RESEARCH REPORT

Applying the ICT4H model to understand the challenges for implementing ICT-based health information services in primary healthcare in South Ethiopia

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Abstract

Introduction: The implementation of Information and Communication Technology (ICT) in the Primary Level Health Care (PLHC) of low-income countries is at the proof-of-concept level. Despite the wide-ranging efforts over the past 35 years, healthcare facilities are grappling with implementation; the essential health information sources are inaccessible. Consequently, the potential benefits are marred by various challenges. Therefore, the aim of this study is to explore the challenges in the implementation of an ICT-Based Health Information system (ICT-BHIS) in the PLHC facilities of Wolaita Zone, South Ethiopia.

Methods: We conducted an 8-month ethnographic study to develop and validate the Chibs ICT4H model. More specifically, a total of 160 h of observational data along with 21 key informant interviews were collected in the form of field notes and audio records. Both data were transcribed and entered into the Qualitative Data Analysis mine software version 1.4. Building on the constant comparative method of data analysis, we identified initial themes inductively, revisited the ICT4H model, and expanded and collapsed the themes prior to interpretation to generate new meaning.

Results: The findings of this study revealed that infrastructures, financial cost, technical constraints, human capital, stakeholders' engagement, and organizational commitment are the pressing challenges PLHC facilities face in the implementation of ICT-based health information services.

Conclusions: This implies the need to shift the paradigm/gaze from piecemeals of multiple solo pilot projects to a unified strategy that touches multiple buttons/challenges for the successful implementation of ICT-BHIS in the context of PLHC facilities.

KEYWORDS
challenges of ICT implementation, ethnographic design, primary level health care

1 | INTRODUCTION

A health information system based on Information and Communication Technology (ICT) contains explicit data and medical knowledge that can be held in text, audio, or video format for healthcare professionals.[1] Nowadays, health information systems are designed to manage the people, process, and technology interactions in the collection, storage, management, and use of health and health-related data.[2] Although persistent growth in the utilization of ICT has now become a characterizing component of every organizational system, the health information systems of most African countries are described as inefficient, costly, and lacking transparency.[2,3]

The sustainable use of ICT in the healthcare sector drives efficient and safe client-centric care.[3] For instance, ICT-Based Health Information system (ICT-BHIS) has the potential to be very important for healthcare facilities, even though its success is marred by various challenges.[4] The medical knowledge/information currently in Primary Level Health Care (PLHC) is inaccessible and sometimes difficult to understand due to the poor method of storing and retrieving health information.[5] The translation of its benefits and implementation in the sector has been very slow and challenging.[5]

Despite the wide-ranging efforts over the past 35 years, healthcare facilities in low-income countries are lagging behind other sectors and grappling in terms of implementation.[5] More importantly, the incapacity to get the necessary ICT continues to be a pressing problem in the PLHC sector.

ICT-based health information services mean the use of computers and other digital and electronic devices to facilitate the delivery of health services. Basically, the application of ICT in healthcare, such as Telemedicine, Electronic Health Records (EHR), District Health Information System two (DHIS-II), and other e-health applications helps in addressing the shortage of healthcare providers in low-income countries and provides access to high-quality health information to improve care. Thus, it has the potential to lower healthcare costs[6] and, healthcare providers can collaborate more easily when distance is a key factor.[7] Further, the use of mobile applications by health extension workers in Ethiopia is deemed to be an efficient and groundbreaking opportunity to keep longitudinal community data records.[2]

Many developing countries, including Ethiopia face plentiful challenges in implementing ICT interventions. The implementation tends to be solo and donor-driven, in unsustainable piecemeals of pilot projects.[6] For instance, most ICT in health applications deployed in Ethiopia are not based on the needs of healthcare providers in the PLHC facilities. The Federal Ministry of Health of Ethiopia began the process of integrating all ICT solutions in the health sector by commissioning neither a systematic nor a fully strategic framework for delivering eHealth and mHealth interventions to the population.[2] As a result, the presented ICT-BHIS implementation frameworks in Ethiopia, such as the deliver project, Logistics Management Information System (LMIS), Supply Chains for Community Case Management of Pneumonia and Other Common Diseases of Childhood (SC4CCM), eHealth, mHealth, and other interventions, were less sustainable and less cost-effective.[8]

The most frequently vented problems that refute the implementation of ICT-based health information services in the healthcare sector include, but are not limited to, issues of infrastructure, such as electricity supply, computers, and other hardware and software; financial costs of ICT equipment; and technical challenges related to problems of standardization and interoperability.[9] In addition, the competencies of potential users, technology compatibility, and policy provisions are discussed as challenges.[6] Previous research highlighted, consistent with the developed countries' individual characteristics (ICT attitude and ICT competence), the major challenges of ICT-based health information services in Ethiopia.[10] Another research conducted by Chibs conceptualized the various challenges in the implementation of ICT-BHIS in four dimensions using the ICT4H conceptual framework.[11] The ICT4H framework primarily discusses the challenges from infrastructural, technological, socio-cultural, and economic perspectives. Consequently, building on the ICT4H conceptual framework and other relevant literature, we argue that the implementation also relies upon other unique individual and organizational factors. For instance, lack of interoperability, digital literacy, connectivity, slow technology adoption, and health IT workforce shortage are other locally important challenges slowing down efforts on ICT-BHIS implementation.[12,13]

Although strong infrastructure, finance, technical capacity, ICT competence, stakeholders' engagement, and favorable ICT policies and procedures are paramount for the successful implementation of ICT-based health information, there are locally relevant bottlenecks that should be explored. Thus, the primary aim of this research is to explore the challenges in the implementation of ICT-BHIS in the PLHC facilities of Wolaita Zone, South Ethiopia.

2 | METHODS AND MATERIALS

This study employed an ethnographic research design to explore the challenges in implementing ICT-based health information services in PLHC facilities context. Building on the theoretical belief that reality is socially constructed, we followed the interpretive research paradigm. In this study, the Chibs ICT4H model was used as a theoretical framework to deductively synthesize the data. The model proposes four types of challenges/barriers in the implementation of ICT-BHIS, namely, infrastructural, social, technological, and economic barriers.

2.1 | Settings and gaining access to a community

The Southern Nation and Nationalities Peoples Representative are one of the 11 regions in Ethiopia. The region has more than 15 administrative zones. Wolaita Zone is the largest zonal administration in terms of population and healthcare service delivery. According to the zonal health department report, there were 69 PLHC facilities.[14] The PLHC facilities and health professionals found in Wolaita Zone, such as the Wolaita Sodo Town health center and the Bedessa District health center, were purposefully selected because they have a history

of implementation of various ICT-based health information services and are used as pilots for testing different health-related innovations in the zone.

The principal researcher contacted various professionals in the field and attended informal meetings to initiate and sustain desirable relationships with the selected primary points of contact that facilitated access and assisted their understanding of the group. In this study, the key informants interviewed were mainly Health Informaticians (HI), Laboratory Technologists (Lab), Pharmacists (Pharmacy), Health Extension Workers (HEW), Medical Doctors (MD), Health Officers (HO), Midwifery (MW), Head of the Health Center (HoH), Environmental Health (EH), and Nurses. PLHC facilities were used as a context to frame the challenges based on the professional experience above.

2.2 | Field study methods

In this study, the principal researcher framed a considerable 8 months of participant observation and triangulated it with a total of 160 h of observational data along with 21 key informant in-depth interviews. The interviews were audio recorded, and field notes were taken at both study locations to clarify the meanings. As a pure observer, the researcher did not participate in the actions. The key informant in-depth interview guide and observation tools were developed according to the larger research question of this study, what are the challenges of ICT-BHIS in PLHC facilities. Accordingly, we reviewed various studies and outlined the broad areas of knowledge that are relevant while constructing the questions to fit the particular kind of respondents. To tap into study participants' lived experience in PLHC settings, the broad knowledge areas proposed in the Chibs ICT4H model (economic, infrastructure, socio-cultural, and technological challenges) were used to frame the interview questions.[11]

2.3 | Data analysis

The analysis of observational data, field notes, and in-depth interviews was started in the field. The first author listens to the audio recorded, reads, and re-reads the field notes collected and transcribed. The Qualitative Data Analysis mine software version 1.4 was used for further coding and analysis of data[15] To be more precise, we created initial codes (highlighting meaningful terms in a text and coding them), reviewed those codes, and grouped them into sub-themes and themes. In addition, striking field notes and quotes are linked to the ICT4H model to provide a narrative account of the challenges of ICT-based health information services. For details, see Table S2 under the Supporting Information tab. Building on the constant comparative method of data analysis, we identified initial themes inductively, revisited the ICT4H model, and expanded and collapsed the themes prior to interpretation to generate new meaning.

3 | RESULTS

This study highlighted the deep-rooted challenges in the implementation of ICT-BHIS peculiar to primary level healthcare facilities. The inductively enriched in-depth interviews and observation field notes of the current study are linked to the challenges proposed by the ICT4H model.[11] Furthermore, the current study suggests considering additional variables unique to PLHC settings as challenges to be faced for the successful implementation of an ICT-BHIS. These are electric power outages, project-based, and unsustainable solo ICT interventions, a lack of integration of ICT in pre-service curricula of health science education, and the traditional bureaucratic professional hierarchy (see Figure 1 and Table 1).

The model (ICT4H) based analysis of challenges in PLHC settings in Wolaita Zone, Ethiopia, resulted in the emergence of themes and sub-themes unique to primary-level health facilities. These are infrastructure, cost, human capital, stakeholders' engagement, and technical and organizational level challenges.

3.1 | Theme 1: Infrastructure

In this study, the ICT components that are required to operate the various types of ICT-BHIS in PLHC settings, such as hardware (equipment), software, networking devices, and electricity, are inductively coded, categorized, and thematized as infrastructures. Although there are solos throughout the field stay, it was learned that infrastructure is the basic minimum that should be available to facilitate ICT-based healthcare delivery.

3.1.1 | Sub-theme 1.1: Hardware (equipment)

The equipment used to deliver ICT-based health information services in the context of PLHC settings, such as desktop computers, laptops, and mobile phones, is labeled as hardware/equipment. However, the limited availability of this equipment is found to be one of the most pressing challenges in implementation. For instance, field observation discerned that:

> There are few desktop computers in both health centers studied. Most of the available computers lack either a keyboard or a mouse and are not functional. For example, in one of the health centers, there are only three functional desktop computers. Of these, the two is in the medical record room and are used to register patient personal and medical information into the electronic medical record system. The other is found in the health informatics department and shared by the head of the health center. (Field note 2: September 9, 2019)
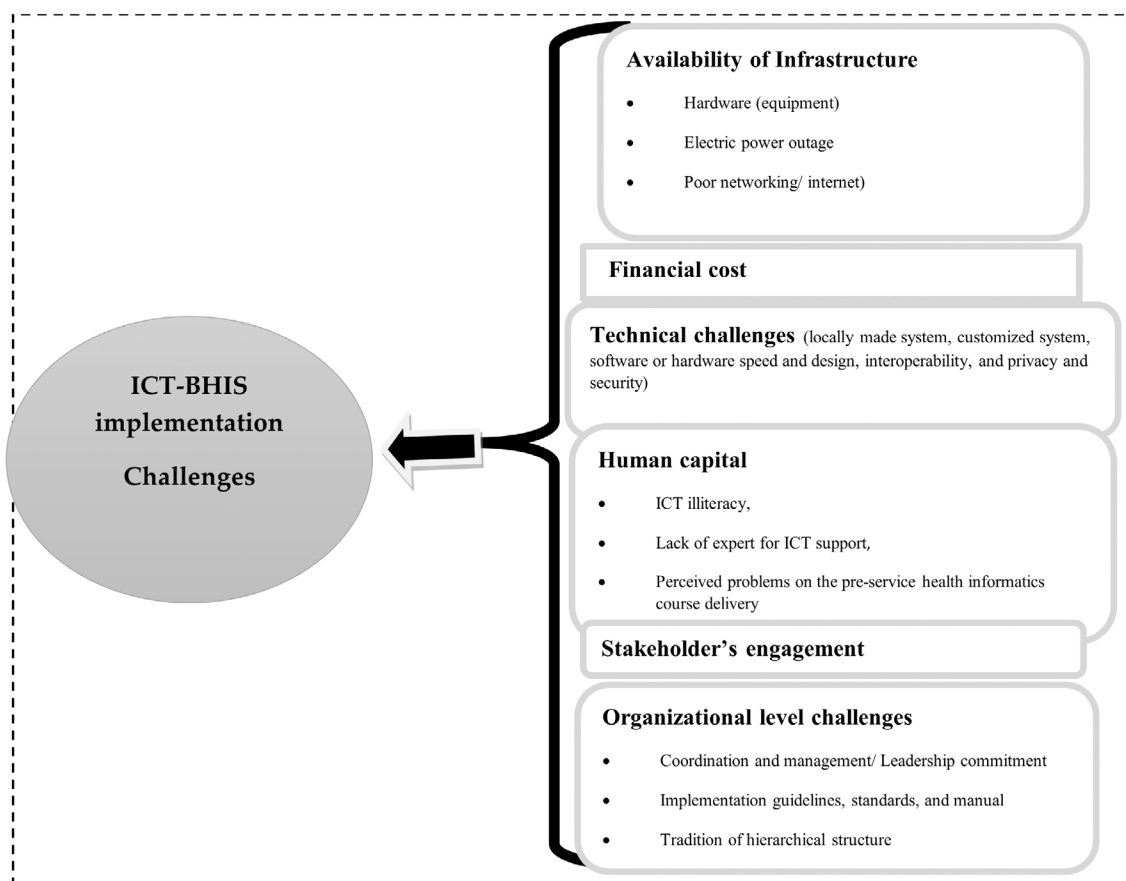
FIGURE 1   Proposed theoretical framework. *Source*: Adapted fromReference [11]

3.1.2 | Sub-theme 1.2: Electric power outage

The unstable and poor electricity supply is proving a major challenge to the implementation of ICT-BHIS in PLHC settings. It must be noted that, despite the many laudable policies initiated in the past, the poor electricity supply in Ethiopia is proving a major challenge in PLHC settings. In a nutshell, access to electricity is a primordial provision for the successful implementation of ICT-BHIS in PLHC settings. For instance, the following quote summarizes the situation:

> "The erratic and trickle electric power supply made the poorly developed ICT infrastructures of health centers totally not functional. It is disgusting, what if we have a standby generator in the health center and if the higher officials reduce the unnecessary expense in the name of per diem and transfer it to the purchase of fuel." (Lab 1)

3.1.3 | Sub-theme 1.3: Poor networking/internet

The internet connection is one of the critical ICT infrastructures that enable healthcare providers to have access to online medical data-bases, decision support systems, some features of DHIS-II, and other

ICT-BHIS. However, it must be noted that there is poor to no access to the internet connection in the PLHC settings of the studied area. For example, from the field observation, it was learned that:

> An ethernet cable is installed in every room but the wires are exposed by terminations. There is no modem. However, there is unstable and poor wireless network. The wireless network access point is damaged. It was observed that healthcare providers leave their office and stand near the wireless access point and struggle with their phones. (Field note 4: September 21, 2019)

3.2 | Theme 2: Cost

The financial cost of starting up, maintaining, and upgrading ICT-BHIS is one of the challenges in the implementation of ICT in primary-level health units. In this study, it is noted that the already installed ICT infrastructures, such as broadband internet and WI-FI, DHIS-II, elec-tronic medical records, and others are derailed by budgetary limita-tions and the associated bureaucracy of approving expenditures. The key informants highlighted the budget constraint as a challenge. Fur-thermore, the findings of a meeting during the field observation sup-ported the interviews. Based on the empirical information we

TABLE 1 Definition of variables used in the proposed theoretical model

Variable	Definition
Infrastructure	The ICT components that are required to operate the various types of ICT-based health information services in PLHC settings such as hardware (equipment), software, networking devices, and electricity.
Financial cost	The amount of money required for starting up, maintaining, and upgrading ICT-based health information services.
Technical challenges	Technology-related conditions or events such as software or hardware speed and design, interoperability, and privacy and security prevent an ideal solution to end users (healthcare providers).
Human Capital (resources)	The intangible collective resources possessed by the PLHC facilities, such as ICT literacy, experts for ICT support, and pre-service education.
Stakeholders' engagement	The active involvement of an individual, group, or organization that has an interest in the implementation of various technology in health. Accordingly, ICT focal persons, non-governmental organizations, Wolaita Sodo University, the district health office, and the Zonal health department are identified as the key stakeholders.
Organizational level challenges	The health center's leadership commitment, availability of local ICT implementation guidelines and manuals, and the deep-rooted tradition of the hierarchical structure remain operational as the organizational level changes.

gathered from the field (see Table S2 under the supporting information table S1), one can note that formally the budget is not allocated by the PLHC facilities, but still the actual cost for ICT-BHIS is an implementation challenge.

3.3 | Theme 3: Technical challenges

The implementation of ICT-BHIS in PLHC settings should consider technical constraints, such as software or hardware speed and design, interoperability, privacy, and security. In this study, it was observed that there is a plethora of various ICT-based applications that can be potentially implemented in PLHC settings. However, technical issues limit the successful implementation. For instance, key informants reflected:

> "I remember the implementation of a mobile health application called Enat Messenger. The Health Extension Workers (HEW) has given Nokia 2700 mobile phones with solar chargers, and it is a web-based application with databases. However, during

implementation, there were interruptions to the system and unplanned down times." (HI 3)

The aforementioned challenges of implementation could be explained because of the technical constraints, probably linked to the software or hardware design and the inappropriate development tools. The other important technical challenge identified in the PLHC settings of the studied area is the inability of different ICT-BHIS to readily connect and exchange health information (interoperability). In this study, it was observed that:

> There are multiple sources of health information generated through various ICT-BHIS. For instance, EHMIS, DHIS-II, eCHIS, EMR, mBrana, Dagu, and others. However, these data sources or systems are not interacting together. In addition, the digital data collection tradition is in its infancy in the PLHC context. Therefore, healthcare providers in the PLHC settings find it complex or demanding to abstract constructive information. (Field note 11: 12 Nov 2020)

For example, the Dagu project, aiming to develop Ethiopian excellence in public health evaluation and advance the quality and utilization of primary and community-based healthcare services is primarily developed by the London School of Hygiene & Tropical Medicine; the mBrana mobile-based inventory management system is developed by Gavi, the vaccine alliance; and Enat Messenger, to increase the retention of women in antenatal care to ensure delivery at a health center, is developed by the Clinton Health Access Initiative. From the above information, it must be noted that there are silos of multiple ICT projects that are not aligned, which hinders the successful implementation of ICT-BHIS.

In this study, the issue of privacy and security of health information held digitally is reflected as a minor challenge for the implementation of ICT-BHIS. For instance, key informant reflected:

> "In my thinking and level of understanding... I don't believe the data we have in the DHIS-II or eCHIS are valuable enough to be stolen by cybercriminals. Because our data are incomplete and lacks multiple information for key variables due to several reasons related to data collection." (EH 3)

Although not all primary-level healthcare providers vented the notion of privacy and security as a challenge, a few healthcare providers and HI highlighted the need to consider it.

3.4 | Theme 4: Human capital

In earlier times, healthcare providers were required to have the necessary competencies in clinical and public healthcare services. However,

at these times, they need to have additional ICT competencies for the successful delivery of primary-level care. In this study, it was learned that the ICT/digital age has completely brought about a different way of providing primary-level healthcare services. For instance, PLHC facilities are using an EMR system to register patient personal information that was previously done fully on paper, DHIS-II for providing and tracking comprehensive health information, decision support systems to assist with diagnosis, and various mobile based applications to improve the health status of the community, such as mBrana, eCHIS, Enat Messenger, and so forth. Ironically, this study highlighted computer/ICT illiteracy, the absence of experts/professionals for ICT support, and poor instructional design as implementation challenges for ICT-BHIS in PLHC settings.

3.4.1 | Sub-theme 4.1: ICT illiteracy

ICT and/or computer illiteracy are observed to be one of the key challenges for the successful implementation of ICT-BHIIS in PLHC settings. In this study, it is conceptualized as the inability of primary-level healthcare providers to easily utilize a variety of ICT devices available (eg, desktop computers, smartphones) and interfaces (eg, DHIS-II, EMR, eCHIS), and mHealth applications (Enat Messenger, Mbrana) in order to improve healthcare. Both field observation and in-depth interview findings are highlighted as follows:

> "I am tired of hearing the importance of ICT application in health. Now, I want to realize the benefit at large. However, most of my colleagues are refusing to face the onslaught of ICT in our facility. If this is not addressed, I fear there will be a new healthcare team of specialized ICT illiterates." (MD 5)

Accordingly, from the field observation, it was noted that:

> Health extension workers have been ignoring notifications to update eCHIS software they use every day. The health informatician, record officers, and a few healthcare providers using DHIS-II have been demonstrating a lack of basic technical skills to solve simple and routine hardware and software problems. Rather, they usually complain about the absence of technical support from the Zonal health department or woreda/district health office (Field note 16, April 23, 2021)

3.4.2 | Sub-theme 4.2: Lack of expert for ICT support

The other important challenge for the implementation of ICT-BHIS in PLHC settings was the absence of technical support. In this study, key-informant interviews and field observation findings consistently

suggested a lack of experts to support troubleshooting ICT-related challenges. The observation findings are depicted as follows:

> It was observed that multiple healthcare providers are complaining of various technical issues on different occasions. The complaints vary and are specific to each healthcare provider who use the technology. For instance, on one of the working days, the midwife complained about the technical problem she faced while using DHIS-II and she is not able to troubleshoot. She mentioned the need for support to accomplish the assigned duties. Similarly, the health extension worker reflected on multiple occasions where the mobile phone for the implementation of eCHIS was stacked. On such occasions, she stops working on the mobile phone and waits for days to fix the problem. (Field note 17, April 29, 2021)

3.4.3 | Sub-theme 4.3: Perceived problems in the pre-service health informatics course delivery

In the pre-service healthcare professionals' training, there is a dedicated course dealing with various health technologies and their implementation in healthcare service delivery. According to this study, the course [health informatics] is delivered as part of a freshman course during the start of academic training. Furthermore, the key informants highlighted that the delivery of health informatics courses is mainly theoretical, and there is no chance to develop the skills and create connections in the ideal time [pre-service education]. For instance,

> "When I was in University, I had the chance to attend a course on health informatics. The course goals, objectives, and contents are inspiring and linked to real-world experience. However, the course instructor finished the course by delivering the theory only." (MD 1)

3.5 | Theme 5: Stakeholder's engagement

This study discerned healthcare providers, ICT focal persons, non-governmental organizations, Wolaita Sodo University, the district health office, and the Zonal Health Department as the key stakeholders in the implementation of ICT-BHIS. Their engagement in every endeavor of ICT-BHIS in the PLHC setting is paramount for successful and sustainable implementation. However, it must be noted that there is on- and off-base engagement of stakeholders as shown below:

> "What surprised me is that everything associated with ICT implementation in our health center is a campaign for one month. The NGOs with zonal health department office holders visit the health center on the first

day and gave us a smartphone in the second day. With only a brief introduction to the system, we are forced to collect health information using the mobile phone [eCHIS]. There is no consistent follow-up and support." (HEW 2)

Furthermore, the field observation findings consistently highlighted poor stakeholders' engagement as a challenge in the implementation of ICT-BHIS in PLHC settings.

> From the direct observation, it was learned that: There is no instilled mechanism to identify the different stakeholders from the PLHC sides. For example, there are eight computers dumped in the store that are supported by Wolaita Sodo University. The internet cable trees supported by the NGOs are broken, and the wires are torn out. There is no official form of communication such as a memorandum of understanding between NGOs, Universities, and the PLHC facilities on the issues of implementation of ICT-based health information services. (Field note 19, April 3, 2021)

3.6 | Theme 6: Organizational level challenges

In this study, the PLHC facility as an organizational entity has its own level of challenges in the implementation of ICT-BHIS. The most striking sub-themes categorized under the organizational level challenges are issues related to health center leadership commitment, availability of local ICT implementation guidelines and manuals, and the deep-rooted tradition of hierarchical structure.

3.6.1 | Sub-theme 6.1: Coordination and management/Leadership commitment

Most of the healthcare providers in PLHC settings argue that health center leadership determines how ICT-BHIS is implemented and its subsequent impact on health service delivery. From the field observation, it was learned that the positive attitudes of the heads/leaders of PLHC, the zonal health department, and the district health office toward the implementation of the ICT-based health system encouraged the healthcare providers to be actively involved in the implementation. For instance:

> The head of health center one (HoH 1), although he is relying on the government and NGOs to equip the health center with ICT infrastructure, is sensitizing all healthcare providers to use the DHIS-II and strives to allocate budgets for training that would promote implementation. For example, he organized a one-day refresher training on DHIS-II utilization in collaboration

with the district health office ICT focal persons. (Field note 21: January 5, 2021)

On the contrary, the other striking finding that must be noted from this study is the lack of clear visions and strategic plans for implementing ICT-BHIS in the context of PLHC. The key informants' reflections are summarized as follows:

> "… as far as my knowledge is concerned the healthcare leadership ideally should craft a vision that empowers healthcare providers in using specific ICT-BHIS. However, this not happened in our case. Even we are not allowed to think out of the box and exploit the opportunities brought via technology" (MD 3)

3.6.2 | Sub-theme 6.2: Implementation guidelines, standards, and manual

In this study, the lack of locally relevant ICT-BHIS implementation guidelines, manuals, and standards was vented as a major bottleneck for successful implementation. From the field observations, it was noted that:

> In studied PLHC facilities, district health offices, and Zonal health departments there is no written ICT-BHIS implementation guideline or manual. (Field note 20: December 4, 2020)

3.6.3 | Sub-theme 6.3: Tradition of hierarchical structure

In this study, healthcare providers identified themselves in the various hierarchical structures depending on their professional background and division of labor. The hierarchy in PLHC settings becomes a battleground between professionals. Accordingly, it was observed that the hierarchization and associated tensions, unfortunately, contributed to the negative attitudes and thereby bias in the implementation of ICT-BHIS, as shown below:

> It was observed within a group of Nurses while they were trying to define what the field is and preserve certain privileges as a nurse. They were claiming and viewing new technologies with distrust and fearing the anticipated challenges to their professional status.

4 | DISCUSSIONS

This study describes the results of an in-depth exploration of the challenges of ICT-BHIS implementation in the PLHC settings of Ethiopia,

which show resources such as trained human power, infrastructure, and finance; technical issues; organizational factors; and poor stakeholders' engagement as the most pressing challenges. This suggests that, although the current finding builds on existing evidence from the Chibs (2010) ICT4H model, it discerns the PLHC facilities' unique and specific challenges, such as poor internet connectivity, electric power outages, donor-based unsustainable solo support, lack of experts, and leadership commitment.[11,12]

The possible explanation could be the lesser attention given to PLHC by top-level management and the associated bypassing of the referral chain to specialized hospitals by service users. More specifically, in the context of Ethiopia, PLHC facilities are bypassed by users, and the resources are underutilized. Thus, there is a demonstrated tendency by the government to equip secondary and tertiary level facilities via various ICTs as compared to PLHC facilities.[14] Drawing attention from the Chibs (2010) ICT4H model, we claim that leadership commitment is paramount for the successful implementation of ICT-BHIS in the PLHC. Because leadership is supposed to plan, implement, and evaluate any program. According to the Kasozi and Nkuuhe report, the sustainable use of ICT in the healthcare sector drives efficient and safe client-centric care. However, in this study, it was noted that PLHC was failing to take the initiative and sustain the few pilot ICT projects by various donors.

Various works of literature have documented the inadequacy of ICT infrastructures as a core challenge for successful implementation of ICT-BHIS.[14-16] The ICT infrastructures in most developing countries are too little, too expensive, and poorly managed; as a result, ICT-BHIS becomes even less useful in PLHC facilities.[17] Consistently, the current study highlights poor infrastructure in terms of hardware equipment, networking/internet devices, and electric power outage as pressing challenges PLHC facilities are facing in the implementation of various ICT-BHIS. This could be explained in relation to the erratic and trickle electric power supply that made the poorly developed ICT infrastructures of the health center not totally functional in the study area. Furthermore, the World Bank report on ICTs for Health in Africa consistently extrapolated facility set-up and maintenance costs, poor connectivity, and insufficient access to phone hardware as a critical challenge.[16]

Several studies conducted either in Ethiopia or elsewhere concisely illustrated the cost associated with both maintaining and acquiring ICT infrastructures as the most pressing challenge in the implementation of ICT in health.[18-20] Furthermore, healthcare facilities that tried to integrate ICT into healthcare environments have faced the problem of high costs in purchasing ICT tools and maintenance.[12] Similarly, this study uncovered the financial cost of starting up, maintaining, and upgrading ICT-BHIS, which is one of the challenges in the implementation of ICT in PLHC facilities. The possible explanation could be the lack of evidence-based budgeting, heavy reliance on the few plus unsustainable piecemeals of solo project funding, and budgetary limitations and associated bureaucracy with approving expenditures for maintenance in PLHC facilities.[8,21]

The other challenge discussed both in the ICT4H model and various literature[11,22,23] is the technical constraint inherent to the ICT-BHIS. For instance, this study pinpointed technical issues such as software or hardware speed and design, interoperability, privacy, and security. More importantly, interruptions to the system and unplanned downtimes due to software or hardware design and inappropriate development tools; the inability of different ICT-BHIS to readily connect and exchange health information (interoperability), are the most vented concepts. This is consistent with the studies on the implementation of eHealth, which mention technical challenges, such as the need for flexibility and usability, and the need for the software to be fit for its purpose.[24,25] However, the issue of privacy and security of health information held digitally is reflected as a minor challenge for the implementation of ICT-BHIS. This contrasts with the popular view of securing information technology in healthcare.[5,22] The possible reason could be due to the pre-existing misconception that PLHC facilities generated data are incomplete and lacks multiple pieces of information for key variables due to their poor data collection and thus does not cater to the attention of cybercriminals.

According to various studies, the smooth implementation of newly introduced ICTs in healthcare settings is usually constrained by the scarcity of ICT literate health professionals and experienced managers.[24-27] Consistently, this study has uncovered and categorized ICT illiteracy, a lack of ICT experts for support, and perceived problems in pre-service health informatics course teaching and learning as thematic areas linked to human capital-related challenges. It must be noted that healthcare professionals are not technical nor are they technology experts; hence, they need significant training and support.[28] This could be explained by the fact that ICT-BHIS implementation in healthcare settings requires literate health professionals for its effective operation.[12]

The significance of stakeholders' analysis and their active engagement is documented as very imperative for the successful and sustainable implementation of ICT-BHIS in various studies.[8,16,17,25,29-31] and However, this study uncovered that there is no instilled mechanism to engage stakeholders who are working in the areas of ICT-BHIS to incorporate their perspectives and concerns and mobilize their expertise and skills. Thus, it was found to be one of the prevailing challenges for implementation. A possible explanation could be the practice of unsustainable and uncoordinated piecemeals of pilot projects like eCHIS, mBrana, Dagu, and DHIS-II in the context of the PLHC facilities studied. Consistently, another study documented that, the lack of a clear link between the ICT project and the healthcare facility's key strategic priorities, including agreed measures of success, is a challenge.[25]

A study conducted by Ibeneme and colleagues (2020) discussed a health facility's leadership commitment and implementation frameworks, such as guidelines and manuals as crucial factors necessary for the successful implementation of ICT in the health sector.[17] Similarly, in this study, it was observed that poor health center leadership commitment and the unavailability of local ICT implementation guidelines and manuals are bottlenecks. This could be explained by the fact that poor leadership commitment could potentially lead to poor psychological ownership in implementing the principles set and defining a clear

information framework (guidelines and manuals) to make the system easy. Similarly, a lack of clear senior management and ministerial ownership and leadership, lack of skills, and a lack of a proven approach to project management and risk management are also reported as a challenge.[31-33] Therefore, future work (research or projects) could seek to include the early involvement of the stakeholders, especially local healthcare providers, throughout the whole software project lifecycle of any ICT-BHIS.

5 | CONCLUSIONS

Generally, the findings of this study have implications for PLHC facility administrators, stakeholders, the government, and health practitioners to move beyond business as usual in dealing with the challenges. Overall, in the PLHC facilities, the implementation of ICT-BHIS has not matured beyond a policy debate into a very tangible, organized, and implementation-oriented endeavor. Thus, future researchers could validate empirically and contextualize the newly proposed model to the context of PLHC elsewhere.

The study explored the barriers to implementing ICT-BHIS in primary-level healthcare using the ICT4H model. The findings of this study revealed that infrastructures, financial cost, technical constraints, human capital, stakeholders' engagement, and organizational commitment are the pressing challenges PLHC facilities face in the implementation of ICT-BHIS. This implies that it is important to shift the paradigm/gaze from piecemeals of multiple pilot projects to a unified strategy that touches multiple buttons/challenges for the successful implementation of ICT-BHIS in the context of PLHC facilities.

CONFLICT OF INTEREST

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

DATA AVAILABILITY STATEMENT

All data are reported in the article and there are no publicly archived data sets.

ETHICS STATEMENT

The study was approved by the institutional review board of faculty of computing and informatics, Institute of Technology, Jimma University, Ethiopia (Ref. No: IS/07/64/2011 E.C). Written informed consent was obtained from all study participants.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.