Cloud Horizons: Strengthening Rural Healthcare Through Telemedicine's Digital Canopy

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ABSTRACT

INTRODUCTION: Cloud-based telemedicine holds promise for improving healthcare accessibility and delivery, particularly in rural areas of developing countries like Tanzania. However, little is known about its determinants and benefits in such contexts. This study investigates the factors influencing the usage of telemedicine in Mvomero district, Morogoro region, Tanzania, focusing on both supply and demand sides.

METHOD: Using structured interviews and key informant interviews, the study examines various cloud-based telemedicine platforms, including remote monitoring, electronic health records, cloud-based storage, and machine learning algorithms. The study used descriptive statistics to analyze quantitative data, while thematic analysis was used to analyze qualitative data.

RESULTS: Results reveal several factors influencing telemedicine usage. On the demand side, perceived benefits (53.96%), technology cost (62.79%), legal practices (62.79%), and resource availability and affordability (49.77%) are crucial. On the supply side, technological innovation (35%) and access to financial resources (43%) play pivotal roles. Environmental and institutional factors such as political willingness (38%) and regulatory support (34%) also impact telemedicine usage. Moreover, results reveal that cloud-based telemedicine platforms in rural healthcare facilities have several benefits including improved access (32.74% to 57.44%), cost efficiency (37.88% to 54.82%), timely consultations (56.83% to 65.21%), health monitoring, and prescription management (43.89% to 75.90%). Private facilities particularly emphasize health monitoring.

CONCLUSION: Adopting telemedicine technologies can revolutionize rural healthcare by providing customized and easily accessible services. Policymakers can use these findings to develop targeted strategies, including subsidized infrastructure, innovative financing models, and clear regulatory frameworks. Clear guidelines on data transfer and privacy are essential to ensure legal compliance and equitable access to telemedicine benefits. Simplifying registration requirements and implementing explicit consent mechanisms are recommended to address data privacy concerns. These measures aim to promote operational efficiency, data safety, and enhanced health outcomes in resource-limited settings.

KEYWORDS: Cloud-based telemedicine, remote monitoring, machine learning, data privacy and security, rural healthcare telehealth, health information technology, healthcare delivery, digital health, healthcare innovation

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Introduction

Telemedicine, an integral facet of modern healthcare, involves the remote provision of medical services, and consultations through telecommunication technologies.[1-3] Originating in the mid-20th century to overcome geographical barriers, telemedicine has evolved to include real-time video consultations, store-and-forward telemedicine, and remote patient monitoring.[4-6] Recently, cloud-based telemedicine has emerged, integrating cloud technology to enhance accessibility, scalability, and data management in healthcare delivery.[7-9] The rapid adoption of cloud-based technologies has revolutionized healthcare, enabling providers to access patient data and deliver care remotely, thereby improving healthcare accessibility and personalized care.[10-12]

Cloud-based electronic health record (EHR) systems facilitate real-time data sharing among providers, ensuring up-to-date patient information and reducing medical errors.[13-15] This is particularly beneficial for remote monitoring and care in underserved areas.[16] Additionally, cloud storage and real-time analysis of remote monitoring data enable personalized patient care and swift responses to health issues.[17,18] Machine learning in cloud systems offers tailored healthcare recommendations, optimizing treatment.[19] Further, the integration of machine learning algorithms enhances the accuracy and personalization of patient care.[20] In emergency services, cloud technologies ensure rapid assessments and interventions, crucial for rural areas.[21] These technologies enable healthcare delivery without direct contact, thus reducing infection risks.[22] Ensuring data privacy and security with robust encryption and access controls maintains patient trust in these systems.[22,23]

Previous research demonstrates the significant advantages of cloud-based technologies in telemedicine and remote monitoring.[24,25] Despite their potential, the awareness, adoption and usage of cloud-based telemedicine in developing nations remains limited.[26-28] These healthcare systems often rely on manual processes, causing delays and inaccuracies in patient information transfer.[29] This inadequacy has led to tragic medical errors,

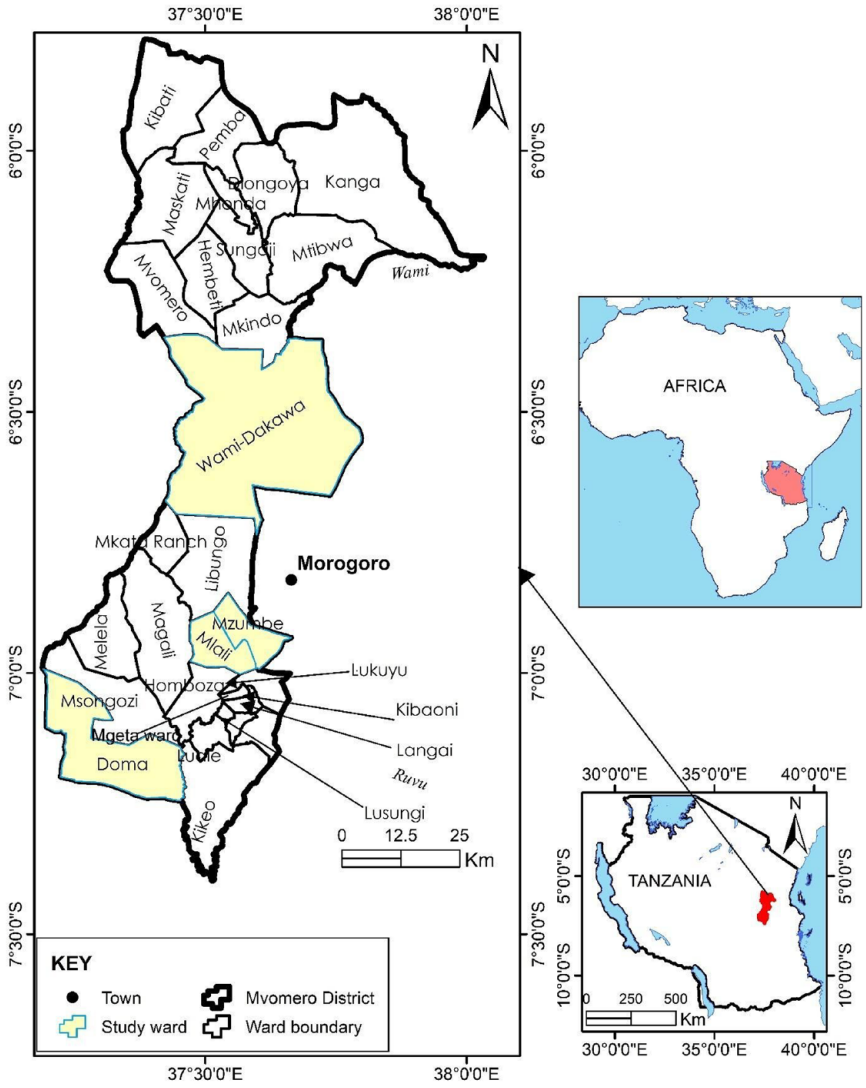

Figure 1. Map of Morogoro region showing Mvomero district.
Source: Mangita and Sangeda.[33]

highlighting the need for digital transformation.[30,31] However, challenges remain, particularly in developing countries like Tanzania, where primary healthcare settings face resource and technology gaps. This study explores the benefits of cloud-based telemedicine in rural healthcare, examining applications like remote consultations, monitoring, EHRs, cloud storage, and machine learning for personalized care. It also addresses data privacy and security issues, emphasizing the importance of these technologies in enhancing healthcare delivery and improving patient outcomes. Addressing persisting challenges requires comprehensive analysis and policy support to fully realize the potential of cloud-based healthcare technologies.

Methods

This study employed a multistage sampling approach to select various facilities in Morogoro region, Tanzania. The first stage involved the purposeful selection of Morogoro Region. Morogoro was chosen because it is one of the most densely populated regions in Tanzania and is noted for having some of the poorest health outcomes, as reported by the Ministry of Health.[32] The region's challenging geography, with many residents living in mountainous areas, further complicates access to adequate healthcare services. These factors made Morogoro an ideal location for this study.

In the second stage, the Mvomero district was selected because it exemplifies the broader healthcare challenges within the region particularly poor health outcomes, limited access to healthcare, challenges in managing referral cases, a shortage of healthcare personnel, and a low number of primary health facilities, providing a relevant and focused context for the study. The third stage involved purposively selecting three specific wards within Mvomero District: Melela, Mlali, and Mzumbe (Figure 1). These wards were chosen because they represent a cross-section of the district's healthcare challenges, including issues related to accessibility, healthcare delivery, and resource availability. By focusing on these wards, the study aimed to

Table 1. General Characteristics of Respondents, (n = 40).

CHARACTERISTICS	ATTRIBUTES	PUBLIC HEALTH FACILITY	PRIVATE HEALTH FACILITY	FAITH BASED ORGANIZATION	OVERALL
Sex	Male	10 (66.66%)	12 (60.00%)	1 (20.00%)	23 (57.50%)
	Female	5 (33.34%)	8 (40.00%)	4 (80.00%)	17 (42.50%)
	Total	15 (37.50%)	20 (50.00%)	5 (15.00%)	40 (100.0%)
Marital status	Single	4 (26.66%)	9 (45.00%)	3 (60.00%)	16 (40.00%)
	Married	7 (46.66%)	7 (35.00%)	1 (20.00%)	15 (37.50%)
	Widow	1 (6.68%)	0 (0.00%)	0 (0.00%)	1 (2.50%)
	Divorced	3 (20.00%)	4 (20.00%)	1 (20.00%)	8 (20.00%)
	Total	15 (37.50%)	20 (50.00%)	5 (15.00%)	40 (100.0%)
Education level	No formal education	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
	Primary education	1 (6.68%)	0 (0.00%)	0 (0.00%)	1 (2.50%)
	Secondary education	3 (20.00%)	2 (10.00%)	1 (20.00%)	6 (15.00%)
	Vocational training	7 (46.66%)	12 (60.00%)	2 (40.00%)	21(52.50%)
	University education	4 (26.66%)	6 (30.00%)	2 (40.00%)	12 (30.00%)
	Total	15 (37.50%)	20 (50.00%)	5 (15.00%)	40 (100.0%)

capture a detailed and in-depth understanding of the healthcare environment within Mvomero District.

In the final stage, healthcare facilities within the selected wards were purposively selected based on accessibility, the range of services offered, and logistic reasons. The selection of respondents was then made from these facilities. A total of 44 healthcare workers were selected, with the sample size determined using the Yamane formula (1967). The formula, applied to a total population of 50 healthcare workers in the selected primary healthcare facilities, and with a precision level of 5%, yielded a sample size of 44 respondents. The 44 practitioners were selected based on their experience in the facilities, particularly their involvement with digital healthcare infrastructure and their understanding of telemedicine. This careful selection process ensured that the respondents were well-equipped to provide informed and accurate insights into the challenges and opportunities related to telemedicine in the region.

Key informant interviews

Key informant interviews were conducted with 4 of the respondents who were purposively selected based on their knowledge of implementation of digital technologies in the country and willingness to provide in-depth information. An interview guide with predefined questions focusing on the factors influencing the usage of telemedicine platforms and the benefits of these platforms was used to collect data. The key informants were from diverse healthcare settings: A1 from private health facilities, A2 from a faith-based organization, A3 from public health facilities, and A4 from another faith-based organization. Interviews were audio recorded to capture complete and accurate responses. Data were collected between 17th January 2023 to 3rd March 2023. Before data collections the preparatory meetings with respondents clarified study objectives, timelines, and data collection processes, building rapport and trust.

Data management, coding and analysis

Qualitative data were analyzed using thematic analysis in NVivo, where the authors carefully read and coded the transcribed interviews to identify key patterns, which were then organized into themes. Two experienced data coders, who are also study authors, independently reviewed, and coded the transcripts to ensure consistency and reliability. Regular cross-checks and discussions resolved any discrepancies, capturing diverse insights and maintaining high methodological rigor. Quantitative analysis was conducted using SPSS for statistical computations and visualizing numerical survey data. The qualitative and quantitative data were triangulated to provide a comprehensive understanding of the study objectives.

Results

General respondents' characteristics

Majority of respondents across all healthcare facilities were male (57.5%) and 50% from private health facilities (see Table 1). In terms of marital status, 40.0% of the respondents were

Table 2. Primary Health Facilities' Practitioners Understanding on Cloud-Based Platforms.

CLOUD-BASED PLATFORMS	PUBLIC HEALTH FACILITY		PRIVATE HEALTH FACILITY		FAITH BASED ORGANIZATION	
	YES	NO	YES	NO	YES	NO
Electronic health records	8 (53%)	7 (47%)	13 (65%)	7 (35%)	5 (100%)	0 (0%)
Storage and analysis of remote monitoring data	11 (73%)	4 (27%)	12 (60%)	8 (40%)	4 (80%)	1 (20%
Machine learning for telemedicine and remote monitoring	0 (0%)	15 (100%)	1 (5%)	19 (95%)	1 (20%)	4 (80%)
Telemedicine and remote monitoring for emergency services	1 (7%)	14 (93%)	3 (15%)	17 (85%)	3 (60%)	2 (40%)
Telemedicine and remote monitoring for rural healthcare	2 (13%)	14 (87%)	4 (20%)	16 (80%)	3 (60%)	2 (40%)
Data privacy and security in cloud-based telemedicine and remote monitoring	1 (7%)	14 (93%)	1 (5%)	19 (95%)	4 (80%)	1 (20%)

single. Regarding education levels, more than half of the respondents (52.5%) had vocational training and 30% had university education. Further, the majority of respondents were health workers from private healthcare facility (50%).

Results in Table 2 show that, there are disparities regarding healthcare practitioners' understanding on cloud-based telemedicine platforms services across different types of healthcare facilities. Respondents from Faith based organizations were more familiar with electronic health records (100%), storage and analysis of remote monitoring data (80%), telemedicine and remote monitoring for rural healthcare (60%) and Data privacy and security in cloud-based telemedicine and remote monitoring (80%) compared to the public and private health facility respondents.

Conversely, results in Table 2 show that public and private health facility respondents were more familiar with Machine learning for telemedicine and remote monitoring compared to the Faith based organization respondents. Telemedicine and remote monitoring for emergency services is similarly underrecognized, with only 7% in public, 15% in private, and 60% in faith-based organizations reporting familiarity. Generally, faith-based organizations and private healthcare facilities exhibit a higher level of understanding and familiarity with cloud-based platforms compared to public health facilities. Public facilities demonstrate lower awareness, particularly in more advanced areas such as machine learning and data privacy. This highlights a notable disparity in the adoption and utilization of cloud-based technologies among different types of healthcare providers, with faith-based organizations leading in engagement with these digital tools.

Factors Influencing Usage of Cloud-Based Platforms Among Primary Health Facilities

Demand factors influencing usage of cloud-based platforms

Generally, respondents positively perceive the benefits accorded by cloud-based platforms, more pronounced among the respondents from the private (85% - strongly agree and agree) and faith-based health facilities (72%). However, the cost of these technologies is perceived as daunting among all respondents. There was a strong voice from all respondents that availability and affordability in inputs influenced the usage of cloud-based platforms. Noteworthy, 22% of respondents from Faith based organizations felt otherwise. Additionally, respondents from private health facilities (64.05%), and those in public health facilities (57.90%) agree that usage of cloud-based platforms is influenced by the availability and affordability for cloud-based platform services (see Table 3).

Furthermore, the influence of social and cultural norms on the uptake of cloud-based platforms was more pronounced among respondents from private healthcare facilities (74.65%) and faith-based organizations (78.58%). In contrast, 71.61% of respondents from public health facilities disagreed that social and cultural norms were factors influencing the usage of cloud-based platforms.

In private primary health facilities, a significant majority of respondents (85.25% - strongly agree and agree) identified user preference as a key factor influencing the usage of cloud-based platforms, while 75.29% agreed that legal practices play a crucial role. In public primary health facilities, 62.86% of

Table 3. Demand Factors Influencing the Usage of Cloud-Based Platforms Among Primary Health Facilities.

DEMAND FACTORS	PUBLIC PRIMARY HEALTH FACILITY					PRIVATE PRIMARY HEALTH FACILITY					FAITH BASED ORGANIZATION (FBO)				
	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
Perceived benefits	15.27%	50.42%	15.02%	9.29%	10.00%	53.96%	31.01%	4.03%	10.00%	1.00%	48.14%	23.59%	5.23%	7.77%	15.27%
Cost of technology	20.03%	54.17%	4.39%	11.41%	10.00%	62.79%	21.22%	2.62%	8.03%	5.34%	42.27%	34.65%	1.84%	11.11%	10.13%
Availability and affordability of inputs	29.93%	40.08%	4.65%	15.34%	10.00%	49.77%	27.17%	6.76%	10.47%	5.83%	26.02%	31.67%	5.83%	14.53%	21.95%
Availability and affordability of services for Cloud-based platforms	17.35%	40.55%	7.00%	27.03%	8.07%	9.29%	54.76%	2.94%	23.58%	9.43%	0.00%	0.00%	6.67%	40%	53.33%
Social and cultural norms	2.95%	18.06%	7.38%	37.51%	34.10%	36.67%	37.98%	10%	8.68%	6.67%	38.10%	40.48%	9.52%	7.14%	4.76%
User preference	11.31%	51.55%	3.62%	18.52%	15.00%	60%	25.25%	2.94%	9.43%	2.38%	8.82%	17.65%	29.41%	38.24%	5.88%
Legal practices	16.44%	44.17%	12.39%	11.64%	15.36%	62.79%	12.50%	10.62%	7.75%	6.34%	32.27%	44.05%	7.50%	11.15%	5.03%
Technology awareness	33.33%	38.55%	4.71%	15.08%	8.33%	46.67%	24.76%	2.41%	13.16%	13.00%	17.92%	21.70%	15.09%	26.42%	18.87%

respondents acknowledged the importance of user preference, and 60.61% recognized the impact of legal practices. Faith-based organizations showed lower agreement, with only 26.47% acknowledging user preference and 76.32% recognizing legal practices as important.

In addition, key respondents' perceptions revealed that there are great variations in their views pertaining legal implication in the use of cloud-based telemedicine in rural areas in Tanzania:

> "*Navigating the legal landscape for private health facilities in Tanzania involves formidable challenges, particularly in registering digital health systems. The intricate bureaucratic processes and substantial fees associated with registration act as deterrents, hindering the widespread adoption of digital health technologies.*" (Respondent A1, Private healthcare facility)

Moreover, another key informant argued that:

> "*Complexities surrounding the legal standards for data transfer impose burdensome obligations on most of the private and faith-based healthcare facilities. The stringent requirements for registration in the broader health sector further exacerbate the hurdles, limiting the inclusivity and diversity of the healthcare landscape. Streamlining these legal processes is imperative to not only facilitate the integration of digital health systems but also to foster a more collaborative and inclusive healthcare sector in Tanzania.*" (Respondent A2, Faith Based healthcare facility)

On the other hand, technological awareness was recognized by 71.43% of respondents in private primary health facilities and 71.88% in public primary health facilities as significantly influencing the usage of cloud-based platforms. However, faith-based organizations showed more divided opinions, with only 39.62% of respondents agreeing, while a substantial 45.29% disagreed with the impact of technological awareness.

Supply factors influencing usage of Cloud-based platforms

Results in Table 4 demonstrate that respondents positively perceive the level of technological innovation as an influencing factor for the usage of cloud-based platforms, with this perception being more pronounced among respondents from faith-based organizations (80%—strongly agree and agree). However, public health facilities display a more divided opinion, with 24.17% strongly disagreeing with this view. The availability of finance is seen as a critical factor across all facility types, especially in faith-based organizations, where 85.71% of respondents strongly agree or agree on its importance. Noteworthy, 26.42% of respondents from private health facilities disagreed, reflecting varied opinions within this group.

Digital infrastructure is regarded as a significant influence by respondents from public health facilities, with 50% strongly agreeing. However, this view is less prevalent in private health facilities, where responses are more evenly distributed. There was a strong consensus among respondents from private health facilities (85.72%—strongly agree and agree) that internet connectivity is a key factor in the usage of cloud-based platforms. Meanwhile, bandwidth costs are perceived as a major barrier, particularly in public health facilities, where 93.33% of respondents disagreed with the proposition that it supports cloud platform usage.

The availability of expertise is viewed as a critical factor, especially among respondents from faith-based organizations (88.10%—strongly agree and agree). Public health facilities also recognize its importance, though to a slightly lesser extent (78.58%—strongly agree and agree). These findings indicate a generally positive perception of the supply factors influencing cloud-based platform usage, with variations depending on the type of healthcare facility.

Environmental factors influencing usage of cloud-based platforms

Generally, results in Table 5 show that respondents positively perceive the influence of political willingness on the usage of cloud-based platforms, with this view being more pronounced among respondents from faith-based organizations (83.33%—strongly agree and agree) and private health facilities (65.46%). However, a significant portion of respondents from public health facilities (50.24%) disagrees, indicating a more divided opinion.

There was a strong consensus across all respondents that regulatory support is crucial for the usage of cloud-based platforms, particularly among those from faith-based organizations (92.86%—strongly agree and agree). Noteworthy, 20.76% of respondents from public health facilities felt otherwise, disagreeing with this view. Additionally, respondents from private health facilities (83.04%—strongly agree and agree) and those from public health facilities (70%) agree that economic factors significantly influence the usage of cloud-based platforms. In contrast, respondents from faith-based organizations show more varied opinions, with a substantial 32.36% disagreeing.

Institutional structure is viewed as an important factor, especially among respondents from public health facilities (80.95%—strongly agree and agree) and faith-based organizations (73.59%). However, opinions from private health facilities are more mixed, with 28.71% of respondents either disagreeing or strongly disagreeing. Stakeholder support also sees strong positive perceptions among faith-based organizations (83.33%—strongly agree and agree), though this view is less consistent among private and public health facilities, where a notable proportion of respondents disagree.

Figure 2 illustrates the varied usage rates of cloud-based platforms in primary healthcare facilities, revealing significant differences across digital healthcare components. The results show that 65% of facilities use Electronic Health Records (EHRs). Remote monitoring systems are utilized by 68% of facilities, while machine learning has a minimal usage rate of

Table 4. Supply Factors Influencing the Usage of Cloud-Based Platforms Among Primary Health Facilities.

SUPPLY FACTORS	PUBLIC PRIMARY HEALTH FACILITY					PRIVATE PRIMARY HEALTH FACILITY					FAITH BASED ORGANIZATION (FBO)				
	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
Level of technological innovation	21.50%	29.33%	16.67%	8.33%	24.17%	8.82%	17.65%	29.41%	38.24%	5.88%	43.33%	36.67%	10.00%	10.00%	0.00%
Availability of finance (funds)	42.86%	38.10%	11.90%	7.14%	0.00%	17.92%	21.70%	15.09%	26.42%	18.87%	35.71%	50.00%	11.90%	2.38%	0.01%
Digital infrastructure	50.00%	13.24%	4.22%	16.47%	16.07%	26.67%	30%	33.33%	6.67%	3.33%	11.76%	20.59%	26.47%	17.65%	23.53%
Internet connectivity	36.79%	28.30%	16.98%	11.32%	6.61%	40.48%	45.24%	7.14%	4.76%	2.38%	30.19%	36.79%	16.04%	9.43%	7.55%
Bandwidth costs	0.00%	0.00%	6.67%	40%	53.33%	32.36%	20.59%	5.88%	8.82%	32.35%	36.67%	46.67%	10.00%	3.33%	3.33%
Availability of expertise	38.10%	40.48%	9.52%	7.14%	4.76%	33.97%	33.02%	14.15%	6.60%	12.26%	47.62%	40.48%	4.76%	0.00%	7.14%

Table 5. Environmental Factors Influencing the Usage of Cloud-Based Platforms Among Primary Health Facilities.

ENVIRONMENTAL FACTORS	PUBLIC PRIMARY HEALTH FACILITY					PRIVATE PRIMARY HEALTH FACILITY					FAITH BASED ORGANIZATION (FBO)				
	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
Political willingness	14.71%	32.35%	2.70%	11.76%	38.48%	24.71%	40.75%	16.98%	9.43%	8.13%	43.33%	40%	10%	6.67%	0.00%
Regulatory support	33.96%	39.62%	5.66%	4.72%	16.04%	33.96%	46.67%	9.07%	6.67%	3.63%	54.76%	38.10%	4.76%	0.00%	2.38%
Economic	36.67%	33.33%	16.67%	10%	3.33%	36.04%	47%	11.90%	2.38%	2.38%	23.53%	17.65%	26.47%	17.65%	14.71%
Institutional structure	28.57%	52.38%	19.05%	0.00%	0.00%	28.57%	35.19%	7.53%	17.65%	11.06%	41.51%	32.08%	13.21%	7.55%	5.66%
Stakeholder support	8.82%	32.35%	14.71%	20.59%	23.53%	8.30%	44.34%	13.21%	23.43%	10.72%	33.33%	50%	11.90%	2.37%	2.30%

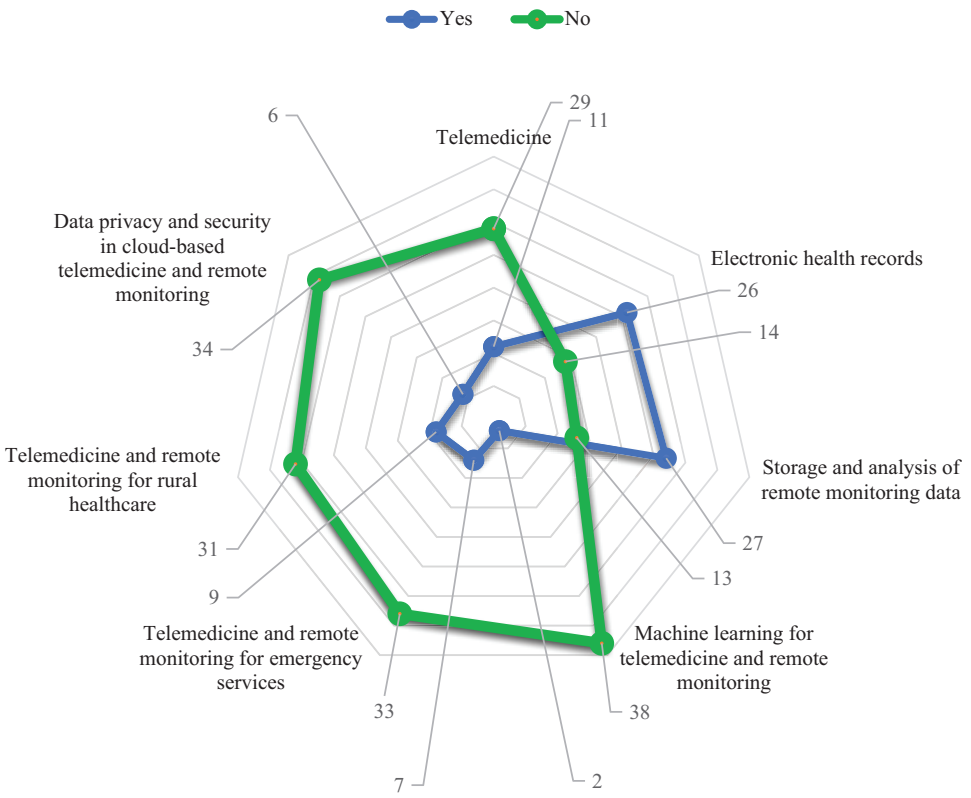

Figure 2. Overall results on the usage of cloud-based platforms across primary healthcare.

5%. Remote monitoring for emergency services is employed by only 18% of facilities, and adoption in rural areas is at 23%. Additionally, 85% of facilities lack adequate data privacy and security measures.

Benefits of Cloud-based telemedicine in rural areas healthcare delivery

Generally, respondents positively perceive the benefits of using cloud-based telemedicine platforms in rural healthcare delivery, with this view being more pronounced among respondents from private primary health facilities (96.77%—strongly agree and agree) and faith-based organizations (93.59%). However, there is a slightly lower level of positivity among public primary health facilities, where 86.65% of respondents strongly agree or agree with the benefits, but with a slightly higher incidence of neutrality and disagreement (see Table 6).

There was a strong consensus across all respondents that access to healthcare is a significant benefit of these platforms, particularly among those from private health facilities (98.11% - strongly agree and agree) and public facilities (89.96%). Noteworthy, 7.76% of respondents from faith-based organizations felt otherwise, showing some neutrality or disagreement regarding this benefit. Additionally, respondents from public health facilities (97.30% - strongly agree and agree) and those in faith-based organizations (94.73%) agree that cost efficiency is a major advantage of using cloud-based telemedicine platforms.

In cementing these results, a key informant from public healthcare facility added that:

> *"The use of cloud-based telemedicine has resulted in a noticeable improvement in timely responses across the health sector. This has effectively reduced both time and costs associated with medical care. Now, a patient can simply visit a nearby medical facility and receive the same information that would have been obtained at a different hospital for diagnosis. This enhancement signifies a significant reduction in geographical barriers and associated costs, highlighting the transformative power of cloud technology in healthcare."* (Respondent A3, Public healthcare facility)

Timely consultation is also widely valued, with strong agreement from respondents in private (97.52%) and faith-based facilities (93.88%). Public health facilities also show significant support (91.42%), though with a slightly higher percentage (8.01%) disagreeing with this benefit. Health monitoring is perceived as a particularly strong benefit, especially among respondents from faith-based organizations (99.9%—strongly agree and agree) and private facilities (99.26%). Moreover, public facilities demonstrate a slightly lower yet significant level of support at 60.79%, with a higher proportion of respondents (28.21%) expressing disagreement.

Additionally, these results were supported by those in the key informant interview as it suggested that:

> "*The significance of consultation time diminishes when healthcare facilities deliver high-quality services, as people are inherently drawn to these hospitals.*" (Respondent A2, Faith Based healthcare facility)

Table 6. Benefits of Using Cloud-Based Telemedicine Platform in Rural Healthcare Delivery.

BENEFITS	PUBLIC PRIMARY HEALTH FACILITY					PRIVATE PRIMARY HEALTH FACILITY					FAITH BASED ORGANIZATION (FBO)				
	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
Access to healthcare	32.74%	56.85%	1.70%	6.73%	1.98%	41.67%	57.44%	0.00%	0.80%	0.09%	32.98%	48.98%	10.28%	4.99%	2.77%
Cost efficiency	48.63%	48.67%	0.00%	2.59%	0.11%	37.88%	54.82%	1.40%	5.00%	0.90%	44.85%	49.88%	2.56%	1.79%	0.92%
Timely consultation	59.64%	31.78%	0.57%	7.99%	0.02%	56.83%	40.69%	0.07%	2.11%	0.30%	65.21%	28.67%	0.00%	3.86%	2.26%
Health monitoring	21.85%	38.94%	11.00%	22.83%	5.38%	68.59%	30.67%	0.00%	0.74%	0.00%	77.00%	22.90%	0.00%	0.10%	0.00%
Prescription management	43.89%	50.33%	0.22%	4.32%	1.24%	75.90%	19.69%	1.70%	2.71%	0.00%	45.90%	51.77%	1.85%	0.48%	0.00%
Total %	206.75%	226.5%	13.49%	44.46%	8.73%	280.8%	203.3%	3.17%	11.36%	1.29%	265.94%	202.2%	14.69%	11.22%	5.95%
Average	41.35%	45.3%	2.70%	8.89%	1.75%	56.17%	40.6%	0.63%	2.27%	0.26%	53.19%	40.4%	2.94%	2.24%	1.19%

In contrast, a key informant from public sector asserted that:

> "*Effective infrastructure for cloud-based telemedicine can notably shorten treatment time, particularly given the higher patient influx attributed to affordable medical costs.*" (Respondent A4, Faith Based healthcare facility)

Health monitoring is perceived as a particularly strong benefit, especially among respondents from faith-based organizations (99.9%—strongly agree and agree) and private facilities (99.26%). Public facilities show lower but still substantial support (60.79%), with a higher percentage of respondents (28.21%) remaining neutral or disagreeing. Additionally, prescription management is highly regarded across all facility types, with private facilities (95.59%) and public facilities (94.22%) showing strong agreement. Faith-based organizations also recognize this benefit, though with slightly lower overall agreement (97.67%).

Adding to this, one key informant from the private sector argued that:

> "*The private sector's ability to quickly integrate new technologies and bypass bureaucratic hurdles allows us to fully leverage the benefits of cloud-based telemedicine platforms. We can implement new systems without the prolonged approval processes that are typical in public institutions. This agility means that we can stay ahead with the latest advancements, provide timely and efficient patient care, and continuously improve our services without being held back by red tape.*" (Respondent A1, Private healthcare facility)

Overall, the perceived benefits of cloud-based telemedicine platforms are most strongly acknowledged by respondents from private primary health facilities (96.77%), followed by faith-based organizations (93.59%) and public facilities (86.65%), indicating a generally positive reception across all healthcare facility types, with some variability in the degree of enthusiasm.

Discussion

This study has demonstrated that a greater understanding of cloud-based telemedicine significantly impacts the decision on using these platforms across various dimensions, including demand, supply, and environmental factors. Moreover, this understanding extends to the perceived benefits of cloud-based telemedicine, indicating that knowledge and awareness play crucial roles in the uptake of these technologies. The findings reveal that healthcare workers in private and faith-based primary healthcare facilities exhibit a higher level of understanding and utilization of telemedicine compared to those in public facilities. This disparity can be attributed to several factors, including differences in resource allocation, organizational structure, and the influence of bureaucracy in public health systems, where decision-making processes are often more complex and slower due to government protocols.[34,35]

In addition, the study demonstrates varying levels of cloud-based telemedicine usage across different healthcare settings. The lower usage rates observed in public primary health facilities suggest a cautious but growing interest in telemedicine. Despite recognizing the potential benefits of these platforms, such as improved healthcare delivery in remote areas and enhanced chronic disease management, public facilities face significant barriers to full-scale implementation. These barriers include infrastructural limitations, financial constraints, and a lack of targeted training for healthcare professionals.[36] Additionally, regulatory challenges and the slow pace of decision-making in public institutions further hinder the adoption of advanced digital solutions.[37]

In contrast, private healthcare facilities and faith-based organizations demonstrate significantly higher adoption rates of cloud-based telemedicine. This can be attributed to their more robust financial resources and greater autonomy in decision-making.[36,37] These facilities often have the flexibility to invest in necessary infrastructure and training, fostering a more innovation-friendly culture. The stronger embrace of digital technologies in these sectors highlights the critical role of organizational leadership and funding in facilitating technological adoption and usage. In addition, private healthcare organizations tend to adopt new technologies more rapidly due to their ability to allocate resources more effectively. The enthusiastic response from faith-based organizations, which are often driven by mission-oriented goals to provide comprehensive care, suggests that aligning digital adoption with organizational values can further enhance uptake.[38]

The discussion also extends to the implications of cloud-based telemedicine for improving healthcare outcomes. The high levels of agreement on the effectiveness of telemedicine in prescription management and chronic disease monitoring in private and faith-based settings indicate a clear recognition of the value these innovations bring. Telemedicine's ability to improve healthcare access, especially in rural areas where challenges are more pronounced, is crucial.[39] This technology not only enhances immediate health outcomes but also contributes to broader public health goals by improving continuity of care and reducing the need for costly emergency services.[40,41]

However, the disparities in usage levels and the challenges associated with adoption underscore the need for comprehensive strategies that address both technological and non-technological barriers. Policymakers and healthcare administrators should consider multi-faceted approaches that include enhancing infrastructural capabilities, revising regulatory frameworks to support digital innovations, and fostering a culture of continuous learning and adaptation among healthcare providers.[42,43] Additionally, targeted initiatives to boost stakeholder engagement, particularly in rural and underserved communities, could accelerate the acceptance and effectiveness of telemedicine solutions.[43]

Furthermore, while the benefits of cloud-based telemedicine and digital health records are widely acknowledged across the healthcare spectrum, realizing their full potential requires addressing the complex web of factors that influence technology adoption and integration.[44] By focusing on these areas, healthcare providers can ensure that the advantages of digital health technologies are fully leveraged to meet the evolving needs of all patient populations. This approach will not only enhance healthcare delivery but also contribute to more equitable health outcomes across different sectors of the healthcare system.

Study Limitations

Despite valuable insights, the study acknowledges limitations such as a small sample size, lack of pilot testing, potential interviewer bias, and reliance on self-reported data. Further research with larger, diverse samples and validated tools is needed to enhance the findings' robustness.

Conclusion

The study reveals the transformative potential of cloud-based telemedicine in rural healthcare, showing varied adoption across public, private, and faith-based facilities. Public facilities demonstrate cautious acceptance, while private and faith-based organizations show stronger endorsement, highlighting cloud technology's ability to bridge geographical gaps and enhance healthcare accessibility. The findings emphasize the need for targeted financial incentives, robust infrastructure development, and comprehensive training programs to enable wider telemedicine adoption and integration.

Policy implications stress the necessity for supportive regulations and legal frameworks to facilitate cloud-based telemedicine adoption. The study suggests enhancing expertise through ongoing training, establishing robust data protection laws, and crafting multifaceted supportive regulations. These measures aim to address supply and demand-side barriers, fostering a conducive environment for digital healthcare technologies.

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Author Contributions

FAK and SS prepared the original manuscript, FAK made a data curation, performed analyses, and interpreted results. All authors reviewed and approved the manuscript.

Ethics Approval and Consent to Participate

a) The study was performed in line with the principles of the Declaration of Helsinki. Ethical approval for this study was granted by the Mvomero District Council, with reference to MVDC/L.10/1VOL.1/149.

b) Authors declare that all methods were carried out in accordance with relevant guidelines and regulations.

c) Authors declare that a written informed consent was obtained from all participants.

Consent for Publication

Not applicable.

Data Availability

Data and material used will be available upon reasonable request from the corresponding author.

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Supplemental Material

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