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Determinants of effective electronic health record utilization in hospital settings: Evidence from Uganda

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Abstract

The implementation of Electronic Health Record (EHR) systems has expanded across healthcare institutions in low- and middle-income countries; however, effective utilization remains inconsistent, particularly in resource-constrained healthcare settings. This study examined determinants influencing effective EHR utilization among healthcare professionals in selected hospitals within the Greater Bushenyi region of Uganda. Guided by the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Digital Competence Framework, and Socio-Technical Systems Theory, the study employed a cross-sectional explanatory survey design. Data were collected from 228 healthcare professionals using a structured questionnaire, representing a response rate of 91.2%. Data were analyzed using descriptive statistics, Pearson correlation, and multiple regression techniques. The findings revealed that effective EHR utilization is significantly influenced by human, organizational, technical, and system-level factors. Organizational factors emerged as the strongest predictor of effective EHR utilization ($\beta = 0.378$, $p < 0.001$), followed by system factors ($\beta = 0.298$, $p < 0.001$), technical factors ($\beta = 0.189$, $p = 0.022$), and human factors ($\beta = 0.175$, $p = 0.014$). Correlation analysis further indicated significant positive relationships between all determinants and effective EHR utilization ($r = 0.410–0.527$, $p < 0.01$). The regression model explained 44.0% of the variance in effective EHR utilization ($R^2 = 0.440$). The study concludes that effective EHR utilization extends beyond system adoption and depends on the alignment of digital competence, organizational readiness, technical usability, and infrastructural reliability. The findings provide evidence-based guidance for healthcare administrators and policymakers seeking to strengthen sustainable EHR utilization and improve healthcare service delivery in resource-constrained settings.

1.0 Introduction

The digital transformation of healthcare represents one of the most significant structural changes in contemporary health systems. Over the past two decades, digital health technologies have fundamentally reshaped how patient information is generated, stored, shared, and utilized for clinical and administrative decision-making. Globally, digital health is increasingly recognized not only as a technological advancement but also as a strategic mechanism for improving healthcare efficiency, patient safety, service coordination, and equity (Mauro et al., 2024; Stoumpos et al., 2023)The World Health Organization further emphasizes that digital health systems are essential for strengthening data-driven governance and advancing universal health coverage goals(Welfare, 2022).

At the center of digital health infrastructure is the Electronic Health Record (EHR), which serves as a comprehensive digital repository of patient information. EHR systems support a wide range of healthcare functions, including clinical documentation, medication management, laboratory reporting, inter-professional communication, and health analytics (Butler et al., 2020). Existing empirical evidence demonstrates that effective EHR use can improve documentation accuracy, reduce medical errors, strengthen care coordination, and enhance operational efficiency within healthcare organizations (Melkas et al., 2020).

However, increasing attention has been directed toward the distinction between EHR adoption and effective EHR utilization. While adoption refers primarily to the implementation or availability of an EHR system, utilization reflects the extent to which healthcare professionals meaningfully integrate digital systems into routine clinical workflows (Woldemariam & Jimma, 2023). This distinction is important because the availability of digital systems does not necessarily translate into sustained operational use or improved healthcare performance.

Existing studies consistently demonstrate that underutilization, partial engagement with system functionalities, and continued reliance on parallel paper-based processes often persist even after EHR implementation(Borges do Nascimento et al., 2023; Milenkovic et al., 2020). These findings suggest that successful digital transformation in healthcare is inherently socio-technical and depends on coordinated alignment between workforce capability, organizational readiness, system usability, and infrastructural reliability.

In low- and middle-income countries (LMICs), digital health initiatives have expanded rapidly through government reforms, donor-supported programs, and national digital health strategies. In Uganda, national efforts have promoted the implementation of digital platforms such as the District Health Information Software 2 (DHIS2) to strengthen health reporting, surveillance, and healthcare management(Wamema et al., 2025). At the hospital level, EHR systems have increasingly been introduced to support clinical documentation, laboratory services, pharmacy management, and administrative processes.

Despite these developments, effective EHR utilization within Ugandan healthcare settings remains inconsistent. Healthcare professionals continue to report challenges related to system downtime, limited interoperability, insufficient training, workflow disruption, and infrastructural instability (Mwogosi, 2025). Furthermore, hybrid documentation environments, where digital and paper-based systems coexist, remain common in many hospital settings, potentially reducing the efficiency gains expected from digital health investments.

Although existing research in Uganda has examined eHealth adoption and implementation barriers, relatively limited attention has been directed toward understanding determinants of effective EHR utilization within routine clinical practice. Much of the existing literature conceptualizes system use as a binary outcome based on adoption or non-adoption, without adequately examining the depth, consistency, and quality of utilization required for meaningful healthcare performance improvement (Cadena et al., 2019).

Similarly, studies on digital competence have predominantly focused on educational or non-clinical contexts, with limited evidence explaining how healthcare professionals' digital capabilities influence sustained EHR utilization in operational hospital environments(Longhini et al., 2024; Mikkonen et al., 2026). Consequently, there remains insufficient understanding of how human capability, organizational support, technical usability, and infrastructural conditions interact to shape effective EHR utilization within resource-constrained healthcare systems.

This study addresses these gaps by examining determinants of effective EHR utilization among healthcare professionals in hospital settings within the Greater Bushenyi region of Uganda. Unlike prior studies that focus primarily on adoption and implementation, this research conceptualizes EHR utilization as a multidimensional construct involving consistency of use, workflow integration, functional engagement, and sustained reliance on digital systems within routine healthcare delivery.

By adopting a socio-technical and digital competence perspective, the study contributes to the growing body of digital health research emphasizing utilization effectiveness rather than system adoption alone. The findings provide context-specific empirical evidence relevant to healthcare administrators, policymakers, and digital health planners seeking to strengthen sustainable EHR utilization and improve digital transformation outcomes in low-resource healthcare environments.

2.0 Literature Review

2.1 Theoretical Framework

Understanding effective utilization of EHR systems requires a theoretical perspective that accounts for both individual capability and broader organizational and technological interactions. Increasingly, EHR implementation is recognized not merely as a technological intervention but as a complex socio-technical transformation within healthcare environments (Fennelly et al., 2020; Taneja et al., 2025). Existing digital health literature consistently demonstrates that successful EHR utilization depends on the interaction between healthcare professionals, institutional processes, technological systems, and infrastructural conditions. Consequently, this study is grounded in complementary information systems and socio-technical perspectives that collectively explain determinants of effective EHR utilization in hospital settings.

2.1.1 Technology Adoption and Information Systems Perspectives

Research on EHR utilization has frequently been informed by established information systems and technology adoption theories, particularly the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Information Systems Success Model(Heinsch et al., 2021; Lee et al., 2025). Collectively, these frameworks explain how users perceive, adopt, and engage with information systems within organizational environments.

The Technology Acceptance Model identifies perceived usefulness and perceived ease of use as central determinants of technology acceptance and utilization. Across healthcare environments, studies consistently demonstrate that healthcare professionals are more likely to engage with EHR systems when systems are perceived as user-friendly, efficient, and supportive of clinical workflows. Similarly, UTAUT emphasizes performance expectancy, effort expectancy, social influence, and facilitating conditions as key determinants of technology use behavior(Al-Momani & Ramayah, 2025). In hospital environments, facilitating conditions such as training, organizational readiness, and technical support have repeatedly been identified as critical predictors of sustained EHR engagement.

The Information Systems Success Model further extends understanding of system utilization through dimensions such as system quality, information quality, and service quality. Existing evidence suggests that reliability, accessibility, interoperability, and information accuracy significantly influence healthcare professionals' trust in digital systems and their willingness to integrate EHR platforms into routine clinical workflows(Gedikci Ondogan et al., 2023).

Although these theories provide important explanations for technology acceptance and initial system adoption, much of the existing literature remains focused on behavioral intention and system uptake rather than effective utilization within operational healthcare environments. Consequently, adoption-oriented models alone may not sufficiently explain the depth of use, workflow integration, and sustained engagement required for meaningful EHR utilization in complex hospital settings.

This study therefore integrates the Digital Competence Framework and Socio-Technical Systems Theory to extend beyond adoption-focused perspectives and provide a broader understanding of effective EHR utilization within clinical practice.

2.1.2 Digital Competence Framework

Digital competence refers to the knowledge, skills, attitudes, and confidence required to effectively use digital technologies in professional environments. Within healthcare contexts, digital competence extends beyond basic computer literacy to include the ability to navigate clinical information systems, manage electronic documentation, interpret system alerts, maintain data security, and adapt to evolving digital workflows (Longhini et al., 2024).

Existing literature consistently identifies digital competence as a major determinant of healthcare technology utilization. Studies conducted across diverse healthcare settings demonstrate that healthcare professionals with stronger digital capabilities are more likely to engage effectively with EHR systems, utilize advanced functionalities, and integrate digital processes into routine clinical workflows (Mikkonen et al., 2026). Conversely, inadequate digital competence has been associated with incomplete documentation, delayed system interaction, workflow disruption, and continued reliance on parallel paper-based processes.

However, much of the existing evidence has focused primarily on technology acceptance and digital readiness rather than examining how digital competence contributes to sustained utilization within operational clinical environments. Furthermore, many digital competence studies have been conducted outside low-resource healthcare settings, leaving limited understanding of how digital skills influence effective EHR utilization within resource-constrained hospital environments.

2.1.3 Socio-Technical Systems Theory

While the Digital Competence Framework focuses primarily on individual capability, Socio-Technical Systems Theory emphasizes the interaction between social and technical components within organizational environments. The theory posits that optimal system performance emerges when human elements, organizational processes, and technological systems are

effectively aligned (Melkas et al., 2020). Within healthcare settings, EHR utilization is increasingly understood as a socio-technical process shaped by workforce capability, organizational support structures, system usability, and infrastructural conditions. Existing studies suggest that even highly skilled healthcare professionals may underutilize EHR systems if organizational support is inadequate, workflows are poorly aligned, or system usability is limited (Tutty et al., 2019; Provenzano et al., 2024).

Collectively, socio-technical research demonstrates that successful digital health implementation depends not only on technological functionality but also on institutional readiness, workflow integration, and infrastructural reliability. Misalignment among these domains may contribute to workflow disruption, user resistance, inefficiencies, and reduced utilization effectiveness, particularly in resource-constrained healthcare environments.

2.2 Conceptualization of Effective EHR Utilization

Existing EHR literature increasingly distinguishes between system adoption and effective utilization. While adoption refers primarily to the availability or initial acceptance of an EHR platform, utilization reflects the extent to which healthcare professionals meaningfully integrate digital systems into routine clinical practice (Mwogosi & Kibusi, 2024). Studies conducted across both high-income and low-resource healthcare environments suggest that effective EHR utilization is multidimensional and extends beyond simple system access or occasional use. Effective utilization includes consistency of use during patient encounters, comprehensive electronic documentation, engagement with advanced system functionalities such as clinical decision support and electronic prescribing, and reduced reliance on parallel paper-based systems (Alhassan et al., 2025; Zharima et al., 2024). The literature further suggests that workflow integration represents a critical dimension of utilization effectiveness. Systems that align poorly with clinical workflows may experience low engagement despite successful implementation. Consequently, effective EHR utilization is increasingly viewed as a performance-oriented construct reflecting depth of use, functional engagement, workflow integration, and sustained reliance on digital systems within healthcare delivery processes.

2.3 Human Factors Influencing EHR Utilization

Human factors represent individual-level determinants influencing how healthcare professionals interact with EHR systems. Existing literature consistently identifies digital literacy, operational competence, prior experience, attitudes toward technology, and perceived workload as major predictors of EHR engagement (Mwogosi, 2025). Research across multiple healthcare environments indicates that healthcare workers with stronger digital competence and positive attitudes toward technology are more likely to utilize EHR systems effectively and integrate digital workflows into patient care activities. In contrast, inadequate digital skills, limited confidence, and perceived system complexity have been associated with incomplete documentation, workflow disruption, and resistance to system use (Borges do Nascimento et al., 2023). Although prior studies consistently identify human capability as a major determinant of EHR utilization, many have focused primarily on technology adoption and acceptance rather than examining sustained operational engagement within routine hospital workflows.

2.4 Organizational Factors

Organizational readiness has consistently emerged as a critical determinant of EHR utilization outcomes. Existing studies identify training programs, leadership commitment, ICT support availability, workflow alignment, and institutional policies as important organizational facilitators of digital health implementation(Harerimana et al., 2025). Research conducted across both developed and developing healthcare systems demonstrates that structured training and continuous professional development significantly improve healthcare professionals' confidence, reduce uncertainty, and strengthen long-term system engagement (Kaihlanen et al., 2024; Kulju et al., 2024). Similarly, responsive ICT support systems help minimize technical frustration and operational disruptions, thereby improving sustained utilization. However, studies conducted in low-resource healthcare environments suggest that organizational limitations, including insufficient training opportunities, weak technical support systems, and inadequate workflow integration, continue to constrain effective EHR utilization despite increasing rates of system adoption.

2.5 Technical Factors

Technical factors relate to the usability and functional characteristics of EHR systems, including interface design, ease of navigation, accessibility, and error-handling mechanisms (Tutty et al., 2019). Existing evidence consistently demonstrates that user-friendly systems reduce cognitive workload, improve efficiency, and enhance user satisfaction.

Studies further indicate that poorly designed interfaces, unclear navigation structures, and complex workflows may negatively affect healthcare professionals' engagement with EHR systems, particularly in high-pressure clinical environments characterized by heavy workloads and limited staffing (Milenkovic et al., 2020). Collectively, the literature suggests that technical usability represents a major determinant of healthcare professionals' willingness to integrate EHR systems into routine clinical workflows.

2.6 System-Level Factors

System-level factors refer to broader infrastructural and performance-related characteristics influencing EHR utilization, including system reliability, speed, interoperability, data accuracy, and infrastructural stability (Melkas et al., 2020). Existing studies demonstrate that healthcare professionals are more likely to depend on EHR systems when systems are stable, responsive, and capable of supporting efficient communication across departments. However, research conducted in low-resource healthcare environments consistently identifies infrastructural instability, including unreliable internet connectivity, power interruptions, and system downtime, as persistent barriers to sustained digital health utilization (Ddamba et al., 2025; Wamema et al., 2025). These findings collectively suggest that infrastructural reliability remains a critical requirement for effective and sustainable EHR utilization within hospital settings.

2.7 Empirical Gap

Despite the growing body of literature on EHR adoption and digital health implementation, important empirical and conceptual gaps remain unresolved. Existing studies have predominantly focused on technology acceptance, adoption intention, and implementation barriers rather than examining effective utilization as a multidimensional construct involving workflow integration, functional engagement, consistency of use, and sustained reliance on digital systems within routine clinical practice. Furthermore, while digital competence has been widely studied in educational and non-clinical contexts, limited evidence exists regarding how healthcare professionals' digital capabilities interact with organizational readiness, technical usability, and infrastructural conditions to influence sustained EHR utilization in hospital environments. Research conducted in low- and middle-income countries has similarly emphasized infrastructural and implementation challenges, yet relatively few studies have examined the combined socio-technical determinants shaping effective EHR utilization within resource-constrained hospital settings. In Uganda specifically, existing evidence has largely focused on eHealth adoption and implementation barriers, with limited attention to the depth, quality, and operational integration of EHR use within healthcare workflows. Consequently, there remains insufficient understanding of how human, organizational, technical, and system-level determinants interact to influence effective EHR utilization in clinical environments. This study addresses this gap by conceptualizing EHR utilization as a multidimensional socio-technical outcome and examining the interrelated determinants influencing sustained utilization among healthcare professionals in Ugandan hospital settings.

2.8 Conceptual Framework

Drawing from TAM, UTAUT, Information Systems Success Model, Digital Competence Framework, and Socio-Technical Systems Theory, this study conceptualizes effective EHR utilization as a multidimensional outcome influenced by human, organizational, technical, and system-level factors. Human factors encompass healthcare professionals' digital competence, attitudes, confidence, and motivation to engage with EHR systems. Organizational factors include training, leadership support, ICT assistance, and workflow alignment. Technical factors relate to usability, accessibility, interface design, and ease of navigation, while system-level factors comprise reliability, interoperability, data quality, and infrastructural stability. Collectively, these determinants are expected to influence the extent to which healthcare professionals effectively integrate EHR systems into routine clinical practice. Figure 1 presents the conceptual framework guiding the study.

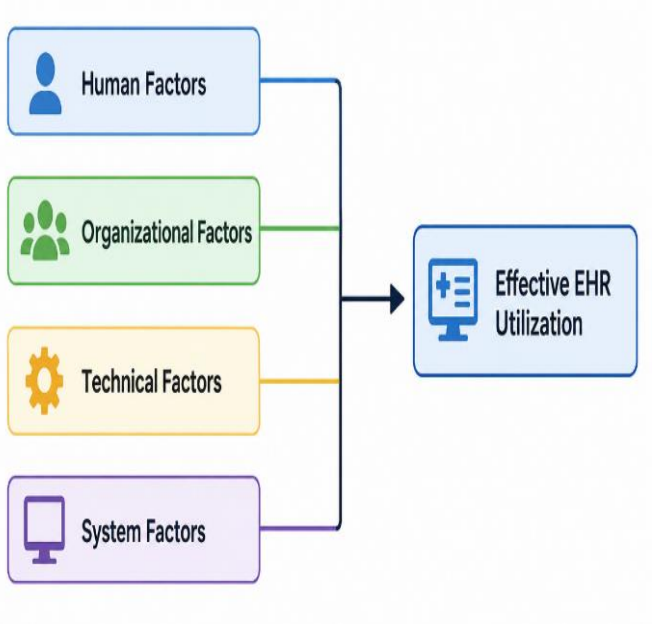

Figure 1. Conceptual Framework for Effective EHR Utilization

Source: Adapted from TAM (Davis, 1989), UTAUT (Venkatesh et al., 2003), Information Systems Success Model (DeLone & McLean, 2003), Digital Competence Framework, and Socio-Technical Systems Theory.

The conceptual framework illustrates the hypothesized relationships among the study variables. Human factors, organizational factors, technical factors, and system-level factors constitute the independent variables, while effective EHR utilization represents the dependent variable. The framework assumes that improvements in these determinants enhance healthcare professionals' ability to integrate EHR systems into routine clinical workflows, thereby improving utilization effectiveness. The framework further reflects the socio-technical perspective that effective EHR utilization is not determined by technology alone but emerges through interaction among users,

organizational processes, technological characteristics, and infrastructural conditions.

3.0 Methodology

3.1 Research Design

This study employed a cross-sectional explanatory survey design to examine determinants influencing effective utilization of EHR systems in hospital settings. Cross-sectional survey designs are widely applied in health informatics research to assess relationships among human, organizational, and technological factors at a specific point in time. The explanatory approach enabled investigation of associations between digital competence, organizational readiness, technical characteristics, system-level factors, and effective EHR utilization. The study was conducted in selected hospitals within the Greater Bushenyi region of Western Uganda, including Kampala International University Teaching Hospital and Ishaka Adventist Hospital. These facilities were purposively selected because they had operational EHR systems integrated into routine clinical workflows, making them appropriate settings for examining actual system utilization practices. Also, the study constructs were derived from established information systems and technology utilization theories, including the TAM, UTAUT, Information Systems Success Model, Digital Competence Framework, and Socio-Technical Systems Theory.

3.2 Study Population and Sampling Technique

The target population comprised healthcare professionals who routinely interacted with EHR systems, including doctors, nurses, clinical officers, laboratory personnel, medical records staff, and ICT personnel. A multi-stage sampling approach was employed. First, hospitals were purposively selected based on the existence of operational EHR systems actively used in patient management, laboratory services, pharmacy operations, and administrative processes. Second, stratified sampling was applied to ensure proportional representation of healthcare professionals across departments and professional categories. This approach enhanced representativeness and minimized sampling bias (Parsons, 2017). Only healthcare professionals with direct interaction with the EHR system and a minimum period of operational experience were included in the study. Administrative staff without direct EHR interaction were excluded from participation. This ensured that responses reflected actual system utilization experiences rather than hypothetical perceptions.

3.3 Sample Size Determination

The sample size was determined using Yamane's formula for finite populations at a 95% confidence level and a margin of error of 5%.

$$n = \frac{N}{1+N(e^2)}$$

Where:

- (n) = required sample size
- (N) = target population size
- (e) = margin of error (0.05)

The calculated sample size ensured adequate representation of healthcare professionals across different departments and professional categories. A total of 250 questionnaires were distributed, of which 228 were successfully returned and analyzed, yielding a response rate of 91.2%.

3.4 Questionnaire Design and Validation

Data were collected using a structured self-administered questionnaire developed from constructs grounded in established information systems and digital health theories, including the Digital Competence Framework, and Socio-Technical Systems Theory. The questionnaire consisted of five sections measuring; human factors, organizational factors, technical factors, system-level factors, and effective EHR utilization. All items were measured using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Likert-scale instruments are widely recognized for their effectiveness in assessing perceptions, attitudes, and behavioral tendencies in healthcare systems research. To ensure content validity, the instrument was reviewed by experts in health informatics, information systems, and research methodology to assess clarity, relevance, and alignment with study objectives. A pilot study was conducted among healthcare professionals outside the main study sample to refine questionnaire wording and improve item consistency. Internal consistency reliability was assessed using Cronbach's alpha, and all constructs exceeded the recommended threshold of 0.70, indicating acceptable reliability. Construct validity was further evaluated using item consistency checks, inter-variable correlations, and collinearity diagnostics to ensure conceptual coherence and independence among predictor variables.

3.5 Operationalization of Effective EHR Utilization

In this study, effective EHR utilization was conceptualized as the extent to which healthcare professionals consistently and meaningfully integrate EHR systems into routine clinical workflows. Unlike basic system adoption, which refers primarily to the availability or occasional use of an EHR platform, effective utilization reflects sustained, functional, and workflow-oriented engagement with the system. Effective utilization was operationalized using multiple dimensions derived from digital health and information systems literature. These dimensions included;

- frequency and consistency of EHR use during routine clinical activities,
- integration of EHR systems into patient care workflows,
- utilization of multiple system functionalities beyond basic data entry,
- reliance on digital records instead of parallel paper-based processes,
- confidence in accessing, retrieving, and managing patient information electronically,
- and perceived contribution of EHR systems to task efficiency and care coordination.

Measurement of effective utilization was based on self-reported responses obtained through a structured questionnaire using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Respondents assessed their level of agreement with statements related to routine system use, workflow integration, usability, efficiency, and functional engagement with EHR systems. Consequently, the utilization construct was measured as a multidimensional composite variable reflecting depth of use, consistency of engagement, workflow integration, and operational dependence on digital systems within hospital environments.

3.6 Data Analysis

Data were analyzed using both descriptive and inferential statistical techniques. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize respondents' demographic characteristics and perceptions regarding human, organizational, technical, system-level, and EHR utilization factors. All study variables were measured using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Inferential statistics were employed to examine relationships among the study variables. Pearson correlation analysis was conducted to assess the strength and direction of associations between human, organizational, technical, and system-level factors and effective EHR utilization. Multiple linear regression analysis was further performed to determine the relative contribution of each determinant to effective EHR utilization and to identify the strongest predictors while controlling for the influence of other variables. Prior to inferential analysis, assumptions of normality, linearity, and multicollinearity were assessed to ensure the suitability of the statistical procedures. Statistical significance was evaluated at the 5% level ($p < 0.05$). This analytical approach is consistent with established empirical studies examining technology utilization and digital health implementation in healthcare settings.

3.7 Ethical Considerations

Ethical approval for the study was obtained from the relevant institutional ethics review body prior to data collection (Ethical approval was obtained from the Kampala International University Research Ethics Committee (KIU-REC), Approval No. KIU-2025-911.). Permission to conduct the study was also obtained from participating hospitals. Participation in the study was voluntary, and informed consent was obtained from all respondents before questionnaire administration. Participants were informed about the purpose of the study, confidentiality of responses, and their right to withdraw from the study at any stage without penalty. And to ensure confidentiality and anonymity, no personally identifiable information was collected, and all responses were used strictly for academic and research purposes.

4.0 Results

4.1 Reliability Analysis

Reliability analysis was conducted using Cronbach's alpha to assess the internal consistency of the measurement scales used in the study. A Cronbach's alpha value of 0.70 or higher is generally considered acceptable for establishing reliability.

Table 1. Reliability Analysis of Study Constructs

Construct	Cronbach's Alpha	Interpretation
Human Factors	0.741	Acceptable Reliability
Organizational Factors	0.737	Acceptable Reliability
Technical Factors	0.729	Acceptable Reliability
System Factors	0.767	Acceptable Reliability

All constructs demonstrated satisfactory internal consistency, with Cronbach's alpha values exceeding the recommended threshold of 0.70. The highest reliability was observed for System Factors ($\alpha = 0.767$), while Technical Factors recorded the lowest reliability coefficient ($\alpha = 0.729$), which remained within the acceptable range. These findings indicate that the items within each construct consistently measured their intended domains and that the instrument was reliable for assessing determinants of effective EHR utilization.

4.2 Operationalization of Variables

Table 2. Operational Definition and Measurement of Study Variables

Variable Category	Variable	Indicators	Measurement Scale
Independent Variable	Human Factors	Digital competence, operational skills, confidence, attitudes toward EHR use	5-point Likert scale
Independent Variable	Organizational Factors	Training, ICT support, leadership support, workflow alignment	5-point Likert scale
Independent Variable	Technical Factors	Ease of use, interface usability, accessibility, navigation clarity	5-point Likert scale
Independent Variable	System-Level Factors	System speed, reliability, interoperability, data accuracy	5-point Likert scale
Dependent Variable	Effective EHR Utilization	Frequency of use, workflow integration, feature utilization, reduced reliance on paper records	5-point Likert scale

All study variables were measured using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

4.3 Descriptive Statistics

Descriptive statistics were computed to examine respondents' perceptions regarding the determinants of effective EHR utilization. Mean scores and standard deviations were used to summarize responses across the four major determinant categories: human factors, organizational factors, technical factors, and system-level factors

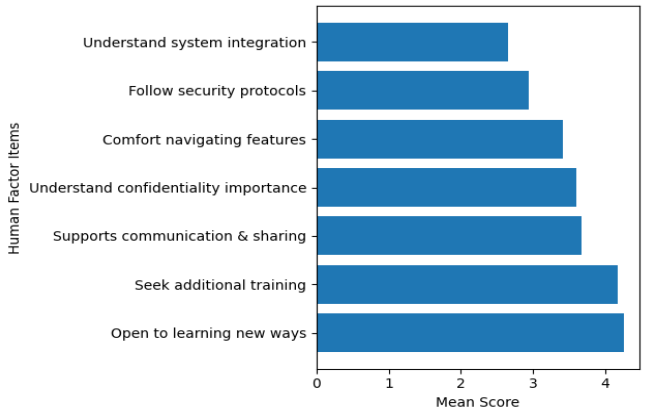

Figure 2: Descriptive Statistics for Human Factors Influencing Effective EHR Utilization

Descriptive analysis revealed varying levels of human-factor determinants influencing effective EHR utilization. The highest mean scores were observed for openness to learning new approaches to improve system efficiency (M = 4.26, SD = 0.85) and proactive pursuit of additional training opportunities (M = 4.18, SD = 0.77), suggesting strong motivational readiness among healthcare professionals to strengthen digital competence. Moderate agreement was observed regarding system communication and data-sharing support (M = 3.68, SD = 0.67) and understanding of patient confidentiality requirements (M = 3.60, SD = 0.71), indicating functional awareness of institutional data management responsibilities. However, comparatively lower mean scores were recorded for understanding system integration with other hospital technologies (M = 2.65, SD = 0.91) and consistent adherence to cybersecurity protocols (M = 2.94, SD = 0.96). These findings suggest limitations in advanced system knowledge and information security practices, which may affect optimal EHR utilization. Comfort navigating system features demonstrated moderate agreement (M = 3.41, SD = 0.69), indicating that although respondents possessed basic operational competence, opportunities remain for strengthening advanced navigation skills and system interaction capabilities.

Overall, the findings suggest that healthcare professionals exhibit strong willingness to improve EHR-related skills, although targeted interventions may still be required to strengthen integration knowledge, cybersecurity awareness, and advanced operational competence. As shown in figure 2, Mean values above 3.50 indicate positive agreement among respondents regarding human-factor determinants of effective EHR utilization, while values below 3.50 indicate moderate agreement or potential competency gaps requiring improvement.

Table 3. Descriptive Statistics for Organizational Determinants of Effective EHR Utilization

Item	Mean	Std. Dev.

I have received adequate training to use the EHR system effectively.	3.93	0.89
I can access technical support when needed.	2.79	1.09
The training provided for EHR usage was sufficient and relevant to my role.	3.82	0.74
I feel confident in using the system based on my training.	3.62	0.73
I receive timely assistance when facing challenges with the EHR system.	3.14	1.03
Technical support is readily available and helpful.	3.33	0.81
I have received training specific to my role in using EHR.	3.90	1.05
The training provided has equipped me with the necessary skills to use EHR effectively.	3.91	0.97

The findings indicate that organizational readiness plays a substantial role in supporting effective EHR utilization. High mean scores for role-specific training, adequacy of training, and skill acquisition suggest that respondents generally perceived institutional training structures as beneficial for strengthening EHR competence and operational confidence. However, comparatively lower ratings regarding technical support accessibility and timely assistance indicate that institutional support systems may not consistently meet operational demands during routine system use. These findings suggest that although foundational training structures are present, continuous ICT support and responsive technical assistance remain areas requiring improvement to sustain long-term utilization.

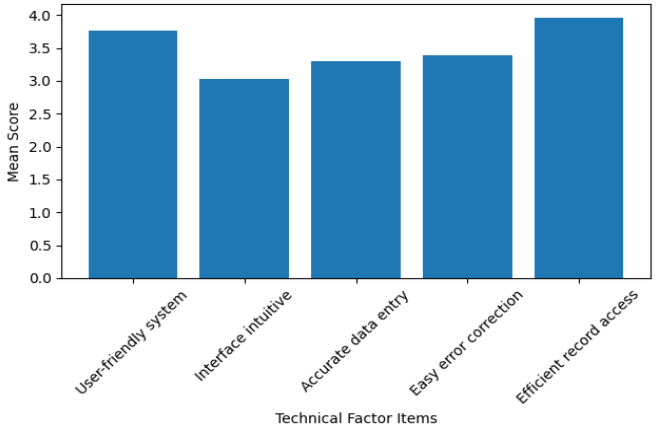

Figure 3: Descriptive Statistics for Technical Factors Influencing Effective EHR Utilization

Descriptive analysis demonstrated generally positive engagement with EHR systems across routine clinical activities. Respondents reported relatively high interaction frequency (M = 3.81, SD = 0.87) and confidence in system use (M = 3.66, SD = 0.84), suggesting meaningful integration of EHR systems into daily clinical workflows. The highest mean score was observed for task efficiency using EHR systems (M = 4.15, SD = 0.85), indicating strong agreement that EHR systems support operational performance. Similarly, access to patient records was rated favorably (M = 3.96, SD = 0.85), reflecting positive perceptions regarding system accessibility and workflow support. Usability indicators demonstrated moderate agreement. Although respondents generally perceived the systems as user-friendly (M = 3.76, SD = 0.67), lower ratings for interface intuitiveness (M = 3.03, SD = 0.92) suggest potential design-related limitations affecting user experience. Data accuracy indicators also revealed moderate agreement levels. Confidence in managing patient data electronically (M = 3.51, SD = 0.75) and ability to enter patient data accurately (M = 3.30, SD = 0.73) were positive but not consistently high. Lower mean scores regarding understanding of data accuracy procedures (M = 3.07, SD = 0.98) indicate variability in user awareness related to data quality management. Overall, the findings suggest that EHR systems are functionally integrated into clinical operations and perceived as efficiency-enhancing technologies, although usability refinement and strengthened data quality competencies may further improve effective utilization.

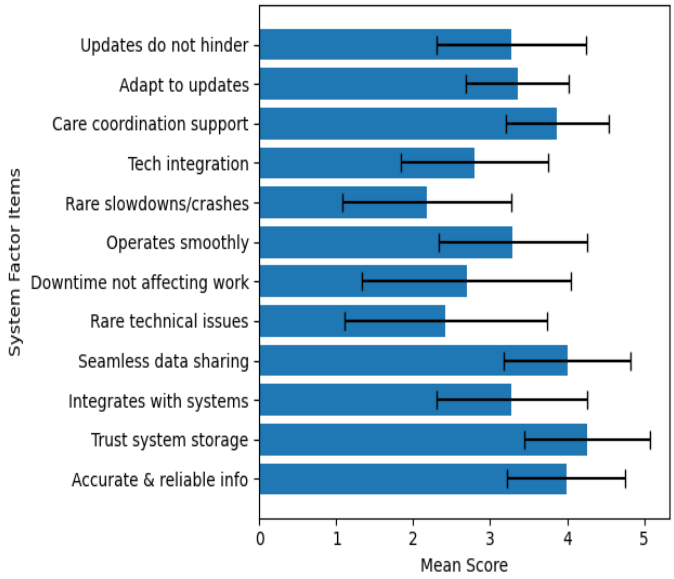

Figure 4: Descriptive Statistics for System-Level Factors Influencing Effective EHR Utilization

Mean values above 3.50 indicate positive agreement regarding system reliability, interoperability, data accuracy, and infrastructural support for effective EHR utilization, while values below 3.50 indicate concerns related to system stability, technical performance, or operational reliability. The findings revealed strong confidence in informational quality and digital coordination capabilities of EHR systems. The highest mean score was observed for trust in system storage of patient information (M = 4.26), followed by seamless data sharing between departments (M = 4.00) and perceived accuracy and reliability of stored information (M = 3.99). These results indicate positive

perceptions regarding data integrity and interdepartmental communication support. Conversely, performance stability indicators recorded comparatively lower mean scores. Rare experience of system slowdowns or crashes (M = 2.18) and minimal technical interruptions (M = 2.42) reflected concerns regarding infrastructural stability and operational reliability. The relatively larger standard deviations associated with these indicators suggest variability in user experiences across departments and operational contexts. Moderate mean values were also observed regarding system integration with other hospital technologies (M = 2.80–3.28) and adaptability to updates (M = 3.27–3.36), indicating functional but suboptimal integration and adaptability performance. Overall, the findings demonstrate that healthcare professionals generally trust the informational reliability and coordination capabilities of EHR systems, although infrastructural instability and technical performance limitations remain important barriers to sustained and optimal utilization.

4.4 Correlation Analysis

Pearson correlation analysis was conducted to examine relationships between human factors, organizational factors, technical factors, system-level factors, and effective EHR utilization. Statistical significance was assessed at the 0.01 level (2-tailed).

Table 4. Pearson Correlation Analysis of Study Variables

Variables	Human Factors	Organizational Factors	Technical Factors	System Factors	Effective EHR Utilization
Human Factors	1	.517**	.486**	.568**	.430**
Organizational Factors	.517**	1	.741**	.547**	.527**
Technical Factors	.486**	.741**	1	.537**	.410**
System Factors	.568**	.547**	.537**	1	.511**
Effective EHR Utilization	.430**	.527**	.410**	.511**	1

Note: p < 0.01 (2-tailed).

The correlation analysis revealed statistically significant positive relationships between all independent variables and effective EHR utilization. Organizational factors demonstrated the strongest association with effective EHR utilization (r = .527, p < .001), followed closely by system factors (r = .511, p < .001). Human factors showed a moderate positive relationship with utilization (r = .430, p < .001), while technical factors recorded the lowest, though still significant, correlation (r = .410, p < .001). These findings suggest that improvements in organizational readiness, training, ICT support, system reliability, and infrastructural performance are likely to enhance effective EHR utilization among healthcare professionals. The strong positive relationships among the predictor variables further support the socio-technical perspective that effective EHR utilization emerges through interaction among human, organizational, technical, and system-level determinants.

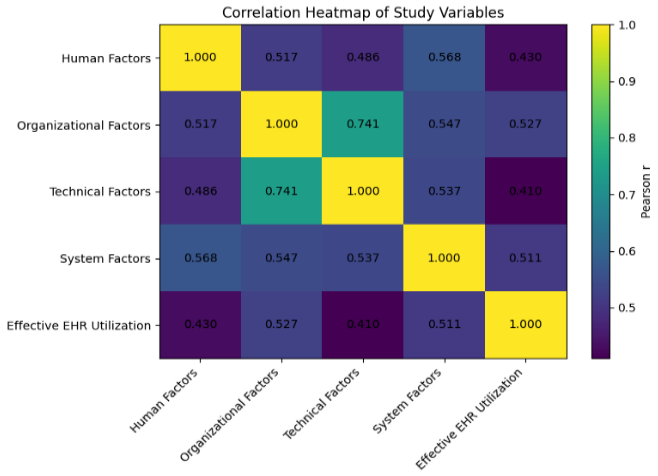

Figure 5. Correlation Heatmap of Determinants and Effective EHR Utilization

The heatmap illustrates Pearson correlation coefficients among human, organizational, technical, and system-level factors and effective EHR utilization. Darker color intensity represents stronger positive correlations. All reported correlations were statistically significant at p < 0.01. Figure 4 provides a visual representation of the relationships among the study variables. All determinants exhibited positive and statistically significant correlations with effective EHR utilization (p < 0.01). Organizational factors demonstrated the strongest relationship with effective EHR utilization (r = 0.527), followed by system factors (r = 0.511), human factors (r = 0.430), and technical factors (r = 0.410). A particularly strong association was observed between organizational and technical factors (r = 0.741), suggesting that institutional support mechanisms and system usability are closely interconnected. These findings support the socio-technical perspective that effective EHR utilization emerges from the interaction of human, organizational, technical, and infrastructural dimensions.

4.5 Multiple Regression Analysis

Table 5. Model Summary

Statistic	Value
R	0.663
R^2	0.440
Adjusted R^2	0.430
Standard Error of Estimate	1.221

The multiple regression model produced a correlation coefficient of R = 0.663, indicating a strong positive relationship between the predictor variables and effective EHR utilization. The model explained 44.0% of the variance in effective EHR utilization (R^2 = 0.440). After adjusting for the number of predictors, the explanatory power remained substantial (Adjusted R^2 = 0.430), indicating that human, organizational, technical, and system-level factors collectively account for approximately 43% of the observed variation in effective EHR utilization among healthcare professionals.

Table 6. ANOVA Results for the Regression Model

Source	Sum of Squares	df	Mean Square	F	p-value
Regression	261.057	4	65.264	43.761	<0.001
Residual	332.554	223	1.491		
Total	593.311	227			

The regression model was statistically significant, F (4,223) = 43.761, p < 0.001, indicating that the combination of human, organizational, technical, and system-level factors significantly predict effective EHR utilization. This finding confirms that the overall model provides a substantially better explanation of EHR utilization than a model without predictor variables.

Table 7. Multiple Regression Analysis of Determinants of Effective EHR Utilization

Predictor	B	Beta (β)	t	p-value	Decision
Human Factors	0.072	0.175	2.483	0.014	Significant
Organizational Factors	0.195	0.378	4.756	<0.001	Significant
Technical Factors	0.074	0.189	2.313	0.022	Significant
System Factors	0.181	0.298	4.525	<0.001	Significant

The regression analysis revealed that all four determinants significantly influenced effective EHR utilization. Organizational factors emerged as the strongest predictor (β = 0.378, p < 0.001), indicating that training, leadership support, ICT assistance, and workflow alignment play the most important role in promoting effective EHR utilization among healthcare professionals. System-level factors were the second strongest predictor (β = 0.298, p < 0.001), suggesting that system reliability, interoperability, data quality, and infrastructural stability substantially influence sustained EHR engagement. Technical factors also demonstrated a significant positive effect (β = 0.189, p = 0.022), indicating that usability, interface design, accessibility, and ease of navigation contribute to effective utilization. Similarly, human factors significantly predicted effective EHR utilization (β = 0.175, p = 0.014), highlighting the importance of digital competence, confidence, and positive attitudes toward EHR systems.

Overall, the results demonstrate that effective EHR utilization is a multidimensional socio-technical outcome shaped by the combined influence of individual capabilities, organizational support mechanisms, system usability, and infrastructural performance.

4.6 Hypotheses Testing Results

Based on the correlation analysis and regression analysis, all four study hypotheses were supported.

Table 8. Summary of Hypotheses Testing

Hypothesis	Statement	Result
H1	Human factors significantly influence effective EHR utilization.	Supported
H2	Organizational factors significantly influence effective EHR utilization.	Supported
H3	Technical factors significantly influence effective EHR utilization.	Supported
H4	System-level factors significantly influence effective EHR utilization.	Supported

The results demonstrate that human, organizational, technical, and system-level determinants all contribute significantly to effective EHR utilization in hospital settings, supporting the integrated theoretical framework underpinning this study. The correlation analysis supports the conceptual framework presented in Figure 1. All four determinant categories, human, organizational, technical, and system-level factors, demonstrated positive and statistically significant relationships with effective EHR utilization. These findings provide empirical support for the hypothesized socio-technical model underpinning the study.

4.7 Integrated Theoretical Synthesis

The findings of this study provide strong empirical support for the integrated application of the TAM, UTAUT, Digital Competence Framework, and Socio-Technical Systems Theory in explaining effective EHR utilization within hospital settings. Collectively, these frameworks suggest that successful utilization of digital health systems is influenced not only by individual user capabilities and perceptions but also by organizational, technical,

and infrastructural conditions. The significance of human factors in both the correlation and regression analyses highlights the importance of digital competence, confidence, and user readiness in facilitating effective EHR utilization. This finding aligns with the Digital Competence Framework and supports TAM and UTAUT propositions that users are more likely to engage with technology when they possess the necessary skills, confidence, and positive perceptions regarding its usefulness and ease of use.

The findings further revealed that organizational factors emerged as the strongest predictor of effective EHR utilization. This underscores the critical role of institutional support mechanisms, including training, leadership commitment, workflow alignment, and ICT assistance. These results are consistent with UTAUT's concept of facilitating conditions and reinforce the socio-technical perspective that organizational environments significantly influence users' ability to integrate technology into routine work practices.

Technical and system-level factors also demonstrated significant positive effects on EHR utilization, highlighting the importance of usability, system reliability, interoperability, and infrastructural stability. These findings support both the Information Systems Success Model and Socio-Technical Systems Theory, which emphasize that system quality and technical performance are fundamental determinants of sustained technology utilization. The results suggest that healthcare professionals are more likely to depend on EHR systems when they are reliable, user-friendly, and effectively integrated into clinical workflows.

Overall, the findings validate a multidimensional socio-technical model of effective EHR utilization in which human capability, organizational readiness, technical usability, and system reliability operate as complementary and interdependent determinants. The study therefore demonstrates that effective EHR utilization extends beyond technology adoption and is best understood as a coordinated outcome of interactions among individuals, organizations, technologies, and infrastructure within healthcare environments.

5.0 Discussion

This study demonstrates that effective utilization of EHR systems in Ugandan hospital settings is influenced by a complex interaction of human, organizational, technical, and system-level determinants. The findings reinforce the TAM, UTAUT, Digital Competence Framework, and Socio-Technical Systems Theory, all of which suggest that successful utilization of digital health technologies depends on the alignment of individual capabilities, organizational support mechanisms, technological functionality, and infrastructural conditions. The regression model explained 44.0% of the variance in effective EHR utilization, indicating that these determinants collectively play a substantial role in shaping utilization outcomes within healthcare environments.

The study conceptualized EHR utilization as a multidimensional construct extending beyond simple system adoption to include consistency of use, workflow integration, functional engagement, and sustained reliance on digital systems during routine clinical practice. This distinction is particularly important in low-resource healthcare environments, where EHR systems may be implemented but not fully integrated into everyday service delivery processes.

The findings revealed that organizational factors were the strongest predictor of effective EHR utilization ($\beta = 0.378$, $p < 0.001$). This highlights the critical role of institutional support structures, including role-specific training, leadership commitment, workflow alignment, and responsive ICT support services. These findings are consistent with previous studies conducted in low- and middle-income countries, which identify organizational readiness as a key facilitator of successful digital health implementation(Musa et al., 2023; Mwogosi, 2025). Within the Ugandan healthcare context, where opportunities for formal digital health training remain limited, healthcare professionals often depend on institution-based support mechanisms to develop and maintain EHR-related competencies. The findings therefore suggest that hospitals should prioritize continuous professional development, mentorship programs, and responsive technical support systems to sustain effective utilization.

System-level factors emerged as the second strongest predictor of effective EHR utilization ($\beta = 0.298$, $p < 0.001$). Respondents expressed strong confidence in the accuracy, reliability, and storage capacity of EHR systems, indicating positive perceptions regarding information quality and digital record management. However, concerns regarding system slowdowns, technical interruptions, and infrastructural instability remained evident. Similar challenges have been reported in several low-resource healthcare settings where unreliable internet connectivity, power interruptions, and limited technical infrastructure continue to constrain digital health utilization(Mwogosi, 2025; Wamema et al., 2025). These findings suggest that sustained utilization depends not only on user acceptance but also on reliable technological infrastructure capable of supporting routine clinical operations.

Technical factors also demonstrated a significant positive influence on effective EHR utilization ($\beta = 0.189$, $p = 0.022$). Healthcare professionals generally perceived EHR systems as useful for improving workflow efficiency, facilitating access to patient information, and enhancing coordination of healthcare activities. These findings support earlier studies emphasizing the importance of system usability, interface design, and workflow

compatibility in influencing user satisfaction and long-term technology utilization(Milenkovic et al., 2020; Tutty et al., 2019). Nevertheless, moderate ratings regarding interface intuitiveness suggest that some users continue to experience operational difficulties. In busy clinical environments characterized by high patient volumes and limited staffing, poorly designed interfaces may increase cognitive workload and reduce operational efficiency. Consequently, user-centered system design remains essential for optimizing EHR utilization.

Human factors were also found to significantly influence effective EHR utilization ($\beta = 0.175$, $p = 0.014$), underscoring the importance of digital competence, confidence, and readiness to engage with digital technologies. Respondents reported high levels of motivation to improve their digital skills and adapt to evolving healthcare technologies, suggesting a positive culture of digital learning among healthcare professionals. These findings align with previous studies demonstrating that digital competence contributes significantly to technology acceptance, engagement, and performance outcomes in healthcare settings(Longhini et al., 2024; Mikkonen et al., 2026). Within the Ugandan context, where many healthcare facilities continue to operate hybrid paper-digital systems, digitally competent healthcare workers are more likely to integrate EHR systems into routine patient care activities and maintain confidence in digital workflows despite environmental challenges.

Collectively, the findings demonstrate that effective EHR utilization is best understood as a multidimensional socio-technical outcome shaped by the interaction of workforce capability, organizational readiness, system usability, and infrastructural reliability. The prominence of organizational and system-level factors suggests that healthcare institutions seeking to improve EHR utilization should move beyond technology deployment and invest in supportive organizational environments and reliable technological infrastructure. These findings support broader digital health scholarship arguing that successful implementation requires coordinated attention to human, organizational, technical, and infrastructural dimensions.

From a practical perspective, the findings suggest that hospital administrators should prioritize continuous digital competence development, structured training programs, responsive ICT support services, and workflow-sensitive implementation strategies. At the policy level, national digital health initiatives should shift from measuring adoption rates alone to evaluating utilization effectiveness, organizational readiness, and infrastructural performance. Such an approach would provide a more accurate assessment of digital transformation outcomes within healthcare systems.

By shifting the focus from EHR adoption to effective utilization, this study contributes to the growing body of digital health research emphasizing performance-oriented evaluation of health information systems in low-resource healthcare environments. The findings provide empirical evidence that meaningful digital transformation requires coordinated investments in workforce capability, organizational support structures, system usability, and infrastructural reliability to achieve sustainable and effective utilization of EHR systems.

6.0 Conclusion

This study provides empirical evidence that effective utilization of EHR systems in hospital settings is a multidimensional socio-technical outcome influenced by human, organizational, technical, and system-level determinants. The findings demonstrate that meaningful digital transformation extends beyond the implementation or availability of EHR systems and depends on the extent to which healthcare professionals can effectively integrate digital technologies into routine clinical workflows.

The study revealed that organizational factors were the strongest predictor of effective EHR utilization, followed by system-level, technical, and human factors. These findings underscore the importance of institutional readiness, continuous training, responsive ICT support, system usability, and reliable infrastructure in promoting sustained engagement with EHR systems. Although healthcare professionals generally exhibited positive attitudes toward digital technologies and strong motivation to enhance their digital competencies, the effectiveness of EHR utilization was largely dependent on supportive organizational environments and stable technological systems.

By conceptualizing EHR utilization as a multidimensional construct encompassing workflow integration, functional engagement, consistency of use, and sustained reliance on digital systems, this study contributes to the growing body of digital health research that emphasizes utilization effectiveness rather than adoption alone. The findings further validate the application of the TAM, UTAUT, Digital Competence Framework, and Socio-Technical Systems Theory in explaining EHR utilization within resource-constrained healthcare environments.

From a practical perspective, the study highlights the need for healthcare institutions and policymakers to move beyond deployment-oriented digital health strategies and prioritize continuous workforce development, organizational support mechanisms, usability-focused system improvements, and sustainable infrastructural investments. Strengthening these interconnected dimensions is essential for maximizing the contribution of EHR systems to healthcare quality, efficiency, coordination, and patient outcomes.

Overall, the study reinforces the importance of adopting holistic socio-technical approaches to digital health implementation and provides context-specific evidence to inform ongoing digital transformation efforts in Uganda and other low-resource healthcare settings.

Declarations

Ethics Approval and Consent to Participate

Ethical approval for this study was obtained from the relevant institutional review body. Participation was voluntary, and informed consent was obtained from all participants prior to data collection. All procedures were conducted in accordance with ethical standards for research involving human subjects.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available in the Zenodo repository (https://doi.org/10.5281/zenodo.19387267). The materials include anonymized datasets, analysis outputs, and supporting documents used.

AI Usage

Artificial intelligence tools (ChatGPT) were used to support language refinement, editing, and structuring of the manuscript. All intellectual content, study design, data collection, analysis, and interpretation were conducted and verified by the authors.

Competing Interests

The authors declare that they have no competing interests.

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Author Contributions

- **Brian Mugisha:** Conceptualization, study design, data collection, analysis, and original draft preparation.
- **Maninti Venkateswarlu:** Supervision, methodological review, and critical revision of the manuscript.
- **Joe Mutebi:** Methodological guidance, validation of analysis, and manuscript review and editing.
- **Paul Akampurira:** Data analysis support, visualization, and manuscript review.
- **Richard Kirungi:** Literature support, data validation, and manuscript editing.

All authors read and approved the final manuscript.

Abbreviations

- EHR – Electronic Health Record
- EMR – Electronic Medical Record
- LMICs – Low- and Middle-Income Countries
- ICT – Information and Communication Technology
- CDSS – Clinical Decision Support System
- EHRs – Electronic Health Records

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