

# Assessing the usability and performance of digital healthcare systems in Nigerian teaching hospitals: Challenges and future directions

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## Abstract

**Background:** Several developing countries, including Nigeria, are still in the nascent stages of adopting digital healthcare support solutions to enhance clinical service delivery. Consequently, there currently exists a scarcity of research and gaps in the literature regarding the efficacy, effectiveness, overall performance, and possibly success factors associated with these systems, or conversely, identify the design and implementation deficiencies, as well as the use-based challenges present in them. This is the gap this research seeks to address. The findings from these evaluations are anticipated to inform improvements to the existing systems and guide future implementations.

**Method:** The research was conducted at three referral and university teaching hospitals in southern Nigeria. It involved an extensive period of on-site observations and clinician engagements. A validated 5-point Likert scale questionnaire was designed to capture the peculiarities of the prevailing contexts across these hospitals. The survey targeted 150 clinicians, and responses were analyzed using SPSS, while visual representations were created in MS Excel.

**Result:** Findings showed that 79.4% of clinicians identified feature gaps and expressed the need for additional functionalities. However, 71.9% acknowledged that their systems had interfaces facilitating electronic requests to service units like radiology and pharmacy. Despite this, some clinicians faced challenges due to missing features, which prevented them from fully achieving their clinical goals. Furthermore, 80.2% reported experiencing instances where the electronic health record (EHR) systems were slow, unresponsive, or caused prolonged interruptions that hindered workflow efficiency.

**Conclusion:** The findings, particularly the 79.4% of clinicians desiring additional features and the 80.2% experiencing system slowdowns, highlight the urgent need for digital healthcare policies in developing nations to prioritize user-centered design protocols during systems implementation in order to better align EHR systems with clinical workflows and reduce clinician burnout. It would as a result be pertinent to engage the clinicians in any future design or redesign process and also provide targeted trainings which will ensure EHR systems better support healthcare providers in delivering quality patient care.

## Keywords

Electronic health record system, EHR usability evaluation, digital healthcare support system, digital health adoption, developing economies, health information systems, digital transformation in healthcare, developing country health systems

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## Background

Digital healthcare systems have become essential in enhancing clinical service delivery and improving patient outcomes in today's rapidly evolving healthcare landscape. Technologies such as electronic health records (EHRs), telemedicine, and health information exchanges facilitate seamless communication among healthcare providers, streamline clinical workflows, and enable real-time access to patient data.<sup>1–3</sup> These advancements not only foster informed decision-making and personalized care but also enhance the overall efficiency of healthcare delivery. Moreover, digital healthcare systems play a crucial role in addressing disparities in healthcare access, particularly in underserved and rural areas, by enabling remote consultations and improving the management of health information.<sup>4–6</sup>

The potential for these technologies to transform healthcare is immense, as they can lead to better coordination of care, reduced medical errors, and improved patient engagement.<sup>7–9</sup> However, the historical trajectory of digital transformation initiatives within the healthcare sector has been fraught with challenges, often characterized by a sluggish pace of implementation.<sup>10</sup> Resistance from various stakeholders, particularly those in clinical roles such as doctors and nurses who engage directly with patients and integrated digital healthcare systems like EHRs, is frequently encountered.<sup>11</sup> Many clinicians express concerns regarding the misalignment of these digital systems with their established clinical workflows, while others report experiencing cognitive overload due to the demands of the new technology. Reports of burnout heightened stress, and increased workloads among doctors are prevalent.<sup>12</sup> In some instances, clinicians have opted to circumvent the use of these systems whenever feasible, leading to a significant waste of the investments and resources allocated for the development of these essential healthcare technologies. It is imperative that newly implemented systems designed to enhance clinical operations prioritize optimal user experience (UX) for healthcare professionals. This consideration should be a primary focus for both regulatory authorities and EHR vendors; however, as previously noted, the literature reveals persistent dissatisfaction among end users, who frequently highlighted the disconnect between EHR system designs and the realities of clinical workflows, procedures, and protocols.<sup>13</sup> Instances of suboptimal design have been linked to cognitive overload and increased burden, which can interfere with the doctor–patient relationship.<sup>14,15</sup> Some healthcare professionals have expressed a positive outlook regarding the potential for mobile devices to facilitate access to EHRs through multimodal approaches, thereby enhancing mobility and flexibility in their practice.<sup>16</sup> The usability and user experience challenges associated with the design and implementation of EHR systems have persisted as

significant concerns, often proving to be quite elusive over time. Notably, Smelcer et al.<sup>17</sup> indicated approximately a decade ago that around 30% of EHR system implementations were unsuccessful, primarily because many doctors struggled to utilize these systems effectively due to prevalent user experience issues across various clinics where these systems were introduced.

In addition to the use of electronic health record systems, telemedicine is another digital healthcare system that remains infrequently adopted within the context of developing economies and Nigeria in particular. This slowness in adoption is often attributed to poor.<sup>18</sup> Nevertheless, it is important to highlight that Remote Patient Monitoring Systems (RPMS), an implementation of telemedicine, possess significant potential for transformative impact within the healthcare landscape of Nigeria, as evidenced by the insights provided by Onyeabor et al.,<sup>19</sup> which suggest that such systems hold great promise for Nigeria and could enhance patient care and accessibility.

Now, the current circumstances in developing nations, especially in Nigeria, are notably challenging and warrant significant attention. A majority of public hospitals continue to function using manual and paper-based systems across all levels of healthcare—primary, secondary, and tertiary.<sup>20–22</sup> Many of these facilities lack experience with the adoption of digital intervention programs and technologies that could enhance their clinical operations.<sup>23</sup> Consequently, numerous institutions have become completely disconnected and marginalized from the substantial opportunities presented by digital transformation initiatives and projects arising from the digital economy.<sup>24</sup> It is important to highlight that certain hospitals in developing nations have begun to explore the implementation of digital intervention initiatives, such as electronic health record systems. This segment would evaluate various cases of electronic health records interventions in developing contexts, their performance, usability and users experience and challenges.

### *Cases of electronic health records interventions in developing contexts and their performance/usability/user experience evaluations and challenges*

**e-Health implementation in Bangladesh.** Although not an African country, Bangladesh provides a relevant example of eHealth implementation challenges in a developing context. The country faced significant obstacles such as inadequate Information and Communication Technology (ICT) infrastructure, unreliable electricity supply, and limited ICT skills among rural populations. These challenges hindered the effective implementation of eHealth solutions. Addressing these issues through improved infrastructure and capacity-building initiatives is crucial for realizing the benefits of digital health interventions.<sup>25</sup>

*Digital health systems in Africa.* A white paper by IQVIA discussed the digital maturity of health systems across African countries. The paper highlighted the potential of digital technologies to address health challenges such as the rise of non-communicable diseases and the impact of climate change. Key areas of focus included the development of EHR systems, the prominence of mobile health (mHealth), and the need for scalable and long-term digital health solutions. The paper emphasized the importance of collaboration, open-source technologies, and pan-African standards to unlock the potential of digital health in Africa.<sup>26</sup>

*Digital health interventions in sub-Saharan Africa.* A scoping review of digital health interventions in sub-Saharan Africa over the past decade highlighted the disproportionate focus on service delivery and healthcare providers, with limited emphasis on system-wide impacts. The review found that many digital health solutions were institution-specific and lacked coordination, integration, scalability, and sustainability. To address these challenges, the World Health Organization (WHO) proposed the adoption of a Digital Health Platform (DHP) to streamline various solutions into a cohesive system. This platform aims to improve data accuracy, program delivery, and informed decision-making at all levels of the health system.<sup>27</sup>

#### Global usability studies in digital healthcare systems

- *United States and other countries:* A recent research (2025) had a goal to evaluate the impact of EHR design on usability and medication safety, particularly given that nearly 50% of US physicians report symptoms of burnout, often exacerbated by poor EHR design.<sup>28</sup> The study utilized a systematic review methodology, analyzing 32 studies published between 2009 and 2024, focusing on user satisfaction, efficiency, and medication safety while adhering to ISO design recommendations. Key findings indicated a mean usability score of 80.00, revealing issues like excessive clicks, long forms, and data loss that negatively impacted user experience, highlighting the need for effective EHR design to improve healthcare outcomes and address physician burnout. The research was conducted across multiple countries, showcasing a variety of healthcare environments.<sup>29</sup>
- *United Kingdom:* Similarly another research conducted to evaluate the usability of EHR systems in emergency departments across the United Kingdom (UK), aiming to identify usability issues that could impact patient safety and clinician efficiency. The study employed an open web-based survey conducted by the Royal College of Emergency Medicine (RCEM) Informatics Committee, utilizing the System Usability Scale (SUS) to gather responses from 1663 emergency physicians between June and August 2019.<sup>30</sup> The key finding revealed that the median SUS score was 53, indicating that none of the EHR systems assessed met the acceptable usability threshold of 68, highlighting significant usability challenges that varied across different EHR systems and healthcare organizations.<sup>30</sup>
- *Usability evaluation in Indonesia:* In Indonesia, a study evaluated EHR systems' usability and user experience at the Rumah Keluarga Sehat Clinic in Jember Regency. The evaluation used the SUS and User Experience Questionnaire (UEQ) instruments. The results showed a SUS score of 77.14, indicating a "Good" category and above-average results on the UEQ scales for perspicuity and dependability, with excellent scores for attractiveness, efficiency, and stimulation.<sup>31</sup> This case highlights the importance of involving end users in the system development process to ensure the EHR system meets their needs and expectations.
- *Sierra Leone:* In Sierra Leone, the goal of similar research was to evaluate the acceptance and satisfaction of healthcare workers regarding the usability of digital health goods in Kono District, Sierra Leone. A health facility-based cross-sectional study design was employed, involving 151 participants who provided data through a validated questionnaire that assessed their experiences and perceptions of digital health systems.<sup>32</sup> The key finding revealed that a significant majority (72.2%) of respondents demonstrated good acceptance of the digital health tools, with 95.4% expressing satisfaction; however, barriers such as the inability to use the systems offline and slow performance were identified as challenges to effective implementation.<sup>32</sup>
- *Australia:* In Australia the goal of this another research was to explore the usability perceptions of EMR systems among hospital clinicians in Australia, utilizing the National Usability-Focused Health Information Systems Scale (NuHISS) developed by Finnish researchers.<sup>33</sup> The method involved a purposive sampling approach to recruit medical, nursing, and midwifery clinicians, who were invited to participate in a survey that included both quantitative questions and an open-ended free-text item to comment on EMR usability. Key findings indicated that a significant portion of respondents provided feedback on usability, highlighting the importance of optimizing EMR systems to enhance user experience and patient-centered care in the Australian healthcare context.<sup>33</sup>
- *Germany:* In Germany, a similar research was conducted to evaluate the satisfaction and usability of

EHR among physicians working in university hospitals, particularly focusing on their experiences with direct patient contact. The researchers employed an online survey method, adapted from a previous study in Finland, which included questions about general background, EHR experience, and specific usability aspects of hospital information systems.<sup>34</sup> Key findings revealed that while 69% of participants found EHRs helpful in their daily work, a significant 55% reported experiencing serious adverse events due to system malfunctions, highlighting issues with speed and intuitiveness. Based on these findings, the study recommends that developers prioritize improvements in the usability, stability, and responsiveness of EHR systems to better support healthcare professionals in their clinical routines.<sup>34</sup>

- *South Korea:* Then in South Korea, another research investigated the usability problems associated with electronic medical record (EMR) systems in emergency departments (EDs) in South Korea, focusing on the distinct workflows and requirements of both physicians and nurses. The study employed a qualitative approach, utilizing interviews and observations of clinicians at the largest medical institution in South Korea, followed by an online survey that included 44 questions related to EMR functions and 12 socio-demographic questions, targeting a total of 200 healthcare providers.<sup>35</sup> The key finding revealed significant usability issues, particularly in patient selection and information visibility, which contributed to clinician inefficiency and dissatisfaction, ultimately posing risks to patient safety. As a recommendation, the research suggests enhancing the visual design and user interface of EMR systems to better support clinical tasks and improve overall usability, thereby fostering a more effective working environment for healthcare professionals.<sup>35</sup>
- *Sub-Saharan Africa:* A literature review evaluated the usability of EMR systems implemented in sub-Saharan Africa. The review used a usability evaluation criterion developed by the Healthcare Information and Management Systems Society (HIMSS), focusing on five key metrics: efficiency, effectiveness, ease of learning, cognitive load, and user satisfaction. The overall usability score for all systems was calculated to be 66%, with ease of learning obtaining the highest percentage score of 71%.<sup>36</sup> This case underscores the importance of evaluating usability based on well-defined metrics to identify areas for improvement and ensure the successful implementation of EMR systems.
- *United States:* Again another research conducted in the United States, was to evaluate the usability of two EHR systems specifically in the context of clinical notes entry and information-seeking tasks among

Internal Medicine residents. The researchers employed an ethnographic field study complemented by post-observation questionnaires to gather qualitative data through direct observations and subjective feedback from the participants.<sup>37</sup> A key finding revealed that System-1 significantly outperformed System-2 in clinical notes entry tasks, with a positive usability rating of 26% compared to 12% for System-2, while both systems showed similar performance in information-seeking tasks. Based on these insights, the researchers recommend that future EHR designs should prioritize user-centered features, such as improved navigation and autopopulation capabilities, to enhance usability and better meet the needs of healthcare providers.<sup>37</sup>

Collectively, these case studies from the United States, United Kingdom, Sierra Leone, Australia, Germany, and South Korea underscore the critical importance of usability in the design and implementation of EHR systems. They reveal common challenges such as complex navigation, poor interface design, and inadequate training, which can negatively impact physician satisfaction, clinical workflow, and patient safety. The studies advocate for user-centered design, continuous usability testing, and iterative improvements to enhance the effectiveness and efficiency of digital healthcare systems globally.

*Nigeria national digital health policy.* Nigeria has recognized the transformative potential of digital technologies in enhancing healthcare delivery and has initiated several policies to integrate these innovations into its health system. The Nigeria Digital in Health Initiative (NDHI) stands at the forefront of this endeavor, aiming to revolutionize the healthcare landscape by improving accessibility, efficiency, and quality of services nationwide.<sup>38</sup> In May 2024, the federal government inaugurated a 20-member committee to oversee the implementation of the NDHI, underscoring the nation's commitment to digital health transformation. The NDHI focuses on key areas such as establishing robust standards and innovative solutions, restructuring digital health governance, and updating policies to align with the evolving digital health landscape.<sup>38</sup> Complementing these efforts, Nigeria has adopted 32 ISO/TC215 Health Informatics Standards to ensure interoperability and standardization across digital health systems.<sup>39</sup> These initiatives collectively aim to create an integrated, scalable, and sustainable digital health ecosystem that enhances patient care and health outcomes across the country.

*Challenges and recommendations.* Implementing EHR systems in developing economies faces several challenges, including limited financial resources, inadequate ICT infrastructure, unreliable electricity supply, and limited ICT skills among healthcare workers. Additionally, data privacy



concerns, interoperability issues, and organizational and social barriers further complicate the adoption of EHR systems.<sup>40</sup> To overcome these challenges, several recommendations have been proposed, such as developing robust infrastructure, creating supportive policy frameworks, building capacity among healthcare workers, engaging stakeholders, ensuring interoperability, and planning for sustainability.

A study conducted across 12 African countries revealed significant challenges in producing quality health data due to underdeveloped health information systems (HIS). The study found that most countries had adopted a data warehouse approach supported by the DHIS2 system, which improved data reliability. However, the lack of a national health information management strategy aligned with donor strategies posed a threat to HIS performance. This case underscores the importance of developing coherent national strategies to guide the integration of digital applications into HIS for long-term sustainability.<sup>41</sup>

These case studies and insights demonstrate the importance of assessing usability and user experience to ensure the successful adoption and effectiveness of EHR systems in developing economies. By addressing these factors, healthcare systems can improve the quality of care, enhance patient outcomes, and achieve better public health management.

These cases illustrate the diverse challenges and opportunities in the implementation of digital health systems in developing and African healthcare contexts. By addressing infrastructure gaps, developing coherent national strategies, and leveraging innovative digital solutions, these regions can improve healthcare delivery and achieve better health outcomes.

Now, there still exists a significant lack of research focused on the experiences of clinical practitioners utilizing these digital innovations in developing countries and Nigeria in particular, as well as the challenges they face, which is essential for informing effective strategies for future implementation.

This research therefore specifically evaluates EHR systems implemented at three tertiary healthcare institutions in Southern Nigeria, specifically a federal university teaching hospital, a state university teaching hospital, and a tertiary non-university teaching hospital. These EHR systems are designed to enhance healthcare delivery by streamlining clinical workflows, improving patient data management, and facilitating better communication among healthcare providers. Studying these three hospitals is particularly relevant as they represent a cross-section of Nigeria's tertiary healthcare landscape, allowing for a comprehensive understanding of the challenges and successes in digital health adoption. Therefore, the aims and objectives of this study are to identify deficiencies in design and implementation, as well as usability and operational challenges

associated with these systems. There currently exists a scarcity of research and gaps in the literature bordering on the Nigerian healthcare context, regarding the efficacy, effectiveness, overall performance, and possibly success factors associated with these systems, or conversely, identify the design and implementation deficiencies, as well as the use-based challenges present in them. This is the gap this research seeks to address. It is hoped that valuable insights so derived can facilitate the successful implementation of digital transformation initiatives in healthcare and guide future implementations within these healthcare ecosystems. This research will contribute to a deeper understanding of clinician engagement with digital healthcare systems, ultimately enhancing clinical service delivery in these institutions.

## Methods

### *The research design*

The investigation commenced with a detailed observation of how clinicians utilized the current EHR systems within the selected hospitals. This exercise lasted for about three months. Notably, the EHR systems employed in these three institutions were the same and provided by the same vendor. This study formed a component of a broader research initiative engaged by the research team and focused on the digital transformation of healthcare in tertiary and university hospitals located in developing economies. Throughout this process, it was observed how the clinicians verbally expressed their experiences with the technologies in use. In response to these observations, the researchers developed a questionnaire designed to gather comprehensive insights into end-users' desires, experiences, expectations, and possibly any shortcomings regarding the existing system. Subsequent discussions with clinicians on their experiences with electronic health record systems further enhanced and led to insights that informed the questionnaire's design and depth. The questionnaire was later validated by the clinicians and the researchers, some of whom were senior academics at the medical schools of the respective referral and teaching hospitals.

*Nature of the study:* This research explored clinicians' usability and user experiences with digital healthcare support systems, specifically focusing on EHR at three tertiary/university teaching hospitals.

*Study duration and location:* The study lasted approximately five months, during which time extensive observation of the systems' use was conducted, and data was collected through surveys. These five months included the time it took for the ethical committees to deliberate and approve the application to conduct research. In fact, the exact duration of this study was spanned from

February 2022 to June 2022 at a federal university teaching hospital, a state university teaching hospital, and a tertiary non-university teaching hospital, all located in Southern Nigeria.

**Sample selection process.** The three referral and university teaching hospitals under study were randomly selected because they were known to represent a cross-section of Nigeria's tertiary healthcare landscape, including a federal university teaching hospital; another, a state university teaching hospital; and then a non-university teaching/specialist hospital. This choice was to enable one to have a detailed understanding of the level of usability and user experience of clinicians who use these systems and probably the challenges faced by clinicians using the digital healthcare systems' initiatives across the tertiary healthcare ecosystem. This allows one to have a comprehensive understanding of the challenges and successes in digital health adoption. Meanwhile, the study participants were randomly selected based on the criteria that they have worked at least 1 year in their respective care facility and have had practical experience using the digital healthcare systems under study.

**Ethical considerations.** Researchers can confirm that a written approval to conduct this research was received from the appropriate ethical committees from each of the respective teaching/tertiary hospitals under study. The researchers also confirm that informed consent was received from all participants in this study. They also confirm that the same ethical committees studied the scope of our research, which they found breaching no ethical protocols, before approval was given.

**Data collection.** Data collection was conducted through the distribution of questionnaires to clinicians utilizing the current system. As previously mentioned, the questionnaire was developed following a detailed observation of the existing system's operations within its current usage context. The primary objective was to ensure that the questionnaire comprehensively addressed all aspects of the clinicians' experiences within the target hospitals. Subsequently, the questionnaire underwent validation by both clinical stakeholders and researchers. Following this validation, a target sample of 150 clinicians was surveyed, comprising doctors, nurses, and medical record officers who actively engaged with the existing EHR system across these three clinical institutions. The researchers manually administered the survey over a span of three months, resulting in the collection of 131 valid and usable questionnaires suitable for data analysis. Among the respondents, 89 doctors, 25 nurses, and 17 medical record officers from the three tertiary/university teaching hospitals participated in the survey. The questions posed in the survey primarily focused on the end-user

experience of clinicians with the existing system. The next section discusses the study participants inclusion criteria.

**Study participants inclusion/exclusion criteria.** *Inclusion criteria:*

- Clinicians actively engaged with the existing electronic health record (EHR) system, including doctors, nurses, and medical record officers.
- Participants must have been employed at the three designated tertiary/university teaching hospitals during the study period.
- Clinicians with a minimum of one year of experience in their respective roles to ensure familiarity with the EHR system.

*Exclusion criteria:*

- Clinicians who were not directly involved with the EHR system or had limited interaction with it.
- Individuals in training or those who had recently joined the hospitals (less than one year of experience).
- Any clinician who declined to provide informed consent to participate in the study.

**Questionnaire validation and justification for the choice of questions.** Overall, the survey questions were carefully chosen to reflect clinicians' technical needs by focusing on their experiences with the EHR systems, including usability, desired features, and overall satisfaction, ensuring that the instrument captured relevant insights into their daily interactions with the technology. The survey instrument underwent a validation process involving both clinicians and researchers, ensuring that the questions accurately addressed the specific challenges faced in the clinical environment. Specifically, the validation method for the survey instrument involved a two-step process: first, the questionnaire was reviewed by a panel of clinical stakeholders, including practicing clinicians and researchers, to ensure that the questions were relevant, clear, and accurately reflected the technical needs and experiences of end-users. Following this expert review, a pilot test was conducted with a small group of clinicians to identify their impressions and if there were any ambiguities or issues in the survey, allowing for necessary adjustments before the final distribution to the larger sample. This comprehensive validation approach ensured that the survey effectively captured the intended data on the usability and performance of the EHR systems. Usability and performance were assessed through targeted questions that explored system responsiveness, ease of data entry, and the presence of essential functionalities, which are critical for effective clinical practice.

During data collection, challenges such as varying levels of clinician engagement and time constraints were encountered; these were addressed by scheduling flexible survey administration times and providing clear explanations of the study's importance to encourage participation.

**Statistical methods/data analysis.** In this study, data were collected using a validated questionnaire based on a 5-point Likert scale, which allowed clinicians to express their level of agreement with various usability factors of the digital healthcare system. The responses were analyzed using SPSS software, which involved calculating simple percentages and mean (scores) used as a measure of central tendency to quantify the overall perceptions of clinicians regarding the system's usability. The data visualization was performed through a dashboard created in MS Excel. This quantitative analysis facilitated straightforward comparisons across different clinician groups and identified trends and areas needing improvement in the digital health system.

It is crucial to emphasize that the data analysis was executed at four distinct levels to comprehensively evaluate the perspectives of clinicians across the three hospitals concerning their experiences with the current system. Initially, the dataset was analyzed to ascertain the clinicians' positions, followed by a disaggregation of the data to compare the experiences of doctors and nurses and juxtapose these findings with the information from the analysis of medical records officers' data. This methodology was anticipated to elucidate which group of clinicians encountered greater success or challenges with the existing EHR system, thereby allowing for targeted attention in future implementations.

**Justification of the choice of test used for analyzing usability factors.** The mean was deemed a suitable measure of central tendency for analyzing usability factors in this study because it provides a clear and quantifiable representation of clinicians' overall perceptions regarding the usability of EHR systems, derived from a 5-point Likert scale. By calculating the average mean, researchers could effectively summarize the collective stance of stakeholders on various usability items, allowing for straightforward comparisons across different aspects of the systems evaluated. This approach facilitates the identification of trends and areas needing improvement, ultimately supporting the goal of enhancing user experience and system functionality.

### The research setting

1. *Federal university teaching hospital:* The federal university teaching hospital is a key institution in Southern Nigeria, known for its historical significance as one of the oldest teaching hospitals in the region. It serves as a major referral center, providing a wide range of services, including specialized care

in obstetrics, pediatrics, internal medicine, and surgery. The hospital is dedicated to training medical students and residents, offering hands-on clinical experience while actively engaging in research initiatives aimed at improving patient outcomes and advancing medical knowledge.

2. *State university teaching hospital:* The state university teaching hospital emphasizes the integration of medical education and community health services, providing high-quality healthcare to the local population. It offers a variety of services, including outpatient and inpatient care, surgical interventions, and emergency services. The hospital collaborates with multiple departments to enhance clinical training and participates in community outreach programs to promote health awareness and preventive care, addressing the healthcare needs of surrounding communities.
3. *Tertiary non-university teaching hospital:* The tertiary non-university teaching hospital is recognized for its specialization in orthopaedic care, serving as a national center of excellence for trauma and rehabilitation services. It employs a multidisciplinary approach to patient care, integrating surgical, physiotherapy, and rehabilitation services for comprehensive treatment of musculoskeletal disorders. The hospital also engages in research and education, offering training programs for healthcare professionals and participating in community health initiatives to raise awareness about injury prevention and rehabilitation.

### Results

A total of 150 questionnaires were distributed among three tertiary/university teaching hospitals, resulting in the retrieval of 131 questionnaires that were deemed suitable for data analysis. This reflects a response rate of 87%. Detailed information regarding the characteristics of the respondent population is presented in Table 1:

The analysis of the dataset with 131 clinical respondents revealed that 79.4% believed the current EHR system lacked essential features. Only 9.9% disagreed with this view, while 10.7% were uncertain. Furthermore, 80.2% reported difficulties with the system, citing issues like slow performance and freezes that disrupt operations; only 8.4% did not support this claim, and 11.5% remained undecided. Over half of the clinicians, particularly 55.7% of doctors, felt the EHR was not adequately designed to manage necessary patient information, and they showed no desire to revert to paper documentation (see Figure 1). The analysis also aimed to identify which clinician categories experienced the system more positively or negatively, with 79.4% indicating a desire for additional functionalities. Among the respondents, 80% of doctors, 68% of nurses,

**Table 1.** Characteristics of the respondent population.

	N	%
Total	131	100
Gender		
Male	74	56.5%
Female	57	43.5%
Age range of clinicians (doctors, nurses, and medical record officers)		
18 years to 38 years	84	64%
39 years to 56 years	47	36%
How long have you been working		
1 year to 10 years	111	84.8%
11 years to 20 years	19	14.7%
21 years to 33 years	1	0.8%
Highest educational qualification		
High school	8	6.1%
Diploma	15	11.5%
Bachelor	104	79.4%
Masters	2	1.5%
PhD/fellowship	2	1.5%
Job title		
Doctors	89	67.9%
Nurses	25	19.1%
Medical record officers	17	13.0%
Does your work involve direct patient care?		
Yes	131	100%
No	0	0.0%
How often do you use computer systems?		
Daily	72	55.0%
A few times a week	52	39.7%
A few times a month	5	3.8%

(continued)

**Table 1.** Continued.

	N	%
A few times a year	2	1.5%
How do you rate your skill on a scale of 1–5: where 1 = very poor, 2 = poor, 3 = good, 4 = very good, 5 = proficient		
1: Very poor	7	5.3%
2: Poor	8	6.1%
3: Good	69	52.7%
4: Very good	35	26.7%
5: Proficient	12	9.2%
Do you have any experience using electronic health record before coming to your present hospital		
No	40	30.5%
Yes	91	69.5%
Have you ever received any structured training on your current electronic health record		
No	74	56.5%
Yes	57	43.5%

and 82.3% of medical record officers expressed this sentiment. Concerns were raised about the system's impact on patient engagement, with 50.7% of clinicians indicating it hindered care delivery; this included 63.7% of doctors, 28% of nurses, and 17.6% of medical record officers. In fact, Figures 1–4 represent the visualization of each of the clinician category's user experience with the EHR systems under study. The findings highlight a negative perception of the EHR implementation among doctors across the three tertiary teaching hospitals, and further examination of the perspectives of different clinical stakeholders is presented in the Table of Means (Table 2) and detailed interpretation in Table 3.

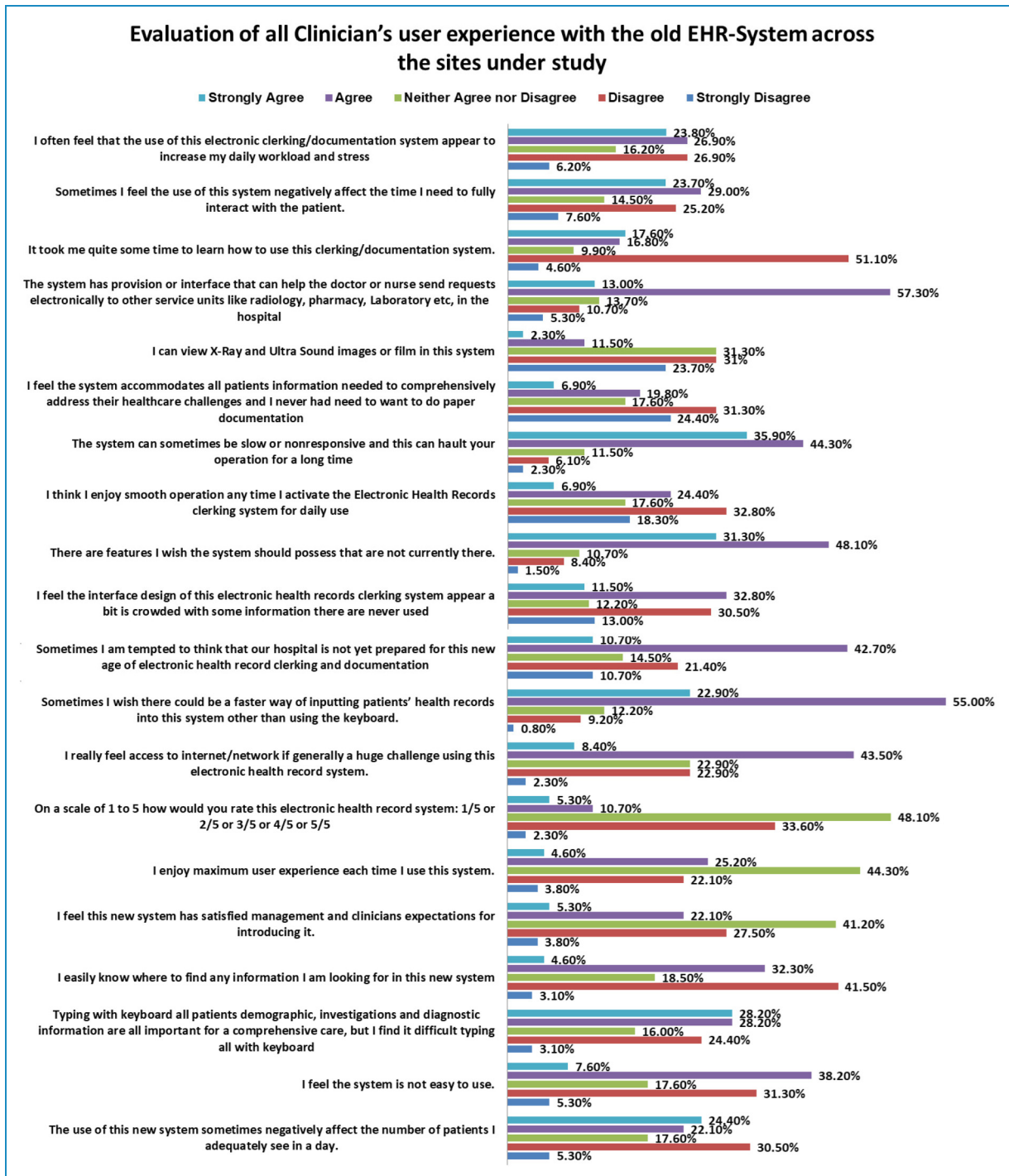
Meanwhile, for further engagement with the result, multidimensional tabular visualization of Figures 1–4 is shown in the same order via Appendix Tables A1, A2, A3, and A4, respectively; all in Appendix 1:

Figure 2 shows the result of the doctor's position with the existing EHR system across the three sites under study.

Figure 3 shows the result of the nurses' position with the EHR system across the three sites under study.

Figure 4 shows the result of the medical record officers' position with the EHR system across the three sites studied.





**Figure 1.** Visualization of clinicians' user experience with existing EHR systems across the sites under study.

Meanwhile, Figure 5 shows the system usability heat map based on clinicians' responses.

### Further interpretation of the system usability heat map

The heat map visualizes clinicians' responses across 20 key usability questions regarding the EHR system. The color

gradient represents the proportion of respondents selecting each response category, from strongly disagree to strongly agree.

#### Key observations:

1. *Usability challenges and missing features:* A significant 79.4% of respondents agreed or strongly agreed that the system lacks desired features. Additionally,

**Table 2.** Comparison of clinicians' user experience with existing EHR systems across all sites studied.

DS/ N	Survey questions	Dr No	Doctor mean values	Nr No	Nurses mean values	MED No	MED. record officer mean values	Total	unified mean
1.	I feel the interface design of this electronic health records clerking system appears a bit crowded with some information that is never used	89	<u>2.85</u>	25	<u>2.92</u>	17	<u>3.82</u>	131	<u>2.99</u>
2.	There are features I wish the system should possess that are not currently there.	89	<u>4.09</u>	25	<u>3.68</u>	17	<u>3.94</u>	131	<u>3.99</u>
3.	I think I enjoy smooth operation any time I activate the electronic health records clerking system for daily use	89	<u>2.38</u>	25	<u>3.44</u>	17	<u>3.18</u>	131	<u>2.69</u>
4.	The system can sometimes be slow or nonresponsive and this can halt your operation for a long time	89	<u>4.17</u>	25	<u>3.72</u>	17	<u>3.94</u>	131	<u>4.05</u>
5.	I feel the system accommodates all patients information needed to comprehensively address their healthcare challenges, and I never had need to want to do paper documentation	89	<u>2.26</u>	25	<u>3.24</u>	17	<u>2.94</u>	131	<u>2.53</u>
6.	I can view X-ray and ultrasound images or film in this system	89	<u>2.29</u>	25	<u>2.76</u>	17	<u>2.24</u>	131	<u>2.37</u>
7.	The system has a provision or interface that can help the doctor or nurse send requests electronically to other service units like radiology, pharmacy, laboratory, etc., in the hospital	89	<u>3.57</u>	25	<u>3.72</u>	17	<u>3.71</u>	131	<u>3.62</u>
8.	It took me quite some time to learn how to use this clerking/documentation system.	89	<u>3.15</u>	25	<u>2.52</u>	17	<u>2.29</u>	131	<u>2.92</u>
9.	Sometimes I feel the use of this system negatively affects the time I need to fully interact with the patient.	89	<u>3.62</u>	25	<u>2.76</u>	17	<u>2.88</u>	131	<u>3.36</u>
10.	I often feel that the use of this electronic clerking/documentation system appears to increase my daily workload and stress	89	<u>3.69</u>	25	<u>2.72</u>	17	<u>2.53</u>	131	<u>3.35</u>
11.	The use of this new system sometimes negatively affects the number of patients I adequately see in a day.	89	<u>3.61</u>	25	<u>2.64</u>	17	<u>2.65</u>	131	<u>3.30</u>
12.	I feel the system is not easy to use.	89	<u>3.37</u>	25	<u>2.52</u>	17	<u>2.65</u>	131	<u>3.11</u>
13.	Typing with a keyboard, all patients' demographics, investigations, and	89	<u>3.82</u>	25	<u>2.96</u>	17	<u>2.94</u>	131	<u>3.54</u>

(continued)

**Table 2.** Continued.

DS/ N	Survey questions	Dr No	Doctor mean values	Nr No	Nurses mean values	MED No	MED. record officer mean values	Total	unified mean
	diagnostic information are all important for comprehensive care, but I find it difficult typing all with a keyboard								
14.	I easily know where to find any information I am looking for in this new system	89	<u>2.69</u>	25	<u>3.32</u>	17	<u>3.65</u>	131	<u>2.94</u>
15.	I feel this new system has satisfied management and clinicians' expectations for introducing it.	89	<u>2.81</u>	25	<u>3.40</u>	17	<u>3.24</u>	131	<u>2.98</u>
16.	I enjoy maximum user experience each time I use this system.	89	<u>2.85</u>	25	<u>3.56</u>	17	<u>3.29</u>	131	<u>3.05</u>
17.	On a scale of 1–5, how would you rate this electronic health record system: 1/5 or 2/5 or 3/5 or 4/5 or 5/5	89	<u>2.65</u>	25	<u>3.04</u>	17	<u>3.47</u>	131	<u>2.83</u>
18.	I really feel access to internet/network is generally a huge challenge using this electronic health record system.	89	<u>3.39</u>	25	<u>3.00</u>	17	<u>3.47</u>	131	<u>3.33</u>
19.	Sometimes I wish there could be a faster way of inputting patients' health records into this system other than using the keyboard.	89	<u>3.90</u>	25	<u>4.12</u>	17	<u>3.59</u>	131	<u>3.90</u>
20.	Sometimes I am tempted to think that our hospital is not yet prepared for this new age of electronic health record clerking and documentation	89	<u>3.35</u>	25	<u>2.76</u>	17	<u>3.18</u>	131	<u>3.21</u>

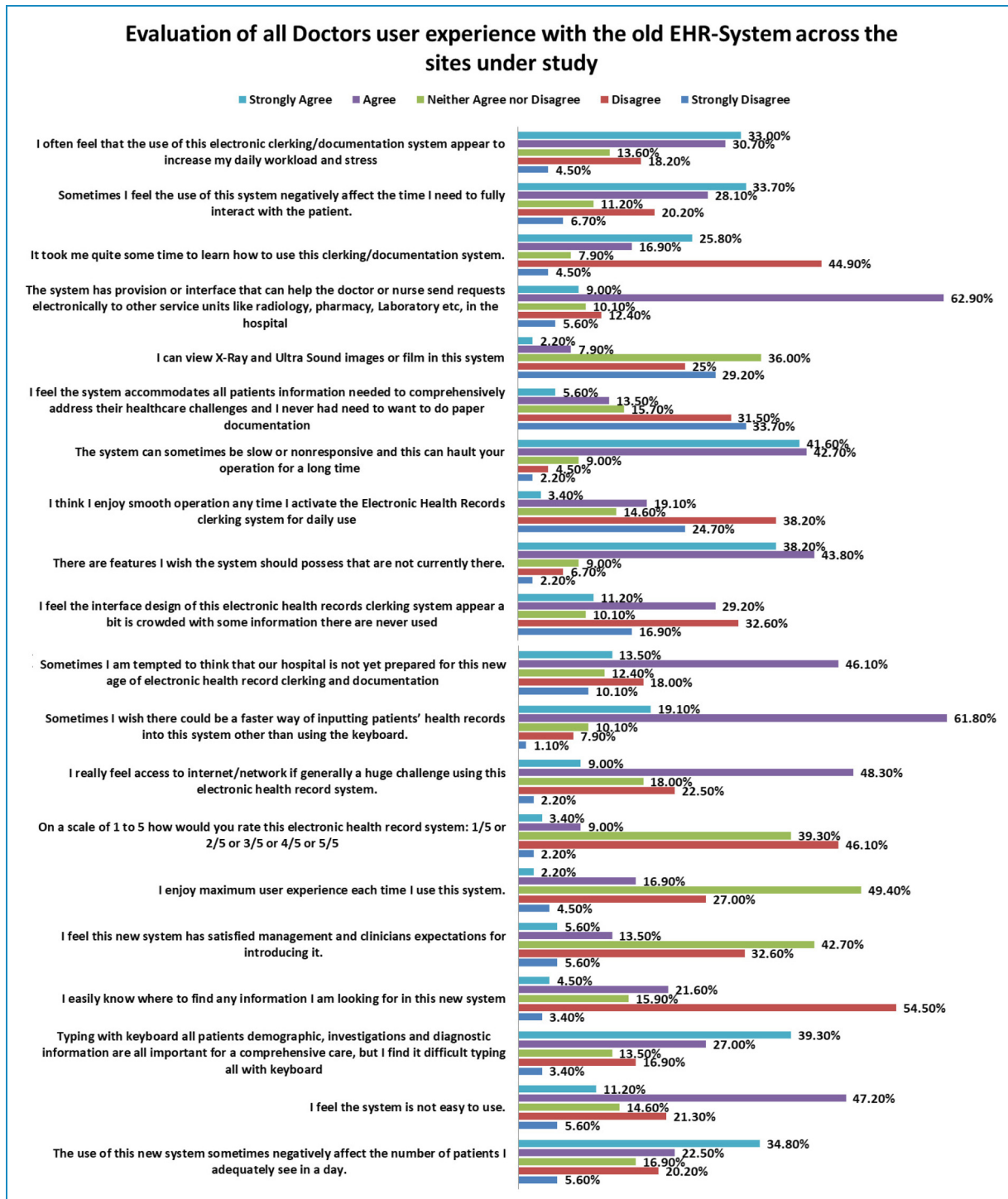
**Table 3.** The 5-point scale interpretation (scoring range of Likert scale of the survey).

Weight/ scale	Mean score range	Mean rating/ interpretation	Further interpretation
5	4.21–5.00	Strongly agree	Very positive
4	3.41–4.20	Agree	Positive
3	2.61–3.40	Neither agree nor disagree	Moderate
2	1.81–2.60	Disagree	Negative
1	1.00–1.80	Strongly disagree	Very negative

Source: Suebwongsuawan, and Nomnian.<sup>42</sup>

a substantial proportion (44.3% agree, 35.9% strongly agree) reported that the system often slows down, hangs, or freezes, leading to frustration. Moreover, many clinicians (55.7%) disagreed that the system accommodates all necessary patient information, indicating a lack of comprehensiveness in data handling.

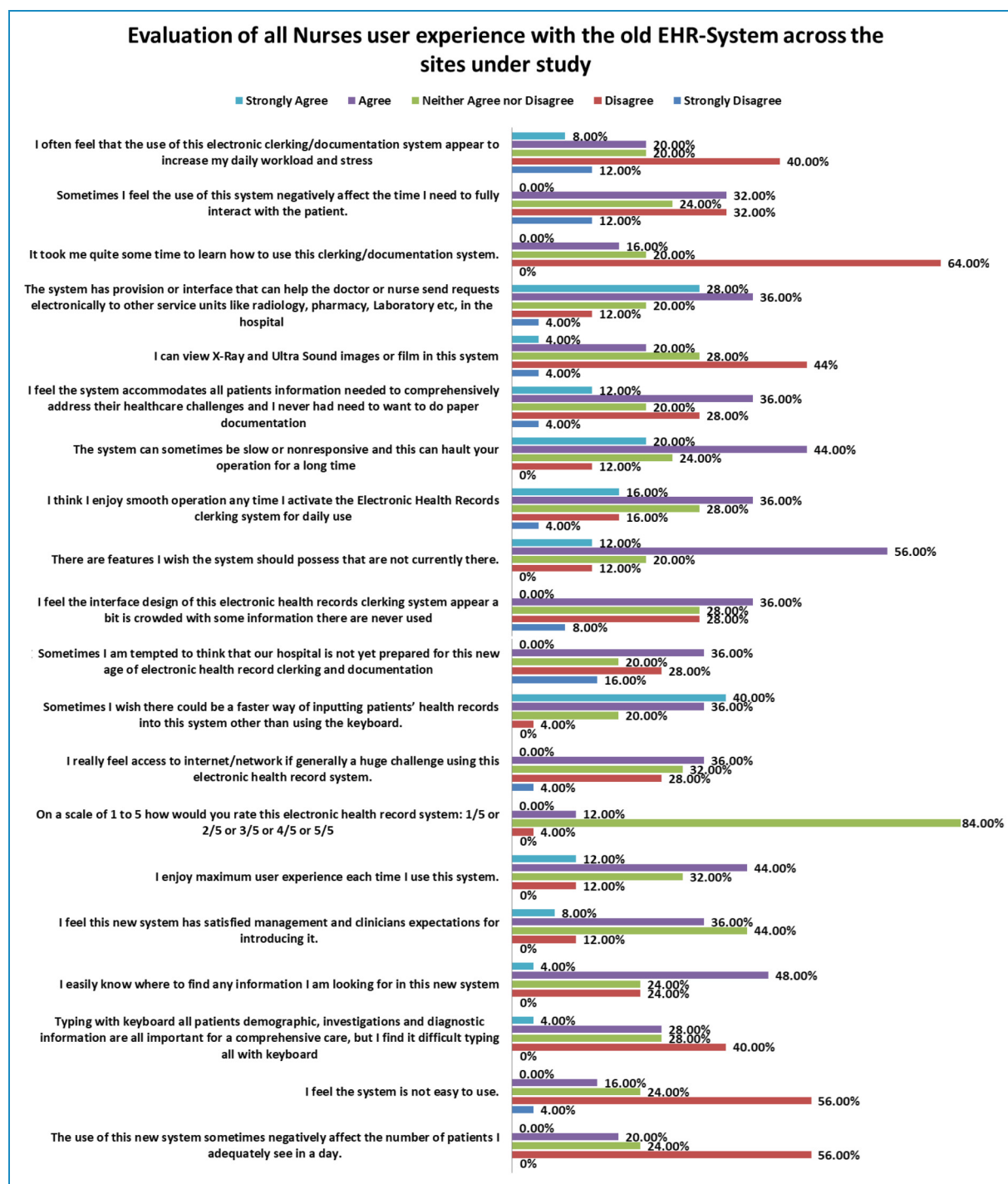
2. *Navigation and ease of use:* Navigation within the system appears to be a challenge, as 43.6% of respondents disagreed or strongly disagreed that information is easy to find, suggesting poor interface design. Furthermore, a large proportion (38.2% agree, 7.6% strongly agree) admitted to looking for shortcuts to bypass usability issues, signaling inefficiencies in system design. Difficulties in typing were also evident, with 56.4% of respondents agreeing that entering patient information is a challenge.



**Figure 2.** Visualization of doctors' user experience with existing EHR systems across the sites under study.

3. *Operational efficiency and impact on workflow:* The system's impact on operational efficiency is concerning. About 48.4% of clinicians reported that learning the system was time-consuming, indicating a steep learning curve. Furthermore, 52.8% felt that the system negatively impacted

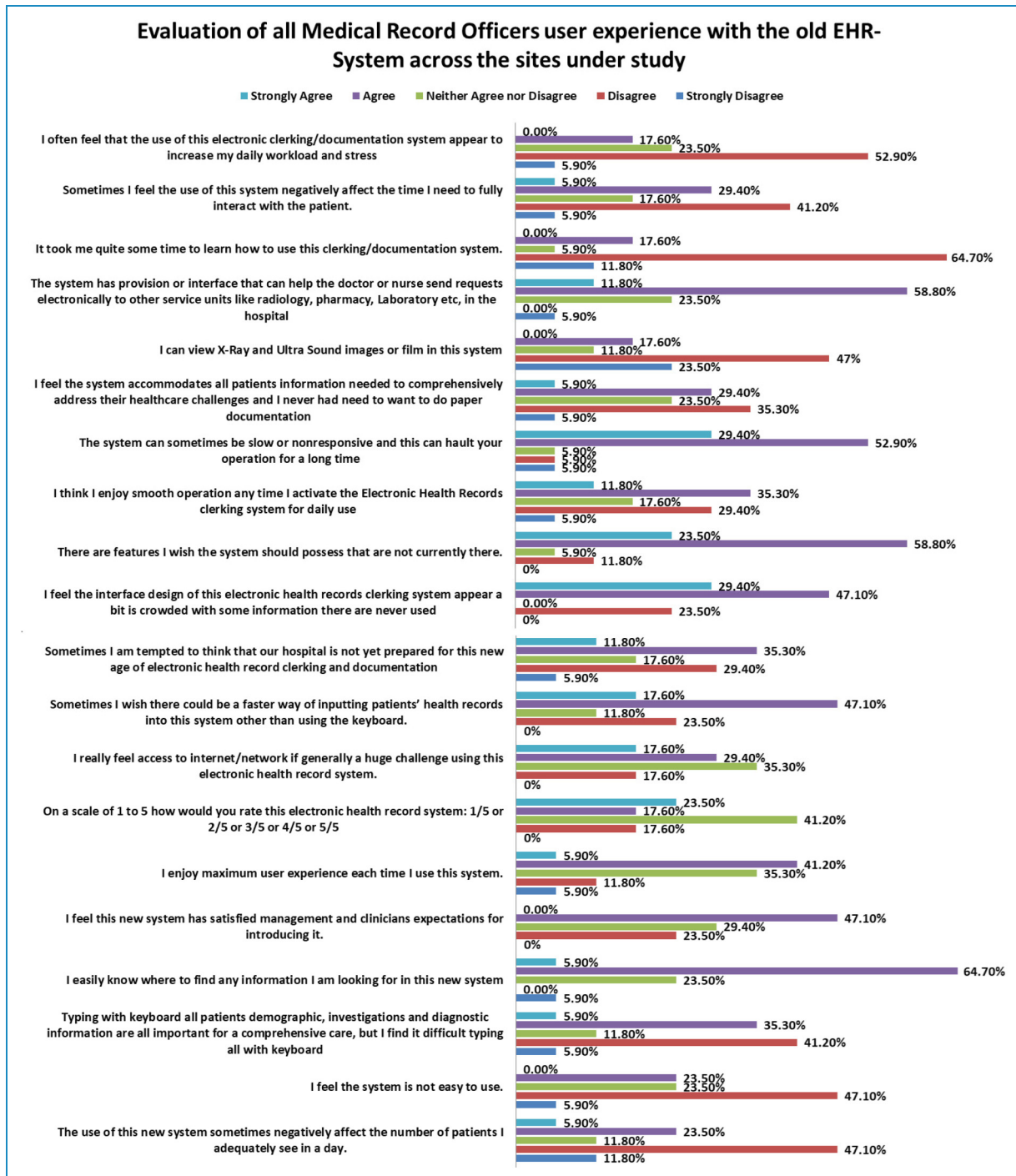
their ability to interact with patients, suggesting that usability problems disrupt clinician-patient engagement. Additionally, 50.7% believed that the system increased their workload and stress, implying inefficiencies in workflow automation.



**Figure 3.** Visualization of nurses' user experience with existing EHR systems across the sites under study.

4. *Clinician satisfaction and system expectations:* Clinician satisfaction levels remain low. Only 5.3% of respondents strongly agreed that the system met management and clinician expectations. Additionally, 48.1% rated the system 3/5, suggesting a neutral stance, while 33.6% rated it 2/5, reflecting dissatisfaction. These findings indicate a pressing need for improvements in system design and functionality.
5. *Technical and infrastructure issues:* Technical and infrastructure challenges further exacerbate usability concerns. A notable 52% of respondents found internet connectivity to be a major challenge, impacting system accessibility and reliability. Additionally,



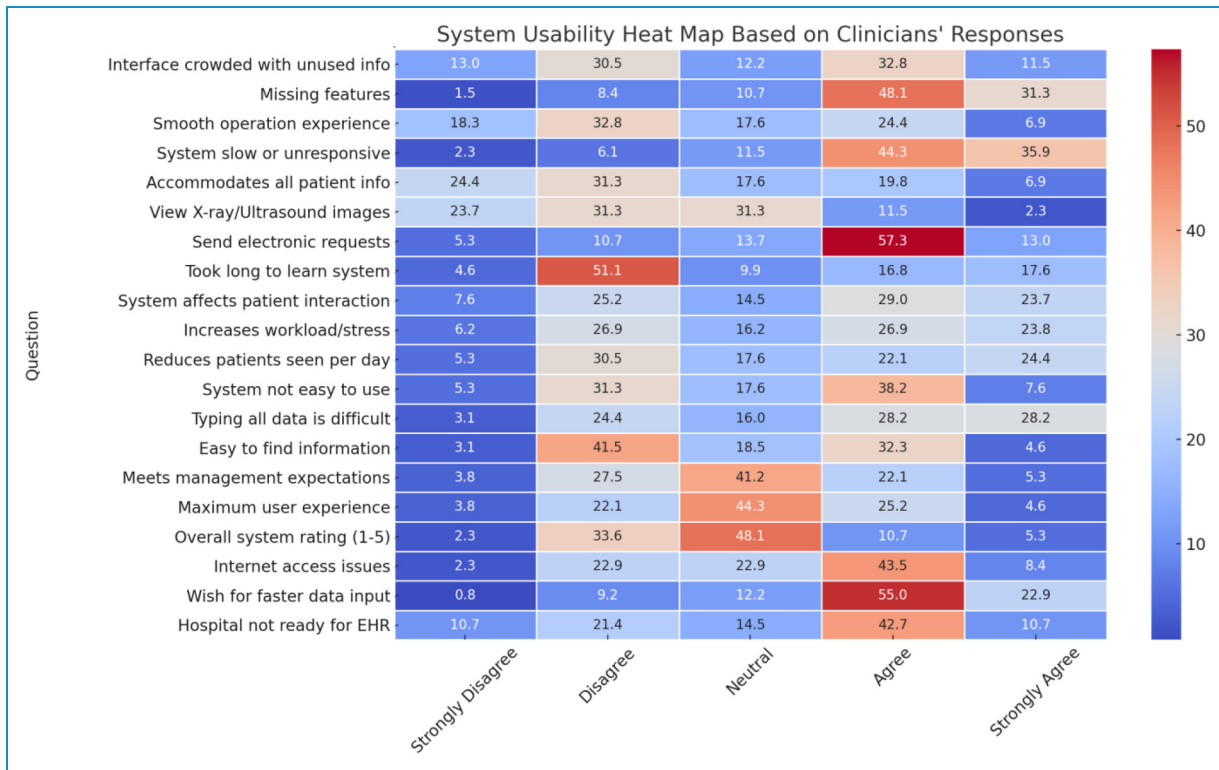


**Figure 4.** Medical record officers' user experience with the existing EHR system across the sites under study.

77.9% of clinicians expressed a desire for a faster input method beyond traditional keyboard typing, highlighting the need for alternative data entry solutions such as voice input or AI-based automation.

*Summary and recommendations:* The findings highlight significant usability issues in the EHR system. To enhance its effectiveness:

- System optimization is needed to address speed and performance issues.
- Improved UI/UX design should prioritize ease of navigation and reduce cognitive load.
- Comprehensive data accommodation should be ensured, minimizing reliance on paper documentation.
- Alternative data entry methods (voice recognition, templates, auto-completion) could improve efficiency.



**Figure 5.** System usability heat map based on clinicians' responses.

- Stronger internet infrastructure is critical to ensure smooth system operation.

Now, Table 2 provides a comparative analysis of clinicians' perspectives on their experiences with the current EHR system, using the mean as a measure of central tendency. The findings show that doctors have a mean score of 4.09, nurses at 3.94, and medical record officers at 3.99, all indicating a desire for additional features not present in the system. Additionally, doctors (mean of 4.17), nurses (3.72), and medical record officers (3.94) agree that the EHR system is often slow and prone to hanging, which significantly affects their operational efficiency. While doctors strongly disagree (mean of 2.26) that the system adequately accommodates necessary patient information, nurses (mean of 3.24) and medical record officers (mean of 2.94) remain neutral on this issue. Further insights can be found in Table 2.

For further engagement with the results of this study please refer to the multidimensional tables of percentages as shown in Appendix 1:

## Discussion

The findings from the analysis of the result highlighted several issues associated with the existing system. For instance, all three categories of clinicians unanimously expressed a desire for additional features that were absent from the

existing system (please see Figures 1–5 and Table 2 for more details). This clearly indicates that sufficient testing of the current system may not have been conducted or that clinicians were not adequately involved in the system acquisition process. User-Centered Design (UCD) is indeed a valuable approach in the development of EHR systems, and should be employed in future developments. By involving users—such as clinicians, nurses, and other healthcare professionals—throughout the design process, UCD ensures that the system is fit for purpose, meets their needs, and improves usability. This approach can lead to more intuitive and efficient EHR systems, ultimately enhancing patient care and safety.<sup>43,44</sup> Implementing UCD in EHR design can significantly reduce errors, improve clinician satisfaction, and enhance overall system performance.<sup>45</sup>

Again, the doctors were particularly adversely affected by the existing system. They reported difficulties in achieving a seamless operation whenever they attempted to utilize the system for their daily tasks. This assertion was corroborated by our daily observations of their interactions with the system. Frequent complaints were made regarding the EHR application freezing or losing previously entered data. Indeed, all clinicians concurred that such issues were commonplace. Additionally, challenges related to network access were noted, which hindered their overall daily operations. There is a clear necessity for a more robust infrastructure to facilitate the effective use of these systems, with some

components potentially being outsourced to cloud services. Poor network and infrastructure have remained major challenges for electronic health record implementation in developing countries.<sup>46–48</sup>

Similarly to the previous point, the doctors expressed dissatisfaction with the system, noting that it lacked the comprehensive patient health information required to effectively manage a patient's case. Specifically, the doctors reported that they had never accessed digital copies of X-rays through this system. The nurses and medical record officers expressed uncertainty regarding the impact of the current system on their daily patient interactions, whereas the doctors explicitly reported a decline in the number of patients they attended to as a consequence of utilizing the existing system. It is plausible to infer that inadequate training in computer skills may be a contributing factor; notably as 56.5% of clinicians acknowledged that they had not received any training in the use of electronic health records. Inadequate training and poor digital skills remain major challenges to EHR adoption in developing economies.<sup>28,49,50</sup> Furthermore, the doctors, who appeared to be the most adversely affected, indicated that the implementation of this system had exacerbated their daily workload and stress levels. Clinician burnout continues to pose a significant challenge in the context of modern technological advancements, including the electronic health record system.<sup>51,52</sup>

Researchers further sought to evaluate the usability of the existing system among clinicians, and it was only the medical record officers who concurred that the system was user-friendly. In contrast, the doctors and nurses remained ambivalent. This disparity highlights a concerning lack of usability among the primary stakeholders, namely the nurses and doctors. The positive feedback from the medical record officers may be attributed to their familiarity with fewer interfaces, which they have likely mastered over time.

The doctors expressed challenges in utilizing a keyboard for data entry, primarily due to the extensive amount of information required for each patient and the high volume of patients they attend to on a daily basis. It is important to note that cognitive burden and burnout are real and remain major issues in electronic health record adoption.<sup>53–55</sup> Indeed, all healthcare providers expressed a desire for alternative methods of data input that do not rely solely on keyboard usage. Researchers propose that this requirement could be effectively addressed by incorporating speech-to-text technology into the design of EHR, thereby enhancing the efficiency of clinical documentation. Evidence suggests that the integration of speech-to-text capabilities can significantly improve the documentation process for doctors when embedded within the system architecture.<sup>56</sup>

In an evaluation of the current system, doctors assigned a rating of 2.65 on a scale from 1 to 5, indicating a notably inadequate performance. Furthermore, there was a general uncertainty among clinicians regarding the readiness of

these hospitals for the adoption of such advanced technological solutions.

This study discovered the usability challenges and feature gaps in electronic health record systems that can be beneficial for improving clinician experiences and enhancing patient care. This study will help the researchers uncover the critical areas of digital healthcare implementation that many researchers were not able to explore. Thus, a new theory on effective digital transformation in healthcare may be arrived at.

In light of the above findings and in summary, it is crucial to enhance the design of the EHR system by adopting a user-centered approach that actively involves clinicians in the development and procurement processes.<sup>43–45</sup> This can be achieved by conducting comprehensive user research to identify specific needs and desired features, followed by iterative testing of prototypes to ensure usability aligns with clinical workflows. Additionally, targeted training programs should be implemented to equip clinicians with the necessary skills to navigate the system effectively, focusing on practical, hands-on sessions that address common challenges identified in the usage, such as slow performance and data retrieval issues.<sup>28,49,50</sup> Comparatively, usability studies from other developing countries, particularly in the sub-Saharan Africa,<sup>21</sup> have similarly highlighted the importance of clinician involvement in EHR design and the need for robust training programs to mitigate frustrations and enhance user satisfaction.<sup>43–45</sup> These studies underscore that without addressing the unique contextual challenges faced by healthcare professionals in developing regions, the potential benefits of digital health solutions may remain unrealized, emphasizing the need for tailored strategies that consider local healthcare dynamics and resource constraints. By integrating these recommendations, the EHR system can be transformed into a more effective tool that supports clinicians in delivering high-quality patient care.

Finally, **the strengths of this study** are evident in its comprehensive evaluation of digital healthcare systems within the unique context of developing countries. By employing a mixed-methods approach that combines qualitative observations with quantitative data from a validated questionnaire, the research effectively captures the diverse experiences of clinical stakeholders, including doctors, nurses, and medical record officers. This inclusive perspective not only highlights specific challenges faced by users but also offers actionable insights for future system improvements, thereby enhancing the relevance and applicability of the findings in similar healthcare settings.

### *Comparing the result of the systems' usability performance with usability of other digital healthcare systems around the world*

The usability heat map based on clinicians' responses provides insights into the perceived strengths and weaknesses

of the digital healthcare system under evaluation. Key usability concerns include difficulties with electronic requests to service units, a long learning curve, system speed issues (e.g., slow performance, non-responsiveness), and a need for faster input methods. These align with global challenges observed in EHR usability studies, particularly in the United States, United Kingdom, and South Korea.

In the United States, research (2025) evaluating EHR usability and its impact on physician burnout found that nearly 50% of physicians experienced burnout due to inefficient EHR design. Excessive clicks, long forms, and data loss were common usability issues. The study, analyzing 32 publications (2009–2024), emphasized the importance of ISO-aligned design to improve user experience and mitigate burnout. Notably, the mean usability score of 80.00 suggests an overall positive assessment, but persistent inefficiencies remain.<sup>29</sup>

Similarly, the United Kingdom faced significant usability challenges in emergency department EHRs. A 2019 study by the RCEM assessed 1663 emergency physicians and reported a median SUS score of 53, below the acceptable usability threshold of 68. This indicates that most EHRs in UK emergency settings fail to meet usability expectations, leading to workflow inefficiencies and potential patient safety risks.<sup>30</sup>

Findings from the heat map align with these concerns, particularly regarding system efficiency and workflow integration. The results show strong agreement among clinicians that the system is slow, difficult to use, and increases stress levels. Electronic requests to service units were the most problematic, with a 57.3% agreement that this feature posed significant usability challenges. The learning curve was also highlighted as a major concern (51.1% disagreement with ease of learning), suggesting that training and system design improvements are needed.

In contrast, Indonesia reported a SUS score of 77.14, indicating “Good” usability in an EHR evaluation at Rumah Keluarga Sehat Clinic. High scores for perspicuity, dependability, efficiency, and stimulation suggest that involving end users in system development is crucial for optimizing EHR usability.<sup>31</sup> This contrasts with the heat map’s results, where system expectations were met only to a limited extent, with 41.2% neutrality and only 5.3% strong agreement.

A study in Sierra Leone assessed digital health tool usability in Kono District. While 72.2% of respondents showed good acceptance and 95.4% expressed satisfaction, barriers such as the lack of offline functionality and slow system performance were major concerns.<sup>32</sup> These findings are consistent with the heat map, which shows 43.5% agreement that internet/network challenges hinder system efficiency, impacting real-time clinical decision-making.

In Australia, a usability-focused study on EMRs found that hospital clinicians emphasized usability improvements

for patient-centered care. Usability issues highlighted in the Australian study—such as navigation challenges and inefficient data input—mirror those in the heat map, where 38.2% of respondents found the system difficult to use, and 55% agreed on the need for faster input methods.<sup>33</sup>

In Germany, a study evaluating EHR usability among university hospital physicians found that while 69% found EHRs helpful, 55% experienced serious adverse events due to system malfunctions.<sup>34</sup> These findings resonate with the heat map’s data on system malfunctions, where 44.3% of respondents agreed that the system slows down and sometimes freezes, affecting workflow.

In South Korea, EHR usability issues in emergency departments included poor patient selection features and limited information visibility, negatively impacting clinician efficiency.<sup>35</sup> The heat map reflects similar concerns, as only 6.9% of clinicians strongly agreed that the system met expectations, while 32.8% disagreed.

Lastly, a sub-Saharan Africa review of EMR usability yielded an overall score of 66%, with ease of learning (71%) ranking highest.<sup>36</sup> This differs from the heat map results, where ease of learning was a major issue, reinforcing the need for better onboarding processes.

A separate US study comparing two EHR systems found that System-1 outperformed System-2 in clinical notes entry, scoring 26% vs. 12%, while both were equally inefficient in information-seeking tasks.<sup>37</sup> This aligns with the heat map’s findings on information retrieval challenges, where 41.5% disagreed that finding information was easy.

In summary, the heat map’s findings align with global usability challenges, emphasizing navigation difficulties, inefficiencies, and increased cognitive workload. While some countries (e.g., Indonesia, Sierra Leone) report high satisfaction rates, others (e.g., UK, US, Germany, and South Korea) struggle with usability-related stress, safety risks, and burnout. The results highlight the need for user-centered design, streamlined workflows, and continuous usability testing to enhance digital healthcare system effectiveness.

### Actionable steps for policymakers and stakeholders

To improve digital health adoption, policymakers should take several actionable steps. First, they should mandate the incorporation of user-centered design principles in the development of EHR systems, ensuring that clinicians’ feedback is integral to the design process. This can be achieved by establishing collaborative platforms where healthcare professionals can share their experiences and suggestions during the system development phase.

Second, comprehensive training programs should be implemented, focusing on the specific functionalities of EHR systems and tailored to different user groups, such as doctors, nurses, and administrative staff. These programs should include hands-on workshops and ongoing support to



help users become proficient and confident in utilizing the technology.

Third, policymakers must invest in the necessary infrastructure to support digital health initiatives, including reliable electricity, high-speed internet access, and adequate technical support. This investment will help mitigate common barriers to effective system use, such as system downtime and connectivity issues.

Additionally, creating supportive policy frameworks that address data privacy, security, and interoperability will foster trust among users and encourage the seamless exchange of information across different healthcare systems. By implementing these strategies, policymakers can facilitate a smoother transition to digital health solutions, ultimately leading to improved healthcare delivery and outcomes.

### *Strategies for improving user experience and clinician engagement with EHR systems*

Improving user experience and clinician engagement with EHR systems requires a multifaceted approach that prioritizes usability, training, and ongoing feedback. First and foremost, adopting a UCD methodology is essential. This involves actively involving clinicians in the design and development process, allowing them to provide input on system features, workflows, and interface design. By conducting comprehensive user research, including surveys, focus groups, and usability testing, developers can identify specific pain points and desired functionalities that align with clinicians' daily tasks. Iterative testing of prototypes with real users ensures that the final product is intuitive and meets the practical needs of healthcare professionals, ultimately enhancing their satisfaction and engagement with the system.

In addition to design improvements, targeted training programs are crucial for equipping clinicians with the skills necessary to navigate EHR systems effectively. These training sessions should be tailored to different user groups, focusing on practical, hands-on experiences that address common challenges, such as slow performance and data retrieval issues. Incorporating ongoing support, such as refresher courses and access to help desks, can further empower clinicians to utilize the system confidently. Moreover, fostering a culture of continuous learning and adaptation within healthcare organizations encourages clinicians to embrace digital tools as integral components of their practice, rather than viewing them as burdensome obligations.

Lastly, establishing a robust feedback mechanism is vital for maintaining clinician engagement and ensuring that EHR systems evolve in response to user needs. This can be achieved by creating channels for clinicians to report usability issues, suggest enhancements, and share their experiences with the system. Regularly scheduled meetings

or forums where clinicians can discuss their challenges and successes with EHR usage can foster a sense of community and collaboration. Additionally, leveraging data analytics to monitor system usage patterns and clinician satisfaction can provide valuable insights for ongoing improvements. By prioritizing user experience and clinician engagement through these strategies, healthcare organizations can enhance the effectiveness of EHR systems, ultimately leading to improved patient care and outcomes.

### *International best practices for usability improvements in EHR systems*

As healthcare systems worldwide increasingly adopt EHR systems, it is essential to draw upon international best practices that have proven effective in enhancing usability and clinician engagement. One notable approach is the implementation of standardized usability evaluation frameworks, such as the SUS and the Health Information Technology Usability Evaluation Scale (Health-ITUES). These tools have been successfully utilized in various countries, including the United Kingdom and Australia, to assess user satisfaction and identify specific areas for improvement. By adopting these standardized metrics, healthcare organizations can benchmark their EHR systems against global standards, facilitating a more objective evaluation of usability and enabling targeted enhancements based on user feedback.

Another best practice is the integration of interdisciplinary teams in the design and implementation of EHR systems. Countries like Sweden and the Netherlands have demonstrated the effectiveness of involving a diverse range of stakeholders, including clinicians, IT professionals, and patient representatives, in the development process. This collaborative approach ensures that multiple perspectives are considered, leading to a more comprehensive understanding of user needs and preferences. By fostering collaboration among various disciplines, healthcare organizations can create EHR systems that are not only user-friendly but also aligned with clinical workflows and patient care objectives.

Furthermore, international best practices emphasize the importance of continuous training and support for clinicians. For instance, in Canada, healthcare organizations have adopted a model of ongoing education that includes regular workshops, online training modules, and peer mentoring programs. This model not only equips clinicians with the necessary skills to navigate EHR systems effectively but also fosters a culture of continuous improvement and adaptation. By providing ongoing support, healthcare organizations can help clinicians overcome initial resistance to new technologies and encourage them to engage fully with EHR systems, ultimately enhancing their overall experience and satisfaction.



Additionally, leveraging technology to enhance usability is a growing trend observed in countries like Singapore and Germany. These nations have invested in advanced user interface designs that prioritize simplicity and efficiency, incorporating features such as customizable dashboards, voice recognition, and predictive text functionalities. By utilizing cutting-edge technology, healthcare organizations can streamline workflows and reduce cognitive load, allowing clinicians to focus more on patient care rather than navigating complex systems. Implementing these international best practices can significantly improve the usability of EHR systems, leading to enhanced clinician engagement and better patient outcomes across diverse healthcare settings.

In summary, by adopting standardized usability evaluation frameworks, fostering interdisciplinary collaboration, providing continuous training and support, and leveraging advanced technology, healthcare organizations can implement effective strategies for improving EHR usability. These international best practices not only enhance clinician satisfaction but also contribute to the overall effectiveness of digital health solutions, ultimately leading to improved healthcare delivery and patient care.

## Conclusion

In conclusion, this research has illuminated several key findings regarding the usability and performance of EHR systems within tertiary and university teaching hospitals in Southern Nigeria, revealing significant gaps in system design and functionality that must be addressed to enhance clinical service delivery. The study found that a substantial 79.4% of clinicians expressed a desire for additional features that are currently absent from the EHR systems, indicating a critical disconnect between the existing technology and the practical needs of healthcare providers. Moreover, the reported issues of system slowness and interruptions, experienced by 80.2% of respondents, not only hinder clinical workflows but also contribute to clinician frustration and potential burnout, particularly among doctors who rated the system poorly. These findings underscore the urgent need for a comprehensive reassessment of the EHR systems, emphasizing the importance of revisiting their design to ensure alignment with clinician workflows and operational realities. Specific actions should include engaging clinicians in the redesign process to foster a sense of ownership and ensure that the systems are tailored to meet their daily operational needs effectively. Additionally, implementing targeted training programs will equip clinicians with the necessary skills to navigate the systems efficiently, addressing common challenges identified in the study. The relevance of this research extends beyond the immediate findings, as it contributes valuable insights to healthcare policy and digital transformation efforts in Nigeria. By addressing the highlighted usability issues, policymakers

can facilitate a more successful integration of digital health solutions, paving the way for improved health outcomes across the nation. Ultimately, this study serves as a call to action for stakeholders to prioritize clinician engagement and system usability in their digital health initiatives, ensuring that the benefits of technology are fully realized in the pursuit of better healthcare outcomes.

Future research should aim to explore the impact of emerging technologies, such as artificial intelligence and machine learning, on the usability of digital health systems, assessing how these innovations can enhance user experience and streamline workflows. Policymakers should support initiatives that encourage the integration of these technologies into existing EHR systems while ensuring that adequate training and resources are provided to healthcare professionals. Additionally, creating a feedback mechanism that allows users to report usability issues in real time can help inform ongoing improvements and foster a culture of continuous enhancement in digital healthcare usability.

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## Ethical considerations

It is important to highlight that ethics committees do not issue approval numbers for research; instead, they provide certificates of approval. Before commencing our study, we obtained the necessary ethical clearances from the relevant committees of each tertiary/university teaching hospital where the research took place. These approvals were formally documented through three certificates, each certificate issued by the respective hospital's ethics committee. We presented the certificates to the appropriate department and unit heads to obtain institutional support. Following a systematic process, we secured research approvals from the following ethics committees:

## Author contributions

OUS oversaw the distribution and retrieval of the survey, wrote the manuscript, and conducted data analysis. OO and OWO

contributed to data collection through access to various unit and department heads. They also monitored the survey distribution across facilities. OUS, OO, and OWO all reviewed and validated the survey design; all authors read and approved the manuscript. Meanwhile, this project is part of a series of research projects in the area of healthcare digital transformation in developing countries and was supervised by TS, NP, and FB. All authors read, reviewed, and approved the manuscript.

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### Guarantor

OUS.

### Informed consent

The researchers could confirm that written consent was obtained from the participant prior to the study.

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## Appendix I

Multidimensional tabular visualization of Figures 1–4 as shown in the same order via Appendix Tables A1, A2, A3, and A4, respectively.

**Table A1.** Overall summary of evaluation of all clinicians user experience with the existing EHR system across the sites under study.

S/ No	Survey questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total %ages	Mean Score
1.	I feel the interface design of this electronic health records clerking system appears a bit crowded with some information that is never used	13.0%	30.5%	12.2%	32.8%	11.5%	100%	
2.	There are features I wish the system should possess that are not currently there.	1.5%	8.4%	10.7%	48.1%	31.3%	100%	
3.	I think I enjoy smooth operation any time I activate the electronic health records clerking system for daily use	18.3%	32.8%	17.6%	24.4%	6.9%	100%	
4.	The system can sometimes be slow or nonresponsive and this can halt your operation for a long time	2.3%	6.1%	11.5%	44.3%	35.9%	100%	
5.	I feel the system accommodates all patients information needed to comprehensively address their healthcare challenges, and I never had need to want to do paper documentation	24.4%	31.3%	17.6%	19.8%	6.9%	100%	
6.	I can view X-ray and ultrasound images or film in this system	23.7	31.3%	31.3%	11.5%	2.3%	100%	
7.	The system has a provision or interface that can help the doctor or nurse send requests electronically to other service units like radiology, pharmacy, laboratory, etc., in the hospital	5.3%	10.7%	13.7%	57.3%	13.0%	100%	
8.	It took me quite some time to learn how to use this clerking/documentation system.	4.6%	51.1%	9.9%	16.8%	17.6%	100%	
9.	Sometimes I feel the use of this system negatively affects the time I need to fully interact with the patient.	7.6%	25.2%	14.5%	29.0%	23.7%	100%	
10	I often feel that the use of this electronic clerking/ documentation system appears to increase my daily workload and stress	6.2%	26.9%	16.2%	26.9%	23.8%	100%	
11.	The use of this new system sometimes negatively affects the number of patients I adequately see in a day.	5.3%	30.5%	17.6%	22.1%	24.4%	100%	
12.	I feel the system is not easy to use.	5.3%	31.3%	17.6%	38.2%	7.6%	100%	
13.	Typing with a keyboard, all patients' demographics, investigations, and diagnostic	3.1%	24.4%	16.0%	28.2%	28.2%	100%	

(continued)



Table A1. Continued.

S/ No	Survey questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total %ages	Mean Score
	information are all important for comprehensive care, but I find it difficult typing all with a keyboard							
14.	I easily know where to find any information I am looking for in this new system	3.1%	41.5%	18.5%	32.3%	4.6%	100%	
15.	I feel this new system has satisfied management and clinicians expectations for introducing it.	3.8%	27.5%	41.2%	22.1%	5.3%	100%	
16.	I enjoy maximum user experience each time I use this system.	3.8%	22.1%	44.3%	25.2%	4.6%	100%	
17.	On a scale of 1–5, how would you rate this electronic health record system: 1/5 or 2/5 or 3/5 or 4/5 or 5/5	2.3%	33.6%	48.1%	10.7%	5.3%	100%	
18.	I really feel access to internet/network, if generally a huge challenge using this electronic health record system.	2.3%	22.9%	22.9%	43.5%	8.4%	100%	
19.	Sometimes I wish there could be a faster way of inputting patients' health records into this system other than using the keyboard.	.8%	9.2%	12.2%	55.0%	22.9%	100%	
20.	Sometimes I am tempted to think that our hospital is not yet prepared for this new age of electronic health record clerking and documentation	10.7%	21.4%	14.5%	42.7%	10.7%	100%	

Table A2. Summary of evaluation of the doctor's user experience with the existing EHR system across the sites under study.

S/ No	Survey questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total % ages
1.	I feel the interface design of this electronic health records clerking system appears a bit crowded with some information that is never used	16.9%	32.6%	10.1%	29.2%	11.2%	100%
2.	There are features I wish the system should possess that are not currently there.	2.2%	6.7%	9.0%	43.8%	38.2%	100%
3.	I think I enjoy smooth operation any time I activate the electronic health records clerking system for daily use	24.7%	38.2%	14.6%	19.1%	3.4%	100%
4.	The system can sometimes be slow or nonresponsive, and this can halt your operation for a long time	2.2%	4.5%	9.0%	42.7%	41.6%	100%
5.	I feel the system accommodates all patients information needed to comprehensively address their healthcare challenges and I never had need to want to do paper documentation	33.7%	31.5%	15.7%	13.5%	5.6%	100%

(continued)

Table A2. Continued.

S/ No	Survey questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total % ages
6.	I can view X-ray and ultrasound images or film in this system	29.2%	24.7%	36.0%	7.9%	2.2%	100%
7.	The system has a provision or interface that can help the doctor or nurse send requests electronically to other service units like radiology, pharmacy, laboratory, etc., in the hospital	5.6%	12.4%	10.1%	62.9%	9.0%	100%
8.	It took me quite some time to learn how to use this clerking/documentation system.	4.5%	44.9%	7.9%	16.9%	25.8%	100%
9.	Sometimes I feel the use of this system negatively affects the time I need to fully interact with the patient.	6.7%	20.2%	11.2%	28.1%	33.7%	100%
10	I often feel that the use of this electronic clerking/ documentation system appears to increase my daily workload and stress	4.5%	18.2%	13.6%	30.7%	33.0%	100%
11.	The use of this new system sometimes negatively affects the number of patients I adequately see in a day.	5.6%	20.2%	16.9%	22.5%	34.8%	100%
12.	I feel the system is not easy to use.	5.6%	21.3%	14.6%	47.2%	11.2%	100%
13.	Typing with a keyboard, all patients' demographics, investigations, and diagnostic information are all important for comprehensive care, but I find it difficult typing all with a keyboard	3.4%	16.9%	13.5%	27.0%	39.3%	100%
14.	I easily know where to find any information I am looking for in this new system	3.4%	54.5%	15.9%	21.6%	4.5%	100%
15.	I feel this new system has satisfied management and clinicians' expectations for introducing it.	5.6%	32.6%	42.7%	13.5%	5.6%	100%
16.	I enjoy maximum user experience each time I use this system.	4.5%	27.0%	49.4%	16.9%	2.2%	100%
17.	On a scale of 1–5, how would you rate this electronic health record system: 1/5 or 2/5 or 3/5 or 4/5 or 5/5	2.2%	46.1%	39.3%	9.0%	3.4%	100%
18.	I really feel access to internet/network is generally a huge challenge using this electronic health record system.	2.2%	22.5%	18.0%	48.3%	9.0%	100%
19.	Sometimes I wish there could be a faster way of inputting patients' health records into this system other than using the keyboard.	1.1%	7.9%	10.1%	61.8%	19.1%	100%
20.	Sometimes I am tempted to think that our hospital is not yet prepared for this new age of electronic health record clerking and documentation	10.1%	18.0%	12.4%	46.1%	13.5%	100%

**Table A3.** Summary of evaluation of nurses user experience with the existing EHR system across the sites under study.

S/ No	Survey questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total % ages
1.	I feel the interface design of this electronic health records clerking system appears a bit crowded with some information that is never used	8.0%	28.0%	28.0%	36.0%	0%	100%
2.	There are features I wish the system should possess that are not currently there.	0%	12.0%	20.0%	56.0%	12.0%	100%
3.	I think I enjoy smooth operation any time I activate the electronic health records clerking system for daily use	4.0%	16.0%	28.0%	36.0%	16.0%	100%
4.	The system can sometimes be slow or nonresponsive and this can halt your operation for a long time	0%	12.0%	24.0%	44.0%	20.0%	100%
5.	I feel the system accommodates all patients' information needed to comprehensively address their healthcare challenges, and I never had need to want to do paper documentation	4.0%	28.0%	20.0%	36.0%	12.0%	100%
6.	I can view X-ray and ultrasound images or film in this system	4.0%	44.0%	28.0%	20.0%	4.0%	100%
7.	The system has a provision or interface that can help the doctor or nurse send requests electronically to other service units like radiology, pharmacy, laboratory, etc., in the hospital	4.0%	12.0%	20.0%	36.0%	28.0%	100%
8.	It took me quite some time to learn how to use this clerking/documentation system	0%	64.0%	20.0%	16.0%	0%	100%
9.	Sometimes I feel the use of this system negatively affects the time I need to fully interact with the patient.	12.0%	32.0%	24.0%	32.0%	0%	100%
10	I often feel that the use of this electronic clerking/ documentation system appears to increase my daily workload and stress	12.0%	40.0%	20.0%	20.0%	8.0%	100%
11.	The use of this new system sometimes negatively affects the number of patients I adequately see in a day.	0%	56.0%	24.0%	20.0%	0%	100%
12.	I feel the system is not easy to use.	4.0%	56.0%	24.0%	16.0%	0%	100%
13.	Typing with a keyboard, all patients' demographics, investigations, and diagnostic information are all important for comprehensive care, but I find it difficult typing all with a keyboard	0%	40.0%	28.0%	28.0%	4.0%	100%
14.	I easily know where to find any information I am looking for in this new system	0%	24.0%	24.0%	48.0%	4.0%	100%
15.	I feel this new system has satisfied management and clinicians' expectations for introducing it.	0%	12.0%	44.0%	36.0%	8.0%	100%

(continued)

**Table A3.** Continued.

S/ No	Survey questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total % ages
16.	I enjoy maximum user experience each time I use this system.	0%	12.0%	32.0%	44.0%	12.0%	100%
17.	On a scale of 1–5, how would you rate this electronic health record system: 1/5 or 2/5 or 3/5 or 4/5 or 5/5	0%	4.0%	84.0%	12.0%	0%	100%
18.	I really feel access to internet/network is generally a huge challenge using this electronic health record system.	4.0%	28.0%	32.0%	36.0%	0%	100%
19.	Sometimes I wish there could be a faster way of inputting patients' health records into this system other than using the keyboard.	0%	4.0%	20.0%	36.0%	40.0%	100%
20.	Sometimes I am tempted to think that our hospital is not yet prepared for this new age of electronic health record clerking and documentation	16.0%	28.0%	20.0%	36.0%	0%	100%

**Table A4.** Summary of evaluation of medical record officers' user experience with the existing EHR system across the sites under study.

S/ No	Survey questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total % ages
1.	I feel the interface design of this electronic health records clerking system appears a bit crowded with some information that is never used	0%	23.5%	0%	47.1%	29.4%	100%
2.	There are features I wish the system should possess that are not currently there.	0%	11.8%	5.9%	58.8%	23.5%	100%
3.	I think I enjoy smooth operation any time I activate the electronic health records clerking system for daily use	5.9%	29.4%	17.6%	35.3%	11.8%	100%
4.	The system can sometimes be slow or nonresponsive and this can halt your operation for a long time	5.9%	5.9%	5.9%	52.9%	29.4%	100%
5.	I feel the system accommodates all patients information needed to comprehensively address their healthcare challenges, and I never had need to want to do paper documentation	5.9%	35.3%	23.5%	29.4%	5.9%	100%
6.	I can view X-ray and ultrasound images or film in this system	23.5%	47.1%	11.8%	17.6%	0%	100%
7.	The system has a provision or interface that can help the doctor or nurse send requests electronically to other service units like radiology, pharmacy, laboratory, etc., in the hospital	5.9%	0%	23.5%	58.8%	11.8%	100%

(continued)

Table A4. Continued.

S/ No	Survey questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total % ages
8.	It took me quite some time to learn how to use this clerking/documentation system.	11.8%	64.7%	5.9%	17.6%	0%	100%
9.	Sometimes I feel the use of this system negatively affects the time I need to fully interact with the patient.	5.9%	41.2%	17.6%	29.4%	5.9%	100%
10	I often feel that the use of this electronic clerking/documentation system appears to increase my daily workload and stress	5.9%	52.9%	23.5%	17.6%	0%	100%
11.	The use of this new system sometimes negatively affects the number of patients I adequately see in a day.	11.8%	47.1%	11.8%	23.5%	5.9%	100%
12.	I feel the system is not easy to use.	5.9%	47.1%	23.5%	23.5%	0%	100%
13.	Typing with a keyboard, all patients' demographics, investigations, and diagnostic information are all important for comprehensive care, but I find it difficult typing all with a keyboard	5.9%	41.2%	11.8%	35.3%	5.9%	100%
14.	I easily know where to find any information I am looking for in this new system	5.9%	0%	23.5%	64.7%	5.9%	100%
15.	I feel this new system has satisfied management and clinicians' expectations for introducing it.	0%	23.5%	29.4%	47.1%	0%	100%
16.	I enjoy maximum user experience each time I use this system.	5.9%	11.8%	35.3	41.2%	5.9%	100%
17.	On a scale of 1–5, how would you rate this electronic health record system: 1/5 or 2/5 or 3/5 or 4/5 or 5/5	0%	17.6%	41.2%	17.6%	23.5%	100%
18.	I really feel access to internet/network is generally a huge challenge using this electronic health record system.	0%	17.6%	35.3%	29.4%	17.6%	100%
19.	Sometimes I wish there could be a faster way of inputting patients' health records into this system other than using the keyboard.	0%	23.5%	11.8%	47.1%	17.6%	100%
20.	Sometimes I am tempted to think that our hospital is not yet prepared for this new age of electronic health record clerking and documentation	5.9%	29.4%	17.6%	35.3%	11.8%	100%