FEeSU - A Framework for Evaluating eHealth Systems Usability: A Case of Tanzania Health Facilities

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Abstract
The adoption of eHealth systems in the health sector has changed the means of providing health services and increased the quality of service in many countries. The usability of these systems needs to be evaluated from time to time to reduce or completely avoid the possibility of jeopardizing the patients' data, medication errors, etc. However, the existing frameworks are not countries contexts sensitive since they are designed with the mind-set of practices in developed countries. Such developed countries' contexts have different cultures, levels of resource settings, and levels of computer literacy compared to developing countries such as Tanzania. This paper presents the framework for evaluating eHealth system usability (FEeSU) that is designed with a focus on developing country contexts and tested in Tanzania. Healthcare professionals, including doctors, nurses, laboratory technologists, and pharmacists, were involved as the main participants in this research to acquire practice-oriented requirements based on their experience, best practices, and healthcare norms. The framework comprises six steps that are to be followed in the evaluation process. These steps are associated with important components, including usability metrics, stakeholders, usability evaluation methods, and contextual issues necessary for usability evaluation. The proposed usability evaluation framework could be used as guidelines by different e-health system stakeholders when preparing, designing, and performing the evaluation of the usability of a system.
Keywords: Usability metrics, Usability evaluation, Contextual issues, eHealth systems, Framework for usability evaluation

1 Introduction
The application of information and communication technology (ICT) in healthcare has improved the quality of service in health institutions in many parts of the world. According to the World Health Organization [1], 58% of the WHO member states have adopted eHealth systems. The governments of those countries that have adopted eHealth systems have established several strategies and initiatives to enhance their implementation and improve the quality of the system. Examples of developing countries that have made strategies and initiatives include Kenya, which has the National eHealth Policy 2016–2030, which aims to overcome pre- and post-implementation challenges [2]. In addition, the South African National Digital Health Strategy for 2019–2024 aims to enhance the efficiency and quality of healthcare services, establish an integrated platform, and create awareness for successful digital health [3].

Tanzania, as one of the developing countries, has also been introducing several eHealth policies and strategies to enhance the implementation and improvement of eHealth systems' quality. Examples of eHealth strategies in Tanzania include the National eHealth Strategy 2013–2018 and the recently introduced National Digital Health Strategy 2019–2024. The current strategy aims to improve healthcare services of high quality for all Tanzanians [4].

This rapid adoption of eHealth systems is catalysed by the benefits of using such technology in the health sector. Among the benefits of adopting eHealth systems are cost savings, health safety improvement, health service accessibility, improved decision-making, reducing medical errors, and generally improving the quality of healthcare service delivery, etc. [5] [6]. These promising benefits have pushed many countries to adopt various eHealth technologies. Despite the adoption and initiatives that developing countries have taken, previous studies such as [7] [8] [9] and [10] show that the poor usability of those systems is the major challenge for the penetration of eHealth systems not only in developing countries but also in developed countries.

The term usability in this study is defined as the ability of the user to apply a system to accomplish goals that are anticipated in a simple way with effectiveness and efficiency, resulting in user satisfaction with less cognitive effort, subject to the context of use. This definition demonstrates that "a usability problem" is anything that could interrupt the smooth usage of a system or create barriers to achieving the goal and hence lower the level of user satisfaction. Furthermore, the term eHealth system usability in this study refers to the ability of healthcare providers and other stakeholders to apply the eHealth system to accomplish the goal without experiencing difficulties either physically or cognitively while maintaining efficiency and data integrity. The level of usability of a system depends on its design, the technical and physical environment in which it is to be used, the characteristics of its users (e.g., education, experience, etc.), and the intended goal to be accomplished [11] [12]

[13]. In developing countries, including Tanzania, eHealth systems face poor usability in different aspects, such as user-system interactivity difficulties, frequent system errors, poor data quality, and a lack of system interoperability. Task-technology mismatch, and poor communication and collaboration among the healthcare providers within the health facility are other usability issues of the eHealth systems in developing countries [7] [8] [9] & [10].

The level of usability of a system is determined by choosing an appropriate evaluation framework with proper evaluation metrics. The level of usability of a system is determined by choosing an appropriate evaluation framework with proper evaluation metrics. The existence of a framework with proper usability metrics that contemplate the contexts of developing countries could be used as a guide to designing eHealth systems that fit the contextual issues to increase the usability of eHealth systems. Additionally, the usability evaluation framework will help reveal the usability problems of the existing eHealth systems and rectify them.

According to Msanjila and Afsarmanesh in [14], a framework is a conceptual design that is used to address and solve complicated problems by specifying the procedures and outlining the methodology for each step in order to get the best possible overall result. The study in [14] further emphasizes that the framework must contain all necessary steps to complete the processes and provide the answer. As a result, the framework for usability evaluation summarizes the criteria that should be followed when preparing, creating, and performing the evaluation of a system's usability.

2   Existing Framework for Evaluating the Usability of eHealth Systems

Several usability evaluation frameworks have been used to evaluate various information systems. However, they are either not explicitly designed to evaluate eHealth systems or are designed for specific country contexts that could not necessarily fit into developing country contexts. The developing countries, including Tanzania, have the specific contexts that are necessary for being considered in a framework to guide the eHealth system developers. Such contexts include low-resource settings such as a low number of healthcare professionals, inadequate computers in health facilities, inexperienced computer users, and culture [15]. For example, in this study, we observed that due to the small number of healthcare professionals in health facilities, there are times when the nurses observe the changes in the patient and directly consult the laboratory technician to investigate according to the symptoms before the doctor arrives. This means that the systems must allow collaboration between the nurse and laboratory technician in emergency cases. Moreover, the inadequate number of doctors forces the eHealth systems to allow the outpatient department (OPD) doctor to access the inpatient department (IPD) records for follow-up of the patient who was first admitted to the OPD and later transferred to the IPD. This feature might be unnecessary in countries with adequate healthcare professionals.

The existing frameworks include ISO 9241-11:2018 [16], the Health-IT Usability Evaluation Model (Health-ITUEM) [17], the National Usability-Focused Health Information Systems Scale (NuHISS) [18], the Nielsen usability model [19], and the TAM model for usability factors [20]. The ISO 9241-11:2018 standard has many usability aspects and considers context issues such as user characteristics, tasks, environment, and technology compared to other generic usability evaluation frameworks. However, since it is a general usability evaluation framework for evaluating systems, products, and services, it lacks specific eHealth usability evaluation metrics. Additionally, there is limited information on its applicability in evaluating eHealth systems, particularly in developing countries. The eHealth system has unique contexts that should be considered during the design and evaluation processes. Among the unique contexts associated with healthcare are professional roles, medical activity-minded collaboration, physician-patient interaction, and cognitive workload [12] [13] [21].

Although NuHISS and Health-ITUEM are designed specifically for evaluating the usability of eHealth systems, they are precisely designed for evaluating a single type of user, such as nurses or doctors. Therefore, using a framework designed for specific healthcare professionals to fit multiple professionals might affect evaluation comprehension. In addition, eHealth systems have recently been integrated to incorporate all professionals because inter-professional collaboration in healthcare is inevitable [22]. Therefore, it is necessary to evaluate the system with all incorporated professionals to assess all attributes contributing to poor usability. This will also enable the evaluators to reveal usability problems associated with the collaboration features of a system, which cannot be found on a framework designed to evaluate a single professional.

Furthermore, this research used the Fit for Individuals, Tasks, Technology, and Environment (FITTE) framework as a backbone in developing the FEeSU. The FITTE highlights the contextual issues that are necessary for the system's usability evaluation, including the user's characteristics (individuals), tasks, resources and technology, and environments [11]. The FITTE framework has the advantage of showing the relationships between the contextual issues. Examples of these relationships include the relationship between the user and tasks, tasks and technology, the user and technology, and the environment, among all other contexts of use. The FITTE provides the skeleton of a framework as it includes the essential contextual issues. Moreover, this research has considered various studies about the usability of eHealth systems in order to ensure that the proposed framework includes both generic and specific usability metrics that are particularly applicable to evaluating the usability of

eHealth systems. Additionally, to guarantee that the framework is applicable to developing countries, the obtained metrics were tested in Tanzania's context, specifically using the government of Tanzania hospital management information system (GoTHoMIS) system as a platform.

3 Methodology

To address the problem associated with the existing frameworks, this study has developed a new framework for evaluating eHealth system usability (FEeSU) that considers contextual issues relevant to developing countries. First we considered the contextual issues as proposed in the FITTE framework and the usability metrics from literature review. Then, a research survey was conducted to collect both quantitative and qualitative data, whereas the quantitative data was collected using the questionnaire and the qualitative through the interview. Quantitative data was applied to isolate metrics that were not suitable for inclusion in the framework from the pool of many metrics obtained from the literature. For qualitative data, 21 experienced healthcare practitioners and ICT personnel were interviewed to add metrics and items that could not be foreseen in a quantitative research tool based on their experience and best practices. The aim of conducting a survey was to acquire the usability metrics and contextual issues that are applicable for evaluating the usability of eHealth systems. Thus, the contextual issues as proposed in the FITTE [11] and usability metrics from the literature review were tested using confirmatory factor analysis (CFA) through structural equation modeling (SEM) analysis to reveal those that are suitable in Tanzania's environment.

Six health facilities in Tanzania exist at three different levels: two health center-level facilities, including Makole (Dodoma) and Kachwamba (Geita); three district hospital-level hospitals, including Chato district hospital, Biharamulo designated district hospital, and UDOM hospital (Dodoma); and one referral-level hospital, the Coastal Region Referral Hospital (Tumbi Hospital). The selection of these health facilities was done through consultation with the system developers from the president's office, regional administration, and local government (PO-RALG) office. The main criteria were to involve the health facilities that are installed with GoTHoMIS Lite (or version 4), that have all necessary modules that enable multiple healthcare professionals to use the system, and should include three levels, including health centers, district hospitals, and regional referral hospitals. Based on these criteria, in consultation with the PO-RALG officers, the selection was made. A sample of 370 participants included different healthcare practitioner cadres such as nurses, doctors, pharmacists, laboratory technologists, and supporting staff such as IT support personnel, data clerks, and cashiers, as further presented in the demographic data of the respondents in **Table 1**.

Table 1: Demographic data of the respondents

Variable	Items	Frequency (N)	Percentage (%)
Gender	Male	164	44.3
	Female	206	55.7
Total		**370**	**100.0**
Age group	18 – 24 years	17	4.6
	25 – 34 years	179	48.4
	35 – 44 years	81	21.9
	45 – 54 years	77	20.8
	55 – 65 years	16	4.3
Total		**370**	**100.0**
Occupation role	Physician/Doctor/Clinician	109	29.5
	Pharmacist	35	9.5
	Lab technologist	44	11.9
	Nurse/Midwifery/Anesthetists	143	38.6
	Accountant	16	4.3
	ICT	2	0.5
	Reception/Data Clerk	11	3
	Other	10	2.7
Total		**370**	**100**
Academic qualifications	Form Four	37	10.0
	High school	3	0.8
	Certificate	56	15.1
	Diploma	159	43.0
	Bachelor degree	107	28.9
	Master degree	8	2.2
Total		**370**	**100.0**

Variable	Items	Frequency (N)	Percentage (%)
Health facilities levels	Regional Referral Hospital	155	41.9
	D/DDH	181	48.9
	Health Center	34	9.2
Total		**370**	**100.0**
Health facilities names	Biharamulo DDH	65	17.6
	Chato DH	71	19.2
	Kachwamba HC	9	2.4
	Makole HC	25	6.8
	Coastal RRH (Tumbi)	155	41.9
	UDOM Hospital	45	12.2
Total		**370**	**100.0**

The framework development process passed through five stages, including problem identification, problem analysis, design and analysis, developing a framework, and validating the framework. In problem identification, a scoping review was conducted, whereby 15 articles from three journal databases, including Emerald, PubMed, and SAGE, met the criteria for inclusion. In a scoping review, various models, frameworks, and other studies related to the usability of eHealth systems were reviewed. The search phrases were "usability" along with "metrics" "evaluation metrics" "factors" "attributes" "framework" "models" "taxonomy" "eHealth" "health" "telehealth" and "mHealth". Solely research written in English was taken into consideration for the reviewed papers, which were only limited to articles published from 2012 to 2021. As a result, the metrics that appeared at a high frequency (at least four times) in these 15 articles were considered. Additionally, the data from the opinions of healthcare practitioners and local eHealth system developers was collected through an unstructured interview. This process resulted in obtaining the usability metrics and contextual issues required for evaluating the usability of eHealth systems. In the problem analysis stage, the research tools (i.e., questionnaire and interview guide) were developed and used in data collection from the participants.

The quantitative data was analysed by conducting the CFA through SEM analysis to validate the metrics and contextual issues that are applicable in developing countries, specifically Tanzania. As a result, 11 usability metrics and 5 contextual issues with their 72 items were analysed to test the model fit. Those items that scored low factor loadings (i.e., items with factor loadings less than 0.7) [23] [24] *were eliminated from the model. For qualitative data, 21 participants, including 5 doctors, 5 laboratory technologists, 3 pharmacists, and 8 nurses, had a working experience of 3 years or more. Thematic analysis was used to acquire other metrics based on the opinions and feelings of the respondents according to experience and best practices.* Phase 4 of developing a framework was conducted by including the results from phase 3 and also supporting them with other knowledge that was necessary for the framework, such as evaluation methods, important stakeholders to be involved, and evaluation framework guidelines. Lastly, in phase 5 the framework was validated by conducting a focus group discussion that included three local eHealth system developers and three experienced healthcare practitioners.

Figure 1 illustrates the procedures taken to develop a framework for evaluating the usability of an eHealth system.
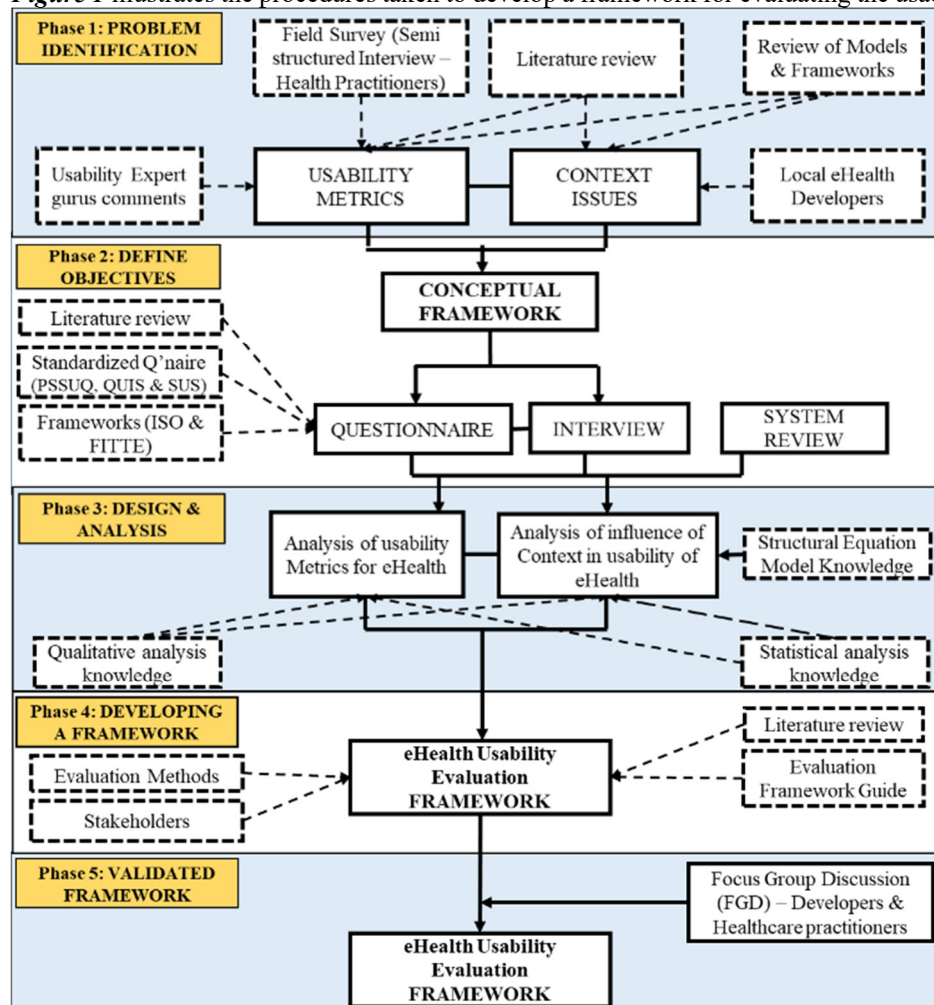

Figure 1: Framework development phases

4   Results and Discussion
4.1. Usability metrics for evaluating eHealth systems
From the quantitative data analysis, this research has established eleven (11) usability metrics that are classified into two categories namely: common metrics constituting of navigation, accessibility, visibility, and perceived ease of use; and specific metrics constituting of collaboration, information quality and terminologies, technical qualities, guide and support, and perceived benefits of the system. Common metrics in this context are the metrics that are used in evaluating generic information systems, and or other products. Specific metrics are those which are mostly used in evaluating the usability of the eHealth systems. Each of these metrics comprises a number of measurement items. In testing the applicability of the metrics using the CFA, some items statistically failed to prove applicability as their factor loadings were below the threshold of 0.7 and caused the model unfit. Therefore, in the process of modifying the model, the items with low factor loadings were eliminated from their corresponding metrics. **Table 2** presents the summary of the validation of the metrics and their items. Moreover, the results of the qualitative analysis identified eight (8) items that were merged into

Table 2: Usability Metrics Extraction

Usability metrics	Total metric items from literature	Qualified metrics items after conducting CFA	Metrics added from qualitative analysis	Total metrics
Common metrics	18	15	3	18
Specific metrics	32	32	5	37
Total	**50**	**47**	**8**	**55**
Contextual issues	22	16	0	16

The metric navigation is aimed at measuring how easy it is to understand how to move from one page (or screen) to another, a system has a consistent layout, and has the correct links to the correct tasks. Visibility is the common metric that is used in assessing whether the icons, pictures, and fonts are clear, readable, and attractive.

The system should make it easy to access information and enter data without taking away the attention of the user (in this case, a doctor) from the patient during the diagnosis. Also, the system should be easy to use in terms of being easy to learn at first and easy to remember when the user has not used it for a while. Consequently, although the metric error correction has been used in evaluating generic information systems and thus be categorized as a common usability metric, it showed to have more importance in evaluating the usability of eHealth systems. This was proved statistically, whereas, the metric showed more significance influencing the usability on eHealth system when grouped with other specific metrics than when it was grouped with other common metrics. Error correction, tests the ability of a system to cancel the process, undo the action, avoid duplicates, and provide alerts and warnings to prevent errors from occurring, were also added as a metric. Therefore, this study has categorized error correction as the specific metric for evaluating eHealth systems.

Moreover, a metric for information quality and terminologies is the specific metric for evaluating eHealth systems that is used to assess the quality of the information in the system, such as laboratory results, patients' medication lists, the ability to generate a summary of the patients' health status, clear and understood medical terminologies, etc. The technical quality metric deals with the suitability of the technical functionality (no downtimes) and the ability of the system to retain data. Collaboration metrics (both internal and external) assess the ability of the system to allow the interaction of stakeholders within and outside the health facility. For example, Internal collaboration measures the ability of the system to allow interaction between healthcare professionals and inter-department interaction, while external collaboration assesses the ability of the system to allow external stakeholders such as the government authorities to access the statistical data, interaction with outside stakeholders such as suppliers, and interaction with other health facilities, for example, on referral cases. Guide and support is the metric used to assess how the system provides enough instructions to accomplish the tasks accurately and has the ability to notify users when a current task is taking place, such as saving data, sending or delivering messages, and updating. The metric named benefits assesses how the system improves the quality of care. **Table 3** presents the usability metrics constructs corresponding to their measurement items, along with the codes per items as used in the analysis. The green highlighted items were added from the qualitative results.

Table 3: Usability metrics for evaluating eHealth systems

Common Usability Metrics		
Constructs	**Code**	**Measurement items**
Navigation	NAV1	Ability to "go back" to the previous screen
	NAV2	Easy to go to the next screen
	NAV3	Ability to predict the following procedure
	NAV4	The consistency of the system's layout from screen to screen.
	NAV5	No need to stop and think about which icon to click
	NAV6	Correct icon or link to navigate to correct task
Perceived ease of use	PEOU3	The system is ease to learn how to use
	PEOU4	The system is ease to remember how to use (it does not take me long to recall the process)
	PEOU5	Ease to cope with the system skilfully
	PEOU6	It is simple to enter data in the system
Visibility	V1	Pictures, icons, texts and links on screen are visible
	V2	The interface of an eHealth is attractive
	V3	The fonts (style, colour) are easy to read in on-screen
Accessibility	ACC1	eHealth system supports the diverse users to accomplish the tasks
	ACC2	Ability to serve patients easily while entering data in the system
	ACC3	Ability to use system without taking away an attention on the patient
	ACC4	The system does not demand extra cognitive workload while performing tasks
	ACC5	The ability of the OPD doctor to access the IPD patients' information
Specific eHealth Usability Metrics		
Error Correction	EC1	Reminders, alerts, and warnings to avoid errors
	EC2	Ability to cancel the process prior to completion
	EC3	Default values to select and check for validity
	EC4	Ability to undo action to avoid errors
	EC5	Popup message to understand what is going on
	EC6	Ability to avoids duplicate tests and examinations
	EC7	Recover easily from errors and mistakes

Common Usability Metrics		
Constructs	**Code**	**Measurement items**
External Collaboration	EXTCOL1	The eHealth system allows the government authorities to access the statistical data influence its usability
	EXTCOL2	The system allows the interaction with other health facilities
	EXTCOL3	The information on medications ordered in other organizations
	EXTCOL4	I can obtain patients' information from another health facility quickly
	EXTCOL5	The system support co-operation and communication between doctors working in different health facilities
Internal Collaboration	INT COL6	The system support co-operation and communication between healthcare multi-professionals
	INT COL7	I can work together with other members (other health professionals) from other departments through eHealth system
	INT COL8	The work of one user does not interrupts the work of another user in the system
	INTCOL9	Ability of lab technician to communicate pending investigation results to the doctor (e.g., bacteria culture test)
	INTCOL10	The ability of the system to allow collaboration between nurse/midwife and lab technician when necessary to rescue emergency cases
	INTCOL11	The ability of the lab technician to advise the doctor on the newly discovered disease as a result of the investigation.
Benefits	BEN1	The systems help to improve quality of care
	BEN2	The system helps to ensure continuity of care
	BEN3	The system provides information about the need for and effectiveness of treatment of the patients
Technical Quality	TQ1	The system is stable in terms of technical functionality (does not crash, no downtime)
	TQ2	The system has never caused serious adverse event to the patients' safety/health
	TQ3	The system responds quickly to inputs
	TQ4	Information entered/documented never disappears from the system
	TQ5	There is a quick help whenever the problem occurs
Info Quality & Terminologies	IQ1	The laboratory and diagnostic imaging results are easily available and logically presented
	IQ2	The patient's medication list is presented in a clear format
	IQ3	eHealth system generates a summary view that helps to develop an overall picture of the patients' health status
	IQ4	Terminologies on the screen are clear, understandable (e.g., titles and labels)
	IQ5	Patients' data are comprehensive, up-to-date and reliable
	IQ6	Ability to maintain data after sending to other department
	IQ7	Ability to eliminate investigation test for patients who choose to leave before treatment
Guide and support	GF1	The system provides sufficient information about the patients' progress.
	GF2	The system provides enough information, and instructions, that help to accomplish tasks accurately
	GF3	The system monitors and notifies when the orders given to nurses have been completed
	GF4	The system clearly informs about what it does (e.g., saving data, message delivery, data updated etc.)

Furthermore, the usability evaluation of the eHealth system, like other information systems, depends on contextual issues. These contexts, as proposed by Prgomet et al. in [11], include: user characteristics emphasize the individuals characteristics that affect the ability to use the system; goals and tasks are another context that measures how the system can accomplish the tasks (i.e., complexity, organization of tasks, etc.); resource and technology measure the availability of resources that enable the system to be used; the technical environment measures the availability of the technical resources, including the internet and electricity, and how reliable they are to facilitate the usability of the system. The physical environment deals with the physical office space, safety, and comfortability, as also presented in Table 4.

Table 4: Contextual Issues

Constructs	Code	Measurement items
Users' Characteristics (USERC HAR)	UC1	The contribution of the previous experience on the current system's usability
	UC2	The contribution of trainings on the usability of eHealth system
	UC3	The contribution of the knowledge of computer on using eHealth system
Goals and Tasks (GOALS)	GT2	Routine tasks are performed in a straight forward manner without the need for extra steps
	GT3	The tasks are well organized in the system to allow smooth recording and retrieving information.
	GT4	Ability to perform healthcare tasks easily compare to manual system
Resources and Technology (RESTEC)	RT1	The quality of the hardware and software is sufficient to enhance the usability of an eHealth system
	RT2	The information is relevant and well understood (use of common language to the user)
	RT3	There is a system-support-personnel to solve the problem with the system
Physical Environment (PHYSENV)	EP1	The office has enough space to work with the computer system
	EP2	The working environment is safe to protect the users' physically, legally, confidentiality, and property
	EP3	There is enough space, safety and comfortable for working with the system
Technical Environment (TECHENV)	TE1	The health facility has enough computers
	TE3	The speed of the computers available is good enough to accomplish the tasks quickly.
	TE4	There is no high frequent of internet outage (internet problem)
	TE5	The eHealth system allows working offline (without internet)

4.2. The FEeSU Framework

Studies such as [14] and [25] highlight that the framework must include all necessary actions to accomplish the processes and generate the solution. On this basis, this paper proposes the FEeSU framework, which consists of six steps, including engaging stakeholders, familiarizing the system, choosing evaluation methods, gathering evidence, justifying the conclusion, and disseminating the results, as illustrated in **Figure 1**. These steps interrelated.

The first step aims to engage various stakeholders not only for awareness but also to prepare them for data collection. For example, the ministry of health is involved only to be aware of the exercise that is to be taken and its impact on healthcare services. Engaging this high authority is expected to help with the implementation of the solutions that will be proposed based on the results of the evaluation process. Other stakeholders are expected to be involved in data collection as they will directly participate in the evaluation exercise. Once awareness is created among the stakeholders, the next step is to become familiar with the system. The evaluator will use the stakeholders to gather information about the system, its goal, and the expectations that are intended, as well as to study the contexts of use (i.e., the environment, the level of user understanding of the use of the system, the system's development life cycle stage, etc.). The familiarization of the system leads to the determination of the method by which the usability evaluation should be conducted. This is possible only if the evaluator has enough knowledge about the system, including its level of maturity (i.e., the system's development life cycle stage).
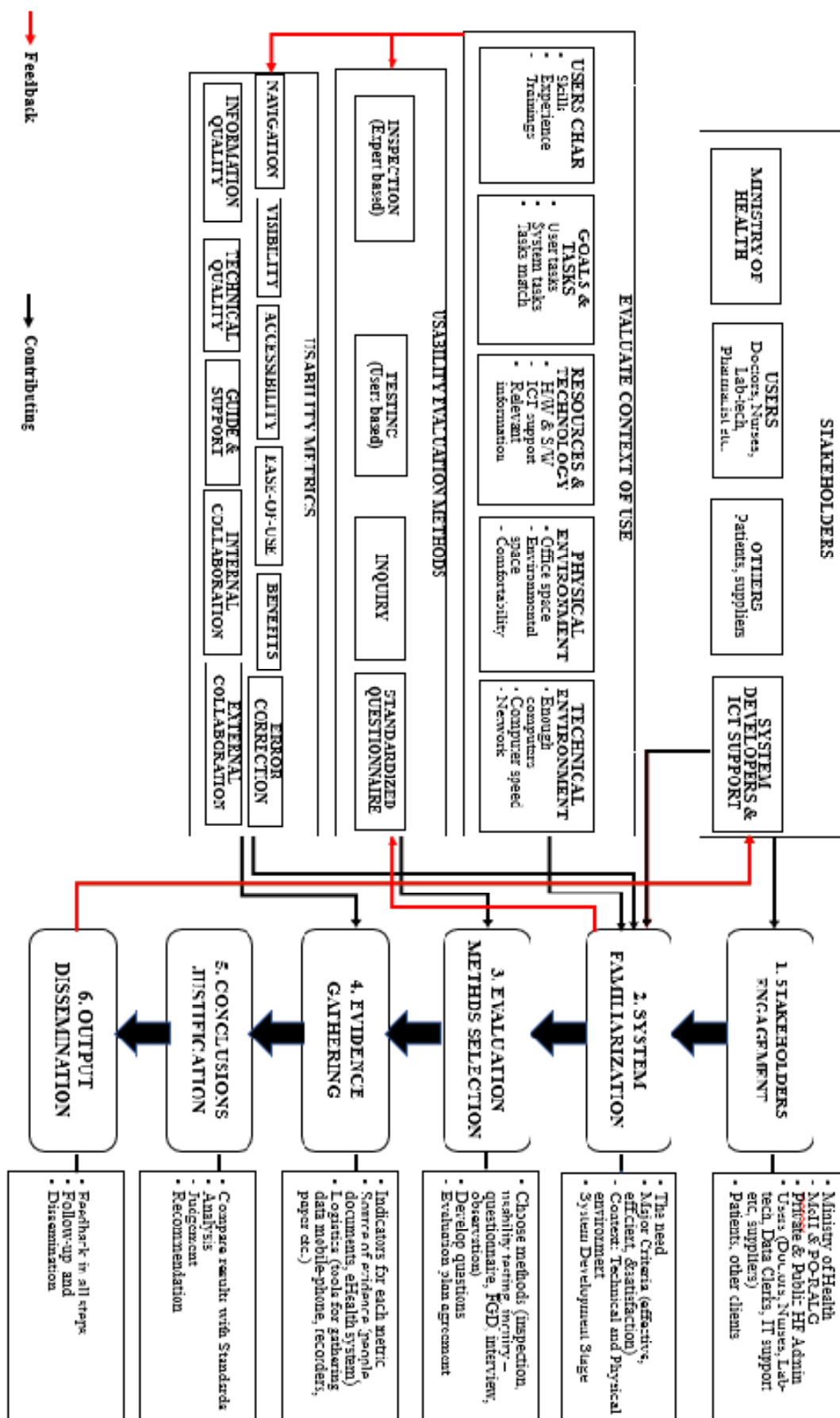
Figure 1: A Context-Specific Framework for Evaluating eHealth Systems' Usability (FEeSU)

Once the evaluation method is known, the evaluator can start gathering evidence using that method. The tool for gathering evidence is expected to be developed using the usability metrics set by this framework. The evidence will be analysed, and the conclusion will be provided and categorized from the critical issues to the simple issues. At this stage, suggestions for actions to be taken to rectify the observed issues are also given. Lastly, the report of the usability evaluation shall be disseminated to the stakeholders for action. The following paragraphs discuss in detail each step of this framework.

Step 1: Engage Stakeholders: The purpose of engaging stakeholders in the evaluation process is to create awareness and increase acceptance of the system and the changes that could be made after the evaluation. Additionally, ignoring the engagement of the stakeholders in the evaluation process can lead to resistance, criticism, and ignoring the findings [26]. In this context, stakeholders are the people or organizations that are affected by the results of the use of the eHealth system. Stakeholders include those who are involved in a system's operation, those who are affected by the system directly or indirectly, and those who are the primary users of the eHealth system.

In this context, the primary stakeholders in evaluating the usability of the eHealth system are the users of the system (i.e., doctors, nurses, lab technicians, pharmacists, data clerks, accountants, etc.) who are daily interacting with the system. Additionally, patients and their network of informal care providers (relatives, family, friends, community health workers, community leaders, and neighbours) are the stakeholders who are either direct users or directly or indirectly affected by the results of the usability of the eHealth system. This is due to the fact that in the management of chronic or communicable diseases, the aforementioned stakeholders also participate in the decisions related to the adoption, acquisition, and acceptance of some technologies. As such, usability evaluation for such an e-health system needs to consider this group of stakeholders as well.

Other organizational stakeholders that are also very important in this framework include government authorities, regulatory boards, and private healthcare provider organizations management. Generally, the health sector in Tanzania comprises stakeholders from several organizations, including government institutions and private sectors such as faith-based organizations (FBOs) and other organizations, namely private for profit (PFP) organizations [27].

Step 2: System familiarization: The evaluator of the system must be acquainted with the objectives or goals that the system is intended to achieve. Detailed information about the system should be well known to the evaluator. Evaluating a system without a clear understanding of its definition is likely to be ineffective. This definition of a system should encompass all necessary aspects, including the need, the expected results, activities, resources, stage of development, and context. The evaluator needs to be familiar with the goals expected to be accomplished by the system, such as enhancing clinical decision-making, helping users manage their health information, allowing doctors to store and retrieve patient information, etc. Additionally, the evaluator is required to be familiar with the context in which the system is operating, including the availability of the internet, computer speed, and the users' experience.

Moreover, through consultation with experienced practitioners, the evaluator shall be well informed of the metrics that will be used to assess the usability success of the system. In this study, navigation, visibility, accessibility, ease of use, internal and external collaboration, information quality and terminologies, technical quality, guide and support, perceived benefits, and error correction are the proposed metrics for evaluating eHealth systems. Consequently, being familiar with the system also includes knowing about the level of maturity of the system, such as its planning, implementation, or effect stage. Each level of maturity determines which usability valuation method should be applied.

Step 3: Choose Evaluation Methods: Based on the maturity level of a system, an evaluator can decide which usability evaluation method to use in the evaluation process. Common usability evaluation methods include inspection (expert-based), testing (user-based), inquiry (interviews and focus group discussions), and questionnaires. For example, if the system is in the effect stage (i.e., has been used for a long time), the evaluator may apply a questionnaire to receive the opinions of the users, and the evaluation in this stage is mainly done for improving operations or overhauling the system. In the implementation stage, the system is evaluated using the testing method. Moreover, qualitative methods such as focus group discussions and interviews can be applied in evaluating the implemented eHealth system to acquire the usability discrepancies discovered after the use of the system.

Step 4: Evidence Gathering: This is the most important stage in the usability evaluation of the eHealth systems. The questions formed based on the identified usability metrics and tested for their validity will reveal the usability issues that are perceived as credible and relevant by the stakeholders. Usability metrics that are essential in evaluating eHealth systems, as tested in Tanzania, are presented in step 2 of this framework.

The evaluator should properly select the participants in the evaluation process. For example, novice users or experienced users could participate, depending on the purpose of the evaluation. If the purpose of the evaluation is to make policy or overhaul the system, the experienced users are important, and if the system is in the implementation stage and the purpose of the evaluation is to propose a modification, both novice and experienced

users could participate. Thus, the novice user will help identify how the system is easy to learn, remember, and efficient, while the experienced user will share the level of errors and how it can accomplish the goal.

Step 5: Conclusion Justification: A good conclusion is based on the evidence gathered (findings) and judged based on the standards set by stakeholders. The evaluator should be able to classify those critical issues and those simple issues revealed in the evaluation. The judgment statements will indicate the level of usability of the system and the implications or consequences that could happen or have happened due to the usability issues identified.

Step 6: Dissemination of the Findings: In this step, the reports are disseminated to the stakeholders. It is the work of the management and evaluator to identify who should receive the report and deal with the particular issue. Although the dissemination of the evaluation results is the last step, its smoothness starts at the beginning of the evaluation exercise. For example, a clear description of the evaluation process helps identify the relevant stakeholders who are involved and will receive the report. To ensure that the stakeholders are able to fully comprehend the final report of the findings, feedback should be offered at each stage by holding regular meetings with them. Lastly, the evaluator and the management of the health facility or other authorities should follow up to identify and avoid those who usually undermine or misuse the findings by disregarding the positive side of the findings.

Furthermore, this framework is designed to accommodate various stakeholders in evaluating eHealth systems. The application of the framework will vary based on who uses it. For example, the involvement of the stakeholders in evaluating the public health facility will differ from private health facility. This is because while the evaluation of the public health facility needs to involve the government authorities, the private healthcare providers will need to involve the top management of the particular organization only.

4.3. Framework innovation

The innovation of this framework is based on the inclusion of the different components together to ensure that not only the evaluation exercise is performed smoothly and is able to reveal usability issues, but also that the revealed issues are taken seriously and corrected timely. This is possible as the evaluation process involves the highest authorities and all important stakeholders. Other components, such as evaluation methods, usability metrics, and contextual issues, together make this framework more comprehensive compared to other usability evaluation frameworks.

This framework was developed in consideration of the opinions of various healthcare professionals and developers. Additionally, this framework was developed based on the context of the country, which has limited resources such as manpower, computers, electricity, and the Internet. For example, due to the limited number of doctors, this study showed that for the eHealth system to be usable, the same doctor attending the OPD should be able to follow up with the patient who was admitted or transferred to the IPD. The current system does not allow the doctor in the OPD to access the information of the patient who was transferred to the IPD.

This framework recognizes professional roles as it considers various professionals and how they should collaborate. For example, the research revealed that eHealth system is usable if the internal collaboration between laboratory technicians and doctors and between laboratory technicians and nurses is considered. This is because healthcare provision is completed with the collaboration of several professionals. Additionally, the framework considered physician-patient interaction and cognitive workload, as some metrics are intended to measure how the system is simple to use and does not cognitively overwhelm the physician, as well as how the healthcare professional (user) can use the system to enter data while communicating with the patient. Examples of these metrics include "the ability to serve patients easily while entering data in the system", "the ability to use the system without taking away attention from the patient", and "the ability to work together with other members (other health professionals) from other departments through the eHealth system". Other metrics that enhance this framework to consider specific contexts include "the ability of the system to allow collaboration between nurse/midwife and lab technician when necessary to rescue emergency cases" and "the ability of the lab technician to advise the doctor on the newly discovered disease as a result of the investigation".

5 Conclusion

This paper presented the framework for evaluating eHealth systems usability (FEeSU) that comprises six steps, including engaging stakeholders, familiarizing the system, choosing an evaluation method, gathering evidence, justifying the conclusion, and disseminating the results. These steps are associated with the components of the framework, including stakeholders (those who are directly or indirectly interacting with or affected by the system), usability metrics, usability evaluation methods, and contextual issues. The skeleton of the FEeSU was generated from the FITTE framework. The specific usability metrics are extracted from the literature and being tested in Tanzania contexts; as a result, 11 metrics with their items are proposed with the framework to be applied for evaluating eHealth systems in Tanzania and other countries with similar contexts to Tanzania. Additionally, since the metrics proposed in this paper are tested on the GoTHoMIS system platform only, this research recommends further studies to focus on testing the proposed usability metrics and the applicability of the framework at large on

other eHealth systems for generalizability.

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