

Evaluating Electronic Medical Records [EMR] usability in Kenyan Clinical Information Network [CIN] hospitals: Task efficiency, errors, and a systematic assessment model

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ABSTRACT

Electronic Medical Records (EMRs) are now central to clinical care delivery, yet persistent usability challenges continue to limit their optimal use, particularly in resource-constrained healthcare settings. This study evaluated the usability and task efficiency of EMR systems across Kenyan county hospitals and developed a systematic model for assessing EMR usability in clinical practice. Guided by a pragmatic paradigm and Nielsen's Usability Heuristics within a Human-Computer Interaction (HCI) framework, the study employed a convergent parallel mixed-methods design across 12 purposively selected Clinical Information Network (CIN) hospitals, drawing on structured questionnaires (n = 132), semi-structured interviews (n = 16), and non-participant observations; quantitative data were analyzed descriptively using R and Python, while qualitative data were analyzed through inductive, axial, and selective coding. Overall, 71.8% of participants rated the EMR systems as competent and 13.7% as outstanding, with task-specific satisfaction highest for information retrieval (72.6%), followed by medication prescription (66.2%) and data entry (65.3%); navigation was rated easy by 70% of respondents, and 52% reported rarely encountering errors, although slow system response times, cumbersome help ticket workflows, and inconsistent interface design emerged as significant barriers. These findings informed the development of a systematic EMR Usability Evaluation Model, a stage-based scoring framework that combines quantitative usability ratings across ten evaluation dimensions with a structured rubric enabling consistent, comparable, and repeatable usability scoring across facilities and systems, distinguishing it from prior descriptive evaluation approaches. The study concludes that EMR systems in Kenyan county hospitals are largely usable and beneficial to clinical workflows, though targeted improvements in interface design, error recovery, and system responsiveness are needed. Practically, the proposed model offers hospital administrators and system developers a replicable tool for benchmarking EMR performance, while enabling policymakers to institutionalize periodic usability assessments and integrated user feedback mechanisms for sustained system improvement.

Keywords: Electronic Medical Records, Clinical Workflows, Human-Computer Interaction, Kenya, Nielsen's Heuristics, Usability Evaluation

I. INTRODUCTION

The healthcare industry has undergone a transformative shift with the advent of Electronic Medical Records (EMRs). EMRs are widely cited as tools for improving clinical efficiency and data management, yet usability challenges continue to undermine their effectiveness in practice, leading to delays in clinical processes, reduced user satisfaction, and increased risk of error (Ding & Peng, 2022). Evidence indicates that the mere presence of an EMR system does not necessarily translate into improved quality and safety of care, suggesting that usability significantly influences system effectiveness.

Usability refers to how useful, usable, and satisfying a system is for its intended users, and is multidimensional, encompassing efficiency, effectiveness, learnability, satisfaction, accessibility, and error prevention (Bitkina et al., 2020; Meehan et al., 2016). Because healthcare information systems involve high-stakes decision-making and time-sensitive workflows, holistic evaluation across these dimensions is essential (Baporikar, 2024). Yet in many hospital settings, including those in Kenya, EMR users continue to experience inefficient task execution, frequent errors, and difficulties with learnability, navigation, and information retrieval. Despite advancements in EMR technology, limited attention has been given to end-user experience and systematic usability evaluation; existing studies have largely focused on adoption rather than on developing structured frameworks for consistently measuring and improving usability across systems (Josiah & Otieno, 2024).

In Kenya, healthcare facilities have increasingly adopted EMRs to improve record-keeping and patient care (Oyugi et al., 2020), relying on a range of systems including OpenMRS, KenyaEMR, and IQCare, with larger facilities more likely to have adopted full-featured platforms (Paton & Muinga, 2018; SS & Rajkumar, 2024). However,

adoption has been poorly coordinated, resulting in fragmented systems with limited interoperability interoperability (Kariuki & Richard, 2024), prompting the Ministry of Health to establish Standards and Guidelines for EMR Systems to promote compatibility. This mirrors a broader global pattern in which EMR adoption has been uneven: some countries have integrated EMRs effectively (Park & Han, 2017), while developing nations continue to lag due to cost barriers and workflow-related resistance (Jimma & Enyew, 2022).

This study is anchored in Human-Computer Interaction (HCI), which provides principles for designing intuitive interfaces (Alrizq et al., 2022; Motlagh & Safaei, 2022), operationalized through Nielsen's Usability Heuristics, a framework of ten empirically derived principles for evaluating interface design (Alonso-Ríos et al., 2018; Nielsen, 1994b). Heuristics such as visibility of system status, error prevention, and recognition rather than recall are particularly relevant to clinical interfaces (Asgari et al., 2024; Gates et al., 2021; Jeddi et al., 2020), and heuristic evaluations have been shown to identify a large majority of critical usability issues before implementation (Robertson et al., 2024).

Empirical evidence demonstrates the operational value of well implemented EMRs: adoption has been linked to substantial reductions in chart-handling time and administrative inquiries (Albagmi, 2021; Baratta et al., 2022), freeing clinician time for direct patient care (Robertson et al., 2024). In Kenya specifically, EMR implementation has been associated with improved adherence to clinical protocols and reduced documentation errors (Kelly, 2022a), while automated decision support has improved ordering of critical monitoring tests (Rojo et al., 2022a). At the hospital level, EMRs have improved care coordination, reduced duplicate testing, and generated cost savings (Adler-Milstein & Jha, 2017; Kruse et al., 2017). Despite these gains, there remains a need for a structured, comprehensive model for evaluating EMR usability that can systematically assess user interaction, identify usability gaps, and support continuous system improvement.

1.1 Statement of the Problem

While EMRs have been widely adopted across Kenyan and global healthcare settings to improve clinical workflows and decision-making, persistent usability challenges, including inefficient task execution, frequent user errors, and poor navigation and information retrieval, continue to limit their effectiveness and negatively affect patient outcomes. Existing research has predominantly focused on EMR adoption and implementation, with limited attention to systematic, structured evaluation of end-user experience. Consequently, there is no consistent, comparable framework for measuring how usability challenges manifest across different EMR systems and user groups in real-world healthcare environments, leaving a gap in how usability can be systematically assessed and improved. This study addresses this gap by developing a structured model for evaluating EMR usability, one capable of systematically assessing user interaction, identifying usability gaps, and supporting continuous system improvement (Josiah & Otieno, 2024)

1.2 Research Objectives

- i. To evaluate the efficiency of core tasks performed by healthcare professionals within the EMR systems, specifically patient data entry, medication prescription, and medical record retrieval, using task completion time, error frequency, and user-reported satisfaction as evaluation metrics.
- ii. To design a stage-based EMR usability evaluation model that scores usability across ten empirically grounded dimensions (including efficiency, effectiveness, learnability, navigation, error prevention, and satisfaction) using a structured, weighted rubric, offering a standardized, comparable, and repeatable alternative to existing usability assessments, which largely rely on descriptive, non-quantified evaluation.

II. LITERATURE REVIEW

2.1 Theoretical Review

Usability encompasses multiple interrelated dimensions efficiency, effectiveness, learnability, satisfaction, accessibility, and error prevention and recovery (Bitkina et al., 2020) whose holistic evaluation is essential in EMRs given the high-stakes decision-making, time-sensitive workflows, and diverse user expertise that characterize healthcare information systems (Baporikar, 2024). A comprehensive usability assessment ensures that EMRs not only support clinical tasks but also minimize cognitive load, reduce errors, and enhance user satisfaction, ultimately supporting adoption and improved patient outcomes. To systematically examine usability within clinical environments, this study adopts a combined conceptual and analytical framework: Human-Computer Interaction (HCI) provides the conceptual foundation, while Nielsen's Usability Heuristics provides the analytical framework for structured evaluation.

2.1.1 Human-Computer Interaction as a Conceptual Foundation

HCI is an interdisciplinary field that provides foundational principles and design approaches for understanding and improving interactions between users and computer systems, in order to optimize usability, efficiency, and user satisfaction (Alrizq et al., 2022). These principles emphasize intuitive interfaces that align with users' cognitive processes and task requirements. In healthcare contexts, effective application of HCI principles is critical for developing

EMR systems that accommodate the complex workflows and high-stakes demands of clinical environments (Motlagh & Safaei, 2022).

Ten HCI principles are of particular relevance to EMR design (Anjum et al., 2024): user-centered design, which involves end users throughout the design and development process so that the system reflects real clinical needs and workflows; visibility and feedback, ensuring the system communicates the results of user actions clearly and immediately; consistency and standards, so that interaction patterns remain predictable and knowledge transfers across the system; efficiency and effectiveness, enabling users to complete tasks quickly and accurately; flexibility and customization, allowing users to adapt the interface to individual preferences and working styles; error prevention and recovery, designing the system to avert mistakes and guide users clearly when they occur; minimized cognitive load, presenting information in an organized manner that reduces mental effort; accessibility, ensuring usability for users with diverse abilities and levels of technological proficiency; aesthetics and design, so that a visually appealing interface reinforces rather than detracts from functionality; and usability testing, the iterative involvement of real users in identifying and refining problem areas. Collectively, these principles provide the conceptual lens through which this study examines how EMR interface design shapes clinical usability.

2.1.2 Nielsen's Usability Heuristics as an Analytical Framework

Nielsen's Usability Heuristics, developed by (Nielsen, 1994a), represent one of the most established and widely adopted usability evaluation frameworks, comprising ten empirically derived principles refined to provide broad explanatory coverage across interface types (Alonso-Ríos et al., 2018). Their continued relevance lies in their ability to identify potential usability problems efficiently, without requiring extensive user testing, making heuristic evaluation a practical approach for early identification of interface-level problems and a well-validated basis for systematic, structured inspection and iterative design (Liu & Yu, 2024).

The ten heuristics are: visibility of system status, ensuring the system maintains transparent, timely feedback about its current state (Jeddi et al., 2020); match between the system and the real world, using language and concepts familiar to users rather than system-oriented terms; user control and freedom, providing clearly marked "emergency exits" that let users undo actions and recover from mistakes; consistency and standards, maintaining predictable design elements and adherence to established conventions; error prevention, incorporating proactive safeguards such as input validation and confirmation prompts to mitigate risk in high-stakes environments (Gates et al., 2021); recognition rather than recall, minimizing memory load by keeping relevant objects, actions, and information visible rather than requiring users to remember them (Asgari et al., 2024); flexibility and efficiency of use, accommodating both novice and expert users through accelerators and shortcuts; aesthetic and minimalist design, removing unnecessary interface elements so users can focus on essential tasks; help users recognize, diagnose, and recover from errors, through plain-language error messages that suggest constructive solutions; and help and documentation, providing accessible guidance for users who need it.

Several of these heuristics carry particular weight for clinical interfaces. Visibility of system status is important where clinicians need immediate confirmation that information has been saved, orders submitted, or results updated. Error prevention is especially consequential because erroneous data entry, selection, or interpretation can have direct implications for patient safety (Zhang et al., 2003). Recognition rather than recall is likewise central to EMR use, since clinicians interact with the system while simultaneously attending to patients, interpreting clinical information, and coordinating care; interfaces that keep relevant information visible reduce the need to remember details across screens and tasks.

2.1.3 Limitations and Extensions of Heuristic Evaluation in Clinical Contexts

Notwithstanding their value, general usability heuristics do not fully capture the complexity of clinical work. Clinical environments are characterized by time pressure, interruptions, multiple concurrent tasks, information-sharing across professional groups, complex documentation requirements, and potentially serious consequences when information is missing, misunderstood, or incorrectly entered. An interface may therefore conform reasonably well to generic usability principles while still creating difficulties within the broader clinical workflow. (Zhang et al., 2003) demonstrated this by adapting heuristic evaluation specifically to medical devices, incorporating considerations directly tied to patient safety, and illustrating that usability assessment in healthcare may need to extend beyond generic interface characteristics.

This limitation has motivated healthcare-specific extensions to generic usability theory. (Zhang & Walji, 2011) proposed the TURF (Task, User, Representation, and Function) framework, which conceptualizes EHR usability as the interaction between users, tasks, system representations, and system functions, rather than as a property of interface design alone asking whether an EHR enables intended users to accomplish goals within their work domain effectively and satisfactorily. Complementing this, (Sittig & Singh, 2010) proposed a sociotechnical framework spanning eight interrelated dimensions hardware and software infrastructure, clinical content, the human-computer interface, people, workflow and communication, internal organizational policies, external rules and regulations, and system measurement and monitoring arguing that health IT performance and patient safety depend on the interaction between interface design,

clinical workflows, organizational processes, and the broader technical environment, rather than on interface usability in isolation. Recent evidence on EHR usability reinforces this concern, showing that interface and system-design problems continue to contribute to documentation burden, workflow disruption, and increased cognitive demands for clinicians even in well-resourced health systems (Olakotan et al., 2025).

Accordingly, this study treats Nielsen's heuristics not as a complete clinical usability evaluation method, but as an organizing framework for identifying interface-level usability dimensions, situated within the broader task, user, and sociotechnical considerations raised by TURF and the sociotechnical model. These theoretical dimensions are complemented by direct empirical evidence from EMR users, gathered through questionnaires, interviews, and observation, allowing the evaluation to consider both the characteristics of the EMR interface and the extent to which those characteristics support or hinder users' actual clinical tasks and workflows.

2.2 Empirical Review

This section reviews empirical studies aligned with the study's two objectives: (i) task-level efficiency of EMR use, and (ii) the development of a structured, standardized usability evaluation model.

2.2.1 Empirical Studies on EMR Task Efficiency (Objective 1)

Empirical evidence directly supports task completion time, error frequency, and satisfaction as efficiency metrics. (Albagmi, 2021) found that EMR adoption reduced manual chart-handling time by 78%, while (Baratta et al., 2022), studying Canadian primary care, documented a 4.2-minute reduction in chart-retrieval time per visit and a 91% decrease in administrative inquiries. In Kenyan facilities, (Kelly, 2022b) reported that EMR use improved clinical protocol adherence by 32% and reduced documentation errors by 41%, and (Rojo et al., 2022b) found that automated decision-support increased appropriate ordering of HIV monitoring tests by 27%, improving retrieval-linked task accuracy. Conversely, (Koppel et al., 2005) demonstrated that poorly designed computerized prescribing interfaces including confusing screen layouts and ambiguous drug-name menus were directly responsible for 22 distinct mechanisms of medication-prescribing error, underscoring that usability failures, rather than clinician error alone, drive task-level inefficiency. Collectively, these studies confirm that task efficiency in EMR use is measurable and highly usability-dependent, validating the metrics adopted in this study's first objective.

2.2.2 Empirical Studies on EMR Usability Evaluation Models (Objective 2)

A parallel body of empirical work supports the need for a standardized, structured evaluation model. (Kavuma, 2019) reviewed 19 EMR implementations across Africa using the HIMSS usability framework, finding generally favorable but largely descriptive, non-quantified ratings across five dimensions. (Ngugi et al., 2021), evaluating KenyaEMR, similarly noted that the instruments applied had not been validated for the Kenyan context, directly motivating locally grounded evaluation tools. (Sacramento et al., 2025), in a systematic review of usability-evaluation tools used across low- and middle-income countries, found that existing frameworks are typically adopted, adapted, or reconstructed ad hoc per country, with no standardized approach consistently applied. (Tilahun & Fritz, 2015), evaluating EMR implementation in Ethiopian hospitals, found that infrastructural and organizational barriers were inadequately captured by generic usability assessments. (Ratwani et al., 2018; Zahabi et al., 2015) further showed that unresolved usability problems in electronic health records remain a recurring contributor to patient-safety incidents, reinforcing the need for rigorous, structured evaluation throughout the system lifecycle. Together, these studies confirm the absence of a standardized, weighted, and comparable EMR usability evaluation approach the gap this study's ten-dimension model directly addresses.

2.3 Common EMR Platforms in Kenyan Hospitals

Implementation of EMR systems in Kenyan hospitals varies with institutional capacity: large referral hospitals typically deploy comprehensive platforms with integrated clinical and administrative modules, whereas smaller primary care facilities more often adopt basic systems focused on core patient tracking (Paton & Muinga, 2018). Commonly used systems include OpenMRS, valued for its flexibility; IQCare, for managing HIV/AIDS and chronic conditions; CliniPAK, developed for resource constrained settings; KenyaEMR, an OpenMRS-based system tailored to national needs; and DHIS2, eCHIS, and TaifaCare KenyaEMR, which support health management information and community and national health programme functions (SS & Rajkumar, 2024). This platform diversity is not merely a technical detail but a substantive methodological challenge: because these systems differ in architecture, target user base, and design maturity, usability findings generated for one platform cannot be assumed to generalize to another, even within the same country. A tool validated on a well-resourced, comprehensive platform at a referral hospital, for instance, may not capture the usability constraints relevant to a lightweight, patient-tracking system used in a primary care facility with limited infrastructure. This underscores the importance of a usability evaluation approach that can be applied consistently across systems of varying complexity, rather than one tailored to, or validated on, a single platform, a gap this study's proposed model directly addresses.

III. METHODOLOGY

3.1 Research Design

Guided by a pragmatic paradigm, the study adopted a convergent parallel mixed-methods survey design, integrating quantitative and qualitative data collected concurrently and analyzed separately before being merged for interpretation. This approach was selected because the research questions required both objective measurement of usability indicators task efficiency, error rates, and navigation performance and deeper, subjective exploration of users lived experiences with the EMR systems in use. The convergent parallel mixed-methods design facilitated methodological triangulation by integrating quantitative and qualitative findings, thereby enhancing the validity and credibility of the results while reducing the potential for bias associated with reliance on a single data source (Creswell & Creswell, 2017).

3.2 Study Area

The study was conducted in 12 county-level public hospitals belonging to Kenya's Clinical Information Network (CIN), purposively selected from the network's 21 member hospitals to ensure representation of the four EMR platforms in routine use: KenyaEMR, CHIS, Medboss, and Funsoft. Hospitals were eligible for selection only if their EMR system was operational and in active clinical use at the time of the study; sites with dormant or partially implemented systems were excluded. Within this eligible pool, hospitals were selected to achieve proportional representation across the four platforms, yielding six KenyaEMR sites and two sites each for CHIS, Medboss, and Funsoft. All 12 selected hospitals had fully functional, actively used EMR systems throughout the study period.

3.3 Target Population

The target population comprised healthcare personnel involved in the use, management, and oversight of EMR systems in public hospitals implementing EMRs in Kenya, including medical superintendents, medical officers, clinical officers, nurses, health information records officers, ICT managers, and data entry clerks. The study population consisted of EMR users drawn from the 12 Clinical Information Network (CIN) hospitals that had implemented EMR systems at the time of the study. These hospitals collectively employed approximately 4,467 personnel across identified professional cadres (Asiamah et al., 2017).

3.4 Sampling Procedure and Sample Size

The study employed a purposive, role-based sampling approach to ensure representation of all key professional categories involved in EMR use. Within each selected hospital, 11 participants representing key EMR user roles were selected using purposive role-based sampling: one Medical Superintendent, two Medical Officers, two Clinical Officers, three Nurses, one Health Records Officer, one ICT Manager, and one Data Entry Clerk. These roles were chosen because they collectively span the full range of EMR interaction within a hospital, strategic oversight (medical superintendent), direct clinical use (medical officers, clinical officers, nurses), records management (health records officer), technical administration (ICT manager), and frontline data entry (data entry clerk). This yielded a total sample size of 132 participants (12 hospitals × 11 users), ensuring consistent representation across facilities and facilitating reliable comparative usability analysis. Sampling was thus stratified along two dimensions; hospital and professional role with fixed quotas per cadre at each site; no further stratification (e.g., by years of EMR experience or facility size) was applied.

3.5 Data Collection Instruments and Procedure

Three main instruments were used for data collection. A structured questionnaire, comprising 23 items across 11 thematic domains (two to three items per domain, to balance thematic coverage against respondent burden), was administered online and orally to physicians, nursing staff, health records professionals, and ICT support personnel to assess EMR usability, including system functionality, workflow integration, and user satisfaction; its development drew on established technology adoption measurement tools (Al-Moghrabi et al., 2021). Semi-structured interviews, guided by open-ended questions, were conducted with 16 nurses and Health Records and Information Officers to explore user experiences, workflow integration, and barriers to optimal system use. Structured non-participant observation was used to assess EMR usability during routine clinical workflows across predefined domains efficiency, errors, navigation, learnability, satisfaction, accessibility, and workflow integration using a standardized checklist with rating scales and structured notes. Data collection took place over a period of four months as from (October 2024 to January 2025).

Validity of the questionnaire and interview guide was established through expert review by two experienced EMR practitioners, who assessed the instruments for relevance, clarity, and comprehensiveness in relation to the study objectives. Each expert independently rated items for relevance and clarity, and discrepancies were resolved through consensus discussion, with items falling below consensus revised or removed. For the questionnaire, this process addressed both face validity, ensuring items appeared relevant to EMR usability from a practitioner's perspective, and content validity, ensuring comprehensive coverage of the critical usability dimensions under study; iterative revisions

were made to eliminate ambiguity and ensure the 23-item instrument adequately captured the latent constructs of EMR implementation success. For the interview guide, validity was further strengthened through pilot interviews with EMR users outside the main study sample, which confirmed the clarity and contextual appropriateness of the questions and informed refinements to wording and sequencing. The observation checklist was similarly reviewed by the expert panel to ensure its usability domains were comprehensive and reflective of real-world EMR interaction in clinical settings. All three instruments were additionally piloted with 20 EMR users drawn from non-study hospitals to test technical functionality, item clarity, and administration procedures before use in the main study. This combined validation process strengthened the instruments' capacity to generate credible, meaningful data while preserving ecological validity for healthcare settings (Wilson, 2023). Questionnaire reliability was established through the pilot exercise described above. Internal consistency of the 23-item scale was assessed using Cronbach's alpha, with a minimum threshold of $\alpha \geq 0.70$ set for acceptability; test-retest reliability was evaluated by re-administering the questionnaire to a subset of pilot respondents, and inter-rater reliability was assessed for orally administered items. This process identified and corrected sources of measurement error; ambiguous terminology and response-scale misinterpretation before the instrument was finalized for the main study.

3.6 Data Analysis

Aligned with the pragmatic paradigm, this study employed a mixed-methods analytical approach. Quantitative data from surveys and structured observations were analyzed using descriptive statistics (means, standard deviations, and frequencies) in R and Python to summarize EMR usage patterns. Observation checklist indicators were quantitatively coded and triangulated with survey findings. Quantitative and qualitative strands were analyzed separately and then merged using a joint display (side-by-side comparison) matrix, enabling systematic comparison of statistical and thematic findings to identify areas of convergence, divergence, and complementarity. Qualitative data from interviews and open-ended survey responses underwent systematic coding in R and Python, involving data cleaning, inductive coding to identify themes, axial coding to explore relationships between themes, and selective coding to integrate key categories into a conceptual understanding of EMR usability. Text mining and word frequency analysis complemented the thematic analysis to identify commonly reported challenges and perceptions, in direct support of the objective to characterize practitioner-reported EMR challenges and expectations; corresponding outputs are presented alongside the thematic findings. This integrated analytical strategy combined objective usability metrics with contextual user experiences, strengthening the validity of findings and informing the development of a comprehensive EMR usability evaluation model.

The EMR usability evaluation model itself was developed in Python using a structured quantitative scoring framework grounded in heuristic evaluation techniques and domain-specific usability criteria, including Nielsen's usability heuristics. Ten usability dimensions; efficiency and task performance, error identification and recovery, user satisfaction, learnability, navigation and information retrieval, accessibility, user feedback integration, interoperability, security and privacy, and workflow integration were each rated on a standardized scale (predominantly 1-5, with accessibility scored 0-1 and user feedback integration scored 1-4). Each rating was converted to a common weighted score out of 10 per criterion, summed across all ten dimensions, and expressed as an overall percentage usability score for each EMR system. This percentage was then classified against a five-band grading scale; Outstanding, Competent, Satisfactory, Needs Improvement, and Unsatisfactory to produce the final usability rating reported.

3.7 Ethical Considerations

Ethical principles guided all stages of the study, ensuring the protection of participants' rights, maintaining research integrity, and enhancing the credibility and trustworthiness of the findings (Creswell & Creswell, 2017). Before participating, everyone received a clear written introduction outlining the study's purpose, institutional approval, and their freedom to participate voluntarily. The questionnaires and interview guides assured participants that their responses would remain anonymous, no names or identifying details would be collected, and all data would be aggregated to protect individual privacy. Formal permissions were secured from both government authorities and hospital management, and ethical clearance was obtained from NACOSTI. Participants were also informed about how the study could benefit their organizations, particularly by improving EMR usability, ensuring they understood the value of their contribution without feeling pressured to participate. This process reflected a careful balance between advancing research objectives and respecting the autonomy and dignity of healthcare professionals who kindly gave their time and insights.

IV. FINDINGS & DISCUSSION

4.1 Findings

4.1.1 Demographic Characteristics

Of the 132 sampled participants, 124 responded, a response rate of 93.9%. As shown in Table 1, most respondents were male (62.9%), while females accounted for 37.1%. In terms of education, most participants held a degree (54.8%), followed by diploma (16.1%) and master's degree (11.3%). Regarding professional roles, nurses formed the largest group (28.2%), followed by clinical officers (18.5%) and medical officers (17.7%). Health Information Records Officers, ICT Managers/Officers, and Data Entry Clerks each accounted for 9.7%, while Medical Superintendents represented the smallest group (6.5%). More than half of respondents (54.8%) had 0-2 years of experience with EMRs, and the majority (70.2%) reported using the EMR system daily. KenyaEMR was the most widely used system (43.5%), with CHIS and Funsoft each at 16.9%, and Medboss at 19.3%.

Table 1

Respondents' Demographic Data Distribution

Variable	Response	Count (N=124)	Percentage
Gender	Male	78	62.9%
	Female	46	37.1%
Level of Education	Certificate	13	10.5%
	Diploma	20	16.1%
	Degree	68	54.8%
	Masters	14	11.3%
	PhD	9	7.3%
Professional Role	Health Records Officer	12	9.7%
	Nurse	35	28.2%
	Medical Superintendent	8	6.5%
	Medical Officer	22	17.7%
	Clinical Officer	23	18.5%
	ICT Manager/Officer	12	9.7%
	Data Entry Clerk	12	9.7%
Years of EMR Experience	0-2 years	68	54.8%
	3-5 years	29	23.4%
	6-8 years	17	13.7%
	9+ years	10	8.1%
EMR Usage Frequency	Daily	87	70.2%
	2-3 times/week	9	7.3%
	Once a week	11	8.9%
	Rarely	14	11.3%
	I don't use	3	2.4%

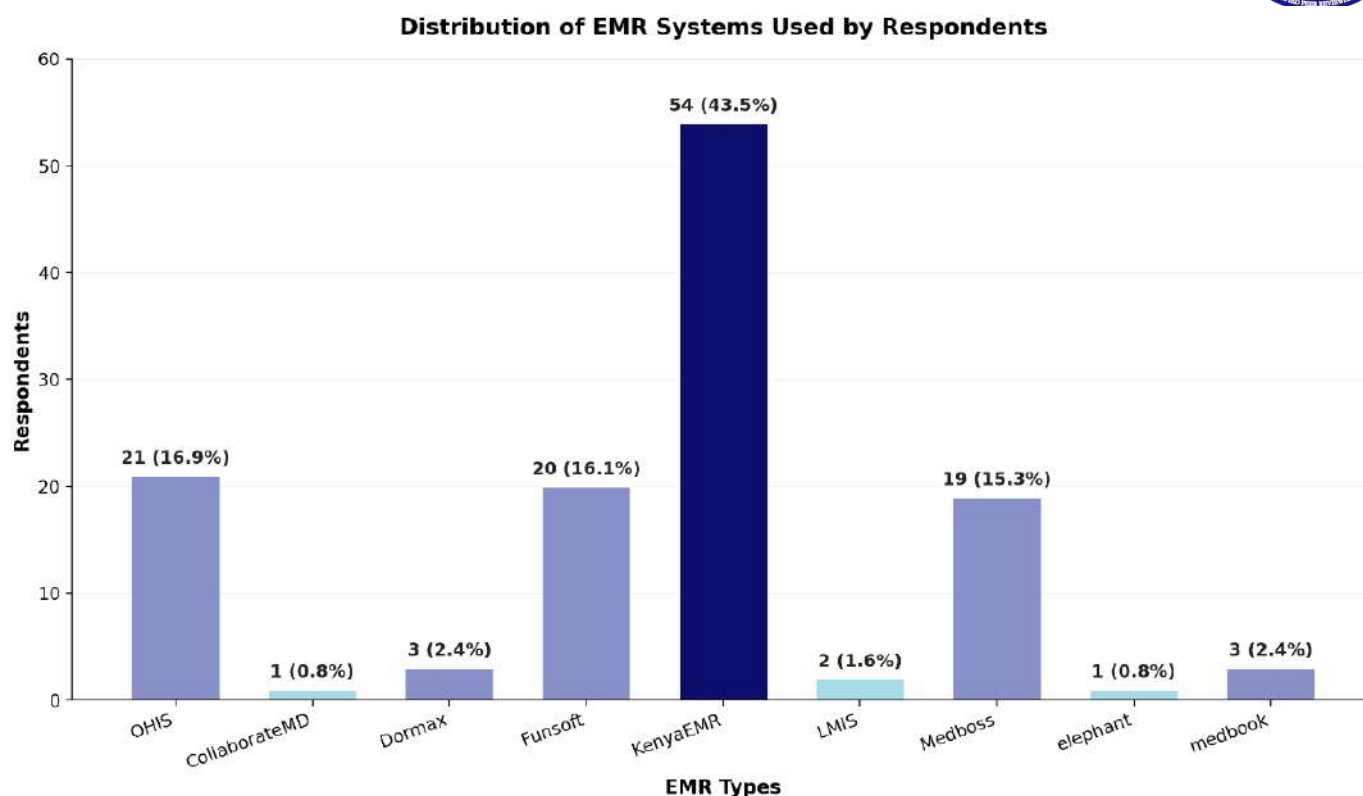


Figure 1
Distribution of Respondents by EMR System in Use

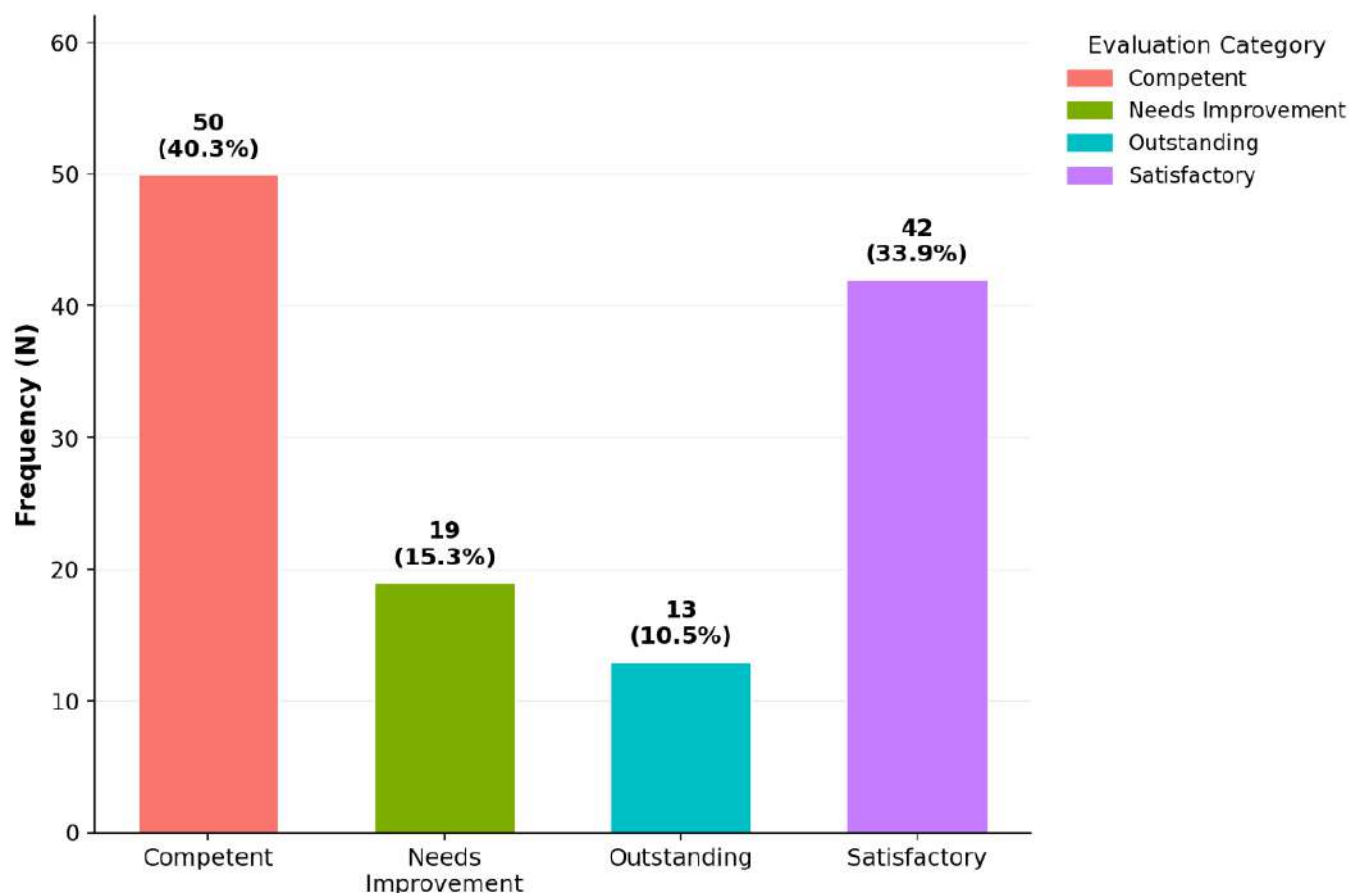
4.1.2 Efficiency of Common Tasks

Task efficiency was generally high. As presented in Table 2, information retrieval recorded the highest satisfaction (72.6%), followed by medication prescription (66.2%) and data entry (65.3%). Navigation received the highest positive rating overall at 77.4%, and 68.5% of respondents perceived information retrieval as quick or very quick. User interface design, however, received more mixed feedback, with 36.3% of respondents remaining neutral and only 32.3% expressing satisfaction, pointing to a specific area of weakness. Applying the study's usability scoring categories, 40.3% of overall task performance was rated Competent, 33.9% Satisfactory, and 10.5% Outstanding, while 15.3% required improvement and none was rated Unsatisfactory. Competency was higher among more highly educated staff, KenyaEMR users, and daily EMR users, suggesting that familiarity, experience and training may influence perceived efficiency.

Of the 132 sampled participants, 124 completed the usability rubric (93.9% response rate), and each respondent's composite usability score was derived from their ratings across the ten usability dimensions: efficiency, error recovery, satisfaction, learnability, navigation, accessibility, feedback integration, interoperability, security, and workflow integration. Each dimension was rated on a standardized scale (predominantly 1–5, with accessibility scored 0–1 and feedback integration scored 1–4), where higher values indicated stronger usability, and was weighted equally to a maximum of 10 points per dimension, calculated as (respondent rating ÷ maximum possible rating on that dimension) × 10; for example, a "Neutral" rating (3 of 5) on user satisfaction yielded a weighted score of $(3/5) \times 10 = 6$. The weighted scores across all ten dimensions were summed for each respondent and expressed as a percentage of the maximum attainable total (100 points), producing an individual composite usability score. Each respondent's percentage score was then classified using a five-tier grading scale: Outstanding (81–100%), Competent (61–80%), Satisfactory (41–60%), Needs Improvement (21–40%), and Unsatisfactory (1–20%). As shown in Figure 2, the majority of respondents rated their EMR systems as either Competent (40.3%, $n = 50$) or Satisfactory (33.9%, $n = 42$), with smaller proportions rating them as Needs Improvement (15.3%, $n = 19$) or Outstanding (10.5%, $n = 13$), and no respondents falling within the Unsatisfactory range (1–20%), indicating that even the lowest-rated EMR experiences in the sample retained a baseline level of functional usability.

Table 2*Reported Satisfaction with Common EMR Tasks*

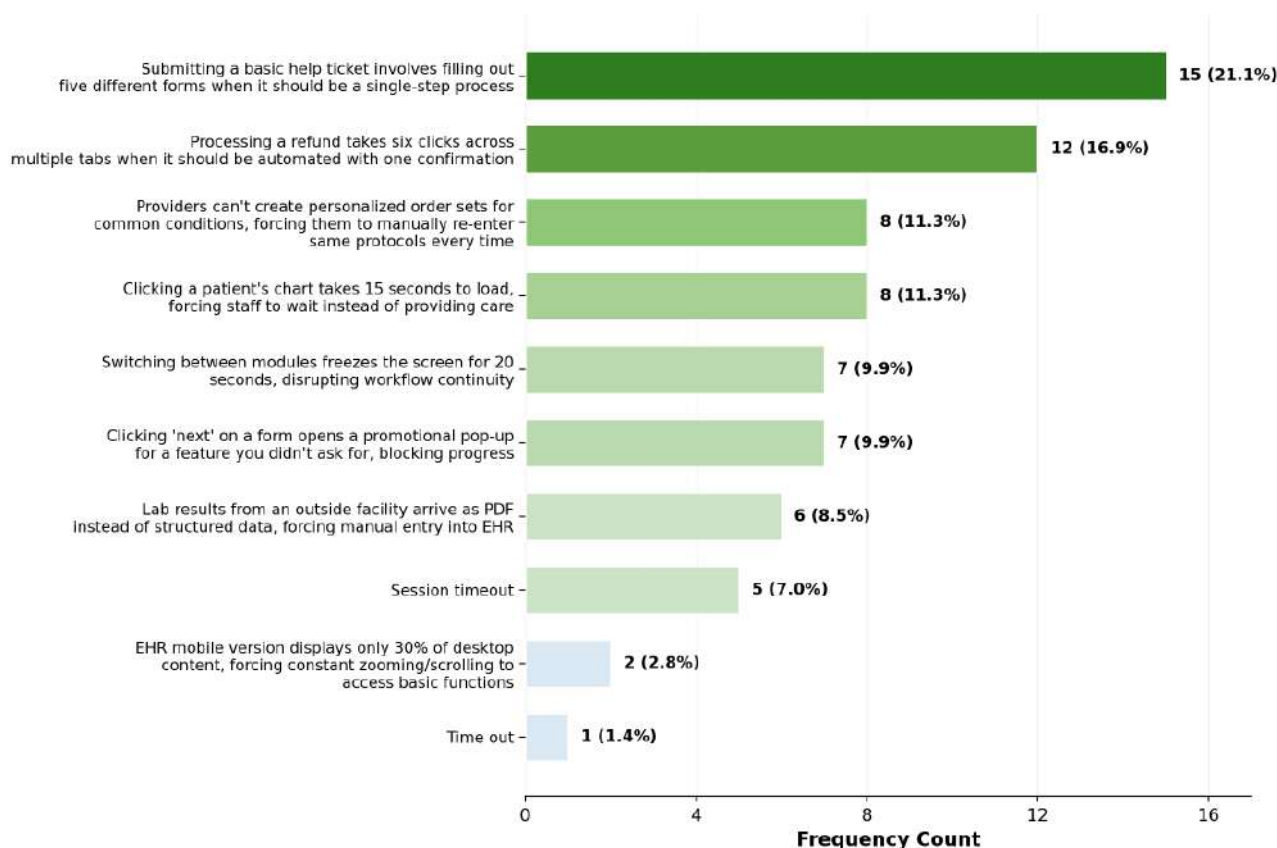
Task	Not at All Satisfied (%)	Somehow Satisfied (%)	Neutral (%)	Satisfied (%)	Very Satisfied (%)
Data Entry	3 (2.4)	19 (15.3)	21 (16.9)	75(60.5)	6 (4.8)
Medication Prescription	5 (4.0)	22 (17.7)	15 (12.1)	56(45.2)	26 (21.0)
Information Retrieval	5 (4.0)	12 (9.7)	17 (13.7)	58(46.8)	32 (25.8)
User Interface Design	7 (5.6)	29 (23.4)	45 (36.3)	40(32.3)	3 (2.4)
Navigation	5 (4.0)	9 (7.3)	14 (11.3)	85(68.5)	11 (8.9)

**Figure 2***Distribution of Overall Task-Performance Evaluation Categories***4.1.3 Frequency and Types of Errors**

As shown in Table 3, just over half of respondents (52%) reported rarely encountering errors, while 26% experienced errors occasionally, 11% frequently, and 6% very frequently; 5% reported no errors at all. Free-text responses identified specific pain points: cumbersome help-ticket submission requiring multiple forms (21.1% of comments), refund-processing complexity (16.9%), slow system response when opening patient charts (11.3%), inability to create personalized order sets (11.3%), screen freezes when switching modules (9.9%), disruptive pop-ups (9.9%), manual entry of PDF lab results (8.5%), session timeouts (7.0%), and poor mobile usability (2.8%). Interview data corroborated this pattern, with 56% of reported errors attributed to technical or system-design flaws and 44% to operational or human factors such as workflow inefficiencies, with recovery typically requiring manual IT intervention.

Table 3*Frequency of Errors Encountered by User*

Frequency Category	Count (N=124)	Percentage (%)
Very Frequently	7	6
Frequently	14	11
Occasionally	32	26
Rarely	65	52
I don't encounter errors	6	5

**Figure 3***Most Frequently Reported EMR Usability Issues***4.1.4 Navigation and Information Retrieval**

Navigation was rated Easy by 70% of respondents and Very Easy by a further 12%, with only 9% neutral and 9% reporting difficulty. Most routine tasks required only two to four clicks (40% requiring two clicks, 20% four clicks, 14% three clicks), suggesting streamlined workflows for most users, although a smaller group experienced longer navigation paths requiring five to eight clicks. Interview participants echoed this, noting that the system became manageable with familiarity, though initial navigation was often hindered by interface complexity, cluttered dashboards, and inconsistent labelling.

Table 4*Distribution of Number of Clicks for Routine Tasks*

Number of Clicks	Count (N=124)	Percentage (%)
1 click	10	8
2 clicks	49	40
3 clicks	17	14
4 clicks	25	20
5 clicks	5	4
6 clicks	7	6
7 clicks	5	4
8 clicks	6	5

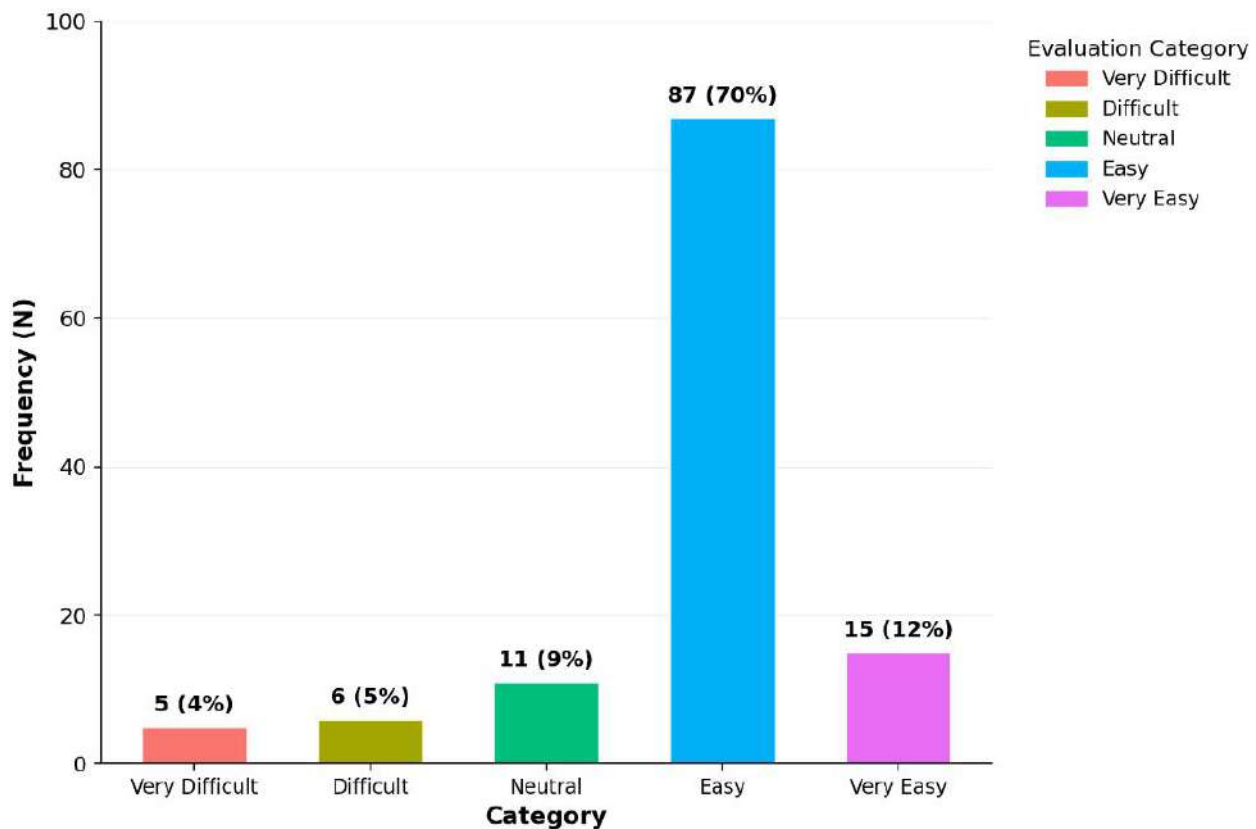


Figure 4
Respondent Ratings of Ease of Navigation and Information Retrieval

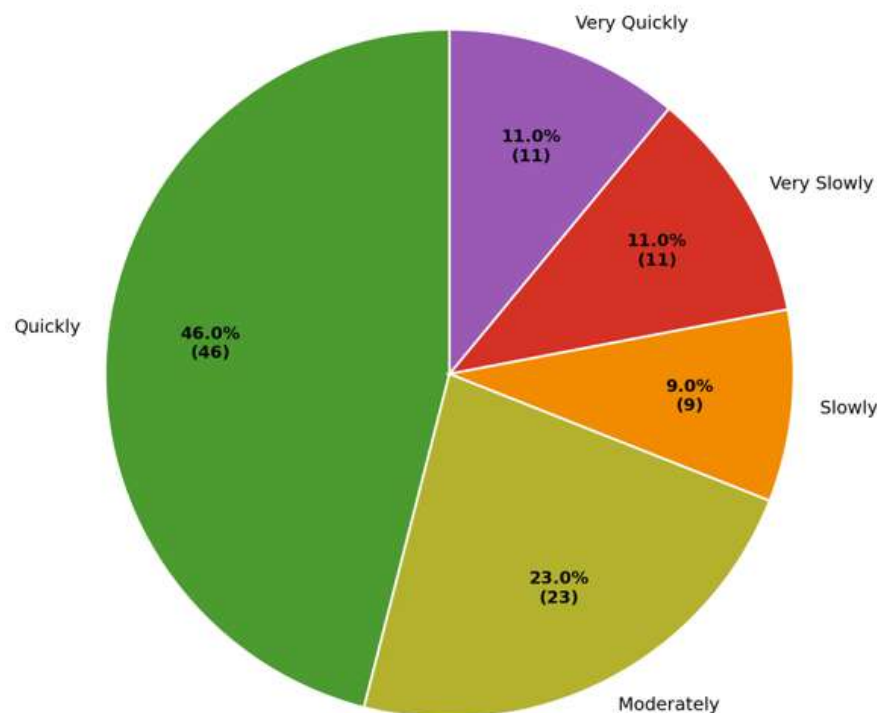


Figure 5
Perceived Speed of Information Retrieval within the EMR

4.1.5 The EMR Usability Evaluation Model

Drawing on these findings together with HCI principles and Nielsen's Usability Heuristics, the study developed a systematic EMR Usability Evaluation Model. The model employs a scoring rubric across ten dimensions efficiency and task performance, error identification and recovery, user satisfaction, learnability, navigation and information retrieval, accessibility, user feedback integration, interoperability, security and privacy, and workflow integration each

rated on a five-point scale. Composite scores are graded as Outstanding (81–100%), Competent (61–80%), Satisfactory (41–60%), Needs Improvement (21–40%), or Unsatisfactory (1–20%). Applying this rubric, 71.8% of respondents rated the evaluated EMR systems as Competent, 13.7% as Outstanding, 11.3% as Satisfactory, and 3.2% as Needing Improvement, with none rated Unsatisfactory. The model is designed to support an interactive dashboard summarizing satisfaction scores, task completion times, error frequencies, system distribution, demographics, and rubric-based evaluations, enabling continuous monitoring across facilities.

Table 5*EMR Usability Evaluation Scoring Rubric*

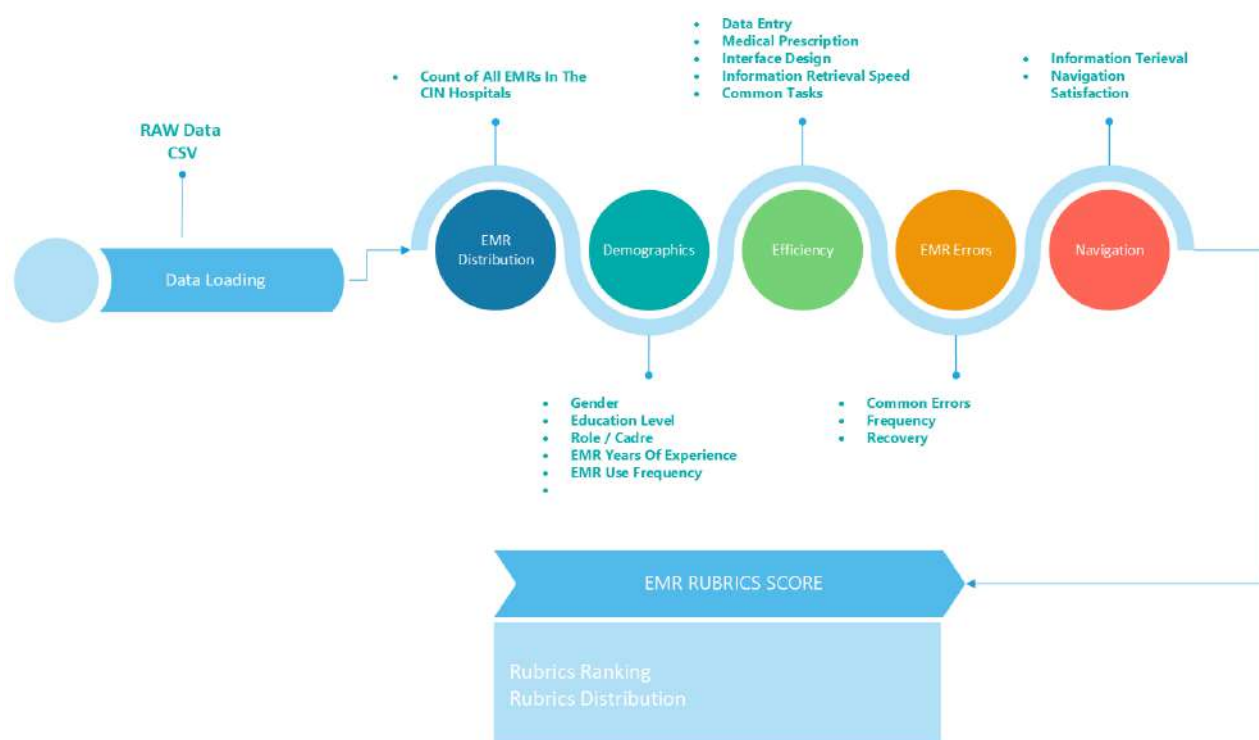
Key Usability Metric	Description	Score Range	Scoring Guide
Efficiency and Task Performance	Measures how quickly healthcare professionals can complete common EMR tasks.	1-5	1 = Very Slowly, 2 = Slowly, 3 = Moderately, 4 = Quickly, 5 = Very Quickly
Error Identification and Recovery	Assesses how often users encounter and recover from errors in the system.	1-5	1 = I don't, 2 = Very Frequently, 3 = Frequently, 4 = Occasionally, 5 = Rarely
User Satisfaction	Evaluates overall user satisfaction with the EMR system.	1-5	1 = Not Satisfied, 2 = Somehow Satisfied, 3 = Neutral, 4 = Satisfied, 5 = Very Satisfied
Learnability	Examine how easy it is for new users to learn to use the EMR.	1-5	1 = Very Difficult, 2 = Difficult, 3 = Neutral, 4 = Easy, 5 = Very Easy
Navigation and Information Retrieval	Assesses ease of system navigation and ability to retrieve patient information.	1-5	1 = Very Difficult, 2 = Difficult, 3 = Neutral, 4 = Easy, 5 = Very Easy
Accessibility	Determines whether the system is accessible to all users regardless of ability.	0-1	0 = No, 1 = Yes
User Feedback Integration	Measures on how frequently user feedback is collected and integrated into improvements.	1-4	1 = Rarely, 2 = Occasionally, 3 = Often, 4 = Very Often
Interoperability	Evaluates how easily the EMR integrates with other health information systems.	1-5	1 = Very Difficult, 2 = Difficult, 3 = Neutral, 4 = Easy, 5 = Very Easy
Security and Privacy	Assesses the level of data protection and privacy offered by the system.	1-5	1 = Not Secure, 2 = Somehow Secure, 3 = Neutral, 4 = Secure, 5 = Very Secure
Workflow Integration	Evaluates how well the EMR supports healthcare providers' workflows.	1-5	1 = Very Difficult, 2 = Difficult, 3 = Neutral, 4 = Easy, 5 = Very Easy

Table 6*Grading Ranges for Suitability Evaluation of EMRs*

Percentage Score Range	Overall Grading
81–100	Outstanding
61–80	Competent
41–60	Satisfactory
21–40	Needs Improvement
1–20	Unsatisfactory

EMR's Usability Evaluation Model

EMR Usability Evaluation Model Stages. Raw Data Loading, EMR Distribution, Demographics, Efficiency, Errors, Navigation and Rubrics Score

**Figure 6***Proposed EMR Usability Evaluation Model — Stages of Assessment***Table 7***EMR Usability Evaluation Model — Grading Results*

Grade	Score Range (%)	Respondents (%)
Outstanding	81–100	13.7
Competent	61–80	71.8
Satisfactory	41–60	11.3
Needs Improvement	21–40	3.2
Unsatisfactory	1–20	0.0

4.1.6 Interview Findings

Key informant interviews with 16 nurses and health records and information officers added depth to the survey results. On task efficiency, 56.3% of participants described the process of completing common tasks as quick or very quick, while 25% rated it moderately efficient and 18.8% described it as slow or very slow, pointing to occasional bottlenecks not fully captured in the quantitative data. Regarding errors, participants attributed 56% of incidents to technical or system-design flaws including instability and poor data synchronization and 44% to broader operational or human factors such as workflow inefficiencies and user oversight, with recovery typically requiring manual administrative or IT intervention rather than being resolved automatically by the system.

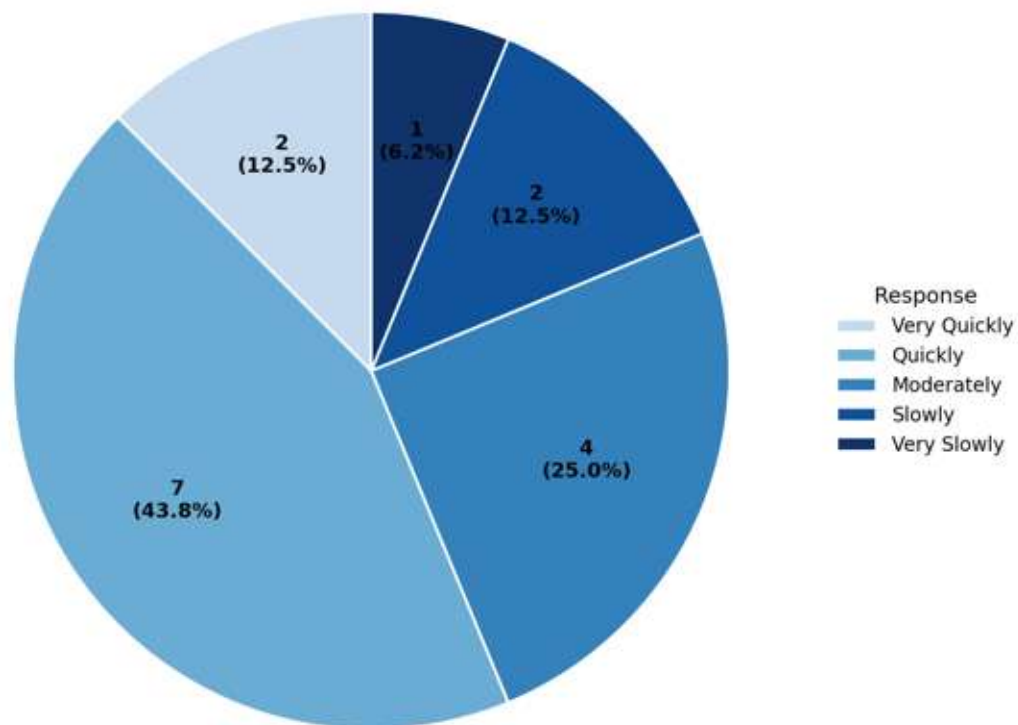


Figure 7
Interview Participants' Ratings of Task-Completion Speed

Table 8
Distribution of Error Frequency by Relation Type (Interview Data)

Relation Type	Frequency (N=16)	Percentage (%)
Closely Related (Technical/System)	9	56.25
Loosely Related (Operational/Human)	7	43.75

On navigation and information retrieval, themes of ease of navigation, retrieval speed, interface design, and training and familiarity each accounted for a comparable share of interview responses. Participants generally described the system as manageable once users became familiar with it but noted that initial navigation was often hindered by interface complexity. Concerns about retrieval speed and interface limitations were echoed across sites, with poor labelling, cluttered dashboards, and a lack of clear visual cues repeatedly cited as design shortcomings warranting attention in future system revisions.

Table 9
Distribution of EMR Navigation Themes (Interview Data)

Theme	Frequency N (%)
Ease of Navigation	2 (12.5)
Information Retrieval Speed	2 (12.5)
Interface Design	2 (12.5)
Training and Familiarity	2 (12.5)
Search Features, Performance	1 (6.25)
System Usability	1 (6.25)
User Familiarity	1 (6.25)
Interface Consistency	1 (6.25)
Workflow Efficiency	1 (6.25)
Device Limitations	1 (6.25)
System Performance	1 (6.25)
Connectivity Issues	1 (6.25)
Total	16 (100)

4.2 Discussion

Taken as a whole, these findings suggest that the evaluated EMR systems are functionally competent rather than uniformly excellent, a distinction that matters for how the results should be read. Rather than simply confirming that

"usability was high," the data point to a system that performs adequately on core task efficiency (data entry, prescription, retrieval) while showing more uneven performance on the design and error-handling dimensions that Nielsen's heuristics single out as safety-critical, namely error prevention, recognition rather than recall, and visibility of system status (Nielsen, 1994a). This pattern is consistent with, but also sharpens, the TURF critique discussed in the literature review (Zhang & Walji, 2011): the systems studied here perform reasonably well on what TURF would classify as core domain functions (the clinical tasks users need to perform), while the recurring complaints about cumbersome help-ticket processes, redundant refund workflows, and disruptive pop-ups are almost entirely overhead functions, system-imposed friction unrelated to clinical work itself. This distinction, largely absent from Nielsen's generic framework, offers a more precise account of where usability breaks down than "mixed interface ratings" alone would suggest, and supports (Zhang & Walji, 2011) argument that healthcare-specific usability constructs capture problems that general heuristics do not.

A notable tension in the data, one the quantitative results alone do not resolve, is the gap between low reported error frequency (57% of respondents rarely or never encountered errors) and the intensity of the free-text and interview complaints about specific system frictions. If errors are relatively infrequent, why did help-ticket complexity and refund processing dominate open-ended responses (21.1% and 16.9% of comments, respectively)? One interpretation is that error frequency and error severity or recoverability are distinct constructs that a simple frequency scale does not capture: infrequent errors that are difficult to resolve, requiring manual IT intervention rather than in-system recovery, may leave a disproportionate impression on users relative to their actual occurrence rate. This reading is consistent with (Nielsen, 1994a) "help users recognize, diagnose, and recover from errors" heuristic, which concerns not whether errors occur but whether the system supports resolution when they do; the interview finding that 56% of errors were attributed to technical or system-design flaws requiring manual intervention, rather than being resolved automatically, suggests this recovery dimension, not raw frequency, may be the more consequential usability failure. This nuance qualifies the otherwise reassuring conclusion that "the relatively low overall error frequency is encouraging."

A second, closely related discrepancy emerges between the quantitative navigation ratings and the qualitative navigation findings. Eighty-two percent of survey respondents rated navigation as easy or very easy, yet interview participants and free-text themes consistently cited interface complexity, cluttered dashboards, and inconsistent labelling as significant initial barriers. Rather than treating this as a data-quality problem, this divergence is itself informative: it suggests a learnability effect that the point-in-time survey rating does not capture, participants appear to be rating navigation as experienced after they have adapted to the system's quirks, while the interview data captures the harder, earlier learning curve. This aligns with the interview observation that "the system became manageable with familiarity," and indicates that learnability and steady-state navigation ease, though scored as separate dimensions in this study's rubric, may be more interdependent in practice than the model's current ten-dimension structure treats them, an observation to note as a possible refinement rather than a limitation to dismiss.

The demographic variation observed, higher competency among male respondents, more experienced staff, daily users, and KenyaEMR users, is broadly consistent with prior research linking proficiency to system intuitiveness, training quality, and frequency of use (Almarzouqi et al., 2022). However, this pattern also warrants a more critical reading than a straightforward confirmation: if competency scores rise consistently with tenure and use frequency, this raises the possibility that the systems are usable primarily for those who have already invested substantial time in learning them, rather than being usable by design for new or infrequent users. This interpretation sits in tension with a core aim of usability evaluation, that systems should minimize reliance on extended learning, and suggests the observed "high usability" ratings may partly reflect user adaptation rather than system design quality, an important caveat for how these results should inform redesign priorities.

The study's ten-dimension scoring rubric offers a structured, quantifiable alternative to the descriptive usability assessments that have dominated prior EMR research, directly addressing the gap identified by (Josiah & Otieno, 2024) regarding the absence of structured usability evaluation frameworks in the Kenyan context. It is worth noting, however, that this study applied the rubric at two levels, an aggregate task-performance scoring (Figure 2) and a full ten-dimension composite scoring (Table 7), which produced meaningfully different distributions (40.3% Competent under the former versus 71.8% Competent under the latter). This is not a contradiction so much as evidence that the scope of what is measured materially affects the resulting usability grade; a system rated only on task efficiency may score lower than one assessed holistically across error handling, security, and workflow integration together. This finding has a practical implication for how the model should be used going forward: composite scores should always be reported alongside the specific dimensions included, since a single "usability grade" can obscure meaningful variation in underlying dimension-level performance.

Taken together, these results support the broader view that EMR usability is not a fixed, binary property but a multidimensional and context-dependent outcome that benefits from structured, ongoing evaluation (Ratwani et al., 2018; Zahabi et al., 2015). Where this study extends that view is in showing that even within a single sample, usability conclusions can shift substantially depending on which dimensions are aggregated, whether frequency or severity of errors is measured, and whether ratings are captured before or after users have adapted to a system, distinctions that a single composite usability score, however carefully constructed, cannot fully convey on its own.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study set out to evaluate the efficiency and usability of EMR systems in Kenyan public hospitals and to develop a systematic model for assessing that usability. The evidence shows that EMR systems within the Clinical Information Network are largely intuitive, efficient, and well-integrated into clinical workflows: core tasks are completed with high satisfaction, navigation is generally rated easy and requires few clicks, and errors are relatively infrequent. At the same time, recurring frictions burdensome help ticket procedures, slow response times, limited interface intuitiveness, and occasional system instability constrain the experience for a meaningful minority of staff and represent clear opportunities for improvement.

The EMR Usability Evaluation Model developed in this study, anchored in HCI principles and Nielsen's Usability Heuristics and operationalized through a ten-dimension scoring rubric, offers healthcare institutions a practical, replicable tool for benchmarking usability across systems and over time. Its application in this study, which classified majority of systems as Competent or Outstanding, demonstrates its feasibility for routine use. Overall, the study affirms that EMRs in Kenyan public hospitals are largely usable and beneficial, while underscoring that sustained effectiveness depends on continuous, structured attention to usability rather than a one-time implementation effort.

As with any survey-based evaluation, the findings should be interpreted with attention to context: the sample was drawn from public hospitals within a single national network using four specific EMR platforms. Future research could extend the evaluation model to private-sector facilities and track usability scores longitudinally as systems are updated. Nonetheless, the consistency of findings across quantitative, qualitative, and observational data sources lends confidence to the study's conclusions and to the practical utility of the proposed evaluation model.

5.2 Recommendations

The findings of this study, particularly the recurring frustrations with slow chart loading, cumbersome navigation, and inconsistent error handling, point to several practical steps that different stakeholders can take to improve EMR usability.

System developers and vendors. The most pressing issue is performance. Delays such as charts taking up to 15 seconds to load, or screens freezing when switching between modules, were among the most frequently cited complaints in this study and directly interfere with clinical workflow. Addressing these bottlenecks, along with collapsing unnecessarily long processes (such as multi-step help ticket submissions) into single actions, should be treated as an early priority. Once these foundational issues are resolved, attention can shift to features that reduce repetitive work, such as configurable order sets for common protocols, alongside stronger validation checks and clearer error prompts to prevent mistakes before they occur. Structured import functionality for lab results currently received as unstructured PDFs would further reduce unnecessary manual entry. Over a longer horizon, mobile versions of these systems need to move beyond their current limited functionality toward genuine parity with desktop platforms, and non-essential interruptions, such as promotional pop-ups appearing mid-task, should be removed from clinical workflows altogether.

Hospital administrators. Administrators can make an immediate difference simply by giving staff a clear and responsive way to report problems when they arise; the absence of such channels was itself a source of frustration among respondents. Beyond this, administrators should work with vendors to tailor system configurations to the realities of local practice rather than relying on generic defaults, involving nurses, records officers, and physicians directly in these decisions. Usability should also not be treated as a one-off implementation concern: periodic feedback collection ought to become a standard part of ongoing EMR performance monitoring.

Policymakers and health IT regulators. At a broader level, policymakers have a role in setting minimum usability benchmarks, covering response times, error recovery, and mobile accessibility, as part of EMR procurement and certification requirements. Mandating periodic post-implementation usability reviews would help ensure that systems continue to serve clinicians effectively well after initial rollout, rather than usability being assessed only at the point of adoption.

Trainers and capacity-building teams. Training providers should focus their efforts on the areas where users struggled most in this study, namely navigation and information retrieval, with practical, role-specific instruction rather than generic onboarding. Given that difficulties often resurface after system updates, refresher training should be scheduled at regular intervals and specifically triggered whenever major changes are rolled out. Taken together, these recommendations are best implemented in phases over a 24-month period as follows:

Phase 1 (0–6 months) focusing on addressing urgent performance issues, establishing effective support channels, and providing initial user training.

Phase 2 (6–12 months) concentrating on system customization, the introduction of error-prevention features, and the establishment of facility-level feedback mechanisms.

Phase 3 (12–24 months) focusing on achieving mobile parity, integrating structured data, and developing national usability standards to promote consistency and long-term system effectiveness.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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