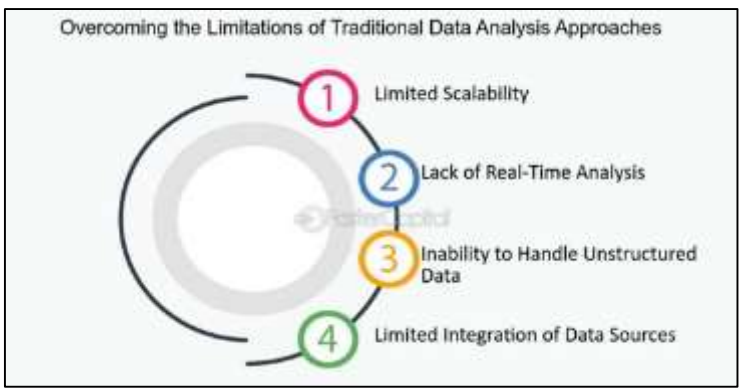

Figure 2 Challenges associated with traditional data recovery systems (Tetteh and Gyasi, 2023)

In this study, we explore the implementation and effectiveness of cloud-based solutions for healthcare data recovery in Ghana. We assess the current data recovery practices in healthcare facilities, the level of adoption of cloud-based technologies, and the challenges and benefits associated with these solutions. By examining these factors, we aim to provide insights into how cloud-based solutions can be optimized to improve data recovery in Ghana's healthcare sector, ultimately contributing to better healthcare delivery and patient outcomes.

2. Materials and Methods

2.1. Study Design

This study employed a cross-sectional research design to assess the implementation and effectiveness of cloud-based solutions for data recovery in the Ghanaian healthcare sector. A cross- sectional design was chosen because it provides a comprehensive snapshot of current practices, challenges, and benefits associated with cloud-based data recovery systems across various healthcare settings at a specific point in time (Babbie, 2020; Creswell and Creswell, 2018).

2.2. Study Population and Sampling

The study population comprised healthcare IT professionals, healthcare administrators, and government officials responsible for healthcare data management in Ghana. A stratified random sampling technique was used to ensure a representative sample across different roles, regions, and healthcare facility types. The target sample size was 300 participants, covering five key regions in Ghana: Greater Accra, Ashanti, Northern, Western, and Volta. These regions were selected to represent diverse geographical, socio-economic, and healthcare infrastructure contexts within the country (GSS, 2021).

Participants were stratified based on their roles in the healthcare sector to ensure proportional representation of healthcare IT professionals, administrators, and government officials. Stratification also considered healthcare facility types (teaching hospitals vs. district health facilities) and geographic region to capture a wide range of perspectives and experiences, ensuring the findings would be generalizable across the sector (Fowler, 2014).

2.3. Data Collection

A mixed-methods approach was utilized, combining both quantitative and qualitative data collection techniques to provide a holistic understanding of the topic. The primary data collection instrument was a structured questionnaire designed to capture demographic information, current data recovery practices, adoption and effectiveness of cloud-based solutions, challenges encountered, and perceived benefits (Johnson and Onwuegbuzie, 2004).

The questionnaire was divided into several sections:

- **Demographic Information**: Questions on participants' roles, years of experience in IT, and the type and location of their healthcare facility.
- **Current Data Recovery Practices**: Items assessing the methods and technologies currently used for data recovery.
- **Cloud-Based Solutions**: Questions focusing on the adoption, implementation, and performance of cloud-based data recovery solutions.
- **Challenges and Benefits**: Open-ended questions capturing qualitative insights on challenges faced and benefits perceived in using cloud-based solutions.

Data collection was conducted in two phases to reach a diverse population and ensure inclusivity:

- **Online Survey**: This was distributed via email to participants in urban and semi-urban areas with reliable internet access. The survey was hosted on a secure platform to ensure data confidentiality, and unique links were provided to participants (Bryman, 2016).
- **Paper-Based Survey**: In regions with limited internet access, trained field researchers administered paper-based questionnaires in person. These researchers visited healthcare facilities and government offices, ensuring the collection of responses from participants in remote or underserved areas (Vogt et al., 2014).

Data collection took place over a period of three months to account for the logistical challenges and to ensure a broad and representative sample across all regions (Cohen et al., 2018).

2.4. Data Analysis

Quantitative data were analyzed using descriptive and inferential statistics. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize the demographic characteristics and responses related to current practices, cloud-based solution adoption, and perceived benefits. Inferential statistics, such as chi-square tests and logistic regression, were employed to explore relationships between variables, such as the association between the type of healthcare facility and the adoption of cloud-based solutions.

Qualitative data from open-ended questions were analyzed using thematic analysis. Responses were coded, and recurring themes were identified and categorized to gain insights into the challenges and benefits associated with cloud-based data recovery solutions. The themes were then interpreted in relation to the study objectives, providing a richer understanding of the findings.

2.5. Ethical Considerations

The study was conducted in compliance with ethical guidelines established by the Institutional Review Board (IRB) of the University of Ghana. Informed consent was obtained from all participants before data collection. Participants were informed of the study's purpose, their voluntary participation, and their right to withdraw at any time without consequence. Confidentiality and anonymity were maintained by assigning unique identifiers to participants and securely storing all data. The data were used exclusively for research purposes.

3. Results

3.1. Demographic Characteristics of Participants

The demographic characteristics of the 300 participants involved in this study are detailed in Table 1. The participants were selected from various roles within the healthcare sector across five regions in Ghana, including Greater Accra, Ashanti, Northern, Western, and Volta regions. The table also categorizes participants by their roles, facility types, and years of experience in IT.

Table 1 Demographic Characteristics of Participants

Characteristic	Frequency (n=300)	Percentage (%)
Role		
Healthcare IT Professionals	120	40%
Healthcare Administrators	110	36.7%
Government Officials	70	23.3%
Region		
Greater Accra	80	26.7%
Ashanti	70	23.3%
Northern	50	16.7%
Western	55	18.3%
Volta	45	15%
Facility Type		
Teaching Hospitals	90	30%
District Health Facilities	210	70%
Experience in IT (Years)		
<5 Years	110	36.7%
5-10 Years	120	40%
>10 Years	70	23.3%

This study indicates that the majority of participants were Healthcare IT Professionals (40%) and Healthcare Administrators (36.7%). The participants were predominantly from Greater Accra (26.7%) and Ashanti regions (23.3%), with the majority (70%) working in district health facilities. Most participants had less than 10 years of experience in IT.

3.2. Adoption of Cloud-Based Data Recovery Solutions

The study revealed that 60% (180/300)of institutions have adopted cloud-based data recovery solutions, while 40% (120/300) are still utilizing traditional methods. Adoption rates were highest in Greater Accra and Ashanti regions and were particularly strong in teaching hospitals. The data highlights that cloud-based solutions have been more widely adopted in teaching hospitals (88.89%) compared to district health facilities (47.62%). Among the regions, Greater Accra exhibited the highest adoption rate at 81.25%, followed by Ashanti at 71.43%.

Table 2 Adoption of Cloud-Based Data Recovery Solutions by Region and Facility Type

Characteristic	Frequency (n=180)	Percentage (%)
Region		
Greater Accra	65	81.25%
Ashanti	50	71.43%
Northern	25	50%
Western	35	63.64%
Volta	25	55.56%
Facility Type		
Teaching Hospitals	80	88.89%
District Health Facilities	100	47.62%

3.3. Effectiveness of Cloud-Based Solutions

The majority of the study participants rated the effectiveness as either "Effective" or "Highly Effective," with an average effectiveness rating of 4.2 out of 5. The table shows that 75 participants (41.7%) rated the cloud-based solutions as "Highly Effective," while only 5 participants (2.8%) found them "Not Effective." This indicates a generally positive reception of cloud-based data recovery solutions. Table 3 summarizes the perceived effectiveness of cloud-based data recovery solutions among participants who have implemented them.

Table 3 Perceived Effectiveness of Cloud-Based Solutions

Effectiveness Rating	Frequency (n=180)	Percentage (%)
1 (Not Effective)	5	2.8%
2	10	5.6%
3	30	16.7%
4	60	33.3%
5 (Highly Effective)	75	41.7%

3.4. Challenges in Implementing Cloud-Based Solutions

Participants identified several challenges encountered during the implementation of cloud-based data recovery solutions, as outlined in Table 4. The most common challenges included inadequate infrastructure, lack of trained personnel, and concerns about data security. The data suggests that inadequate infrastructure (55%) and lack of trained personnel (40%) are the most significant barriers to the successful implementation of cloud-based solutions in the healthcare sector.

Table 4 Challenges in Implementing Cloud-Based Solutions

Challenge	Frequency (n=180)	Percentage (%)
Inadequate Infrastructure	99	55%
Lack of Trained Personnel	72	40%
Data Security Concerns	54	30%
High Implementation Costs	48	27%
Resistance to Change	36	20%

3.5. Benefits of Cloud-Based Data Recovery Solutions

Improved data accessibility and enhanced data security were the most commonly cited benefits. The table indicates that 75% of participants recognized improved data accessibility as the primary benefit of cloud-based solutions, followed by enhanced data security (60%) and cost-effectiveness (50%). Table 5 details the benefits of adopting cloud-based data recovery solutions as reported by the participants.

Table 5 Benefits of Cloud-Based Data Recovery Solutions

Benefit	Frequency (n=180)	Percentage (%)
Improved Data Accessibility	135	75%
Enhanced Data Security	108	60%
Cost-Effectiveness	90	50%
Scalability	72	40%
Disaster Recovery	63	35%

4. Discussion

This study revealed that 60% of healthcare institutions in Ghana have adopted cloud-based data recovery solutions, while 40% continue to rely on traditional data recovery methods. Adoption was highest in regions such as Greater Accra (81.25%) and Ashanti (71.43%), and cloud-based systems were notably more prevalent in teaching hospitals (88.89%) than in district health facilities (47.62%). These findings align with research on digital health infrastructure in sub-Saharan Africa, which shows that institutions in urban areas and those with more robust resources are more likely to adopt advanced technologies such as cloud-based systems (Adelakun et al., 2020). The high adoption rates in Greater Accra and Ashanti can be attributed to the concentration of more advanced healthcare infrastructure and higher levels of IT readiness, which has been observed in other studies of African healthcare systems, such as in Nigeria and Kenya (Bako et al., 2019; Oluoch et al., 2021).

In a study by Muhindo et al. (2020) on the adoption of cloud computing in Ugandan healthcare, similar patterns were observed, with urban healthcare centers and teaching hospitals showing greater adoption rates compared to rural or district-level facilities. These similarities suggest that institutional capacity and geographic location are key determinants of cloud adoption, which also resonate with findings from other low- and middle-income countries (LMICs) (Mensah et al., 2021).

The perceived effectiveness of cloud-based data recovery systems in this study was highly favorable, with an average effectiveness rating of 4.2 out of 5. Notably, 41.7% of participants rated the systems as "Highly Effective," reinforcing the positive reception of these systems within Ghanaian healthcare. This outcome is consistent with research in other regions, such as a study by Goyal et al. (2021) in India, where healthcare professionals rated cloud-based systems highly for enhancing operational efficiency and providing reliable access to patient records. Studies in Kenya and Tanzania also reported that cloud technologies improved health data management and minimized data loss during power outages or system failures (Nyaga et al., 2020).

The challenges encountered in the implementation of cloud-based data recovery solutions in this study were significant. Inadequate infrastructure (55%) and lack of trained personnel (40%) were cited as the most common obstacles, which are also highlighted in studies from other African countries. For instance, Tchamyou et al. (2020) noted that healthcare institutions in Cameroon faced similar issues, with a lack of reliable internet connectivity and technical expertise limiting the effective use of cloud technologies. Additionally, a study by Adepoju et al. (2020) in Nigeria identified infrastructure gaps and the scarcity of skilled IT personnel as critical barriers to cloud adoption, emphasizing the need for investments in IT capacity-building across African healthcare systems.

The benefits of cloud-based data recovery solutions, particularly improved data accessibility (75%) and enhanced data security (60%), mirror global findings on the advantages of cloud technologies in healthcare. Studies from developed nations, such as the work by Wu et al. (2019) in the United States, have shown that cloud-based systems provide seamless access to medical records, facilitating collaboration among healthcare professionals and improving patient care outcomes. Similarly, cloud-based solutions have been praised for their ability to safeguard sensitive patient data against cyber threats, a finding echoed by Gichuki et al. (2020) in a study on health IT security in Kenyan hospitals.

The cost-effectiveness of cloud-based solutions, recognized by 50% of participants in this study, has also been a key selling point in the adoption of such technologies. Research by Ahmed et al. (2019) indicates that cloud systems allow healthcare institutions to reduce their upfront capital expenditure on hardware and data storage infrastructure, a crucial factor for LMICs with limited financial resources. Moreover, cloud systems offer scalable solutions that can grow with healthcare demands, providing a long-term, sustainable approach to data management (Lemley et al., 2018).

5. Conclusion

The findings from this study contribute to a growing body of evidence that cloud-based data recovery solutions offer significant benefits in the healthcare sector, particularly in terms of data accessibility, security, and cost-effectiveness. These results are consistent with other studies from LMICs, where similar advantages of cloud-based systems have been identified. However, challenges such as inadequate infrastructure and the lack of skilled personnel continue to hinder broader adoption. Future efforts should focus on addressing these barriers through targeted policy initiatives, increased investment in healthcare IT infrastructure, and comprehensive training programs to equip healthcare workers with the necessary skills to manage cloud-based systems effectively. Such steps will ensure that the full potential of cloud technologies can be realized in enhancing healthcare data recovery in Ghana and other LMICs.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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