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A framework for assessing cloud-computing readiness in Limpopo provincial hospitals

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Background: Organisational readiness for cloud-computing technology installation is crucial for improving healthcare service delivery. However, it is mostly unexplored in Limpopo provincial hospitals.

Objectives: This study fills this gap by creating a framework for assessing organisational readiness that is uniquely adapted to the healthcare sector in Limpopo province, South Africa. The study incorporates the Human, Organisation, and Technology-Fit (HOT-fit) model and the Information Systems (IS) success model to emphasise the alignment of human, organisational and technological elements in assessing the organisational readiness of cloud-computing implementations.

Method: The study employed a quantitative research approach, collecting data from healthcare professionals and information technology (IT) administrators using survey questionnaires. Statistical analyses, such as regression analysis and correlation tests, are used to validate the suggested framework and determine the correlations between key readiness criteria and cloud-computing implementation.

Results: The findings show that organisational structure, system utilisation, environmental conditions and service quality all have a substantial impact on cloud-computing readiness.

Conclusion: By addressing these readiness elements, Limpopo provincial hospitals can strategically use cloud-computing to improve healthcare service delivery and operational efficiency in resource-constrained environments.

Contribution: The study fills the gap in the existing literature by presenting new factors validated as a theoretical framework to assess the readiness for cloud-computing and contributes to the advancement of this field.

Keywords: cloud-computing; cloud-computing readiness; cloud-computing framework; Limpopo hospitals; South African public hospitals; healthcare professionals.

Introduction

The South African public health industry has begun to move from manual to electronic systems, which has presented various obstacles. Despite the obvious benefits of digitisation, such as increased efficiency, accuracy and accessibility of health records, the public health sector has lagged in implementing these technologies (Tungela 2021). This delayed adoption rate can be linked to a number of problems, including inadequate information technology (IT) infrastructure, poor data storage capabilities, restricted resources, insufficient network connectivity and a scarcity of trained IT people and human capital (Faloye, Ndlanzi & Ajayi 2021). These barriers limit the sector's capacity to fully use technological improvements, which are critical for improving healthcare delivery.

Cloud-computing (CC) has emerged as an achievable strategy for addressing these issues. Its widespread accessibility and affordable price make it an appealing alternative for improving hospital infrastructure (Meri et al. 2023). Cloud-computing demonstrates the potential to provide scalable, cost-effective and secure alternatives for data storage, processing and management, thereby having the ability to revolutionise the delivery of healthcare services. However, there is a notable lack in understanding the extent of readiness within the healthcare sector of South Africa in embracing CC, particularly in remote areas. Furthermore, there are no clear recommendations for community health divisions to transition their apps and services to the cloud environment (Ghaleb et al. 2021).

According to the literature, transitioning to cloud-based services presents challenges in several healthcare sectors (Meri et al. 2023; Mmako & Kgopa 2023; Tungela 2021). Most of the investigation is focussed on the private healthcare sector, with minimal research performed on the readiness of public healthcare systems, particularly in rural areas of South Africa, to embrace CC. This research aims to develop a framework for assessing organisational readiness of CC technology implementation in Limpopo provincial hospitals. The study intends to address this gap by examining Limpopo provincial hospitals' organisational readiness for CC implementation and make recommendations. The findings will help practitioners prepare for the use of CC technology in provincial health institutions by outlining the constraints and opportunities for such deployment. The research will include recommendations for assessing organisational readiness for cloud-based services.

Problem statement

Literature has shown that migrating to the cloud-based services comes with challenges in many healthcare sectors (Khan et al. 2024; Mmako & Kgopa 2023; Tungela 2021). According to Masana (2021), most studies on health sectors transferring of facilities and access to the cloud have been in the private health sector and little has been done for public health sector readiness for cloud-based services, especially in the rural areas of South Africa. This has made it difficult to have a framework to inform the public health sector migration of eHealth services to the cloud.

This research will assist the practitioners in getting prepared to undertake CC technology in provincial health institutions. The study addresses the assessment of organisational readiness in CC technology implementation using Limpopo province health institutions. This includes identifying the challenges and prospects of CC implementation in healthcare using the hospitals as case studies.

Literature review

The conversion to CC in healthcare has already been extensively researched, with a priority on finding challenges and healthcare employees promoting the adoption. In South Africa, various studies have investigated the usage of CC in the healthcare industry, highlighting the unique barriers that public health institutions faced.

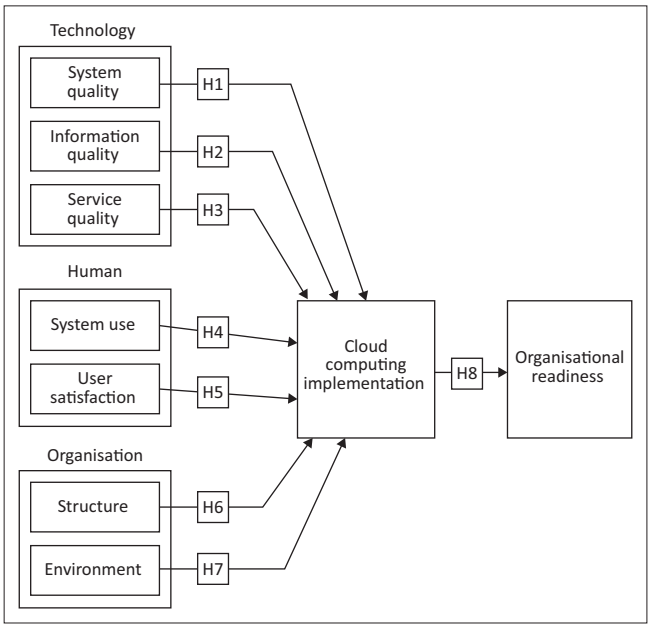
Cilliers and Wright (2017) explored the main challenges linked to the incorporation of electronic health records (EHRs) in the cloud within the public healthcare system of South Africa. Their study emphasised different environmental and organisational hurdles that require resolution to promote the adoption of cloud-based EHRs. In a comparable manner, Masana (2021) evaluated the viability of a unified cloud-based EHR platform in the governmental healthcare facilities of the Free State. Their study discovered that current internet facilities are insufficient for CC, highlighting the necessity for major investment in IT infrastructure.

Kamalizeni, Kamalizeni and Ranjeeth (2020) created a model for effective CC adoption in private South African hospitals, finding crucial quality elements such as system quality, information quality and service quality that influence cloud satisfaction. Trust was also identified as a crucial element impacting cloud service satisfaction. Ndlanzi and Ranjeeth (2021) investigated the barriers to the adoption of EHRs in public hospitals, identifying enablers such as internet connectivity, adequate IT infrastructure, computer skill training, government support and hospital management engagement.

Despite these discoveries, there is an insufficiency of research on the preparedness of public health facilities in rural South Africa to integrate and adopt CC. This study intends to close this gap by evaluating Limpopo provincial hospitals' organisational readiness for CC implementation. By identifying the challenges and opportunities that are unique to Limpopo provincial hospitals, the study will provide significant insights and recommendations for easing the migration to cloud-based services by public health sector.

Related models and hypotheses summary

This study's conceptual framework is based on the Human, Organisation, and Technology-Fit (HOT-fit) model. This model incorporates the Information Systems (IS) success model and emphasises the alignment of human, organisational and technological elements in assessing information system performance (Yusof et al. 2008). The proposed framework for this study, shown in Figure 1, modifies the HOT-fit model to assess the organisational preparedness of CC technology implementation in Limpopo provincial hospitals.



Source: The proposed framework adapted from Yusof, M.M., Kuljis, J., Papazafeiropoulou, A. & Stergioulas, L.K., 2008, 'An evaluation framework for health information systems: Human, organization and technology-fit factors (HOT-fit)', *International Journal of Medical Informatics* 77(6), 386–398. https://doi.org/10.1016/j.ijmedinf.2007.08.011

FIGURE 1: The proposed theoretical framework.

Technological factors

To properly adopt CC, it is critical to examine healthcare staff's current understanding as well as their needs and expectations. Organisations must budget for technology expenditures such as software, hardware and maintenance (Lian et al. 2014). The study employs elements from the model of IS success to assess technological factors:

System Quality: It is described as the total support provided by the service provider through the IS department (DeLone & McLean 2003). This support can be outsourced to a new company or an internet service provider. Users' expectations and what is actually supplied are compared to determine the quality of a service (Jere & Ngidi 2020; Morris, Mbamba & Kessy 2023). The following hypothesis has been proposed to test if the healthcare staff will agree that the adoption of CC technology in their hospital was influenced by system quality:

H1: Systems quality positively influences the implementation of CC.

Information Quality: It is an essential component of IS success and impact. Determining the information's user, the tasks completed and the output quality are all part of it (Çelik & Ayaz 2022). The following hypothesis has been proposed to test if healthcare staff will agree that the implementation of CC technology in their hospital was influenced by information quality:

H2: Information quality positively influences the implementation of CC.

Service Quality: It refers to the high-quality of technical support given to system users, leading to increased system utilisation and satisfaction (DeLone & McLean 2003). According to Morris et al. (2023), service quality provides all accessible direct and indirect assistance with an IT service delivery that the hospital must provide in order to improve the readiness of cloud-computing technology in the hospital. The following hypothesis has been proposed to test if healthcare staff will agree that the implementation of CC technology in their hospital was influenced by service quality:

H3: Service quality positively influences the implementation of CC.

Human factors

Measuring items for Human Factors vary based on the context but generally assess aspects such as system use and user satisfaction (Buheji & Buhaid 2020). These factors can have an effect on the organisations readiness and the way they do business. The following hypotheses have been developed to examine if the perceptions of healthcare professionals (human factors) influence the implementation of CC implementation:

H4: Systems use positively influences the implementation of CC.

H5: User satisfaction influences the implementation of CC.

Organisational factors

Organisational factors in this study include variables encouraged by top management, resource availability and perceived benefits. Organisational factors examine whether CC minimises operational costs and improves organisational benefits (Lian et al. 2014; Jere & Ngidi 2020). Previous research indicates that organisations prioritise prior IT experience, top-level management backing and scale when adopting emerging technologies (Jere & Ngidi 2020). The following hypotheses have been developed to examine if healthcare professionals agree that organisational factors influence the implementation of CC:

H6: Organisational structure (OS) positively influences the implementation of CC.

H7: Environment positively influences the implementation of CC implementation.

Cloud-computing implementation

Cloud-computing implementation involves integrating cloud services into existing IT infrastructure to enhance scalability, cost savings, efficiency and operational agility (Ndlanzi & Ranjeeth 2021). The following hypothesis has been developed to test if the implementation of CC will influence the adoption of the organisational readiness:

H8: Cloud-computing implementation positively influences organisational readiness.

Research method

The study uses a positivism paradigm with a focus on testing hypotheses. A hypothesis serves as the starting point, and theoretical postulates are then evaluated using empirical data. This strategy was chosen because it has a successful track record of generating impartial knowledge and it is used to collect quantitative data (Perera, Nayak & Nguyen 2022).

The study utilised questionnaires as a method of gathering data from participants. According to Babbie (2020), a questionnaire is a tool created specially to extract data that would be valuable for analysis. Electronic mail was used to deliver the study's surveys. The survey link, which was created using a Google Form, was distributed to administrative staff, healthcare professionals and IT

TABLE 1: Research methodology summary.

Design research	Methodology
Research approach	Quantitative
Research paradigm	Positivism
Unit of analysis	Mankweng and Polokwane (Pietersburg) Hospital in Limpopo province
Research strategy	Survey Research Strategy
Data-collection method	Questionnaires
Sampling technique	Stratified Sampling Technique
Data analysis	Regression Analysis using SPSS

SPSS, Statistical Package for the Social Sciences.

professionals via email addresses and WhatsApp. Because of the inadequate level of engagement from respondents via the utilisation of Google Forms, the researchers opted to produce physical copies of certain surveys, which were subsequently distributed in person at various healthcare facilities within the region of Limpopo province. According to Masuku (2023), a well-defined research question and clearly stated objectives guaranteed the relevance of the questionnaire's questions and each question was consequently closely related to both. Table 1 provides a summary of the overall research methods adopted in the study.

Demographic data

Table 2 depicts a breakdown of the business concerns from a sample of 313 responses. The information showcases a diverse range of business focusses, indicating the significance of various sectors within the surveyed sample, with finance holding the most significant share.

Table 3 depicts gender distribution from the sample of 313 individuals. Data show that females account for the majority at 64.2%, followed by males at 34.2% and 'Other' representing 1.6% of the total responses.

The age distribution within the sample of 313 individuals shows a diverse range. The majority falls within the range of 36 years to 45 years (39.3%) followed by individuals aged 26 years to 35 years (21.7%) Those aged 46 years to 55 years represent 23.6%, and individuals above 56 years' account for 9.6%. The smallest percentage is individuals below 25 years, comprising 5.8%. These data reveal a predominant concentration in the middle-aged brackets, with a gradual decline in representation as age increases or decreases from the median ranges.

Ethical considerations

To guarantee that the study upheld research integrity and embodied a variety of good research practices and conduct, such as intellectual honesty, accuracy, equity and the protection of human participants who participated in the research pilot, ethical approval was obtained through Tshwane University of Technology, Faculty of Committee for Research Ethics (Ref: FCRE/ICT/2022/04/001[3]) and the Limpopo Department of Health on 12 May 2023 (with reference number: LP_2023-04-018).

TABLE 2: Business divisions of participants.

Business	Frequency	%	Valid %	Cumulative %
Casualty	24	7.7	7.7	7.7
Communication	5	1.6	1.6	9.3
Compliance	3	1.0	1.0	10.2
Finance	76	24.3	24.3	34.5
Human resource	22	7.0	7.0	41.5
Information technology	17	5.4	5.4	47.0
Operations	7	2.2	2.2	49.2
Other	127	40.6	40.6	89.8
Pharmacy	32	10.2	10.2	100.0
Total	**313**	**100.0**	**100.0**	-

Discussion of results

This section thoroughly investigates the theoretical foundations of research hypotheses, discussing how results align with or deviate from hypotheses and explores intricate relationships between variables in healthcare cloud-computing. Hypotheses rooted in existing literature are also scrutinised based on empirical findings. Furthermore, the study's framework is analysed, limitations of the thesis are evaluated, contributions are delineated and directions for future research are proposed. It concludes by synthesising findings with existing literature, discussing implications, offering recommendations framed within research questions and emphasising the study's contributions to healthcare technology innovation:

H1: Systems Quality (SQ) Positively Influences the implementation of CC

Building upon the foundational work of Mahajan et al. (2023) and Kamalizeni et al. (2020), this study aligns with the understanding that SQ is pivotal in the successful implementation of CC in healthcare settings. Masana (2021), emphasises the significance of robust systems characterised by high reliability, optimal performance and comprehensive functionality, contributing significantly to the seamless adoption and integration of cloud-based solutions. Kamalizeni et al. (2020) further reinforce this notion by highlighting that a seamless adoption and integration of cloud-based solutions are contingent upon the quality of existing systems. In concurrence, insights from Mahajan et al. (2023) underscore the critical importance of a robust technological infrastructure in supporting the transition to CC. The non-significant impact found in the regression analysis (Beta = 0.035, $t = 0.621$, $p = 0.535$) suggests a nuanced relationship, urging healthcare organisations to carefully evaluate the specific dimensions of SQ that contribute significantly to CC implementation:

H2: Information Quality Positively Influences the implementation of CC

Consistent with Darwish et al. (2019), this investigation aligns with the insights of Masana (2021) and Kamalizeni et al. (2020), emphasising the positive impact of Information Quality (IQ) on CC implementation. The importance of accurate, comprehensive and pertinent information in healthcare decision-making processes is emphasised by Darwish et al. (2019). Kamalizeni et al. (2020)

TABLE 3: Sex of participants.

Sex	Frequency	%	Valid %	Cumulative %
Female	201	64.2	64.2	64.2
Male	107	34.2	34.2	98.4
Other	5	1.6	1.6	100.0
Total	**313**	**100.0**	**100.0**	-

further support this perspective, linking effective decision-making in healthcare organisations to high standards in information quality. Molo et al. (2021) complement these views by underscoring the role of information as a strategic asset in cloud adoption. Despite the non-significant impact in the regression analysis (Beta = 0.105, t = 1.473, p = 0.142), the emphasis on IQ remains crucial, suggesting that continuous efforts to maintain high standards are imperative for effective CC implementation:

H3: Service Quality Positively Influences the implementation of CC

In line with the results of Fatima, Malik and Shabbir (2018) and Kamalizeni et al. (2020), the current investigation confirms the positive relationship identified between Service Quality (SEQ) and the efficient incorporation of CC in healthcare facilities. There is a need for approachable, assured and tangible service quality components to facilitate a successful transition to cloud-based services (Darwish et al. 2019). Kamalizeni et al. (2020) further support this perspective, highlighting that a satisfactory experience for healthcare providers is contingent upon the quality of services during the adoption of cloud-based solutions. Fatima et al. (2018) reinforce this perspective by underscoring the strategic importance of service quality in ensuring a seamless transition. The significant impact found in the regression analysis (Beta = 0.170, t = 2.207, p = 0.028) aligns with these perspectives, emphasising the importance of prioritising and enhancing SEQ components in healthcare organisations adopting cloud technologies:

H4: Systems Use Positively Influences the implementation of CC

The findings of this study, in line with Gao and Sunyaev (2019) and Molo et al. (2021), reveal a positive correlation between Systems Use (SU) and successful CC implementation. Molo et al. (2021) emphasise the effectiveness of increased utilisation of cloud-based systems by healthcare professionals as a key factor influencing the overall success of implementation. Darwish et al. (2019) further support this perspective, highlighting the role of effective utilisation in maximising the benefits of CC. Fatima et al. (2018) add that user engagement and training programmes are crucial for optimising system use during cloud adoption. Despite the non-significant impact found in the regression analysis (Beta = 0.012, t = 0.203, p = 0.839), the alignment with existing literature underscores the importance of continued efforts in promoting effective SU among healthcare professionals:

H5: User Satisfaction Positively Influences the implementation of CC

Consistent with Molo et al. (2021) and Darwish et al. (2019), this investigation underscores the critical role of User Satisfaction (US) in influencing the favourable implementation of CC in healthcare environments. Gao and Sunyaev (2019), highlight that higher levels of user satisfaction, driven by user-friendly interfaces and system effectiveness, contribute significantly to the acceptance and utilisation of cloud-based technologies. Molo et al. (2021) complement this perspective by emphasising continuous feedback mechanisms and addressing user concerns. The significant impact found in the regression analysis (Beta = 0.239, t = 3.701, p < 0.001) aligns with these perspectives, underscoring the importance of prioritising US initiatives in healthcare organisations adopting cloud technologies:

H6: Organisational Structure Positively Influences the implementation of CC

Supported by Msomi, Kalusopa and Luthuli (2021) and Ghaleb et al. (2021), the research findings indicate a positive influence of OS on successful CC implementation in healthcare organisations. A well-defined and flexible OS with distinct roles and duties is crucial for enabling a seamless migration to cloud-based solutions (Masana 2021).

Ghaleb et al. (2021) further support this perspective, highlighting the importance of OSs that support innovation and collaboration. Fatima et al. (2018) complement these views by underscoring the significance of adaptive structures in navigating technological advancements. Regression analysis results that show a significant effect (Beta = 0.280, t = 6.544, p < 0.001) support these viewpoints and highlight the critical role that OS plays in affecting the acceptance and successful application of CC technologies in healthcare:

H7: Environment Positively Influences the implementation of CC

The study's findings, consistent with Marutha (2021) and Msomi et al. (2021), establish a positive correlation between the organisational Environment (E) and successful CC implementation in healthcare. Msomi et al. (2021) highlight that a supportive OE, characterised by leadership commitment and adequate resources, plays a pivotal role in influencing the successful adoption and implementation of CC technologies. Parker and Parker (2023) add to this viewpoint by highlighting the significance of an innovative culture within the workplace. The regression analysis's significant impact (Beta = 0.140, t = 2.710, p = 0.007) is consistent with these viewpoints and emphasises the significance of developing an E that is supportive of technological developments, as this influences the acceptance of CC in healthcare settings in a positive way:

H8: Cloud-Computing Implementation Positively Influences the Organisational Readiness (OR)

Drawing insights from the literature, particularly the work of Marutha (2021) and Samuel et al. (2023), this study proposes that CC implementation positively influences Organisational Readiness (OR) in healthcare settings. Samuel et al. (2023) emphasise that successful technology implementation contributes to organisational preparedness and adaptability. Samuel et al. (2023) further support this perspective, underscoring that effective utilisation of cloud technologies enhances the overall readiness of organisations for technological advancements. This hypothesis aligns with the

broader understanding that the successful implementation of CC initiatives contributes to an organisation's overall readiness for embracing and leveraging technological innovations.

In the regression analysis, CC implementation exhibits a substantial impact on OR (Beta = 0.868, $t = 30.776$, $p < 0.001$). These findings underscore the pivotal role of CC implementation in influencing and predicting the variance in OR within the specified framework. The strong positive correlation indicates that as healthcare organisations effectively implement CC solutions, they are more likely to exhibit heightened OR, as supported by Marutha (2021) and Samuel et al. (2023). This emphasises the strategic importance of successful CC adoption in fostering organisational preparedness for future technological changes and advancements.

Final theoretical framework

Research objective: To develop a theoretical framework for assessing organisational readiness of cloud-computing technology implementation in Limpopo provincial hospitals.

The outcomes of a hypothesis test investigating the effects of eight variables on the dependent variable 'CC' reveal noteworthy trends. Notably, OS, US, E and SEQ display statistically significant and positively correlated relationships with CC, indicating a substantial and meaningful impact. The positive beta values associated with these variables suggest a direct relationship, signifying that as OS, US, E or SEQ increases, CC is likely to increase as well. Conversely, IQ, SQ and SU do not exhibit statistically significant relationships with CC, suggesting that any observed connections with these variables are likely of smaller magnitude or possibly attributable to chance. In summary, the results emphasise the significance of OS, US, E and SEQ in influencing CC, while implying a less definitive or inconclusive role for IQ, SQ and SU within the scope of this analysis (see Figure 2).

Recommendations

Based on the findings from the hypothesis testing and the final framework developed for assessing organisational readiness of CC technology implementation in Limpopo provincial hospitals, the following recommendations are proposed:

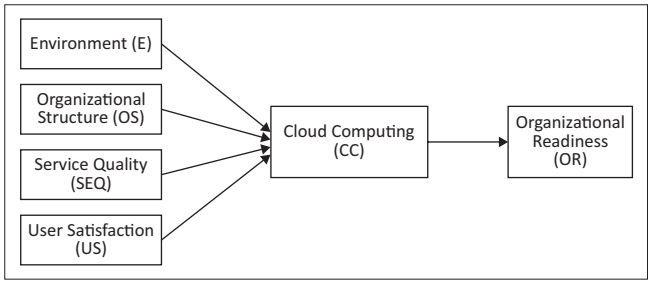


FIGURE 2: The research's final theoretical framework.

Enhance organisational structure

Given the statistically significant positive association between OS and CC adoption readiness, it is advisable to increase organisational support and leadership commitment (Msomi et al. 2021). Hospitals should prioritise top-level management support, give adequate resources and cultivate a culture of technology innovation.

Promote system use

The significant positive link between system utilisation and CC implementation readiness emphasises the necessity of encouraging healthcare professionals to actively embrace CC technologies (Gao & Sunyaev 2019). Training programmes should be provided to improve employees' competency and confidence in using cloud technology efficiently.

Address environmental factors

Environmental considerations have an important influence in helping or limiting CC adoption. Hospitals should evaluate and address regulatory impediments, upgrade infrastructure and align policies to enable CC activities (Parker & Parker 2023). Collaborations with local governments and stakeholders can also contribute to a favourable climate for technical breakthroughs.

Ensure service quality

The discovered positive link between service quality and CC deployment readiness emphasises the need of providing strong technical assistance and maintaining the dependability of cloud services (Fatima et al. 2018). Continuous development in service delivery and user support methods will boost overall satisfaction and acceptance among healthcare professionals.

Conclusion and contribution

The study effectively filled a research gap by using the factors that were validated to develop a theoretical framework for assessing the readiness of CC technology implementation in Limpopo provincial hospitals. The final theorical framework, shown in Figure 2, presents the importance of OS, system use, environmental conditions and service quality in determining CC readiness. Strong leadership support (OS), active system use (US), suitable environmental conditions (E) and high-quality service provision (SEQ), all have a substantial impact on organisational CC preparedness. These characteristics are critical in determining healthcare organisations' readiness to implement CC technology efficiently.

The study also discovered that, in this particular context, there was no statistically significant association between CC readiness and information quality (IQ), SQ, or user satisfaction (SU). This suggests that tactics linked to these characteristics should be explored or refined further in order

to better understand their impact on CC implementation in healthcare settings. Finally, by focussing on improving OS, encouraging system use, resolving environmental concerns and assuring service quality, Limpopo provincial hospitals can improve their readiness to successfully deploy CC technology. These initiatives will contribute to the overall goal of leveraging technology to enhance patient care and operational effectiveness in the healthcare industry, in addition to improving the delivery of healthcare services.

This study is filling the gap in the existing literature by presenting new factors validated as a theoretical framework to assess the readiness for CC and contributes to the advancement of this field. This study made a practical contribution by highlighting the significance of emerging information and communication technologies for information system management. Practitioners need to understand the factors that improve the readiness of CC in hospitals so that they can develop cloud-based services that will satisfy the intended users.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

A.T.K contributed to the conceptualising, reviewing and editing of this journal paper as a supervisor. M.J.M. was the primary investigator and the main author.

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Data availability

The data that support the findings of this study are available from the corresponding author, A.T.K. upon reasonable request.

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