

# Unlocking the Potential of Cloud Computing in Healthcare: A Comprehensive SWOT Analysis of Stakeholder Readiness and Implementation Challenges

Alaa Abas Mohamed

Information System Department, Al-Neelain University, Khartoum, Sudan

**Abstract**—The adoption of cloud computing in healthcare holds the potential to revolutionize healthcare delivery, particularly in developing regions. Despite its promise of scalability, cost-effectiveness, and improved data management, challenges such as digital literacy gaps, infrastructure deficiencies, and security concerns hinder its implementation. This study evaluates the readiness for adopting cloud computing in Sudan's healthcare sector through a comprehensive SWOT analysis. Findings reveal that 93.75% of patients are willing to learn electronic health systems (EHS), yet 53.12% prefer paper records, indicating trust issues. Among medical staff, 34.38% report poor digital literacy, and 46.88% cite limited access to technology as a barrier. Ministry of Health employees highlight poor infrastructure (33.33%) and limited resources (30%) as significant obstacles. By identifying strengths, weaknesses, opportunities, and threats, this research provides actionable recommendations for overcoming these barriers. The findings contribute to the ongoing discourse on digital health transformation, offering insights into fostering trust in cloud technologies for enhanced healthcare outcomes.

**Keywords**—Cloud computing; SWOT; strength; weakness; opportunities; threat

## I. INTRODUCTION

The healthcare sector is undergoing significant digital transformation, with cloud computing emerging as a cornerstone of these advancements. Cloud-based solutions offer scalable, flexible, and cost-effective systems that improve patient care, enhance data management, and facilitate collaboration among healthcare providers (Rimal, Choi, & Lumb, 2017) [1]. Recent studies highlight that cloud computing is pivotal in facilitating the exchange of critical health information, such as in dialysis management, enabling better patient outcomes and streamlined care delivery (Ehteshami et al., 2024) [9]. This potential is particularly critical in developing regions like Sudan, where healthcare systems face persistent challenges, including resource constraints, inadequate infrastructure, and limited access to advanced technologies (Alotaibi, 2020; Liu, Wu, & Sun, 2019) [4], [3]. Furthermore, the COVID-19 pandemic underscored the need for resilient and technology-driven healthcare systems to effectively respond to emerging challenges (Jalali & Kaiser, 2018) [2]. Despite its promise, adopting cloud computing in healthcare is hindered by significant barriers. Key issues

include limited digital literacy among healthcare professionals, insufficient infrastructure, and concerns regarding the security and privacy of sensitive patient data (Griebel et al., 2015) [7]. These challenges hinder the implementation of electronic health systems (EHS), which are critical to leveraging cloud computing's full potential. Additionally, the integration of the Internet of Medical Things (IoMT) with cloud systems offers transformative potential by enabling real-time monitoring and enhancing connectivity across healthcare systems, but this requires overcoming technical and infrastructural challenges (Sarikaya & Dicle, 2024) [10]. Addressing these barriers is vital to creating a robust, secure, and efficient healthcare ecosystem that meets the needs of patients and providers alike. This study evaluates the readiness and feasibility of adopting cloud computing in Sudan's healthcare sector through a comprehensive SWOT analysis. By analyzing the perspectives of patients, medical staff, and Ministry of Health employees, the research identifies the strengths, weaknesses, opportunities, and threats associated with cloud adoption. The findings contribute to the literature by offering actionable recommendations tailored to Sudan's unique challenges and opportunities. The remainder of this paper is structured as follows. Section II outlines the methodology, detailing the data collection process and SWOT framework used. Section III reviews previous studies on cloud computing in healthcare to contextualize the findings. Comparative analysis is given in Section V. Section IV presents the results of the SWOT analysis, while Section VI discusses the implications and offers recommendations. Finally, Section VII concludes with key insights and suggestions for future research. By focusing on readiness and barriers to adopting cloud computing, this study addresses a critical gap in the literature and provides actionable insights for healthcare policymakers aiming to enhance digital transformation efforts.

## II. METHODOLOGY

Cloud computing in healthcare presents multifaceted challenges that require a structured and comprehensive approach to understanding and addressing them effectively. This study employs a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis framework, which is a strategic planning tool widely used to assess both internal and external factors influencing a system or organization. The SWOT framework is particularly suitable for evaluating the

readiness and feasibility of cloud computing adoption, as it allows for a holistic examination of enablers and barriers from multiple stakeholder perspectives. Recognizing the critical importance of data security in cloud adoption, Alshar'e et al. (2024) [11] highlight blockchain technology as an effective solution for enhancing data security and mitigating privacy risks, which underscores the necessity of addressing security concerns in this study. The following steps outline the systematic approach used to conduct the research:

1) *Defining the scope and objectives:* The primary objective of this study is to evaluate the readiness for adopting cloud computing in Sudan's healthcare sector. This involves identifying key strengths, weaknesses, opportunities, and threats from three stakeholder groups: patients, medical staff, and Ministry of Health employees.

2) *Survey design and data collection:* Surveys were designed to capture both qualitative and quantitative data. Each stakeholder group was asked specific questions regarding:

a) Technological readiness such as comfort with using electronic systems).

b) Perceived challenges such as digital literacy and infrastructure.

c) Willingness to adopt electronic health systems.

A structured questionnaire was used to ensure consistency across responses. The data was collected over a predefined period to ensure accuracy and reliability.

3) *SWOT Analysis framework:* Responses were categorized into the four SWOT dimensions:

a) *Strengths:* Positive attributes that support cloud computing adoption.

b) *Weaknesses:* Internal limitations that could hinder adoption.

c) *Opportunities:* External conditions that could facilitate adoption.

d) *Threats:* External risks that could undermine success.

The categorization was performed using a systematic coding process based on predefined criteria.

4) *Comparative analysis across stakeholder groups:* ata from patients, medical staff, and Ministry of Health employees were compared to identify common themes and divergent perspectives. This comparative analysis helped highlight stakeholder-specific needs and challenges.

5) *Synthesis of findings and recommendations:* Based on the SWOT analysis, actionable recommendations were developed to address key barriers and leverage existing opportunities.

### III. PREVIOUS STUDIES

Cloud computing has been extensively studied for its potential to improve healthcare systems globally. A study by Rimal et al. (2017) [1] found that cloud computing offers improved efficiency, flexibility, and cost-effectiveness in managing patient records and delivering telemedicine services. Similarly, Jalali and Kaiser (2018) [2] identified that cloud-

based health systems enable faster data retrieval and collaboration between healthcare providers.

However, barriers such as security concerns and limited infrastructure have been highlighted by Liu et al. (2019) [3], who argued that trust in cloud systems must be built through rigorous data protection measures and staff training. Alotaibi (2020) [4] explored the challenges of adopting cloud solutions in healthcare, finding that staff resistance to change and lack of technical expertise were common obstacles in low-resource settings.

These studies provide valuable insights into the general benefits and challenges of cloud computing in healthcare and form the basis for analysing the specific conditions in Sudan.

## IV. SWOT ANALYSIS

### A. Patients

#### 1) Strengths:

a) *Comfort with technology:* 50% of patients are "very comfortable" using technology, while 93.75% are willing to learn how to use electronic health systems if it improves their healthcare experience.

b) *Implication:* This demonstrates a high level of technological readiness among patients, which can facilitate the adoption of cloud computing systems.

#### 2) Weaknesses:

a) *Preference for paper records:* 53.12% of patients prefer paper records, reflecting distrust in digital systems.

b) *Implication:* Trust-building initiatives will be needed to overcome this preference, especially regarding concerns about data security and reliability.

#### 3) Opportunities:

a) *Need for additional support:* 87.5% of patients believe they need more support to use electronic health systems effectively.

b) *Implication:* Providing educational resources and support can bridge the gap between readiness and effective adoption.

#### 4) Threats:

a) *Resistance to digital records:* The preference for paper records (53.12%) poses a threat to the full implementation of EHS, as it suggests potential resistance to change.

5) *Gender divide:* There may be differences in comfort with technology between genders, indicating a need for tailored training.

### B. Medical Staff

#### 1) Strengths:

a) *Adaptability to technology:* 37.5% of medical staff adapt "Somewhat well," and 25% adapt "Well" to new technologies.

b) *Implication:* Medical staff are generally open to adopting electronic systems, which is crucial for the success of cloud computing initiatives.

2) *Weaknesses:*

a) *Low digital literacy:* 34.38% of medical staff rated their digital literacy as "Poor," while 28.13% rated it as "Fair."

b) *Implication:* Training programs are necessary to enhance the digital competency of staff to effectively use EHS.

3) *Opportunities:*

a) *Demand for additional training:* 93.75% believe that additional training is necessary for EHS to succeed.

b) *Implication:* This presents a clear opportunity for healthcare institutions to implement targeted training programs.

4) *Threats:*

a) *Limited access to technology:* 46.88% of staff reported that limited access to technology is a significant barrier to adopting EHS.

b) *Implication:* Without addressing this issue, the successful adoption of cloud computing could be limited to certain facilities with better infrastructure.

C. *Ministry of Health Employees*

1) *Strengths:*

a) *Strong support from MOH:* 36.67% of Ministry employees rated the Ministry's support for EHS as "High."

b) *Implication:* Institutional support is a key enabler for the transition to cloud computing in healthcare.

c) *Stakeholder engagement:* 96.67% believe that stakeholder engagement is crucial for the success of EHS.

d) *Implication:* The recognition of the importance of collaboration across different sectors can accelerate the digital transformation process.

2) *Weaknesses:*

a) *Technological infrastructure:* 33.33% rated the technological infrastructure as "Poor," indicating a significant gap that must be addressed to ensure the success of EHS.

b) *Implication:* Investment in modern infrastructure is essential to support cloud-based systems.

3) *Opportunities:*

a) *Providing more training:* 36.67% believe that additional training is needed to support the transition to EHS.

b) *Implication:* Investment in capacity-building initiatives is crucial for the success of digital transformation in healthcare.

4) *Threats:*

a) *Limited financial resources:* 30% identified limited financial resources as a key challenge to implementing EHS.

b) *Implication:* Securing adequate funding is essential to support the infrastructure and training needs required for cloud adoption.

V. COMPARATIVE ANALYSIS

A comparison of the perspectives from patients, medical staff, and Ministry of Health employees reveals common themes of willingness to adopt EHS but highlights the need for support and infrastructure improvements. Table I provides a detailed breakdown of responses across stakeholder groups, highlighting key metrics such as comfort with technology, willingness to learn, main weaknesses, opportunities, and threats. Fig. 1 illustrates these metrics visually, showing that while 93.75% of patients and medical staff are willing to learn electronic health systems (EHS), comfort with technology varies significantly, with only 50% of patients feeling very comfortable compared to 37.5% of medical staff and 36.67% of MOH employees. Weaknesses, such as 53.12% of patients preferring paper records and 34.38% of medical staff reporting poor digital literacy, are notable barriers to adoption. Opportunities are evident, as shown in Fig. 2, with all three groups identifying a need for resources and support. 87.5% of patients, 93.75% of medical staff, and 96.67% of MOH employees emphasize the importance of additional resources to enable successful implementation. However, threats such as resistance to digital records (affecting 53.12% of patients) and limited financial resources (affecting 30% of MOH employees) underscore the challenges ahead. Fig. 3 further compares survey responses across the groups, presenting a comprehensive view of the disparities and commonalities in stakeholder perspectives. This highlights the critical areas that need to be addressed, including investment in digital literacy programs, improved access to technology, and sustained stakeholder engagement.

TABLE I. A COMPARISON OF THE PERSPECTIVES FROM PATIENTS, MEDICAL STAFF, AND MINISTRY OF HEALTH EMPLOYEES

Category	Patients	Medical Staff	MOH Employees
Comfort with Technology	50% are "Very comfortable."	37.5% adapt "Somewhat well," 25% "Well."	36.67% rate support as "High."
Willingness to Learn	93.75% willing to learn EHS.	93.75% agree continuous engagement is key.	96.67% agree on stakeholder engagement.
Main Weakness	53.12% prefer paper records.	34.38% rated digital literacy as "Poor."	33.33% rated infrastructure as "Poor."
Opportunities	87.5% need support to use EHS.	93.75% demand additional support/resources.	96.67% believe more resources are needed.
Main Threat	Resistance to digital records (53.12%).	Limited access to technology (46.88%).	Limited financial resources (30%).

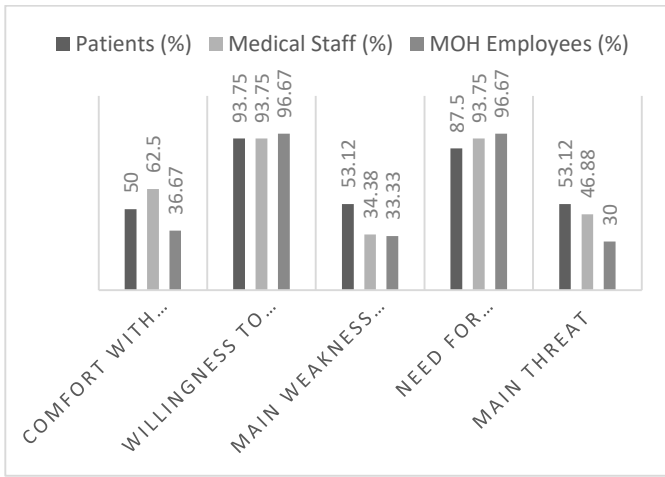


Fig. 1. A comparison of the perspectives from patients, medical staff, and Ministry of Health employees.

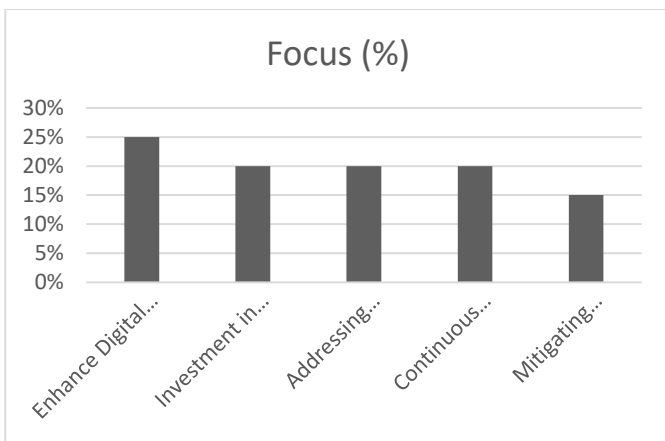


Fig. 2. The focus areas in the recommendations.

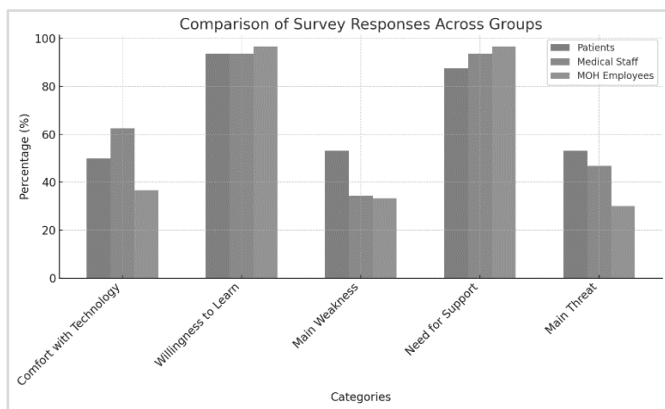


Fig. 3. Comparison of survey response across groups.

## VI. RECOMMENDATIONS

1) *Digital literacy training:* Given the low digital literacy among medical staff (34.38% rated as "Poor"), it is critical to implement targeted training programs. These programs should be designed to improve competency in using electronic health systems (EHS) and address the specific technological needs of both healthcare professionals and patients. Tailored workshops,

online modules, and continuous support could enhance digital readiness.

2) *Investment in technological infrastructure:* 33.33% of Ministry of Health employees reported poor technological infrastructure in healthcare facilities. Investing in modern, reliable infrastructure is essential to support cloud-based systems. This includes upgrading hardware, ensuring stable internet connections, and implementing secure cloud platforms to handle sensitive patient data. Adequate infrastructure is a foundational element for cloud computing in healthcare.

3) *Addressing resistance to digital records:* 53.12% of patients prefer paper records, indicating a significant trust issue with digital systems. To overcome this resistance, awareness campaigns should be launched to educate patients and staff about the benefits of electronic records, including security, accessibility, and efficiency. Building trust in digital systems is critical to ensuring successful adoption. Highlighting the security features and showing real-world examples of the improved outcomes of using cloud systems could help ease concerns.

4) *Continuous support and stakeholder engagement:* 96.67% of Ministry of Health employees and 93.75% of medical staff agree that continuous engagement and support are essential for the success of EHS. To ensure a smooth transition to cloud computing, healthcare institutions must provide ongoing technical assistance, regular feedback sessions, and open communication channels between healthcare providers, patients, and stakeholders. Stakeholder engagement ensures that concerns are addressed in real time, and that users feel supported throughout the process. This could include dedicated technical support teams, helplines, and regular system updates based on user feedback to improve system functionality and user satisfaction.

## VII. CONCLUSION

The adoption of cloud computing in healthcare presents a transformative opportunity to modernize healthcare systems, improve patient outcomes, and enhance operational efficiency. This study evaluated the readiness and feasibility of adopting cloud computing in Sudan's healthcare sector through a comprehensive SWOT analysis, capturing the perspectives of patients, medical staff, and Ministry of Health employees. The findings highlight significant strengths, such as the willingness of 93.75% of patients to learn electronic health systems and the adaptability of medical staff. However, challenges, including low digital literacy among healthcare professionals (34.38% rated as poor), limited technological infrastructure, and concerns about data security, remain significant barriers. Actionable recommendations have been proposed to address these issues, such as targeted training programs, investment in infrastructure, and trust-building initiatives. Despite the contributions of this study, several limitations should be acknowledged. First, the reliance on survey-based data collection may introduce self-reporting biases, as respondents' perceptions may not fully represent their actual capabilities or behaviors. Second, the study's focus on Sudan's healthcare system limits the generalizability of the findings to other

regions or contexts with differing levels of technological readiness and resources. Third, the SWOT analysis, while effective in providing a comprehensive overview, does not explore the causal relationships between the identified factors or quantify their relative impact. Finally, the study primarily assesses the readiness for cloud adoption and does not investigate the long-term outcomes or sustainability of such initiatives. Acknowledging these limitations provides a balanced perspective on the study's findings. Nevertheless, the insights presented offer valuable guidance for policymakers and healthcare institutions seeking to adopt cloud computing. Future research should aim to address these limitations by exploring longitudinal studies, employing mixed-method approaches, and extending the analysis to diverse healthcare contexts to further validate and enhance the understanding of cloud adoption.

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