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****Original Research****

A SCOPING REVIEW OF USABILITY METRICS FOR ASSESSING EHEALTH SYSTEMS

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Abstract

eHealth systems have exploded in popularity worldwide in recent years, fundamentally altering how health services are delivered. However, there has been a long discussion about what usability metrics should be used to evaluate eHealth systems. This paper assesses the usability metrics mostly applied in evaluating eHealth systems. A scoping review method was used, whereas 15 papers were reviewed after being extracted from 2112 studies from PubMed, Emerald Insight, and SAGE. The search terms were "usability" in combination with "metrics", "evaluation metrics", "factors", "attributes", "framework", "models", "taxonomy", "eHealth", "health", "telehealth", and "mHealth". The study established that usability metrics, including ease of use, task-technology match, navigation, information quality, technical quality, guide and support, consistency, visibility, flexibility, accessibility, and collaboration, are mostly applied in evaluating eHealth systems' usability. Although the metric named collaboration had a low frequency, this study recommends that it be used in assessing eHealth systems due to its necessity. Thus, the healthcare process involves multiple healthcare professionals collaborating to accomplish the patients' healthcare process. Additionally, the study revealed limited studies on the usability of eHealth systems in developing countries, specifically Africa. Subsequently, a few African studies applied generic usability metrics only to evaluating eHealth systems compared to developed countries. Future studies should consider validating these metrics' applicability in contexts in developing countries with limited resources.

Keywords: eHealth systems, usability metrics, usability evaluation, contextual issues.

1.0 INTRODUCTION

The use of eHealth systems such as electronic health records, electronic medical records (EMR), telemedicine, mobile health (mHealth), clinical decision support systems, and computerised physician order reporting has recently increased dramatically throughout the world (Busagala & Kawono, 2013). The term eHealth means the use of information and communication technologies in assisting healthcare services (Busagala & Kawono, 2013). Electronic medical record is an eHealth system used by healthcare professionals to enter, store, and retrieve patient medical records. Multiple healthcare professionals can access a patient's records over time through an electronic medical record system, which is designed for use in a healthcare facility and applies to all practitioners.

Unlike electronic medical records systems, which can only be utilised within a single health facility, electronic health records expand the ability to share patient data outside a single health facility (Noraziani et al., 2013). Mobile health (mHealth) uses mobile phones and other mobile wireless devices, such as mobile phones, personal digital assistants, and patient monitoring devices, to deliver and support medical and public health practices (Sadiku et al., 2017). mHealth reminds the patient to take his medication on time via text messages or other

mechanisms such as alarms. Telemedicine is the electronic transmission of medical information from one location to another to enhance the exchange of medical information about the diagnosis, treatment, and prevention of disease and damage using information and communication technology (Aziz & Abochar, 2015). Clinical Decision Support is an intelligent eHealth system that helps doctors, patients, and other healthcare workers make decisions using various tools, including computer alerts and reminders, patient data summaries and reports, diagnostic aids, and documentation templates. (Wasylewicz & Scheepers-Hoeks, 2019).

As a result, both developed and developing countries are investing in eHealth systems (Alanazi, 2015; Gregory & Tembo, 2017). Developed countries, such as Finland, the Netherlands, and Norway, are the leading countries adopting eHealth systems. For instance, all public health facilities in Finland have been fully digitalised and installed with EHR systems since 2010 (Khan et al., 2017; Hyppönen et al., 2019).

Simultaneously, developing countries are undertaking several initiatives to implement eHealth systems. For example, Kenya has recently implemented the National eHealth Policy 2016–2030, which aims to overcome challenges associated with the eHealth system pre- and post-implementation (The Republic of Kenya, 2016). South Africa has also released a National Digital Health Strategy for South Africa 2019–2024 to improve the efficiency and quality of healthcare services, establish an integrated platform, and raise awareness among healthcare workers about the importance of digital health (The Republic of South Africa, 2019). Tanzania is also not behind in adopting eHealth, as more than 160 digital eHealth systems operate within the country (Kikoba et al., 2019; Ministry of Health, Community Development, Gender, Elderly and Children, 2019). In addition, Tanzania has been introducing several strategies and policies to promote adoption. Recently, Tanzania introduced the Digital Health Strategy 2019–2024 to improve users' experience in providing high-quality health services (Ministry of Health, Community Development, Gender, Elderly and Children, 2019).

Despite adopting various eHealth systems and associated initiatives by developing countries, studies show that poor usability is the most significant challenge of eHealth systems (Taiwo et al., 2016; Mugo & Nzuki, 2014). For instance, studies conducted in Tanzania indicate that user-system interactivity difficulties, data security, frequent system errors, poor data quality, task-technology mismatch, and poor collaboration are the significant challenges related to the poor usability of the eHealth systems (Peltola, 2019; Hamad, 2019; Mtebe & Nakaka, 2018; Lungo,

2008). Additionally, even though most eHealth system users in developing countries seem to be comfortable using some eHealth systems, the study conducted in Zambia revealed that usability is still a challenge (Gregory & Tembo, 2017).

A study by Sousa and Lopez (2017) showed that the usability of a system is determined by choosing an appropriate evaluation framework with proper usability evaluation metrics. Several usability evaluation frameworks have been used to evaluate various information systems. However, they are either not explicitly designed to evaluate eHealth systems, or they are designed for specific countries' contexts. For example, usability frameworks such as the ISO 9241-11:2018 standard (International Organizations for Standardization, 2018) and Nielsen usability model (Nielsen, 1993) are designed for evaluating generic information systems.

Moreover, the framework such as the National Usability-Focused Health Information Systems Scale (NuHISS), and Health IT Usability Evaluation Model (Health-ITUEM) frameworks are intended explicitly for evaluating eHealth systems; however, they are designed for evaluating systems that serve single professionals such as nurses or doctors (Hyppönen et al., 2019; Brown et al., 2013) or for a specific country's context. For instance, the National Usability-Focused Health Information Systems Scale was designed for Finnish doctors only. Therefore, using a framework designed for a single specific healthcare professional to fit multiple professionals might affect the evaluation conception (Sousa & Lopez, 2017).

Heeks (2002) also indicates that the usability of technology differs from one country to another. Thus, a framework designed specifically for a particular country will not necessarily fit into another country. In this paper, the researcher sorted the most applied metrics for evaluating the usability of eHealth systems. Future studies will test the applicability of the metrics found in this study in developing countries.

Furthermore, since inter-professional collaboration in healthcare is inevitable (Bosch & Mansell, 2015), modern eHealth systems are integrated to incorporate all professionals. This calls into account the need to determine the usability evaluation metrics that accommodate several professionals' activities in a system. These metrics will help to evaluate not only the separate eHealth features but also the usability issues occurring due to the communication between various professionals in the system.

However, the existing usability evaluation frameworks do not have metrics that could holistically evaluate important issues related to eHealth systems' focus, multiple health professionals' considerations, and eHealth contextual issues. This is because most existing frameworks are not designed in the context of healthcare environments, and those few designed in healthcare contexts do not involve multiple professionals (Kavuta et al., 2023). Therefore, it is challenging to uncover usability problems based on the users' collaboration in a system. It is thus vital to assess the usability metrics from various sources, including existing frameworks and standard questionnaires, to identify the metrics that apply to eHealth systems. A scoping review was conducted to scrutinize the previous research in this area and identify the existing usability metrics that are mostly applied in evaluating the usability of eHealth systems.

2.0 OBJECTIVE OF THE STUDY

The main objective of this study was to assess the usability metrics applicable to evaluating eHealth systems. Specific questions were: What are the usability metrics that are mostly applied in evaluating the usability of eHealth systems? What are the roles of common usability metrics (metrics for evaluating generic information systems) in eHealth evaluation? What are the context-specific metrics for evaluating eHealth systems?

3.0 LITERATURE REVIEW

This section discusses the meaning of the terms related to eHealth usability evaluation. A scoping review was conducted to identify numerous studies related to eHealth system usability metrics. Firstly, various frameworks and models for evaluating information systems, including eHealth systems, were studied to recognise general metrics applied in all information systems evaluation. Moreover, a thorough review was conducted to separate the general metrics and those specific to eHealth systems.

3.1.Usability

Usability is defined as the degree to which specified users can use a system, product, or service to accomplish specified goals with effectiveness, efficiency, and satisfaction within a specified context of use (International Organizations for Standardization, 2018). Nielsen (1993) emphasises that the system is usable if it is easy to learn, easy to remember after some period the user has not been using it, efficient to use, the user can attain a high level of outcome, the system has few errors, and the user can recover those errors once they occur,

and satisfaction, that the system is pleasing to use and be satisfied. These aspects are also defined in Niranjanamurthy et al. (2014) as follows: Learnability is used to measure how easy the system is for users to finish basic tasks the first time they come across the system design. Efficiency measures the speed at which experienced users accomplish the task. Memorability measures how well the user can remember how to use the system after not using it.

In other words, usability testing entails determining how many errors the user makes, the severity of those errors, and the ease with which such errors can be recovered. Finally, satisfaction is another usability testing component that considers how much the users enjoy using the system and whether they feel comfortable using it (Liew et al., 2019). Zahabi, Kaber, and Swangnetr (2015) emphasise that a usable eHealth system should minimise errors and allow the user to achieve goals such as improving patients' safety, increasing work efficiency, and allowing healthcare providers more time with their patients. Moreover, the usability of eHealth systems should be evaluated during the development phase, after installation, and throughout the lifecycle (Price et al., 2016; Tyllinen et al., 2018). The proper evaluation of the eHealth system requires the use of appropriate usability measures. However, because the majority of frameworks used to evaluate eHealth systems are intended for generic systems, they can only show general usability concerns while hiding those particular to the eHealth context (Sousa & Lopez, 2017; Price et al., 2016; Broekhuis et al., 2019; Broekhuis et al., 2021).

3.2.Context of use and eHealth usability

The usability metrics should be designed according to the context of use (Sousa & Lopez, 2017). Context is a term used to describe "the user's goals, and the main user, task and environmental characteristics of the situation in which the system will be operating" (Maguire, 2001). The context of use comprises the user characteristics (background of the user, education, and previous experience), tasks, technical environment (hardware, software, network, etc.), physical environment, organizational environment, and social environment (single user, multiple users, assistance available, and interruption) (Niranjanamurthy et al., 2014). Therefore, due to the differences in culture, background, economics, and level of technology, the usability metrics for evaluating eHealth systems can be rated differently from country to country and appraised differently from one culture to another (International Organizations for Standardization, 2018; Wallace et al., 2013).

Moreover, previous studies emphasise that there are unique contexts associated with healthcare, including professional roles, collaboration, physician-patient interaction, and cognitive workload (Bergström et al., 2015; Squires et al., 2019), which are not incorporated into any usability evaluation framework necessary for determining the usability of eHealth systems. Additionally, studies by Heeks (2002) and Chen et al. (2006) argue that contextual issues such as electricity, ICT infrastructure, cultural, political, economic, knowledge, etc., influence eHealth systems' usability. Therefore, ignoring these issues in the usability evaluation process may lead the evaluator to the wrong results.

Heeks (2002) shows that most e-government systems in developing countries fail due to the gap between the system's design and reality. The other reason for the failure of e-government projects in developing countries is that they borrow the designs from developed countries without considering the historical and cultural aspects, infrastructure, people, and economic and government structures (Chen et al., 2006). Krishna and Walsham (2005) highlight that one of the reasons for the failure of information systems projects in developing countries is the disregard of context issues during the design and implementation. For example, a study by Mtebe and Nakaka (2018) shows that one of the reasons for the failure of the EMR implementation at Kilimanjaro Christian Medical Center was the failure to consider the context of the use. Because the developers were from the United States and designed the system in their context, which did not fit the Tanzanian context, there was a disconnection between the developer and the local user.

Developing a sustainable computerized information system requires the developer's awareness of context issues and local human resources (Tiihonen et al., 2008). However, the literature shows that many information systems developers ignore the contextual aspect (Tiihonen et al., 2008). Therefore, it is recommended that in developing countries with limited resources and a context quite different from Western culture, the local needs and the social and technical context of information system should be considered (Tiihonen et al., 2008). The next section discusses the frameworks used to evaluate various IS, including eHealth systems.

3.3. Frameworks and Models for Evaluating eHealth Usability

A usability evaluation framework can be defined as the guiding principles for planning, designing, and implementing a system's usability evaluation (Allas et al., 2018). It is a

systematic approach that is used to reveal and mitigate the usability issues of a system (Fynn et al., 2020). Several usability evaluation frameworks are used in evaluating generic information systems, such as the Nielsen model (Mtebe & Nakaka, 2018), the TAM model for usability factors (Burney et al., 2017) and ISO 9241-11:2018 (International Organizations for Standardization, 2018) and a few that are specifically for eHealth systems, including the National Usability-Focused Health Information Systems Scale and Health IT Usability Evaluation Model (Brown et al., 2013). This section discusses five usability evaluation frameworks and models developed by previous authors that have been applied to evaluate eHealth systems.

3.3.1 Theory of Acceptance Model for Usability Factors

Burney, Ali, Ejaz, and Siddiqu (2017) formed the theory of acceptance model for usability factors for evaluating general information systems. In their study, Burney et al. (2017) showed a relationship between the elements of the TAM model and usability aspects. Thus, usability aspects such as learnability and memorability influence the perceived ease of use (PEU) factor, while efficiency and effectiveness influence the perceived usefulness (PU) factor of the TAM model.

The authors focused on the relationship between the usability metrics and the TAM model. The metrics used in the research are common to all information systems, such as effectiveness, efficiency, memorability, and learnability. The study, however, does not include any specific metrics for eHealth systems. As a result, the model cannot reveal specific usability issues in eHealth. Furthermore, the model regards the user experience as the sole contextual issue to be addressed during the evaluation. However, user experience is not the only contextual issue to consider; there are other contextual issues.

3.3.2 *ISO 9241-11:2018*

ISO 9241-11:2018 is a framework designed to evaluate the usability of systems, products, and services (ISO, 2018). This standard comprises generic usability evaluation metrics and context-of-use elements to serve a broad range of contexts, such as systems, products, and services. The usability metrics in ISO 9241-11:2018 include effectiveness, efficiency, satisfaction, accessibility, avoidance of harm from use, and user experience and context of use, such as environment, users' characteristics, goals and tasks, and resources. The standard covers many important aspects of evaluating usability. However, its characteristics of

generalisation make it unfit for evaluating eHealth systems. Moreover, limited studies show the use of ISO 9241-11:2018 in evaluating eHealth systems.

3.3.3 Health IT Usability Evaluation Model (*Health-ITUEM)*

The Health IT Usability Evaluation Model model is explicitly designed to evaluate the usability of the eHealth system. This framework comprises the TAM model and ISO 9241-11 metrics, including learnability, error prevention, memorability, completeness, information quality, flexibility/customizability, and competency. However, it is too specific to the single profession of healthcare providers (i.e., for nurses only) and lacks contextual attributes.

3.3.4 *National Usability-Focused Health Information Systems Scale (NuHISS)*

The National Usability-Focused Health Information Systems Scale framework was developed to evaluate the usability of health information systems across Finland. The development process involved only Finnish physicians, and its purpose was specific to evaluating how the system is usable by only Finnish physicians. Factors include technical quality, information quality, feedback, perceived ease of use, benefits, internal collaboration, and cross-organizational collaboration. The framework does not show how other context-related issues were involved during its development and implementation.

3.3.5 *Nielsen Model*

The Nielsen model is a generic framework to evaluate various products and services, including generic information systems. The Nielsen Usability Model is the most accepted in the field of designing the user interface and evaluating the usability of generic information systems (Nielsen J., 2022). This model defines usability in five metrics, including efficiency, learnability, satisfaction, errors, and memorability (Mtebe & Nakaka, 2018). These metrics are so general; thus, the model lacks the specific metrics of eHealth, such as professional roles, collaboration, and physician-patient interaction (Bergström et al., 2015; Squires et al., 2019). Moreover, the model does not specify the context of use that could affect the system's usability.

Of all the reviewed frameworks for generic information system usability evaluation, ISO 9241-11:2018 has more strengths due to the inclusion of all common usability aspects and contextual issues. However, the usability metrics in the International Organization for Standardization are general (not specific to the eHealth context) and are used for evaluating

generic systems, products, and services. Besides, limited studies are showing the applicability of ISO 9241-11:2018 for assessing the usability of eHealth systems.

Moreover, using a generic usability evaluation framework in evaluating eHealth systems will partially discover usability issues (Sousa & Lopez, 2017; Price et al., 2016; Broekhuis et al., 2019). Thus, only those usability issues common to all information systems could be revealed, while those specific to eHealth systems could not be discovered. Although Health IT Usability Evaluation Model and National Usability-Focused Health Information Systems Scale are designed explicitly for eHealth systems, they were created for specific healthcare professional groups, such as nurses or doctors, and are unique to Finland (Hyppönen et al., 2019; Brown et al., 2013). In addition, using the framework designed for a single healthcare professional to evaluate multiple professionals is challenging (Sousa & Lopez, 2017).

3.3.6 Standardized Questionnaire

Standardised questionnaires are validated and accepted for evaluating the usability of systems, products, and services. A standardised questionnaire comprises a set of questions structured in a specified order with rules that yield scores from the responses of the participants (Sauro & Lewis, 2016). The System Usability Scale (SUS), the Post Study-SUS Questionnaire (PSSUSQ), the Questionnaire for User Interface Satisfaction (QUIS), the Telehealth Usability Questionnaire (TUQ), and the Computer System Usability Questionnaire are the familiar standardized questionnaires used for usability evaluation (Broekhuis et al., 2019).

To determine the usability of a system, the SUS consists of ten standard questions that are meant to gather data on perceived usefulness, perceived ease of use, technical support, and perceived inconsistency across system function (Alathas, 2018). The PSSUQ experienced multiple iterations of revision, and the most recent version now includes 16 items that assess the technical quality of the system, information quality, interface quality (navigation and visibility), and overall average responses (Sadiku et al., 2017). The QUIS questionnaire includes a questionnaire for collecting demographic information, a measure of general system satisfaction, and metrics for particular interfaces, including screen visibility, terminology, system feedback learning variables, and system capabilities (Busagala & Kawono, 2013; Kavuta & Magoiga, 2023).

Moreover, the TUQ was developed to evaluate the level of communication between two telehealth locations (i.e., between the patient and the healthcare provider). The TUQ evaluates the effectiveness of audiovisuals, quality of relationships, perceived ease of use, satisfaction, and degree of comfort. The metrics included in the TUQ include usefulness, ease of use, effectiveness, reliability (error prevention), and satisfaction. Table 1 presents a summary of the usability metrics extracted from the frameworks and standardized questionnaires.

Table 1: Usability metrics extracted from various Frameworks and Standardized questionnaires

Author	Usability Frameworks and Models	Year	Effectiveness	Learnability	Information quality	Ease of use (PEOU)	Efficiency	Error prevention	Visibility	Satisfaction	Memorability	Usefulness (PU)	Technical quality	Feedback	Internal collaboration	Navigation	Accessibility	Avoidance of harm	User experience	Completeness	Flexibility	Competency	Benefits	External collaboration	Technical support	Consistency
(Burney et al., 2017)	TAM	2017	√	√		√	√				√	√														
(ISO, 2018)	ISO 9241-11:2018	2018	√				√			√							√	√	√							
(ISO, 2018)	NIELSEN	1993	√	√			√	√			√															
(Hyppönen et al., 2019)	NuHISS				√	√							√	√	√								√	√		
(Brown et al., 2013)	Health-IT-UEM			√	√			√			√									√	√	√				
(Alathas, 2018)	SUS					√						√													√	√
(Sauro & Lewis, 2016)	PSSUSQ				√				√				√			√										
	QUIS			√	√				√	√				√												
	TUQ		√			√		√	√	√		√			√	√										
	CSUQ		√	√	√	√	√	√	√																	
	Total		**5**	**5**	**5**	**5**	**4**	**4**	**4**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

*Table 1***Error! Reference source not found.** reveals various metrics that are used in developing five frameworks and five standardized questionnaires. The frequency of these metrics ranges between 5 and 1. The metrics with a high frequency of being used include effectiveness (5), learnability (5), perceived ease of use (5), and information quality (5). Other metrics with high frequency include efficiency (4), error prevention (4), visibility (4), satisfaction (3), memorability (3), and usefulness (3). The metrics that have less frequency include the technical quality (2), feedback (2), internal collaboration (2), and navigation (2), and the rest of the metrics appeared once, including accessibility, avoidance of harm, user experience, completeness, flexibility, competency, benefits, external collaboration, technical

support, and consistency.

4.0 METHODOLOGY

A scoping review was conducted following the procedures proposed by Arksey and O'Malley (2005), which comprise five stages: identifying the research question, identifying relevant studies, selecting studies, charting the data, and collating, summarizing, and reporting the results. The first stage (i.e., identifying the research question) was covered in the previous sections. As a result, the main question for this study was - what are the usability metrics that are mostly applied in evaluating the usability of eHealth systems? The rest of the stages are discussed in the following sections. The following subsections discuss in detail the methods and procedures used in reviewing the literature to achieve the goal of this study. Among the methods and procedures are the information sources, the study selection techniques, the data collection techniques, and the inclusion and exclusion criteria that helped us decide which study to include in our review.

4.1. Sampling Procedures: Information Source and Search Strategy

To achieve this, the authors reviewed the articles concerned with eHealth systems and those that provide generic usability metrics. Various qualitative, quantitative, and mixed methods studies were reviewed to acquire a broad understanding of the eHealth system domains, including electronic medical records, electronic health records, mobile Health, telemedicine, and clinical decision support systems. To obtain such metrics, studies about usability evaluation frameworks and standardized usability evaluation questionnaires were reviewed.

The literature search was conducted in three databases, PubMed, Emerald, and SAGE, between August 2021 and February 2022. The reason for carrying the scoping review from these databases is that they each consist of many articles related to eHealth and usability. The search terms were "usability" in combination with "metrics" "evaluation metrics" "factors" "attributes" "framework" "models" "taxonomy" "eHealth" "health" "telehealth" and "mHealth". Moreover, the review norms were followed, whereby the selection of the previous studies started with searching using the keywords and reading the titles and abstracts to discard the studies irrelevant to the eHealth system's usability. There are no criteria for limiting the number of participants involved in the studies reviewed or restricting the type of research method used (i.e., qualitative, quantitative, or mixed methods).

4.2. Quality Procedures: Inclusion and exclusion criteria

The articles published from 2012 to 2021 and written in English were included in this study to obtain more current literature. Limiting such a time range was due to the high speed of technological change; thus, the evaluation strategies also change every time. Therefore, using the old studies to decide what usability metrics should be used to evaluate current systems might be wrong. Other criteria include studies on developing or validating frameworks, questionnaires, benchmarks, usability factors and evaluating an eHealth system's usability. Moreover, studies conducted to evaluate medical devices instead of information systems were discarded. Furthermore, all studies that included only basic usability aspects such as effectiveness, efficiency, and satisfaction without an additional emphasis on factors, attributes, or new uncommon metrics were also excluded.

4.3. Data Collection, Analysis, and Reliability of the Study

The review began with screening all search results, followed by a review of the full texts pertinent to the topic. Both authors participated in the full-text review, and only studies they agreed on were included in the analysis. Two reviewers conducted the review and created a data charting form to select relevant studies. Each reviewer independently charted the data, and multiple meetings were held to discuss the findings and update the data chart until both reviewers reached a consensus.

5.0 RESULTS

This section includes two subsections: the findings, which explain the results of the scoping review, and the discussion of the findings in detail to express the revealed metrics mostly applied in eHealth systems usability evaluation.

5.1 Findings

The search resulted in a total of 2112 articles. The duplicates were removed, and other exclusion rules were applied, yielding 15 qualified articles for inclusion. Other information included in this study from the selected papers was when (year of publication) and where (the country) the studies were conducted. Figure 1 illustrates the extraction of the papers included in this study from three databases: PubMed, Emerald Insight, and SAGE. The figure illustrates the review process and exclusion of studies that do not meet the criteria for this study.

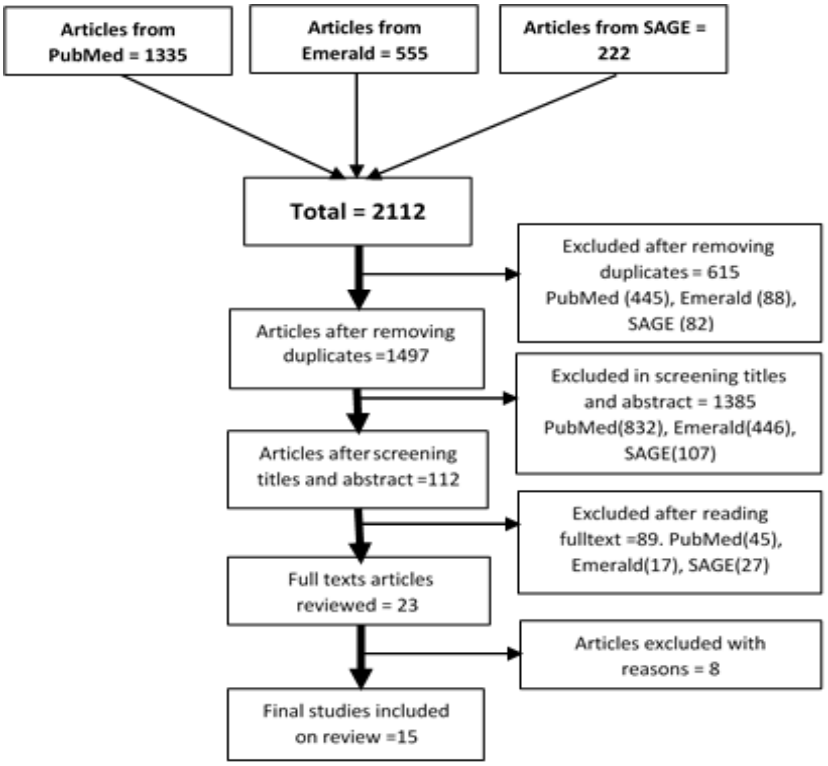


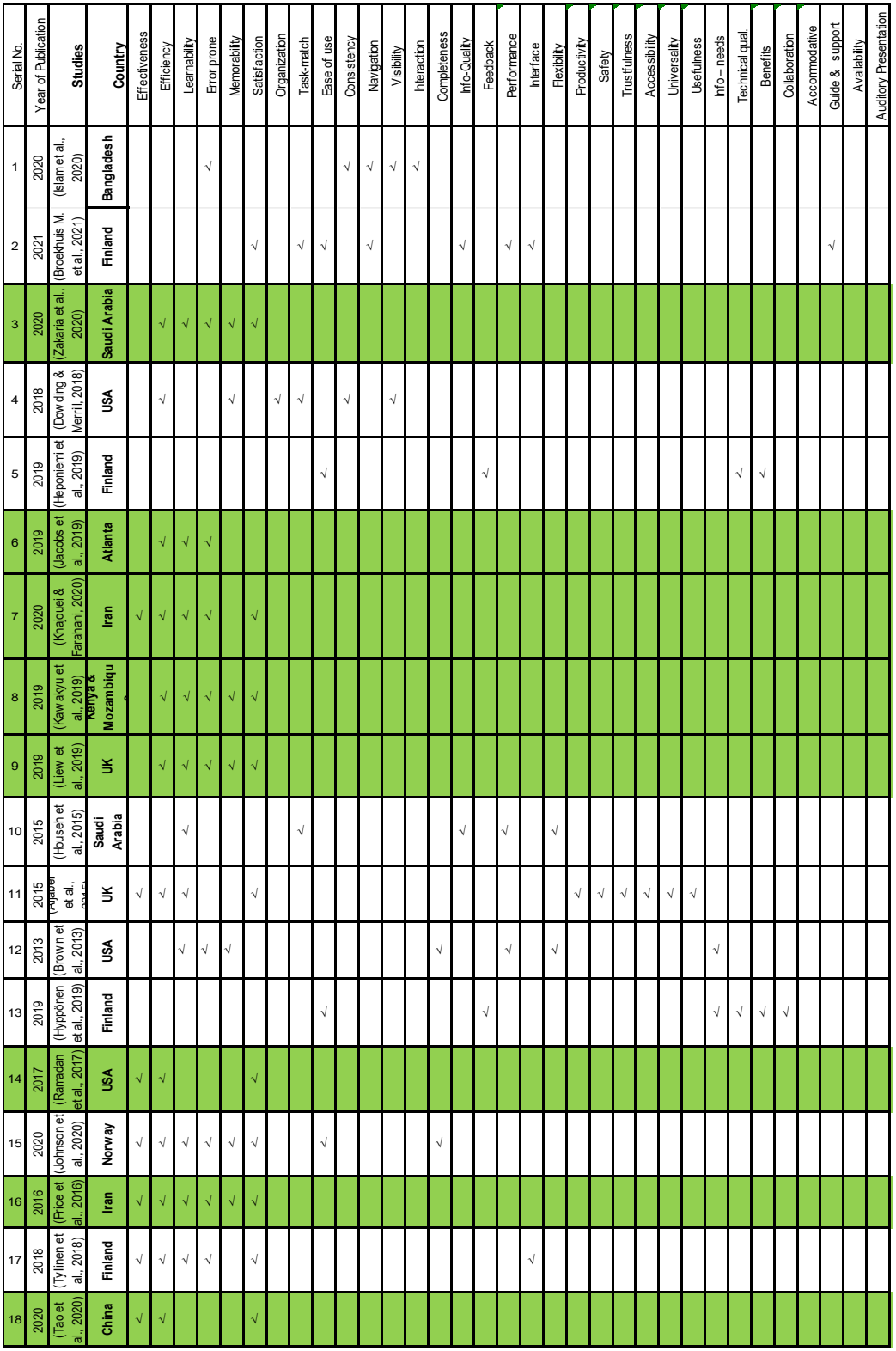
Figure 1: PRISMA flowchart illustrating the literature search and selection process for publications.

5.2 Results

A total of 28 usability metrics were exposed. All 28 metrics were extracted from the studies related to eHealth usability evaluation, including developing and validating the usability evaluation frameworks. The review exposed that six common usability metrics, including efficiency, satisfaction, learnability, error prevention, memorability, and effectiveness, were mostly applied in evaluating the usability of various eHealth systems. Thus, out of 23 studies, these metrics appeared many times as follows: efficiency (15 studies out of 23), satisfaction (15 studies), learnability (14 studies), error prevention (14 studies), memorability (9 studies), and effectiveness (9 studies). The metrics that are categorised as uncommon in this study and shown to have a significant frequency include task-technology match, which scored 7 frequencies, while the frequencies of other uncommon usability metrics, including ease of use, information quality, guidance and support, technical quality, consistency, navigation, visibility, flexibility, and accessibility, range between 5 and 4. The rest of the usability metrics scored less significant frequencies, as shown in Table 2. Based on these results, the researchers decided to eliminate all studies that applied only common metrics in evaluating the usability of the eHealth systems. Therefore, eight (8) studies out of 23 (highlighted green

in Table 2) were eliminated from the findings, leaving 15 studies that applied all uncommon metrics or a mixture of the common and uncommon ones. The purpose was to find out the metrics that are not for generic systems but are specific to eHealth systems.

Table 2: Usability metrics before eliminating studies with only common metrics



Serial No.	Year of Publication	Studies	Country	Effectiveness	Efficiency	Learnability	Error prone	Memorability	Satisfaction	Organization	Task-match	Ease of use	Consistency	Navigation	Visibility	Interaction	Completeness	Info-Quality	Feedback	Performance	Interface	Flexibility	Productivity	Safety	Trustfulness	Accessibility	Universality	Usefulness	Info – needs	Technical qual.	Benefits	Collaboration	Accommodative	Guide & support	Availability	Auditory Presentation
19	2019	(Inal, 2019)	Norway	√	√		√		√		√				√							√														
20	2020	(Hardenbol et al., 2020)	Netherlands	√	√	√	√	√	√				√						√	√																
21	2017	(Rodriguez-Paras & Sasangohar, 2017)	USA (Texas)		√	√	√	√	√																											
22	2019	(Halim, 2019)	Netherlands						√		√			√						√								√	√		√	√	√		
23	2018	(Farzandipour et al., 2018)	Iran			√	√				√	√	√	√	√																			√
	Frequency			10	15	14	14	9	15	1	6	7	4	5	4	1	2	3	3	5	2	3	1	1	1	1	1	2	2	2	2	2	1	2	1	1
				6	7	8	8	5	8	1	6	7	4	5	4	1	2	3	3	5	2	3	1	1	1	1	1	2	2	2	2	2	1	2	1	1

Findings also show that only 7 out of 23 reviewed studies applied the task technology match, and only 2 out of 23 studies considered collaboration as an eHealth usability evaluation attribute, as presented in Table 2.

Task technology match is the essential metric used to determine how similar the tasks involved in the system are to the routine tasks familiar to the user and used to accomplish the whole process of caring for the patient. Additionally, collaboration is the metric that helps to determine how the eHealth system facilitates the teamwork of interdepartmental and/or inter-professional teams, which is the fundamental context of healthcare provision. Thus, ignoring these metrics in evaluating the usability of the eHealth system would have negative consequences, for example, failing to discover the usability issues caused by an improper order of treatment, unnecessary distress to the patients, manual communication between healthcare professionals and departments, etc.

The findings show that most of the studies included were conducted in developed countries; out of the 23 studies, 15 (65%) were conducted in developed countries, including Finland (5), the United Kingdom (2), Norway (2), the Netherlands (2), and the United States of America (5). Only 8 (35%) studies were from developing countries, including China (1), Bangladesh

(1), Saudi Arabia (2), Iran (3), and Kenya (1), as presented in Table 2. Region-wise, the reviewed studies were based on the following: 10 studies in Europe (i.e., Finland, U**nited** K**ingdom**, Norway, and Netherlands), five studies in the United States of America, 7 studies in Asia (i.e., China, Bangladesh, Saudi Arabia, and Iran), and 1 study in Africa. The green-coloured rows in Table 2 indicate the studies that include only the common usability metrics that were finally eliminated for reasons stipulated in this section.

After eliminating 8 studies, the results show that the common metrics' frequencies are still higher than the uncommon ones, as presented in Table 3 and illustrated through a graph in Figure 2. For example, the metrics error prevention, satisfaction, learnability, efficiency, and effectiveness have the frequency of appearance in studies between 9 and 5. Moreover, the following 10 metrics (with frequencies in brackets) are considered by this study as the context-specific usability metrics for evaluating eHealth systems due to their significant frequencies of being applied in previous studies: task-technology match (7), ease of use (5), navigation (5), technical quality (5), information quality (5), guide and support (5), consistency (4), visibility (4), flexibility (4), and accessibility (4).

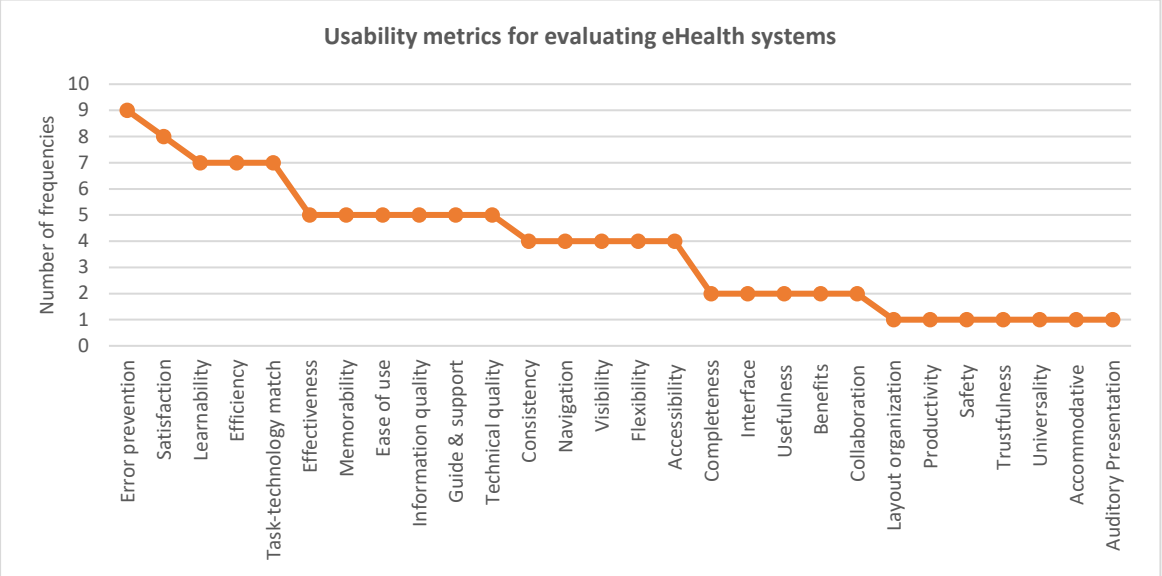


Figure 2: Usability metrics frequency as applied in different studies

Table 2: Usability metrics applied in evaluating eHealth systems

Serial No.	Year of Publication	Citation	Country	eHealth System	Error prevention	Satisfaction	Learnability	Efficiency	Task-technology match	Effectiveness	Memorability	Ease of use	Information quality	Guide & support	Technical quality	Consistency	Navigation	Visibility	Flexibility	Accessibility	Completeness	Interface	Usefulness	Benefits	Collaboration	Layout organization	Productivity	Safety	Trustfulness	Universality	Accommodative	Auditory Presentation
1	2020	[48]	Bangladesh	mHealth	√											√	√	√		√												
2	2018	[64]	Iran	E.H.R	√		√		√			√				√	√	√	√													√
3	2015	[55]	Saudi Arabia	mHealth			√		√				√		√				√													
4	2021	[32]	Netherlands	Mixed		√			√			√	√	√	√		√					√										
5	2019	[51]	Finland	Mixed								√		√	√									√								
6	2015	[56]	UK	mHealth		√	√	√		√										√			√				√	√	√	√		
7	2019	[9]	Finland	E.H.R								√	√	√	√									√	√							
8	2020	[58]	Norway	mHealth	√	√	√	√		√	√	√									√											
9	2018	[30]	Finland	E.H.R	√	√	√	√		√												√										
10	2019	[60]	Norway	mHealth	√	√		√	√	√								√	√													
11	2020	[61]	Netherlands	CDSS	√	√	√	√		√	√			√		√				√												
12	2019	[63]	Netherlands	E.H.R		√			√				√	√	√		√						√		√						√	
13	2017	[62]	USA	mHealth	√	√	√	√			√																					
14	2013	[23]	USA	mHealth	√		√				√		√						√	√	√											
15	2018	[50]	USA	E.H.R				√	√		√					√		√								√						
Total					14	15	14	15	7	9	9	5	5	5	5	4	4	4	4	4	2	2	2	2	2	1	1	1	1	1	1	1

5.3 Discussion

Based on the results presented in Section *4.3*, the review showed that usability evaluation metrics could be categorized into common or general metrics and context-specific eHealth metrics (or uncommon metrics). For this study, the common metrics fit in when evaluating any generic IS, while the context-specific eHealth usability metrics are those specific to eHealth contexts. The review revealed that six common usability metrics were primarily used in evaluating the usability of various eHealth systems, including efficiency, error prevention, satisfaction, learnability, memorability, and effectiveness.

Despite the common usability metrics that have shown great frequency in evaluating eHealth systems, the International Organizations for Standardization (2018) and Broekhuis et al. (2019) recommend that usability evaluation consider context issues such as task characteristics, user characteristics, technology, and environment. However, previous studies have shown that most studies have ignored the context of use (Tiihonen et al., 2008). This has also been confirmed in the findings of this study, whereas the metric collaboration is contextually oriented to eHealth systems, but very few studies have considered this. For instance, collaboration measures how the system enhances communication among departments or between professionals, but only a few studies (i.e., 2 out of 15 studies) considered it in usability evaluation. This indicates that the previous studies have not adequately explored the context-specific eHealth system usability evaluation metrics. Bosch and Mansell (2015) suggest that in the daily performance of healthcare service delivery, inter-professionalism is inevitable. As a result, the authors of this study argue that collaboration should be a key metric for assessing the usability of eHealth systems.

The review also revealed that most of the studies about eHealth usability evaluation were conducted in developed countries: 4 were conducted in Finland, 2 in Norway, 2 in the UK, 2 in the Netherlands, and 5 in the USA. Only a few studies were conducted in developing countries, including two in Saudi Arabia, three in Iran, one in Bangladesh, one in China, and one in Kenya. Moreover, after this study eliminated the papers that comprised only common metrics, the number of studies in developing countries significantly decreased. The reason for the elimination was to include only those studies that have considered eHealth-related context issues to test whether other usability metrics specific to eHealth contexts have been exhausted enough in studies. Thus, eight (8) studies out of 23 were eliminated from the

findings, leaving 15 studies that either applied all the uncommon metrics or a mixture of the common and uncommon ones.

The study discovered that none of the studies from Africa were left after eliminating these eight studies. This indicates limited studies on the usability of eHealth systems in developing countries, mainly in Africa. For example, out of 15 studies, only 3 (20%) were from developing countries, and the remaining 12 (80%) were from developed countries (refer to *Table 3*). This also indicates that most developing countries are using common metrics to evaluate the usability of their eHealth systems. Based on these findings, this study argues that developing countries must design frameworks that include context-specific metrics for evaluating eHealth systems to uncover specific usability issues related to eHealth systems within their contexts.

Moreover, in this study, the authors also argued that although collaboration is less frequently used in evaluating eHealth usability, it is an essential evaluation metric. This is because eHealth systems nowadays are designed to include multiple professionals and multiple health facility levels. Bosch and Mansell (2015) support this argument by revealing that since the operations of healthcare providers are interdependent on the work of multiple health professionals, collaboration is inevitable. The lower frequency of use of the collaboration metric might be because most of the eHealth usability evaluation studies focused on specific professionals, which required less collaboration with other professionals in assessing their usability (Wasylewicz & Scheepers-Hoeks, 2019; Lungo, 2008). Based on this argument, this study adds the collaboration metric to a context-specific metric to make a total of 11 context-specific usability metrics for evaluating eHealth systems, as further discussed in the subsequent paragraphs.

Ease of use: The system is easy to use if it is simple and understandable by the user.
Task-technology match: If the system's tasks have all the necessary content to accomplish the goal, they are expected to match those in the real world, be well organized, and be simple to execute.

Navigation: A system is navigable if it is easy to move between pages without confusion. Thus, the user can understand where to get to a certain page and, when necessary, can easily return to the other pages. Farzandipour et al. (2018), termed this metric "controllability,"

which comprises features such as "easy movement among screens," "directly returning to the main menu from each screen," "easy switching among different levels of the menu," and "the existence of enough help in the system."

Consistency: The system should be consistent in all aspects so that the user can do things that are familiar to him or her based on previous experience (Alathas, 2018). ISO 9241 defines consistency as conformity with user expectations; thus, the user expects similar icons, symbols, functions, colours, methods of displaying, formats of entering information, etc., throughout the system (Farzandipour et al., 2018).

Visibility: The system should be visually clear in terms of the pictures and information that are readable on the screen. The designer must ensure that users can easily read the characters, watch the pictures clearly, and properly display the screens.

Information quality: This metric assesses the understandability and quality of the information in the system. For example, the terminologies used in a system should be common to the user (in the language the user can speak).

Technical quality: This is a metric used to uncover the technical issues that hinder the usability of eHealth systems, including system performance such as speed, security issues, and the ability to handle data entered in the system.

Guide and support/feedback: This metric assesses whether the system provides support and feedback when the user performs tasks. It also assesses whether the system can provide correct feedback when the user makes a mistake or error, helping him/her to correct it instead of accepting the wrong information from the system.

Flexibility: Help assess whether the system is flexible enough to add new features or change something.

Accessibility: The metric that identifies the quality of the system's usability is the ability of the user to access the system easily. This includes the ability to use the system while talking to the patient and access all screens for which the user is responsible.

Collaboration: This metric helps assess the system's capability to enable different health professionals to communicate within and with other health facilities or stakeholders (internal and external collaboration). Studies in *Table 3* are arranged based on the regions in which they were conducted. For example, serials 1 to 3 are the studies conducted in Asia, which are developing countries; serials 4 to 12 are the studies conducted in developed countries in Europe; and studies in serials 13 to 15 are all from the USA, a developed country.

6.0 CONCLUSION AND RECOMMENDATION

Conclusion and Future Works

This study examined the usability metrics, mostly applied in evaluating eHealth systems. Five usability evaluation frameworks and five standardised questionnaires were reviewed to determine the usability metrics. Moreover, 15 studies from reputable journals in the SAGE database, Emerald Insight, and PubMed were reviewed. From the 15 studies, 11 usability metrics were identified as being the most important in evaluating eHealth systems. These metrics include ease of use, task-technology match, navigation, information quality, technical quality, accessibility, guide and support, consistency, visibility, flexibility, and collaboration.

Moreover, the study revealed that there are limited studies on the usability of eHealth systems in developing countries, specifically in Africa. Consequently, those few studies conducted in Africa applied the generic usability metrics only in evaluating eHealth systems compared to developed countries. This indicates that there are limited studies on eHealth usability evaluation that can be used as a baseline for the Tanzania context. Therefore, there is a need for future studies to develop a context-specific eHealth usability framework with eHealth usability evaluation metrics that could fit Tanzania and African contexts at large.

Contribution to the Knowledge

This paper has added value in identifying usability evaluation metrics that should be considered for evaluating eHealth systems. The study has also revealed that the common usability metrics such as effectiveness, efficiency, satisfaction, learnability, memorability and error correction must also be applied in evaluating eHealth systems to uncover those general usability issues. In contrast, specific metrics for eHealth systems are needed to reveal those usability issues specific to eHealth systems. Further studies may focus on testing the revealed usability metrics into practice to validate their applicability in evaluating the usability of eHealth systems in developing countries such as Tanzania and others with lower resource settings.

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