

Better Health

Human, technical and political factors for better coordination and support of e-health in Africa

D4.2: Requirements for sustainable and trustable e-health infrastructure in African LLMICs (Task 4.2)

WP4

Type of deliverable	REPORT
Dissemination date:	Month 12
Dissemination level	PU
Task 4.2 Leader:	University of Gondar
WP4 Lead Partner:	University of Gondar
Project coordinator	SINTEF Digital



Project information

Project number:	101017450
Project acronym:	BETTEReHEALTH
Project title	Human, technical and political factors for better coordination and support of e-health in Africa
Start date of project	January 1, 2021
Duration	24 Months

Document information

Title:	Requirements for sustainable and trustable e-health infrastructure in African LLMICs (Task 4.2)
Lead partner for deliverable:	University of Gondar
Work package:	WP4 – Technical Factors
Work package leader	University of Gondar
Due date in GA	Month 12

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List of Abbreviations and Acronyms

EPHA	Ethiopian Public Health Association
BeH	Better eHealth
DHA	Digital Health Activities
DHIS2	District Health Information System
eCHIS.....	Electronic Community Health Information system
EMR.....	Electronic Health Record
FMoH.....	Federal Ministry of Health
IT.....	Information technology
ICT	Information Communication Technology
JSI	John Snow, Inc.
KII.....	Key Informant Interview
LAN	Local Area Network
LLMIC	Low and Lower Middle Income Countries
mHealth.....	Mobile Health
PSFA.....	Pharmaceutical Supply and Fund Agency
RHB	Regional Health Bureau
UPS	Uninterruptable Power Supply
UoG.....	University of Gondar
WHO	World Health Organization

Acknowledgment

We would like to express our heartfelt gratitude to our partners as well as the University of Gondar team for their unwavering support in completing Task 4.2 of WP4.

We would also like to express our gratitude to the EU for financing the BETTEReHEALTH project. Last but not least, we'd like to thank everyone who took part in this study interview in order to provide data for long-term and trustworthy eHealth solutions.

1. Introduction

It has been well stated that eHealth solutions contribute to more effective and efficient healthcare services by improving diagnosis accuracy, optimizing clinical pathways, avoiding duplicate examinations or treatments, and fostering collaboration among healthcare stakeholders [1]. As the Internet exploded into the public consciousness in the 1990s, a slew of e-terms began to appear and proliferate. The advent of eHealth demonstrated the power of information and communication technologies (ICTs) to improve health and the healthcare system. eHealth refers to all digital health information systems, including clinical, administrative, and research-oriented areas [2].

eHealth has also become an essential term [3]. The WHO 58th assembly urged countries to develop ICTs for health as deemed appropriate to promote equitable, affordable, and universal access to their benefits, as well as to continue working with information and telecommunication agencies and other partners to reduce costs in order to make eHealth a success [4]. For successful implementation, eHealth necessitates the use of appropriate hardware, software, and connectivity technologies [5].

Digital health should be an integral part of health priorities, benefiting people in an ethical, safe, secure, dependable, equitable, and sustainable manner. It should be built with transparency, accessibility, scalability, replicability, interoperability, privacy, security, and confidentiality in mind [6]. The successful implementation of eHealth technologies is thought to improve access, safety, quality, and performance of healthcare services delivery by improving healthcare data management, lowering costs, and decreasing medical errors [7, 8]. The findings revealed that one of the key factors influencing the successful implementation of a technology is the technological capability of eHealth systems; the long-term sustainability of eHealth technology is dependent on the economic, social, and organizational sustainability in which the technology is embedded [9].

Despite the fact that eHealth technology is regarded as a very useful technological approach to addressing many challenges (such as disease burden, scarcity of healthcare professionals, inequity of healthcare service delivery, and shortage of healthcare budget in healthcare service delivery) [9, 10], investment in ICT development in the majority of African countries is limited and has the lowest ICT development Index [11] for its successful implementation.

Financing strategies adopted at national as well regional levels widely affect eHealth long-term sustainability [12]. So availability and effective use of ICT Infrastructure is indispensable for successful adoption of e-health systems [13]. Sustainability may be defined as the capacity to maintain or improve the state and availability of desirable materials or conditions over the long term. It is a normative and fuzzy concept, and depends on the matter of choice of the users [14]. Sustainable infrastructure refers to infrastructure projects that are planned, designed, constructed, operated, and decommissioned in a manner that ensures economic and financial, social, environmental, and institutional sustainability over the entire life cycle of the project [15].

The expectations of eHealth are very high, but actual adoption has so far been low. Findings revealed that low literacy level and experience in using the e-health technology applications, lack of motivation, poor organizational and management policies, perceived usefulness, belief, willingness, as well as attitude of healthcare professionals are the reported reasons for the low adoption and use of e-health technology applications [16]. In addition, lack of trust in eHealth services, structural, social influence and engagement will affect the successful adoption of the eHealth solutions [17]. Commonly identified domains of trustability include benevolence, security, competency, and effectiveness [18, 19]. Providers of eHealth services can use the promoting mechanisms to build trust in all four domains and, ultimately, in the eHealth service as a whole, which will benefit end user adoption [19]. Adjekum A. et al. identified trust attributes in eHealth solutions as personal, institutional, and technological elements [20].

Implementing an eHealth system is a complex process that necessitates significant investments in infrastructure, training, and support. Literatures documented key enablers for successful eHealth implementation, such as a comprehensive implementation plan outlining each stakeholder's roles and responsibilities, detailed phases of roll out, shared dependencies, timelines, and the availability of adequate training and supporting infrastructures [16, 21].

Identified enablers of successful eHealth implementation were altruism, fair data access, ease of use, self-efficacy, socio-demographic factors, user recommendations, usefulness, customizable design features, interoperability, privacy, initial face-to-face contact, guidelines for standardized use, stakeholder engagement, improved communication, decreased workloads, and service provider reputation. On the other hand identified barriers to trust in digital health were excessive costs, limited accessibility, socio-demographic factors, fear of data exploitation, insufficient

training, defective technology, poor information quality, insufficient publicity, time-consuming, and service provider reputation.

Despite the widely anticipated benefits of eHealth technologies in improving healthcare service delivery, eHealth implementation success rates in developing countries are low [22]. Investigating the facilitators and barriers to trustworthy and long-term eHealth solutions would aid in the design, development, and implementation of the technologies in resource-constrained settings. However, data on the characteristics of eHealth implementation in African countries is limited. As a result, the purpose of this research will be to identify the characteristics of long-term and trustworthy eHealth infrastructures.

2. Objective

The goal of this study was to look into characteristics for long-term and trustworthy eHealth solution implementation in low and lower middle income countries (LLMICs) in 2021.

3. Method

3.1 Study setting and period

This research was carried out in African LLMICs. The BETTEReHEALTH partners from the hubs in the four African countries (Ethiopia, Tunisia, Malawi, and Ghana) were expected to help with data collection from September to November 2021. In order to investigate the attributes of sustainability and trustability of eHealth implementation in the context of LLMICs, a phenomenological qualitative approach was used.

3.2 Study participants

Participants in the study included program implementers at various levels, developers of eHealth solutions, government officials (ministries, regional or county leaders), facility administrators, and service providers. Ten to fifteen key informants were interviewed in each lead country, taking into account the country's profile, the type of eHealth solutions, and the nature of program implementation strategies. As a result, study participants were chosen using a purposive sampling strategy. In each of the four countries, key informant interviews were conducted with all together 49 participants. As a result, the 49 key informant interviews conducted in this study were sufficient to generate sufficient qualitative data. At their office, face-to-face interviews were conducted. In addition, one focus group discussion with 15 female and 21 male participants

for a total of 36 participants was held. Participants were interviewed during their break time, when they were less stressed. To investigate potential attributes for sustainable and trustworthy eHealth solutions, a reflective interview guide supplemented by probing questions was used. There are three sections in the interview guide.

3.4 Data collection tools and procedures

Previously published studies [9, 16] were used to develop the interview guide. It includes guiding questions as well as multiple probes. The research team examined the tool's content and comprehensiveness to determine whether it would address the research questions. A tape recorder was used to collect audio data. To supplement the audio record, field notes were also taken. The data collection period lasted between 5 and 39 days (Annex 3). Ethiopia had the shortest data collection period and Tunisia had the longest.

3.5 Data Analysis

The verbatim transcription of audio recorded data from key informant interviews was performed. In qualitative interviews, the most common type of transcription is verbatim transcription. The transcription was done from the native language to English. Multiple readings were performed in order to comprehend the overall meaning of the data. For each identified theme, a code was assigned. In addition, each sentence was assigned a line number, and codes were created and attached to information in order to identify patterns of ideas. The data was scoured for notable patterns and common themes. Themes and subthemes were thus developed based on the emergent ideas. The quantitative data was analyzed using OpenCode software.

4. Ethics approval

The study was carried out in accordance with the WHO Declaration on Ethical Principles [23]. The information was gathered anonymously, with no personal identifiers. To refer to the direct quotations, non-personal identifiers such as gender, education, experience, position, and facility name were used. After explaining the study's benefits and risks, written consent was obtained. Only audio data were used in this study. Following the study, the data was securely stored in a secure repository.

5. Results

The key informant interviews included a total of 49 people (10 from Tunisia, 15 from Ethiopia, 13 from Ghana, and 11 from Malawi). Of the total 20 (40.8 %) were between the ages of 26 and 35. Similarly, 36 (73.5%) of the participants were males, and 35 (71.4%) had an MSc or higher level of education. Furthermore, all of the participants had work experience ranging from 2 to 35 years (Annex 2).

5.1 Barrier and facilitator's for sustainable and trustable eHealth solutions (the context of Tunisia)

5.1.1 Theme 1: Individual and user related facilitators and barriers

5.1.1.1 Individual and user related facilitators

User-related characteristics such as age, ICT skill and knowledge, and awareness of eHealth solution benefits were identified as facilitators of eHealth solution sustainability and trustability.

Participants reported that one of the facilitating factors for the sustainability and trustability of the eHealth solution was the user's age. Participants in the younger age group were more likely to use eHealth solutions due to their increased knowledge and skills and exposure to information communication technologies. Because of the current digital evolution, young age users now have access to ICT technologies and experience with them.

“---the new generations of nurses frequently use new information and communication technologies (Smartphone, connected-sensors, social networks,...), which develop their ICT skills and knowledge and hence they will accept rapidly and fluidly e-health solutions.” (PT09)

Participants also reported that ICT skill and knowledge of users were among the determining factors for the sustainability and trustability of eHealth solutions. Participants reported that users with adequate ICT skills and knowledge accept eHealth solutions because they are confident in their ability to use the system.

Participants reported that user awareness of the benefits of eHealth solutions was one of the identified facilitators of eHealth sustainability and trustability. As a result, they can use those solutions to make their jobs easier, manage care more efficiently, and easily track their progress.

“Users are constantly asking for eHealth solutions because they are aware of their benefits as a means of traceability, efficiency, ease of their work and management of care” (PT05)

5.1.1.2 Individual and user related barriers

The most frequently reported user-related barriers were user age, resistance to change, and a lack of ICT skills and knowledge.

Respondents reported that one of the barriers to the sustainability and trustability of eHealth was the user's age. As users' ages increase, they have less access to and experience with digital technologies, as well as a lack of knowledge and skills because these technologies were not available at the time. They may also lack confidence in using an eHealth solution due to a lack of engagement with technology. Older users also prefer the native habits they developed during their work experience.

“-----. Indeed, elderly nurses have native habits and practices. They only use paper-based approach. Consequently, they cannot accept the migration to new healthcare technologies.”(PT09)

Users' resistance to change was also mentioned as a barrier to the long-term viability and believability of eHealth solutions. Participants reported that users prefer their native habits and consider in-person consultations to be superior to virtual consultations. Users' resistance to change as a result of a lack of acceptance of the technology, as well as a lack of readiness to use the technology, has an impact on the eHealth solution's sustainability and trustability.

“The native habits, culture and practices of end users (using paper-based approach, physical consultation, etc.) can prevent them to accept new healthcare technologies and consequently can lead to a fear of changes. For example, elderly doctors cannot accept to communicate and coordinate with new stakeholders such as data manager, system administrator” (PT08)

Users' skills and knowledge were also mentioned as potential barriers to the long-term viability and trustability of eHealth solutions. Users who lacked ICT knowledge and skills, according to participants, were unable to accept eHealth solutions. Users' confidence in using the eHealth solution is affected by a lack of ICT knowledge and skills.

“Lack of ICT skills and knowledge by users can lead to users doubting to work on eHealth solutions” (PT04)

5.1.2 Theme 2: Human resource and capacity building related facilitators and barriers

5.1.2.1 Human resource and capacity building related facilitators

Human resource and capacity building facilitators are critical for the long-term viability and trustability of eHealth solutions. Respondents stated that the main facilitating factors for the sustainability and trustability of eHealth solutions were support, training, and the availability of ICT experts.

The availability of adequate and continuous technical support from the organization and from some projects was identified as critical for the sustainability and trustability of the eHealth solution by allowing users to understand the system and improve their skills in using the eHealth solution.

The availability of adequate and continuous training, both pre and in service was mentioned as another facilitator for the sustainability and trustability of eHealth solutions by allowing professionals to be aware of the system, develop the required skills, and use the system to achieve the required tasks.

“There is a continuous support delivered to end users with strong training sessions to sustain their ICT Skills in order to meet their expectations” (PT06)

Furthermore, respondents stated that the availability of ICT experts within the organization was the most important facilitating factor for the long-term sustainability and trustability of eHealth solutions. The availability of ICT experts in the organization with relevant skills in the eHealth solution supports the organization's staff and aids them in the system's sustainability and trustability.

“eHealth solutions are mainly related to the presence of IT specialists with relevant skills and knowledge to master and support eHealth solutions. Their presence in health organizations is highly recommended” (PT05)

5.1.2.2 Human resource and capacity building related barriers

On the other hand, the major contributing barriers to the sustainability and trustability of eHealth solutions were a lack of support, training, and human resources with the necessary skills.

The lack of end-user support was the major barrier to sustainability and trustability, affecting the technical soundness or success of eHealth solutions. Users, in fact, have less capacity to use the system to achieve the desired output.

“The lack or absence of support and updates affect the technical soundness or technical success of the eHealth solutions” (PT02)

Another barrier affecting the sustainability and trustability of the eHealth solution has been identified as a lack of training. Untrained users of the eHealth solution were reported to be unable to use the system properly, and even those who received initial training would not be able to master all of the system's features. As a result, ongoing training should be required to keep users' skills up to date.

“The lack or absence of support, documentation and training present major barriers for the continuity and proper use of an eHealth solution. Initial training is not sufficient for the user to master the solution” (PT02)

Respondents also stated that a lack of competent and skilled human resources has an impact on the sustainability and trustability of eHealth solutions due to a lack of support for health professionals.

“I think there is a lack of support for end users of the eHealth solutions. This may be due to the lack of human resources with the necessary competencies and skills within health organizations” (PT10)

5.1.3 Theme 3: Economic related barriers and facilitators

5.1.3.1 Economic related facilitators

Participants identified the availability of an adequate budget and the profitability of eHealth solutions as facilitators of sustainability and trustability.

One of the facilitating factors for the sustainability and trustability of eHealth solutions is the availability of a budget. The availability of an adequate budget allocated by the organization as well as budget from funding agencies' support for purchasing computers and paying for various

ICT infrastructures were determining factors for the sustainability and trustability of eHealth solutions. Constant budget lines should also be marked on the available budget.

“The availability of sustainable funding and solid sponsoring are major facilitator for the implementation of sustainable eHealth solutions. Sufficient budget should cover the implementation of appropriate ICT infrastructure including software, equipment, network, maintenance, updating and end users training” (PT09)

Respondents also mentioned that the profitability of eHealth solutions was another determining factor for the long-term viability and trustability of eHealth solutions. Those eHealth solutions that were profitable and cost-effective by reducing paper-based healthcare costs and increasing organizational revenue were facilitators of eHealth solution sustainability and trustability.

“-----in addition, having cost-effective and profitable e-health solutions make them sustainable” (PT0)

5.1.3.2 Economic related barriers

The lack of an adequate budget and the requirement for a high initial cost were the major economic barriers to the sustainability and trustability of eHealth solutions.

Participants reported that a lack of an adequate eHealth budget was the most significant determining barrier to eHealth's sustainability and trustability. Budgeting for eHealth was given less priority, and there was a scarcity of financial resources for eHealth solutions, which were determinant barriers to eHealth's sustainability and trustability.

“Given the current financial crisis in Tunisia, it is difficult to allocate sufficient budget to invest in the implementation of eHealth solutions. This always depends on external funding because we don't have a clear eHealth strategy and we don't set aside enough money and funds for this” (PT02)

Another impediment to the long-term viability and trustability of eHealth solutions is the high initial cost. Because eHealth solutions require a significant initial investment, organizations did not volunteer to hand over and assume responsibility for the eHealth solution's long-term viability.

“There is an initial budget to invest in eHealth systems, but it is not substantial enough” (PT08)

5.1.4 Theme 4: Infrastructure related barriers and facilitators

5.1.4.1 Infrastructure related facilitators

One of the major enablers of the sustainability and trustability of eHealth solutions is the availability of adequate infrastructure.

Participants reported that the availability of adequate ICT infrastructure, such as reliable and up-to-date hardware and software, as well as a strong and reliable internet connection based on optical fiber, aids the sustainability and trustability of eHealth solutions.

“The current ICT infrastructure is good. There is a strong and reliable network connection based on optical fiber and adequate hardware (servers, printers, computers)” (PT06)

5.1.4.2 Infrastructure related barriers

A lack of adequate ICT infrastructure and a lack of trust in existing ICT infrastructure were identified as infrastructure-related barriers to eHealth solutions. These were identified as the primary barriers to the long-term viability and trustability of eHealth solutions.

Participants reported that one of the determining barriers to the implementation of eHealth solutions is a lack of adequate ICT infrastructure. In this case, there were deficiencies in ICT infrastructure barriers such as: a lack of computers for all offices; a low-speed internet network that occasionally blocks and hinders work within the various administrative departments, particularly in rural areas; and the absence of a secure intranet network to ensure connectivity between different offices. Another barrier to ICT infrastructure is the lack of ICT devices (sensors, data centers, etc.) on the national market.

“The health sector is in constant demand since the infrastructure is currently being created and requires an upgrade in the majority of cases with an obvious lack of equipment (some offices do not even have fixed computers and some hospital and administrative services lack internet coverage)” (PT05)

Other barriers to the implementation of eHealth solutions in Tunisia, according to participants, are a lack of trust in existing ICT infrastructure. Participants reported that the existing infrastructure was untrustworthy because the hardware and network were outdated.

“I do not trust the sustainability and trustability of the existing infrastructure (frequent interruption and poor electric installation, no internet connectivity, etc.) to implement eHealth solutions. It needs more strengthening and improving” (PT09)

5.1.5. Theme 5: Organizational related facilitators and barriers

5.1.5.1. Organizational related facilitators

Participants were informed that the availability of planning, an appropriate organizational strategy, an information use culture, validated eHealth solutions, and the availability of need assessment were facilitating factors for the implementation of eHealth solutions.

Participants reported that the availability of planning facilitates the implementation of eHealth solutions by creating a coasted work plan that covers both the ICT infrastructure (network, hardware, and software) and human resources and lays out responsibilities and sets expectations on how, by whom, and when different tasks should be completed, taking stakeholders and financial availability into consideration.

The plan (which could be short-term, long-term, or maintenance) also included a resource mobilization strategy to ensure sustainability, trustability, and trust ability.

“A major organizational related- facilitator is to propose a long-term organizational (five or more years) plan for resources (financial, human and technological resources) mobilization that includes: a long term coasted plan that covers both ICT infrastructure (hardware, network and software) and human resources, a long-term training plan to grow healthcare providers with the skills needed to sustain eHealth infrastructures, a long-term IT maintenance plan containing the computers operations and maintenance services (data archiving, back-up and recovery services, etc.)”(PT06)

According to participants, having an appropriate organizational strategy was a major facilitating factor for the implementation of eHealth solutions. Participants reported that an organizational strategy that encourages the use of eHealth solutions by preparing documents with clear directions of the national eHealth strategy and involving all stakeholders facilitates the sustainability, trustability, and trust ability of eHealth solutions.

“---, the organizational strategy, that encourages the healthcare providers to use e-health solutions by reducing their workflows (e.g. incorporating tele-consultation into the health facilities workflow), represents an essential facilitator” (PT03)

Another facilitating factor for the sustainability, and trust ability of eHealth solutions was the availability of an information use culture. The COVID-19 era's information use culture was a good lesson that facilitated the sustainability and trustability of eHealth solutions

“It is a positive culture and has proven itself in the COVID19 era particularly through the organization of online meetings and webinars which bypassed health constraints and facilitated access to certain information and knowledge” (PT05)

Participants also noted that having validated eHealth solutions was one of the facilitators for the sustainability and trustability of eHealth solutions by increasing eHealth solution acceptance.

“Having a validated solution through a nationally or internationally recognized community or scientific publication, certified solution (compliance with system quality guidelines, data security and exchange standards and regulatory guidelines) can help doctors to trust” (PT08)

Participants also reported that one of the facilitators for the sustainability and trustability of eHealth solutions was the availability of need assessment. The availability of a long-term need assessment study on the needs of ICT infrastructures, human resources, and financial resources facilitates the implementation of eHealth solutions that are sustainable and trustworthy.

“Developing a long-term study to identify both the information and communications technology (ICT) infrastructure (network, hardware, and software), the number of staff and type of skills needed to support eHealth and the financial resources needed for implementing eHealth solutions is a major organizational facilitator” (PT09)

5.1.5.2. Organizational related barriers

Participants reported that poor administration and coordination, as well as a weak information-use culture, were the major barriers to the long-term viability and trustability of eHealth solution implementation.

Participants reported that poor administration and coordination have a negative impact on the sustainability and trustability of eHealth solutions. Poor administration and coordination lead to a

lack of an appropriate organizational strategy that guides health care teams in their data sharing culture, as well as a barrier to the long-term viability and trustability of eHealth solution implementation.

“The coordination of different healthcare teams is degraded due to poor timing of administration between physicians, pharmacists, nurses, and patients. Consequently, using eHealth solutions can improve the coordination of different healthcare teams to work together and achieve the organizational goal” (PT03)

Participants also reported that a lack of information-use culture was one of the barriers to the long-term viability and trustability of eHealth solution implementation. Participants reported a weakness in sharing and using information for decision making, which is a barrier to the long-term viability and trustability of eHealth solution implementation.

“...a weak culture of skill-sharing among the medical profession (a very important quality for the development of digital health)” (PT10)

5.1.6 Theme 6: Technological related facilitators and barriers

5.1.6.1 Technological related facilitators

Participants reported that the usefulness of the technology, ease of use of the technology, and compliance with data security and standards were the primary facilitators of the sustainability and trustability of eHealth solutions.

Participants stated that one of the main facilitators for the implementation of eHealth sustainability and trustability was the usefulness of technology. Improved information sharing within and across health facilities, improved user performance, and meeting all user needs help to ensure the long-term viability and trustability of eHealth solutions.

“E-health solutions facilitate real time health data collection, improve communication between healthcare providers (doctors, nurses, etc.) and enhance information sharing within and across health facilities. E-health solutions with Big Data technologies allow data processing on several scales and parameters which are not accessible to humans” (PT01)

Participants also reported that the ease of use of the technology was another facilitator of the long-term viability and trustability of eHealth solutions. Participants stated that eHealth solutions

that are simple and easy to use, are not complex, and provide quick access to features are factors facilitating sustainability and trustability.

“Realizing ease of use eHealth solutions with user-friendly interfaces which are not overly complex, well-organized, providing quick access to common features or commands and making it easy to locate different tools and options acts as an essential technological related facilitator. Indeed, non-IT specialists believe that using such solutions would be free of effort” (PT06)

Furthermore, participants reported that compliance with data security and standards was a facilitator for the long-term viability and credibility of eHealth implementations. Having a secure database, an interoperable system, and ensuring data security and privacy, according to the respondents' eHealth solutions, facilitates technology acceptance, which in turn facilitates the sustainability and trustability of eHealth solutions.

“eHealth solutions in use comply with national regulatory framework in terms of compliance with data security and exchange but they need more compliance with internationally traceability of health data management guidelines and standards to ensure transparency and visibility”(PT08)

5.1.6.2 Technological related facilitators

Participants reported that the barriers to the sustainability and trustability of eHealth solutions were a lack of data security, privacy, and confidentiality, a lack of interoperability, and a need for initial face-to-face contact.

Participants stated that a lack of data security, privacy, and confidentiality impedes technology acceptance and creates a barrier to the sustainability and trustability of eHealth solutions. This is due to the fact that the collected data is private biological data, which is difficult to secure.

“Collected data from eHealth solutions are private personal data such as physiological data, genetic data, etc. So, eHealth solutions with security and privacy mechanisms (e.g. Block chain technology) were crucial to ensure trust”(PT10)

Participants also reported that a lack of interoperability was a barrier to the implementation of eHealth solutions. Interoperability reduces the effectiveness of use technologies, even if they are cost effective, and it is a barrier to the sustainability and trustability of eHealth solutions.

“Fragmentation of Health Information Systems that work in silos can be also considered as a technological barrier. In fact, it inhibits interoperability and information sharing within and across health facilities and therefore impedes the guarantee to have a health care continuity and to have health data in order to be able to put in place e-health strategies and programs” (PT02)

Another barrier mentioned by participants was the requirement for initial face-to-face contacts. Prior to the implementation of eHealth solutions, there is a need for initial face-to-face contacts to build trust between health professionals and patients. As a result, if there is no appropriate initial face-to-face contact, it is a barrier to the sustainability and trustability of eHealth solutions.

“There was a need for initial face-to-face contacts and interactions between patients and healthcare providers prior to the introduction of eHealth services to ensure users' trust in the eHealth solutions. Besides, solutions with minimal effort for use influence positively users' trust in the eHealth solutions” (PT04)

5.1.7 Theme 7: Policy and legislation related facilitators and barriers

5.1.7.1 Policy and legislation related facilitators

Participants reported that the availability of policy and legislative frameworks was the primary facilitator of the sustainability and trustability of eHealth solutions. The regulatory and legislative framework on the health domain facilitates digital health and has laws that guide data exchange standards, laws that guide privacy and security, and rules on how to use eHealth solution were the main facilitators for the sustainability and trustability of eHealth implementation.

“A regulatory framework for compliance with structures (such as the National Authority for Personal Data Protection), processes, and procedures to guide end-users (How to use eHealth solutions?) or enforce compliance with data quality, data security and data exchange standards and laws (How to collect patient data? How to share patient data?) and guidelines on how to operate the laws in the context of eHealth” (PT08)

5.1.7.2 Policy and legislation related barriers

The main barrier to the sustainability and trustability of eHealth solutions, according to participants, is a lack of an adequate legislative framework. The lack of a legislative framework that guides how to use eHealth solutions; what can be done if laws are broken while implementing eHealth; and a lack of eHealth prioritization were all barriers to eHealth implementation's long-term viability and credibility.

“The absence of a governing body or structure for eHealth results in the absence of processes and procedures to guide or enforce the implementation of eHealth solutions. Also, the lack of adequate legislative framework related to digital health is a major organizational barrier. Defining a clear eHealth strategy and an operational plan with details related to all required resources including budget, human resources, ICT infrastructure, hardware, and software and internet connection can help to ensure a successful eHealth implementation. Proposed procedures should be aligned with international standards” (PT10)

5.2 Barrier and facilitator’s for sustainable and trustable eHealth solutions (the context of Ethiopia)

5.2.1 Theme 1: Individual or user-related facilitators and barriers

5.2.1.1 Individual or user related facilitators

Individual or user-related attributes such as age, gender, education, attitude, awareness, digital literacy, and commitment were identified as potential facilitators for long-term and trustworthy eHealth solution implementation. Furthermore, positive attitudes, willingness, prior exposure, and acceptability of the eHealth solution by end users were identified as major contributors to the long-term use of digital health applications. Participants in the study also stated that incentivized employees were more likely than their colleagues to use the digital solution.

According to the results of the interview, male end-users were more likely than female end-users to use new eHealth solutions. This was due to females' fear of new technology, which caused them to frequently complain or resist using eHealth solutions in the healthcare system. However, because they are more familiar with new technologies, young-aged

professionals were less resistant to using technology than older age groups. Furthermore, we discovered that fresh graduates outperform seniors when it comes to eHealth solutions. According to reports, this was due to fresh graduates' being more familiar with computer technologies because they had taken computer-related courses beginning in lower grade levels. Furthermore, we discovered that professionals with low educational attainment had difficulty utilizing eHealth solutions.

“... in our case when we began this system 4 years back young or fresh graduates had easily understand and good computer skill and can capture with simple training. But old age groups had limited computer skill and we gave computer training for long time” (PE06)

We also learned from the interviews that educated users (health-professionals) and younger age groups were less eager and comfortable with eHealth solutions than their older counterparts. Similarly, gender differences have no bearing on the implementation of eHealth solutions.

Furthermore, we discovered that employees who are motivated, digitally literate, and have prior experience are more committed to implementing eHealth solutions. We also discovered that health professionals at the federal and regional levels have higher levels of digital literacy than those at the lower levels. We also discovered that high-level healthcare professionals are enthusiastic about the implementation of eHealth solutions. Participants also added that every time we fail because of health workers do not understand the benefits of implementing eHealth solutions. Instead, end users were hesitant and negligent in their use of data generated by eHealth solutions.

“...individual interest is a basic one and needs to be addressed by working on an eHealth solution until end users perceive it as a useful tool” (PE14)

5.2.1.2 Individual or user-related barriers

Despite the fact that many attributes have been mentioned as contributing to trustworthy and sustainable eHealth implementation, there are some that have a significant impact on the technology's viability. Participants reported a lack of trained manpower, low digital literacy, a lack of commitment/motivation, knowledge and skill gap, a lack of trust in technology,

resistance to change, a negative attitude, and fear of technology as potential barriers to the implementation of a sustainable and trustworthy eHealth solution.

According to the interview, the primary goal of digital health is to improve access to health services. Participants stated that eHealth solutions would only be sustainable if end users were equipped with both knowledge and the necessary skills to use the technology. Participants confirmed that digital literacy is relatively low in the Ethiopian context, and that the problem is not limited to the lower levels of the healthcare system. Some of the reasons cited include a lack of digital infrastructure.

”Providers were not even touched the computer before this system but now they are familiar with technology. Most providers know the computer only by name but were never seen the computer before. Currently they are initiated to develop their skill and works on it since they are torched and obeyed to work on the EMR system....” (PE07)

Participants stated that a lack of commitment, low motivation, and an inability to understand the system's benefits all have a significant impact on end-users' ability to use eHealth solutions successfully. They also reported that resistance to changing from a traditional to a modern approach, fear of technology, misconceptions about technology, and a negative attitude toward technology were identified as bottlenecks to the successful implementation of eHealth solutions.

“In most cases, higher officials commonly asked how many patients have been examined and how much were saved but not how well the system has helped the institution. For example, it should show the activities of the institution in a month or three months and be able to report for evaluation. Therefore, the benefits of the system should be considered in this regard” (PE01)

5.2.2 Theme 2: Human resource and capacity building related facilitators and barriers

5.2.2.1 Human resource and capacity building related facilitators

According to the interview, the availability of adequate manpower, technical personnel, IT experts, and adequate training were all significant facilitators of long-term and trustworthy eHealth solutions. Furthermore, the availability of partners' involvement to cover financial issues, as well as the availability of capacity-building activities such as supportive supervision,

mentorship, and conducting review meetings, were cited as potential enablers for the implementation of sustainable and trustable eHealth solutions.

Participants in the interview stated that eHealth solutions are only sustainable when technical personnel are available at all levels of healthcare facilities to fill technical gaps and resolve challenges on time. They also added facilities for IT experts to use eHealth solutions in their organization more effectively than their competitors. We also discovered that the availability of technical personnel and IT experts was a major source of confidence in eHealth solutions.

“...No one maintains our medical technologies like CT Scan when stop working, but are maintained by someone who comes from other areas, which are the sources of our threat and difficult to trust the care organization that provides the technology since they don't want to give full responsibility for us” (PE10)

Participants in this interview testified that continuous capacity building is critical for the eHealth solution's sustainability and trustability. We discovered a variety of capacity-building mechanisms here. Training, on-site technical support, feedback, supportive supervision, mentorship, and review meetings were some of the strategies used to address the issue of capacity building. They stated that providing appropriate training for those working on eHealth solutions by trained professionals was the best strategy for improving healthcare professionals' low digital literacy level. Furthermore, they added that, due to the high turnover of trained technical personnel, providing timely and continuous training was extremely beneficial in closing skill gaps and updating users' current knowledge. Training strategies were reported as the two most prominent strategies, whether short-term or long-term, based on users' knowledge gaps. Furthermore, they stated that an emphasis should be placed on integrating eHealth solutions into existing healthcare systems.

“Professionals are the one who runs the system and we need to be able to create enough capacity among health workers” (PE03)

Continuous support, in addition to training, was mentioned as a good strategy for addressing capacity building gaps. Telephone and telegram communications were revealed to be used to provide off-site support by participants. They also stated that healthcare facilities were only effective if IT professionals were available at lower levels to provide timely technical support.

“I can say that the institutional structure is good at the moment. There is a regional planning and IT directorate. eHealth work is carried out by these two directorates. Technical tasks are carried out in the plan and program department, while system development work and system management are related to the health information technicians directorate. A memorandum of understanding has been prepared and implemented by the two directorates on how to direct and coordinate the work. When it comes to zones and districts, however, the two directorates work together. So the problems are not so great. Limited capacity among health workers at all levels is unresolved problem. I believe this problem can always exist because the capacity of professionals varies” (PE05)

5.2.2.2 Human resource and capacity building related barriers

In these interviews, we discovered that a lack of manpower, staff turnover, a lack of technical support, a lack of digital literacy, misallocation of human resources, and insufficient capacity-building activities were identified as critical challenges to the sustainability and trustability of eHealth solutions.

According to respondents, the major challenge for long-term eHealth implementation is gaining access to trained and diverse professionals in healthcare systems. Furthermore, due to a lack of incentives, there was a high turnover of trained professionals. At the lower level, there were no IT professionals assigned to provide technical support for long-term eHealth solutions. Accessing timely maintenance when eHealth systems fail was also mentioned as a significant challenge. As a result, all of these factors have an impact on the long-term viability and trustability of eHealth solutions.

“... in a region where there are only one or two people, we saw that the systems are not properly supported and that they are open to problems. In this case, it is difficult to support the lower level of health facilities in the health systems” (PE03)

5.2.3 Theme 3: Economic related facilitators and barriers

5.2.3.1 Economic related facilitators

According to the findings of the interview, adequate budget allocation, affordability, and profitability of technologies were key enablers of the long-term viability and trustability of eHealth solutions.

Participants stated that an organization's economic strength was critical in alleviating the lack of finance for system development and deployment of eHealth solutions. Furthermore, they stated that both the provision of ICT equipment and the establishment of ICT infrastructure would necessitate a large budget. According to reports, strong financial support from the government should always be available to keep the system running. Furthermore, implementing cost-effective (affordable and profitable) eHealth solutions played a significant role in the system's sustainability.

“..... the government is spending large sums of money to distribute tablets to health facilities to implement community health information and is allocating large sums of money to provide training”(PE05)

5.2.3.2 Economic related barriers

During this interview, we discovered that a lack of adequate funding and donor reliance were the major barriers to the sustainability and trustability of eHealth solutions.

Participants reported that resolving the budget issue was critical to the successful implementation of eHealth solutions. Most healthcare organizations were unable to obtain ICT infrastructure, develop and deploy systems, expand the existing network, maintain nonfunctional equipment, and provide refreshment training activities due to a lack of adequate funding. They also stated that the majority of eHealth solutions were developed with funds provided by donors because organizations were unable to cover all of the initial investment costs. Donor-driven systems were not successful, and they were phased out once the project was completed. Furthermore, participants stated that an adequate budget was required to provide capacity-building activities. As a result, the budget issue is the primary reason for the system's inability to sustain itself.

“Huge economic investment is very important to sustain the eHealth solution. For example, if I take one example like the electronic community health information system, we reached fifty percent at health centers in the Oromia region in Ethiopia” (PE13)

5.2.4 Theme 4: Infrastructure related facilitators and barriers

5.2.4.1 Infrastructure related facilitators

The availability of ICT infrastructures such as a reliable internet connection, backup and recovery tools, LAN connectivity, and larger storage and memory capacity computers were identified as major facilitators for long-term and trustworthy eHealth solutions during the interviews. Furthermore, adequate power backups, adequate electricity, and infrastructure accessibility were described as prerequisites for the long-term and trustworthy implementation of eHealth solutions.

Participants stated that feasible systems would only be available once adequate and eHealth infrastructures were in place. They confirmed that adequate infrastructure, such as good internet and network connectivity, as well as adequate power sources, were critical to implementing and sustaining eHealth solutions. However, frequent power outages were reported as a critical challenge by participants in the majority of the healthcare facilities. They also supplemented that power with generators, UPSs, and solar panels, which were used as backups.

“Power outages were a major institutional challenge. However, with the help of a backup generator, we were able to turn on the lights on time and without interruption. I believe this has contributed to the sustainability of eHealth solutions” (PE04)

5.2.4.2 Infrastructure related barriers

A respondent in this interview mentioned a number of barriers that are impeding healthcare organizations' long-term implementation of eHealth solutions. A lack of infrastructure, limited capacity of ICT infrastructure, frequent power outages, poor electrical installation, and poor internet connectivity are all potential barriers to the long-term viability of eHealth solutions.

Participants identified ICT infrastructure issues such as frequent network connectivity interruptions, poor network configuration, and low internet bandwidth as key challenges that required strong leadership and financial commitment to sustain an eHealth solution.

“According to our experience, most of the problems are not with the system but with the weak infrastructure. Another problem is the ongoing changes in the ICT infrastructure. For example, the system which we built in with very high cost has changed when the building's services are changed. Changes in each department can lead to problems if not handled properly. It is very easy to come up with a system right now. But with its poor infrastructure, it has become very difficult. Inadequate access to the Internet is a major barrier to sharing information and reading it to systems” (PE01)

Other power sources, such as solar, should be available in every station of the health facility, in addition to grid elasticity. They also stated that frequent power outages were a common cause of data loss, in whole or in part. They stated that organizations were using data backup and recovery tools such as external hard disks and the cloud to address this issue. Furthermore, they reported that the frequent occurrence of power outages caused unnecessary delays for organizations reporting data from lower to higher levels.

“The electricity problem is a major problem that needs to be solved. Some facilities have no electricity, and some facilities use other power options like generators. However, though some facilities have generators to use eHealth solutions in health facilities, they face difficulties in operating the generators, such as the absence of benzene” (PE13)

Another major challenge to sustaining an eHealth solution has been identified as a lack of adequate internet connectivity. They also stated that data accessibility is determined by the internet's bandwidth. Participants reported that a strong commitment to providing internet connectivity for lower-level healthcare facilities is critical. However, the service was extremely limited, especially for lower-level issues.

“.....inadequate access to the Internet is a major barrier to sharing information and reading it to the healthcare organizations” (PE01)

5.2.5 Theme 5: Organization related facilitators and barriers

5.2.5.1 Organization related facilitators

We discovered that the availability of leaders' support, organizational readiness, a conducive environment, and organizational structure were reported as reliable facilitators of sustainable and trustworthy eHealth solutions in this interview. Furthermore, the availability of discussion, the

availability of system requirements, the creation of a sense of ownership, and the involvement of end-users were identified as important facilitators.

We learned from the interviews that creating a sense of ownership and actively engaging end users was critical from the development to the implementation phases. Furthermore, partners' long-term financial support and frequent organizational support, ranging from lower-level healthcare professionals to higher-level executives, as well as domain experts to developers, were identified as key facilitators that influence the long-term viability of eHealth solution implementation.

“... inviting end users during system development should be considered, and widely understanding the environment is more important. Creating a sense of ownership should be there to use and sustain an eHealth solution” (PE14)

Participants also agreed that the availability of a good organizational structure was critical for the long-term viability of eHealth solutions. They reported that in order for systems to function properly, healthcare organizations must have a consistent organizational structure.

“For systems to work properly there must be a consistent organizational structure. In my view, I believe the structure is good at the ministry level. For example, when we look at the structure of health information technology department, it is well organized into two or three teams. According to the structure of the directorate, the required technical staffs are becoming join the department” (PE03)

Non-functional requirements such as interoperability, portability, security, and reliability were mentioned as outstanding facilitators for the continuity of digital health solutions by participants. Furthermore, conducting discussion sessions with end-users, community members, and managers at various organizational levels was reported as a good way to get solutions to eHealth implementation challenges.

“When this system was first implemented, discussions were held with the community and users. In particular, previous practices were not secretive. No one keeps and uses information confidential. During our discussion, we agreed that it would address these issues and provide better service to our customers” (PE04)

5.2.5.2 Organization related barriers

Participants identified low information utilization culture, a lack of homegrown systems, a lack of system integration, delayed bidding and procurement processes, a lack of leadership support, and a lack of incentives as major barriers to sustainable and trustworthy eHealth solution implementations.

Participants stated that the system's poor culture of information utilization was shared by the majority of the organization's top management leaders. They also stated that the healthcare organization's low information utilization culture resulted in a lack of timely, informed decision-making. Overall, information utilization was reported to be low in this interview, despite the use of some eHealth solutions. One of the primary causes of this poor information utilization culture was a lack of data completeness. Participants also stated that decision makers did not trust the information because it was incomplete, making it difficult for them to make informed decisions. Furthermore, the use of in-house systems was critical to ensuring the security, accessibility, and quality of healthcare data. End users will only trust the system if it has been developed in-house by professionals from their country.

“It is good to use and integrate open sources with our homegrown software. It is dangerous to rely on open source alone because one day when things go the wrong way, it can lead to a devastating outcome. At some point in the past, SmartCare and other Tullen University software collapsed because of the session of the project was ended. The good thing was that the ministry of health learnt from these failures and developed many in-house systems. So, in-house developed eHealth solutions are more trustable than open-source and partner-based systems” (PE11)

5.2.6 Theme 6: Technology related facilitators and barriers

5.2.6.1 Technology related facilitators

We learned from the interviews that the system's user-friendliness, system ownership, availability of strong data security, availability of data privacy, and confidentiality were all mentioned as important factors in the success of the eHealth solution implementation.

Participants reported that when systems were user-friendly, their usefulness was not called into question, and the system would support them. Participants also stated that if it was user-friendly or simple to use, end users would use it consistently and frequently. Furthermore, they reported

that home-grown eHealth solutions created by domestic professionals were more user-friendly and simple to use than those created by donors. End-user involvement and discussions with system developers allow eHealth solutions to be sustainable and trustworthy. However, when eHealth solution scripts and codes were in the hands of partners, the system's continuity was always debatable.

“If the systems meet the needs of the user, are easily adapted to other systems, and are sustainable if easy to use. For example, EMR has validation rules, alerting technologies. The use of alerting techniques will be of great benefit to the user, so they will continue to use them. For example, it is very important to have messages to alert the laboratory test results, rather than to have only a laboratory test result. So the more you add such alerts, the more useful they will be and the more lasting they will be. Otherwise, the system will become an additional burden and put pressure on them” (PE01)

Furthermore, they stated that maintaining data privacy, security, and confidentiality were the cornerstones of a system's sustainability and trustability. Password protection and the assignment of privileges (roles) were critical mechanisms for securing patient data and preventing unauthorized access to eHealth systems. They also recommended that end users disable their computers' USB and CD ports to protect them from external threats.

“Electronic system is very prone to data breach unless strong security is ensured. Creating how to access the data of individuals is important because who is going to access, why and when to access should be clear in data sharing practice”(PE15)

5.2.6.2 Technology related barriers

According to the interview, the major barriers to an eHealth solution's sustainability and trustworthiness are a lack of interoperability, system immaturity, a lack of user requirements, system complexity, and central administration.

Furthermore, the lack of system interoperability is a major impediment to the long-term viability of eHealth solutions. They speculated that the cause could be incompatibility between hardware and software. As a result, many systems fail to perform. According to them, respondents cited a lack of interoperability as a major impediment to the successful implementation of eHealth solutions.

“When we take interoperability most of our machines are old and may not interoperable with the current ones. For example we have a problem to display data. That means the analyzed data needs to display by using smart display to give our information or performance to the public and stakeholders but the old device are not interoperable with the current DHIS-2 software output”(PE10)

Participants also mentioned immaturity as a technological barrier to system sustainability. As a result, in collaboration with the Federal Ministry of Health, the organization created a digital ecosystem to address this challenge. They also stated that system testing by both internal and external experts was essential for ensuring system maturity and complexity level. Furthermore, most eHealth systems fail to sustain themselves due to a lack of user consultation and incorporation of their needs during the system development phase.

Respondents also stated that, while central administration had advantages in terms of data security, there were issues with the accessibility and availability of the central database to users at the lower level. Participants also mentioned that end-users at the lower level were frequently experiencing server outages, particularly on weekends.

“....sometimes the server fails at the weekend, meaning that Sunday and Saturday. Most of the time, health extension workers synchronize the data when they came to the city from rural areas, which is usually at the weekend” (PE13)

5.2.7 Theme 7: Policy and legislation related facilitators and barriers

5.2.7.1 Policy and legislation related facilitators

The availability of system governance and legislation were identified as key contributors to the sustainability and trustworthiness of eHealth solutions in this interview.

The availability of system governance and legislation, according to participants, is critical to the sustainability and trustworthiness of eHealth solutions. Even though some documents are used to address issues of system ownership and accountability, it is not widely used in healthcare settings.

5.2.7.2 Policy and legislation related barriers

Lack of accountability, lack of policy and legislation, and lack of standards were identified as potential barriers to the sustainability and trustworthiness of eHealth solutions in this interview.

Participants reported that unauthorized use of patient information would have serious consequences unless disclosure is governed by rules and regulations. They also stated that the issue of ownership is currently a major concern. This is because the majority of eHealth solutions were developed by partners, and systems would cease to function soon after the system developer's project life cycle ended. Furthermore, due to a lack of rules and regulations documents, they did not offer to hand over the system to the government.

“We don’t trust software offered by external sources because, when they become disappointed at some point, they could demolish the system, just as Tullen University did in the past. When they left the country, they didn’t offer the source code of e-HMIS, EMR, and e-HRIS on which our healthcare system relied. This thing is bad. You can’t modify it by adding and deleting variables depending on the context. We have good practice that we keep backup data on a daily basis, as if you have some problem or data disruption at some point, you may regain it”(PE11)

5.3 Barrier and facilitator’s for sustainable and trustable eHealth solutions (the context of Ghana)

5.3.1 Theme 1: Individual or user-related facilitators and barriers

5.3.1.1 Individual or user-related facilitators

Individual or user-related attributes such as age, education, experience, motivation, IT skill, and user perception and confidence were reported as facilitators for long-term and trustworthy use of eHealth solutions in this study. Furthermore, end users' positive attitude, knowledge level, and acceptability of the eHealth solution were identified as drivers for long-term use of digital health applications. Participants in the study also stated that motivated employees were more likely to need and use the digital solution than their counterparts.

As previously stated, the individual characteristics of age, gender, and education were linked to the long-term and trustworthy use of eHealth applications. From the interviews, we learned that younger age groups were more likely to use digital health solutions for a longer period of time. Furthermore, using digital health applications can become difficult for people who do not have a formal education. Individuals with secondary and tertiary education levels made better use of eHealth solutions. The interviewee also stated that the gender of individual users is important for

the long-term use of digital solutions. Concerning the gender of individual users, study participants stated that males are currently more involved and dominant in the IT sector.

Those in the older age brackets are less likely to use it compared to the younger ones. And I'll just say things and I was second sample on the age I remember I did an evaluation on the roll out of the East tracker for the MNCH component Training has been done for all nurses and midwives. I went to their facility and I asked all midwives who were part of the training with the younger nurses. They pushed their tablet to the young Nexus to demonstrate and I asked them whether they were not part of their training. So the young one should use and demonstrate to me how their system works” (PG03)

We learned from the interviews that individuals with skills have long used ICT solutions in the healthcare system. ICT skills are regarded as the foundation for the long-term use of eHealth applications. Furthermore, eHealth applications and digital absolutes are constantly used by people who have a positive attitude toward these solutions. The level of knowledge of an individual is also a significant facilitator in utilizing solutions for longer periods of time. Those with a strong understanding of IT solutions were seen to make extensive use of digital health applications. Similarly, participants stated that organizations with motivated employees make long-term use of the solutions for day-to-day activity follow-up and monitoring.

“ICT skill and Knowledge plays a key role in eHealth solution because technology is evolving, so without the right ICT skills and knowledge users will find it difficult to adapt to the changes that will be done. So with training and awareness creation, the ICT skills and knowledge will help with the sustainability of the eHealth solutions” (PG07)

5.3.1.2 Individual or user-related barriers

Despite the fact that the research found that individual-related attributes significantly support the long-term use of digital solutions, study participants mentioned a plethora of individual or user-related characteristics that impacted their sustainability and trustworthiness. Fear of end-users with technology, lack of knowledge, lack of acceptability, and low confidence in using digital solutions were among the most commonly mentioned barriers to the sustainability and trustworthiness of eHealth applications in the health care system. Participants also agreed that a lack of ICT skills and peer influence had a negative impact on the long-term viability and trustworthiness of digital solutions.

The fear of technology among end-users has hampered the long-term use and trustworthiness of digital applications in the healthcare system. Participants may experience fear for a variety of reasons. As previously stated, healthcare providers believe they will be held accountable for errors made while utilizing the ICT solution. As a result, they are opposed to using digital solutions to provide quality care. Furthermore, users' lack of knowledge or low digital literacy was cited as a barrier to the long-term use of digital health applications. We also observed that efforts to increase digital literacy among end users were insufficient. The technology's lack of acceptability among end users, as well as their lack of confidence in using it, had a significant impact on its long-term viability. As previously stated, acceptability and confidence can be maintained by delivering training and awareness-creation activities at various levels.

“Acceptability can be positive if the proper training and awareness is done then that software can be accepted by the users but if the solution is just deployed without building capacity for it then the solution will fail” (PG07)

Participants repeatedly stated that end-users' low ICT skills were a barrier to the long-term use and trustworthiness of digital solutions. Users retreated from using digital solutions in the healthcare delivery system if they lacked the necessary skills. Furthermore, peer influence among users was mentioned as another barrier influencing the long-term use of digital solutions. To ensure the long-term viability of a particular digital solution deployed in the health system, the majority of users have used it to provide service to clients.

"It's very critical. So usually if the ICT knowledge or background is very weak or it's nonexistent at all. It will be. It becomes very difficult even during the training you have those people lagging behind. They will have their tablets or whatever they have with them, but then they find it difficult to navigate. And after the training because they lack their skill, they eventually dump these tablets somewhere and go back to their manual system” (PG01)

5.3.2 Theme 2: Human resources and capacity bundling issue barriers and facilitators

5.3.2.1 Human resources and capacity bundling related facilitators

The sustainability and trustworthiness of digital solutions are putting additional pressure on a variety of enablers to keep eHealth applications in the health system in sync. Among the many

mentioned facilitators, the availability of trained human resources, training opportunities, and a sufficient budget for running the capacity-building activity were identified as facilitators that fuel the long-term use of digital solutions. Furthermore, the availability of skilled ICT personnel was mentioned as a significant contributor to the long-term viability of digital systems. Similarly, frequent supervision and meetings were cited as facilitators.

The availability of trained human resources assists organizations in strengthening their use of digital solutions by fostering the development of IT-oriented human capital. Study participants stated that if an organization does not have the human resources equipped with the necessary knowledge and expertise to deliver on the goals and objectives, it is a failure at that location. As a result, organizations require a human resource with IT skills, knowledge, and experience in order to achieve their goals. Participants also stated that adequate human resources prevent delays in responding to problems that arise at service delivery points.

“Human resource should be enough to run 24hrs to prevent delays in some delivery. Human resource should be available or strengthened to keep the system running e.g., when it goes down” (PG08)

Furthermore, the availability of capacity-building training at various levels to improve users' digital literacy was mentioned as a facilitator for the long-term viability and trustworthiness of digital eHealth solutions. Iterative training, as previously stated, assists users in gaining a thorough understanding and insight into its significance and application. Thus, participants testified that the availability of skilled ICT personnel played a critical role in identifying the issues that appeared to be impeding the long-term use of digital solutions. As previously stated, an adequate budget for capacity building in the healthcare system is required to leverage ICT development. We discovered that organizations with adequate budget support for training and capacity-building activities had made extensive use of digital solutions.

“I think training truly this one motivating them to education and awareness about new technologies new platform services and also a frequent meetings to deliberate, brainstorming session is very key to identify and iron out issues it is very key” (PG01)

5.3.2.2 Human resources and capacity bundling related barriers

Human and capacity-building barriers were mentioned by study participants as having a potential impact on the long-term and trustworthy use of digital solutions. The inability of healthcare workers to use ICT solutions, as well as the insufficient number of staff, had a significant impact.

“This is a major issue, generally the skill set within various institution is not available as is needed and the process involve. If we have to modify processes and coherent processes this will enhance eHealth or technology but where is individual that is managing then it becomes a problem”

5.3.3. Theme 3: Economic-related facilitators and barriers

5.3.3.1. Economic-related facilitators

Participants discussed economic facilitators and barriers that were critical for the long-term viability and trustworthiness of digital health solutions in the health sector. Economic-related facilitators were mentioned as the availability of an adequate budget and the presence of financial support in the organizations. Furthermore, digital solutions were constantly used if they were profitable, had an affordable price, and required a small initial investment. According to the majority of study participants, economic-related facilitators played a significant role in sustaining digital health solutions for delivering timely decisions, which in turn improves effectiveness and efficiency in service provision.

eHealth solutions, according to the majority of participants, are not one-time use applications. Thus, organizations with adequate financial and budget support from various sources for maintenance and support were observed to use digital solutions for a longer period of time than those that did not. Large sums of money were required by organizations for network payments, appliance replacement, and regular monitoring activities. As a result of the interviewee's response, we learned that institutions with adequate financial and budget support for ICT solutions used eHealth applications on a regular basis.

“Availability of budget for maintenance is important has day in day out technology changes so without that it can't keep up with its changes, training and also purchase of monthly internet service to breach the gap in technology”(PG07)

Affordable prices, low initial investment, and profitable solutions were frequently mentioned as economic characteristics that facilitate the long-term use of digital solutions. As previously

stated, a solution is always something that is put in place in the healthcare organization. Organizations that can afford the cost of digital applications will use them for a longer period of time. We also noted that low-cost digital solutions could be used in the healthcare system indefinitely. The initial investment in the eHealth application is important for its long-term viability. End-users consistently use applications that require only a small initial investment in networking, computers, and training.

“Affordability, pay for PC’S software. Economic gains far outweigh the initial cost. Profitability is key as one would not invest in something that is cost economical considering the budget service charge/month by engaging the vendor. Funding is a challenge Internet charges to the hospital are very huge due to several implementations” (PG08)

5.3.3.2 Economic-related barriers

The study discovered that economic barriers had hampered the sustainability and trustworthiness of digital solutions in Ghana's healthcare systems. The high cost of digital solutions, as well as a lack of financial resources, was two of the most common financial barriers identified by study participants. Furthermore, the majority of eHealth applications deployed in the health care system were donor-driven solutions that were devoid of end-user needs and requirements. This is due to the fact that they are the primary source of funding for the development of IT solutions.

Participants in the study expressed concern about the high cost of purchasing ICT infrastructure. However, in developing countries, such as Ghana, the budget allocated was insufficient to purchase computers, pay network fees, and provide basic and refresher training in order to achieve nationwide coverage. In this regard, unlike developed countries, the majority of health facilities in developing countries has not yet deployed eHealth applications. Occasionally, the price of eHealth applications and their appliances skyrockets to the point where organizations are unable to afford the cost of purchasing and deploying them.

"The cost of living is getting high and high. It means that the eHealth is not free, Internet is not free. This, interestingly, more expensive here in the developing countries compared to the developed countries. Because the inner developed countries, depending on where you are, you can have access to free Internet even in their bus terminals and train stations and restaurants. But in our part of the well, you have to buy and this not

everybody who can afford how to buy data is quite expensive, the network too is also you realize when we tried initially it was not easy connecting what's going on and off” (PG02)

Especially when I used it our own Ghana Health service institutions, you go around and interact with most of the data office and they really have to use your own money to buy data to be able to work for the organization and you get to some places. Officers are tired if spent all their money and they don't even have money to buy more data so they end up waiting at the end of the month they give you into cities” (PG03)

Furthermore, almost all digital solutions currently being implemented, according to study participants, are donor-dependent IT solutions. National health ministries have set aside a small budget for the development and deployment of eHealth applications. As a result, organizations have run healthcare services with limited resources, and the development of local solutions was not on most organizations' priority activity lists. Furthermore, even if they were allocated for maintenance and expansion, they were not for partner-developed and deployed IT solutions.

5.3.4 Theme 4: Infrastructure related facilitators and barriers

5.3.4.1 Infrastructure related facilitators

The backbone, or key pillar, of IT infrastructure is critical to the success of eHealth solutions. As previously stated, reliable electricity supply, internet access, and backup power sources such as UPS and generators were mentioned as infrastructure-related facilitators. The sustainability of digital solutions is based on technology that is powered by electricity. As a result, with no electrical power, no alternative electric source, frequent interruption, and poor electrical installation, these systems will fail, reducing the efficiency of their output and their acceptability by users. As a result, when there is a power outage, an alternate source of power must be available.

The availability of internet access and networking is critical because eHealth is attempting to reduce the role of physical interaction and allow the system to function smoothly. Internet access is critical in healthcare organizations for sharing activities among providers and supporting decisions by having the necessary information on hand. Furthermore, it aided patients and clients involved in treatment selection in receiving feedback on the disease's prognosis. Thus, the

constant availability and speed of the Internet could help to boost and ease the use of this technology in terms of eHealth solutions. A continuous internet connection also improves access to healthcare services for those who live far away from healthcare facilities and is critical for sharing information with the community and other stakeholders.

“The internet gives us access to travel beyond our geographical location and have access to other important and other information sharing. So if we don't have a reliable internet, which has high availability in terms of capacity to transmit information both in and out, it is also going to impede our communication within and outside” (PG01)

5.3.4.2. Infrastructure related barriers

Adequate infrastructure is required for eHealth solutions to function properly in the health care system. As previously stated, facilitators played a significant role in the long-term use of digital solutions. Nonetheless, many infrastructure-related barriers hampered its long-term viability. Among the most frequently mentioned barriers were network switches, insufficient LAN coverage, poor electrical installation, material damage due to power sparks, and continuous electric interruption and outages. Because without a highly resilient and robust ICT infrastructure, all deployments will fail.

With the advancement of technology, the eHealth solution will not function properly without a proper internet and network, and information will not be updated. Thus, health care organizations must have continuous access to networks and the internet in order for eHealth solutions to function properly. The majority of organizations, on the other hand, were operating with extremely limited internet bandwidth. Furthermore, we learned from the interview that network quality was a challenge for many health care facilities. Poor network performance and frequent power outages were major challenges for end-users to accomplish their tasks accordingly. The transmission of health-care information from the lower to the higher levels of the hierarchy was delayed.

“Availability of internet access and networking is important because if we need our system to communicate there is the need for internet connectivity and proper networking infrastructure and also with that aside with every growing in technology and information the availability of good internet access and network is needed” (PG09)

Power in the eHealth system serves as a foundation for other systems to operate in order to fully satisfy the customers' satisfaction. As mentioned by study participants, power outages and interruptions are more common problems faced by the majority of healthcare organizations. As a result, eHealth solutions such as EMRs and the like are failing to function as intended. In some cases, businesses will purchase alternative backup power systems in order to minimize and avoid power outages. However, according to the study participants, purchasing a backup power supply is not common practice for the majority of organizations.

No electrical power, no electric alternative source, frequent interruption, poor electric installation affects the quality of the information from the eHealth solution and also reduce the efficiency of the solution so secondary source of power is need to protect the technology the solution runs on”(PG07)

5.3.5. Theme 5: Organization related facilitators and barriers

5.3.5.2. Organization related facilitators

Participants in the study described various types of organizational-related facilitators. Access to IT solutions, the practice of conducting feasibility assessments prior to the deployment of digital solutions, and reinforcing the culture of ICT use among end-users have all significantly contributed to the long-term use of digital applications. Furthermore, among the facilitators were organizations with material and management support, leadership engagement, necessary infrastructure, and good workflow. Individuals in organizations use available information to make decisions and have faith in the care provided by the organization. This improves the suitability of IT solutions in lower-level organizations.

Digital solutions are primarily intended to provide providers with access to information and patient data. User-friendly digital solutions improve information accessibility. Some study participants stated that organizations have worked to increase data access by deploying eHealth applications in health care organizations. EMR, for example, is one of the solutions designed to strengthen the supply of health information to the care provided in a timely and reasonable manner. Furthermore, participants agreed that conducting a feasibility assessment prior to the deployment of a digital application saved organizations money, which maximized organizational effectiveness and efficiency.

“Accessibility uses confidence to bring quality solutions; I have been at the headquarters for a number of years. And in fact, exposure to events and how it has to be deploy, manage, and then sustain that confidence based on information has helped me to be able to play the kind of role that I'm playing in the sustainability of eHealth solution” (PG01)

Adequate financial support is anticipated to power the digital solutions in the health care system. As previously stated, organizations that received material support from the management body were observed operating the digital solutions effectively. Furthermore, the role of the coordination component in the deployment process was emphasized as a facilitator for effective use of digital applications. In terms of organizational support, if there is no leadership, nothing will run and everything will remain as it is. As a result, leadership is essential in the deployment of these systems.

“So as mentioned earlier, everything rises and falls with leadership so. And the leaders must be interested in it and they must also budget for it and then make install and provide leadership in that area. They must use it. So that the ones they are leading this will also follow their example” (PG02)

Infrastructural support and good workflow are important in the implementation of a digital application in the way that IT developers recommend. Participants in the study also mentioned that organizations with adequate infrastructure within the organization could potentially use digital solutions for a longer period of time. Furthermore, good workflow among service provision areas may have influenced the user's interest.

Workflow is ok because everyone is entitled to what he or she those because everyone has his or her log in credentials and also due to transparency of communication and information it makes workflow improve the quality of the solution as time goes on” (PG09)

5.3.5.3 Organization related barriers

Organizational performance is undoubtedly influenced by aspects of organizational-related barriers. Participants in the study reported organizational barriers such as a lack of information, organizational structure and procedures, and staff motivation. Furthermore, a lack of

coordination among service delivery points and management support in general hampered the sustainability of digital solutions in health care delivery.

Organizational structures are critical to the health sector's effectiveness and goal achievement. When their structures are properly laid out, with procedures and values, it means that things will not be done in any other way because they have established procedures. The appropriate organizational structure must be based on best practices, the organization's staff size, and the complexity of services provided. Organizations with shaky structures and ineffective top management involvement in the development and deployment process would provide clients with subpar care.

“The eHealth solutions doesn't exist independently, it is the organizations that provide the eHealth solutions. The call managers or the topmost hierarchy of the organization must see health as a priority. Then that would trickle down to the ordinary worker” (PG02)

Participants stated that organizations with fragmented service delivery and workflow required a significant investment in digital solution installation and deployment. They also stated that this investment imposed additional costs on organizations. As a result, organizations abandon digital solutions because they lack sufficient funds to run the program effectively. In terms of workflow processes, their system should include a web flow system that clearly defines the various roles of individuals within their system.

“When there is no well documented, Sequential rules and task. There could be a barrier to eHealth solutions. The right workflow process that would help and definitely seem to move towards its achievements with regards to eHealth solutions” (PG12)

Lack of motivation can have an impact on the organizational coordination of health professionals to collaborate. Employees who excelled at using digital solutions were not seen as motivated or recognized for their efforts. Even though, the majority of respondents said their companies lacked a strategy for motivating employees to improve digital solutions. They lacked a strategy and were incapable of motivating their employees. As a result, they did not involve other supporting partners in mobilizing resources for motivating staff, which could help improve the long-term use of eHealth applications.

“Recall that the banking and other sectors that are using digital solutions didn't just start overnight. So as we continue to educate people and ask, they benefit from it, then they will be motivated to use it more. But now it's in the early stage”(PG03)

5.3.6. Theme 6: Technology related facilitators and barriers

5.3.6.1 Technology related facilitators

Technology-related characteristics can have an effect on end-users' ability to function and use IT solutions. The usefulness of a digital solution, software availability, digital solution quality, and user-friendly systems have all been identified as facilitators of long-term use and trust in digital solutions. If the digital eHealth application is useful to the end user, it must be used effectively. The usefulness is determined by the ease with which the eHealth solution treats patients. In line with this, participants stated that health workers and administrators in the healthcare system use eHealth technologies to reduce patient wait times while maintaining service quality.

“... with regards to the usefulness of technology, it depends on the quality of information which leads to motivation because technology is proving its usefulness which is reducing the stress and also making work faster which has made the use of the technology easy to use”(PG09)

Participants in the study stated that digital solutions with high output are being used more frequently and sustainably in healthcare organizations. However, the quality of eHealth solutions must be assessed in terms of end-user needs as well as intended outcomes or objectives. If they discover that the digital solution generates and provides quality information for patient care and management, resource allocation, performance monitoring, and follow-up, they will be eager to use it.

“If the eHealth output is not of good quality in the sense that if the outputs can that, the facility is using it, they should be able to retrieve data easily. So if let's say, to be successful, if we are only able to access the information only in one facility, even in one facility, it should be very user friendly. You don't have to do multiple things just to retrieve data from it. And it should be across like say hospital A because we should be able to assess a patient's folder that in hospital B without stress using the ISO standards” (PG04)

Participants in the study reported that eHealth applications and solutions are frequently used for patient care and management if they are simple to use. Although healthcare providers have limited capacity to operate digital solutions, through capacity-building training, the majority of health workers have developed a positive attitude and an interest in using eHealth solutions. As a result, health care providers and administrators required systems that were simple to use and user-friendly in order to be sustainable. The complexity of IT solutions also has an impact on the deployment process.

“Another thing that I would also help the person to use it would also be the perceived ease of use of that system. OK, if it's the person perceives or has a perception that the system is user friendly. And then the person can use it to solve his or her problem or enhance his or her wake. The person would definitely go in for it, but if it's not user friendly, just as I said, they will all abandon it and go back to their manual way of doing things” (PG01)

5.3.6.2. Technology (Data security and privacy) related barriers

During the interview, a slew of technological barriers were identified. Among the many barriers, poor data security and privacy, software complexity, the inability of systems to share information among users, and a lack of system maintenance were frequently mentioned and reported as technology or eHealth application-related barriers. Furthermore, digital solutions that are not adaptable to local contexts were identified as a significant barrier. Participants in the study stated that the two most important barriers to the sustainability and trustworthiness of eHealth solutions are poor data security and privacy. Organizations will discard systems with poor data security platforms, as well as those that do not protect client or patient privacy. Data security and privacy breaches mean that the user's information will be available in the public domain, which means that anything can happen to the data. The data can be lost, hacked, or affected by software, and anyone can access it, indicating a flaw in the IT technology that has been deployed in their facility.

“Once you have a weak data security and privacy technology, you are doomed. Anyone can access the patient data and you know how people can use data for mischievous reasons and this can put the whole. Organization in trouble or Integrity and whatever

will be at stake and then it could have dire consequences for you as an organization, so these are critical and no one will want to find him or herself in that situation” PG03)

Healthcare providers and program managers rarely require digital solutions that do not have a customizable design for local context and use. As previously stated, the digital solution must have a customizable feature design in order to be used in the delivery of health care services. This could be due to the fact that the organizational structure in many health care facilities is insufficient to deploy digital solutions as they are developed. Furthermore, the need for one facility differs greatly from the need for the other. As a result, a digital solution with no customizable design or interoperable features for end users was less necessary for long-term use.

“If you are developing eHealth solutions, you should also consider the environmental factors. And reports are how they do their things. What is applicable in Accra might not be applicable in other places. And so therefore, if you set them down, customize it to suit them at the end of the day; you might be looking at indicators. You might be looking at other aspects, but bring them into your discussions” (PG06)

5.4 Barrier and facilitator’s for sustainable and trustable eHealth solutions (the context of Malawi)

Four distinct themes were identified as facilitating or impeding e-Health infrastructure sustainability and trust. These were of the social, economic, technological, and organizational variety.

5.4.1. Theme 1: Social related facilitators and barriers

5.4.1.1. Social related facilitators

Social influence tends to facilitate the development of long-term e-health infrastructure. Users' sense of ownership contributes to sustainability, as does the dedication and motivation of both health workers and district supervisors.

In terms of user abilities, informants stated that familiarity with smartphones or computers has a significant impact on a user's ability to master a new eHealth tool (mostly data collection tools).

“We have noted that familiarity to smartphones or computers speaks a lot to a user’s ability to master a new eHealth tool (mostly data collection tools)” (PM01)

Furthermore, having shared values is critical because it creates a more conducive environment for collaboration. Simultaneously, a collaborative culture is required to ensure the long-term viability of eHealth solutions. Partners and government programs cannot operate in isolation. This can be improved by forming a WhatsApp group where questions and information can be shared.

“Creating a WhatsApp group to exchange queries and information” (PM05)

In terms of attitude, willingness, and personal demography, the world is currently technology-centric, and the masses are catching up, so we are seeing a willingness to use these platforms from the majority of the intended primary users. We've noticed that the younger generation is more adept at using these platforms.

5.4.1.2. Social related barriers

Social influence can help to ensure long-term e-health infrastructure. It can also act as a barrier in cases where users lack a sense of ownership. Users lose interest when they believe they do not own the system.

“We were not informed about HSAs going to attend training for iCHIS, yet they expect me and the Senior HSA to supervise them. How can we supervise them when the hierarchy has not been followed?”(PM11)

One of the barriers is a lack of digital skills, particularly when it comes to data collection. This is exacerbated in some cases by the user's age. The older generation is less adept at using these platforms

“Some HSAs are so old that handling ICHIS might be difficult” (PM08)

In some cases, it was also reported that it was simply due to lack of interest and motivation on the part of the users.

“HSAs using digitized systems usually complain of the batteries not able to support them when entering huge data. It might be true but sometimes it is a scape goat to cover up their laziness” (PM08)

5.4.2. Theme 2: Economic related facilitators and barriers

5.4.2.1. Economic related facilitators

A consistent supply of data bundles is required to enable health workers to share and transfer data. A good network is required to sync and update the data captured in a system, especially in areas with intermittent connectivity. Poor network connectivity has an impact on the implementation of any network-dependent system. A poor network may be used as a scapegoat by users.

The availability of power to charge tablets is required and can aid in the sustainability of e-health infrastructure. Users of digitized systems frequently complain about devices' running out of battery power while working. Nonetheless, device battery discharges are occasionally used to mask users' disinterest in a solution.

The government's push for localized hosting for eHealth platforms necessitates significant investment in server infrastructure and maintenance costs, both in terms of hardware and human resources.

The majority of the budget must be spent on infrastructure (hardware). These are typically one-time payments with sporadic maintenance expenses. Another critical area is human resources, particularly in terms of technical expertise. The cost of retaining talent is high. Another option is to invest in the training of government technical officers. However, the number of these officers is insufficient, necessitating technical assistance from partners.

5.4.2.2. Economic related barriers

The country's reliance on donor funding for digital investments jeopardizes its long-term viability. The Malawi government currently contributes no more than 1% of the current digital health investment budget. The majority of the budget must be spent on infrastructure (hardware). These are typically one-time payments with sporadic maintenance expenses. Another critical area is human resources, particularly in terms of technical expertise. The cost of retaining talent is high. Another option is to invest in the training of government technical officers. However, the number of these officers is insufficient, necessitating technical assistance from partners.

Most eHealth investments rely on loosely coordinated short-term project-based funding arrangements, which frequently results in duplication of efforts, poor resource utilization, and a lack of funding for long-term investments like maintenance.

5.4.3. Theme 3: Technological related facilitators and barriers

5.4.3.1. Technological related facilitators

Respondents emphasized the importance of users' having up-to-date and sufficient data collection equipment (i.e., tablets and smart phones). Where the equipment is insufficient to meet everyone's needs, individuals should be encouraged to share the equipment they receive in order to ensure its long-term viability when the recipient is not present.

It was discovered that various types of technology, both hardware and software, are used at the community and health facility levels. However, the technology is not available in all of the health catchment areas that have been visited, nor is it available for all of the programs. The computer and phone models used were donated by various partners and are of various models.

There is no standard patient record system used at the community level across all health catchment areas visited in terms of software. Respondents emphasized the importance of having a robust system that cannot easily collapse and a platform for continuous feedback, similar to how some (262 out of 950) health facilities use a common platform for ART and OPD.

Furthermore, a good maintenance plan for the provided resources is required to ensure sustainability even after the project is completed.

It is critical to have a good network in order to sync and update the system. Poor network connectivity has an impact on the implementation of any network-dependent system. Users may blame a lack of system usage on poor network connectivity. The availability of power to charge tablets is required and can aid in the sustainability of e-health infrastructure. Users of digitized systems frequently complain about devices running out of battery power while working.

In terms of usefulness and ease of use, relatively simple workflows (e.g., data entry workflows) will drive system adoption. Systems have been fragmented for far too long as a result of a lack of a digital health blueprint and a willingness to collaborate among partners and ministry of health programs/departments. Integrating systems across programs and having technical working groups (TWGs) or task forces in place to analyze and drive these interoperability conversations forward, as well as identify areas of synergy, is critical to long-term sustainability. Malawi's MoH/TWGs have made significant progress thus far.

Internet penetration/coverage is lower, with most remote areas experiencing intermittent to no network reception. Because most systems require internet access to function, having consistent and dependable reception across the country is critical.

5.4.3.2. Technological related barriers

The informants noted that complex workflows will leave most users frustrated.

“Fairly straightforward workflows (e.g. data entry workflows) will spur uptake of systems. On the other hand, we have noted that complex workflows will leave most users frustrated” (PM01)

Furthermore, issues with equipment security, ranging from devices without passwords to unlockable rooms and high data costs, will act as impediments to having a sustainable infrastructure. External or internal attacks on systems can result in data loss or the leakage of personal information. The general public is aware of these real risks.

Inadequate network connectivity is another impediment to the long-term e-health infrastructure. In terms of electrical power, some areas have no power, no alternative source of power, or have frequent outages.

5.4.4 Theme 4: Organizational related facilitators and barriers

5.4.4.1. Organizational related facilitators

There is a requirement for intensive training on how to use a solution that has been implemented. The overall level of support provided to end users should meet their expectations; most establishments have established a user support unit that actively supports eHealth solutions. Physical support is sometimes required, just as remote support is. As a result, it is critical to consider striking the right balance between the two in order to ensure that users receive quality support in a timely manner. According to informants, it is critical to train users on how to use implemented solutions in order to build the necessary capacity for effective and intended use of eHealth solutions. Furthermore, informants advocated for the establishment of a system in which local IT teams would be trained and expertise in key areas of implemented eHealth solutions would be developed. It was emphasized that developing expertise among local staff would ensure service continuity in the absence of country-level or external technical experts who may not be readily available once implementation activities were completed.

Having regular review meetings on implemented solutions can also help in the development of a long-term eHealth infrastructure. Review meetings allow implementers to get direct feedback on what is happening on the ground. As a result, regular review meetings enable the correction of things that aren't working properly and provide a forum to encourage positive gains and practices.

Another point raised as an enabler for long-term infrastructure is regular supervision of eHealth solution users. Increased supervision is beneficial because most frontline employees are enthusiastic about digitized systems used for reporting or data collection during training and the first few months of use. They then become preoccupied with other things and complacent.

The availability of end-user manuals was also mentioned as one of the factors that contributed significantly to sustainability. Manuals provide a knowledge base that can be used to refresh the knowledge of eHealth solution users. Users should be allowed to collect data in alternative ways, especially in areas where there is no power. Allow users to, for example, collect data in the field using paper forms while their tablet is charging.

Another factor that would promote sustainability and trust is when supervisors assess users who are having difficulty using the systems and find ways to assist them. It may be necessary to pair them with capable users from the same facility to assist them, particularly during the early stages of system implementation.

Having shared values is critical for organizational structure, procedure, culture, rules, and values because it creates a conducive environment for collaboration. Simultaneously, a collaborative culture is critical to ensuring the sustainability of eHealth solutions; partners/government programs cannot work in isolation.

Internet penetration/coverage is lower, with most remote areas experiencing intermittent to no network reception. Stable and dependable reception throughout the country is critical because most systems require internet access to function. It is critical to have a well-versed leadership hierarchy in terms of technical expertise as well as governance. It is critical for leaders to make evidence-based decisions, and eHealth solutions help them do so. Standard operating procedures and system documentation will undoubtedly aid in the maintenance of eHealth platforms.

Nationally, data analysis culture is gaining traction, but district and facility adoption has yet to catch up. Data collection has greatly improved for aggregate-based systems, but due to the frequency and complexity of the capture process, there is still some ground to be covered for tracker/individual-based systems.

In terms of electric power and ICT infrastructure, a comprehensive data center as well as human resources (systems/network admins/engineers) are required to host the multitude of eHealth solutions. Furthermore, this investment must include the establishment of backup sites and fail-over systems.

5.4.4.2. Organizational related barriers

When users are presented with systems that are not usable due to a limited scope of usability, which could be due to insufficient training, Where there is no teamwork, it is difficult to have a sustainable and trustable infrastructure.

“Need to have proper coordination between health facility and district level and team spirit” (PM11)

“Team work is key, if there are disagreements at a health facility, the eHealth solution can easily fail” (PM10)

Failure can also result from a failure to learn from past mistakes. It is critical to consider why previous apps failed or succeeded. Furthermore, they lack or have insufficient knowledge of relevant programs in use.

5. Discussion

According to this study, attributes for sustainable and trustworthy eHealth solutions encompass individual or user-related, human resource and capacity building related, economic related, infrastructure related, organization related, technology related, and policy and legislation related aspects. For each theme, a variety of factors and challenges encountered at various levels of health care were identified. A lack of a sufficient budget, a lack of infrastructure, a lack of adequately trained personnel, and a lack of homegrown software are among the most frequently mentioned factors.

This study confirmed that individual end-user opinions influenced the implementation of new eHealth solutions in healthcare settings. Although some individual-related factors are shared by

all end users, there are significant differences in end-user perceptions of the contribution of eHealth solutions. This observation is consistent with previous research findings indicating that end-users' negative attitudes and fears about accepting and using new technologies impede the long-term viability of eHealth solutions [24]. On the contrary, current evidence suggests that health professionals' negative perceptions of eHealth solutions are gradually improving [25].

Furthermore, in our study, gender, age, end-user digital literacy, and prior exposure to using eHealth technology applications were identified as key factors in the long-term viability of eHealth solutions. Our findings are consistent with previous published studies [16, 26, 27]. We discovered that males and females express their views on the sustainability and trustworthiness of eHealth solutions in different ways. Male end-users seemed to have a more positive attitude toward accepting and using eHealth solutions than their female counterparts. This might be related to the difference in exposure and access to digital technology described as digital gender gap [28].

In contrast, a study conducted in Bangladesh found that gender had no significant impact on long-term eHealth implementation [27]. Furthermore, we discovered that the end-lack of users' computer literacy was a potential barrier to implementing an eHealth solution. It is obvious that the majority of eHealth end-users lack the necessary skills to resolve computer or network issues. As a result, if end-users are computer literate and have prior exposure, they will accept and use eHealth solutions.

A lack of technical experts with the necessary skills, as well as a lack of training, was identified as major barriers to the long-term viability of eHealth solutions in our study. Being computer literate is becoming increasingly important in order to sustain eHealth solutions [25]. Most health professionals, however, lack the necessary skills to use eHealth solutions. As a result, providing capacity building through training and providing frequent support is essential for establishing a stable working environment. Our findings are consistent with those of other studies conducted around the world [16, 29].

Adequate funding is required for the long-term and trustworthy implementation of eHealth. According to this study, the initial cost of establishing and implementing eHealth solutions was very high. This issue is very common, especially in developing countries, in order to avoid telecommunications costs, end-user training, and the need for new advanced technologies [29-31]. To overcome the challenges associated with a lack of budget, the majority of eHealth

systems are supported by external funds [9, 32]. However, the project's long-term viability is called into question due to its short lifespan. As a result, donor-dependent systems are difficult to maintain.

For technology to be sustainable, it must rely on safe and stable infrastructure [33]. For ICT infrastructure, unreliable electric power, frequent power outages, low internet band width, and a lack of adequate resources were identified as potential barriers to eHealth sustainability and trustability in this study. This study's findings are consistent with those of other studies [31, 34]. Poor ICT infrastructure is also cited as a major factor influencing users' use of eHealth solutions. As a result, considering the available infrastructure is recommended for the successful implementation of eHealth initiatives.

If organizational factors are not carefully considered during the eHealth implementation process, it discourages system acceptance. Because an eHealth system is implemented and used within an organization, ignoring the contribution of organizational factors is unacceptable. Currently, governments in developing countries are attempting to implement various eHealth solutions in order to improve healthcare service delivery. However, other studies [9, 30, 33, 35, 36] have found that a lack of leadership support, a lack of culture for information use, a lack of organizational structure, a lack of leadership and management support, and a lack of supervision are critical barriers to sustaining those implemented systems.

Furthermore, staff resistance to change, a lack of end-user involvement, and staff turnover were identified as critical barriers to the implementation of sustainable and trustworthy eHealth solutions. The findings of this study are consistent with those of other studies conducted around the world [37-39]. System integration, user-friendliness, perceived usefulness, flexibility, privacy, and security were identified as important contributors to the long-term viability of eHealth solutions. This study's findings are consistent with those of other studies [16, 26, 31, 35, 36, 40]. Privacy, on the other hand, was identified as a less important factor in the context of eHealth implementation in Bangladesh [41]. Furthermore, a study conducted in Ghana found that perceived usefulness and ease of use had little influence on eHealth adoption [42].

Furthermore, there is no doubt that trust is a necessary condition for users to accept electronic services. According to articles, trust exists only when the privacy and security of eHealth

systems are ensured [38]. When using eHealth technologies, it is critical to have a strong organizational policy in place to protect against both intentional and unintentional actions from both internal and external sources. The availability of policy and legislative frameworks was identified as a critical factor in the sustainability of eHealth solutions in our study. This finding is supported by studies conducted in various parts of the world, which show that the availability of legal and ethical issues, as well as a specific and clear regulatory framework for eHealth, as well as government policy, determine the sustainability of eHealth solutions [12, 16, 31, 36, 43]..

6. Conclusion and Recommendation

As characteristics for long-term and trustworthy eHealth solutions, seven major themes were identified. Individual or user-related aspects include human resource and capacity building aspects; economic aspects; infrastructure aspects; organization aspects; technology aspects; and policy and legislation aspects. Despite the fact that eHealth has been identified as a promising area of innovation for addressing health system challenges, LLMICs continue to face bottlenecks in implementing sustainable and trustworthy eHealth solutions due to a lack of adequate infrastructure, a lack of an adequate budget, a shortage of technical manpower, and a lack of home-grown software.

Donor-driven eHealth solutions face sustainability challenges related to project lifespan. Context-based home-grown software are perceived as more sustainable. In addition, attention will be paid to addressing challenges related to organizational barriers, particularly infrastructure challenges such as unstable power supply, poor communication networks, inadequate internet connectivity with limited bandwidth, digital gender and age divide and a shortage of manpower resources with required technical expertise to effectively sustain eHealth systems.

7. Strength, limitation and challenges of the organization selection and the data collection process

8.1. Strengths

The following characteristics are highlighted as strengths in this study: First, participants from governmental and non-governmental organizations were invited to represent both the public and private sectors of healthcare. Second, participants with ICT skills or extensive experience in adopting and implementing e-Health technologies such as EMR, Smart Care, and pharmaceutical logistics management systems were invited to participate on behalf of each organization.

8.2. Limitation and future research

Our study is limited by geographical scale, having been conducted in four African countries. This is due mainly to the difficulty of accessing participants. We also missed key participants due to their previous participation in other work packages of this project. We suggest that future researchers conduct research by making its scope wider.

8.3. Challenges

During the participant selection and data collection phases, the following major challenges were identified: The difficulty in finding collaborative and available participants, participant refusal due to a lack of understanding of the concept of the guiding question, the participants' busy schedules, and difficulty in getting the interviewee due to their work burden were some of the identified challenges for this study.

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9. Appendixes

Annex 1: Assessment tool for sustainable and trustable eHealth infrastructure in LLMICs countries

Date: _____

Identification (ID) code: _____

Introduction

Interviewer(s) should introduce him/herself (Name and Organization)

Interviewer should introduce the BETTEReHEALTH project and the purpose of the interview:

We are conducting a study for a European Commission funded project called BETTEReHEALTH, which will contribute to improved health outcomes in African countries through better implementation of e-health. The purpose of this interview is to explore the opinions of important stakeholders of e-health, such as yourself, to help us develop strategies that will address the challenges to successful development and sustainable implementation of e-health. We plan to conduct at least **15** interviews in (insert country) that will be part of a general report on the major stakeholders of e-health. The information obtained through this interview will be for the direct use of the partners of the BETTEReHEALTH project, and will be presented in a report to the European Commission without identifying individual opinions. We would now like to ask you a few questions about your opinion regarding sustainable and trustable eHealth infrastructure in (insert country).

I. Key-informant or participants information

- A. Facility/ organization/ name _____
- B. Age group (years): 18-29, 18 - 25, 26 – 35, 36 – 45, 46 years and above
- C. Sex: Female Male:
- D. Education (the highest level) _____
- E. Professional experience _____
- F. Responsibility _____

II. Facilitators and barriers for sustainable eHealth infrastructures

1. What are the social related factors (*facilitators and barriers*) for sustainable eHealth solutions?

Individual:

- Probe: related to attitude, education, age, sex, and experience of users
- Probe: related to usefulness, motivation and ease of use of the technology
- Probe : related to users acceptability
- Probe : related to users ICT skill and knowledge
- Probe : related to users confidence to work on eHealth solutions

Social influence

- Probe: related to peer groups or social networks influence
2. What are the economic related facilitators for sustainable eHealth solutions?
 - Probe: profitability, affordability, funding
 - Probe: availability of initial investment
 - Probe: availability of budget for maintenance, training and monthly internet service fee
 3. What are the economic related barriers for sustainable eHealth solutions?
 - Probe: Scarcity of resources (such as ICT infrastructures)
 4. What are the technology related facilitators for sustainable eHealth solutions?
 - Probe: in terms of enhancing information sharing within and across health facilities
 5. What are the technology related barriers for sustainable eHealth solutions?
 - Probe: in terms of privacy and security related
 - Probe: in terms of customizable design features, interoperability
 6. What are organizational or system related factors (facilitators and barriers) for sustainable eHealth solutions
 - Probe: related to organizational structure, procedure, culture, rules, values
 - Probe: related to availability of financial, material and human resources allocation
 - Probe: related to ICT infrastructure (such as: availability of internet access and networking)
 - Probe: related to management support and supervision
 - Probe: related to leadership
 - Probe: related data archiving (easily accessing of data when there is need)

- Probe: related to workflow process
- Probe: related electrical power (no electrical power, no electric alternative source, frequent interruption, poor electric installation)

III. Facilitators and barriers for trustable eHealth infrastructures

1. What are the factors (facilitators and barriers) related to users trust in the eHealth solutions?

Probe: users trust in healthcare professionals on eHealth solutions

Probe: users trust in their treatment

Probe: trust in the care organization that provides the technology

Probe: trust in the technology (including safeguards for data loss, perceived control)

Probe: Weak in data security and privacy in the technology

2. With regard to system quality, how do you see the technical soundness or technical success of the eHealth solutions?

Probe: explain in terms of the quality of eHealth solution outputs

3. How do you see the level of the overall support (facilitators and barriers) delivered to end users to meet their expectations?

Probe: Explain in terms of service quality provided by eHealth solutions

4. How do you judge the coordination of different healthcare teams to work together and achieve the organizational goal?

Probe: Could you tell me some points that can facilitate the coordination of healthcare teams to work together and achieve the organizational goal?

Probe: Could you tell me some points that can affect the coordination of healthcare teams to work together and achieve the organizational goal?

5. How do you see the culture of information utilization obtained from eHealth solutions?

Probe: in terms of data collection, analysis, and use of information for decision-making

6. Do you trust the sustainability of the existing infrastructure to implement eHealth solutions?

Probe: in terms of electric power and ICT infrastructure

7. How do you see the financial capacity of the healthcare organization to invest in eHealth systems?

Probe: explain the allocated budget in terms of adequacy

8. How do you see end users' perceptions to accept and use the e-health solutions?

Probe: in terms of data exploitation and training

Probe: in terms of attitude, willingness and personal demography

9. What are the technologies related factors?

Probe: in terms of security, accessibility, information quality and time

Thank you!

Annex 2: Demographic characteristics of respondents

Table A: Demographic characteristics of participants (Tunisia)

Code	Age group (in year)	Sex	Level of education	Prof experience (in years)
PT01	46 and above	Male	PhD in Medicine	26
PT02	46 and above	Male	PhD in Medicine	20
PT03	36-45	Female	PhD in Medicine	5
PT04	46 and above	Female	PhD of Medicine	35
PT05	46 and above	Male	PhD of Medicine	-
PT06	36-45	Male	Computer engineer	7
PT07	46 and above	Male	PhD in Medicine	30
PT08	46 and above	Male	PhD in Medicine	16
PT09	18-29	Female	Diploma of License in nursing	2
PT10	36-45	Female	PhD in computer science	5

Table B: Demographic characteristics of participants (Ethiopia)

No	Age group (in year)	Sex	Level of education	Prof experience (in years)
PE01	36-45	Male	MBA in ICT	14
PE02	26-35	Male	BSc. in Computer science and Information Technology	12
PE03	36-45	Male	MSc. In Computer science	15
PE04	36-45	Female	BSc. Nurse	18
PE05	26-35	Male	MSc. in Health Monitoring and Evaluation	10
PE06	26-35	Male	BSc in IT	4
PE07	26-35	Female	MPH in Nutrition	7
PE08	36-45	Male	MSc	12
PE09	26-35	Male	MSc	10
PE10	26-35	Male	MPH	12
PE11	26-35	Male	BSc in computer science	9
PE12	26-35	Female	MSc	10
PE13	36-45	Male	MSc	14
PE14	26-35	Female	BSc	6
PE15	36-45	Male	MSc	20

Table C-: Demographic characteristics of participants (Ghana)

No	Age group (in year)	Sex	Level of education	Prof experience (in years)
PG01	36-45	Male	Tertiary	10
PG02	36-45	Male	Tertiary	15
PG03	36-45	Male	Master's Degree	16
PG04	26-35	Male	Tertiary	7
PG05	26-35	Male	Tertiary	10
PG06	26-35	Male	Tertiary	10
PG07	26-35	Male	Tertiary	7
PG08	46 years and above	Male	Tertiary	20
PG09	18-29	Male	Tertiary	7
PG10	46 and above	Male	Diploma	23
PG11	46 and above	Male	Masters in IT management	7
PG12	36-45	Male	BSc in IT/Certificate as a Microsoft certified systems engineer	11
PG13	36-45	Male	Tertiary	>15

Table D-: Demographic characteristics of participants (Malawi)

No	Age group (in year)	Sex	Level of education	Prof experience (in years)
PM01	26-35	Male	BSc.	8
PM02	36-45	Male	MSc.	15
PM03	26-35	Male	Diploma in Clinical Services	9
PM04	36-45	Female	MSCE (Malawi School Certificate of Education)	18
PM05	26-35	Female	MSCE (Malawi School Certificate of Education)	4
PM06	36-45	Female	MSCE (Malawi School Certificate of Education)	14
PM07	36-45	Female	MSCE (Malawi School Certificate of Education)	17
PM08	36-45	Male	BSc. Environmental Health	16
PM09	26-35	Male	MSCE (Malawi School Certificate of Education)	5
PM10	46 and above	Male	MSCE (Malawi School Certificate of Education)	28
PM11	18 - 25	Female	Diploma in Clinical Services	9
PM12		Female		

Annex 3: Summary sheet table

Name of regional Hub	List of organization involved for this interview	Data collection duration		Criteria for selection	Challenges encountered	Strategies used to resolve the challenges
		# of days	#in minute			
North African regional hub (Tunisia)	<ol style="list-style-type: none"> 1. University Hospital Center Habib Bourguiba 2. Ministry of Health 3. University Hospital Center Hedi Chaker 4. Regional Directorate of Health of Sfax 5. Errachid Polyclinic 6. Home-Spital 7. DACIMA consulting 8. Digital Research Center of Sfax 	39	Min= 35 Max=121 Ave=83	We have selected government (Healthcare facilities) and non-government organizations (Polyclinic and Healthcare technology Startups) to cover both public and private healthcare sectors in Tunisia. For each organization, we have selected participants with ICT skills or participants with ICT experience. We have chosen young and elderly participants.	We have encountered several challenges regarding finding collaborative and available participants to do interviews. Indeed, we have contacted more than 23 participants and have done only 10 interviews. This can be explained by the fact that eHealth implementation in Tunisia is still in the beginning. Further, several people have refused to participate because they found the guiding questions difficult.	We have contacted many people for each kind of participants.
West Africa (Ghana)	<ol style="list-style-type: none"> 1. Greater Accra Regional Hospital 2. Greater Accra Regional Hospital 3. West Africa Programme to Combat Aids and STI (WAPCAS) 4. Greater Accra Regional Hospital 5. National Public Health And Reference Laboratory 6. Christian Health Association of Ghana (CHAG) 7. Greater Accra Regional Hospital 8. Greater Accra Regional 	20	Min= 90 Max=150 Ave=120	According to the research protocol	Challenges in organization selection: N/A Challenges in the data collection: the busy scheduled of the participants, the questionnaire is very comprehensive and need a lot of time to administer	Re-schedule the meetings, administration of interview during 2 sections etc.

	<p>Hospital</p> <p>9. VENDOR</p> <p>10. 37 Military Hospital</p> <p>11. National Information Technology Agency (NITA)</p> <p>12. National Blood Transfusion Services</p> <p>13. Ministry Of Health</p>					
Central and East Africa (Ethiopia)	<p>1. Felege Hiwot Referral Hospital</p> <p>2. Bahirdar Health Center</p> <p>3. Amhara Regional Health Bureau</p> <p>4. Ethiopian pharmaceutical and supply agency- Gondar branch</p> <p>5. Gondar comprehensive specialized hospital</p> <p>6. Selam Health Center</p> <p>7. Orbit private co.</p> <p>8. Oromia Regional Health Bureau</p> <p>9. EPSA</p> <p>10. EPHI</p> <p>11. DHA/JSI</p> <p>12. PSFA</p> <p>13. Federal Ministry of Health</p> <p>14. Salam Health Center</p> <p>15. Oromia Health Bureau</p>	5	<p>Min= 21</p> <p>Max=76</p> <p>Ave=40</p>	<p>- Their deep experience in adopting and using e-Health technologies like EMR, Smart care and pharmaceutical logistics management system</p> <p>- Their deep experience in administering organizations that have e-Health technologies</p> <p>Purposive</p>	<p>- I have no challenge except some difficulty to get the interviewee due to their work burden.</p> <p>- Absence of interviewee</p> <p>- Time shortage to answer all interview questions</p>	<p>- Appointed them by their convenient time</p> <p>- Appointment preceding the data collection data</p> <p>- Attempted to address all</p>

<p>Southern Africa (Malawi)</p>	<ol style="list-style-type: none"> 1. Last Mile Health/Digital Health Department 2. Community Health Department 3. Nthondo Health Center 4. Kamsonga Health Center 5. Khuwi Health Center, Ntchisi District 6. Malomo Health Center 7. Dziwe Health Center 8. Zomba District Health Office 9. Bua Health Center 10. Dwangwa Health Center 11. Mwanza TDC Group Discussion 	<p>21</p>	<p>Min =24 Max = 120 Avg = 45</p>	<p>- involvement with eHealth at different levels, policy, development, deployment and for most of them as users. Some of the users based at hard to reach areas where connectivity and power is a challenge.</p>	<p>- Some interviewees at policy level did not return the questionnaires - Most respondents were not able to complete all the questions</p>	<p>- for most respondents, a face-to-face interview was conducted</p>
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Annex 4: Summary table for sustainable and trustable eHealth solutions

Table 1: Identified facilitator and barriers for sustainable and trustable eHealth solutions summary table (Tunisia)

No	Identified theme	Facilitators	Barriers
1	Individual or user-Related	Age, user's ICT skill and knowledge, user's awareness of eHealth solution, user's ICT skill and knowledge	User's age, resistance to change and lack of ICT skills and knowledge, Non availability of adequate and continuous technical support
2	Human resource and capacity building	Support, training and availability of ICT experts, availability of adequate and continuous training	Lack of support, lack of training, lack of human resource, lack of competency and skillful
3	Economic related	Availability of budget, profitability	lack of adequate budget, the need of high initial cost
4	Infrastructure related	Availability of adequate infrastructure	lack adequate ICT infrastructure, lack of trust on existing ICT infrastructure
5	Organization related	availability of planning, having appropriate organizational strategy, availability of information use culture, having validated eHealth solution and availability of need assessment	poor administration and coordination and weak culture of information use
6	Technology related	ease of use of the technology and comply with data security and standards	lack of data security, privacy and confidentiality, lack of interoperability and need for initial face to face contacts
7	Policy and legislation related	availability of policy and legislative frameworks	lack of adequate legislative framework

Table 2: Identified facilitator and barriers for sustainable and trustable eHealth solutions summary table (Ethiopia)

No	Identified theme	Facilitators	Barriers
1	Individual or user-Related	- Age, sex, education, attitude, awareness, digital literacy and commitment, end user's positive attitude, willingness, previous exposure and acceptability towards the eHealth solution	reported lack of trained manpower, low digital literacy, lack of commitment/motivation, knowledge and skill gap, lack of trust on the technology, resistance to change, negative attitude and fear of technology
2	Human resource and capacity building	availability of adequate manpower, availability of technical personnel, availability of IT experts and availability of adequate training	shortage of manpower, staff turnover, lack of technical support, low digital literacy, misallocation of human resource and inadequate capacity building activities
3	Economic related	Adequate budget allocation, affordability and profitability of technologies	that lack of adequate budget and donor dependency
4	Infrastructure related	availability ICT infrastructures such as availability of reliable internet connection, availability of backup and recovery tools, availability of LAN connectivity and better storage and memory capacity computers	lack of infrastructures, limited capacity of ICT infrastructure, frequent power interruption, poor electric installation and poor internet connectivity
5	Organization related	availability of leaders' support, organizational readiness, conducive environment and availability of organizational structure, availability of discussion, availability of system	Low culture of information utilization, lack of homegrown systems, lack of system integration, delayed bidding and procurement

		requirements, creating sense of ownership and end-users involvement	processes, lack of leadership support and lack of incentives
6	Technology related	user-friendly of the system, system ownership, availability of strong data security, availability of data privacy and confidentially	lack of interoperability, system immaturity, lack of user requirements, system immaturity, system complexity and central administration
7	Policy and legislation related	availability of system governance and legislation	lack of accountability, lack of policy and legislation and lack of standard

Table 3: Identified facilitator and barriers for sustainable and trustable eHealth solutions summary table (Ghana)

No	Identified theme	Facilitators	Barriers
1	Individual or user-related	age, education, experience, motivation, IT skill, and user's perception and confidence, end users' positive attitude level of knowledge and acceptability towards the eHealth solution	Fear of the technology among end-users, lack of knowledge or low digital literacy, Lack of acceptability
2	Human resource and capacity building	Availability of trained human resources, training opportunities, and sufficient budget running the capacity building activity, availability of skilled personnel in ICT, the availability of capacity-building training	Lack of skill, inadequate number of staff
3	Economic related	Availability of adequate budget and presence of financial support	scarcity of financial resources, high cost
4	Infrastructure related	Reliable electric supply, access to the	Network switch, inadequate

		internet, backup sources of power using UPS and generators	LAN coverage, poor electric installation, material damage due to power spark, continuous electric interruption and outage
5	Organization related	reliable electric supply, access to the internet, backup sources of power using UPS and generators, Accessibility of IT solutions, the practice of doing feasibility assessment before the deployment of digital solutions, organizations with material and management support, leadership engagement, necessary infrastructure, and good workflow	Network switch, inadequate LAN coverage, poor electric installation, material damage due to power spark, and continuous electric interruption and outage, lack of access to information, organizational structure and procedure, and staff motivation.
6	Technology related	usefulness of the digital solution, availability of software, quality of digital solutions, and systems easy for use, health workers and administrators in the healthcare system	weak data security and privacy, complexity of software, inability of systems to share information among users, and lack of system maintenance

Table 4: Identified facilitator and barriers for sustainable and trustable eHealth solutions summary table (Malawi)

No	Identified theme	Facilitators	Barriers
1	Social related	User's sense of ownership, dedication, motivation, users' skill, collaborative culture, attitude, willingness and personal demography	Lack of ownership by users Lack of digital skills Laziness Attitude
2	Economic and infrastructure related	Availability of good network, availability of power, adequate budget for initial investment and maintenance cost, availability of technical expertise	Reliance on donor funds Under budgeting for infrastructure
3	Technological related		Poor connectivity Lack of resources such as tablets, laptops Poor maintenance of equipment
4	Organization related	Availability of intensive training, having regular review meetings, having regular supervision, availability of the manuals	Lack of team work/poor coordination Lack of supervision Lack of sustained training