ORIGINAL RESEARCH

A Descriptive Assessment of Healthcare Workers' Preparedness for Digital Health Systems in Malawi

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Abstract

Introduction

Although Malawi has expanded various digital health initiatives under its National Digital Health Strategy, there is still limited research on how prepared frontline healthcare workers really are to adopt and use Digital Health Systems (DHS). Most previous studies have focused on system level improvements in data reporting rather than on the experiences and preparedness of the users themselves. This is a major gap as healthcare workers' level of preparedness directly influences system performance, and data quality. This study assessed healthcare workers' preparedness to adopt DHS in Malawi.

Methods

A cross-sectional study was conducted using a structured questionnaire administered to 615 healthcare workers in selected districts across the three regions of Malawi. Key TAM constructs were analysed using descriptive statistics and binary logistic regression.

Results

Overall preparedness levels among healthcare workers for DHS adoption were high. Behavioural intention (94.3%), job relevance (94.1%), and subjective norms (92.1%) recorded the highest scores. Significant predictors of adoption were behavioural intention (OR = 2.67, $p < 0.001$), job relevance (OR = 2.12, $p < 0.001$), perceived usefulness (OR = 1.85, $p = 0.002$), and subjective norms (OR = 1.58, $p = 0.014$). Majority of respondents from the Southern region reported having attended DHS training compared to those from the Northern region (OR = 2.337, 95% CI:1.549-3.097, $p < 0.001$), while no significant difference was observed for the Central region ($p = 0.330$). A higher proportion of male respondents reported having previously attended digital health training compared to female respondents (OR = 1.496, $p = 0.019$).

Conclusion

Motivational and social factors are the main predictors of DHS adoption in Malawi, while technical capacity remains a challenge. To ensure successful implementation and scale-up of digital health initiatives in Malawi, policymakers and health managers should focus on strengthening and improving user training, improving access to computers and reliable internet within health facilities, and promoting a supportive organisational culture.

Keywords: Digital health systems, Technology Acceptance Model, Healthcare workers' preparedness, Technology adoption.

Introduction

The rapid growth of digital health technologies is changing how healthcare is delivered around the world. These technologies are helping to make services more efficient, improve data quality, and achieve better patient outcomes. Digital health systems such as electronic health records, mobile health applications, and integrated health information platforms are now seen as vital for strengthening health systems, especially in low and middle income countries[1]. As countries increasingly adopt digital health systems (DHS) which is defined as the deliberate decision to fully utilize digital health innovations to improve healthcare delivery and service efficiency, the preparedness of healthcare workers and health institutions has become critically important[2]. Worldwide, 129 countries have developed national digital health strategies, showing the growing importance of digital transformation in healthcare settings in order to achieve universal health coverage[2,3].

In sub-Saharan Africa, countries are adopting digital health solutions more quickly to address long standing problems such as healthcare workers' shortages, fragmented data systems, poor data quality and heavy disease burdens[4-6]. Malawi's health system faces serious constraints which include shortage of healthcare workers. Physician density is very low, at roughly 0.02 to 0.2 per 1,000 population. While the combined density of doctors, nurses, and midwives stands at 1.55 per 1,000 population[7,8]. These numbers are far below the World Health Organization's recommended minimum of 4.45 health workers per 1,000 population needed for adequate service coverage[8,9]. In addition, many rural health facilities continue to struggle with large numbers of paper based reporting and limited internet connectivity. Despite these challenges, Malawi is slowly integrating and leveraging digital health systems as a strategic approach to improve service delivery and address health workforce shortages.

In Malawi, the Ministry of Health has made significant progress by rolling out the District Health Information Software 2 (DHIS2) nationwide for routine health reporting.

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DHIS2 now serves as the main national health information system and has high reporting completeness, often above 90 percent, for major programmes including malaria, HIV/AIDS, and maternal and child health[5,6]. Nevertheless, important differences remain across districts in how the system is actually used, how complete the data is, and the overall quality of reporting[5].

The preparedness of healthcare workers is widely recognized as a critical determinant of the successful implementation and sustained use of digital health initiative. Preparedness refers to the degree to which individuals are psychologically, behaviourally, and technically ready to effectively engage with digital health systems, informed by their knowledge, skills, confidence, and access to necessary resources[1,4,5]. Preparedness includes digital literacy, technical skills, reliable infrastructure, positive attitudes toward technology, and strong organisational support. Research from low and middle income countries consistently shows that insufficient training and low digital skills are among the biggest barriers to effective use of digital health sytems[2,10]. Many health workers also face infrastructure problems, heavy workloads, and lack confidence when working with electronic systems[10].

Although Malawi has expanded various digital health initiatives under its national digital health strategy 2020 to 2025, there is still limited research on how prepared frontline healthcare workers really are to adopt and use these systems[11]. Most previous studies have focused on system level improvements in data reporting rather than on the experiences and preparedness of the users themselves. This is a major gap as healthcare workers form the crucial link between digital systems and patient care, meaning their level of preparedness directly influences system performance, data quality, and ultimately health outcomes.

Understanding healthcare workers' preparedness is therefore essential for developing more effective digital health strategies. Identifying gaps in skills, infrastructure, and support will help design practical interventions such as targeted training, regular supervision, and better infrastructure investment. Such evidence is also vital to ensure that national digital health policies are grounded in the daily realities faced by health workers at the frontline. This study offers a descriptive assessment of healthcare workers' preparedness for digital health system adoption in Malawi. Specifically, the study assessed healthcare workers' digital literacy, technical competence and skills, and access to enabling infrastructure. Identify the main barriers and facilitators influencing adoption, including attitudes towards digital health systems, training, and institutional support. The study aimed to contribute to the growing body of evidence on digital health implementation in resource limited settings and provides useful insights to guide policy, capacity building, and the successful scale up of digital health systems in Malawi.

Method and Materials

Study design, and Study setting

This study employed a cross-sectional quantitative research design and was conducted across Malawi's three administrative regions: Northern, Central, and Southern regions. To ensure national representation, data were collected from selected districts within each region. In the Northern region, the study included Karonga, Rumphi, and Mzimba districts. In the Central region, data were collected from Lilongwe, Dedza, and Ntcheu districts. In the Southern region, the study covered Mangochi, Machinga, Zomba, Chiradzulu, and Blantyre districts.

These districts were purposively selected to provide geographical and regional representation, allowing the study to capture variations in preparedness among healthcare workers to adopt digital health systems across different parts of the country. Representatives were included from each region to ensure balanced coverage and comparability of results. Figure 1 present geographic distribution of the district.

Study population and sampling

The study targeted healthcare workers. A stratified sample of 615 healthcare workers was drawn from the three main regions of Malawi. The sample comprised of 180 healthcare workers from the Northern region, 180 healthcare workers from the Central region, and 255 healthcare workers from the Southern region.

Study period

Data was collected from April to September 2025.

Variables and Measurement

Data were collected using a structured questionnaire designed based on the Technology Acceptance Model (TAM)[12,13]. The questionnaire captured information on key constructs of TAM, including perceived usefulness, perceived ease of use, behavioural intention, job relevance, computer anxiety, subjective norms, and computer use. Demographic characteristics and contextual variables were included as controls.

Data collection

Data were collected using a structured questionnaire administered using the Kobo Toolbox platform. Responses were measured using a Likert scale, allowing respondents to indicate their level of agreement with a series of statements14. Data collection was conducted across selected districts in the Northern Region, Central Region, and Southern Region of Malawi, ensuring geographical representation. Only respondents relevant to the use or implementation of the digital health system were included in the study.

Ethical Considerations

Participation in the study was strictly voluntary, and informed consent was obtained from all participants prior to participation in the study. Ethical approval for the study was obtained from the Malawi University of Science and Technology Research and Ethics Committee (MUSTREC) with ethical reference number P.04/2025/352

Data Analysis

The analysis was conducted in two stages, combining descriptive statistics and inferential modelling to assess healthcare workers' preparedness and the determinants of Digital Health System (DHS) adoption.

Descriptive Analysis

Descriptive statistics were used to summarise responses across all constructs. Likert-scale data were analysed using three complementary measures: (i) intensity of agreement, (ii) preparedness proportions, and (iii) composite readiness indices. This approach is consistent with established applications of the Technology Acceptance Model (TAM) in health and digital health systems research[12,13].

Table 1: variables and descriptions

Variable	Description
Perceived Usefulness	DHS improve my job performance
	DHS improve my Productivity
	DHS enhance my Effectiveness
	DHS are useful to my work
Perceived Ease of Use	DHS are easy to use
	DHS are easy to understand
	DHS are easy to control
	DHS require low mental effort
	I will work with DHS effectively
Behavioural Intention/Intention to use	Planning to use DHS
	Expect to use DHS
Job Relevance	DHS are important in my job
	DHS are relevant in my job
Subjective Norms	My colleague will support DHS
	My colleague will acceptance DHS
Computer Anxiety	Using computer feels uncomfortabl
	Using computer feels uneasy
	Computers makes me nervous
	Computers do not scare Me
Computer Use	Used computer before
	Access to computer at work
	Access to computer at home
Training	DHS training received

Table 2: Preparedness Across Core Technology Acceptance Constructs

Construct	Indicator	Strongly Agree (%)	Higher Preparedness (%)	p-value
Perceived Usefulness	Job Performance	73.5	88.9	<0.001
	Productivity	69.8	90.6	<0.001
	Effectiveness	67.2	89.8	<0.001
	Usefulness	72.7	91.5	<0.001
Perceived Ease of Use	Easy to Use	59.8	88.4	<0.001
	Easy to Understand	58.4	88.6	<0.001
	Easy to Control	56.4	86.2	<0.001
	Low Mental Effort	43.7	75.0	<0.001
	Effective Use	76.8	95.4	<0.001
	Easy Task	70.7	92.8	<0.001
	Work Easily	73.0	93.3	<0.001
Behavioural Intention	Plan to Use	80.8	94.5	<0.001
	Expect to Use	81.3	94.0	<0.001
Job Relevance	Important in Job	82.8	95.1	<0.001
	Relevant in Job	76.1	93.0	<0.001

(i) Intensity of Agreement

The proportion of respondents who selected "*strongly agree*" for each indicator was computed as:

$$\text{Strongly Agree (\%)} = \frac{n_{SA}}{N} \times 100$$

where n_SA is the number of respondents selecting strongly agree, and N is the total number of respondents. This measure captures the intensity of user perceptions[14].

(ii) Preparedness Proportion

Responses were recoded into binary indicators, where "agree" and "strongly agree" were classified as higher preparedness (1), and all other responses as lower preparedness (0). For negatively worded variables (e.g., computer anxiety), reverse coding was applied[15].

Preparedness was then computed as:

$$\text{Preparedness (\%)} = \frac{\sum_{i=1}^{N} P_i}{N} \times 100$$

where P_i=1 if respondent i is classified as prepared, and 0otherwise.

(iii) Construct-Level Readiness Index

To obtain overall readiness for each construct, an aggregate index was computed as the mean of preparedness scores across all indicators within that construct:

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Table 3: Social, Psychological, and Technical Preparedness Factors

Construct	Indicator	Key Response (%)	Higher preparedness (%)	p-value
Subjective Norms	Colleague Support	64.2 (Strongly Agree)	92.2	<0.001
	Colleague Acceptance	65.9 (Strongly Agree)	91.9	<0.001
Computer Anxiety	Feel Uncomfortable	67.6 (Strongly Disagree)	86.5	<0.001
	Feel Uneasy	65.2 (Strongly Disagree)	86.3	<0.001
	Feel Nervous	69.9 (Strongly Disagree)	83.7	<0.001
	Do Not Scare Me	69.8 (Strongly Agree)	82.1	<0.001
Computer Use	Used Computer Before	95.4 (Yes)	95.4	<0.001
	Computer at Work	57.2 (Yes)	57.2	<0.001
	Computer at Home	73.7 (Yes)	73.7	<0.001
	Training Received	38.2 (Yes)	38.2	<0.001

Construct	Readiness (%)	Rank
Behavioural Intention	94.3	1
Job Relevance	94.1	2
Subjective Norms	92.1	3
Perceived Usefulness	90.2	4
Ease of Use	88.5	5
Computer Anxiety	84.7	6
Computer Use	75.4	7

Variable	Odds Ratio (OR)	95% CI	p-value
Perceived Usefulness	1.85	1.25 – 2.74	0.002
Ease of Use	1.41	0.98 – 2.03	0.063
Behavioural Intention	2.67	1.75 – 4.05	<0.001
Job Relevance	2.12	1.45 – 3.11	<0.001
Computer Anxiety	0.74	0.52 – 1.06	0.098
Subjective Norms	1.58	1.10 – 2.27	0.014
Computer Use	1.29	0.91 – 1.83	0.152

$$\text{Readiness}_k = \frac{1}{J_k}\sum_{i=1}^{J_k} \text{Preparedness}_{jk}$$

where k denotes the construct (e.g., perceived usefulness) and J_k is the number of indicators under construct k. This aggregation approach is consistent with composite index construction in behavioural and health systems research[16].

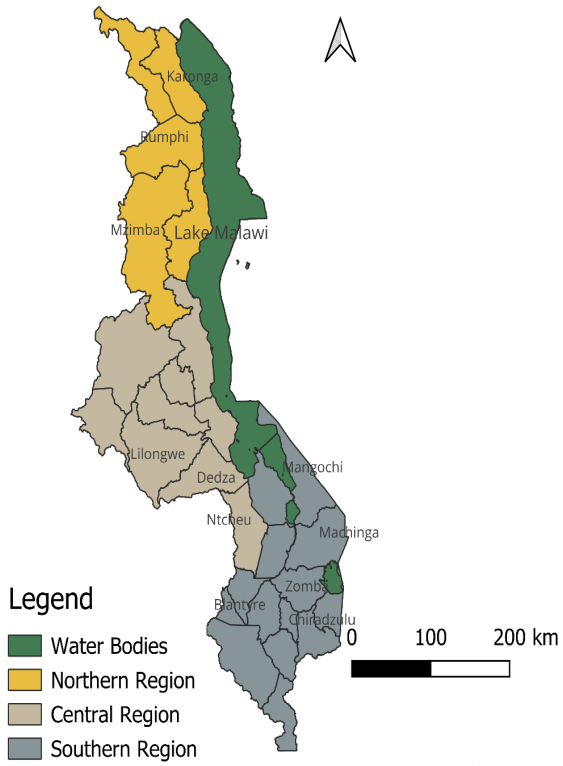

Figure 1: Study area showing selected districts for data collection across the Northern, Central, and Southern Regions of Malawi

(iv) Ranking of Constructs

Constructs were ranked based on their readiness scores in descending order, allowing comparison of the relative strength of each construct.

(v) Statistical Significance of Descriptive Measures

Differences in response distributions were assessed using hypothesis testing, with statistical significance evaluated at $p<0.05$ for all test[17].

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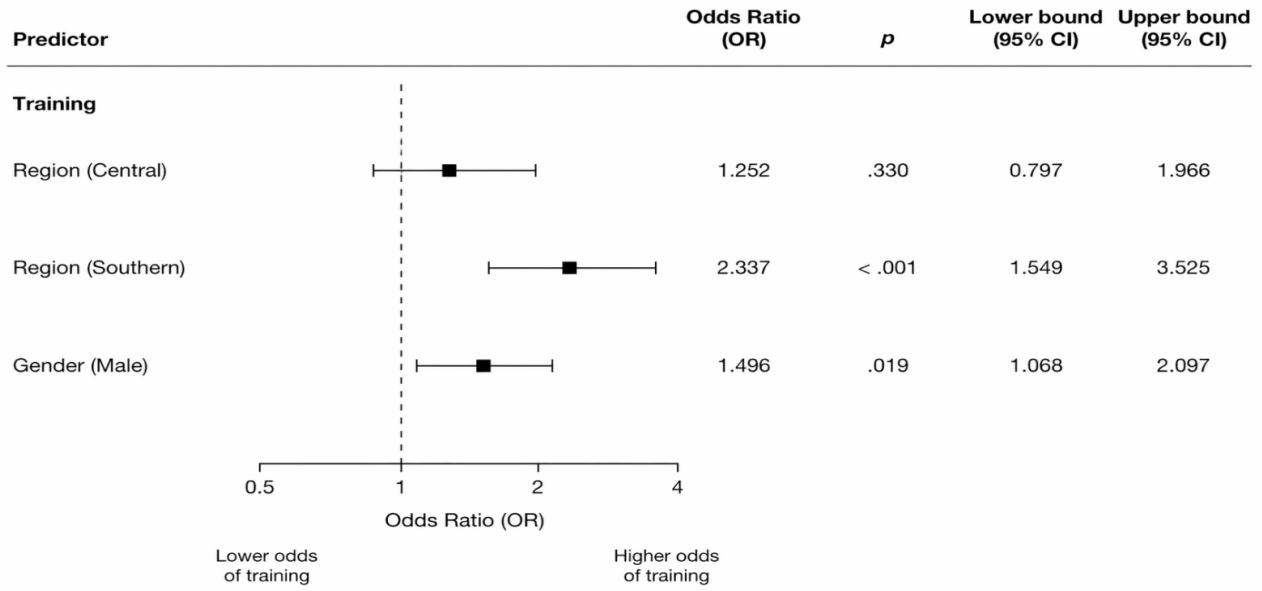

Figure 2: Forest plot, DHS training across gender and regional differences: Squares represent odds ratios (OR) and horizontal lines indicate 95% confidence interval (CI). The dashed vertical at OR=1 indicate no association

Inferential Analysis

To analyse the determinants of DHS adoption, a binary logistic regression model was employed. The dependent variable was DHS adoption, measured as a binary outcome (1 = adopted, 0 = not adopted).

The empirical model is specified as:

$$\text{Adoption}_i = \beta_0 + \beta_1 \text{PU}_i + \beta_2 \text{PEU}_i + \beta_3 \text{BI}_i + \beta_4 \text{JR}_i + \beta_5 \text{CA}_i + \beta_6 \text{SN}_i + \beta_7 \text{CU}_i + \varepsilon_i$$

Binary logistic regression is appropriate for modelling dichotomous outcomes and estimating the probability of adoption as a function of explanatory variables18. Results were reported as odds ratios (ORs) with 95% confidence intervals (CI). Statistical significance was evaluated at the 5% level ($p<0.05$).

Subgroup Analysis

An additional logistic regression analysis was conducted to assess differences in DHS training across gender and regional groups. Odds ratios were used to compare the likelihood of training exposure, and overall model significance was evaluated using the Chi-square ($\Delta\chi$^2) statistic[18].

Results

Core TAM Constructs

The results in table 2 show that overall perceived usefulness of digital health systems was very high, with over 88% of respondents demonstrating high levels of healthcare workers' preparedness across all indicators. Specifically, most respondents "strongly agreed" that digital health systems improve job performance (73.5%), improve productivity (69.8%), effectiveness (67.2%), and overall usefulness (72.7%), all of which were statistically significant ($p < 0.001$). This suggests that users clearly recognise the practical benefits of DHS in enhancing work outcomes.

Similarly, perceived ease of use was also associated with high levels of preparedness among the participants, with healthcare workers' preparedness levels ranging from 75.0% to 95.4%. Although a relatively lower proportion strongly agreed that the system requires low mental effort (43.7%), overall responses still indicated that most users find the system easy to use, understand, and control. These results highlight that usability is not a major barrier to adoption.

Behavioural intention to use digital health system was the strongest construct, with over 94% of participants intent to use DHS. A large majority of respondents reported that they plan to use DHS (80.8%) and expect to use DHS (81.3%), indicating a strong likelihood of actual adoption.

In addition, job relevance was highly rated, with more than 93% overall participants indicating that DHS is relevant in their job. Most respondents strongly agreed that DHS is important (82.8%) and relevant (76.1%) to their job roles, suggesting strong alignment between DHS functionality and work responsibilities.

3.2 Enabling and Contextual Factors

The findings summarized in the table 3 further show that subjective norms are positively associated with healthcare workers' preparedness, with over 91% of respondents indicating strong support and DHS acceptance from colleagues. This suggests that social influence plays an important role in encouraging system adoption.

Regarding computer anxiety, most respondents reported low levels of anxiety, as most strongly disagreed with feeling uncomfortable (67.6%), uneasy (65.2%), or nervous (69.9%) when using computers. This indicates that psychological barriers to adoption are minimal.

For computer use and experience, almost all respondents (95.4%) had prior experience using computers. However, access to computers at work (57.2%) and formal training (38.2%) remain relatively limited, suggesting potential gaps in institutional support despite high individual preparedness.

The overall readiness analysis in the table 4 below shows that behavioral intention (94.3%) ranks highest, followed by job relevance (94.1%) and subjective norms (92.1%). Perceived usefulness (90.2%) and ease of use (88.5%) also demonstrate strong readiness, while computer anxiety (84.7%) and computer use (75.4%) rank lower. This indicates that motivational and social factors are stronger predictors of readiness than technical or infrastructural factors.

3.3 Determinants of DHS Adoption (Logistic Regression)

The logistic regression results identify key predictors of

DHS adoption. Behavioural intention (OR = 2.67, p < 0.001) and job relevance (OR = 2.12, p < 0.001) are the strongest significant predictors, indicating that individuals who intend to use the system and perceive it as relevant to their work are more than twice as likely to adopt it.

Perceived usefulness was also a significant predictor (OR = 1.85, p = 0.002), suggesting that recognising the benefits of the system increases the likelihood of adoption. Additionally, subjective norms (OR = 1.58, p = 0.014) significantly influence adoption, highlighting the importance of peer support and organisational culture.

In contrast, ease of use (p = 0.063), computer anxiety (p = 0.098), and computer use (p = 0.152) were not statistically significant predictors, although their effects were in the expected direction. This suggests that while these factors may contribute to adoption, they are less influential compared to motivational and social factors.

DHS training across gender and region

Logistic regression analysis on digital health system training comparison across gender and region showed that region and gender, were significantly associated with healthcare workers' intention to use digital health. More participants from the Southern region reported having attended DHS training compared to those from the Northern region (OR = 2.337, 95% CI:1.549-3.097, p < 0.001), while no significant difference was observed for the Central region (p = 0.330). More males reported having ever attended digital health training compared to females (OR = 1.496, p = 0.019). The overall model was statistically significant ($\Delta\chi^2 = 29.18$, p < 0.001).

Discussion

The rapid growth of digital health technologies is changing how healthcare is delivered around the world. In healthcare settings, the success of digital health systems implementation depends on the preparedness of healthcare workers and institutions. In this study, preparedness was evaluated by looking at factors such as healthcare workers' knowledge, training, individual attitude, behavior intention, and ICT infrastructure that are necessary to facilitate the adoption and sustainability[2]. The findings show a generally high level of preparedness among healthcare workers. Behavioural intention, job relevance, and subjective norms emerged as the strongest predictors. This suggests that health workers are not only willing to use the system but also see it as relevant to their daily work and supported by their colleagues and organisation.

Behavioural intention stood out as the highest-ranked and the strongest predictor of adoption in the regression analysis. This result aligns with core TAM theory, which identifies behavioural intention as the most immediate predictor of actual technology use[12,13]. Healthcare workers who clearly expressed their intention to use the system were significantly more likely to adopt it. Strengthening users' commitment and motivation could therefore play a major role in improving DHS adoption.

Job relevance also proved to be an important predictor of preparedness. Respondents who felt the system was useful for their specific job tasks showed higher likelihood of adoption. This finding highlights that technology adoption depends not only on the features of the system itself but also on how well it fits into the everyday responsibilities of healthcare workers[19]. When a system is seen as directly supporting routine work, acceptance tends to be higher.

Perceived usefulness was significant predictor of healthcare workers' preparedness to adoption DHS. Participants who believed the system would improve their productivity and performance were more willing to use it. This result is consistent with the central assumption of TAM that perceived benefits drive technology acceptance[12,13]. In contrast, perceived ease of use, although positively related, was not a statistically significant predictor. This suggests that in this setting, health workers place greater importance on the system's usefulness than on how easy it is to operate, particularly when performance gains matter more in their daily practice. This is similar to results from a comprehensive review of ICT acceptance theories in social and healthcare contexts, which found that perceived ease of use frequently contributes to technology adoption by shaping perceptions of usefulness and trust rather than directly determining behavioral intentions[20].

Subjective norms also had a significant association to intention to adopt DHS. This indicates that social and organisational factors matter. When colleagues and supervisors support and encourage the use of the system, health workers are more likely to adopt it. Several studies in sub-Saharan Africa have similarly found that peer influence and organisational culture play a key role in the acceptance of digital health tools[21,22].

Although computer anxiety and previous computer use were not statistically significant predictors, their patterns followed expected directions. Lower anxiety and more computer experience were linked to higher preparedness. However, the descriptive findings revealed that computer use had the lowest readiness score among all dimensions. This points to ongoing gaps in access to computers, reliable internet, and adequate training. Even when motivation is high, structural limitations can still hinder full utilisation of the system[2,20].

The study results show that training was not significant in influencing healthcare workers' intention to adopt digital health system. Descriptive results show that more than half of the participants had no prior training about DHS. These findings indicate inadequate institutional efforts toward strengthening preparedness and enhancing the implementation of digital health systems. These results are consistent with results from a study done by Nyamtema, A. S. (2010)[23], on bridging the gaps in the health management information system in the context of a changing health sector, in which 81% of healthcare workers had no training on health management and information system being implemented in their health facility, which resulted in poor implementation, poor health data collection, and lack of informed decision-making at the facility level[23]. The lack of digital health system training within health facilities reflects institutional unpreparedness for the adoption and effective implementation of digital health systems.

Regional differences and gender also appeared to influence the differences in preparedness in this study. Participants from the Southern region, where pilot digital health systems projects are more established including DHIS2 and Prevention Adaptive Learning and Management System (PALMS), indicated higher levels of preparedness than those from the Northern region. The majority of participants from the Southern Region reported having previously attended digital health system training[22]. The study also identified gender variation in DHS training participation, whereby a greater proportion of male healthcare workers

reported having attended DHS training programmes, indicating comparatively higher levels of preparedness among males than females. These findings align with similar evidence from low- and middle-income countries, which reported that institutional exposure and infrastructure availability significantly enhance adoption levels in regions with prior digital health interventions[24,25]. Another study similarly reported that disparities in connectivity and policy implementation often lead to uneven preparedness across geographical areas[23].

Overall, while healthcare workers demonstrate higher levels of preparedness and positive attitudes toward the system, addressing technical capacity through continuous training, better access to equipment, and ongoing user support will remain essential for successful and sustained implementation.

Conclusion

This study assessed healthcare workers' preparedness for the adoption of the digital health systems in Malawi using Technology Acceptance Model. The findings demonstrate a generally high level of preparedness, with behavioural intention, job relevance, perceived usefulness, and subjective norms emerging as the strongest predictors of adoption. These results highlight that healthcare workers in Malawi are motivated and willing to use digital health systems, particularly when they perceive them as relevant to their daily tasks and supported by their colleagues and organisation. However, gaps in computer use, training, regional variations and access to enabling infrastructure remain important challenges that need attention.

The study confirms that motivational and social factors play a more significant role than technical factors in driving DHS adoption in Malawi. To ensure successful implementation and scale-up of digital health initiatives in Malawi, policymakers and health managers should focus on strengthening user training, improving access to computers and reliable internet, and fostering a supportive organisational culture. By addressing these areas, Malawi can better harness the potential of digital health technologies to improve data quality, enhance decision-making, and ultimately strengthen the delivery of healthcare services across the country.

Limitation of the study

The study measured behavioural intention rather than actual system use, and important contextual factors such as unreliable electricity and internet connectivity were not deeply explored. Despite these limitations, the findings provide valuable insights into healthcare workers' preparedness for digital health system adoption in Malawi.

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Ethical approval and consent to participate

Ethical approval for the study was obtained from the Malawi University of Science and Technology Research Ethics Committee (MUSTREC) with ethical reference number P.04/2025/352.

Conflicts of Interest

The authors declare no conflict of interest.

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