Frugal User Involvement

Opportunities for affordable quality user involvement in LMICs

Mats Blakstad

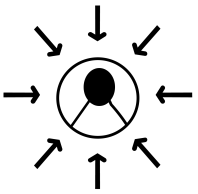
Thesis submitted for the degree of
Master of Informatics: Design, Use, Interaction
60 credits

Department of Informatics
The Faculty of Mathematics and Natural Sciences

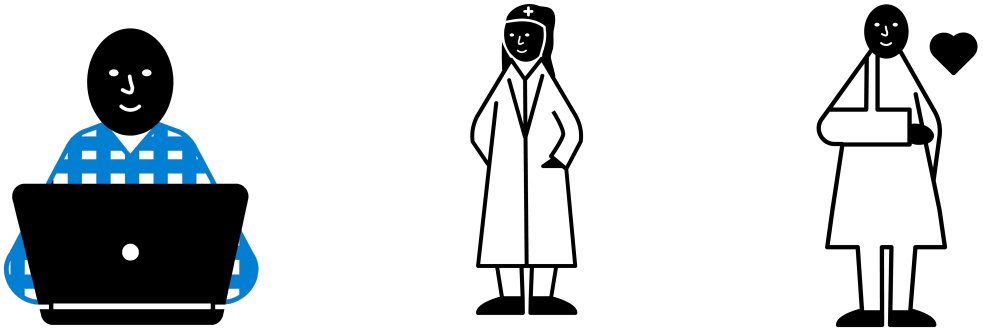
UNIVERSITY OF OSLO

November 2022

Frugal User Involvement



Opportunities for affordable quality user involvement in LMICs



2022

Frugal User Involvement

http://www.duo.uio.no/

Trykk: Reprosentralen, Universitetet i Oslo

Abstract

Digital solutions play an increasingly central role in promoting and delivering healthcare in low- and middle income countries (LMICs), but such digital interventions have a high failure rate. Parts of the reason, many argue, is related to limited user involvement during design of eHealth solutions. Although user involvement is claimed by many to be important in securing usable and relevant software solutions, the practitioners who design and implement these systems in LMICs, referred to as eHealth designers, face a range of multi-layered and complex challenges to involve the users. Existing literature identifies some main challenges of involving users in LMICs; lack of resources, limited IT literacy, significantly skewed power relationships and lack of cultural appropriateness of conventional means to involve users. However opportunities to better involve users in LMICs have most often been explored from the perspective of foreign researchers than from the local eHealth designers that work in these contexts on a daily basis.

The thesis explores the question: *Which opportunities do eHealth designers in LMICs see for better involvement of healthcare workers during design of eHealth solutions?* Based on a qualitative study probing experiences and future speculations from the perspective of 37 eHealth designers in 7 African countries, the following opportunities for better user involvement are identified: role play, instant messaging group, visual means, design thinking, prototyping with generic software, peer-driven user involvement, effective stakeholder feedback mechanisms and improved organizing of projects. The identified opportunities have in common that they have a combination of cost efficiency, appropriateness to context and focus on attaining quality. In addition to the perspectives of eHealth designers in LMICs on opportunities for better user involvement, this master thesis contributes to existing knowledge about user involvement in LMICs, by presenting a definition of frugal user involvement which can guide both eHealth designers and researchers to cope with multiple layers of complex challenges to involve users and identifying viable means for affordable quality user involvement in LMICs.

Keywords: user involvement, design methods, ICT for development, eHealth design, healthcare workers

Acknowledgments

First and foremost I would like to express great appreciation for the guidance from my two supervisors; Magnus Li, who have evoked countless interesting discussions, key insights and pragmatic advices which have highly guided this master thesis, and also developed a very enabling research environment within the DHIS2 Design Lab, and Jens Johan Kaasbøll, who have willingly shared his wide network, in-depth knowledge, years of experience, clever mind and critical remarks, throughout the process.

I would like to appreciate the HISP network and BETTEReHEALTH research project for assisting with their valuable international network and all the 37 participants from the participating organizations: University of Malawi, Cooper Smiths, HIPS Malawi, HISP Nigeria, HISP Rwanda, HISP South Africa, HISP Uganda, HISP West and Central Africa, and Saudigitus. I would also like to express my gratitudes to the DHIS2 Design Lab and all the other lab members who have created an engaging research environment and a priceless resource for sparring and collaboration through presentations, discussions, brainstorming, workshops and valuable feedback. I'm also in dept to many who have contributed with creative ideas and craftsmanship for the design of the presented infographics visualizing the research results in this thesis, especially the graphic designer Persia Duncan, and for valuable feedbacks and discussion on both the infographics and the research results from Guri, Joshi, Alma, Henriette, Merete and Ivan.

I would also like to send a big thank you to all the community healthcare workers I met while living in a rural village in Malawi in 2019, especially Charles who opened up and let me stay in his home for 10 days to live in the community within a very welcoming atmosphere doing research on my initial master thesis research plan, which later unfortunately collapsed due to the COVID-19 pandemic. The opportunity to live in the community and follow community healthcare workers during their daily work activities, has however been an eye opener for me, paramount for being able to ground the analysis, and motivated the completion of the master research thesis, even though it didn't turn out exactly as originally planned.

Finally I would like to express my great gratitude to my parents, family and friends, who have supported and motivated me unconditionally throughout - this master thesis would not have been possible without your support.

Table of Contents

1. Introduction

Development interventions in low- and middle income countries (LMICs) increasingly use digital solutions as a strategy to create impact (Ho et al., 2009), but such digital interventions have a high failure rate (Heeks, 2002). During implementation of digital solutions in LMICs there can often become a mismatch between how the solution was designed to be used, and how it is actually used within the real world context, referred to as the design-actuality gap (Heeks, 2002). *Design* means the shaping of ideas into materials (Schön, 1983), and involving users during design of digital solutions can be both highly empowering for the users (Bratteteig & Wagner, 2014) and positively impact the quality of the solution (Gulliksen et al., 2003; Kujala, 2003). Involving users can mean giving users an informative role in the design process, consulting users about their opinions, or letting users take part in decision making (Damodaran, 1996). User involvement in LMICs however typically entails weak forms of involvement where users have an informative or consultative role with limited possibilities to influence the design and implementation of technology (Ho et al., 2009).

The last two decades many LMICs have increasingly started to use digital technology to promote and deliver healthcare, referred to as *eHealth*. One design-actuality gap typically identified during deployment of eHealth in LMICs, is that healthcare workers who already experience heavy work burden, are provided solutions that further increase their workload, resulting in healthcare workers being unable or unwilling to use the provided system (Shuvo et al., 2015; Stansfield et al., 2008). The solutions are provided by *eHealth designers* who work with the user organization conducting a range of activities throughout the design and implementation process such as scoping and planning of new projects, gather system requirements, designing and developing the solutions often based on generic softwares, end-user training, user support and system maintenance (Li, 2021). Making the eHealth designers in LMICs better involve healthcare workers during design of eHealth can potentially provide a better fit between the digital solutions and healthcare workers practices, and empower the healthcare workers. Making healthcare workers and other users in LMICs become more involved during design can also give LMICs more autonomy, make LMICs take a more active role in digital innovation processes and generate digital innovations more tailored to a LMICs context (Nielsen, 2017). Better user involvement during design of digital solutions in LMICs can ultimately become an important contributor to achievement of the Sustainable Development Goals (Dearden & Rizvi, 2008).

Applying conventional means of user involvement has however been challenging in LMICs contexts (Heeks, 2002; Maunder et al., 2007; Winschiers, 2006). Several layers of interrelated challenges have been identified for involving users in LMICs such as; lack of resources to conduct user involvement activities (Backhaus et al., 2014; Chetty et al., 2004; Dearden & Rizvi, 2008), challenges involving users who have little experience with digital technology (Kimaro & Hodne, 2008; Maunder et al., 2007; Winschiers-Theophilus et al., 2010), significantly skewed power relationships (Dearden & Rizvi, 2008; Heeks, 2002; Teka et al., 2017), and lack of cultural appropriateness of conventional means to involve users (Backhaus et al., 2014; Maunder et al., 2007; Sherwani et al., 2009; Winschiers, 2006; Winschiers-Theophilus & Bidwell, 2013). Yet how these issues relate to each other, their magnitude, and how to resolve them is still largely unknown.

Some opportunities have been identified such as altering local norms and styles of communication (Chetty et al., 2004; Puri et al., 2004; Winschiers-Theophilus & Bidwell, 2013), early exposure of users to digital technology (Maunder et al., 2007; Molapo & Marsden, 2013; Ramachandran et al., 2007), using functional prototypes (Kimaro & Hodne, 2008; Maunder et al., 2007), focusing on local needs beyond the project scope (Dearden & Rizvi, 2008, 2008; Winschiers-Theophilus & Bidwell, 2013), peer-driven forms of user involvement (Kam, 2008; Ramachandran et al., 2007; Teka et al., 2017), using visual means (Makamba et al., 2019; Ramachandran et al., 2007; Winschiers-Theophilus & Bidwell, 2013), and improving organizing of projects (Li, 2021; Teka et al., 2017). However these opportunities have not been studied in depth or tested extensively. The opportunities identified have also mostly been explored by foreign scholars doing field research in LMICs with limited consideration of the local eHealth designers' experiences, work practices and cost limitations. Exploring perspectives from experienced eHealth designers’ in LMICs can potentially provide insights based on experiences and lessons learned from the real world context of user involvement in resource constrained contexts. Their perspectives can help identify robust means to carry out affordable quality user involvement with large user groups in LMICs that fit with the work practices of the eHealth designer working in LMICs.

1.1 Research problem

As the perspectives from the local eHealth designers in LMICs have received relatively little attention, there is a gap in knowledge on cost efficient means to carry out quality user involvement during design of eHealth solutions in LMICs. In the face of multi-layered and complex challenges, there is also a lack of clear criterias for analyzing and selecting viable

means for affordable quality user involvement appropriate to LMICs and other resource scarce contexts.

1.2 Research question

Based on the described motivations and research problems the thesis addresses the following research question;

> RQ: Which opportunities do eHealth designers in LMICs see for better involvement of healthcare workers during design of eHealth solutions?

To answer the research question eight opportunities envisaged by eHealth designers in Africa will be presented. The identified opportunities have in common that they have a combination of cost efficiency, appropriateness to context and focus to attaining quality. I will coin this as *Frugal User Involvement* which represents a theoretical contribution of the thesis which I argue can be used by eHealth designers, researchers and vendors of generic software packages to cope with multi-layered and complex challenges and evaluate opportunities of viable means for affordable quality better user involvement in LMICs and other resource constrained contexts.

1.3 Research approach

The research questions have been investigated using an Engaged Scholarship approach through an explorative qualitative study involving eHealth designers in 7 African countries. The data was collected through 4 semi-structured interviews and 19 remote workshops including 37 participants using online whiteboarding, exploring the eHealth designers' knowledge and perspectives. The eHealth designers participating in this research can, based on experiences designing eHealth solutions in rural communities with limited fundings available, provide valuable insights on viable means for better user involvement in such contexts. The analyses were further refined by presenting and discussing the results with both the participating eHealth designers, as well as researchers having background from various research fields related to eHealth and design.

1.4 Research contribution

The master thesis contributes to the body of knowledge on user involvement in LMICs by presenting opportunities for better user involvement in LMICs based on the perspectives of eHealth designers in Africa. The identified opportunities are not concrete, but represent topics for further exploration that can potentially address some of the challenges involving

users in LMICs described in related literature, and provide valuable insights on affordable means to quality user involvement applied and envisaged by experienced eHealth designers in Africa. This thesis also contributes to the body of knowledge on user involvement in LMICs by conceptualizing frugal user involvement. The concept can guide both eHealth designers, researchers and vendors of generic software packages concerned with how to facilitate better user involvement in LMICs by providing criterias to cope with complex multi-layered challenges, analyze and select cost efficient means to better involve users during digital design appropriate to resource constrained contexts. The analysis have been shared back to the eHealth designers participating in the study, and the research community, through publicly available infographics[1] to make the results more accessible. The research results will also be used to build content for the DHIS2 Method Toolkit which is under development.

The research approach used in this master thesis is also an example of an innovative approach to research using remote workshops through online whiteboarding.

1.5 Thesis structure

Chapter 2 provides an overview of research focusing on conventional user involvement during design of digital solutions, and literature describing challenges and opportunities to user involvement in LMICs contexts. The concept of frugal user involvement is developed with description of the definition criteria which can guide eHealth designers, researchers and vendors of generic softwares to select means of affordable quality user involvement appropriate for resource constrained contexts. Chapter 3 describes the methodology used, Engaged Scholarship through exploratory qualitative research, and provides an overview of the research context, participants and and the research process. Chapter 4 presents a comprehensive overview of the empirical findings describing the work practices of the eHealth designers, challenges of involving healthcare workers in rural and resource scarce contexts, and opportunities envisaged for better involvement of healthcare workers in the future. Chapter 5 analysis and discusses the identified opportunities for better involvement of healthcare workers during design of eHealth solutions in LMICs. First the eHealth designers' perspectives are compared with related literature. Then the definition criterias from frugal user involvement are used to analyze and discuss the identified opportunities: role play, instant messaging group, visual means, design thinking, prototyping with generic software, peer-driven user involvement, effective stakeholder feedback mechanism and improved organizing of projects. The discussion provides an example of how the concept can be used

[1] https://www.mn.uio.no/hisp/english/dhis2-design-lab/projects/involving-health-workers-in-ehealth-projects/frugal-user-involvement.pdf

to evaluate the frugality of different means to involve users during design of digital solutions, elaborate on key characteristics for frugal user involvement and implications for key stakeholders. Chapter 6 summarizes the conclusions on the research questions, elaborates on the limitations of the research, and outlines some possibilities for future research.

2. Theoretical Foundation

This master thesis research examines opportunities for better involvement of users during design of digital solutions in LMICs. This chapter starts by outlining an overview of conventional perspectives of user involvement. Then an overview of literature focusing on user involvement in LMICs is provided. Finally the concept of *frugal user involvement* is defined and described.

2.1 User involvement during design of digital solutions

Design of digital solutions can be conceptualized as the design of digital "spaces for human communication and interaction" (Winograd, 1997). It involves both questions about "how" and "why" our daily interactions with computers are designed (Thackara, 2001). Socio-technical perspectives emphasize the intertwined relationships between design of technical systems and broader social arrangements (Mumford, 2006). Nonetheless many different conceptualisations, the various perspectives commonly agree about the importance of involving the users during design for successful deployment of digital solutions. Design of digital solutions can also be considered as an art being practiced by eHealth designers, and designers of other information systems, sharing similar experiences, knowledge and conventionally used means for design and user involvement within a community of practice.

We will now look into a brief historical overview of research on user involvement during design of digital solutions, then describe main principles of user involvement, and go through an overview of conventional means used to involve users.

A brief history

The body of knowledge describing involvement of users during design of digital solutions is a broad field containing various academic paradigms theorizing why and how future users of a digital solution should be involved during design of digital solutions. The different paradigms have different historical roots and emerged as technology has evolved, the use of technology has changed, and at the intersection of other research fields, especially the social sciences and engineering sciences. Despite differences the paradigms do however have a common aspiration to involve users in order to design better digital solutions for the users.

The concept of 'users' within the design of digital solutions surfazed in the early 1980s as personal computers started to be offered at the markets. The field of Human-Computer Interaction (HCI) emerged in North America trying to apply positivistic research approaches from psychology attempting to design better user interfaces by observing users from the

outside as objects without really involving them (Kensing & Greenbaum, 2012). In the same period Scandinavia researchers collaborated with the labor unions through action research projects to experiment with approaches to empower the workers and negotiate institutional arrangements that provided workers some rights to influence over the introduction of technology at the workplaces (Braa et al., 2004). Later in the 1980s the field of Computer Supported Cooperative Work (CSCW) inspired by socio-technical approaches emphasizing the skewed power relationships, the collaborative dimension of work, and the intertwined relations between the solutions and the social context, started introducing more social science and ethnographic approaches to the design of digital solutions (Kensing & Greenbaum, 2012).

The increased focus on users as active and creative agents using technology to solve activities in lived environments inspired two of the main design traditions used today Participatory Design (PD) and User Centered Design (UCD), but whereas perspectives from UCD have roots from HCI focusing on increasing the quality of digital solutions for individual users, PD have traditions from socio-technical approaches taking a critical look at the design in a broader social context emphasizing the social and cultural dimensions of design, motivated by supporting future users democratic right to influence their future environments (Bannon & Ehn, 2012). PD entails empowering users to take part in decision making, whereas UCD usually entails a more consultative role for the users (Simonsen & Robertson, 2012).

Other design disciplines emphasising user involvement are for instance Activity Centred Design focusing on the purpose of actions, tools and social construction of meaning (Gay & Hembrooke, 2004), Human Centered Design focusing on humantisic values and a wider range of stakeholders in addition to the users (Zachry & Spyridakis, 2016) and Socio-technical design emphasizing co-evolving both the social and technical aspects of the organisation in parallel (Mumford, 2006).

Principles of user involvement

Despite different theoretical perspectives and approaches shaping the field of user involvement during design of digital solutions there are several similarities and shared principles between the different paradigms for involving users that are commonly highlighted in the literature. The following section will elaborate more on my own synthesis of the main principles of involving users during design of digital solutions based on recommendations from various traditions (Gulliksen et al., 2003; Simonsen & Robertson, 2012; Verne & Bratteteig, 2018):

End-users needs

The design of technology should be underpinned by the end users' needs (Gulliksen et al., 2003), rather than the needs of for instance product owners, managers or funders. However identifying needs is not straightforward as different users have different needs and interests, and different solutions entail different implications for the various users and stakeholders (Kensing & Greenbaum, 2012). Introduction of a solution is never neutral and is always created to solve something for someone and therefore imply a particular worldview (Bratteteig et al., 2012). Design can be seen as processes to solve “wicked problems” where it is not always clear what the problem really is and whose problem it is (Buchanan, 1992). Design typically approaches the problem-situation as a process of reframing a problematic situation (Paton & Dorst, 2011). Giving users the possibility to take part in defining the initial problem from the start, opening up the problem/solution space, and helping the users understand the different opportunities, can be highly empowering for the users during the process of designing digital solutions (Bratteteig & Wagner, 2014, 2016). User involvement, especially from a PD tradition, will emphasize to support the most disempowered users both to empower them and to provide them better solutions (Kensing & Greenbaum, 2012).

End-users' practices

The design of technology should also be driven by an understanding of end users' practices (Gulliksen et al., 2003; Kensing & Greenbaum, 2012). Designers should learn about the users’ domain, lived context, values and beliefs, and emphasize the real user's context over assumptions based on abstract models representing what users should be doing in theory (Schmidt et al., 2007). Emphasizing the real use and real user context implies leaning towards using in-context means working directly with the users to understand the actual setting and the users real behaviors (Simonsen & Robertson, 2012). This perspective relates to the concept of *installed base* emphasizing developing technology altering existing infrastructure, organization and practices within the user's context, to design for immediate usefulness, and to make use of existing resources and infrastructure (Hanseth & Lyytinen, 2003).

Mutual learning

It is not only the designers that should learn about the users, but the users should also learn about technology. The users are considered as creative agents and experts on their own lived environments, and should learn about the possibilities of technology to broaden their horizon and better envisage viable propositions for future digital solutions suitable for their own needs and context throughout the design process (Bratteteig et al., 2012; Kensing &

Greenbaum, 2012; Simonsen & Robertson, 2012). The process of mutual learning, where the users learn about technology while the designers simultaneously learn about the users, can make the users and the designers develop a common understanding, language and vision, enabling them to effectively collaborate and pull in the same direction.

Co-creation

Co-creation involves co-imagination and *abductive* reasoning exploring alternative situations of possible futures (Steen, 2013). The users are seen as potential creative contributors (Sanders et al., 2010) and the designers should harness trust, collaboration and shared knowledge putting the users in position to co-create more human, robust and sustainable solutions. Co-creation can happen through prototyping to explore, understand, mutually learn and analyze together (Bratteteig et al., 2012; Houde & Hill, 1997; Sanders & Stappers, 2008). The co-creation is not only limited to the technical solutions, but also organizational processes that can be co-developed in parallel with the digital solution (Gulliksen et al., 2003).

Multiple design iterations

The users are involved through explorative collective ‘reflections-in-actions’ using a series of co-created prototypes (Simonsen & Robertson, 2012) to continuously evaluate and iterate on the design to evoke feedbacks and improve the quality of the design and experience for the users (Gulliksen et al., 2003). Designers are typically recommended starting with several alternative low-fidelity prototypes, e.g. paper based prototypes, making it easier to evaluate design concepts early on, adjust and make changes at low costs, with minimal efforts avoiding implementing unnecessary features (Gulliksen et al., 2003). The users should be activated throughout the different phases of the iterations such as problem definitions, requirement gathering, analyzing and learning, prototyping, design, development and evaluation (Gulliksen et al., 2003).

Adapt the means of user involvement to context

The aforestated principles of user involvement have been manifested in a range of conventional means of user involvement aiming at revealing users’ real needs, mapping out and tailor for users’ actual practises, capacitating users to involve themselves in design of digital solutions, and creating shared understanding and vision between the users and the designers to co-evolve the new design in collaboration. The means of user involvement are however not applied regious following any routine recipes, strict rules or preset “best practices”, but needs to be flexibly adapted to the context of design. The means should be

creatively and empathically tailored to the user's context, language and communication styles (Bratteteig et al., 2012). Involving users is an explorative process where creative leaps and use of imaginative approaches are encouraged (Bratteteig et al., 2012). The activities to involve the users should successively build on each other, tailoring the rhythm and tempo of activities taking into consideration the users' life situations and motivation to be involved (Kanstrup & Bertelsen, 2018). The planned process also needs to be altered agilely as the designers learn and discover new issues (Simonsen & Robertson, 2012). Similarly as technology should be designed to alter users and their needs, so does the means of user involvement need to be tailored to the users and the design context.

These are some values and beliefs shared by the main design paradigms emphasizing the involvement of users in the design of digital solutions and can be considered as key principles of conventional user involvement during design. Figure 2.1 illustrates the principles of user involvement.

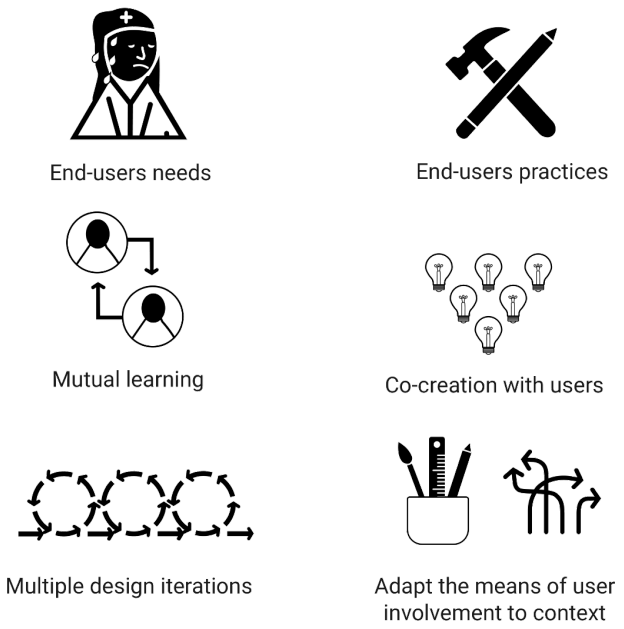


Figure 2.1: Principles of user involvement

Conventional means of user involvement

Means of user involvement is in this master thesis used to refer collectively to tools, techniques and methods for user involvement. Tools are the material components used within activities, techniques describe how tools are put into action during activities, and methods describe how tools and techniques are put together to address system design goals

(Sanders et al., 2010). We will now examine the different types of means to involve users, as well as some emerging methodological issues applying these means.

Types of means to involve users

Means to user involvement can involve activities for gathering, processing and presenting data, sparking user creativity, models for representing design concepts, and guidelines for how to organize projects (Brandt et al., 2012). The activities have different types of *purposes*, *forms* and *design context* (Sanders et al., 2010). The purpose can be to *prime* users into the domain of interest, to *probe* users to elicit feedback, to *understand* users' experiences and needs, or to *generate* ideas or future design concepts (Sanders et al., 2010). The forms can be to involve users through activities for *telling*, *making* and *enacting* (Brandt et al., 2012; Sanders et al., 2010). Activities for users to talk, explain and tell stories are often aiming at making the users' subconscious knowledge more explicit. Activities for making tangible artifacts typically invite users to speculate about and co-create possible futures. Activities for acting, enacting and playing aims at letting users draw on their tacit knowledge to explore future design by simulating, performing and experiencing possible future use. The types of design context can be activities for individuals or groups, different composition of users, venue setting, face-to-face or online (Sanders et al., 2010).

As means of user involvement are not applied rigorously, a myriad of tools, techniques and methods for involving users have been developed. That being said, the field has developed an array of well-known and well-tried conventional means of user involvement creating a shared repository for designers of means that can readily be adapted and used to involve users in design activities for a range of purposes within various contexts. User involvement during design of digital solutions typically involves some traditional qualitative methods such as interviews, focus groups, observation and field studies, but is expected to also go beyond using such approaches. Some readily available examples for conventional means for telling activities can be cultural probes (Gaver et al., 1999), card sorting (Nawaz, 2012), brainstorming and future workshops (Vidal, 2006). Classical examples of making activities are for instance image collaging (Visser et al., 2005), and prototyping (Houde & Hill, 1997). Some examples of activities for enactment are bodystorming (Schleicher et al., 2010), Wizard of Oz (Dow et al., 2005), and ‘In the wild’ studies (Chamberlain et al., 2012). Means to model and represent the end-users and interaction with future design are fornstance personas (Miaskiewicz & Kozar, 2011), user scenarios (Nardi, 1992), storyboards (Lelie, 2006) and user journey maps. Some typical characteristics of means to involve users are use of in-context means where the designers can get first hand experience with the natural use

context, face to face means for team building activities between individual users and the designers, and paper based means to avoid implementation costs.

Emerging issues for conventional means of user involvement

The conventional means to user involvement has emerged in Western countries in a context of designing solutions from scratch typically to be used as tools within professional organizations (Bratteteig et al., 2012). However, as society has changed and technology has evolved and penetrated new areas of use, several shortcomings of the conventional means to involve users have been identified. Two challenges are especially relevant to this master thesis research; involving users in design of solutions based on generic software packages, and involvement of users in LMICs.

Digital solutions are increasingly not designed from scratch as singular projects, but by using generic software packages developed over long time spans through multiple life cycles that are being customized to fit the local context of many diverse organizations (Pollock et al., 2008). The continuous life cycle of development blurs the boundaries between design, requirement gathering and deployment. It is still an open question how to effectively involve various users over longer periods during the life cycles of design and development of such large and complex information systems (Blomberg & Karasti, 2012). These software packages are also often highly configurable providing possibilities for ‘design-after-design’, blurring the line between designer and users, and between design and use (Bratteteig et al., 2012). Another emerging issue has been the increasing penetration of digital technology in LMICs and how to effectively involve users in contexts that are socially and culturally different than the Western wealthy societies where the conventional means of user involvement originally emerged (Blomberg & Karasti, 2012; Winschiers-Theophilus & Bidwell, 2013).

2.2 User involvement in LMICs

An emerging field of research, especially within the field of ICT for Development, focuses on how to involve users during design and implementation in LMICs. We now move to examine challenges and opportunities that have been identified in the literature.

Challenges

The existing academic literature primarily focuses on the following challenges of involving users during design and implementation of digital solutions; lack of resources, limited IT literacy, significantly skewed power relationships and lack of cultural appropriateness of conventional means to involve users.

Lack of resources

Due to limited resources available in LMICs there is a lack of resources and budget to conduct activities to involve users such as field visits, workshops, testing and piloting of solutions, as well as conducting training. Traveling to users in sparsely inhabited rural areas increases cost and use of time to travel and meet the users (Chetty et al. 2004). Limited resources also mean that there is a lack of infrastructure and equipment making the requirement gathering and conducting workshop sessions challenging (Backhaus et al. 2014). Lack of trained manpower and skills in carrying out user centered design has also been reported (Teka et al., 2017). There can also be a lack of attendance on activities from users who experience long work days and have other more important priorities to attend. The busy work schedule and difficult life can make it difficult for users to allocate time to involve themselves in the design and implementation of digital solutions (Chawani et al., 2014; Dearden & Rizvi, 2008; Elovaara et al., 2006). The rhythm of life can often make it difficult to expect planned sessions to happen on time, making planned sessions easily become delayed or postponed (Winschiers-Theophilus et al. 2010). In some cases this can make especially women, who have extra household responsibilities, more limited to become involved (Winschiers-Theophilus & Bidwell, 2013).

Limited IT literacy

LMICs are less penetrated with digital technology, both in professional and social life, meaning many users, especially in rural areas, have less digital experiences and skills (Maunder et al., 2007). Conventional means of user involvement have typically been deployed in contexts where there already exists other technologies, and when applied in contexts with little or none existing digital technologies the means can fail to reveal the socio-cultural issues (Maunder et al., 2007). Involving users with little digital experience and skills requires more time during the design and requirement gathering phase, as it can be more difficult for users with limited IT literacy to understand the possibilities of ICT (Molapo & Marsden, 2013; Ramachandran et al., 2007), express needs in terms of technology (Chetty et al., 2004), and to envisage new possible digital solutions (Maunder et al., 2007). During design it can be more difficult for users with limited digital literacy to relate abstract low-fidelity prototypes (e.g. paper based prototypes) to future envisaged digital technologies (Kimaro & Hodne, 2008; Maunder et al., 2007; Teka et al., 2017, 2017; Watkins et al., 2015; Winschiers-Theophilus et al., 2010). Use of more high-fidelity functional prototypes can make the design concepts more clear, but are usually more expensive to develop, and provide more feedback on the specific design than to broaden the imagination for alternatives (Maunder et al., 2007). Users with limited IT literacy might also be hesitant to provide critical

remarks on high-fidelity prototypes that they perceive as close to finished products (Watkins et al., 2015), or feel too unskilled to provide any feedback at all (Maunder et al., 2007). Such users might find it difficult to understand the purpose of design activities and be reluctant to involve themselves in activities to ‘co-imagination digital future solutions’, but rather be afraid to make mistakes and wait for step-by-step instructions on how to complete tasks (Maunder et al., 2007), and can more easily experience the prototype evaluation as it is themselves who are being tested (Watkins et al., 2015). Involving users with less experience in technology can also require more effort to tailor the solutions to users with less experience with digital technology, and require more training of users after deployment (Chetty et al., 2004).

Significantly skewed power relations

Design of digital solutions in LMICs are often primarily developed based on wishes from top-level managers and donors who need, e.g. aggregated data to measure indicators and plan resources, rather than needs of the users on the ground, such as improving quality and speed of consultations for healthcare workers and healthcare receivers (Alhassan et al., 2016; Kesse-Tachi et al., 2019; Lippeveld et al., 2000). Digital solutions are designed and implemented in a top-down manner for specific programs leading to vertical and fragmented solutions for the users on the ground (Braa & Muquingue, 2007). This can make the solutions introduced increase the workload for workers and decrease the quality of services (AbouZahr & Boerma, 2005; Stansfield et al., 2008). Digital tools being introduced top-down can also be perceived as surveillance tools from managers (Maunder et al., 2007).

Users in community settings can, due to historical experiences, be skeptical to outsiders from privileged settings claiming to bring benefits to the community (Dearden & Rizvi, 2008). Historical power relations, as well as local values, in many LMICs also discourage critique of authorities (Teka et al., 2017; Winschiers-Theophilus & Bidwell, 2013). The users are also often involved too late in the design and implementation process to actually influence the design of the solution (Dearden & Rizvi, 2008; Li, 2021).

The solutions are often implemented based on generic software to reduce the costs both of development and maintenance, however such solutions provide less room for customization (Li, 2021). The team developing the generic softwares are often distant from the users in LMICs making assumptions that do not hold (Heeks, 2002; Sæbø et al., 2021). When many users in LMICs end up getting extensive training to master systems developed in western countries, the systems can end up dominating them more than empowering them (Heeks, 2002).

Lack of cultural appropriateness of conventional means to involve users

Many of the conventional means of user involvement during design of digital solutions have originated from Western countries and have been difficult to apply in a non-Western setting (Backhaus et al., 2014; Blomberg & Karasti, 2012; Ho et al., 2009; Irani et al., 2010; Maunder et al., 2007; Sherwani et al., 2009; Winschiers, 2006; Winschiers-Theophilus & Bidwell, 2013). Many users in LMICs have other styles of communication and cultural etiquette than users in the Western countries where many of the conventional means to involve users during design of digital solutions originated (Maunder et al., 2007; Winschiers, 2006), such as paper prototyping, future workshops, brainstorming, scenario building and developing personas (Winschiers-Theophilus et al. 2010). For instance many of the conventional means of user involvement are paper and text based, and there is a lack of appropriate means for involving users preferring oral and performed styles of communication (Winschiers, 2006). Conventional means of user involvement also typically "privileges first person subjective over communal relationality" (Winschiers-Theophilus & Bidwell, 2013). Some attempts to work around these issues have led to models for user involvement in LMICs criticized for still being ethnocentric, postcolonial, and western biased depicting users in LMICs as culturally Others (Irani et al., 2010; Winschiers-Theophilus & Bidwell, 2013).

Opportunities

After examining the challenges to involve users during design of digital solutions in LMICs, we will now continue to go through the various opportunities to better involve the users described in research. Existing literature focuses on; altering local norms and styles of communication, focusing on local needs beyond the project scope, early exposure of users to digital technology, functional prototyping, peer driven user involvement, visual means and improved organizing of projects.

Alter local norms and styles of communication

Means of user involvement should be shaped by local practices, concepts and indigenous knowledge, altering local etiquette and styles of communication (Winschiers-Theophilus & Bidwell, 2013). Engagement in communities are often driven by conversational and embodied interactions (Winschiers-Theophilus & Bidwell, 2013). Orally based cultures rely on storytelling for information transfer through verbal and performed actions rather than text-based means (Winschiers-Theophilus et al., 2010). Building on the local premises such as using local languages and local facilitators trusted by the community can be crucial to create engagement (Chetty et al., 2004; Dearden & Rizvi, 2008; Puri et al., 2004; Winschiers-Theophilus, 2006). Personal relationships are crucial to involve users from

communities in LMICs, and means for involving users in communities needs to facilitate design processes for already existing groups and networks rather than bringing together individuals (Winschiers-Theophilus & Bidwell, 2013). Within an African context prospects are planned more pragmatic than futuristic, focusing more on what is available and possibilities to make best use of it, rather than problems and future visions (Winschiers-Theophilus, 2001).

Focus on local needs beyond the project scope

Dialogical approaches to design can be used to suspend judgment and emphasis plural perspectives rather than the rightness of any opinions or worldviews, to contextualize and negotiate for local meaningfulness of design (Winschiers-Theophilus & Bidwell, 2013). Dialogical approaches are not just limited to words, but the whole structure of the experience (Winschiers-Theophilus & Bidwell, 2013), for instance to also consider issues important to the community members beyond the project scope (Dearden & Rizvi, 2008). Helping users to reveal issues around common problems that before was experienced as individual problems can become an empowering process (Dearden & Rizvi, 2008).

Early exposure of users to digital technology

Exposing users in communities for variations of technologies can generate engagement, elicit attitudes and attract users with interest in technology (Molapo & Marsden, 2013). Displaying digital technology publicly in communities and letting random bypassers try it can be used as a snowballing technique creating curiosity and attracting highly motivated users (Maunder et al., 2007; Ramachandran et al., 2007). When involving users with limited IT literacy it is crucial that the means also boost users capacity to become involved (Maunder et al., 2007). Using simple and cheap ‘off-the-shelf’ technology can stimulate initial dialogue and serve as a “technology baseline” to learn about users' technological skills (Maunder et al., 2007; Molapo & Marsden, 2013; Ramachandran et al., 2007). Providing early training to users that will participate in the design process can be used to co-evolve the solution with the user (Maunder et al., 2007). Using digital means to involve users can be another way to expose users to technology and build capacity (Ramachandran et al., 2007).

Functional prototyping

Increased tailorability of systems can make high-fidelity functional prototyping more and more feasible to use (Kimaro & Hodne, 2008; Simonsen & Robertson, 2012). Involving users to customize software can many times provide more useful feedbacks than involving users to envisage new digital solutions using low fidelity prototypes (Dearden & Rizvi, 2008; Kimaro &

Hodne, 2008), as making users with limited IT literacy experience interactions and functionalities makes the capabilities of digital technology more obvious (Maunder et al., 2007). Functionalities can also be simulated to the users using content prototyping where existing paper based material familiar to the users is presented as digital content (Molapo & Marsden, 2013), or Wizard-of-Oz simulating speech in local languages (Ramachandran et al., 2007). One challenge using high fidelity prototypes early in the design process is that users can be reluctant to criticize something they experience as finished products (Watkins et al., 2015), or be limited to give feedback on specific solutions rather than broaden their perspective (Maunder et al., 2007). Means helping to show users the different possibilities of technology can build capacity, start conversations where users can contribute with their local knowledge, and elicit design ideas. As the users learn about the capabilities of technologies, design concepts can start to make more sense for them (Molapo & Marsden, 2013).

Peer driven user involvement

Users in resource-constrained communities often prefer to learn about technology from their peers who they experience as equals rather than visitors who are perceived as authority figures (Kam, 2008; Ramachandran et al., 2007). When seeing each other through trial and error while using digital technology in public, users can become less hesitant to start using technology (Ramachandran et al., 2007). Evaluating and discussing with peers can make it easier for users to criticize and give negative feedback (Teka et al., 2017).

Visual means

Video and photos recorded by the users can be used to probe the users about their everyday life and also to generate new design ideas through interviews and group discussions, both by displaying the users own recordings as well as recordings from other users (Makamba et al., 2019; Ramachandran et al., 2007; Winschiers-Theophilus & Bidwell, 2013). Multimedia content can be used to engage users while they can steadily get experience and confidence in the use of technology and contribute to the requirement gathering (Molapo & Marsden, 2013; Winschiers-Theophilus et al., 2010).

Improved organizing of projects

Improving the practices of eHealth designers, how eHealth design projects are scoped to mandate user involvement, and capacitating the eHealth designers to negotiate such scopes, has been identified as opportunities to better involve users in LMICs during design (Li, 2021). Use of boundary objects has been proposed to be used to mediate needs and requirements between diverse stakeholders, for instance using personas to both help create a better

understanding of the users both within the development team and for other key stakeholders (Teka et al., 2017)

2.3 Frugal user involvement

Having established the conventional perspectives of user involvement during digital design, and gone through emerging research related to various challenges and opportunities to involve users in LMICs, we now turn to defining the key analytic concept of the thesis *frugal user involvement*. The concept has emerged through the research process to analyze the empirical findings, and has been developed based on the literature related to user involvement in LMICs, and literature related to frugal user involvement. We will now first go through what frugal user involvement is and then define the definition criterias for frugal user involvement.

Frugal innovation

Another strain of research, also thematizing development of products and services within a context of limited resources (typically LMICs), is the research field of *frugal innovation*. Frugal approaches to involve users during design and implementation of digital solutions have been identified as an area that needs more attention to better involve users in LMICs (Li, 2018). Concepts and theories can be borrowed and transferred between research fields to discover new theoretical perspectives (Darbellay et al., 2014), and frugal innovation seems meaningful for exploring user involvement in LMICs and resource constrained contexts. We will now first examine what frugal innovation is, and then go through the definition of frugal user involvement.

Frugal innovation has been described as products and services that are “doing more with less” (Sahay et al., 2018), simpler and better meeting customers real need (Koerich & Cancellier, 2019), affordable and good-enough (Agarwal et al., 2017), developed in resource constrained contexts providing high performance-to-price ratio (Agnihotri, 2014), resilient and sustainable (Farooq, 2017), adaptable, rugged and lightweight (Basu et al., 2013), robust and portable (Kumar & Puranam, 2012), scarcity-induced, minimalist, and disruptive (Rao, 2013), scalable by leveraging resources in new ways and outperforming alternatives (Bound & Thornton, 2012), focusing on fundamental needs, spare in the use of resources, and eliminating non-essential functions (Kuo, 2014), and less pricey meeting the needs of otherwise underserved customers (Hossain et al., 2016). Frugal innovation has also been described as a process limiting all wasteful and not valuable activities, or as a mindset cleverly improvising and utilizing resources at hand to address needs of disenfranchised

people (Soni & Krishnan, 2014). By effectively minimizing the use of resources while increasing accessibility to products and services, frugal innovation has been seen as a potential tool for both social and environmental sustainability (Albert, 2019). Frugal innovation typically takes place in LMICs within a setting of resource scarcity, but can also penetrate developed markets and disrupt product markets through so called reverse engineering (Simula et al., 2015).

Weyrauch and Herstatt (2016) attempts to clarify some concrete criterias to be used to identify frugal innovation, suggesting three definition criterias that needs to be satisfied simultaneously: (1) *substantial cost reduction*, (2) *concentration on core functionalities*, and (3) *optimized performance level*. The reduction of costs required is not specified, but suggested to be at least one third of the price to comparable products, and can include both costs related to purchasing and owning the product. Concentrating on core functionalities entails focusing on essentials, simplifying and reducing waste, being easy to use and maximizing benefits. Optimized performance level will greatly depend on the intended use and context, but imply fulfilling functional criterias, and at the same time being reliable and robust, at an *optimized* level, meaning not overperforming which is costly, while avoiding cuttings costs leading to underperformance and a useless result (Weyrauch & Herstatt, 2016). The understanding of the definition has been expanded to also include the optimized performance level related to users characteristics such as taste, prestige and comfort (Winkler et al., 2019). Summarized based on this understanding, frugal innovation implies delivering very affordable products focused on core needs with optimized functionality and user experience.

Definition criterias for frugal user involvement

Based on existing academic literature on user involvement in LMICs we can now translate the definition of frugal innovation into a new definition of *frugal user involvement* to help identify viable means to make user involvement more affordable and accessible in resource constrained contexts. The concept will be used to analyze the empirical findings of this study to evaluate how the opportunities identified by the eHealth designers to involve users in LMICs address the main challenges of involving users in resource constrained contexts. Frugal user involvement will be used to clarify the trade-offs to select affordable and viable means to quality user involvement in the face of multi-layered and highly complex challenges of involving users in LMICs

Whereas frugal innovation focuses on providing products and services, user involvement is not focused on delivering commodities, but the process of involving users during design and implementation of digital solutions. Frugal approaches to user involvement therefore entails carrying out quality user involvement that is cost efficient, while appropriate to the context. Means to user involvement is frugal, I argue, when all three criterias are satisfied simultaneously;

(1) cost efficient

(2) attaining quality

(3) appropriate to the context

However, how these criterias are manifested in different types of user involvement is highly contextual and will depend on various factors such as the type of design and implementation project, work practices of the eHealth designers, type of users, type of stakeholders, infrastructure and resources available, etc. The following sections will describe different dimensions of each definition criteria for frugal user involvement and the different aspects that need to be taken into consideration.

Cost efficiency

Taking into consideration the limited resources available in LMICs, there is a need for resource efficient approaches (Weyrauch & Herstatt, 2016). Therefore user involvement needs to be carried out at an affordable cost, to be feasible. Cost efficiency can be achieved by obtaining cost efficient facilitation, long term cost efficiency for sustainability, reducing costs for users, and sharing of costs between more stakeholders by attracting resources.

Cost efficient facilitation can make user involvement more feasible resource-wise for eHealth designer and the user organization in LMICs, by “doing more with less” (Sahay et al., 2018) for instance by reducing costs to travel and meeting users, or material needed to involve the users, or reducing time needed to be spent on involving users (Backhaus et al., 2014; Chetty et al., 2004). Cost efficient facilitation of user involvement entails altering means that make use of the local resources within the context, without pushing hidden costs on the users, but to sophisticatedly build upon and harness local resources while enriching and developing them further.

Long term cost efficiency can make user involvement more feasible by efficiently using resources and obtaining cost efficient facilitation for all implementation projects, rather than considering short term cost efficiency for singular interventions, considering that many

projects are being designed and implemented in a fragmented manner (Stansfield et al., 2008). This means taking a holistic long term perspective for sustainability, prioritizing for instance means to user involvement that build long term capacity for users to become more easily involved also in future implementations. A long term perspective also gives precedence to means that effectively involve users while minimizing any potential negative impact on the society and the environment (Kanstrup & Bertelsen, 2018).

Reducing costs for the users being involved can make user involvement more cost efficient by minimizing the burden of design and implementation activities on the users (Chawani et al., 2014; Dearden & Rizvi, 2008; Elovaara et al., 2006). Keeping the process simple and reducing complexity of the process can make it more simple and less costly for the users to become involved, as well as reducing facilitation costs to involve users. Costs need to be considered from an ethical perspective, considering that many users are people who already struggle with their own lives. An intriguing question is questioning who bears the costs for user involvement, and what types of costs. Reducing costs for users also entails reducing potential hidden costs for secondary groups of people that the user is assisting, such as healthcare recipients or family members (Kanstrup & Bertelsen, 2018).

Attraction of resources can make user involvement more feasible resource-wise by effectively engaging key stakeholders in order to withdraw more resources to involve users and share cost burden between more stakeholders, such as living labs (Sahay et al., 2018).

Attaining quality

Attaining quality entails keeping the process simple and focusing scarce resources on core activities (Weyrauch & Herstatt, 2016) that support user involvement enhancing the quality of outputs and outcomes, rather than carrying out indiscriminate “more” user involvement. However, focusing on quality outputs and outcomes means different things depending on the design paradigms of the eHealth designer.

However, focusing on quality outputs and outcomes can mean different things depending on the design paradigms of the eHealth designer, as quality has slightly different meanings within perspectives from for instance UCD, PD, socio-technical design, human-centered design, etc. The ability of an approach to provide quality depends on the ability to achieve aspirations based on the design paradigms. For instance, from a UCD perspective attaining quality emphasizes enhancing product design of the final digital solution, while from a PD perspective quality user involvement also emphasizes empowering the users (Bannon & Ehn, 2012).

Appropriate to the context

Appropriateness of user involvement deals with how appropriate the means is to the context, purpose of use and the intended outcome to be achieved. Some main aspects that need to be considered are the means ability to illuminate the real-world problem situation, engage users, build user capacity, engage stakeholders and the means robustness to be used in various contexts.

Illumination of the real-world problem situation is central to assess the merits of user involvement (Gulliksen et al., 2003). Users need to be involved in a way so eHealth designers can learn about their needs, practises, uncover critical details and conflicting interests. Conventional means to involve users in contexts with limited penetration of digital technology often fails to uncover socio-cultural issues (Maunder et al., 2007). The qualitative nature of such endeavors is usually resource demanding, and attempting to use resources more efficiently can easily compromise on the appropriateness of the mean. For instance, if the eHealth designer's purpose is to understand a user's work context and teach them about technology, replacing a field visit with a phone interview to save costs is not appropriate as a phone call will in many cases probably not sufficiently illuminate the real-world problem situation.

User engagement deals with the aspect of the approach to engage users. Increasing the user engagement can reduce the costs and burden for the user to be involved. Different means to involve users can facilitate or inhibit user engagement depending on the context. To be engaged the users need to experience the process and topics as relevant and important, be able to express their needs, feel comfortable giving suggestions and feedback (Teka et al., 2017), feel respected throughout the process, etc. The user's cultural norms and styles of communication needs to be altered, for instance do many LMICs have more orally and verbally based cultures (Makamba et al., 2019; Winschiers-Theophilus & Bidwell, 2013), and collective cultures (Winschiers-Theophilus & Bidwell, 2013). The user's life situation and the eHealth designer skills to perform the approach and interpersonal skills will also influence the level of user engagement.

Building user capacity is essential for involving users in the co-creation of digital solutions. Resource constrained contexts often entails users with limited IT literacy. Users with limited IT literacy need to start building capacity early in the process to be involved in co-creation, and be exposed to various kinds of technologies in order to better understand the possibilities. The appropriateness of the means to involve users needs to be assessed based

on its ability to capacitate users with limited IT literacy to become involved in the process (Kimaro & Hodne, 2008; Molapo & Marsden, 2013).

Stakeholder engagement deals with how the means are able to engage key stakeholders within a design context of significantly skewed power relationships, such as within the healthcare sector in LMICs (Stansfield et al., 2008). In some cultural contexts it can be crucial to involve senior figures and governmental officials to involve users and give the project legitimacy (Dearden & Rizvi, 2008; Puri et al., 2004). Stakeholder engagement focuses on ensuring that the involvement of users eventually can be translated into decisions that are favorable for the users, for instance decisions concerning project scope and plan, design decisions, allocation of resources, long term commitment to capacity building, empowering users to participate in decision making, etc.

Robustness deals with the aspects making the means viable in many different contexts. Resource constrained contexts require ruggedness and lightweightness (Basu et al., 2013) As many LMICs have limited equipment and infrastructure available methods to involve users should be easy to carry out on many different locations without complex setups (Backhaus et al., 2014; Kumar & Puranam, 2012). As there is limited availability of trained professionals and skills in carrying our user centered design (Teka et al., 2017), means to involve users should be able to be used by eHealth designers having different experience levels and work practices, considering the skewed power relations the means should also be less fragile for situations with skewed power-relations (Backhaus et al., 2014), etc.

Figure 2.2 illustrates the concept by providing an overview of the main dimensions to be considered for each of the defining criterias for frugal user involvement.

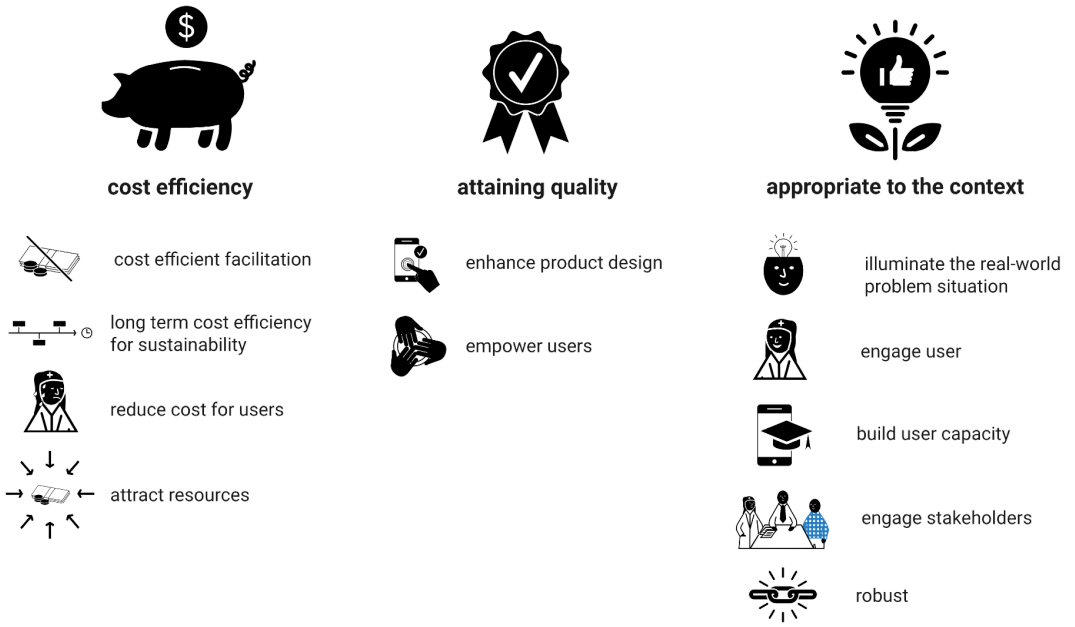


Figure 2.2: Main aspects to be considered for each of the definitions criterias for frugal user involvement.

2.4 Summary

Involving users during design can both empower the users and enhance the design of the digital solution. To involve users the designers need to learn about the users needs, users practices, help users learn about digital technologies, and facilitate creative contributions from the users through multiple design iterations. This can be done through using a range of means that needs to be flexibly adapted to the users and design context. Conventional means to involve users has however been challenging to apply in LMICs with limited resources to involve users, users having limited IT literacy, significantly skewed power relations and lack of cultural appropriateness of conventional means to involve users. Opportunities identified in related research are to alter cultural norms and conventions in the user group, such as verbal and orally based activities, focusing on local needs beyond the project scope, exposing users with limited IT literacy for digital technology early in the process, using functional prototypes, various forms of peer driven user involvement, using visual means, and improving organizing of projects. To analyze the different opportunities to involve users in LMICs the concept of frugal user involvement has been developed. The concept can help clarify the trade-off in order to cope with the identified challenges and carry out quality user involvement at affordable costs rather than an unguided advice to conduct “more user involvement”. Frugal user involvement takes place when carrying out quality user involvement that is cost effective and appropriate to the context. Cost efficiency can be

achieved by obtaining cost efficient facilitation, long term cost efficiency for sustainability, reducing costs for users, and sharing of costs between more stakeholders by attracting resources. Quality can be attained through empowering users or enhancing the product design. The means are deemed appropriate to the context based on their ability to illuminate the real-world problem situation, engage users, build user capacity to be involved, engage other stakeholders and their robustness.

3. Research approach

The empirical research of this master thesis is based on a three years Engaged Scholarship project exploring opportunities for better involvement of users in LMICs during design of digital solutions, through a qualitative study probing the experiences and perspectives of eHealth designers in Africa.

This master thesis research explores the practises, experiences and perspectives of 37 eHealth designers from 7 African countries, living and working daily in the real-world problem situation, implementing eHealth solutions being deployed in a LMICs context. This research has been guided by a broad perspective on both the work processes of the eHealth designers, and which challenges they experience when attempting to involve users within their own work context. Having participants with the same profession from several countries working within many different contexts has helped bring into focus commonalities and general lessons learned. The eHealth designers have been involved through semi-structured interviews and a series of online workshops. The research results have both been presented back to the participants and to other researchers from various related research fields to help co-analyze the results and as a strategy to explore both empirically and theoretically.

This chapter elaborates on the methodology used, the research context within two international research networks, background of the participants, and provides an overview of the research process. Lastly, ethical considerations are discussed.

3.1 Engaged Scholarship through exploratory qualitative research

This research falls within the scope of interpretive qualitative research (Walsham, 2006) emphasizing the participants' perspectives to understand the complexity of the real-world problem situation. The goal of the research has been to explore a knowledge gap on how to effectively involve users during design of eHealth in LMICs, by building on the experiences and expertises of eHealth designers in Africa. The research has been, both in its theme and aspiration, driven towards attempting to make relevant contributions both to scientific knowledge as well as practical knowledge that can be applied in the field by grounding the research problem in the real-world problem situation. The methodology used for the research process can therefore be described as an engaged scholarship through exploratory qualitative research.

Exploratory qualitative research

Exploratory research is a broad and thorough, primarily qualitative, investigation of a topic to discover new insights, building novel concepts and theory bottom-up by asking questions with an open mindset, seeking to avoid being driven by framing devices like established theories, specific hypotheses or preconceived notions, which is typical for confirmatory research (Stebbins, 2001). The exploratory research agenda should be guided by a wide range of questions to gain overview and describe the real-world problem situation without being conclusive, as well as identify key areas that can be examined more in depth during subsequent follow-up studies (Stebbins, 2001). The purpose of exploratory research is to discover new insights by for instance producing grounded theory through "*inductively derived generalizations about the group, process, activity, or situation under study*" (Stebbins, 2001). However, grounded theory has been criticized for being inadequate for developing theoretical innovations due to its primary focus on inductive reasoning (Timmermans & Tavory, 2012). Abductive reasoning, an iterative process of creative inference by comparing surprising empirical findings with different conceptual and theoretical frameworks, has been suggested as an alternative analytical approach to develop novel theoretical insights (Timmermans & Tavory, 2012) and has been argued suitable for exploratory research (Swedberg, 2020). Abductive reasoning can also be conducted in an interdisciplinary way to borrow and transfer theories and concepts from different research fields as a strategy for scientific discovery (Darbellay et al., 2014).

Exploratory qualitative research is particularly well suited to research problems that are not clearly defined, or topics with limited prior research and understanding, but the research approach can also be used to gain fresh perspectives and new understanding on well-explored fields, in order to avoid theoretical closure and the narrowness of established theories in the face of the rapidly changing social reality (Stebbins, 2001). Pursuing discovery of new insights while ignoring demand for verification also makes exploratory research apt for less rigorous application of methods, whereby a wide range of approaches that can help generate new ideas and perspective can be deemed valid (Swedberg, 2020)

Engaged Scholarship

This master thesis research was conducted using an Engaged Scholarship approach which emphasizes collaboration with practitioners in the field directly experiencing the real-world problem situation to gear the research towards producing knowledge that advance both science and practice (Mathiassen, 2017; Van De Ven, 2007). Academic research is criticized for lacking empirical studies of knowledge from practitioners and to ground research agendas in real-world problems, failing to produce knowledge that can be used to solve practical

problems, and to not properly disseminate research knowledge to practitioners, resulting in a theory-practice knowledge gap (Van De Ven, 2007).

This research has attempted to mitigate such issues by exploring the perspectives, experiences and lessons learned from eHealth design practitioners in Africa. The eHealth designers have deep contextual understanding of the real-world problem situation, are in a good position to take part in co-exploring opportunities for new and better ways of involving users during future design processes. The possible opportunities they envisage for better involvement of users in the future has been explored in broadness. Results and preliminary analysis has been presented and discussed with the eHealth designers throughout the research process, both to validate findings, and to co-produce the knowledge. The analysis has also been presented and discussed with other researchers having background from different relevant fields of study such as design of digital solutions, information systems and health information systems, in order to co-analyze the result and be stimulated by different theoretical perspectives. The research results have, in addition to the publication of this master thesis, also been provided back to the eHealth designers, research community and the public, in the form of an infographic.

3.2 Research context

The topic of this thesis research was initiated based on my own interests in collaboration with the DHIS2 Design Lab which focuses on user oriented design and innovation within the Health Information System Program (HISP). HISP is an international action research project coordinated by the University of Oslo. The master thesis research also became engaged in the network of BETTEReHEALTH which is another international research project where the University of Oslo is one of the partners. Conducting this master thesis research within the frame of two ongoing international research projects has provided an opportunity to involve eHealth designers from several African countries, and also to get a broad perspective on eHealth research and different processes around eHealth design and implementation.

Health Information System Program (HISP)

The research was done as a member of the DHIS2 Design Lab, which is an initiative at the University of Oslo as part of the Health Information System Program (HISP) network. We will now first go through what the HISP network is, and then elaborate more about the DHIS2 Design Lab.

HISP is a global action research project aiming to strengthen health information systems. The research project is organized as a network of action (Braa et al., 2004) consisting of

researchers, and practitioners designing and implementing eHealth predominantly in LMICs. HISP is also a vendor which is developing the District Health Information System (DHIS2), an open source generic software for health information systems now implemented in more than 70 LMICs. DHIS2 is a web-based platform which is both flexible considering many configuration options and extendable for custom apps through various APIs, making it easier, quicker and cheaper to design and implement eHealth solutions. In addition HISP builds and maintains resources to support the eHealth designers, such as the DHIS2 Community. HISP is organized in different national and regional HISP nodes. The HISP nodes provide technical support and expertise to the Ministries of Healths in their regions to implement and strengthen implementation of national health information systems based on DHIS2. In addition the HISP nodes collaborate by sharing experiences and participate in research projects on robustness, scalability and sustainability of health information systems. HISP and the DHIS2 software was initially developed in South-Africa after apartheid as an attempt to improve a fragmented and segregated healthcare system (Braa et al., 2004), and today the development is coordinated by the University of Oslo through the Information Systems research group at Department of Informatics. The Information System research group has also established the DHIS2 Design Lab.

The DHIS2 Design Lab is an initiative under the HISP node in Oslo aiming at exploring how user oriented design and innovation can be promoted within DHIS2 as a generic software ecosystem. The lab consists of researchers and post-graduate students researching topics related to relevance and usability of implementations based on generic softwares (Li, 2019), and has provided fruitful spaces for ongoing reflection and learning during the master thesis research. Through seminars the lab members present and discuss research design, experiences, findings and preliminary analysis. The lab members also involve each other in different research activities, for instance interviews, online workshops and evaluations sessions. Being in this vibrant environment with other post-graduate students researching similar topics in a multitude of different research projects has been both educational and inspirational. The lab engages with various HISP nodes as well as the DHIS2 Core team to research needs of end-users and the eHealth designers in LMICs, and are experimenting with building different new resources that can support better design and implementation of digital solutions in LMICs. One such initiative is the DHIS2 Method Toolkit which aims to build a resource with means for user-oriented design and innovation within the DHIS2 ecosystem, where this master thesis research has contributed with both knowledge and content.

BETTEReHEALTH

The thesis research project was also done as part of the international research project BETTEReHEALTH which is a consortium of African and European research partners from both the medical, technical and academic fields, including the University of Oslo. BETTEReHEALTH aims to increase the international collaboration in eHealth, and to empower end-user communities, eHealth implementers and policy makers during decision making for successful evidence-based eHealth implementation. The project researches both technical, political and human factors for eHealth implementation. I have worked professionally as a research assistant within the project which has provided a broader perspective on eHealth research and eHealth implementation in LMICs. Being part of the network has also provided an opportunity to recruit participants for this master thesis research, and to present results for other researchers within the field and get feedback.

3.3 Participants

The participants of this research were recruited through BETTEReHEALTH and the HISP network. We will now focus on the participants' sample, their profession designing and implementing eHealth solutions, and experiences working in rural communities and resource constrained contexts.

Sample

The eHealth designers in this research were sampled purposively through the networks of HISP and BETTEReHEALTH. The participants in this study were 37 eHealth designers, 9 women and 28 men, working in 7 African countries; Malawi (14), Mozambique (3), Nigeria (7), Rwanda (3), South Africa (3), Togo (3) and Uganda (4). Many of the participants also support eHealth design and implementation projects in other neighboring countries having experiences from design and implementation of eHealth solutions throughout the African continent[2]. The eHealth designers are both juniors with only 1 year experience up to seniors with more than 13 years of work experience with design and implementation of eHealth solutions. The participants work in various kinds of organizations such as the Ministry of Health, universities, international NGOs, HISP nodes, and other IT consultancy firms. The eHealth designers work in interdisciplinary teams having a broad range of roles and

[2]The participants reported experiences designing and implementing eHealth solutions in 34 African countries: Angola, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Eswatini, Ethiopia, Gambia, Ghana, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Namibia, Nigeria, Rwanda, São Tomé Prince, Sierra Leone, South-Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

responsibilities within the design and implementation process like, advising managers, donors and policy makers during decision making, product management, system analysis, requirement gathering, design, development, user training, user support, system monitoring and maintenance. The participants developed eHealth solutions based on the generic software DHIS2. Most of the participants work closely with the Ministry of Health to design and implement eHealth solutions used within the public system for primary healthcare services at community level throughout Africa. From this work the participants have gained experience in designing eHealth solutions in rural communities and resource constrained contexts. Figure 3.1 provides an overview of the participants' backgrounds.

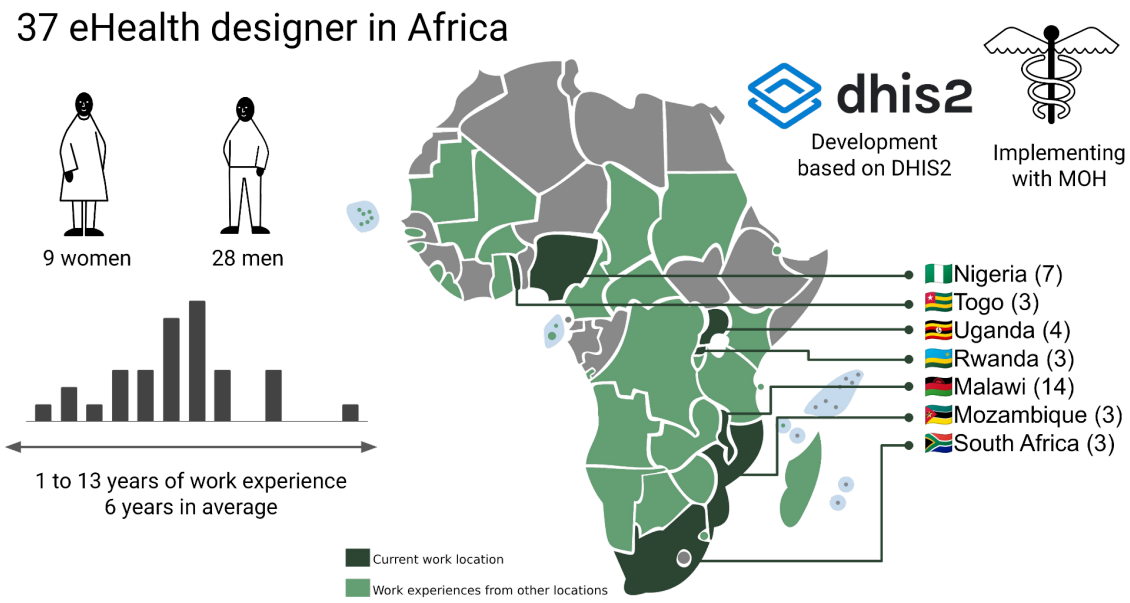


Figure 3.1: *Background information about the sampled eHealth* designers *participating in this study; Their gender, years of work experiences with eHealth design and implementation, current work location, and work experience from other countries in Africa.*

Design of eHealth in resource constrained contexts

The participants have, given their day-to-day work context as eHealth designers throughout Africa, developed expertise on how to involve uses during design in rural communities with limited resources available.

Most of the eHealth designers were experienced working with community healthcare workers (CHWs) which is a type of healthcare workers that typically have a shorter medical training that can last from a week to a year providing primary healthcare services such as health education, public health information, basic preventive health care, first aid, home visits,

maternal and child health, family planning, malnutrition, recognizing symptoms, providing referral services to other parts of the healthcare system, and follow up of cases (Lehmann & David Sanders, 2007). The CHWs collaborate with other healthcare workers at the community facilities such as doctors, nurses, laboratory staff and pharmacists, and sometimes also data entry clerks who register information about the healthcare recipients in paper based and/or electronic solutions. The CHWs are often also assisted by community volunteers, and expert clients who are using their own experience with health issues to help other healthcare receivers with similar issues. The CHWs are at the frontline of the healthcare system between the health facilities and the communities, and provide for many healthcare receivers the only healthcare service they will use. The CHWs ability to deliver the health services and positively impact the community health depends on a range of key community stakeholders, including traditional authorities like community leaders or religious leaders, traditional medical practices, informal drug outlets, school teachers, food producers like farmers and fishers, as well as poverty and other socio economic issues. Figure 3.2 provides an overview of the key community health stakeholders.

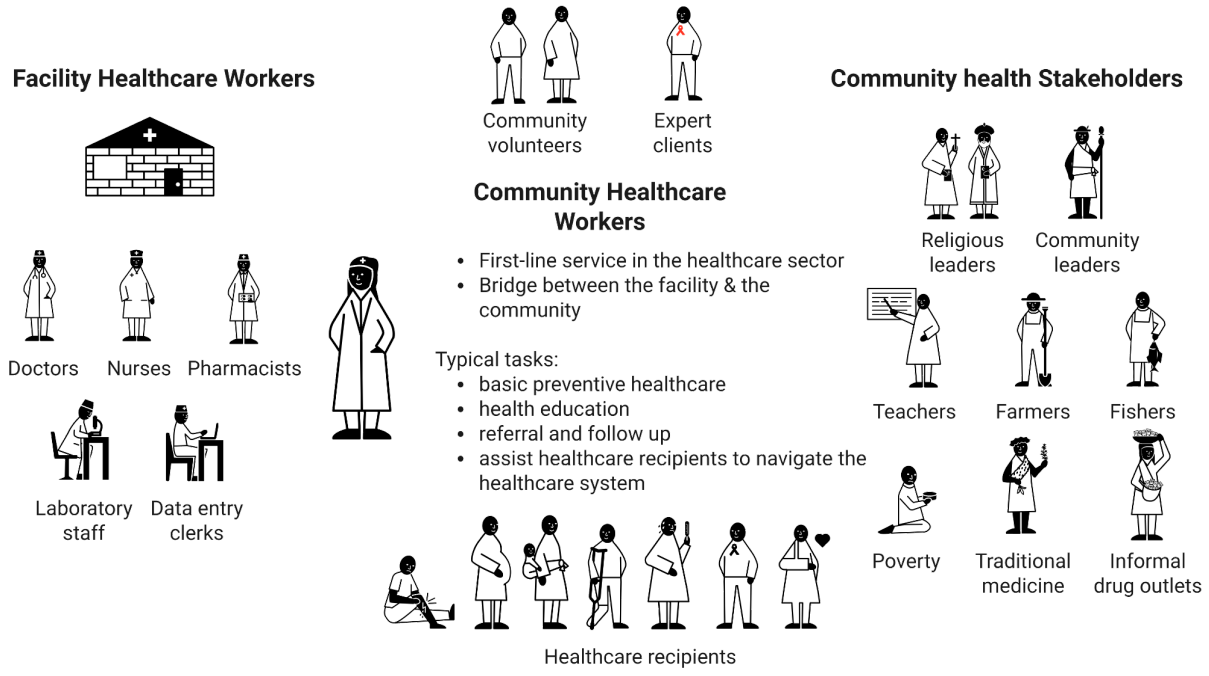


Figure 3.2: Key community health program stakeholders seen from the perspective of eHealth designers.

CHWs are users at the lowest level of the healthcare system farthest away from where decisions are made, delivering first line healthcare services working in many of the most rural areas with little connectivity and limited resources available. The eHealth designers participating in this research have practical experiences to involved users within the

real-world problem situation, and lessons learned from trying to improvise in the face of intricate complex situations, and are therefore in a good position to understand what kind of user involvement that is possible, or difficult, to conduct in resource constrained environments.

Knowledge gained about how to better involve CHWs, and other users in rural and resource constrained contexts, during design, can potentially be used to better involve some of the most marginalized users within the healthcare system, provide better quality of healthcare service delivery in the communities, and also create a bridge into the rural communities making it possible to better involve the healthcare recipients and other key community health stakeholders. Perspectives from eHealth designers experienced involving CHWs, can also be used to better understand how to involve other types of users in rural communities throughout Africa and other LMICs.

3.4 Research process

The design of this research has been emerging in a flexible way rather than being preconfigured, being adjusted both based on findings and preliminary analysis, experiences with applying the methods, opportunities and unexpected events that have unfolded during the timeframe.

The research project started initially as an ethnographic field research project to test out and explore means of user involvement within the context of a community in Malawi, but due to the COVID19-pandemic situation the research design had to be pivoted into using solely remote means of data collection. This however provided the opportunity to gain insights from many perspectives from eHealth designers working in various countries and contexts, through 4 semi-structured video interviews and 19 online workshops (see detailed overview in Appendix 1). The first phase of the research project was characterized by exploring in broadness on how the eHealth designers conduct their work, challenges and opportunities, the second phase was geared towards identifying themes, distill interesting findings, and conceptualize a suitable framework to make sense of the collected data. The analysis and conceptual framework was visualized, presented and developed iteratively in dialogue with both the eHealth designers and other researchers in order to make valuable contributions to both groups. Figure 3.3 provides an overview of the research process.

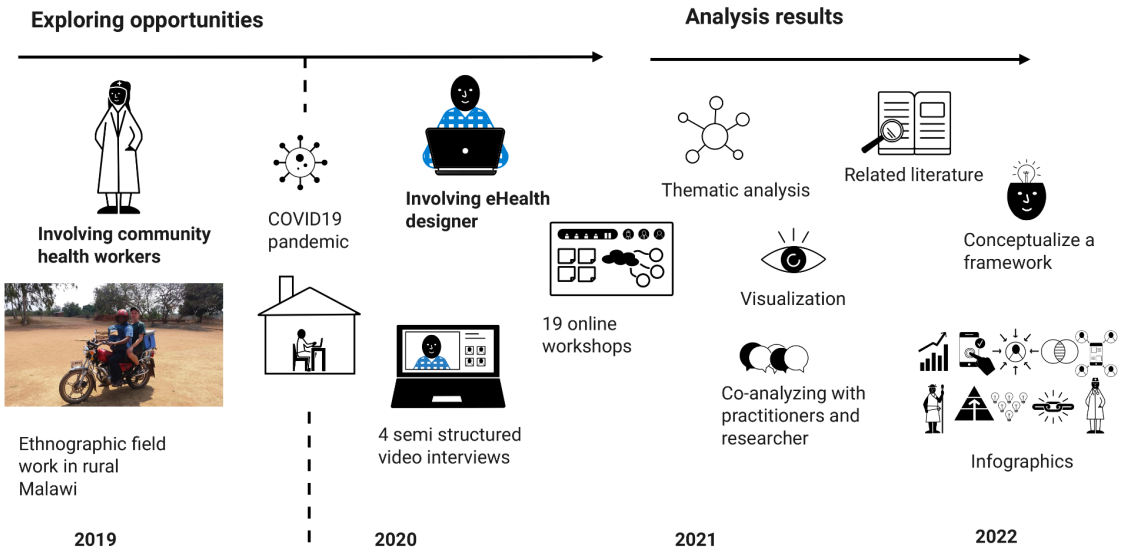


Figure 3.3: An overview of the research process

Ethnographic field work in rural Malawi

Challenges of involving users in LMICs are complex and related to multiple layers of issues such as lack of resources, poor infrastructure, users IT literacy, skewed power relations and users' cultural norms. The initial research plan was to investigate these intricate issues through ethnographic field research in Malawi and explore new forms of user involvement in-context with the CHWs bottom-up. The initial research question was:

> *Which means for involvement can engage & empower community healthcare workers in Malawi?*

A pre-visit was arranged in August 2019 together with the Computer Science Department at Chancellor College, Malawi where I moved into the home of a healthcare worker and lived 10 days in a village nearby Zomba in Malawi. The purpose of the field research was to learn about work practices of CHWs and to experiment with means to involve the CHWs. It was intended as a pre-research to familiarize myself with the real-world problem situation so I could later come back for a longer field research.

During this visit I followed CHWs in their daily work doing outreach in the communities for activities like maternal care, HIV treatment, contraception, hunger program, public health talks and health promotion songs. Figure 3.4 and 3.5 show how I was following CHWs during their work. I also got the opportunity to test out photo based and paper based means of involving CHWs which is displayed in figure 3.6 and 3.7.

Figure 3.4: Being escorted by a CHWs during the field research

Figure 3.5: CHWs explaining about the paper based health passport they use to log health records for the healthcare receivers.

Figure 3.6: One CHWs instructing another CHWs on how to use the photo camera provided for them to document their everyday work.

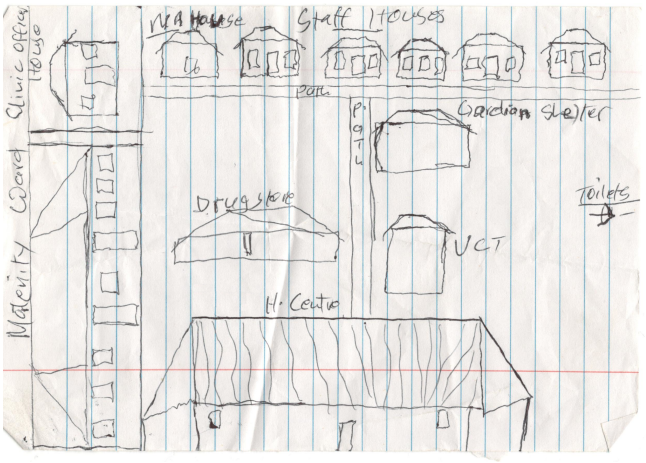


Figure 3.7: One of eight drawing from CHWs illustrating their “dream health facility”

The COVID19-pandemic

The plan was to come back to live in the community for a longer field work of 3-4 months in April 2020, however the COVID-19 pandemic which emerged in March 2020 disrupted all plans for field research. Even though data collected during the ethnographic field research was not used directly in this master thesis, the experiences of being within the real-world problem situation for some time and interacting with CHWs have helped to relate the continued research to a concrete context. Getting a better understanding of the real-world problem situation and understanding the importance of the research also helped to motivate continuing researching the topic, even though the research approach had to be changed.

Throughout the COVID19-pandemic using solely remote means of data collection was required. The disadvantage was not being within the real-world problem situation to research practices and context in depth. Working remotely made it challenging to continue work directly with the CHWs. The research agenda switched to focus on the eHealth designers who are currently involving the CHWs during design and implementation of eHealth implementation. A new research question was developed focusing on using the expertise of the eHealth designers:

Which opportunities do eHealth designers in LMICs see for better user involvement?

Shifting the focus to the eHealth designers who involve the CHWs during design and implementation of eHealth gave some advantages to the research approach taking more into consideration the eHealth designers work practices and available resources, gearing the research towards results that could actually be used by the eHealth designers in LMICs. Doing remote data collection also provided the advantage of accessing participants from many different locations, being able to gain a broader perspective, identify differences and similarities, brainstorm topics more thoroughly, and share experiences between different countries as a contribution back to the participants.

Semi structured interviews with eHealth designers

The purpose of the interviews with the eHealth designers was to get a broad understanding of their work context and work practices, as well as how the eHealth designers currently involve users. An interview guide was developed (Appendix 2) to conduct semi-structured interviews (Edwards & Holland, 2013). The interviews were conducted together with other members of the DHIS2 Design Lab researching related topics. The eHealth designers were initially very occupied setting up new covid tracker systems in response to the COVID-19 pandemic and were not available for participation before several months after the outbreak. 4 semi-structured video interviews were conducted. The interviews provided useful initial insights on a broad range of topics related to the whole design and implementation process such as current work practices, stakeholders, means of involving the users, challenges, and opportunities of user involvement.

The interviews were transcribed and a reflexive thematic analysis (Braun et al., 2019) was conducted where themes are flexibly reworked, splitted, combined, renamed and continuously evolve throughout the research process by discovering unexpected unifying patterns of meaning, and with increasing analytical understanding of the data. Figure 3.8 shows a screenshot of some of the preliminary analysis done in collaboration with other members of the DHIS2 Design Lab using an online whiteboard. A key lesson learned was

that any means for involving users needs to fit within the resource constraints and work practices of the eHealth designers working in LMICs. Doing research without the local eHealth designers can make analysis on how to conduct better user involvement less useful for the eHealth designers working within the real-world problem situation.

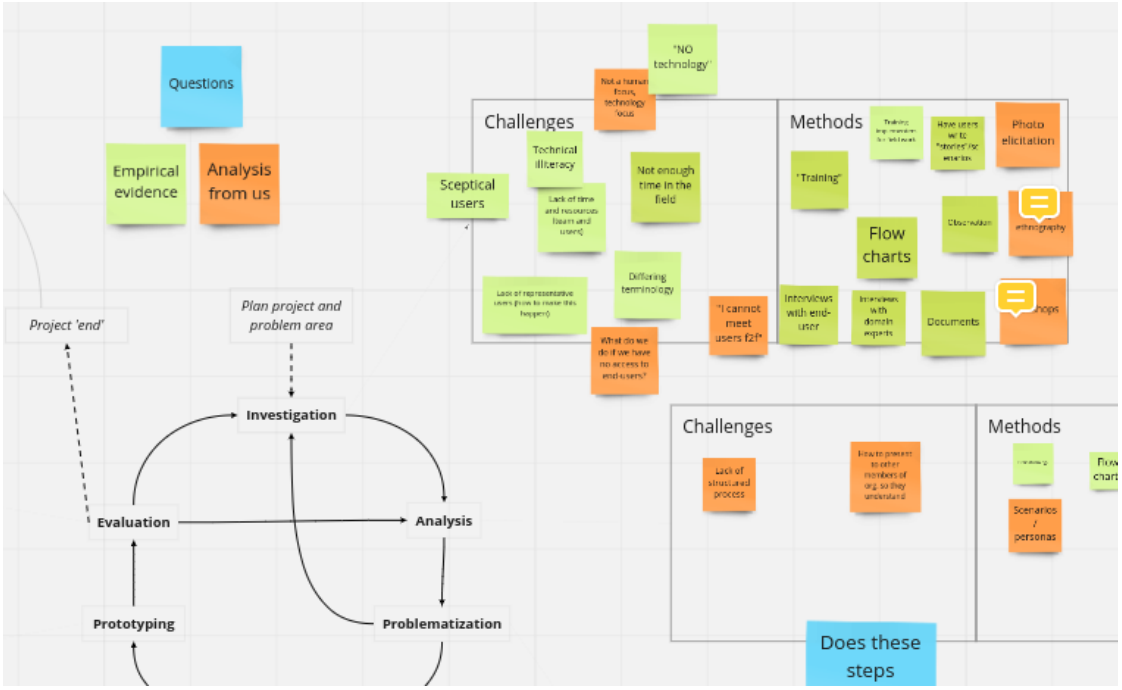


Figure 3.8: *Screenshot of preliminary analysis conducted using online whiteboard together with other members of the DHIS2 Design Lab*

During the remote interviews there were also frequent connectivity issues and sound lagging to the extent that a lot of valuable information was lost. The interviews also several times lost focus on the main research topic as conversations wandered in many different directions, making it difficult to compare and analyze findings from the different interviews. The responses also had some ambiguity, it was for instance not always clear who the participants described when referring to *users*.

When the participants shared screens and displayed different content, such as their work process models, it became easier to keep the focus during connectivity fluctuations, and it also seemed easier to keep the interview focused on the research topic when sharing screen with content and models back to the participants. The positive experience of sharing screens with content during remote interviews with poor connectivity made it intriguing to experiment using more visual aids to support the remote data collection. During the COVID-19 pandemic many became more positive towards testing out new digital tools for remote interaction, and

this provided a possibility to experiment with conducting online workshops (Galabo et al., 2020).

First online workshops with eHealth designers

The purpose of the first workshops was also to focus more on the design, but also get a broad understanding of the work practices. All questions were also phrased to be targeted about *healthcare workers* instead of *users*, and the research question was updated again:

> Which opportunities do eHealth designers in LMICs see for better involvement of healthcare workers during design of eHealth solutions?

The initial series of online workshops (Appendix 1 & 3) were conducted 9 times for a total of 34 participants. The goal was to actively involve participants in brainstorming sessions using virtual sticky notes on the whiteboard.

The online workshops were conducted over video call using a collaborative online whiteboard tool called Miro where participants can create virtual sticky notes with their inputs, add images, and draw connections between objects. The virtual board has unlimited space in all directions and participants can zoom in and out to study details. The participants can also see each other's cursor with pseudonyms indicating where on the board other participants are looking. Participants were introduced to the tool in the start of the workshop and most of the participants, who all had IT background, seemed to manage using the tool well.

The online whiteboard was used to provide visual assistance during the online workshops (Galabo et al., 2020), to activate the participants, and to keep the sessions more focused. The questions to the participants were always written on the board, to facilitate more clear communication in case of unstable internet connection. The topics for discussion were organized as small brainstorming sessions using virtual sticky notes. The participants were asked various questions and given time to put up the virtual sticky notes on the digital whiteboard with their answers. This gave the participants time to think and write before discussing answers to the questions, and also to think more for themselves before hearing other participants' answers.

The brainstorming sessions during the first online workshops generated in total 548 sticky notes on 5 topics; type of implementation projects, stakeholders, means of involving the healthcare workers, challenges of involving the healthcare workers, and speculation about opportunities for better involvement of healthcare workers in the future. After each brainstorming session participants briefly presented their answers on the sticky notes providing more details and descriptions. Every participant was asked to present their sticky

notes and comment on every question, making sure everyone in the group participated. The screen was shared to look at the participants' sticky notes with the answers while they presented. The group based sessions also allowed participants to comment on each other's answers and facilitated exchange of experiences between the colleagues. The sticky notes from the participants with keywords from their answers were also helpful keeping the conversation more focused than in the semi-structured interviews, help visualize relationships between different inputs, and make better sense of their response during connectivity fluctuations. Figure 3.9 and 3.10 provides some screenshots from the sessions.

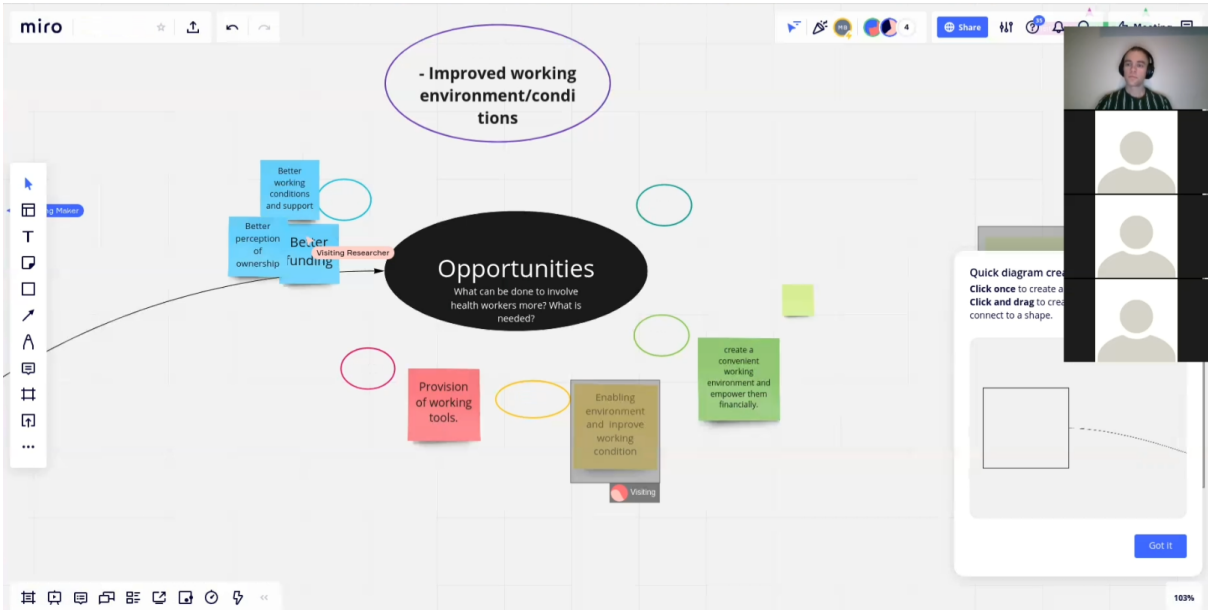


Figure 3.9: *Screenshot from one brainstorming session in one of the first workshops.*

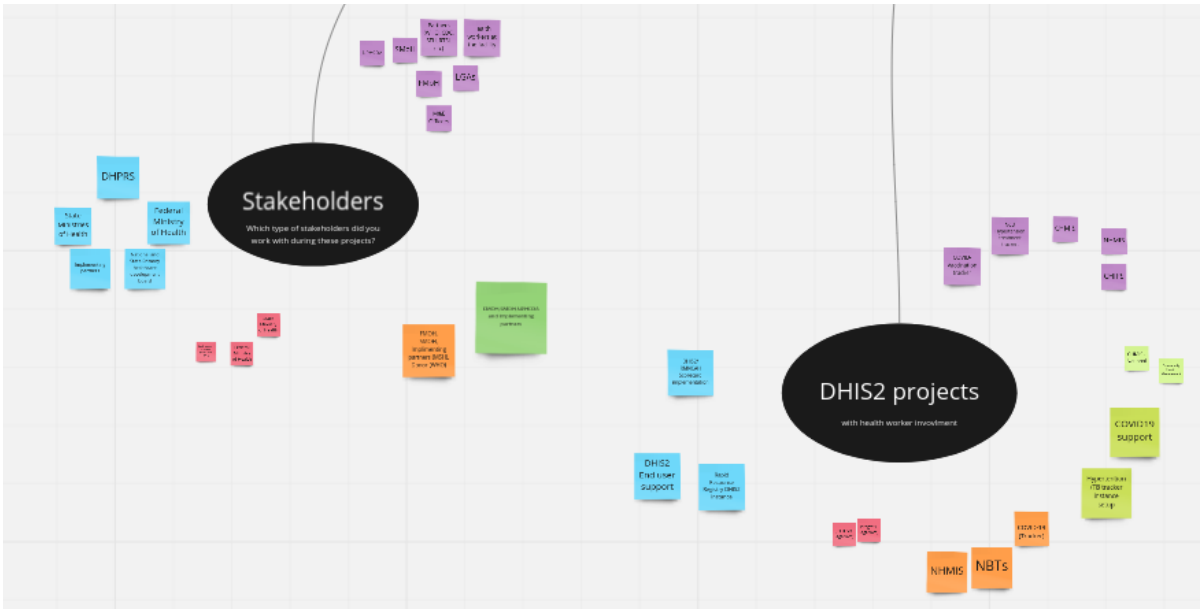


Figure 3.10: *Screenshot of results from brainstorming sessions in one of the first workshops.*

Online whiteboarding seemed to activate the participants by making the sessions more engaging and allowing involvement of more participants simultaneously. Several participants also expressed it was a useful tool they could also use for other projects. The online whiteboard was also available for the participants after the workshop.

Preliminary analysis

The virtual sticky notes from the brainstorming sessions were anonymized, but marked with professional role and country to provide context and make the data traceable, before all the sticky notes were placed together on a common online board. The recordings were transcribed and additional sticky notes with paraphrases from the transcriptions were created to enrich the keywords from the eHealth designers.

A reflexive thematic analysis (Braun et al., 2019) was conducted for each topic, identifying different experiences related to work practices and involving healthcare workers. The use of online whiteboards for the analysis made it easy to regroup the data according to different themes being redefined, split and refined by rereading the transcripts, looking through the video recordings and getting a deepening understanding of the material. The emerging themes also led to new insight and analysis, which led to new understanding and reframing of the data in a heuristic manner. The sticky notes were clustered together using an heuristic approach where topics emerged from the data, leading to insight and analysis, which lead to new understanding and reframing of the data.

The large amount of inputs generated many themes for each topic. The themes were organized in a mind map drawing relations between them as well as key stakeholders in the implementation process. Based on the result of the initial analysis a simplified model was built and presented to the eHealth designers in the second workshop. Figure 3.11 shows a screenshot of the results from analyzing challenges involving the healthcare workers, and figure 3.12 displays an example of the simplified model.

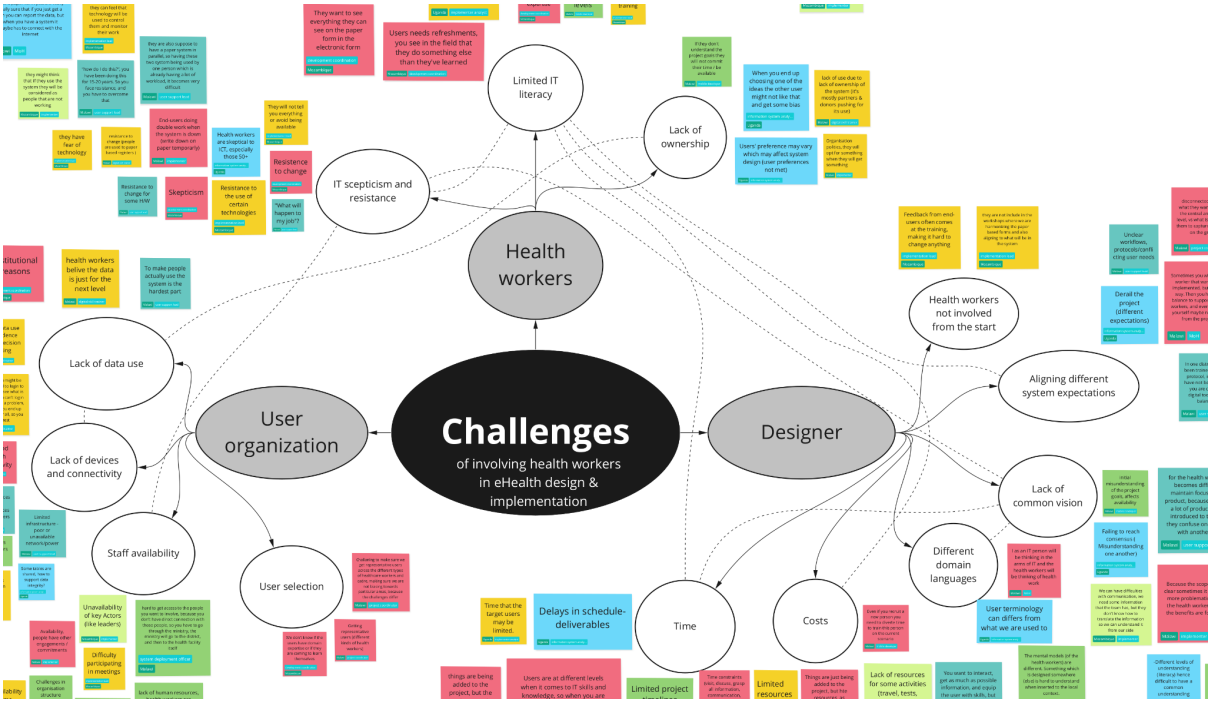


Figure 3.11: *Screenshot of how the initial data on the topic challenges involving* healthcare workers *was analyzed identifying themes related to the stakeholders user organization, health workers and eHealth designers.*

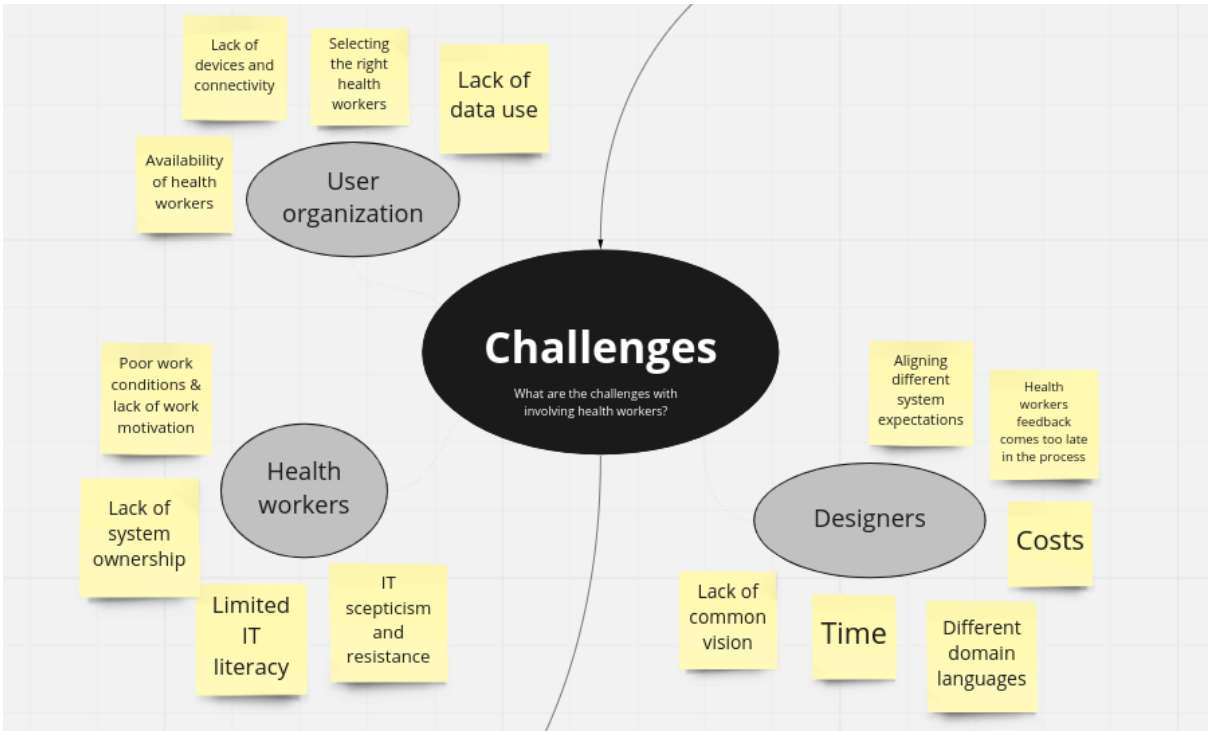


Figure 3.12: *A screenshot of the simplified model on challenges involving* healthcare workers.

Second online workshops with eHealth designers

The second follow-up workshops (Appendix 1 & 4) were conducted 10 times having in total 25 participants. The eHealth designers were presented with preliminary analysis for feedback, and also given some few more brainstorming sessions focusing on opportunities for better involvement of healthcare workers in the future.

Analysis of current means, challenges and stakeholders were presented to the eHealth designers to validate the findings, clear up ambiguous language, and to probe participants for additional inputs (Brandt et al., 2012). Mind mapping was used to draw connections between various themes and visualize relations. Some of the results were presented as image collages combining sticky notes with icons and photos to avoid ambiguity and also to make the sessions more engaging, see figure 3.13 as a sample on presentation of current remote means of involvement of healthcare workers.

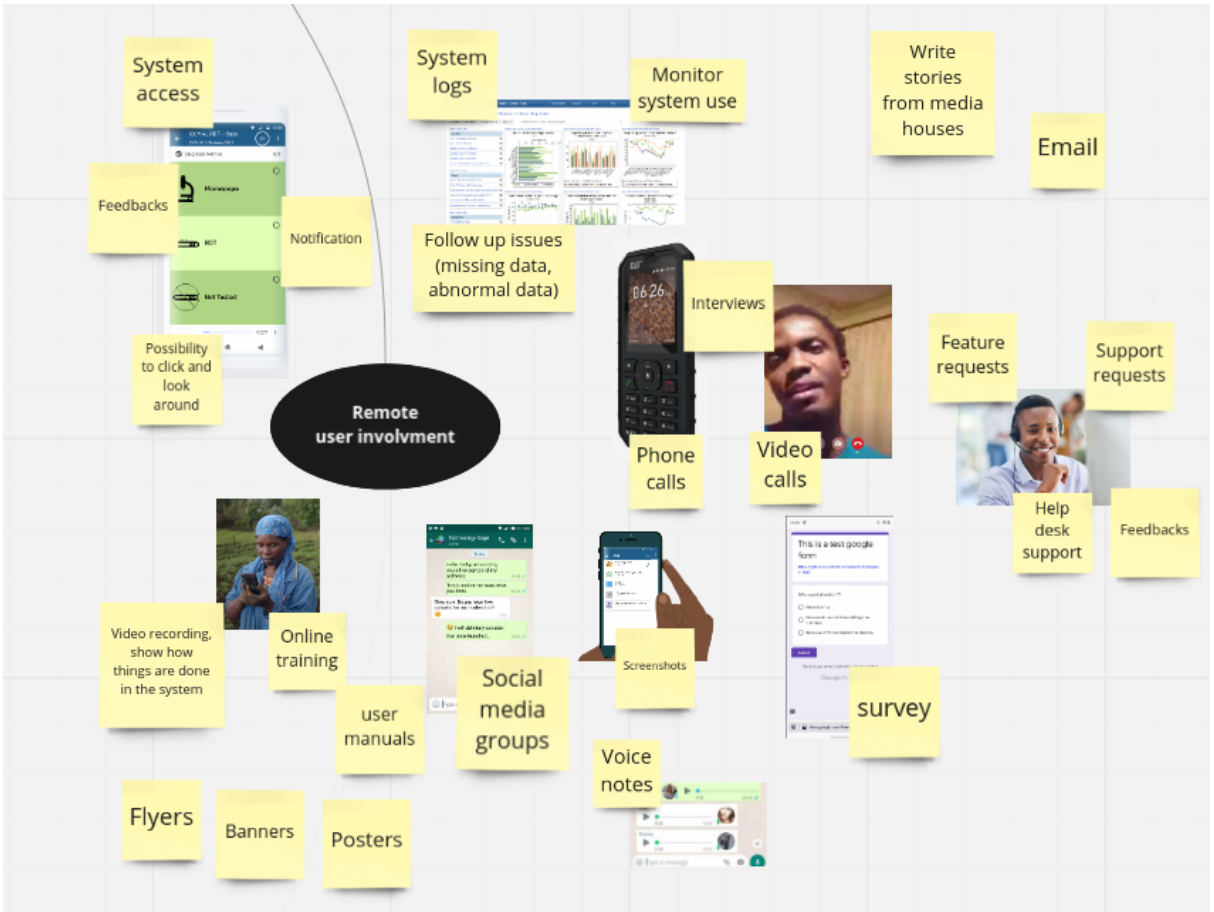


Figure 3.13: *Screenshot of how current remote means of healthcare workers involvement was presented using image collaging. Current means were presented in sections based on on-site and remote means of user involvement as this was a key division discussed in the first workshop due to the COVID19-pandemic.*

The images helped to visualize relationships between issues and get a quicker overview of a larger qualitative analysis. The image collages were made very simple looking like sketches attempting to make it easier for participants to give feedback and suggest improvements. Images and illustrations were replaced based on eHealth designers feedback to make them better represent the real-world problem situation. In this way the visualization of relations on the online whiteboard assisted in co-analysing the result together with the eHealth designers. The analysis was iterated on and adjusted between each workshop based on feedback from the eHealth designers. Figure 3.14 shows a screenshot of the initial analysis of stakeholders, whereas figure 3.15 displays how the analysis of stakeholders looked after being iterated on through 9 workshops. In this way the analysis has been going on continuously in parallel with the data collection to co-analyse the result with the participants.

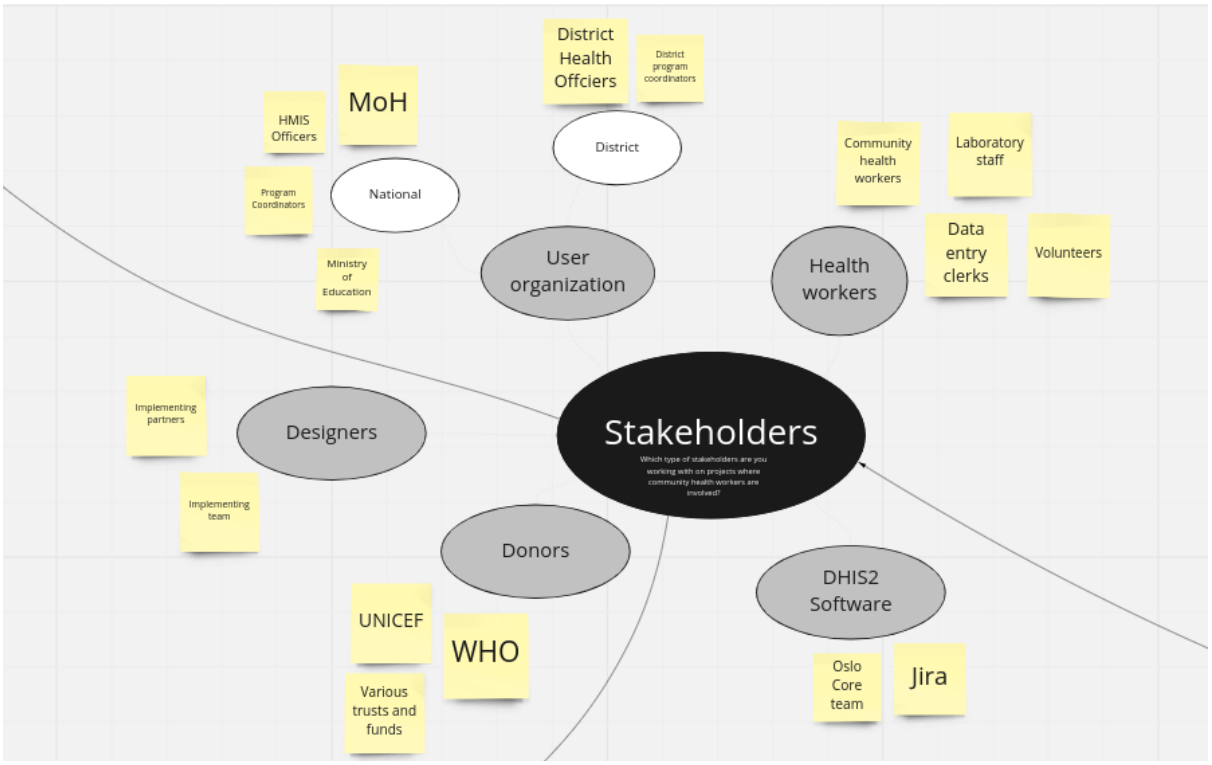


Figure 3.14: *A screenshot of preliminary analysis of implementation stakeholders*

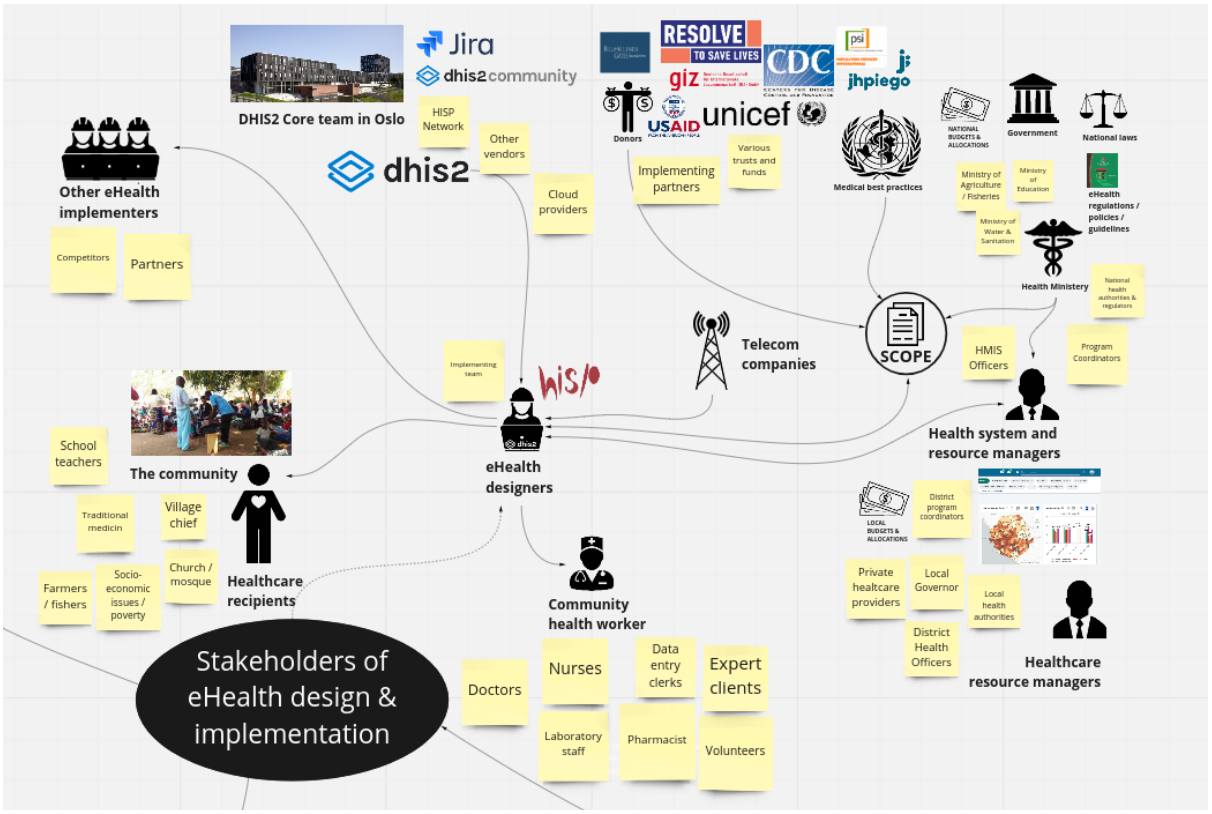


Figure 3.15: *A screenshot of analysis of implementation stakeholders after iterating through 9 workshops using image collaging.*

The visualizations were also used to prime the eHealth designers for brainstorming sessions towards the end of the second workshop on opportunities for better involvement of the healthcare workers in the future, exploring both on-site and remote means of users involvement, as well as communication between stakeholders. The brainstorming sessions generated in total 77 new sticky notes with inputs. After the brainstorming each participant also presented their inputs more in depth and commented on each other's suggestions. Figure 3.16 displays analysis of results combined from all participants in the study brainstorming a broad range of opportunities.

Figure 3.16: *Screenshot of results from brainstorming sessions on opportunities for better involvement of healthcare workers.*

Identifying opportunities and building a conceptual framework

In March 2022 I visited Malawi as part of the BETTEReHEALTH project and conducted a field visit to a community health facility nearby Kasungu together with local eHealth designers which provided the possibility to reflect more on the findings. In April 2022 I also arranged a webinar as part of the BETTEReHEALTH project about involvement of CHWs during design and implementation of eHealth solutions where eHealth designers from Ethiopia, Malawi, Nigeria, and South-Africa presented to each other about experiences involving the CHWs during design and implementation projects.

After the second round of workshops, field visit and webinar, the analysis was reworked again. Based on the participants' recommendations, the analysis focused more on which phase of the design and implementation process the themes related to, rather than the stakeholders, see for instance figure 3.17 with themes related to opportunities for better involvement of healthcare workers suggested by the eHealth designers. Different elements such as stakeholders, practices, tools used, situations, and goals, were converted into icons that have helped as shortcuts to get overview of the large qualitative material, to easily be

moved around to update the analysis based on new insights, and also to communicate the analysis more clearly when presenting them.

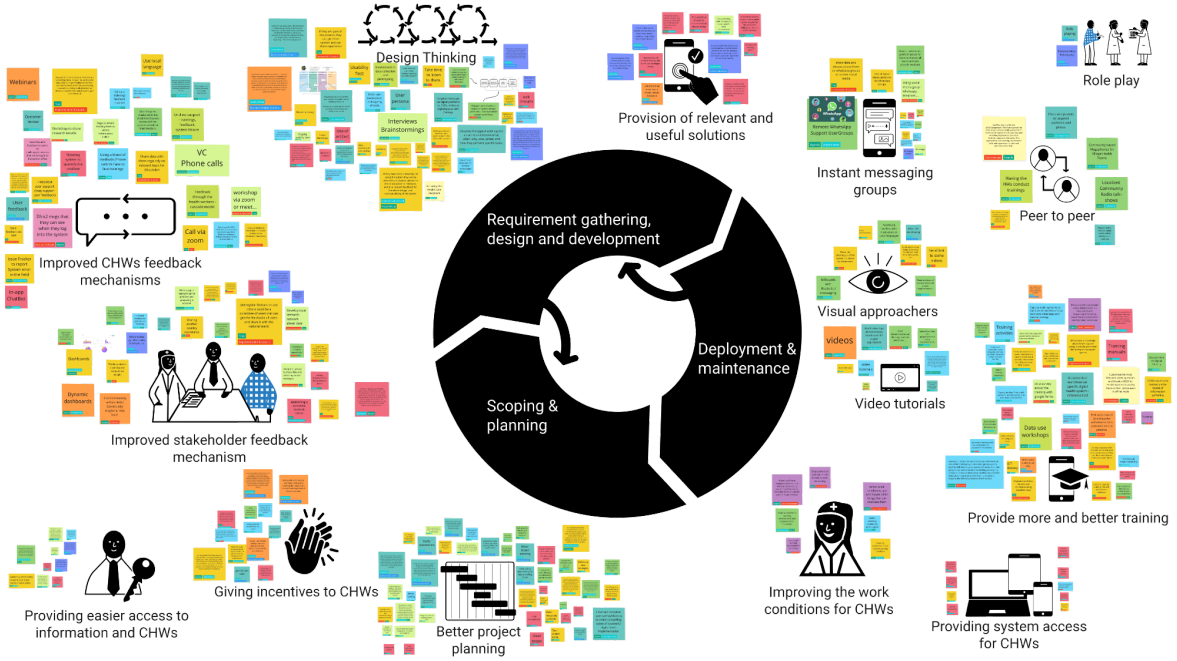


Figure 3.17: *Themes on opportunities for involving the* healthcare workers *organized by the different phases of the design and implementation process.*

A broad spectrum of opportunities were identified based on the eHealth designers experiences and speculations about future viable means. During the process of visualizing, analyzing and regrouping both applied and envisaged opportunities some interesting prospects were identified, which will be presented under section 4.3. The identified prospects represent somehow surprising suggestions compared with conventional design methods, having in common that they are simple to use with limited complexity, fit into the context, adaptable, can be applied at low cost, and potentially be sustainable in the long term perspective. Many participants pointed to challenges related to limited resources and I therefore worked further in the analysis to identify possible means that could fit in such contexts. Based on the inputs from the eHealth designers, discussions with other researchers, as well as analyzing related literature, *Frugal user involvement* was conceptualized to focus attention on affordable means to carry out quality user involvement appropriate to a LMICs context. The concept has been helpful to analyze and discuss the research results, and to focus which part of the broad data material collected in this qualitative study that should be presented.

Narrative literature review

To identify relevant literature searches have been done in the databases PudMed, Google Scholar, Scopus and AIS eLibrary using keywords related to user involvement, and LMICs. Literature on user involvement has been identified using similar terms such as user centered design, user centric design, use centered design, human centered design, user oriented design, activity centered design, participatory design, and usability engineering. To find relevant articles about user involvement in LMICs I've used keywords such as, developing countries, global south, Africa, and all the individual names of the African countries. The related literature has also been supplemented by literature from relevant courses I've been enrolled to at the university, and advices from my supervisors as well as other researchers. After discovering the relevance of frugal innovation for user involvement in LMICs literature on frugal innovation was also searched using the same databases.

Discussing the analysis with eHealth designers and researchers

Finally the results and concept of frugal user involvement was presented to both eHealth designers and researchers for feedback. This involved presentations for researchers from University of Oslo affiliated with both the Design Research group and the Information System research group, researchers with diverse backgrounds related to eHealth from the BETTEReHEALTH project, researchers and post-graduate students with informatics background at the DHIS2 Design Lab, and health researchers at SINTEF Digital. The research was also presented for participants from Nigeria, Rwanda, Uganda, Malawi, Mozambique and Togo, as well as in a seminar for eHealth designers from various African countries involved in developing a curriculum for master level eHealth students in African countries.

Based on the feedback, several adjustments were made to refine the analyses, enriching some aspects, reworking the level of details, and clarifying ambiguities. Also the concept of frugal user involvement was reworked several times based on critical remarks, questions and discussion on the usefulness of the definition.

3.5 Ethical considerations

This research has been done according to Norwegian research regulations; The project has been reported to the Norwegian Centre for Research Data (NSD). All participants were provided a consent form according to NSDs guidelines explaining the purpose of the research. Consent was given orally in the start of the interview / workshop. The collected data have been kept securely, and all participants have been anonymised in both

transcriptions as well as this publication. No sensitive data such as information about healthcare recipients, e. g. medical records, were collected. Only remote means of data collection were used to avoid the spread of COVID19 during the pandemic.

The participants have benefited from this research in various ways: The research was driven by democratic values of participation so all the participants had a voice on every topic raised, and the workshop included participation from many different geographical locations. Many of the participants learned a new tool (online whiteboard) that they can use for remote collaboration beyond this research. The participants also had access to the result from each workshop after it finished for their own reference. The research results have been presented back to the participants during live sessions and in the form of an infographic, providing them overview of each other's experiences, and maybe provide inspiration or expand their perspectives on possible new work practices, thereby giving value directly back to those spending their time participating in the study. This research also assists in mapping out various challenges and opportunities for eHealth designers working in LMICs and gives them a stronger voice within the research community. That can hopefully contribute to improving eHealth designers' work conditions and practices so they're able to deliver eHealth solutions providing better work conditions for healthcare workers and improved service delivery to healthcare recipients. In a broader perspective this research also contributes to building knowledge about key processes that can influence achievement of sustainable development goals such as good health and well being for all, and decent work.

4. Findings

This chapter presents the findings based on the thematic analysis of the empirical data. First, to give an overview of the context the eHealth designers' current work practices throughout the design and implementation process is presented broadly. Then the eHealth designers challenges involving healthcare workers are described. Finally the opportunities for better involvement of healthcare workers envisaged by the eHealth designers are outlined.

4.1 Work practises of eHealth designers

We will now look at the work practices of the eHealth designers, which includes various tasks during the whole design and implementation process. The process can roughly be divided into three main phases;

- **Scoping and planning,** where the purpose of the solution and the plans for the project are decided
- **Requirement gathering, design and development**, where the eHealth designer try to learn about the work context of the healthcare workers and start to develop the eHealth solution based on generic software
- **Deployment and maintenance**, where healthcare workers are provided training, documentation, user support, follow-up on data entries, and feedback on entered data.

This is a cyclic process where for instance issues discovered during requirement gathering can lead to renegotiation of the project scope or adjustments to plans, and issues discovered during deployment can lead to new requirements causing further design and development on the current system or feed into requirements for future systems. We will go through activities the eHealth designers explained to be doing in various eHealth projects, however the specific activities and means of involving healthcare workers will obviously vary depending on the specific eHealth project.

Scoping and planning

During the scoping and planning phase the purpose of the solution and the plans for the eHealth projects are decided. The eHealth designers counsel the donors and top-level managers within the user organization how to make the best use of current eHealth solutions or plan for new solutions. The donors and the top-level managers, such as information system officers and program coordinators, sign off the project scope and are the most influential stakeholders.

The eHealth designers explained that the project scope and plan is also informed by some feedback from healthcare workers to the eHealth designers across different channels throughout the implementation process such as during field visit, workshops and focus groups, training sessions, help desk support, feedback forms within the user interface and during routine data collection. The eHealth designers from South Africa also shared an example of the possibility for the healthcare workers to pitch an idea for a new system. However the eHealth designers also explained that healthcare workers are typically not too much involved during the scoping and planning phase.

Requirement gathering, design and development

During the requirement gathering the eHealth designers report to use many conventional means for user involvement such as interviews, field research and observations, document analysis, workshops and focus groups, brainstorming and survey. The eHealth designers also describe frequently using instant messaging groups (IMGs) to keep in touch with the healthcare workers remotely.

The eHealth designers explained to typically start the technical implementation of the eHealth solution with an instance setup of the system based on the generic software (DHIS2). The eHealth designers described integrating the system with data sources from other systems, configure forms, set up indicators, scorecards and dashboards, and in some cases also develop dedicated apps. The eHealth designers can conduct user testing or semi-deploy the system as an early prototype to be tested and used in the real environment generating feedback from the healthcare workers. Several eHealth designers also explained the need to provide early training to healthcare workers being involved in this phase to capacitate them.

Deployment and maintenance

After the system is deployed the eHealth designers conduct training sessions for healthcare workers. The eHealth designers try to make the training sessions engaging, for instance using group based activities and role plays. The eHealth designers also discussed the training as a possible space to get feedback on the system from the healthcare workers. The eHealth designers reported to often conduct activities for training, requirement gathering and evaluation of the system in combination. During the COVID-19 pandemic the eHealth designers described having gone from doing mostly face-to-face training and group based training to conducting mostly remote training, for instance using video conference tools or IMGs.

The healthcare workers are also provided resources like user manuals, guides and video tutorials over IMGs. The healthcare workers are assisted over help desk support, often using IMGs, which can also generate feedback on the current system to the eHealth designers. In addition, the eHealth designers monitor systems logs and follow up data quality issues which can help uncover various underlying issues relating to system use such as flaws in the system, power shortage, users not feeling comfortable with the system, lack of training or motivation, too heavy work-load, poor work conditions, and also healthcare workers who enter "*cooked data*" indicating that the healthcare workers is not doing their work properly and enter false data. The eHealth designers explained that IMGs can be used to share back results from submitted data to the healthcare workers, to spark discussion about use of data as well as how to adapt the solution to become more useful for them.

The donors and top-level managers are usually kept updated during the design and implementation process using reports, powerpoints & video presentation. Issues and requirements can also be shared with the developers of the generic software to improve the next version, or with policy makers to improve the regulatory framework. The healthcare workers are usually not provided that much feedback before deployment, and are mostly provided feedback on submitted data.

Summary

The eHealth designers cover a range of responsibilities throughout the design and implementation process. The healthcare workers are not included much when eHealth projects are scoped and planned. The involvement of healthcare workers in the requirement gathering, design and development is limited. The feedback from the healthcare workers mostly comes after the system has been developed and deployed. The eHealth designers also explained combining activities, e.g. doing requirement gathering, evaluation and training during the same field visit, and to semi-deploy systems, blurring the lines between these activities. Figure 4.1 illustrates the findings on current work practices and means used to involve the healthcare workers during the different phases of the implementation process.

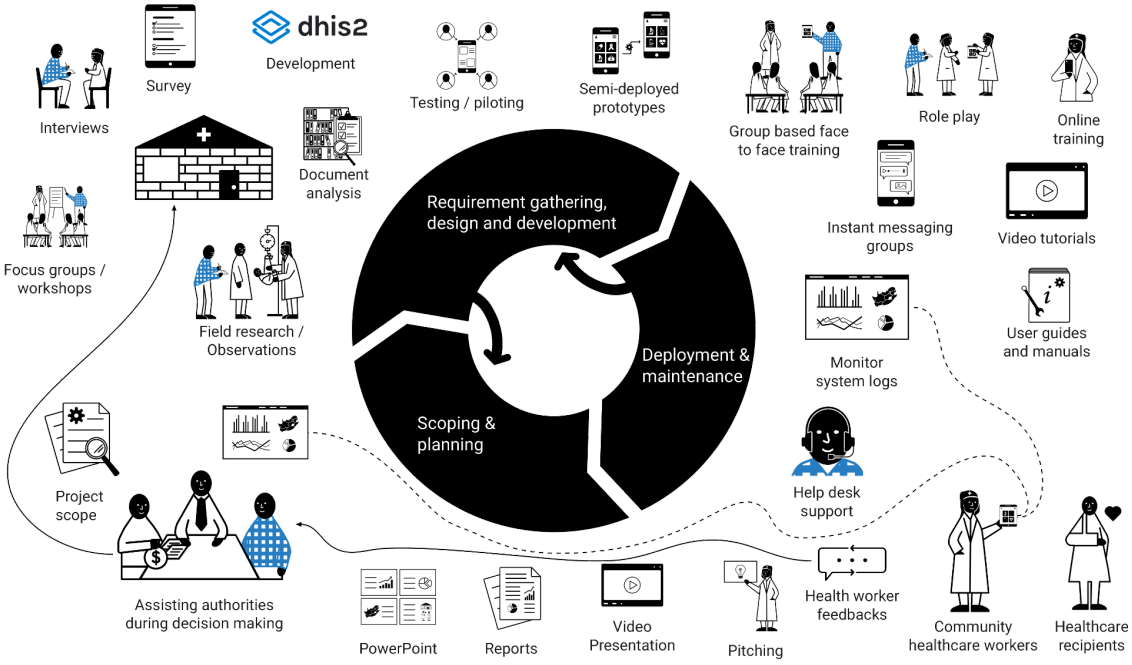


Figure 4.1: Illustration of activities reported to be carried out by the eHealth designers during the different phases of the design and implementation project.

4.2 Challenges of involving healthcare workers

After getting an overview of eHealth designers' current work practices we will continue focusing on which challenges the eHealth designers are experiencing when trying to involve the healthcare workers. Some of the challenges relate to how the implementation is planned and organized, other challenges relate to the healthcare workers experiences, skills and attitude. Lastly, some challenges relate to different types of managers within the user organization who manage access to resources such as documents and information, devices and connectivity, and the availability of healthcare workers.

Project scope not based on healthcare workers needs

During the scoping and planning phase the eHealth designers' described to mostly be in touch with the donors and top-level managers, and little in direct touch with the healthcare workers. The project scope is thereby often mostly influenced by the donors and top-level managers, who need aggregated data, whereas the healthcare workers, who need systems that support their work, are little involved in defining the project goals.

The eHealth designers explained that there often seem to be too little collaboration between the managers and the healthcare workers at the lower level within the healthcare system. The eHealth designers reported that the solutions typically are suggested by donors and

top-level managers and then the eHealth designers wrongly assumes that the managers understand the needs on the ground. This can subsequently make it difficult to reach a common vision with the healthcare workers and explain to the healthcare workers how they can benefit from the solution during activities like requirement gathering, design and training, which can negatively affect healthcare workers willingness to become involved.

The eHealth designers reported that eHealth projects often are scoped as isolated instances leading to fragmented implementation of solutions. For instance different solutions for various vertical health programs each with their own managers, donors and solutions. Politics and competition between donors to implement and show off their own solutions were claimed to be a major driver for the fragmentation of solutions, sometimes even leading to very similar solutions being implemented within the same facility, making healthcare workers use different devices for similar tasks and increasing their work burden. The design and implementation process were explained to often be planned with a short term perspective until the system is deployed and end-user training is finished, but lacking the long term perspective on how the system will work within the context of the healthcare workers day-to-day work and provide value for the healthcare workers after deployment. The eHealth designers also attributed fragmentation of solutions to managers' lack of compliance with policies and strategies providing opportunities for monetary funds to influence the process. The eHealth designers argued that fragmentation of solutions can weaken the current system and processes in place, and make the healthcare workers confuse solutions with each other during requirement gathering. Figure 4.2 displayed sticky notes with some of the inputs from the eHealth designers on poor project scoping.

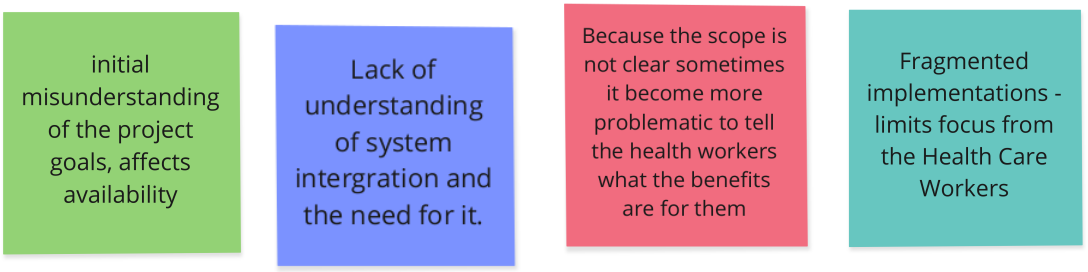


Figure 4.2: Screenshots of sticky notes created with inputs from the eHealth designers during brainstorming challenges involving healthcare workers relating to poor project scope.

Too short project timeline

The project timelines were reported to typically be based on donors and top-level managers' need for delivery of solutions, often resulting in a too short timeline to meaningfully involve

healthcare workers. Involving healthcare workers can be quite time consuming, for instance, traveling to the field, especially considering that traveling to some of the places where healthcare workers work can include long journeys into very rural areas, meeting physically, discussing and grasping all the information and doing walk-throughs. Involving healthcare workers with low digital literacy also requires extra time both before and after deployment for capacity building, to teach and explain the healthcare workers more, and also to design and tailoring the solution for end-users with low digital literacy, stretching the required implementation timeline. Other aspects reported making involvement of healthcare workers time consuming were related to managing more requirements, stakeholders and communication like providing orientation, aligning different system expectations and adapting the system to different real life scenarios, going forth and back on more issues, etc.

Healthcare workers being involved too late

Many eHealth designers reported that feedback from the healthcare workers often comes at the end of the process during user testing or training sessions, when it is too late to make major changes in the design and fix issues, rather than at the start of the process when issues can be resolved more easily. The eHealth designers claimed that there is a tendency to focus on planning enough time for development as it is assumed this will take up much time, but less time is planned to understand the healthcare workers needs before the development starts. The eHealth designers also reported that lack of time and funding makes it difficult to design prototypes prior to development.

Lack of resources to facilitate for user involvement

Lack of resources for involving the healthcare workers was also discussed by the eHealth designers as a major challenge. The eHealth designers discussed how implementation costs are increased by involving the healthcare workers, especially field visits, workshops and training activities that require funding for staff, traveling, logistics, renting space for activities and lodging, devices and connectivity. Contributing factors to lack of resources to involve healthcare workers was lack of budgeting for user involvement, lack of allocation of funds that have been budgeted for, and discontinuation of funding, for instance when funding stopped after the pilot stage of the system.

Managing requirements, stakeholders and communication

Managing requirements, stakeholders and communication was reported to be major challenges, as the different types of end-users have different system expectations. For instance there can be different expectations between what data managers on the central and

national level want collected, vs what is realistic for healthcare workers to capture and collect on the ground, or different expectations between healthcare workers working in different districts using different workflows and receiving training in different protocols, as well as individual preferences between different healthcare workers. The eHealth designers warned about the possibility of going on and on continuously with requirements, adjustments and inclusions based on not only needs, but wish lists, and losing focus on core functionalities which can eventually affect the timeline and cause delays, as well as having financial implications. The lack of common vision between the stakeholders was discussed as a challenge to clearly communicate the findings and keep a common understanding, and to figure out how to integrate the solution with the different healthcare services and programs. Also interference from competitors, politics and corruption was claimed by eHealth designers to make collaboration with stakeholders more difficult, and making it difficult to create a common vision with the healthcare workers which can experience fragmented implementation of similar solutions even within the same facility by different partners. Different domain languages between the eHealth designers and the healthcare workers leading to misunderstandings was also brought up as a challenge as medical and technical professions use different terminology and mental models. Various sticky notes related to challenges of managing requirements, stakeholders and communication are displayed in figure 4.3.

Figure 4.3: Screenshots of sticky notes with inputs from eHealth designers relating to management of requirements, stakeholders and communication created during brainstorming challenges involving healthcare workers.

Technical limitations with the software

Technical limitations with the software were also discussed by the eHealth designers as a challenge during development. Lack of user interface translation into local languages was raised as an issue by several eHealth designers. Some also experienced challenges with system upgrades, especially when working with end-users in remote areas.

Poor work conditions and lack of work motivation

Poor work conditions and lack of work motivation among the healthcare workers was stressed by many eHealth designers as one of the major challenges of involving the healthcare workers. The healthcare workers are often underpaid, working in under facilitated and understaffed work places, overloaded with too much work. In such a context it can be difficult to come and start to gather requirements for a new system and create engagement for it, as the healthcare workers might feel you are bringing extra work to them. One implementer from Nigeria explained the situation on the ground: "*When you go to the majority of the health centers at the community level you'll find out that you have just one person handling almost all activities in a particular health facility. When you have a 'one man facility', you can imagine what goes on in that facility. Some services will not be rendered and the impact of the service would be cut short*". Some solutions have not been designed with the healthcare workers in mind, or how the system will function in their day-to-day work, and the solutions will therefore give healthcare workers an extra work burden negatively affecting the work environment, instead of supporting and providing values for the healthcare workers. One example of this can be duplicated data collection due to parallel systems, as well as parallel paper based and digital systems. The eHealth designers also raised the issue of staff turnover, for instance healthcare workers trying to get jobs in places where they get better work conditions, often in private health facilities. The eHealth designers claimed that poor work conditions generally can be challenging to do something about, but with better scoping and planning duplicated data collection could be avoided. Figure 4.4 displays sticky notes with some of the inputs from the eHealth designers about healthcare workers' poor work conditions and lack of work motivation.

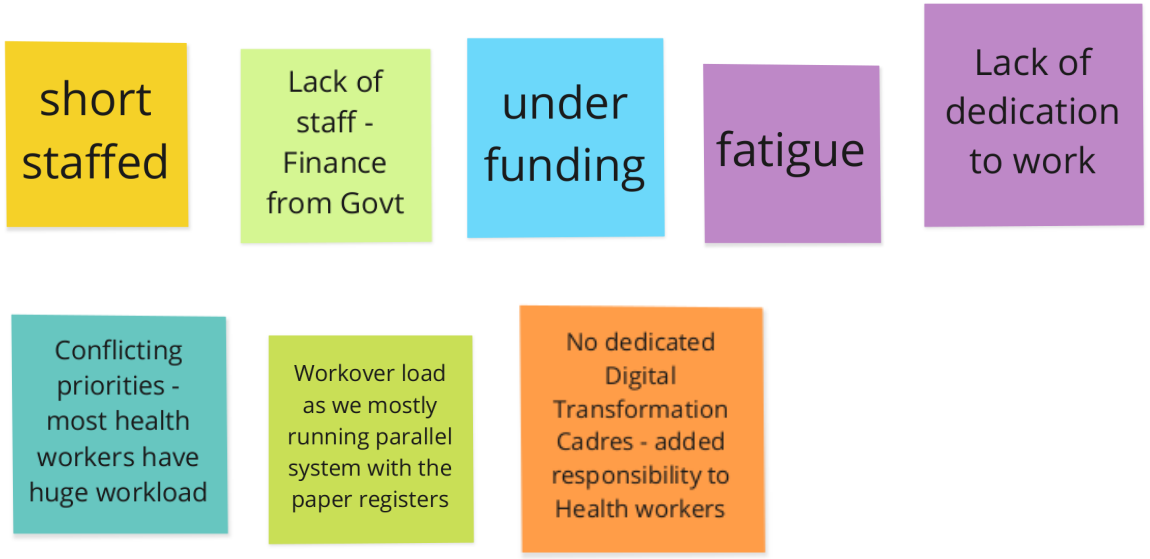


Figure 4.4: Screenshots of sticky notes created with inputs from the eHealth designers during brainstorming challenges involving healthcare workers related to poor work conditions and lack of work motivation.

Skepticism and resistance towards IT

Skepticism and resistance towards IT from the healthcare workers was reported to make healthcare workers avoid being available for activities like workshops and training, and to avoid using the solution once deployed. Various reasons were mentioned such as limited IT literacy which can make introduction of new IT tools appear as threatening for the healthcare workers as the solution might change healthcare workers work practices and make healthcare workers afraid to become underskilled, especially among the elderly generation. Previous experiences with minor errors or system bugs can also make the healthcare workers hesitant to use the system. The eHealth designers shared examples of data being lost within the digital system leading to fear from healthcare workers that it will happen again. The eHealth designers also claimed many healthcare workers prefer paper based systems as they are used to paper forms and dislike changes. Paper forms also just require a pen, whereas digital systems make the healthcare workers dependent on devices, connectivity and power supply to conduct their work - which are often in short supply. Once devices, connectivity or power is unavailable the healthcare workers are required to fallback on the paper based system, and later re-enter the data into the digital system. The eHealth designers explained that digital systems are often introduced in parallel with paper based systems, instead of replacing them, as a backup in case the digital system is unavailable, increasing the workload of the healthcare workers, without providing much benefit to their

work. The healthcare workers were also explained to in some cases fear that the new solution will be used to monitor their work.

Lack of system ownership

Lack of system ownership was explained to be a challenge for involving healthcare workers both during requirement gathering and for healthcare workers to start using the system after deployment. For instance when the healthcare workers don't understand the project goals or how they can benefit from the solution, or the solutions are forced on them using top-down means. The eHealth designers also reported that healthcare workers often experience a long time before they receive feedback on reported issues, or the feedback will not come at all because it needs to be solved at a higher level, e.g. policy level, so the issue is just forwarded from the eHealth designers up in the hierarchy, demotivating healthcare workers to involve themselves. Lack of sustainability, such as short term funding and changing plans due to new political leadership, was claimed to alienate the healthcare workers as they experience constant changes, for instance new solutions first being introduced, until the funding stops, and then they are back to use paper forms again, and then later a new solution is introduced once again, and it was claimed these kinds of experiences can make some healthcare workers lose interest in new solutions.

Limited IT literacy

Limited IT literacy among the healthcare workers, such as lack of training, experience and skill in IT, was another issue discussed by many eHealth designers as a challenge during both the requirement gathering and after deployment, especially when working with healthcare workers in the rural areas. The eHealth designers claimed that healthcare workers sometimes can be a little over reliant on paper registers. One implementer from South Africa explained that "*we want data to understand how to make better decisions, their skill set is something different, their skillset is focussed on the patients and not data science*". The eHealth designers explained that limited IT literacy can make it more difficult for healthcare workers to understand and conceptualize the digital system workflow, making it necessary to explain more, provide more training and teach digital skills to get higher quality feedback for requirement gathering. Lack of IT literacy also makes it necessary to provide more training to the healthcare workers before starting to use the system once deployed. Limited IT literacy in combination with a poor work environment was claimed to make it especially difficult to motivate the healthcare workers to start using the system. Some eHealth designers also claimed that limited IT literacy makes it necessary to tailor eHealth solutions more to the healthcare workers stretching the project timeline. Other eHealth designers challenged the

idea of the magnitude of the IT literacy problem, claiming that IT literacy didn't seem to be such a big issue for the healthcare workers when using IMGs, and theses eHealth designers therforefore attributed lack of systems use more with lack of relevance and usefulness of the solution than limited IT literacy. Figure 4.5 displays some of the inputs from the eHealth designers about challenges relating to limited IT literacy.

Figure 4.5: Screenshots of sticky notes created with inputs from the eHealth designers during brainstorming challenges involving healthcare workers related to limited IT literacy.

Unavailability of healthcare workers

The healthcare workers being unavailable for activities, such as requirement gathering, workshops and training sessions, was also argued by several eHealth designers to be a challenge both during the requirement gathering and after the system has been deployed, making it necessary for eHealth designers to change plans and delaying project timeline. Various reasons were given such as challenging and time consuming processes to get permission to conduct the activities, due to bureaucratic structures in the user organization, as well as lacking availability of time for healthcare workers which are usually already overwhelmed by other work tasks and conflicting priorities, or healthcare workers suddenly being transferred to other facilities. The eHealth designers also experienced that healthcare workers not understanding the value of the eHealth project, or being skeptical towards the project, as well as skepticism from healthcare workers, could make them avoid activities. The healthcare workers not being used to collaborate remotely using video calls was also reported as a challenge especially during the COVID-19 pandemic.

The eHealth designers explained that the user organization sometimes does not select the appropriate healthcare workers to participate in activities for requirement gathering and training. In some cases managers are sending inexperienced staff for requirement gathering activities when the eHealth designers might prefer someone with at least basic business knowledge to provide the necessary information. In other cases managers are sending staff with very good IT skills trying to impress the eHealth designers, whereas the eHealth designers also want to meet staff with more limited IT skills to get a realistic idea about who will be the user of the future system. The managers can also send staff that are irrelevant for the activity motivated by gaining from incentives such as free food and lodging.

Lack of system access

Lack of system access was also pointed out as a challenge by many of the eHealth designers making it difficult for eHealth designers to observe how the healthcare workers are using the eHealth solutions during requirement gathering or piloting of the system, and difficult for healthcare workers to access the eHealth solutions once deployed, often resulting in fallback on the paper based systems. The eHealth designers elaborated on various reasons for lack of system access for instance local power outage or server downtime, connectivity issues such as non-existing, poor or unreliable network, or shortage of devices such as smartphones, tablets, or computers. The eHealth designers also reported that in many cases the healthcare workers need to use their own personal devices for data collection and provide the data bundles themselves. Lack of login credentials for healthcare workers were also discussed, and in some facilities the data is not entered by the healthcare workers but by dedicated data entry clerks.

Lack of data and system use

Several of the challenges during the requirement gathering persisted after deployment of the system resulting in lack of data and system use. Various reasons were highlighted to explain why healthcare workers in some cases do not use the system after deployment such as lack of usability and usefulness of the solution providing extra work burden for healthcare workers already working under poor conditions and lacking work motivation, limited IT literacy among healthcare workers for instance due to lack of training, making it difficult for healthcare workers to understand the features and the workflows in the digital system, as well as skepticism and resistance towards the solution. The eHealth designers also discussed lack of data use culture, for instance lack of feedback to the healthcare workers after data submission causing an absence of ownership of the solution (e.g. if the healthcare workers do not use the data themselves, but are just collecting data to be used at the next levels).

The eHealth designers claimed that sometimes the managers at different levels of the hierarchy are not even using the data themselves. Lack of system access was also discussed by many of the eHealth designers. These various issues can all contribute to making the healthcare workers unwilling or unable to use the system.

Figure 4.6 illustrates the main challenges reported by the eHealth designers during the different phases of the design and implementation process.

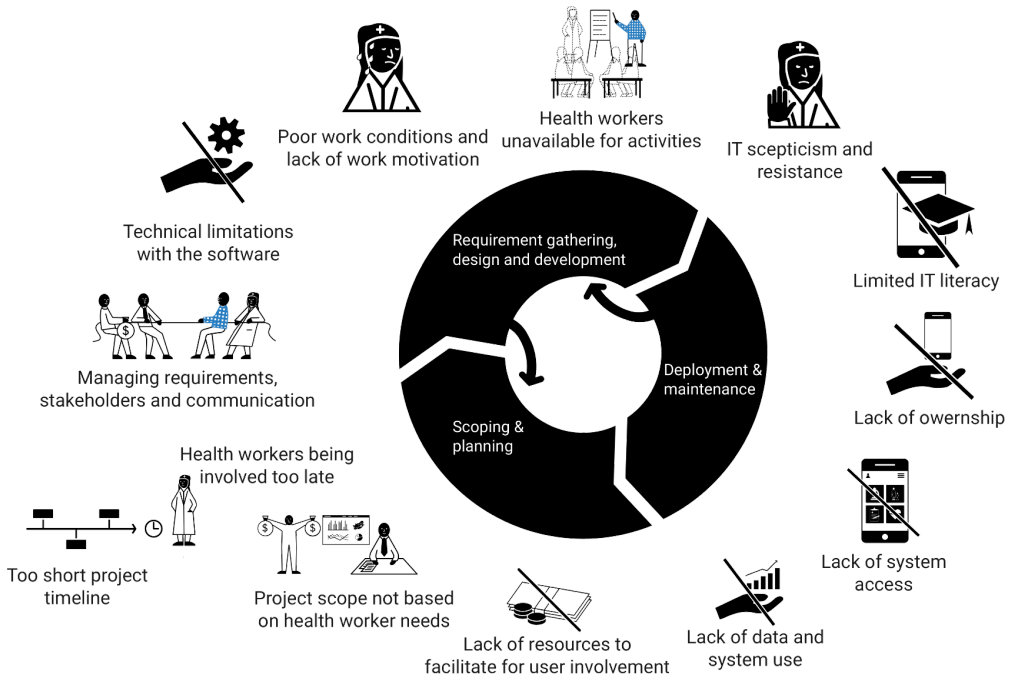


Figure 4.6: Illustration of the main challenges to involve healthcare workers reported by eHealth designers.

4.3 Opportunities for better involvement of healthcare workers

Finally a range of opportunities suggested by the eHealth designers for better involvement of healthcare workers will be outlined, based on both lessons learned through currently applied practises and new potential practises envisaged by the eHealth designers trying to mitigate some of the identified challenges. The identified opportunities are not concrete, but represent themes that have emerged through a range of proposals from the eHealth designers. The main identified opportunities based on the eHealth designers inputs to better involve healthcare workers are role play, IMGs, visual means, design thinking, prototyping with generic software, peer driven user involvement, effective stakeholder feedback mechanism and improved organizing of projects.

Role play

Role play was reported to be used by eHealth designers from Malawi and Nigeria where the healthcare workers will be assigned different roles and will need to play out a scenario mimicking activities that could happen in real life solving a task using technology. Role play was primarily explained to be used in training sessions, but also as a way to discover new requirements and explore the possible use of the solutions. One implementer from Malawi elaborated on the utility of role play during training sessions "*Presentation alone is not sufficient. They might feel they have understood, but once they go to practice they realize they don't have the skills. So in a role play you assume or mimic a scenario where the digital product is being used. So one might be the client and the other might be the health worker, and you ask them to play a role of health workers and client playing to use the digital tool. That way you are able to see whether the person being trained has been captured, or is having issues. And also to have a feeling about what else should be considered in a real life involvement*". In other words observing the healthcare workers act out these scenarios can help observe whether the person being trained has really learned the skills and knowledge they are supposed to, as well as assisting in generating feedback from healthcare workers helping to discover new use cases and requirements.

Role play was also explained to activate the healthcare workers as they will explore by physically doing something to understand what should be achieved, make the training sessions more engaging, and put the healthcare workers in a conducive mood to learn in a different way while having fun. Role play was also explained to facilitate group training as the healthcare workers can learn by observing each other using the eHealth solution. Role play was claimed to make the session more relaxed, fun and seem less like a work burden, and provide different kinds of feedback than using other means of involvement.

Other eHealth designers not experienced with role play were enthusiastic when presented about the concept. The eHealth designers proposed using more role play during the design phase to let the healthcare workers physically explore prototypes, while putting them in a more playful state making them more comfortable to give feedback and share suggestions. Figure 4.7 illustrates how role play can be used during the design and implementation process.

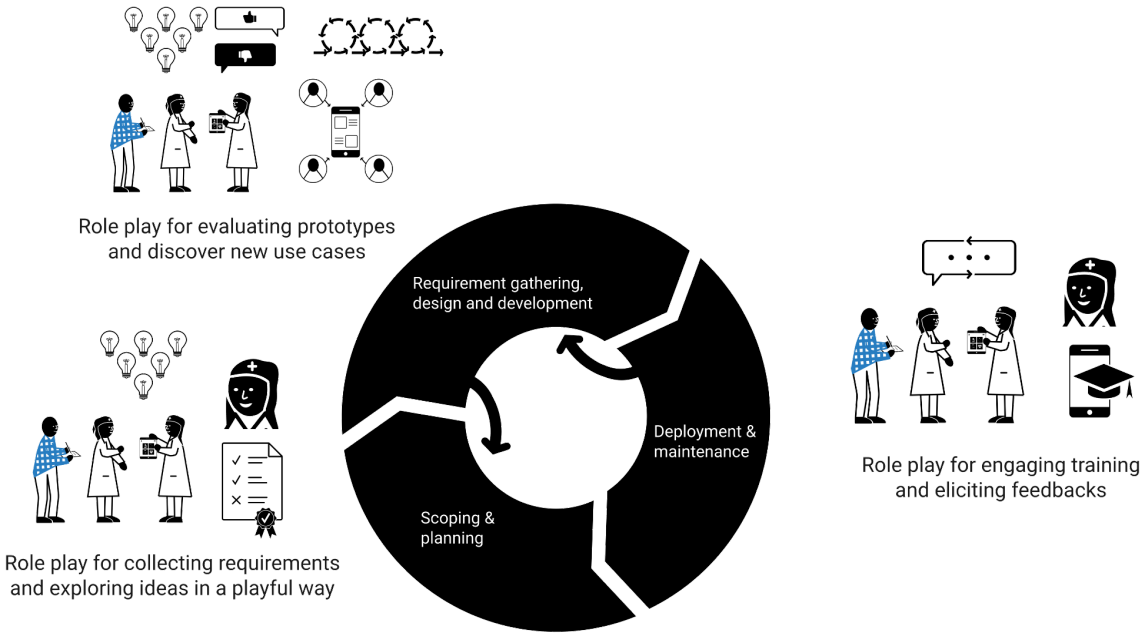


Figure 4.7: Illustration of opportunities to use role play to involve healthcare workers reported by eHealth designers.

Instant Messaging Groups (IMGs)

IMGs were reported to be used by participants from all countries in this research to communicate directly with healthcare workers, as well as other stakeholders, through group chats having a two-way remote instant communication, typically using international platforms such as WhatsApp and Telegram, or more local platforms for instance Vula used in South Africa. The eHealth designers explained that group chats over IMGs can be organized based on specific implementation projects, geographical areas or types of healthcare worker professions. The eHealth designers explained that the IMGs can be a good way to keep in touch with healthcare workers remotely, be in touch more frequently and instantly, and reach healthcare workers in more districts using less resources.

The group chats were explained to be used in many different ways throughout the design and implementation process like getting feedback from the group, learning about new issues, find out if these issues are common for the whole group, facilitating group discussions, brainstorming solutions, providing training materials, and sharing feedback on submitted data. The eHealth designers also explained that IMGs could be used to give updates on changes in the system, instructing healthcare workers on how to update the app, and asking healthcare workers for instant feedback remotely, making it possible to contact the healthcare workers from time to time remotely evaluating their experience with the solution after

upgrades and changes. The eHealth designers highlighted the possibility for healthcare workers to share rich feedback in the group chats like screenshots, photo or voice messages to elaborate on their thoughts and any potential challenges. The eHealth designers suggested that IMGs can provide healthcare workers low threshold assistance by letting them ask for help in an unlayered environment mixed with both eHealth designers, managers and peers or colleagues, as one implementer from Rwanda explained "*if someone faces a challenge on the field they don't have to go through the whole email process or anything, they can just go to the WhatsApp group, post it and anybody that is close by within the WhatsApp group can easily give support to them*". IMGs were also claimed to facilitate peer-to-peer assistance where colleagues can help each other, which both can provide quicker response when help is needed, build capacity among the healthcare workers and provide help desk support using less resources. IMGs were also explained to let healthcare workers join activities, like reading updates, checking video tutorials or answering messages, at a time when it is most convenient for themselves, at their own pace.

Several eHealth designers recommended increasing the use of IMGs both to provide help desk support, and to get more feedback by conducting ongoing usability testing, evaluating the healthcare workers experiences with the solution. IMGs were also proposed to be used more to engage other stakeholders. The eHealth designers reported to have started to use more IMGs after the COVID-19 pandemic and their experiences were mixed. The eHealth designers reported becoming more open to remote interaction after having experienced that it somehow worked, but some eHealth designers mostly still preferred conducting physically face-to-face sessions when possible arguing that it give better quality on the interaction, makes it easier to get more feedback from the healthcare workers and to assess weather the healthcare workers are on the same page, for instance if they learn what they are supposed to during training sessions, and to switch it up when necessary. Some eHealth designers recommended combining more on-site and remote means of involving healthcare workers. The eHealth designers also explained that in very remote areas only phone calls or sms are viable for remote communication, not even IMGs can be effectively used. Another challenge with IMGs reported by the implementers was that the healthcare workers' activities are varied where some can be very active while others do not respond to messages at all. For some users with very limited IT literacy using the IMGs were also considered too advanced. The increasing number of chat groups being created for various projects was also reported to sometimes make it difficult to keep track of communication. Figure 4.8 provides a visual overview of how the eHealth designers explained that IMGs could be used throughout the design and implementation process.

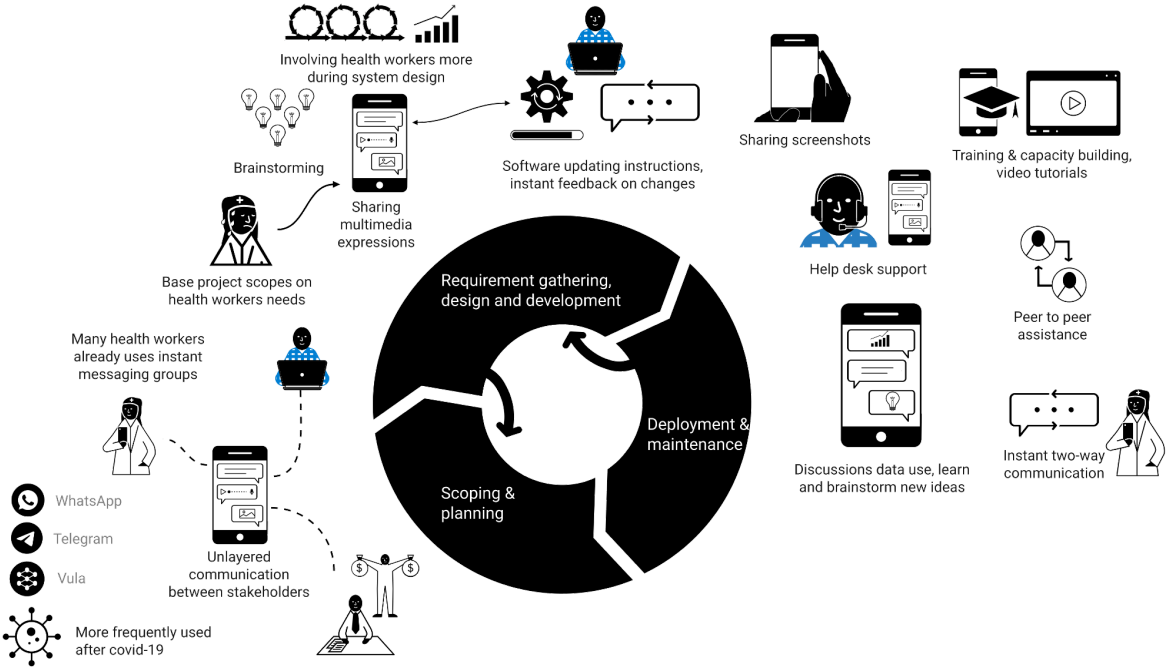


Figure 4.8: Illustration of how the eHealth designers explained that IMGs could be used throughout the design and implementation process to involve healthcare workers.

Visual means

The eHealth designers claimed healthcare workers often are more practical, relating better with things they see visually, like photos, illustrations, and videos.

Photos and videos were claimed to give healthcare workers and eHealth designers the possibility to document healthcare workers' work context and give more rich insights to those unfamiliar with the context. IMGs were explained to provide possibilities for effectively sharing such multimedia content. Visual content was also claimed to be more engaging for other stakeholders providing possibility for more impactful messages.

Visual content was also highlighted as more engaging than text, making it more easy to learn. In addition the visual content was highlighted as educative, making it easier for healthcare workers to learn by seeing what they should do, rather than reading instructions. The eHealth designers proposed providing more video tutorials about how to use the applications so the healthcare workers can go back and watch steps to follow if they forget something. However connectivity issues and data bundle expenses can be a challenge for the healthcare workers to retrieve the video files. It was further suggested creating shorter and more visual user guides containing straightforward steps with illustrations of the system workflows to make it easier to understand as a quick reference for the healthcare workers on the fly.

The eHealth designers proposed making the user interface of the solutions more user friendly by using less text while carefully selecting and composing images and illustrations. The eHealth designers also suggested providing healthcare workers with tools like illustrated messages on leaflets, pamphlets and billboards at the market or by the roadside using local languages so public health information can be easily read up and passed on to the recipients in the community together with visual supportive material. The eHealth designers explained that even though visual means can be both very engaging and educational for healthcare workers, healthcare recipients and other stakeholders, creating such visual content is often time consuming and expensive. Figure 4.9 illustrates various visual means to involve healthcare workers the eHealth designers explained could potentially be used during the different phases of the design and implementation process.

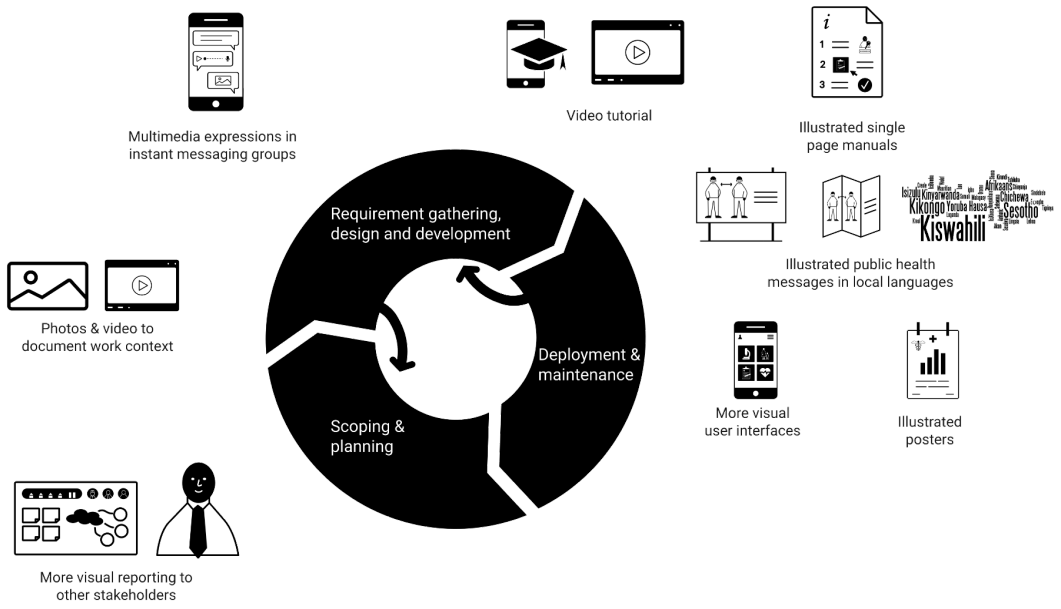


Figure 4.9: Illustration of various visual means to better involve healthcare workers the eHealth designers explained could potentially be used during the design and implementation process.

Design thinking

Many of the proposals from the eHealth designers entailed a typical means for design thinking. The eHealth designers suggested starting to discuss challenges and pain points with the healthcare workers, without asking technological questions. As one the implementer from Malawi phrased it: "*Most of the time we ask questions like, how can we improve your reporting? Sort of timeless. But the user doesn't know the system yet, so instead of us asking*

about the system, just ask them how they do their work on a daily basis and listing how the system can address the issues". It was proposed to wait discussing with the healthcare workers how the technology can fit into their context until after the healthcare workers pain points have been identified.

The eHealth designers suggested using personas to get a better overview of who the typical healthcare workers are, and creating user journey maps to get a better understanding of how the healthcare workers operate during a day or a month, mapping out the sequence of events needed for their tasks like what healthcare workers do, when they do it, where they do it, why they do it, how they perform their tasks, and who they engage. The eHealth designers suggested making the system workflow resemble the workflow on the ground, so they don't need to relearn everything. The eHealth designers suggested conducting more field visits to gain better contextual insights.

Involving the healthcare workers was argued to potentially contribute to new innovations, as they can assist in generating ideas for solutions that are more relevant for the healthcare workers and centered around solving key problems on the ground, which in many cases also can help address and resolve fundamental challenges for the whole organization. The eHealth designers proposed brainstorming more solutions with healthcare workers, for instance using future workshops.

The eHealth designers suggested involving the healthcare workers in the less technical aspects of the design, especially in those parts of the system design that will affect their work environment such as what data to submit in the solution, which indicators to be used, and system workflow. Providing more training for healthcare workers was also perceived to make them more able to give better and more relevant feedback in the design phase, one implementer from Mozambique explained "*If they have more knowledge of using the system they will be able to have a better opinion in the construction or feedback, and give relevant feedback for the whole design and conceptualizing of the system*". The eHealth designers also proposed setting up meetings with the facilities to integrate indicators needed locally beyond the initial project scope into the solution to appropriate the solutions more to the local context and make it more useful within the context.

Provision of relevant and useful solutions that healthcare workers can benefit from was claimed by several eHealth designers to be key for getting the buy-in from the healthcare workers, so they will see the relevance of the solution and feel that it was made for them, rather than the system use being pushed on the healthcare workers. Providing healthcare workers with solutions that will help them make their work easier was also claimed to

motivate the healthcare workers to use the system through immediate work incentives, with potential huge benefits for both the healthcare receivers and the whole organization. Figure 4.10 visualizes some of the main means for design thinking that the eHealth designers proposed using to better involve healthcare workers.

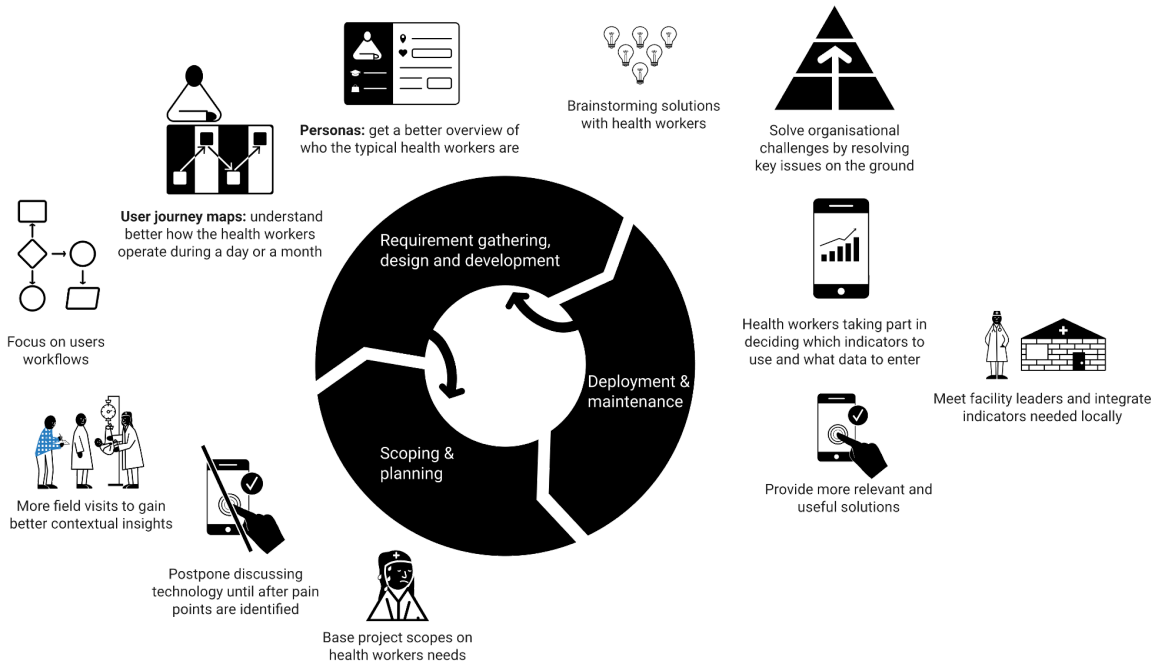


Figure 4.10: Illustration of design thinking activities proposed to be used by eHealth designers to better involve healthcare workers.

Prototyping with generic software

The eHealth designers suggested that giving the healthcare workers more insights into how the system works and the concepts behind the system early in the process can help to build capacity in order to get relevant feedback about how the solution should be designed locally. Using generic softwares for prototyping was claimed to make it possible to quickly make a functional prototype where healthcare workers can interact with, click around, see what happens and get a better understanding how the system works and possibilities. This can for instance be done by only setting up a basic installation of the generic software, one eHealth designer from Mozambique explained "*In the initial release we test to see how they will interact with the system, but sometimes there is nothing new, it is just DHIS2*". However the eHealth designers recommended using plain and simplified language without technical jargon when explaining the system to the healthcare workers for better understanding.

It was proposed to use more prototypes before implementing the system, so the healthcare workers can understand better what the system is capable of, and give feedback if the

solution is something they really need. The eHealth designers proposed that the healthcare workers could take part in selecting solutions / features they are most comfortable with. One implementer from Uganda explained "*When they see how it is being built they can make suggestions that fits better with existing systems and work environment*".

The new systems can be semi-deployed as a working prototype to generate feedback from the healthcare workers. The semi-deployed prototypes were explained by eHealth designers to provide the possibility to co-configure the system. Once the prototype is more matured the eHealth designers will start conducting user testing to generate feedback on the semi-deployed system and improve on it, while also providing training in the new system. An implementer from Uganda explained prototyping as "*a recursive process where we develop a tool and then try to simulate the environment it is going to be in, or actually try to semi-deploy it and improve on it as you go along*". Generic software was claimed to make it possible to continuously configure and make adjustments quickly based on experiences and feedback, which can be engaging for the healthcare workers. However some eHealth designers suggested using prototypes using generic softwares could be too complicated for the users with the most limited IT literacy. A visual overview of how generic softwares can be used to involve healthcare workers is provided in figure 4.11.

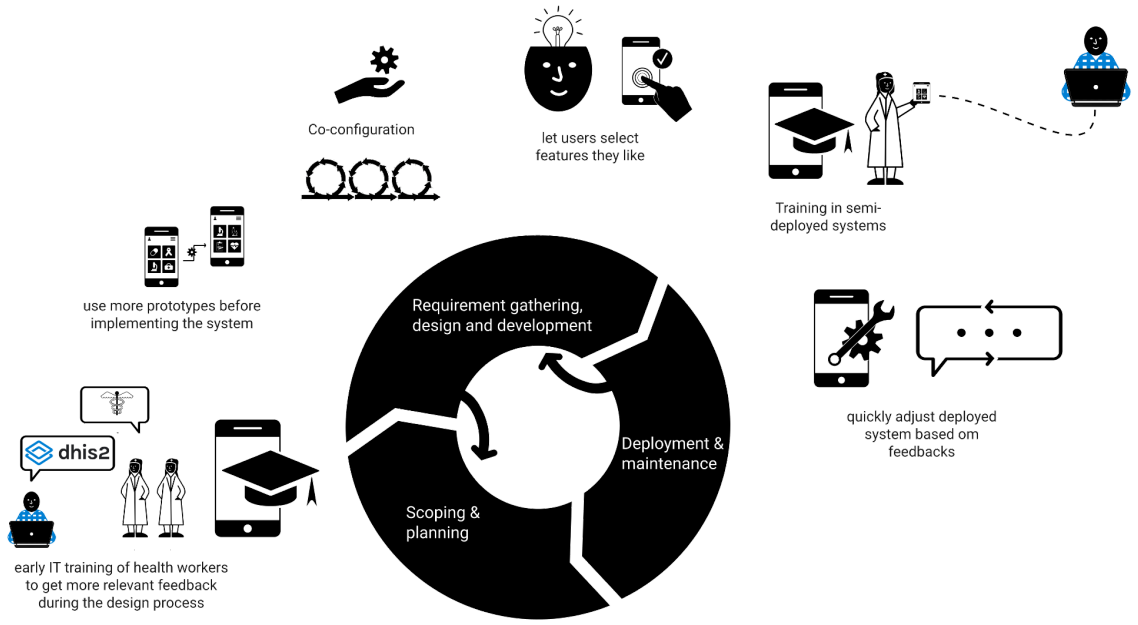


Figure 4.11: Illustration of how eHealth designers explained that generic software could be used for prototyping and involving healthcare workers.

Peer driven user involvement

The eHealth designers proposed giving the healthcare workers more responsibility during the different phases of the implementation. The healthcare workers were suggested to assist more in the data collection for requirement gathering, can make the healthcare workers become involved earlier in the process and avoid design gaps that are obviously seen from the ground level such as duplicated data collection. Giving healthcare workers more responsibility during requirement gathering was also claimed to support transfer of knowledge and skills between the healthcare workers as they will learn about each other's work practices. The eHealth designers suggested creating a committee of end-users to receive and manage feedback, give the healthcare workers representatives within the national implementation team, and provide career paths for the healthcare workers promoting a mix between medical and digital skills, building more capacity at the community level.

The eHealth designers also proposed that healthcare workers can be involved in providing the training and support of each other to facilitate peer learning. For instance it was suggested that healthcare workers from one facility could explain and expose healthcare workers from other facilities about the eHealth solutions, helping to transfer knowledge between the facilities, however some eHealth designers warned that healthcare workers might have less respect for the knowledge they learn from their peers. The eHealth designers also suggested providing regular slots within the health facility team to discuss digital issues, letting the healthcare workers be involved in monthly data review meetings, and providing healthcare workers feedback on submitted data through the facility managers or colleagues

The eHealth designers claimed that it can be highly engaging for the healthcare workers to be given more responsibility to better involve the healthcare recipients and the community. The eHealth designers suggested producing localized community radio talk shows to target illiterate community members, in an engaging and entertaining way, where listeners for instance can call in and ask questions. eHealth designers also proposed organizing community based megaphones for village health teams that can go from village to village to disseminate information and strengthen public health messaging. One implementer from Uganda shared positive experience with using megaphones to recruit healthcare recipients, for instance announce health programs at the marketplace encouraging the target group to show up at specific venues at specific time slots: "*In a project concerning information dissemination regarding family planning, we've used megaphones. They go down to the market area in the community with a megaphone just stand by the roadside and then just speak. [...] after speaking out, you see people coming and asking what is this about? You know it could just be 15-20 minutes of just speaking out, that alone is good for massive education*". Several of the ideas suggested by eHealth designers concerning involvement of

healthcare recipients entailed healthcare activities beyond traditional health record journals, such as public health promotion messaging. Figure 4.12 illustrates how eHealth designers envisaged that healthcare workers could become better involved through their peers.

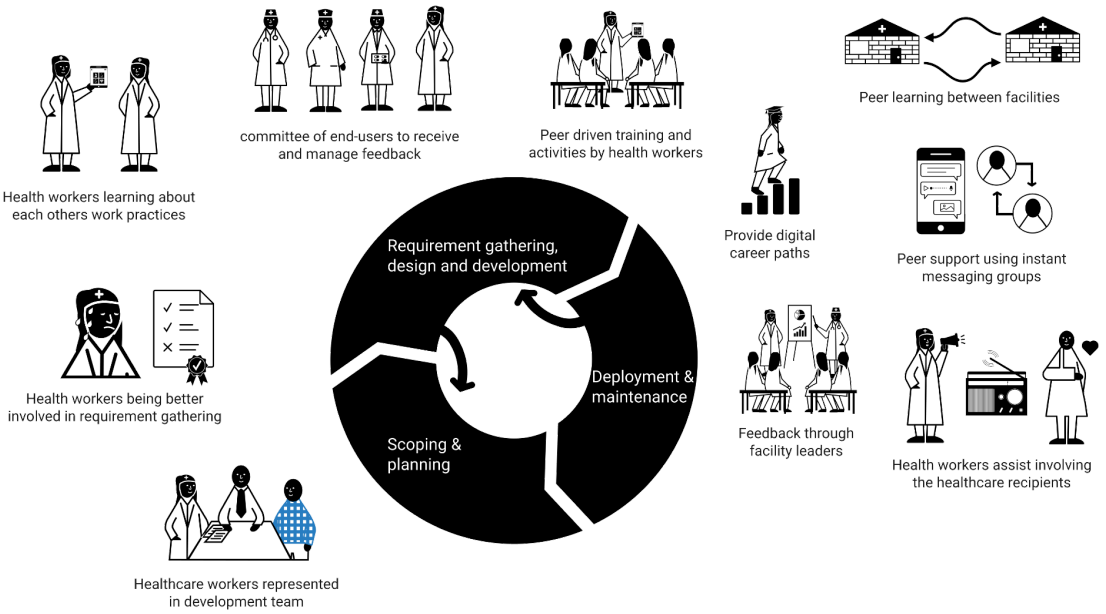


Figure 4.12: Illustration of how eHealth designers envisaged that healthcare workers could become better involved through their peers.

Effective stakeholder feedback mechanisms

Improved stakeholder feedback mechanisms were suggested in order to improve communication between the healthcare workers and other key stakeholder such as managers, donors and eHealth designers, especially to ensure that healthcare workers are given a stronger voice in the process, as explained by one implementer from Togo "*I think there's a need to improve feedback mechanism to ensure that there's a lot of communication between health workers and other stakeholders in the system so that it actually gives them this opportunity or this voices to talk about what they want*". Improved mechanisms for feedback from the healthcare workers were proposed to disseminate more understanding of healthcare workers needs, how they are using the current system and where improvement could effectively be made, to elicit buy-in from key stakeholders, and make the solutions and the data more relevant and useful for the healthcare workers.

The eHealth designers proposed establishing networks of digital health coordinators at the district level that have eyes, ears and hands on the district, involving the healthcare workers supervisors and healthcare workers seniors more, and also have healthcare workers

representatives, to institutionalize a consistent feedback culture. The eHealth designers suggested letting the healthcare workers participate in workshops with other stakeholders for aligning paper based and digital forms, so they can be considered from the start of the process. It was also suggested to arrange webinars with the healthcare workers and other stakeholders to give them demonstrations on prototypes and system changes, and facilitate discussions together.

The eHealth designers especially explained about the need to enhance the relationship between the eHealth designers and the healthcare workers, proposing to set up more meetings, call healthcare workers more often, and create webinars for the healthcare workers. One implementer from Nigeria stated that "*at any point, any system upgrade or build, the healthcare workers should be the first to know about it*". The eHealth designers suggested having a dedicated team of eHealth designers to interact with the healthcare workers at the lowest level. It was also proposed to create features within the digital solutions where healthcare workers can receive more frequent updates, and also submit their suggestions during their daily work. The eHealth designers suggested trying to use local languages when interacting with the healthcare workers, in system user interface, and on posters and fliers to improve communication. The eHealth designers proposed sending healthcare workers more feedback after requirement gathering and design sessions, for instance sending out sms or providing notification within the solution, with links to digital space with information about results. Participants also suggested giving more positive feedback of appreciation to recognize the healthcare workers, and provide healthcare workers feedback on reported issues, so they feel listened to, and make them feel included.

The eHealth designers suggested keeping other key stakeholders better informed in the process by using more photo and video documentation, for instance short documentaries, to showcase implementation progress, success stories and impact of the solution for the healthcare recipients, and to systematically plan these presentations better like showcase before vs after. The eHealth designers claimed photos and videos can create more engagement among the stakeholders than the usual reports, and that they could be sent out in regular newsletters or posted in social media. Several eHealth designers explained to already be using photo and video documentation actively. The eHealth designers suggested online whiteboards could be used as a space to add multimedia content and keep stakeholders informed in a more engaging and interactive way. The eHealth designers also suggested using online whiteboards and other interactive tools during online workshops where everyone can interact on a shared screen to make it easier for everyone to become actively involved, see what is going on and see their own contributions. However the eHealth

designers were skeptical about using online whiteboards for healthcare workers as it requires a certain level of IT skills, and also a potential high use of mobile data.

It was further proposed that additional system needs discovered, as well as use cases and challenges from the lower levels in various countries, could be communicated back to the vendor of the implemented generic software to improve the next version of the software also for other implementation projects. Figure 4.13 provides a visual overview of some of the inputs from the eHealth designers about how to improve feedback mechanisms between stakeholders.

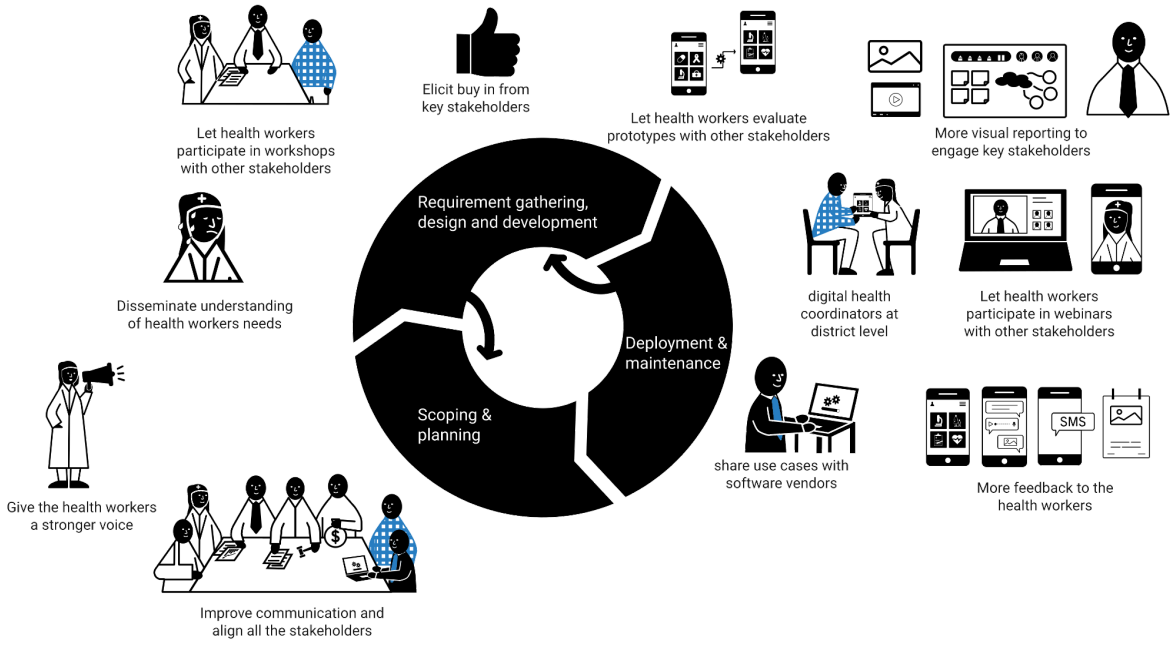


Figure 4.13: A visual overview of inputs from the eHealth designers during brainstorming opportunities related to improving stakeholder feedback mechanisms.

Improved organizing of projects

Many of the eHealth designers' suggestions to provide better user involvement evolved around making the design and implementation projects better organized. A better project scope more based on healthcare workers needs was claimed by the eHealth designers to make it easier to explain to the healthcare workers how they can benefit from the solution and make them participate in activities during the process.

Earlier involvement was proposed to make it possible for healthcare workers to actually inform the requirement gathering and influence the design to make necessary changes early, designing more relevant and user friendly systems, promoting ownership, and avoiding the

eHealth designers having to discover and fix a lot of issues towards the end of the project. The eHealth designers suggested that the role of the healthcare workers should be clarified early in the process, that the right team should be identified early, and the healthcare workers should be properly informed at the start of the process to clarify expectations rather than pulling them along on the way. Providing early training to improve the healthcare workers digital skills was claimed by the eHealth designers to make healthcare workers able to provide better and more relevant feedback during requirement gathering. The eHealth designers proposed making a more inclusive implementation plan where also the healthcare recipients should be involved and planned into the process early on. The eHealth designers also highlighted the importance of a timeline long enough to meaningfully involve the healthcare workers throughout the process, so the eHealth designers will have sufficient time being in direct contact with the healthcare workers. The eHealth designers also suggested improving preparation before field visits or workshops, and to time activities better with the activities going on at the health facility so the activities can fit into the work schedule of healthcare workers.

Clear procedures to access information, and to recruit healthcare workers for activities was proposed by the eHealth designers. During the requirement gathering the eHealth designers explained that healthcare workers who know at least the basics knowledge about the daily business processes and that have at least basic IT skills should be recruited. If the healthcare workers involved do not have knowledge and skills they can't inform the process, however if the eHealth designers are too skilled or knowledgeable the eHealth designers can get unrealistic ideas about who the eventual end-user will be. It was suggested to randomly select healthcare workers to participate to ensure representative users. It was also explained by one implementer that "Workshops" can sometimes connote "free lodging and food" which can make the user organization not necessarily send the most appropriate users to the workshops, however naming your workshop a "training" can increase the likelihood of the user organization sending the appropriate user.

More resources were requested to be available in the budget specified to conduct thorough consultations to better involve the healthcare workers in activities like field studies, workshops, training and field testing of digital products. One idea proposed was to create a standard template for the design process to present to funders, where activities and resources needed for involving the healthcare workers are specified. It was proposed that stakeholders from implementation projects within the same area of interventions should sit together and try to better align their activities and goals, to avoid fragmentation of solutions, combine resources and efforts for user involvement from different projects targeting the same

groups, and develop more integrated solutions. The eHealth designers also proposed to streamline infrastructure investments and make access agreements with mobile network operators to provide affordable access.

Monitoring and evaluating involvement of healthcare workers and other users was suggested by eHealth designers to keep overview of progress and make corrections. The eHealth designers suggested collecting more feedback after activities to evaluate, learn and improve, for instance to make sure the training sessions reflect the real work practices. The eHealth designers proposed to develop indicators for end-user involvement during implementation as well as sustainability measures to make sure the system is still being used whether there are partners to push for it or not. It was suggested that the monitoring and evaluation should be owned by the government or the ministry of health for sustainability. It was further suggested that for the top-level managers to become better in following up their own strategies, the evaluation should be done together with external partners.

Systematic research was proposed about challenges and opportunities to involve healthcare workers, and about the use of data and information at the local level, to create future guidelines for better practices and building better solutions. The eHealth designers suggested trying to leverage on past experiences and apply lessons learned with successful solutions where the healthcare workers are now receptive to digital tools, or avoiding solutions and means similar to those that previously have existed, but never really worked out for the healthcare workers. The implementers proposed that lessons learned from implementation projects at the lower level can be exchanged between different countries. Some key lessons learned by the eHealth designers were for instance design solutions based on mobile devices as it seems IT literacy is less of an issue with mobile devices, develop integrated solutions instead of fragmented solutions, to restrict which functionalities healthcare workers can use to simplify the user interface and to use local languages in the user interface. Other important lessons were to make sure the solutions help healthcare workers do their work easier and quicker to provide immediate work incentives, making sure the solutions provide back useful information on the data submitted back to the healthcare workers, for instance alerts when the prevalence of different health issues increases with information and tips about how to deal with the situation. The eHealth designers suggested developing a research network to share more experiences between the different countries, and to publish the results to disseminate the knowledge. Figure 4.14 illustrates some of the main inputs from the eHealth designers on how organizing of projects could be improved to better involve healthcare workers.

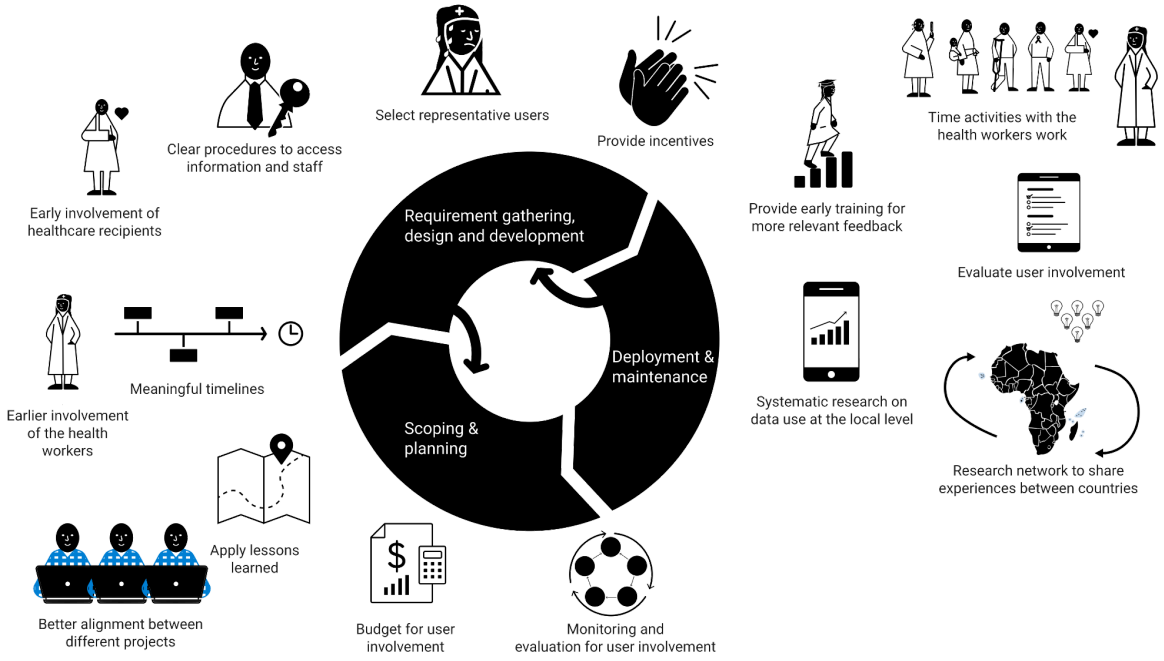


Figure 4.14: Illustration of inputs from the eHealth designers on how organizing of projects can be improved to better involve healthcare workers.

5. Analysis and discussion

The empirical findings will now be discussed based on the research question:

> *Which opportunities do eHealth designers in LMICs see for better involvement of healthcare workers during design of eHealth solutions?*

As detailed in the findings chapter, the main identified opportunities by the eHealth designers to better involve healthcare workers are role play, IMGs, visual means, design thinking, prototyping with generic software, peer driven user involvement, effective stakeholder feedback mechanism and improved organizing of projects. The identified opportunities are not concrete, but represent themes that can be explored further by both researchers and the eHealth designers. The opportunities have some similar traits, being appropriate to the context, tuned into cost efficiency, and focusing on improving the quality of user involvement, and can potentially address some of the challenges identified by the eHealth designers, as well as challenges to involve users in LMICs identified in related literature.

To analyze the identified opportunities we will first compare the perspectives from the eHealth designers in Africa with literature related to user involvement in LMICs. The opportunities will further be examined using the definition criterias of frugal user involvement to discuss the suitability of opportunities to address identified challenges and specific design contexts. The analysis will also provide an example of how the definition criterias of frugal user involvement can be used. We will discuss implications of the analysis for frugal user involvement which can provide insights on means appropriate to involve also other users in LMICs and resource constrained contexts. Finally an overview of the contributions will be presented.

5.1 Comparing eHealth designers perspectives with related literature

The perspectives from the eHealth designers in Africa will now be compared with the literature related to user involvement in LMICs. First we will compare the identified challenges that need to be resolved to involve users, and then we will compare the identified opportunities. The comparison will also help reveal if the concept of frugal user involvement, which is based on the related literature, is suitable to use for analyzing the opportunities from the eHealth designers in Africa or need further refinement.

Challenges

The challenges reported by the eHealth designers will now be compared with the challenges to involve users in LMICs identified in related research; limited IT literacy, significantly

skewed power relations, and lack of resources and lack of cultural appropriateness of conventional means to involve users. The identified challenges resemble many of the challenges reported by the eHealth designers.

Limited IT literacy has been identified as a challenge to involve users during design and implementation (Maunder et al., 2007) and was also reported by the eHealth designers in this study. Skepticism and resistance towards IT was also reported by the eHealth designers to be related to both limited IT literacy, as well as skewed power relationships where healthcare workers fear that the solutions will be used to monitor them. Users' fear of being monitored has also been reported in related literature (Maunder et al., 2007), and the eHealth designers reported in fact monitoring the healthcare workers data collection.

Skewed power relationships such as eHealth solutions not being based on the healthcare workers needs (AbouZahr & Boerma, 2005), and healthcare workers being involved too late (Li, 2021) was also reported by the eHealth designers. Different needs between national managers and healthcare workers (Stansfield et al., 2008), politics and corruption was also explained by the eHealth designers to make management of requirements and communication difficult. The eHealth designers also related challenges to lack of system ownership to disempowerment such as healthcare workers lacking feedback on reported issues, and discontinuation of systems due to financial and political changes. Lack of data and system use was also mainly related to power imbalance by the eHealth designers as the systems are being pushed top-down on the healthcare workers and increase their work burden. The heavy work burden, healthcare workers' skepticism to the digital solutions, and managers sending inappropriate users to activities motivated by incentives, were reported by the eHealth designers to be related to the healthcare workers absence from activities in requirement gathering as well as training sessions.

Lack of resources causing poor work conditions (AbouZahr & Boerma, 2005) were also reported by the eHealth designers as a challenge to involve users and was related to healthcare workers' absence from activities. Other barriers related to limited resources such as costs and time to facilitate user involvement (Chetty et al., 2004), access to devices and connectivity (Backhaus et al., 2014) and limitations with the software (Li, 2021) were reported by the eHealth designers as well.

Lack of cultural appropriateness of conventional means to involve users reported in related literature (Backhaus et al., 2014; Blomberg & Karasti, 2012; Ho et al., 2009; Irani et al., 2010; Maunder et al., 2007; Sherwani et al., 2009; Winschiers-Theophilus et al., 2010; Winschiers-Theophilus & Bidwell, 2013) was not reported by the eHealth designers. This can

be because the eHealth designers mostly reported to use conventional means from the social sciences such as interviews, observations, and document analysis. The eHealth designers did however overall express great challenges using these means. Another reason can be that the eHealth designers were all locals and have less challenges navigating the cultural context. The implementers did however emphasize the need for less text-based approaches when discussing visual means, and the aptness of embodied means when discussing role play. Perhaps the emphasis on lacking cultural appropriateness of conventional means to involve users reported in related literature is somehow exaggerated? Table 5.1 provides an overview comparing challenges identified in related research and challenges reported by the eHealth designers.

Related research	eHealth designers
Limited IT literacy	Limited IT literacy for healthcare workers
Skewed power relationships	Skepticism and resistance towards IT from healthcare workers
	Project scope not based on healthcare workers needs
	Healthcare workers being involved too late
	Managing requirements, stakeholders and communication
	Lack of data and system use
	Lack of system ownership for healthcare workers
	Healthcare workers unavailable for activities
Lack of resources	Poor work conditions and lack of work motivation for the healthcare workers
	Lack of system access for healthcare workers
	Lack of resources to facilitate for user involvement
	Too short project timeline
	Technical limitations with the generic software
Lack of cultural appropriateness of conventional means to involve users	

Table 5.1: Relation between challenges to involve users in LMICs identified in related research and challenges reported by the eHealth designers.

Opportunities

After comparing the challenges we will now compare the opportunities reported by the eHealth designers with the main opportunities identified in related literature; alter local norms and styles of communication, focus on local needs beyond the project scope, early exposure of users to digital technology, functional prototyping, peer driven user involvement, visual means and improved organizing of project.

Alter local norms and styles of communication such as oral and embodied interaction as well as storytelling (Winschiers-Theophilus & Bidwell, 2013) was also discussed by the eHealth designers who proposed role play as a concrete opportunity to embed such characteristics in a concrete activity, and as a form of peer-driven user involvement altering the existing local social structures. Peer-driven approaches to improve users recruitment (Ramachandran et al., 2007), user training (Kam, 2008), and evaluation sessions (Teka et al., 2017), was also reported by the eHealth designers.

Early exposure of users to digital technology, and the use of functional prototyping, to let users with limited IT literacy experience the capabilities of technology reported as an opportunity in related literature (Kimaro & Hodne, 2008; Maunder et al., 2007; Molapo & Marsden, 2013) and was also reported as an opportunity by the eHealth designer who involved healthcare workers using prototypes based in generic software to quickly set up something the healthcare workers can interact with, make healthcare workers better understand the possibilities with digital technology, and get more relevant feedbacks from the healthcare workers.

Visual means such as photo and videos have been identified as an avenue for more user involvement in orally and embodies based cultures (Makamba et al., 2019), and was also reported by the eHealth designers as a promising opportunity for better involvement of the healthcare workers. Focus on local needs beyond the project scope (Dearden & Rizvi, 2008; Winschiers-Theophilus & Bidwell, 2013) was also discussed by the eHealth designers who discussed using different means of design thinking with the healthcare workers. Improved organizing of projects have been identified in related research as an opportunity to make key stakeholders better understand the needs on the ground (Li, 2021; Teka et al., 2017), and the eHealth designers also reported the need for better structuring of projects to involve the

healthcare workers, and more effective feedback mechanisms between the different stakeholders.

Using IMGs to involve users were extensively discussed by the eHealth designers from all countries in the study, but have not yet been described extensively in related literature.

Table 5.2 provides an overview comparing opportunities identified in related research and opportunities reported by the eHealth designers.

Related research	eHealth designers
Alter local norms and styles of communication	Role play Peer-driven user involvement
Peer-driven user involvement	
Early exposure of users to digital technology	Prototyping with generic software
Functional prototyping	
Visual means	Visual means
Focus on local needs beyond the project scope	Design thinking
Improved organizing of project	Effective stakeholder feedback mechanisms
	Improved organizing of projects
	IMGs

Table 5.2: Relation between opportunities to involve users in LMICs identified in related research and opportunities reported by the eHealth designers.

Summary

Most of the challenges identified by the eHealth designers are similar to those described in related research, however the perspectives of the eHealth designers doesn't emphasize the lack of means that are culturally appropriate to the context as a major challenge. Many of the opportunities identified by the eHealth designers are also similar to the opportunities identified in related research, however role play provides a concrete example of the notion in related research to alter local norms and styles of communication, and using IMGs to involve users in LMICs have not been described extensively in related literature before. Overall the challenges and opportunities identified by the eHealth designers resemble the challenges

and opportunities described in related research that was used to develop the concept of frugal user involvement.

5.2 Analysis and discussion of the opportunities

To analyze how the opportunities identified by the eHealth designers can address specific design contexts and challenges, the definition criterias of frugal user involvement will now be used. The definition criterias of frugal user involvement needs to be satisfied simultaneously; (1) cost efficient, (2) attaining quality, (3) appropriate to the context. Cost efficiency can be considered for the designers, the user organization or the users, quality entails both enhancing the product design and empowering the users, and being appropriate to the context means illuminating the real world problems, engaging users, building users capacity, engaging key stakeholders, and being robust. The definition criterias and the different dimensions of the criterias is elaborated more in section 2.3, and will be used as a guide to navigate the multi-layered and complex challenges of involving users in LMICs

Role play

In terms of cost efficiency, role play can address challenges related to facilitation costs (Backhaus et al., 2014) by reducing the need for tools or equipment, as all that is needed are the healthcare workers, their natural context, and some tasks or challenges. Role play as other face-to-face means does however require the presence of a group of people including some travel expenses, but can potentially provide better involvement of the healthcare workers than other on-site means such as interviews or group discussions. The eHealth designers speculated in role play having a big potential in providing long term cost efficiency by being used as part of the early design process as healthcare workers through role play can explore and validate ideas physically by enacting and evaluating potential future use of technology, and identify potential design-actuality gaps earlier in the process. Considering the heavy work burden and difficult life situation of many users (Chawani et al., 2014; Dearden & Rizvi, 2008), role play was suggested to involve healthcare workers in a potentially fun, engaging and relaxed activity, reduce costs of being involved, as well as reducing waste of facilitation costs by avoiding healthcare workers being absent from planned activities.

In terms of attaining quality, there is a lack of means to help reveal socio-cultural issues in contexts with little penetration of digital technologies (Maunder et al., 2007), leading to a design-actuality gap (Heeks, 2002), and role play can be a potential means that makes it easy to explore and assess the value proposition of a digital solution in a simulated but

realistic environment. Role play can by altering embodied and verbal interaction involve healthcare workers expressing themselves and their needs in a natural or more familiar language, and can assist in putting the healthcare workers in a more playful mode lowering the threshold to give feedback and suggestions. Role play can potentially let the eHealth designers *become participated* by the community (Winschiers-Theophilus et al., 2010). Role play can also offer some interesting possibilities to critical design for development as actors can take the perspectives of other actors, for instance healthcare workers experiencing to be a healthcare recipient, or the eHealth designers can try to be a healthcare worker. Role play can also potentially address challenges related to skewed power relationships (Teka et al., 2017), by letting the healthcare workers express needs in their own language, providing opportunity for healthcare workers to be involved earlier in the design process by enacting prototypes and by creating a playful setting where it is easier to give feedback.

In terms of appropriateness to context, role play can illuminate how healthcare workers would actually use an eHealth solution in a simulated yet realistic context and identify new use cases. Role play can address challenges related to lack of cultural appropriateness of conventional means of user involvement (Winschiers-Theophilus & Bidwell, 2013), by facilitating involvement using verbal and embodied communication. Role play can potentially address issues related to limited IT literacy (Maunder et al., 2007) by making it easier to envision future technology by enacting it physically and improving capacity building for the healthcare workers through more engaging group based peer-learning. Role play was also explained to be robust, requiring little equipment and could potentially be used at all stages of the eHealth designers, both during design, evaluation and training in the new system.

Instant messaging groups (IMGs)

In terms of cost efficiency, IMGs can address challenges related to lack of resources to facilitate user involvement (Chetty et al., 2004), by providing remote multimedia communication with the healthcare workers, reducing the need to travel on-site, and facilitating low cost help desk support. IMGs also build on the existing infrastructure as many community healthcare workers already use IMGs, have it installed on their phones, and don't need much introduction to start using them. IMGs can provide long term cost efficiency by facilitating peer-to-peer assistance and are feasible to be used throughout the design and implementation process. IMGs can also address challenges related to users' lack of time (Chawani et al., 2014; Dearden & Rizvi, 2008) by using a platform the healthcare workers are used to, and providing asynchronous communication where users can get engaged at a time that is most convenient for themselves.

In terms of attaining quality, IMGs were described as a place to discuss issues and brainstorm solutions, giving the healthcare workers the possibility to give more feedback on the eHealth solutions and to involve and get inputs from more healthcare workers from more districts. Updates of apps and remote instant feedback through IMGs provides the possibility to conduct several design iterations remotely with the healthcare workers and enhance the product design. IMGs provide the possibility for two-way remote instant communication with the healthcare workers, allowing them to not only receive information but also provide feedback, and to keep continuous communication between the healthcare workers and eHealth designers through the process, including before the first field visit. IMGs can also address challenges related to skewed power relationships (Teka et al., 2017; Winschiers-Theophilus & Bidwell, 2013), by providing a space for unlayered direct communication between healthcare workers, managers and eHealth designers giving the healthcare workers a stronger voice with rich opportunities for users to express themselves through multimedia content, which potentially can expose issues on the ground, increase the stakeholder engagement, and attract resources where they are needed.

In terms of appropriateness to the context, IMGs can illuminate real-world problems as eHealth designers remotely can communicate instantly with the community through rich media formats such as voice messages, photos, videos, and feedback on system changes with screenshots. The multimedia possibilities provide many opportunities for telling activities where healthcare workers can for instance document their daily work through images, and visualize their challenges in a more engaging way. The rich and easily accessible content can also make the involvement more fun and engaging for the healthcare workers. IMGs can be used to address challenges related to users' limited IT literacy (Maunder et al., 2007), by building on the users' existing digital skills, building local capacity through peer-to-peer assistance, and disseminating learning materials such as video tutorials making it easier for the healthcare workers to go back and see how things should be done. IMGs can also build capacity for the healthcare workers by building on and expanding existing digital skills using digital tools for instance receiving instructions in the IMGs to make new operations, like update apps, give feedback or take screenshots. IMGs was also suggested to facilitate peer-to-peer assistance, which can capacitate healthcare workers to become better involved and and build more long term capacity at the local community level. As IMGs are used by eHealth designers in all countries participating in this study, and is reported to be used extensively by healthcare workers, IMGs can potentially be considered a robust approach, however IMGs can be challenging to use in the most rural areas with minimal connectivity and healthcare workers less exposed to IMGs. IMGs was suggested to facilitate many of the other identified opportunities such as peer-driven user involvement, visual means,

prototyping with generic software and effective stakeholder feedback mechanism. IMGs can therefore probably be considered as an archetypical means of frugal user involvement.

Visual means

In terms of cost efficiency, visual content such as illustrations and video tutorials were explained to be easy and reduce the burden for the healthcare workers, but to be more expensive to produce. Visual content can be highly educational, providing the possibility for more cost efficient training activities and less burdensome user interfaces for the healthcare workers in the long term. Visual content was also claimed to engage stakeholders and have potential to attract extra resources by making the reality on the ground more visible.

In terms of attaining quality, visual means was proposed to make it easier for healthcare workers to influence the design both by better understanding information and by visually showing their own context to other key stakeholders. Visual means can enhance the product design both by involving the healthcare workers in design, but also by providing more visual user interfaces. In terms of addressing challenges related to skew power relationships (Winschiers-Theophilus & Bidwell, 2013), visual means can make it easier for healthcare workers, especially from less text-based cultures, to express their needs and voice their opinions, and make issues on the ground more visible for decision makers.

In terms of appropriateness to the context, visual means can be used for better requirement collection by letting healthcare workers document their work context through photos, or probing healthcare workers using images, for instance through IMGs. Visual means can also address challenges related to lack of means that are culturally appropriate for orally and embodied based cultures (Makamba et al., 2019). The eHealth implementers reported that visual content can also be highly engaging for healthcare workers as well as other stakeholders. Visual means are also robust, being less ambiguous than for instance text, however video sharing will be limited for rural areas.

Design Thinking

In terms of cost efficiency, design thinking can be less cost efficient in a short term perspective using more time on investigating the real-world problem situation trying to solve fundamental problems for both the healthcare workers and the healthcare system, but has potential to be very cost efficient in a long term perspective. Similarly, design thinking requires more from the users in a short term perspective, but has potential to decrease the burden on the healthcare workers in a long term perspective.

In terms of attaining quality, considering that many healthcare workers in LMICs experience eHealth solutions providing them heavy work loads (Stansfield et al., 2008), design thinking in LMICs can often entail negotiating within a context of exceptionally skewed power relations and depend on a more open project scope than what the eHealth designers currently described to work with. Design thinking has however a great potential for enhancing the quality of the eHealth solutions by creating a better fit with work practices of the healthcare workers. Design thinking can address challenges related to skewed power relationships (Li, 2021), by involving the healthcare workers earlier, and make the solution more based on the healthcare workers needs. Involving the healthcare workers more before the system is being implemented can make the healthcare workers influence the design of the product more, but it is not a neutral process; for instance data entry clerks run the risk of becoming redundant when healthcare workers will get direct access to the system.

In terms of appropriateness to the context, design thinking means having potential to put a focus on the healthcare workers' real needs and context, which can also be highly engaging for the healthcare workers and create ownership.

Prototyping with generic software

In terms of cost efficiency, prototyping using generic software, such as DHIS2, can reduce implementation costs by eHealth designers being able to quickly set up a working system and adjust it based on feedback. Providing there are feedback mechanisms in place back to the vendors about limitations of the generic software, long term cost efficiency can also be obtained. Using early functional prototypes can reduce the burden for users to be involved by getting a more immediate impression of what the digital technology is able to do.

In terms of attaining quality, using generic software for prototyping can enhance the quality of the digital solution providing the generic software has been induced by feedback from users in many similar contexts. Prototyping with generic software can make it possible to involve users with limited IT literacy earlier in the process, however, providing the users only one functional prototype can make it difficult to make the healthcare workers think beyond the single solution provided and try to imagine alternative solutions (Maunder et al., 2007). eHealth designers often come with the agenda to set up a specific type of system that will collect the data needed by managers and the donors. The configuration options and flexibility of the software will also highly influence the ability of the user's involvement to enhance the product design and influence design decisions (Li, 2021).

In terms of appropriateness to the context, prototyping with generic software can address challenges related to limited IT literacy during design (Molapo & Marsden, 2013, p. 20) by

quickly providing functional prototypes which can be iterated on rapidly so the healthcare workers more easily can understand what the future technology could potentially be doing (Kimaro & Hodne, 2008). Providing something tangible that can be changed rapidly based on feedback can also be engaging for the healthcare workers.

Peer driven user involvement

In terms of cost efficiency, challenges related to resources (Chetty et al., 2004) can potentially be addressed in a long term perspective using peer-driven user involvement by capacitating the healthcare workers to take more responsibility to lead activities instead of the eHealth designers, but can be costly in a short term, as it requires training of super users at the local level who both are healthcare workers and have the skills to facilitate user involvement of their peers. Peer-driven user involvement has the potential to reduce the costs for healthcare workers who can more easily get help, but also has the potential to increase the burden for the healthcare workers who are providing the support.

In terms of attaining quality, issues of skewed power relationships (Li, 2021; Maunder et al., 2007), was suggested to potentially be addressed by peer-driven user involvement making the healthcare workers become involved earlier in the process and improve the requirement gathering which potentially can empower the healthcare workers and also enhance the product design. Peer-driven user involvement was also proposed giving the healthcare workers a stronger ownership of the process and building capacity at the local community level empowering the healthcare workers to understand potential implications of new technology and protect their own interests once new systems are introduced.

In terms of appropriateness to the context, peer-driven user involvement has potential to illuminate the real-world problem situation as healthcare workers are more likely to give honest feedback to their peers. Peer-driven user involvement was reported to be potentially engaging for the healthcare workers by giving them more responsibility to involve the community through activities altering orally based approaches such as megaphones and radio talk shows. Peer driven user involvement can potentially address the challenge of lacking means facilitating for groups that already exist rather than individuals (Winschiers-Theophilus & Bidwell, 2013) by building on existing networks in the community. Peer-driven user involvement can also potentially address the challenge of limited IT literacy (Maunder et al., 2007), by building more long term capacity at the local community level among the healthcare workers, and facilitating more low-threshold peer-to-peer feedback and learning. Peer driven user involvement is also robust making the healthcare workers less dependent on eHealth designers.

Effective stakeholder feedback mechanism

In terms of cost efficiency, more effective stakeholder feedback mechanisms can be cost efficient in both a short and a long term perspective by better aligning the stakeholders within the organization, making negotiation of requirements easier. Effective stakeholder feedback mechanism also has the potential to attract necessary resources to where they are needed (Sahay et al., 2018).

In terms of attaining quality, effective stakeholder feedback mechanisms can involve the healthcare workers by giving them a strong voice to express their opinions in the process. Considering that the design of eHealth solutions often are not based on the needs of the healthcare workers (Stansfield et al., 2008), effective stakeholder feedback mechanisms can enhance the product design by keeping decision makers better informed about the needs on the ground.

In terms of appropriateness to the context, effective stakeholder feedback mechanisms can help illuminate the real-world problem situation on the ground for those making decisions, which can be both engaging for the decision makers and for the healthcare workers.

Improved organizing of projects

In terms of cost efficiency, improved organizing of projects by utilizing lessons learned and organizing according to best practices can provide more efficient use of resources both in a short and long term perspective. Involving users according to best practices can also reduce the burden on the users.

In terms of attaining quality, improved organizing of projects by providing healthcare workers the possibility to be involved before design decisions are made can both empower the healthcare workers and enhance the product design (Li, 2021).

In terms of appropriateness to the context, improved organizing of projects can ensure that the real world problems are illuminated in a timely manner, and users are being capacitated early enough in the process.

Summary

The opportunities for better user involvement identified by the eHealth designers fulfill the definition criterias of frugal user involvement to various degrees and in various ways. The identified opportunities provide varied answers to attempt to tackle the multi-layered challenges of involving users in LMICs. IMGs, visual means, and design thinking will primarily

involve healthcare workers through telling and making activities. Role play and prototyping with generic software will mostly involve healthcare workers through activities for making and enactment. Peer-driven user involvement, effective stakeholder feedback mechanism and improving organizing of projects focuses on better structuring of the design and implementation processes.

In terms of cost efficiency, all opportunities were deemed to have potential to reduce long term costs, however role play, visual means, design thinking and peer-driven user involvement were not deemed cost efficient facilitation in a short term perspective. Design thinking and peer-driven user involvement can also potentially increase the burden on the users in the design process.

In terms of attaining quality, role play and peer-driven user involvement was deemed to empower users by letting them express needs in their natural language and lowering threshold to give honest feedback, and IMGs were explained to be a platform for more unlayered communication. Visual means, effective stakeholder feedback mechanisms and IMGs were deemed to empower healthcare workers by giving them a stronger voice towards other stakeholders. IMGs, prototyping with generic software, role play, design thinking, peer-driven user involvement, and better organizing of projects were deemed to empower healthcare workers by making it possible for earlier involvement. IMGs and prototyping with generic software were deemed to enhance product design by facilitating multiple rapid design iterations. Role play and prototyping with generic software were deemed to potentially enhance product design by letting users explore use of future technology by enacting it. Peer driven user involvement was deemed to empower the local level by building long term capacity at the community level making healthcare workers more able to protect their own interests.

In terms of appropriateness to context, role play and visual means were deemed as engaging and fun for users, and can increase their chance of attending activities. Design thinking and peer-driven user involvement can engage users by focusing on their problems within the context, and build stronger ownership. Visual means and effective stakeholder feedback mechanism can help illuminate the real world problems and engage key stakeholders, for instance by letting users document their context through video and photos making the reality on the ground more visible. IMGs were deemed able to provide instant feedback remotely from the field, through multimedia functionality and interactive group based discussion. Role play, peer-driven user involvement, visual means, IMGs and prototyping with generics software were reported to be suitable means to involve users with limited IT literacy. Role play and peer-driven user involvement can help users understand technology by providing

effective group based learning and more effective training for users through their peers. Role play can also improve the training by letting users enact the use of technology. IMGs build on healthcare workers' existing digital skills, providing peer-to-peer support and a space for effective distribution of training materials. Prototyping with generic software gives the users a more immediate tangible impression of what the digital technology is capable of, especially when the prototype is adapted based on their feedback. Visual means was suggested to be less ambiguous than text and to provide better documentation and training materials. Role play was deemed to be robust by not being dependent on a lot of equipment, and peer-driven users involvement can build more capacity at the local community level, giving the healthcare workers more independence and autonomy. Better organizing and management of projects can ensure a minimum standard of user involvement throughout the process.

Table 5.3 provides an overview of how the opportunities stand against the definition critias of frugal user involvement.

Opportunity	**Frugality**
Role play	Cost efficiency: - Requires travel expenses + Requires little equipment + Relaxed activity for users + Identify potential design-actuality gaps earlier Attain quality: + Let users with limited IT literacy become involved earlier + Let users express needs in a natural language + Lower threshold for feedback + Let users take each others perspectives Appropriateness to the context: + Engaging & fun + Less absence from activities + Group based learning + Understand users acquired skills level + Understand use, discover new use cases & requirements + Help users with limited IT literacy envision future technology + Little dependency on equipment
Instant messaging groups	Cost efficiency: + Requires little resources + Reach more users using less resources + Users already familiar with the technology + Can be used when it is convenient for the users Attain quality: + Earlier involvement of users

	+ Multiple design iterations remotely + Two-way communication + Give users a stronger voice + Unlayered communication Appropriateness to the context: + Building on the users existing digital skills + Peer-to-peer support & learning + Interactive group discussions + Multimedia expressions + Instant feedbacks from the field + Sharing learning materials
Visual means	Cost efficiency: + Less effort for the users - Can be expensive to produce, increasing short term costs + more effective training reducing training costs in long term - Costs related to connectivity for video material + Can help attract resource by making problems on the ground visible Attain quality: + Easier for users to express needs + More impactful messages + Make decision makers better understand what is going on at the ground + Enhance product design by using less text and carefully compose more visual user interfaces Appropriateness to the context: + Let users document their context through photos + Engaging for users and stakeholders + Easier for users to learn from training materials + Less ambiguous than text
Design thinking	Cost efficiency: - Expensive in short term + save costs in long term - More effort needed from user in short term + less burden for users in long term Attain quality: + Empower users with earlier involvement and identifying needs before development starts + Better fit between the solutions and the use context Appropriateness to the context: + Create engagement around users real world problems + Build ownership
Prototyping with generic softwares	Cost efficiency: + Functional prototypes at low cost

	+ Make it easier for the users to understand the purpose of the process Attain quality: + Earlier involvement of users with limited IT literacy + A challenge that user might be narrow their perspective rather then broaden it + Faster design iterations - Limited flexibility (depending on the generic software) Appropriateness to the context: + Build early capacity for users with limited IT literacy to get involved by quickly set up a functional prototype + Facilitate co-configuration / co-creation + Engaging for users when they see tangible results from their inputs - Can be too complicated for the users with most limited IT literacy
Peer-driven user involvement	Cost efficiency: - Expensive in short term + potential to be cost efficient in long term + Can reduce costs for users who more easily can become involved - Can increase costs for users who take up more responsibility Attain quality: + Earlier involvement of healthcare workers + Make the local community more autonom + Empower the local community to protect their own interest by building local knowledge about technology Appropriateness to the context: + Engage users through orally based means + Facilitate involvement for groups who already exists + Better requirement gathering done bottom-up + More honest feedback in requirement gathering through peers + Better training between peers + Build capacity at the local level, super users with mixed skills between health and technology + Create ownership of the process + Robust, user less dependent on designer
Effective stakeholder feedback mechanism	Cost efficiency: + Attract resources + Better alignment of stakeholders + Less resources needed for negotiation of requirements Attain quality:

	+ Give users a stronger voice + Convince key stakeholders for better decision making Appropriateness to the context: + Make problems on the ground visible + Engaging key stakeholders
Improving organizing of projects	Cost efficiency: + Better management of resources + Apply lessons learned + Make necessary changes early + Reduce burden on users by applying best practices Attain quality: + Ensure timely involvement of users Appropriateness to the context: + Ensure real world problems are illuminated in a timely manner + Ensure users are being capacitated early in the process

Tabel 5.3: The table provides an overview of which of the definition criterias for frugal user involvement that the identified opportunities can fulfill, based on the analysis of eHealth designers perspectives. + indicated potential factors supporting better user involvement, while - indicates potential challenges to apply the mean.

5.3 Discussion of frugal user involvement

After being guided by *frugal user involvement* to analyze the opportunities, we will now finally discuss which implications the analysis can have for the concept of frugal user involvement, which was developed based on related literature and emerged through the research process. We will first go through which implications the identified opportunities have for the definition criterias of frugal user involvement; cost efficiency, focus on attaining quality and appropriateness to context. We will then take a broader perspective on how frugal user involvement can be promoted by different stakeholders.

Implications for the definition criterias

All the opportunities identified by the eHealth designers were deemed to provide long term cost efficiency, but not all means were deemed to give cost efficient facilitation in the short term and to reduce the burden for users, which can be challenging within a LMICs context (Backhaus et al., 2014; Chetty et al., 2004; Dearden & Rizvi, 2008). The limited access to resources and the heavy work burden for many users in LMICs suggests that means of user

involvement not providing immediate cost efficient facilitation of user involvement, as well as reducing the costs for users to be involved, are not viable options. Based on this one of the main focuses of frugal user involvement should be to identify means that can give immediate cost efficiency facilitation while simultaneously reducing cost for users, which will also eventually imply long term cost efficiency. Building on the existing social and technical infrastructure within the context can be used as a strategy to provide cost efficiency, but there is also a tension between cost efficient facilitation and potentially pushing hidden costs on the users to be involved (Kanstrup & Bertelsen, 2018).

The eHealth designers reported lack of devices and infrastructure as challenges to involve the healthcare workers, and characteristics of robust means to involve users in resource constrained contexts were therefore involvement through peers building on the existing social and technical infrastructure within the context (Hanseth & Lyytinen, 2003), not being dependent on a lot of equipment (Backhaus et al., 2014), as well as using remote means of user involvement. These characteristics can also serve as guides for frugal user involvement. However many eHealth designers also stressed the importance of combining remote and on-site involvement of healthcare workers, as remote means can't entirely replace what you learn within the context and by meeting the healthcare workers face-to-face. This also highlights one important tension of frugal user involvement between the need of better user involvement which entails in-context and face-to-face means with depth of involvement, and the lack of resources which alter means that are sparse in contact or remote, less expensive for the eHealth designers and less burdensome for the healthcare workers.

The implications of the analysis for *frugal user involvement* is that cost efficiency should focus on the two dimensions: cost efficient facilitation and reducing burden for the users. Leveraging existing social and technical infrastructure can be used as a strategy for cost efficient user involvement. However there is a risk of cost efficient means to not be appropriate to the context.

Implications for stakeholders

After considering which implications the identified opportunities have for the definition criterias of frugal user involvement we will now look at which implications the findings have for the different stakeholders to involve users in resource constrained contexts needs to be resolved. Some of the challenges to involve users can be attempted to be resolved by the eHealth designers themselves, but the eHealth designers work based on contracts and cannot solely resolve the different challenges. Some of the challenges also need to be addressed by more structural approaches in collaboration with the user organization and

donors who finance the design and implementation, the policy makers and the vendors of generic softwares.

The eHealth designers, being both out in field researching directly with the healthcare workers, and also meeting top-level managers, donors, and policymakers, are in a unique situation to make decision makers endorse processes to empower users, and to mediate between the end-users and decision makers. The eHealth designers can improve their organizing of projects and the feedback mechanisms, focus on involving the healthcare workers from the start of the process, make the sessions more engaging, fun and educational, capacitate users with limited IT literacy to become involved, making users provide more honest feedback, and to make key stakeholders become more engaged about the users needs.

The user organization and donors can facilitate better inclusion of healthcare workers in the scoping and planning processes including more long-term perspective on how the eHealth solutions can fit the daily activities of the healthcare workers, provide easier access to the healthcare workers for the eHealth designers during activities, provide more resources to involve the healthcare workers during the design process and better time to involve the healthcare workers before deployment.

The policy makers can resolve issues such as poor work conditions for healthcare workers, more devices and better connectivity, fragmented implementation of eHealth solutions for vertical health programs and short term funding of eHealth projects. These issues are not in the sole hand of national policy makers in LMICs, but related to international power imbalance with donor driven interventions, thus policy makers influencing activities of international donors probably need to be engaged to resolve these issues.

The vendors of generic software deliver the technical components to the eHealth designers and can support the eHealth designer with resources and tools in this process, and build a community of practice to exchange experiences and knowledge about user involvement between resource constrained contexts. Vendors can also facilitate user involvement by making their software provide simple updates to users in rural and remote areas with low bandwidth, make the software more flexible to be adapted for many different use cases in such contexts, and provide effective feedback mechanisms where feedback from users on the ground can be effectively be feeded into the requirement gathering of the software ecosystem.

6. Conclusion and future research

Finally a conclusion on the research question will be given, followed by some reflections on limitations of this study and potential avenues for future research.

6.1 Conclusion

Opportunities to better involve users in LMICs have mostly been explored by foreign researchers rather than from the perspective of local eHealth designers that work in these contexts on a daily basis. This master thesis has explored opportunities to better involve healthcare workers during design of eHealth solutions based on the perspectives of eHealth designers working on a daily basis in 7 African countries. Some opportunities identified in the empirical example have already been outlined in related literature; visual means, design thinking, prototyping with generic software, peer-driven user involvement, effective stakeholder feedback mechanisms and improved organizing of projects. However some opportunities have also been identified that have not yet been discussed extensively yet in related research; role play and IMGs. Focusing on the experiences and perspectives of the local eHealth designers in LMICs can gear the research agenda towards exploring means to involve users that can fit work practices and context of the local eHealth designers that design technology used in LMICs.

The identified opportunities have in common that they have a combination of cost efficiency, appropriateness to context and focus on attaining quality. Based on the empirical findings and related literature the concept of Frugal User Involvement has been developed which can be used to guide eHealth designers, researchers and vendors of generic software to cope with multi-layered and complex challenges and evaluate opportunities of viable means for affordable quality better user involvement in LMICs and other resource constrained contexts. This master thesis contributions to practice and to research will now be described.

Contributions to practice

The master thesis contributes to practice by identifying eight opportunities that can potentially be used by eHealth designers in LMICs concerned with how to better involve users. The thesis also describes the concept of frugal user involvement which can be used by both eHealth designers and vendors of generic software packages concerned with how to facilitate better user involvement. The findings and analysis has also been made available publicly to make the research results more accessible.

The eight opportunities for better user involvement during design and implementation of eHealth in LMICs contexts provide practical contributions to the eHealth designers working in LMICs as part of their idékit to better involve healthcare workers, as well as other user groups. The opportunities provide valuable insights on affordable means to quality user involvement, and can be tailored and used by the eHealth designers depending on the challenges experienced to involve healthcare workers within the local context. The identified opportunities are also being used as content for the DHIS2 Method Toolkit which is under development aiming to build a resource of means for user-oriented design and innovation within the DHIS2 ecosystem.

The concept of frugal user involvement can be used by eHealth designers, and vendors of generic software to identify opportunities for better user involvement in LMICs and resource constrained contexts. eHealth designers implementing digital solutions in LMICs can use the concept to better understand the trade-offs between different approaches to effectively involve users in specific projects and contexts. Vendors targeting LMICs can use the concept to better understand which means that are sustainable and should be facilitated for in a long term perspective within their ecosystem.

The eight identified opportunities and the concept of frugal user involvement have been illustrated as infographics and published to make the research results more accessible for the eHealth designers[3].

Contributions to research

This thesis contributes to the stream of research within the field ICT for development concerned with how to better involve users in LMICs (Backhaus et al., 2014; Chetty et al., 2004; Kimaro & Hodne, 2008; Li, 2021; Maunder et al., 2007; Ramachandran et al., 2007; Teka et al., 2017; Winschiers-Theophilus & Bidwell, 2013, p. 201), by describing perspectives from the eHealth designers in LMICs which both support identified challenges and opportunities, but also differ on some aspects. The thesis also makes a theoretical contribution by developing the concept of frugal users' involvement which can guide further research. Finally the research approach represents an example of an innovative approach to research using remote workshops through online whiteboarding.

Current research has mostly been based on the perspectives of foreign scholars doing field research in LMICs, and this study contributes with an elaborative description of perspectives

[3] https://www.mn.uio.no/hisp/english/dhis2-design-lab/projects/involving-health-workers-in-ehealth-projects/frugal-user-involvement.pdf

from the eHealth designers working on a daily basis in LMICs on how to carry out better user involvement. These perspectives can be used by researchers concerned with understanding practices for better user involvement that can be used by the local eHealth designers that work in these contexts on a daily basis.

The empirical findings support previous research suggesting that users with limited IT literacy can be capacitated to be involved by being exposed to technology early in the design process by using functional prototypes (Molapo & Marsden, 2013, p. 20), and like previous research the study identify prototing with generic software as one such opportunity (Kimaro & Hodne, 2008). The findings are also aligned with previous research identifying visual means (Makamba et al., 2019) as appropriate to involve users in cultures altering orally and embodied communication. The empirical findings also support related research claiming that peer-driven user involvement can be an approach to involve users in LMICs (Ramachandran et al., 2007).

The empirical findings also provide some new prospects for user involvement in LMICs. There is a lack of means to capacitate users with limited IT literacy to be involved, and to learn about how technology can be designed in contexts with limited penetration of technology (Maunder et al., 2007), and this study contributes to identifying an opportunity to close the design-actuality gap (Heeks, 2002), by using role play to build capacity for users and explore use of technology in a simulated yet realistic environment, which can be explored further by researchers focusing on involving users in LMICs. The empirical findings also identify IMGs as a current practise being used to involve users throughout the African continent, that can reduce the need of resources to facilitate user involvement (Chetty et al., 2004), and reduce users' burden of being involved (Dearden & Rizvi, 2008), while at the same time empowering users to express their needs and get direct contact with decision makers.

In the face of multi-layered and complex challenges, there is a lack of clear criterias for analyzing and selecting viable means for affordable quality user involvement appropriate to LMICs and other resource scarce contexts. The thesis contributes with describing the concept of frugal user involvement which can be used to guide researchers to explore and investigate practices that can be promising to be used by the local eHealth designers that work in LMICs and resource constrained contexts on a daily basis. The thesis also identifies carry out cost efficient facilitation while simultaneously reducing the burden for the users to be involved as a promising avenue for frugal user involvement. Using existing social and technical infrastructure has been identified as one strategy for achieving this. One key

challenge for frugal user involvement is that there is a risk for cost efficient user involvement to not be appropriate to the context.

In addition, the thesis makes a smaller methodological contribution. The research approach used in this master thesis is also part of an emerging field of shift from in-person to online approaches in the face of the COVID19-pandemic (Galabo et al., 2020), and is an example of how online whiteboarding and visualization can be used to engage and probe participants, that can be especially suitable during global research when involving participants with bad internet connectivity and to avoid cross-cultural ambiguity.

6.2 Limitations

In the following sections the limitations of this research is discussed. The main limitations with this research is that it was conducted using exclusively remote means of data collection, and that it only includes the perspectives from the eHealth designers without considering other stakeholders.

This research was conducted exclusively using remote means of data collection due to the COVID19-pandemic. This has allowed participation from 37 eHealth designers working in 7 LMICs in Africa and exploration of a broad range of practises, challenges and opportunities, however given the limited time, most topics could only be surfaced. Work practices are best studied within the context, rather than using remote data collection methods, to get a more in-depth understanding and reduce ambiguity, and to identify disparity between what participants say and what they do. The research has facilitated brainstorming of ideas, but not tested anyone out in practice. The use of remote means of data collection have also been challenging due to for instance connectivity issues that have obscured parts of the data collection. There is also some ambiguity in the collected data as the participants discussed involvement of various kinds of healthcare workers, as well as ‘users’ interchangeably making it unclear in some instances about exactly who they were talking about. The healthcare workers discussed in this research also consist of a very diverse group of professionals, working in a diverse setting with various tasks and responsibilities, anywhere from Cape Town to the northern rural Togo, and it can be difficult to generalize based on such diverse contexts. It is also questionable how valid these results are for user involvement in other African countries than the participants worked in, and even more so in other LMICs outside Africa. The somehow fuzzy concept of LMICs includes countries with quite distinct geographical, social and cultural characteristics, and even the African continent has a great variety between the different countries. Similar socioeconomic do however implies some commonalities when it comes to infrastructure, access to devices, IT literacy and education.

Further exploration needs to be done to evaluate the relevance for the identified opportunities in other LMICs.

This research is also limited to the perspectives from the eHealth designers, but does not include perspectives from other key stakeholders such as donors who fund the activities and sign of the scope, managers who lead the healthcare workers and organize their day-to-day activities, the healthcare workers who are going to use the implemented systems, or the healthcare receivers who will eventually use the services provided by the healthcare workers. However, the eHealth designers' perspectives are important, being a key mediator between these stakeholders and having the professional responsibility to drive the user involvement. I therefore urge further research to explore the perspective of other stakeholders which could be interesting to compare with my findings.

6.3 Further research

Based on the described contributions to research, and taking into consideration some limitations, there are several interesting directions for further research that could be explored.

As the identified opportunities in this study have been explored in broadness rather than depth, they are not very concrete, e.g. activities within IMGs can be organized in a multitude of ways, visual means represent very different kinds of content, and peer-driven users involvement can include many different kinds of interventions. The identified opportunities, as well as the definition criterias of frugal user involvement, needs to be explored further in follow-up studies. This should preferably be done in-context together with the eHealth designers using ethnographic or action research approaches to provide insights on means that can be used by the eHealth design practitioners working in LMICs. Considering the broadness of the research results I will try to point in some directions that could be especially interesting to explore.

Instant messaging groups

My findings point to IMGs as a promising means of frugal user involvement, however the use of IMGs to involve users in the various phases of the design and implementation process have not been extensively described. The eHealth designers also described emerging challenges with IMGs with increasing numbers of chat groups due to their popularity. Based on this it could be interesting to get a better understanding of current practices of using and organizing IMGs for various purposes to identify lessons learned and best practices for more effective use of the IMGs. Furthermore the eHealth designers described more limited use of IMGs in the early stages of scoping, planning and requirement collection, and future research

could therefore explore extended use of IMGs to include the healthcare workers earlier in the design and implementation process.

Role play

Role play was also used in some locations, and yielded high curiosity among eHealth designers not familiar with this activity. Moving forward it could be of interest to better understand how role play is currently being used by eHealth designers to involve healthcare workers. It could also be interesting to test out the use of role play in new locations to see if it can scale, and to explore how role play could be used to involve healthcare workers in the early stage of the design process. The possibility to record and share video recordings within IMGs can also be an interesting opportunity to explore further in combination with role play.

Prototyping with generic software

Prototyping with generic software was identified to be used by almost all the eHealth designers in this study, but can, as discussed, be problematic. Future research could try to understand better the eHealth designers' practices to prototype with generic softwares focusing on how to make these functional prototypes extend rather than narrowing the users perspective.

Visual means

Visual means were identified as an opportunity with big potential to involve users in an engaging and educative manner, but more costly to produce. It could therefore be interesting to explore with tools and techniques to produce visual content such as video and illustrations at a lower cost. This could also involve peer-driven means to co-produce the visual content, for instance using photos and videos from the healthcare workers.

Remote vs on-site means in LMICs

Remote means of user involvement such as IMGs have high potential to scale and involve many healthcare workers in a cost efficient manner. However remote involvement was not always seen to be optimal as the eHealth designers experienced being more able to connect with the healthcare workers and 'switch things up' more easily when being on-site. The COVID19-pandemic has however made both many eHealth designers and healthcare workers in LMICs more used to diverse forms of remote involvement. How to effectively combine remote and on-site means of user involvement in a LMICs setting could be interesting to explore further.

Negotiation of projects

Another key challenge identified is how the projects are scoped and planned in a way so the eHealth designers do not have the flexibility to involve the healthcare workers the way they want. This suggests that how eHealth designers can better negotiate the space needed for involvement of healthcare workers in future projects could be an interesting topic to explore further. One topic in such research could be to explore how findings and requirements from the community level are reported to the decision makers and how it could be possible to improve the reporting to make them more engaging.

Perspectives of the healthcare workers and healthcare recipients

Another interesting topic that has not been explored in this research could be to find out more about the preferences of the healthcare workers, for instance how they would like to be better involved, and which means that would fit best into their own work practices.

7. References

AbouZahr, C., & Boerma, T. (2005). Health information systems: The foundations of public health. *Bulletin of the World Health Organization*, *83*(8), 578–583.

Agarwal, N., Grottke, M., Mishra, S., & Brem, A. (2017). A Systematic Literature Review of Constraint-Based Innovations: State of the Art and Future Perspectives. *IEEE Transactions on Engineering Management*, *64*(1), 3–15. https://doi.org/10.1109/TEM.2016.2620562

Agnihotri, A. (2014). Low-cost innovation in emerging markets. *Journal of Strategic Marketing*, *23*, 1–13. https://doi.org/10.1080/0965254X.2014.970215

Albert, M. (2019). Sustainable frugal innovation—The connection between frugal innovation and sustainability. *Journal of Cleaner Production*, *237*, 117747. https://doi.org/10.1016/j.jclepro.2019.117747

Alhassan, R. K., Nketiah-Amponsah, E., & Arhinful, D. K. (2016). Design and implementation of community engagement interventions towards healthcare quality improvement in Ghana: A methodological approach. *Health Economics Review*, *6*(1), 49. https://doi.org/10.1186/s13561-016-0128-0

Backhaus, N., Brandenburg, S., & Trapp, A. (2014). Positive Technology and User Experience for Human Needs in Developing Countries: Some Considerations. *HCI*. https://doi.org/10.1007/978-3-319-07635-5_39

Bannon, L., & Ehn, P. (2012). Design matters in participatory design. Routledge International Handbook of Participatory Design, Edition 1st Edition

Basu, R., Banerjee, P., & Sweeny, E. (2013). Frugal Innovation: Core Competencies to Address Global Sustainability. *Journal of Management for Global Sustainability*, *1*, 63–82. https://doi.org/10.13185/JM2013.01204

Blomberg, J. L., & Karasti, H. (2012). *Ethnography: Positioning ethnography within participatory design*. Routledge International Handbook of Participatory Design, Edition 1st Edition

Bound, K., & Thornton, I. (2012). *Our Frugal Future: Lessons from India's innovation system*. London : NESTA

Braa, J., Monteiro, E., & Sahay, S. (2004). Networks of Action: Sustainable Health Information Systems Across Developing Countries. *MIS Q.* https://doi.org/10.2307/25148643

Braa, J., & Muquingue, H. (2007). *Building collaborative networks in Africa on health information systems and open source software development-experiences from the HISP/BEANISH Network*, IST-Africa

Brandt, E., Binder, T., & Sanders, E. (2012). *Tools and techniques: Ways to engage telling, making and enacting*. Routledge International Handbook of Participatory Design. Edition 1st Edition,

Bratteteig, T., Bødker, K., Dittrich, Y., Mogensen, P., & Simonsen, J. (2012). *Methods: Organising principles and general guidelines for Participatory Design projects*. Routledge International Handbook of Participatory Design. Edition 1st Edition,

Bratteteig, T., & Wagner, I. (2014). Design decisions and the sharing of power in PD. *In Proceedings of the 13th Participatory Design Conference: Short Papers, Industry Cases, Workshop Descriptions, Doctoral Consortium papers, and Keynote abstracts - Volume 2 (PDC '14). Association for Computing Machinery, New York, NY, USA, 29–32. https://doi.org/10.1145/2662155.2662192*

Bratteteig, T., & Wagner, I. (2016). Unpacking the Notion of Participation in Participatory Design. *Computer Supported Cooperative Work (CSCW)*, *25*(6), 425–475. https://doi.org/10.1007/s10606-016-9259-4

Buchanan, R. (1992). Wicked Problems in Design Thinking. *Design Issues*, *8*(2), 5. https://doi.org/10.2307/1511637

Chamberlain, A., Crabtree, A., Rodden, T., Jones, M., & Rogers, Y. (2012). *Research in the wild: Understanding "in the wild" approaches to design and development* : Proceedings of the Designing Interactive Systems Conference, p. 796.

https://doi.org/10.1145/2317956.2318078

Chawani, M. S., Kaasbøll, J., & Finken, S. (2014). Stakeholder participation in the development of an electronic medical record system in Malawi. *PDC*. https://doi.org/10.1145/2661435.2661444

Chetty, M., Tucker, W., & Blake, E. (2004). *Developing locally relevant software applications for rural areas: A South African example*. SAICSIT '04: Proceedings of the 2004 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries.

Damodaran, L. (1996). User involvement in the systems design process-a practical guide for users. *Behaviour & Information Technology*, *15*(6), 363–377. https://doi.org/10.1080/014492996120049

Darbellay, F., Moody, Z., Sedooka, A., & Steffen, G. (2014). Interdisciplinary Research Boosted by Serendipity. *Creativity Research Journal*, *26*, 1–10. https://doi.org/10.1080/10400419.2014.873653

Dearden, A., & Rizvi, S. M. H. (2008). Participatory IT design and participatory development: A comparative review. *PDC*. https://doi.org/10.1145/1795234.1795246

Dow, S., MacIntyre, B., Lee, J., Oezbek, C., Bolter, J. D., & Gandy, M. (2005). Wizard of Oz support throughout an iterative design process. *IEEE Pervasive Computing*, *4*(4), 18–26. https://doi.org/10.1109/MPRV.2005.93

Elovaara, P., Igira, F. T., & Mörtberg, C. (2006). *Whose Participation? Whose Knowledge? – Exploring PD in Tanzania-Zanzibar and Sweden*. . In: Proc. of PDC, pp. 105–114. ACM

Farooq, R. (2017). A conceptual model of frugal innovation: Is environmental munificence a missing link? *International Journal of Innovation Science*, *9*, 00–00. https://doi.org/10.1108/IJIS-08-2017-0076

Galabo, R., Nthubu, B., Cruickshank, L., & Pérez, D. (2020, December 29). *Redesigning a Workshop from Physical to Digital: Principles for Designing Distributed Co-design*

Approaches. Proc. Des. Vert. Horiz. Growth.

Gaver, B., Dunne, T., & Pacenti, E. (1999). Design: Cultural Probes. *Interactions*, *6*(1), 21–29. https://doi.org/10.1145/291224.291235

Gay, G., & Hembrooke, H. (2004). *Activity-Centered Design: An Ecological Approach to Designing Smart Tools and Usable Systems*. Mit Press, https://doi.org/10.7551/mitpress/1085.001.0001

Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S., Persson, J., & Cajander, Å. (2003). Key principles for user-centred systems design. *Behaviour & Information Technology*, *22*(6), 397–409. https://doi.org/10.1080/01449290310001624329

Hanseth, O., & Lyytinen, K. (2004). *Theorizing about the design of Information Infrastructures: Design kernel theories and principles*. *, Sprouts Work. Pap. Inf. Syst., vol. 4, no. 12, p. 208–241,*

Heeks, R. (2002). Information Systems and Developing Countries: Failure, Success, and Local Improvisations. *The Information Society*, *18*(2), 101–112. https://doi.org/10.1080/01972240290075039

Ho, M., Smyth, T. N., Kam, M., & Dearden, A. (2009). *Human-Computer Interaction for Development: The Past, Present, and Future*. Information Technologies & International Development (ITID), 5(4), 1-18.

Hossain, M., Simula, H., & Halme, M. (2016). Can frugal go global? Diffusion patterns of frugal innovations. *Technology in Society*, *46*. https://doi.org/10.1016/j.techsoc.2016.04.005

Houde, S., & Hill, C. (1997). What do Prototypes Prototype? In M. G. Helander, T. K. Landauer, & P. V. Prabhu (Eds.), *Handbook of Human-Computer Interaction (Second Edition)* (pp. 367–381). North-Holland. https://doi.org/10.1016/B978-044481862-1.50082-0

Irani, L., Vertesi, J., Dourish, P., Philip, K., & Grinter, R. (2010). Postcolonial computing: A lens on design and development. *CHI*. https://doi.org/10.1145/1753326.1753522

Kam, M. (2008). Involving local undergraduates in fieldwork. *INTR*. https://doi.org/10.1145/1374489.1374503

Kanstrup, A., & Bertelsen, P. (2018). Participatory rhythms: Balancing participatory tempi and investments in design with vulnerable users. *PDC*. https://doi.org/10.1145/3210604.3210631

Kensing, F., & Greenbaum, J. (2012). *Heritage: Having a say*. Routledge International Handbook of Participatory Design. Edition 1st Edition, https://doi.org/10.4324/9780203108543-9

Kesse-Tachi, A., Asmah, A. E., & Agbozo, E. (2019). Factors influencing adoption of eHealth technologies in Ghana. *DIGITAL HEALTH*, *5*, 205520761987142. https://doi.org/10.1177/2055207619871425

Kimaro, H. C., & Hodne, O. (2008). Challenges of user participation in the design of a computer based system: the possibility of participatory customisation in low income countries [Electronic Version]. Journal of Health Informatics in Developing Countries, 2, 1-9 from http://www.jhidc.org/index.php/jhidc/issue/view/4.

Koerich, G. V., & Cancellier, É. L. P. D. L. (2019). Frugal Innovation: Origins, evolution and future perspectives. *Cadernos EBAPE.BR*, *17*(4), 1079–1093. https://doi.org/10.1590/1679-395174424x

Kujala, S. (2003). User involvement: A review of the benefits and challenges. *Behaviour & Information Technology*, *22*(1), 1–16. https://doi.org/10.1080/0144929030178

Kumar, N., & Puranam, P. (2012). Frugal engineering. An emerging innovation paradigm. *Ivey Business Journal*, *76*, 14–16.

Kuo, A. (2014). *Creating Social Value through Frugal Innovation* In book: Entrepreneurship in Asia Social Enterprise, Network and Grassroots Case Studies.

Lelie, C. (2006). The value of storyboards in the product design process. *Personal and Ubiquitous Computing*, *10*, 159–162. https://doi.org/10.1007/s00779-005-0026-7

Li, M. (2018). *Utilizing the Space for User Participation—Enabling and Constraining Factors*

for User Involvement when Designing a Data Entry Interface in a Generic Health Information Software in Uganda. University of Oslo. https://www.duo.uio.no/handle/10852/62760

Li, M. (2021). *Generic Enterprise Software implementation as Context for User-Oriented Design: Three Conditions and their Implications for Vendors.* 12th Scandinavian Conference on Information Systems (SCIS), Orkanger, Norway.

Lippeveld, T., Sauerborn, R., Bodart, C., & Organization, W. H. (2000). *Design and implementation of health information systems*. World Health Organization. https://apps.who.int/iris/handle/10665/42289

Makamba, P., Matewa, C., van Dijk, J., van Stam, G., & Vhoko, P. (2019). Participatory Video, Giving Voice and Respect to the Epistemic Sovereignty of Communities in Rural Zimbabwe. In P. Nielsen & H. C. Kimaro (Eds.), *Information and Communication Technologies for Development. Strengthening Southern-Driven Cooperation as a Catalyst for ICT4D* (pp. 110–121). Springer International Publishing. https://doi.org/10.1007/978-3-030-19115-3_10

Maunder, A., Marsden, G., Gruijters, D., & Blake, E. (2007). Designing interactive systems for the developing world—Reflections on user-centred design. *2007 International Conference on Information and Communication Technologies and Development*. https://doi.org/10.1109/ICTD.2007.4937419

Miaskiewicz, T., & Kozar, K. (2011). Personas and user-centered design: How can personas benefit product design processes? *Design Studies*, *32*, 417–430. https://doi.org/10.1016/j.destud.2011.03.003

Molapo, M., & Marsden, G. (2013). Content Prototyping—An Approach for Engaging Non-technical Users in Participatory Design. *INTERACT*. https://doi.org/10.1007/978-3-642-40483-2_56

Mumford, E. (2006). The Story of Socio-Technical Design: Reflections on its Successes, Failures and Potential. *Inf. Syst. J.*, *16*, 317–342.

https://doi.org/10.1111/j.1365-2575.2006.00221.x

Nardi, B. (1992). The use of scenarios in design. *ACM Sigchi Bulletin*, *24*, 13–14. https://doi.org/10.1145/142167.142171

Nawaz, A. (2012). *A Comparison of Card-sorting Analysis Methods*. 10th Asia Pacific Conference on Computer Human Interaction.

Nielsen, P. (2017). Digital Innovation: A Research Agenda for Information Systems Research in Developing Countries. In J. Choudrie, M. S. Islam, F. Wahid, J. M. Bass, & J. E. Priyatma (Eds.), *Information and Communication Technologies for Development* (Vol. 504, pp. 269–279). Springer International Publishing. https://doi.org/10.1007/978-3-319-59111-7_23

Paton, B., & Dorst, K. (2011). Briefing and reframing: A situated practice. *Design Studies - DESIGN STUD*, *32*. https://doi.org/10.1016/j.destud.2011.07.002

Pollock, N., D'Adderio, L., & Williams, R. (2008). Global Software and its Provenance: Generification Work in the Production of Organizational Software Packages. *Social Studies of Science*, *37*. https://doi.org/10.1177/0306312706066022

Puri, S. K., Byrne, E., Nhampossa, J. L., & Quraishy, Z. B. (2004). Contextuality of participation in IS design: A developing country perspective. *PDC 04*. https://doi.org/10.1145/1011870.1011876

Ramachandran, D., Kam, M., Chiu, J., Canny, J., & Frankel, J. F. (2007). Social dynamics of early stage co-design in developing regions. *CHI*. https://doi.org/10.1145/1240624.1240790

Rao, B. (2013). How Disruptive is Frugal? *Technology in Society*, *35*. https://doi.org/10.1016/j.techsoc.2013.03.003

Sæbø, J., Nicholson, B., Nielsen, P., & Sahay, S. (2021). Digital Global Public Goods. *ArXiv*.

Sahay, S., Nielsen, P., Faujdar, D., Kumar, R., & Mukherjee, A. (2018). Frugal Digital Innovation and Living Labs: A Case Study of Innovation in Public Health in India. *ICIS*

2018 Proceedings. https://aisel.aisnet.org/icis2018/innovation/Presentations/10

Sanders, E., Brandt, E., & Binder, T. (2010, January 1). A Framework for Organizing the Tools and Techniques of Participatory Design. *ACM International Conference Proceeding Series*. https://doi.org/10.1145/1900441.1900476

Sanders, E., & Stappers, P. (2008). *Co-creation and the new landscapes of design*. Co-Design, 4, 5-18. https://doi.org/10.1080/15710880701875068

Schleicher, D., Jones, P., & Kachur Niedzielski, O. (2010). Bodystorming as embodied designing. *Interactions*, *17*, 47–51. https://doi.org/10.1145/1865245.1865256

Schmidt, K., Wagner, I., & Tolar, M. (2007). *Permutations of cooperative work practices: A study of two oncology clinics*. In Proceedings of GROUP. https://doi.org/10.1145/1316624.1316626

Sherwani, J., Ali, N., Rosé, C., & Rosenfeld, R. (2009). Orality-Grounded HCID: Understanding the Oral User. *Information Technologies & International Development, 5(4), pp. 37-49*.

Shuvo, T., Islam, R., Hossain, S., Evans, J., Khatun, F., Ahmed, T., Gazi, R., & Adams, A. (2015). *eHealth innovations in LMICs of Africa and Asia: A literature review exploring factors affecting implementation, scale-up, and sustainability*. Innovation and Entrepreneurship in Health. Volume 2015:2 pages 95-106. https://doi.org/10.2147/IEH.S88809

Simonsen, J., & Robertson, T. (2012). *Routledge International Handbook of Participatory Design*. https://doi.org/10.4324/9780203108543

Simula, H., Hossain, M., & Halme, M. (2015). Frugal and reverse innovations – Quo Vadis? *Current Science*, *109*. https://doi.org/10.18520/v109/i9/1567-1572

Soni, P., & Krishnan, R. (2014). Frugal innovation: Aligning theory, practice, and public policy. *Journal of Indian Business Research*, *6*. https://doi.org/10.1108/JIBR-03-2013-0025

Stansfield, S., Orobaton, N., Lubinski, D., Uggowitzer, S., & Mwanyika, H. (2008). *The Case*

for a National Health Information System Architecture ; a Missing Link to Guiding National Development and Implementation, Paper presented at the Making the eHealth Connection, Making the ehealth Connection Conference, Bellagio, Italy

Steen, M. (2013). Co-Design as a Process of Joint Inquiry and Imagination. *Design Issues*, *29*(2), 16–28. https://doi.org/10.1162/DESI_a_00207

Teka, D., Dittrich, Y., & Kifle, M. (2017). Contextualizing user centered design with agile methods in Ethiopia. *2017 IEEE AFRICON*. https://doi.org/10.1109/AFRCON.2017.8095603

Thackara, J. (2001). The Design Challenge of Pervasive Computing. *Interactions*, *May/Jun*, 47–52.

Verne, G. B., & Bratteteig, T. (2018). Inquiry when doing research and design: Wearing two hats. *IxD&A*.

Vidal, R. (2006). The Future Workshop: Democratic problem solving. *Journal of Economic Analysis Working Papers (EAWP), 5: 1–25.*.

Visser, F., Stappers, P., Lugt, R. van der, & Sanders, E. (2005). *Contextmapping: Experiences from practice*. https://doi.org/10.1080/15710880500135987

Watkins, C., Loudon, G., Gill, S., & Hall, J. (2015). *The Challenges of taking a User-Centric Approach within developing countries: A case study of designing medical solutions for Zambia*. Proceedings of the 11th European Academy of Design Conference, Paris Desartes University, Boulogne Billancourt, France, April 22-24.

Weyrauch, T., & Herstatt, C. (2016). What is frugal innovation? Three defining criteria. *Journal of Frugal Innovation*, *2*(1), 1. https://doi.org/10.1186/s40669-016-0005-y

Winkler, T., Ulz, A., Knöbl, W., & Lercher, H. (2019). Frugal innovation in developed markets – Adaption of a criteria-based evaluation model. *Journal of Innovation & Knowledge*, *5*. https://doi.org/10.1016/j.jik.2019.11.004

Winograd, T. (1997). *From Computing Machinery to Interaction Design*. In Human-Centered Systems: Information, Interactivity, and Intelligence.

Winschiers, H. (2006). *The Challenges of Participatory Design in a Intercultural Context: Designing for Usability in Namibia*. Proc. PDC.

Winschiers-Theophilus, H. (2001). *Dialogical system design across cultural boundaries: System design out of Africa*. University of Hamburg, Germany, pp. 1-206

Winschiers-Theophilus, H. (2006). *The Challenges of Participatory Design in an Intercultural Context: Designing for Usability in Namibia*. In: Proc. of the PDC'06.

Winschiers-Theophilus, H., & Bidwell, N. J. (2013). Toward an Afro-Centric Indigenous HCI Paradigm. *Int. J. Hum. Comput. Interact.* https://doi.org/10.1080/10447318.2013.765763

Winschiers-Theophilus, H., Chivuno-Kuria, S., Kapuire, G. K., Bidwell, N. J., & Blake, E. (2010). Being participated: A community approach. *PDC '10*. https://doi.org/10.1145/1900441.1900443

Zachry, M., & Spyridakis, J. H. (2016). Human-Centered Design and the Field of Technical Communication. *Journal of Technical Writing and Communication*, *46*(4), 392–401. https://doi.org/10.1177/0047281616653497

8. Appendix

Appendix 1: Overview of data collection
Appendix 2: Interview guide
Appendix 3: First online workshop, agenda
Appendix 4: Second online workshop, agenda

Appendix 1: Overview of data collection

Conducted March 2021 - February 2022.

Semi-structured interviews

Date	Country	Participants
5. June 2020	Mozambique	1
17. September 2020	Uganda	1
1. October 2020	Malawi	1
20. October 2020	Mozambique	1

Online workshop 1

Date	Country	Participants
10. March 2021	Malawi	3
16. March 2021	Uganda	3
29. March 2021	Mozambique	3
6. April 2021	Malawi	7
17. November 2021	Rwanda	3
3. December 2021	Togo	2
16. December 2021	Nigeria	6
18. January 2022	South-Africa	3
26. January 2022	Malawi	4

Online workshop 2

Date	Country	Participants *
20. December 2021	Malawi	6
10. January 2022	Uganda	1
18. January 2022	Mozambique	3
24. January 2022	Uganda	1

28. January 2022	Malawi	1
3. February 2022	Malawi	1
22. February 2022	South Africa	3
24. February 2022	Togo	2
15. March 2022	Nigeria	5
31. March 2022	Rwanda	2

* Many, but not all participating in workshop 2 had already participated in workshop 1.

Appendix 2: Interview guide

The interview guide used for the semi-structured interviews. It has some main questions for different phases of the implementation process, with sub-categories of topics for follow-up questions.

- **Introduction**
    - Can you tell me about your work? What do you do?
        - Position / profession
        - Institution / company
        - Daily activities
    - What DHIS implementations have you been working on?
        - Kinds of projects
            - Any more open / experimenting / unusual projects?
        - Your role in these projects
- **Projects and activities**
    - Who initiates the projects and decides the project scope?
        - The purpose / “Why”
        - Based on what knowledge
        - Negotiation
        - Can scope change?
    - What activities are done during the projects?
        - Stages
        - Actors
        - Collaboration
        - Tools / resources used
- **Requirements**
    - What requirements do you collect?
        - Types
            - Functionality
            - Data / information
            - User interfaces
            - Organizational
            - ++ ?
        - Examples
    - How do you collect the requirements?
        - The process
        - Means / methods
        - Who is involved
        - Analysis
        - Prioritization
        - Documentation
- **User-involvement**
    - Who are the typical end-user and how do you try to involve them throughout the process?
        - Who
        - The purpose / “Why” / Benefits
        - Information needed

        - Means / methods / forms of participation
        - When and where?
        - Interaction with users
        - Interacting and developing with users
    - How much do you manage to actually involve them?
        - Degree of participation
        - Challenges
        - Trends (before/now)?
    - How do you think end-users could be involved more in future projects?
        - Possibilities
        - Tools / techniques
        - Communication
        - Resources needed
        - Politics
        - Project scoping
- **Development**
    - How do you go from requirements to deciding what to build?
    - How do you develop on DHIS? *Develop or implement?*
        - Configuration
        - Customization
        - App development
- **Evaluation & maintenance**
    - How are projects evaluated?
        - Who
        - Means / methods
        - Success criterias / metrics
        - Analysis / Documentation
    - What happens after an evaluation?
        - Training
        - Support
        - Maintenance
        - Continuous development

Appendix 3: First online workshop, agenda

- **Introduction**
    - Consent form
    - DHIS2 Design Lab
    - Agenda
- **Presentation**
    - Participants
    - Researchers
- **Introduction of tool**
    - Miro
    - Demonstrate (shared screen)
    - Participants choose sticky notes with unique colours
- **Implementation projects involving CHWs**
    - Which implementation projects have you been involved in with / without CHWs?
    - Presentation of sample answers to scaffold
    - Brainstorming 5 min
    - Look at results, each participants present their sticky notes
- **Implementation Stakeholders**
    - Which type of stakeholders did you work with during these projects?
    - Brainstorming 5 min
    - Look at results, each participants present their sticky notes
- **Means of involvement used**
    - Which means (methods, tools & techniques) did you use to involve community health workers / other stakeholders?
    - Brainstorming 5 min
    - Look at results, each participants present their sticky notes
- **Benefits of involving CHWs**
    - What are the benefits of involving community health workers during DHIS2 implementation?
    - Brainstorming 5 min
    - Look at results, each participants present their sticky notes
- **Challenges of involving CHWs**
    - What are the challenges with involving community health workers?
    - Brainstorming 5 min
    - Look at results, each participants present their sticky notes
- **Opportunities of better involvement of CHWs**
    - What can be done to involve community health workers more? What is needed?
    - Brainstorming 5 min
    - Look at results, each participants present their sticky notes

Appendix 4: Second online workshop, agenda

- **Introduction**
- **Challenges**
    - Present analysis from first workshop
    - Feedbacks from each participant
        - Are any challenges missing?
        - Which are the three most important challenges?
        - Are any challenges here surprising to you?
- **Current involvement (on-cite + remote)**
    - Present analysis from first workshop
    - Feedbacks from each participant
        - Are any methods your are using missing?
        - Which of these methods are you using most commonly?
        - Which of these methods are you using the least / not using?
        - Which would you be curious to use?
- **Opportunities for better involvement**
    - Conventional means of user involvement
        - Which other means for user engagement could be used to better involve community healthcare workers?
    - Brainstorming 5 min
        - New on-site user involvement: Imagine a new way for better on-cite user involvement - how would it look like?
        - New remote user involvement: Imagine a new way for better remote user involvement - how would it look like?
    - Look at results, each participants present their sticky notes
- **Stakeholder**
    - Present analysis from first workshop
    - Feedbacks from each participant
        - Which type of stakeholders are you working with on projects where community health workers are involved?
- **Communication between the stakeholders**
    - Brainstorming 5 min
        - How are findings from health workers' involvement communicated to other stakeholders?
    - Look at results, each participants present their sticky notes
- **Tools / resources needed**
    - Brainstorming 5 min
        - Which tools, guidelines and other resources / aids are you using to involve community health workers?
    - Look at results, each participants present their sticky notes