Master Thesis Master's Degree in International Development Cooperation

Assessing barriers to the implementation of mHealth applications in the field of maternal health in Ethiopia

Análisis de las barreras para desplegar aplicaciones móviles de salud (mHealth) en el campo de la salud materna. Estudio de caso: Etiopía

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Acronyms

ADI	Affordability Drivers Index
AHPSR	Alliance for Health Policy and Systems Research
ANC	Antenatal Care
BEmONC	Basic Emergency Obstetric and Newborn Care
CEmONC	Comprehensive Emergency Obstetric and Newborn Care
CSA	Central Statistical Agency Federal Democratic Republic of Ethiopia
DIV	Development Innovation Ventures
EDHS	Ethiopia Demographic and Health Survey
EU	European Union
GDP	Gross Domestic Product
HEP	Health Extension Program
HEWs	Health Extension Workers
HIPAA	Health Insurance Portability and Accountability Act
HIV	Human Immunodeficiency Viruses
HSTP	Health Sector Transformation Plan
ICT	Information and Communications Technology
LMIC	Low-to-Middle-Income Country
MDG	Millennium Development Goal
mHealth	Mobile Health
MMR	Maternal Mortality Ratio
MOH	Ministry of Health Federal Democratic Republic of Ethiopia
MNO	Mobile Network Operator
NGO	Non-Profit Organization
NPC	National Planning Commission Federal Democratic Republic of Ethiopia
PMNCH	Partnership for Maternal, Newborn & Child Health
SMS	Short Message Service
UHC	Universal Health Coverage
UN	United Nations
UNFPA	United Nations Population Fund
USAID	United States Agency for International Development
RMNCH	Reproductive, Maternal, Neonatal, Child and Youth Health

SDG	Sustainable Development Goal
ITU	International Telecommunication Union
WBG	World Bank Group
WHO	World Health Organization

Abstract

Despite remarkable progress in recent decades, maternal mortality still stands out amongst Ethiopia's biggest healthcare challenges. Mobile health ("mHealth") apps have the potential to improve maternal health outcomes in the country, but numerous barriers must be addressed for successful implementation. The goal of this master thesis is to identify barriers to implementation of mHealth apps for maternal health in Ethiopia, present strategies to mitigate some of the difficulties, and provide best practices for the setup of such apps. To gather data eleven semi-structured qualitative research interviews were conducted with key stakeholders involved in mHealth apps for maternal health in Ethiopia. The study identified barriers relating to lack of funding; inadequate infrastructure; lack of evidence of cost-effectiveness; low mobile penetration and usage; low digital literacy of health workers; poor enabling environment for telecom companies; and sociocultural factors at household level. The results of the study identify several barriers that could be mitigated by focused policy from the government and development actors in Ethiopia.

Key words: Ethiopia, mHealth, maternal health, barriers

Resumen

A pesar del progreso en las últimas décadas, la mortalidad materna sigue siendo uno de los mayores problemas sanitarios de Etiopía. Las aplicaciones de salud móvil ("mHealth") tienen un gran potencial de mejorar la salud materna en el país, pero existen numerosas barreras que deben ser abordadas para implantar con éxito estas tecnologías. El objetivo de este estudio es identificar las barreras existentes para la implantación de aplicaciones de mHealth en el campo de la salud materna en Etiopía, presentar estrategias para mitigar dichas barreras y proporcionar una serie de buenas prácticas que podrían adoptarse para desplegar tales aplicaciones en el país. Para el trabajo de campo se realizaron once entrevistas semiestructuradas con distintos grupos de interés que son claves en la implantación de aplicaciones de mHealth para salud materna en Etiopía. Se identificaron barreras relacionadas principalmente con la falta de financiación; una infraestructura inadecuada; la falta de evidencia de costo-efectividad de las aplicaciones; la baja penetración y utilización de la telefonía móvil; la baja alfabetización digital de los trabajadores sanitarios; la ausencia de un entorno propicio para las empresas privadas en el sector de las telecomunicaciones; y la existencia de factores socioculturales en los hogares. Los resultados del estudio identifican varias barreras que podrían ser mitigadas mediante políticas específicas por parte del gobierno y de los agentes de desarrollo presentes en Etiopía.

Palabras clave: Etiopía, mHealth, salud materna, barreras

1. Introduction and background

1.1. Maternal mortality in Ethiopia

Over the past three decades Ethiopia has made remarkable progress in reducing maternal mortality, down to 412 per 100,000 live births in 2016 (National Planning Commission Federal Democratic Republic of Ethiopia [NPC], 2017, pp. 21) against 1,400 per 100,000 live births in 1990 (World Health Organization [WHO] and United Nations [UN] partners, 2015, pp.1). Advancements have been driven by multiple factors: implementation of the Health Extension Program (HEP) which has deployed over 38,000 Health Extension Workers (HEWs) tasked with providing maternal health services in pastoral and rural areas (Ministry of Health Ministry of Health Federal Democratic Republic of Ethiopia [MOH], 2015); the significant expansion and rehabilitation of primary health care facilities (MOH, Partnership for Maternal, Newborn & Child Health [PMNCH], WHO, World Bank Group [WBG], Alliance for Health Policy and Systems Research [AHPSR] and participants in the Ethiopia multi stakeholder policy review, 2015) resulting in greater access to essential health care (NPC, 2017); and society's increased awareness of the benefits of maternal care amid efforts led by the government and non-profit organizations (NGOs) to drive greater engagement with the healthcare system (NPC, 2017).

Yet despite such progress, Ethiopia failed to achieve its Millennium Development Goal (MDG) 5 target of reducing the maternal mortality ratio (MMR) to 267 per 100,000 births by 2015. In the Sustainable Development Goal (SDG) era maternal mortality still stands out amongst the country's biggest healthcare challenges (appendix A). Ethiopia aims to reduce the MMR to 199 per 100,000 by 2020 (Central Statistical Agency Federal Democratic Republic of Ethiopia [CSA] and ICF, 2017, pp. 133) and to less than 70 per 100,000 live births by 2030, in line with the global aspiration laid out for target 1 *"by 2030, reduce the global MMR to less than 70 per 100,000 live births"* (UN, 2019) of SDG 3 *"Ensure healthy lives and promote wellbeing for all at all ages"* (UN, 2019).

Against this backdrop, improving maternal health -defined as the health of women during pregnancy, childbirth and the postpartum (WHO, 2019a)- remains a top priority for the MOH as outlined in its five-year Health Sector Transformation Plan (HSTP) covering the period 2015-2020. The HSTP's strategic priorities with regards to maternal health care are *"delivery at a health facility with skilled medical attention and hygienic conditions; reduction in complications and infections during labour; timely postnatal care that treats complications from delivery; and education of the mother on care for herself and her infant"* (CSA and ICF, 2017, pp. 133).

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1.2. Role of technology in achieving the SDGs

The 2030 Agenda has positioned Science, Technology and Innovation as a key means of implementation to achieve the SDGs. Within the healthcare sector, eHealth – an umbrella term defined as *"the cost-effective and secure use of information and communication technologies in support of health and health-related fields"* (WHO, 2018, pp. 1)– is *"seen as a driver of development, innovation and economic vitality, changing how healthcare is delivered and how healthcare systems are run"* (International Telecommunication Union [ITU], 2017, pp. 24, 25). States are moving eHealth *"to the centre of strategic health planning"* given that it *"supports functions that will be critical to achieving SDG 3 and many of its sub targets"* (ITU, 2017, pp. 25).

Under the eHealth ecosystem there is mHealth, defined as *"the use of mobile wireless technologies for public health"* (WHO, 2018, pp. 1). Supported by the rapid uptake in mobile phones, its wide acceptance, broad reach, and ease of use (WHO, 2018), mHealth has emerged as an important tool in developing countries given its potential to overcome: lack of equity in access to healthcare; poor health infrastructure; shortage of health workers; elevated cost of accessing health; and financial constraints (Mendoza, Levine, Kibuka and Okoko, 2014).

In the field of maternal health innovations in eHealth are having a vital role in achieving target 1 of SDG 3 *"saving the lives of women in some of the most vulnerable populations"* (WHO and ITU, 2014, pp 4). For example, mHealth apps are helping increase the retention of women in antenatal care (ANC) care to ensure facility delivery and improving the skills of health workers. Yet despite their potential, many barriers limit the ability of developing countries to take full advantage of mHealth apps for maternal health.

The study is structured into six sections: 1) a description of the research goals; 2) an overview of the conceptual framework for maternal mortality and the role of mHealth apps in improving maternal health outcomes; 3) an explanation of the research methodology; 4) a discussion on maternal mortality in Ethiopia and the barriers to implementation of mHealth apps; 5) an overview of the research outcomes; and 6) a discussion regarding the main conclusions and recommendations for the mHealth ecosystem in Ethiopia.

2. Research goals and research question

This study adopts the hypothesis that mHealth apps can play an important role in improving a public health system, particularly maternal health in Ethiopia. Based on this hypothesis, the overall research

goal is to analyse the potential of mHealth apps to improve the maternal health care system in Ethiopia. The overall research goal breaks down into the following specific research goals:

- Identify barriers to the implementation of mHealth platforms for maternal health.
- Identify strategies to address barriers to the implementation of mHealth platforms for maternal health.
- Identify best practices for successful mHealth platforms for maternal health.
- Analyse the above factors in relation to Ethiopia.

To meet the goals above the master thesis aims to answer the following research question: Can mHealth apps improve maternal health in Ethiopia?

3. Conceptual framework

3.1. Maternal death and socio-economic development

Maternal death is defined as:

> *"The death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes"* (WHO 2019b, pp.1).

It is a cause of underdevelopment (Thomson and Sofo, 2015) shown to have a disastrous impact on *"child survival, loss of economic opportunities, and spiraling cycles of poverty in the communities"* (Miller and Belizán, 2015, pp. 1).

Maternal mortality has a hefty impact on orphaned children and their families, especially in countries that display high MMRs like Ethiopia (Molla, Mitiku, Worku, and Yamin, 2015). Orphaned children are less likely to survive than those whose mothers remain alive (Ronsmans, Chowdhury, Dasgupta, Ahmed, and Koblinsky, 2010) and are more likely to face malnutrition and have less access to needed health care (Molla et al., 2015). Surviving older children are more likely to drop out of school to take care of younger siblings and support household and farm labour even at a young age or choose to migrate in search of opportunities (Molla et al., 2015). Further, for girl children, research has shown a link between maternal mortality and early marriage, early childbearing, and increased risk of repeated maternal mortality (Miller and Belizán, 2015).

Maternal death is also shown to follow economic hardship and poverty, as a source of family income is lost and elevated debt is acquired to pay for hospital bills and funeral costs (Molla et al., 2015). In

fact, Thomson and Sofo (2015, pp. 74) found that *"if maternal mortality goes up by 1 person per year, gross domestic product (GDP) per capita decreases by $4.33 on the average"*.

3.2. Conceptual frameworks for the determinants of maternal mortality

McCarthy and Maine (1992) developed a framework for analyzing determinants of maternal mortality (appendix B). The framework is composed of three stages of the process of maternal mortality. Closest to the event of maternal death are a sequence of outcomes that culminates in either disability or death; these outcomes are pregnancy (a precondition for maternal death) or complications during the pregnancy, delivery or postpartum period (McCarthy and Maine, 1992).

This sequence of outcomes is most directly influenced by five sets of intermediate determinants: a woman's personal health status, including preexisting healthcare conditions that exacerbate chances of developing a complication such as malaria, anemia, and malnutrition; her reproductive status; her access to health care services, including factors such as physical distance, financial access, and access to adequate care; her health care behavior, particularly the use of prenatal health services and the use of care during delivery; and a set of unknown factors (McCarthy and Maine, 1992).

A set of socioeconomic and cultural factors that operate at the individual, family and community level is at the greatest distance from a maternal death (McCarthy and Maine, 1992). However, they influence maternal mortality through the intermediate determinants. Amongst the socioeconomic and cultural factors are a woman's education, her income level, and her autonomy (e.g. to travel or make independent decisions about her health [McCarthy and Maine, 1992]).

The "Three Delays Model" developed by Thaddeus and Maine (1994) also describes the factors that contribute to maternal death (appendix C):

- Delay 1: The delay in seeking care on the part of the woman or the family and is influenced by multiple socioeconomic and cultural variables such as financial and opportunity costs, perceived quality of care, previous experience with the health system, and women's status (including age, educational, cultural, and economic);
- Delay 2: The delay in reaching an adequate healthcare facility and is driven by physical accessibility factors such as travel time to facility, availability and cost of transportation and condition of roads;
- Delay 3: The delay in receiving adequate care at the facility and is determined by factors such as adequacy of the referral, shortages of medical supplies, equipment, and skills of available personnel.

While all delays contribute to maternal mortality, any one phase can prove fatal (Thaddeus and Maine, 1994).

3.3. How mHealth strategies support maternal health system constraints

Kasthurirathne, Mamlin, Purkayastha and Cullen (2017) performed a literature review to identify innovations that successfully improved maternal health outcomes across low-to-middle-income countries (LMIC). It found that many informatics-based innovations, including mHealth and teleHealth, focused on delivery of actionable information to reduce the three delays identified by Thaddeus and Maine (1994).

To systematically describe the constituent parts of mHealth platforms for maternal health, Labrique, Vasudevan, Kochi, Fabricant and Mehld (2013) developed a framework which describes the twelve common applications of m-Health platforms for Reproductive, Maternal, Neonatal, Child and Youth Health (RMNCH) in relation to the health systems constraints that they address. While few mHealth projects deployed a single application, most comprised a package of two or more of the twelve applications (Labrique et al., 2013).

In Ethiopia, the majority of mHealth apps for maternal health target the primary level of health care (appendix D) and comprise a package of two or more of the twelve applications identified by Labrique et al. (2013), most notably: registries and vital events tracking; electronic health record; electronic decision support; provider work planning and scheduling; human resource management; client education & behavior change communication; data collection and reporting; and provider training and education (appendix E).

Figure 1. Types of mHealth apps for RMNCH

Type of mHealth app	Description	Health system constraint or purpose
1) Client education communication	Appointment reminders and maternal health promotion messages to pregnant mothers.	Improve health knowledge; influence health behaviour such as ANC use.
2) Sensors and point-of-care diagnostics	External devices connected to mobile phones such as tele-ultrasound solutions.	Facilitate remote monitoring; curb logistical barriers when health worker and pregnant mother are apart.
3) Provider training and education	Mobile delivery of training material to health workers.	Address the low densities of skilled personnel assisting live births in developing countries.
4) Supply chain management	Report daily stock levels of drugs; request additional materials electronically.	Address drug stock-outs that hamper maternal health care service delivery in remote areas.
5) Electronic health records	Health workers access and contribute to electronic health records in rural clinics or in the pregnant mother's home.	Allow the continuity of care that was impossible in non-hospital-based settings.
6) Provider-to-provider communication	Health providers communicate with one another or across hierarchies of technical expertise.	Allow the exchange of images/ sounds for immediate remote consultation when an expert is not available locally.
7) Registries/ vital events tracking	Health workers register on their mobile devices pregnant mothers eligible for specific services.	Maintain population registries; construct indicators (e.g. maternal mortality); strengthen accountability for pregnant mothers to receive all scheduled health services (e.g. ANC visits).
8) Data collection and reporting	Collect digital records and shift from paper-based records.	Allow the near-instantaneous reporting of survey or patient data; reduce time spent for routine health care reporting.
9) Human resource management	Track performance of rural health workers with limited contact with supervisory staff.	Enable supportive supervision; recognition of exceptional field staff.
10) Provider work planning and scheduling	Send reminders to health workers of upcoming visits to pregnant mothers; promote accountability by prioritizing follow-up.	Address the shortage of health providers in low-resource settings.
11) Financial transactions/ incentives	Users pay for health care services using their mobile phones.	Decrease financial barriers to care for clients.
12) Electronic decision support	Incorporate point-of care decision support tools with rule-based instructions.	Ensure quality of maternal care; address limited formal training of frontline health workers.

Source : Adapted from Labrique et al. (2013)

4. Research methodology

The starting point of the master thesis was the selection of a research topic based on the criteria of relevance to the international development community; feasibility in terms of resources needed and research skills required; and appropriateness in terms of one's potential to provide fresh insights into the topic.

Once the topic of eHealth in Ethiopia was selected, it was narrowed by searching scientific literature to identify Ethiopia's healthcare challenges and potential eHealth applications that could help address those challenges. During such research, it emerged that one of the most pressing issues facing Ethiopia's healthcare sector is the reduction in the still high MMR. At the same time, two exploratory

interviews were conducted with doctors working as volunteers in eHealth programs in Ethiopia in order to identify specific themes that could be of interest to the eHealth ecosystem in Ethiopia.

After completing the background research on the topic and the preliminary interviews, maternal mortality was identified as an area suitable for further investigation. Next, the specific research goals were established and the hypothesis constructed. This was followed by the development of the conceptual framework by reviewing the existing scientific literature on the topic. The literature review led to specific research areas and objectives were fine tuned to reflect the research needs.

An inductive approach to research was followed given that a qualitative research method was used to gather data for the analysis of the research topic. To collect data one-hour semi-structured interviews were conducted. Five interview scripts were developed on the topic based on the literature review (appendix F to J), although each conversation took different paths depending on the response of the informant[1]. Semi-structured interviews were judged particularly relevant given the open-ended nature of the research question, thereby allowing a range of possible answers that would provide new insights to the topic. Semi structured interviews also provided greater flexibility given that they allowed, over the course of the interview, in-depth exploration of certain points. Semi-structured interviews also minimized errors of misinterpretation given the possibility of requesting clarifications if necessary.

Before the start of formal interviews, the interview protocol was validated by the tutor and the script was refined based on his feedback. Informants were selected based on their experience and knowledge and a sample of key stakeholders involved in the implementation of mHealth platforms in Ethiopia was used (appendix K). Interviewing multiple stakeholders supported triangulation of data and increased the validity of research as responses were contrasted and compared.

The last stage involved selecting, analyzing and interpreting the interview data to draw empirical conclusions and develop recommendations (appendix L). At this point data was collected from secondary sources such as WHO, MOH and WBG in order to support methodological triangulation, test the validity of certain findings obtained through the interviews, and reduce sampling bias.

The study met several limitations. Due to time constraints, the sample size consisted of eleven informants. However, research has shown the more heterogenous the sample the more interviews required, given that it takes more informants to achieve saturation (Guest, Bunce and Johnson, 2006). Less structured interviews with variable content also require more interviews as data saturation takes longer to achieve (Guest et al., 2006). The research paper may be subject to analysis bias, which occurs

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[1] Interview script developed for NGOs and mHealth app developers; midwifes; government; mobile network operator (MNO), and hospital manager.

when the researcher naturally looks for data that confirms their hypotheses or own personal experience, overlooking data inconsistent with personal beliefs (Smith and Noble, 2014). In addition, due to my lack on interview skills, data collection and measurement bias may have occurred. For example, during interviews how questions are asked can influence the information elicited (Smith and Noble, 2014). The lack of up to date data on health and demographic statistics in Ethiopia was a further limitation when triangulating data.

5. Material and discussion

5.1. Causes of maternal death in Ethiopia

In Ethiopia, research shows that factors that contribute to maternal death identified by both McCarthy and Maine (1992), and Thaddeus and Maine (1994), occur to a large extent. Using data from three Ethiopian Demographic and Health Surveys (EDHS), United Nations Population Fund (UNFPA) conducted a study to identify the determinants of maternal mortality in Ethiopia. Amongst the drivers were: lack of access to antenatal, postpartum and delivery care; the low proportion of live births delivered in health facilities; and the low ratio of births assisted by skilled personnel (UNFPA, 2012).

An additional challenge was the lack of adequacy and quality of ANC compared to international standards: only 11% of the women began attending ANC in the first trimester (UNFPA, 2012, pp. 56), and 19% made the recommended number of four visits (UNFPA, 2012, pp. 56).

The study identified health-related factors that contribute to maternal death such as high-risk pregnancies because of old maternal age; closely spaced pregnancies and high parity; malnutrition; high anemia in pregnancy; and Human Immunodeficiency Viruses (HIV) prevalence (UNFPA, 2012).

Socio-economic factors were also shown to influence maternal mortality, with rural, uneducated and poor women less likely to deliver in health facilities and to receive ANC services and more exposed to malnutrition and high-risk pregnancies (UNFPA, 2012). Nonetheless, it found that *"women in general were less likely to blame on service costs and accessibility among the major barriers… rather the vast majority of women with home deliveries saw institutional delivery as «unnecessary» and «not a customary practice»"* (UNFPA, 2012, pp. 6).

Ethiopia's latest EDHS confirmed many of the factors UNFPA identified to contribute to maternal deaths in Ethiopia (appendix M). It found that it still displays low ANC coverage (only 32% of women had at least four ANC visits, [CSA and ICF, 2017, pp.134]), high rates of home deliveries (74% of women, [CSA and ICF, 2017, pp. 137]) and poor postnatal care coverage (only 17% of women receive a postnatal check within the first 2 days of birth [CSA and ICF, 2017, pp. 139]). The survey also shed

light over the lack of births assisted by skilled personnel: 42% of births were attended by traditional birth attendants (CSA and ICF, 2017, pp. 138), while only 20% were attended by nurses and midwifes (CSA and ICF, 2017, pp. 138) and 6% by doctors (CSA and ICF, 2017, pp. 138).

As with UNFPA's study, large differences were observed between urban and rural women, across wealth quintiles and educational levels. For instance, women in urban locations were far more likely than rural women to receive any ANC from a skilled provider (90% against 58% [CSA and ICF, 2017, pp. 134]) and far more prone to facility delivery than women in rural areas (79% against 20% [CSA and ICF, 2017, pp. 137]).

The EDHS asked women to identify the barriers that prevented access to medical advice during pregnancy and delivery. Amongst the determinants were factors that contribute to the three delays identified by Thaddeus and Maine (1994) including: financial constraints (55% of women [CSA and ICF, 2017, pp. 141]), distance to a health facility (50% [CSA and ICF, 2017, pp. 141]), not wanting to go alone (42% [CSA and ICF, 2017, pp. 141]), and getting permission to go for treatment (32% [CSA and ICF, 2017, pp. 141]).

Austin et al. (2015) adapted the classic "Three Delays Model" of Thaddeus and Maine (1994) to identify the barriers to quality and timely emergency obstetric care in Ethiopia (appendix N). Healthcare providers identified the

> *"lack of transportation and communication infrastructure and overcrowding at the referral hospital, insufficient pre-service and in-service training in obstetric emergencies, and lack of supportive supervision as barriers to the provision of timely, quality emergency obstetric care"*
> Austin et al. (2015, pp. 3)

Amongst the most prominent barriers contributing to "Delays Two" was the lack of transportation and communication infrastructure between the health centers before and after referral as the ambulance system was unreliable due to driver shortages or vehicle breakdowns (Austin et Al, 2015). Contributing to "Delay Three" was the lack of provider training in Basic Emergency Obstetric and Newborn Care (BEmONC) and Comprehensive Emergency Obstetric and Newborn Care (CEmONC) (Austin et Al, 2015). For instance, one respondent cited that none of the six midwives available in the facility were trained in BEmONC and able to detect complicated issues (Austin et Al, 2015). Finally, *"the relatively short duration of service and staff rotation reduced the benefit of in-service BEmONC training to individual healthcare institutions and in some cases, for the healthcare system as a whole"* (Austin et al., 2015, pp. 8). For instance, the survey found that 40% of providers had been at their current facility for less than a year (Austin et al., 2015).

5.2. Barriers to implementing mHealth platforms to support maternal health

Despite the potential of mHealth to address the factors that cause maternal mortality, there are significant barriers to implement mHealth, particularly in LMICs (WHO, 2016). In 2016 WHO's Global Observatory for eHealth conducted the third global survey on eHealth. Countries were asked to rate common barriers to implementation of mHealth programs by order of importance and the key barriers were:

1) Lack of funding: Classified as "very/extremely important barrier" by 71% of countries given the significant upfront investment to set up the mHealth system along with ongoing evaluation and operational costs (WHO, 2016, pp. 45).

2) Lack of legal regulation: Classified as "extremely/very important barrier" by 51% of countries (WHO, 2016, pp. 45). For instance, some countries have security policies which inhibit mHealth programs that wish to access patient health information (WHO, 2016, pp. 45).

3) Lack of prioritization over other health services: Classified as "extremely/very important barrier" by 51% of countries (WHO, 2016, pp. 45). Sometimes mHealth apps can increase costs in *"the short to medium term as users who were not covered gain access to health services"* (WHO, 2016, pp. 45), thereby conflicting with other health care priorities.

4) Lack of evidence of cost-effectiveness: Classified as "extremely/very important barrier" by 44% of countries (WHO, 2016, pp. 43). In fact, it found that only 11% of countries in Africa had completed an impact evaluation of a government-sponsored mHealth program (WHO, 2016, pp. 43) and noted that the socioeconomic return for the government of using these apps takes times to filter through (WHO, 2016).

WHO recognized that other barriers facing countries may not have been captured including digital literacy of the population and sociocultural aspects in the use of mobile phones (WHO, 2016).

Figure 2. Barriers to implementing mHealth programs to support universal health coverage (UHC)
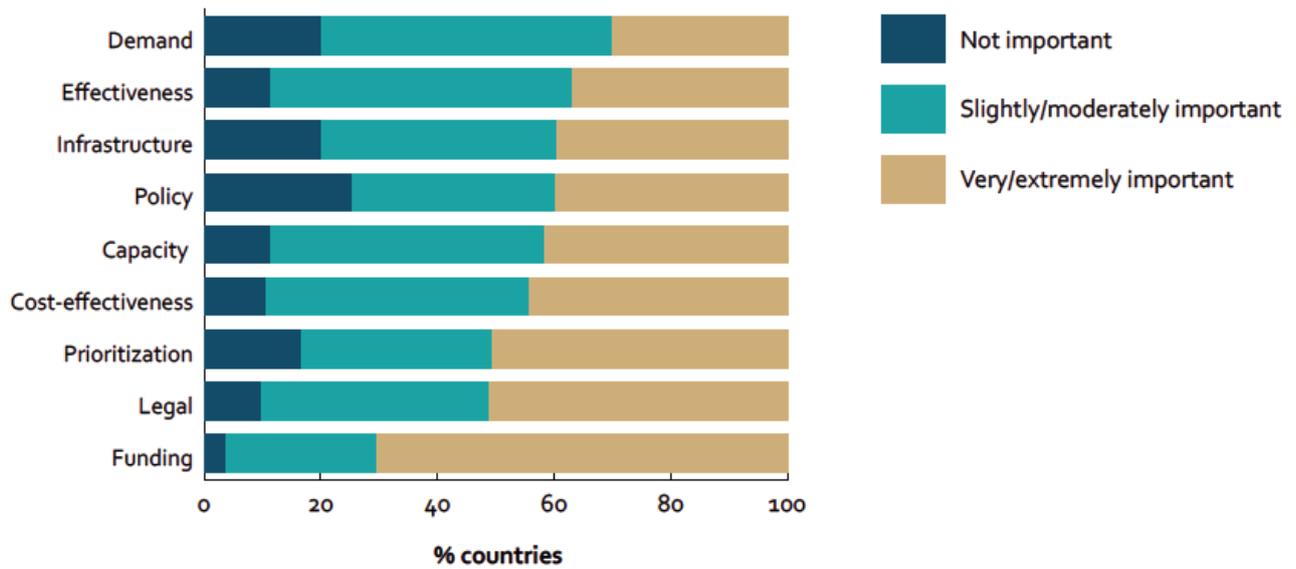
The results above are to some extent aligned with another survey also from WHO and ITU which identified barriers to implementation of eHealth programs (not just mHealth) specifically addressing women's and children's health. The most prominent barriers to implementation were:

1) Human resources: Classified as a barrier by 78% of countries given the lack of suitably-qualified health-care professionals who can develop and implement eHealth (WHO and ITU, 2014, pp. 49).

2) Infrastructure: Classified as a barrier by 77% of countries given the lack of cost effective or accessible infrastructure to support services (WHO and ITU, 2014, pp. 49).

3) Financial: Classified as a barrier by 59% of countries (WHO and ITU, 2014, pp. 49).

4) Leadership: Classified as a barrier by 55% of countries given that the national strategy does not include eHealth as an approach to support women's health (WHO and ITU, 2014, pp. 49).

Some countries also pointed out development barriers, including the level of education and Information and Communications Technology (ICT) literacy of the general population, and unreliable electric power infrastructure, (WHO and ITU, 2014).

Figure 3. Barriers to implementing eHealth services for women's and children's health
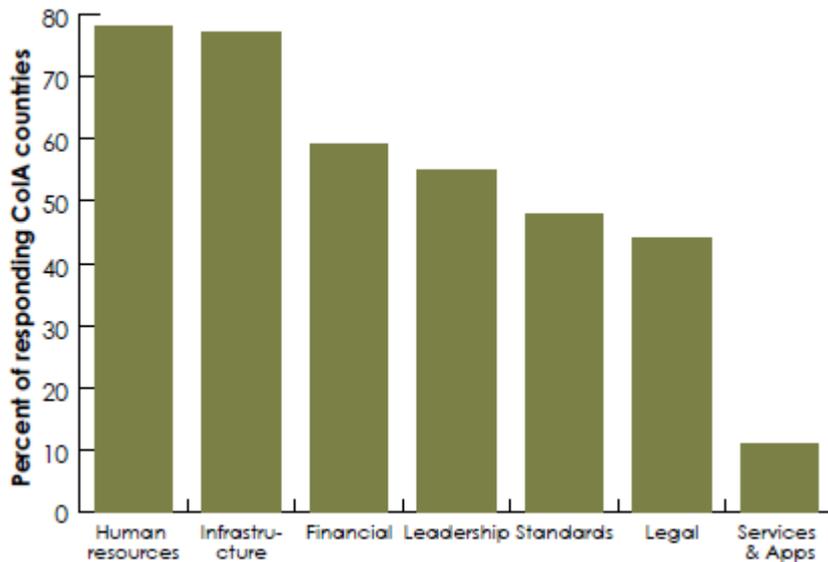
Source: WHO and ITU (2014)

6. Research outcomes

The research findings are grouped into the same categories used by WHO and ITU to classify the barriers to implement mHealth and eHealth. The research findings do not relate to the twelve mHealth apps identified by Labrique et al. (2013). Rather, findings relate to the key types of mHealth apps for maternal health found in Ethiopia (appendix E):

- **Client education communication:** mHealth apps that reach out to pregnant women with appointment reminders and maternal health promotion messages (appendix O, P).

- **Provider work planning and scheduling:** mHealth apps that keep health care workers informed through reminders of upcoming appointments of the pregnant mother. As Labrique et al. (2013) pointed out, these apps are comprised of a package of other applications, most notably -**registries and vital events tracking, electronic health records, data collection and reporting** and **human resource management-** as the health worker registers and submits basic information about the pregnant mother on her phone (appendix Q).

- **Provider training and education:** mHealth apps that support distance learning of health workers through educational short message service (SMS) or videos (appendix R).

6.1. Human resources

Like in many other countries, respondents agreed that human resource is a barrier to implementation of mHealth apps for maternal health in Ethiopia.

6.1.1. Limited digital literacy of health workers

There was broad consensus that low computer literacy of HEWs is a challenge for mHealth apps part of an IT system: *"Most HEWs are not literate in computer systems. When we trained them with the mHealth system we realised some could not use a simple computer".* Another stated: *"The man reason why HEWs are not passing their Certificate of Competency is the test that requires them to write in a computer".*

Majority of respondents addressed this issue with regular trainings and mentorship:

> *"Computer courses and providing mentorship to the HEW by the nearest health facility, which is the health centre team, is the best strategy. We created a cluster between the health centre and the health post so that HEWs get adequate support and mentorship from the health centres".*

As for digital literacy of mobile phones, responses were mixed:

> *"Digital literacy for mobile phones was not an issue for us… with the advent of android smartphones it was much easier for HEWs to learn how to use smartphones... when we started the program majority of HEWs had a basic phone but not a smartphone… we gave them three lessons on how to use the smartphone and they learnt very fast".*

In contrast, one respondent highlighted:

> *"It's really important to give time for these apps... when we implemented the app many of the health workers had never seen a smartphone… you cannot underestimate the value of explaining things again and again… because of their lack of experience with smartphones some of the elder health workers were resisting and it took longer for them to adapt… the youngest were eager to use it".*

Another respondent stated how app design influenced training needs:

> *"We kept the interface in the app as simple as we could and used the same type of layouts and user interface designs that you get in the core apps that come pre-installed on Android. If you keep those consistent it definitely keeps down the amount of training".*

6.1.2. Resistance of health care workers to change

Respondents were asked whether health workers complained about using mHealth apps because of the additional workload.

Users of mHealth apps designed for remote data collection often perceived the app as an additional burden:

> *"Working with apps to record ANC visits they find that a burden because they have to record it twice, on paper and on their device… they often don't see the relationship between data collection and how that improves their work".*

Another respondent stated: *"We provide training to health workers so that they understand the impact of data collection on pregnant mothers' health… but the extra burden of record keeping is one of the biggest challenges."*

However, one respondent explained how this issue receded over time*: "Initially they couldn't see the benefit of registering pregnant mothers, so they complained. But after some time, they recognised it decreased the burden of travelling long distances to meet each household. Now they ask for the app".*

In contrast, mHealth apps that provide training to health workers didn't face resistance to change:

> *"They see the benefits to their work much more clearly since the training is for them… HEWs are very keen to learn about how to use smartphones since they see them as status symbols… if HEWs are visiting a mother and are referring to a book the mother doesn't trust them because she thinks «they don't know everything because they have to look it up» whereas if HEWs are looking up exactly the same content but on a mobile she trusts them more because they can use this technology".*

Another respondent highlighted: *"It is so clear they really want to learn… most of them experienced a woman die in their hands so they are eager to use the app to avoid that".*

6.1.3. Elevated health worker attrition

Majority of respondents agreed that high health worker turnover is a significant challenge for mHealth apps targeting health workers:

> *"Unless you have the budget, it is a difficult to pay for trainings of new HEWs all the time. We trained the focal person at district level on the mHealth app. Personnel at the district health office are the ones who are training the HEWs and there is less attrition at the district level".*

Another respondent stated:

"Ethiopia is a huge country. It is the government who decides where health workers work, and they can be moved any time… in two years, we tried to find the health workers again, but we could only find 10-20 out of 150".

However, one respondent pointed out:

"Turnover was not an issue… we worked with level 3 community health workers that had been in the role for 4-5 years… when they completed their training most returned to their health centre… turnover might be an issue when working with younger health workers below level 3 as they may get sent to a different health centre".

6.1.4. Mobile device and computer system misuse and retention

Some of the programs that procured devices to health workers agreed mobile device misuse was a slight issue:

"Device misuse is an issue especially to start with since they haven't had devices like this before… we deliberately leave the smartphones unlocked so that they can rapidly become their personal devices… a few weeks after the program starts the devices run out of space because they have spent hours videoing, taking photos, etc... but it is not necessarily something that you need to try and stop, it is just an education thing as they realise these devices don't have unlimited storage… as they own them they can see how valuable they are and they take more responsibility for them."

In contrast, mobile retention didn't emerge as a meaningful issue:

"We had 150 health workers and only 2 phones that we gave disappeared. Our way of trusting health workers and implementing telling them «this is your tool just as much as measuring a heart rate» works well… of course, you will lose some phones so you need extra phones but it has to be clear that they have to take care of it and you need to sign a contract with them saying they will take of the device".

Another respondent stated:

"Some projects procure mobile devices and lock them so they are only used for work-related tasks... but then they also need to carry their personal device which is not convenient… the advantage of procuring unlocked phones that can be used as their personal device is that it will always be charged and they will carry it everywhere… only 5% of the mobile devices that

we gave broke... as soon as they realised how valuable it was in meeting their training needs, it became a treasured asset".

On misuse of computers part of mHealth programs, several respondents agreed it was an issue:

"When health workers learnt how to manipulate the computer they used it to watch videos, play games, etc... they also brought CDS and in some places we faced data loss because of this. When we realised this issue, we created personal log ins".

6.2. Infrastructure

6.2.1. Lack of mobile network connectivity

Lack of network connectivity in rural areas emerged as one of the most prominent barriers for mHealth apps, so more for mHealth used in humanitarian settings. Data from ITU supports this view, given that in 2017 only 18% of households had internet access (ITU, 2018, pp. 1).

To address the issue several programs designed mHealth apps to function offline:

"Mobile coverage, especially data coverage is a challenge. We specifically developed our app to function offline and presumed health workers occasionally have a connection. Network is improving but it doesn't keep up at the same rate as networks in other countries".

On the most appropriate slots to send SMS, one respondent highlighted:

"There is no regulation that curtails evening hours for calls or SMS. However, if you send SMS during the peak hour -lunchtime and dinner time- you get charged more and it might not get delivered due to congestion... it is better to send SMS at night since both the rate and traffic are lower".

However, one respondent highlighted: *"because of the low income of the society many people cannot afford smartphones and internet....".* The 2018 Affordability Drivers Index (ADI) underscores these views; it ranked Ethiopia 60 out of 61 low- and middle-income countries listed in order of internet affordability and noted that the monopoly status of Ethio Telecom had restrained Ethiopia's performance on the ADI over the past three years (A4AI, 2018, pp.11).

6.2.2. Low availability of electricity for charging

All respondents agreed that the lack of electricity for charging phones was an issue, particularly in rural areas and humanitarian settings: *"Access to electricity is a challenge. Rural households and most*

of our health posts don't have access to electricity… if you are travelling to rural areas, you may not charge your phone for one or two days".

Ethiopia's EDHS underscores such views; it showed that only 7.7% of the rural population has access to electricity (CSA and ICF, 2017, pp. 21).

To address the lack of electricity majority of respondents used solar chargers: *"During the enrolment phase we selected health facilities that had good network, access to electricity, and generator. We provided HEWs solar chargers for their phones and the charger had a lamp for night visits".*

Nonetheless one respondent cited:

> *"Solar chargers are a little expensive and many people in rural areas can't afford that. They may not be aware of such a solution, or they might not be able to find it in their neighbourhood. Solar chargers come from China in limited amounts, so availability is an issue".*

6.2.3. Selecting the most appropriate message delivery channel

Respondents agreed that channel selection depended on the type of audience of the mHealth app.

At the household level respondents stated: *"If you are targeting pregnant mothers you should provide health messages in audio formats in addition to SMS because the literacy status of women is limited".*

Another respondent stated: *"Most target users at household level are unlikely to have smartphones, so SMS would be only way to contact them digitally".*

One respondent highlighted how SMS is convenient for reachability purposes: *"With smartphones there is an affordability and a network connectivity issue at household level… internet sometimes goes down, the speed is low, we have limited bandwidth, and the internet cost is a bit higher than SMS".*

One respondent stressed the importance of involving the community, in line with the principles for Digital Development: *"When selecting the delivery channel, it is crucial to work with the community through representative groups to ensure that the info in the app can be understood".*

In contrast, on mHealth programs targeting health workers one respondent stated: *"If they have smartphones, it is better to provide the messages in apps with visual format combined with text and audio".*

One respondent highlighted *"Health workers learn much better with videos. They don't have practical experience… they don't see real deliveries before they finish studies, so the app is gives them a better idea of reality".*

However, using apps for health worker trainings comes with challenges: *"The app uses a lot of battery, especially the videos, so you need to charge it often, but electricity is an issue"*.

6.3. Financial

6.3.1. Donor funding

Like in many other countries, respondents widely agreed that lack of donor funding is a major barrier for scaling mHealth apps for maternal health in Ethiopia.

One respondent stated: *"The design, piloting and funding of these apps is made by donors and implementing partners (NGOs)... The MOH requested whether our mHealth app for remote data collection could be scaled to all the country but there was no donor funding. Ethiopia is a big country, we needed a big investment"*.

One respondent highlighted:

> *"Developing innovations is a long-term process and donors fail to provide long-term funding. Sometimes a grant is for two years but when financing ends there is no mechanism providing more substantial support if you demonstrate the app works. In addition, donors offer large grants to fund innovation but it's better to offer small amounts to invest in a pilot and once you demonstrate evidence of impact to provide more funds. Few donors offer a tiered funding model"*.

Another respondent highlighted: *"90% of innovations fail... donors must be accepting of this risk... often if the innovation fails it impairs the NGOs ability to raise funds in the future"*.

On key success factors to secure donor funding, responses varied.

One respondent highlighted:

> *"Having the funding for this is tricky, that is why we went for an approach that is not RMNCH specific. Apps that focus on very specific health area are going to struggle to get funding since it conflicts with where the ministries are trying to go... rather than having 15 different apps that they have to support they want to be able to run these on two or three different platforms"*.

One respondent stated:

> *"Being evidenced based was key to secure donor funding. Having established partnerships on the ground is something donors also focus on... having a strong team of experts is also something you can try and sell the project on because it is a success factor"*.

One respondent highlighted: *"Securing funding from donors is easier when mHealth programs fall within the country's strategic health care priorities or address the SDGs".*

6.3.2. Government funding

There was ample consensus regarding the government's inability to provide financial support.

One respondent stated*:*

> *"It is difficult to justify investment in mHealth apps given the lack of evidence of impact and the fact that there are still many unmet basic healthcare needs in Ethiopia... in the future evidence of impact will likely be the criteria for the government allocating funds"*

One respondent stated: *"In some countries governments are used to donors paying. If governments are to subside the app it needs to be implemented from the beginning like that".*

One respondent highlighted: *"Convincing government to fund these apps is tough… mHealth apps can help spend less per person but it does not imply lower costs for the system because your outreach also increases".*

The views above are in line with the statements made by the MOH; it estimates that the overall cost of implementing the HSTP will be USD 15.6 billion for the next five years under the base case, but the funding gap under this scenario is 21% even after taking into consideration significant contributions from development partners[2] (MOH, 2015, pp. 14).

6.3.3. Private sector funding

On the role of the private sector funding responses were mixed.

One respondent stated:

> *"As long as the telecoms sector is owned by government, government will take the lead. If Ethio Telecom gets privatised and the government creates an enabling environment, probably the big MNOs would be interested, assuming these apps generate a massive use of mobile phones".*

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[2] The financial availability for the HSTP of USD 12.3 billion includes the following sources of financing: government budget (accounting for 56.9% of total cost), external aid from development partners (30.4%) community contribution (7.1%) and health insurance (5.6%).

One respondent stated: *"I strongly suggest public-private partnerships to scale up. The private sector must get involved because the government has no capacity, both financial and technical… but there must be a supportive environment for private companies"*.

In contrast, one respondent stated:

> *"There is scope for the private sector to fund these apps in Ethiopia, but it depends on their motives. Ethiopia is still a very communist country, so it needs to be clear that the motive is for the good of the people, not for the business"*.

One respondent stated:

> *"If the private sector enters, end users would have to pay but the income level is low, so affordability would be an issue… I don't think the private sector is well positioned… often they don't know the context as they focus on solutions for developed countries or urban areas"*.

6.3.4. End-user payer models

Interviewees agreed it would be difficult to charge end-users for the service, however responses varied across apps.

On apps used for data collection and monitoring it was quite clear: *"It would be impossible for HEW to pay since they are not using the app for their personal benefit. They are government workers, so government should pay"*.

Charging health workers for apps that provide training would also be challenging:

> *"We would struggle to get HEWs to pay unless you offer some key benefit for them like a British medical journal or WHO accredited certificate… but health workers would struggle to afford that so probably ministries or donors who end up paying"*.

One respondent stated:

> *"If you had to pay it would only work for doctors and midwifes living in Addis who have money but if you want to have an impact where maternal deaths are high it is out in the community and they cannot afford to pay"*.

However, one respondent acknowledged: *"Currently the licensing of the health care professionals is underway so if we integrate the education and the curriculum with the licensing part the health care workers would be obliged to pay for the app"*.

One respondent suggested: *"Users could pay a portion so that they value the app more, but it should not be the main funding mechanism given the low-income level of the population"*.

6.4. Leadership, institutional strength and legal framework

6.4.1. Leadership and legal framework

On the topic of the legal framework, one respondent highlighted that Ethiopia has made strides in incorporating mHealth to the national health strategy:

> *"We have an eHealth strategy since 2014 and mHealth and digitalizing the health information system is a priority area for the MOH. Our HSTP has four transformation agendas, one is the information revolution. This revolution has three pillars, one of them to digitalize the sector"*.

However, several respondents highlighted that Ethiopia still lags its neighbours:

> *"The MOH is definitely getting its ICT polices put together, but they still have some way to go before they have universally implemented those. For example, Uganda is more advanced, and this is where Ethiopia is heading. Uganda had a massive problem with hundreds of mHealth apps and making it impossible to manage so they demanded that everyone stop their implementation. Since they put in place and eHealth working group run by their MOH which includes mainly ministry people but also NGOs. Any new digital health product in Uganda must be approved by the eHealth working group. They have even gone so far that it has to be presented by somebody local"*.

Another respondent highlighted:

> *"The main issue with mHealth in Ethiopia is leadership. At the ministry there should have been good leadership. We need strong leadership and commitment. The government has its strategy, so they should implement it and allocate budget to mHealth apps. We should learn from countries with successful mHealth apps such as Kenya or South Africa"*.

One respondent stated: *"The main challenge to scale up mHealth apps is having the right technical expertise within the MOH since the programs can only scale if managed by the MOH"*.

6.4.2. Institutional strength

On the topic of institutional strength one respondent referred to the lack of a sound legal framework for telecom sector companies: *"It is risky to set up apps or telecom companies given the government's*

track record in cutting off internet access… in 2016 we suffered an internet blockade and many social media sites and blogs were banned for a year".

As for the prevalence of corruption, it didn't emerge as an issue during interviews. This contrasts with the results from the Corruption Perception Index published by Transparency International which ranked Ethiopia 114 of 180 countries, below regional peers such as Tanzania or Rwanda (Transparency, 2018).

On the ease of doing business, one respondent cited: *"We didn't register as an organisation in Ethiopia -it can be a very long and bureaucratic process- generally we've worked through partnerships with other organisations".*

6.4.3. Compliance with data security and privacy standards

Respondents agreed compliance with data security and privacy standards is not a challenge: *"There are few privacy and security standards implemented… the Health Insurance Portability and Accountability Act (HIPAA) is not exercised in Ethiopia".*

However, two respondents highlighted it might change in the near-team: *"With the move by the MOH to require platforms being hosted and run by them on their own servers, the MOH will be in control of how the data is secured and managed".* Another respondent added: *"There is no security issue if you don't share the information. But now it is going to be shared so it's definitely going to be an issue".*

6.5. Mobile services and apps

6.5.1. Low mobile penetration and engagement of the population

Several respondents identified low mobile penetration and engagement in Ethiopia as a barrier to the adoption of mHealth apps for maternal health: *"Technology utilisation is poor compared to other countries like Kenya. Even the educated portion of the population are poor in utilising technology. If we receive an SMS, we are often not reading it".*

Data from the Global System for Mobile Communications Association (GSMA) supports this view: it showed that in 2016 mobile penetration in Ethiopia was 34% (GSMA, 2017, pp. 11), against 43% in Sub-Saharan Africa (GSMA, 2017, pp. 27). Further, those who own a mobile phone in Ethiopia display very low levels of engagement with their device. According to the Global Mobile Engagement Index (GMEI), which measures the level of engagement of mobile phone users in 56 countries, Ethiopia is the lowest ranked country worldwide, with almost 80% of mobile phone users classified as "Talkers",

who display low usage recorded across all use cases except for traditional communications such as voice (GSMA, 2017, pp. 28).

However, respondents noted wide disparities in the number of mobile devices between households and HEWs: *"All HEWs have their own basic mobile phones"* but at the community level there is often *"one mobile per one household in most of the kebeles"* or *"the mobile phone is shared across households"*. A baseline study conducted by Amref in Amhara Region supports this view: it found that 90% of midwives and HEWs owned a mobile phone (Amref, 2018). At the household level however, mobile ownership is much lower; Ethiopia's 2016 EDHS found that only 47% of rural households owned at least one mobile phone (CSA and ICF, 2017, pp. 22).

6.5.2. Gender gaps in mobile ownership

The great majority of respondents agreed gender gaps in mobile ownership is an issue for mHealth apps, but only for programs targeting pregnant mothers: *"Most community health workers are female and there are no gender gaps in mobile ownership, but for mothers' gender is a barrier as most mobile phones are owned by their husbands"*. Ethiopia's EDHS underscores such views; it found that only 15% of rural women owned a mobile phone (CSA and ICF, 2017, pp. 276) against 47% of men (CSA and ICF, 2017, pp. 276), and just 9% of women with no education owned a mobile phone (CSA and ICF, 2017, pp. 276), against 32% of men (CSA and ICF, 2017, pp. 276).

According to respondents, a factor believed to influence female mobile ownership is the mobile affordability issue, which is more pronounced in women: *"Men can buy a mobile phone that women cannot afford to buy because they work… gender gaps in mobile ownership is not a gender discrimination issue, it is an income issue"*. Ethiopia's most recent National Labour Force Survey supports this view given lower female labor participation rates than men (only 75% of women were economically active, compared to 85% of men [CSA, 2014, pp. 55]) and the formidable gender wage gap (males were paid 46% more than females across all industries [CSA, 2014, pp. 80]).

Respondents suggested several customer enrolment strategies to prevent leaving behind poor mothers who don't own a mobile phone. One respondent referred to Ethiopia's communist "one to five" system that involves one-woman leader and one-man leader responsible for monitoring the activities of five households. *"This set up is very good for health purposes… it is a way of including mothers who don't have a phone because they get the information from others who own a phone and who might have received a message"*.

Another mHealth app included husbands in its intervention:

"When the device is owned by husbands we send an SMS to their phones so that they pass on the information to pregnant mothers. If we use voice, we call three times per the day in case they miss the call".

One respondent explained how procuring devices to pregnant mothers could be challenging:

"The device may be taken away from her or she may sell it on the market… it would only work if sensitization activities with all family members is carried out so that role of the mHealth app in improving maternal health is well understood… but it is not sustainable to procure one phone per woman, so you would have to rotate the device".

6.5.3. Poor enabling environment for telecom and technology companies

Several respondents highlighted the absence of an enabling environment for private sector companies which interviewees blamed on the state monopoly:

"We don't have many private ICT companies taking the lead in designing mHealth apps. This is linked to the fact that the telecommunications sector is owned by the government so there is not an attractive environment to do this".

Another respondent stated: *"In countries like Kenya and Tanzania the telecom sector has been liberalised… MNO costs are much lower and there are many more mHealth apps than in Ethiopia… the state monopoly is a barrier to innovation".*

The views above are in line with the World Development Report which stated *"Only a handful of countries, including Ethiopia, still maintain state-run monopolies in the provision of mobile services and the internet, and they have generally not fared as well as their neighbours… mobile penetration is only half the level in the countries that have retained monopolies than in Kenya, which has had mobile competition since 2000, or in Sudan, since 2005"* (WBG, 2016, pp. 205) .

On the outlook on the telecoms sectors following the announced partial privatisation of state-owned monopoly Ethio Telecom, responses were mixed:

"Privatisation should spur competition, lower SMS costs and improve network coverage, but I don't know if the private sector will be interested since it might not be profitable to roll out network infrastructure in rural areas… Ethio Telecom however as part of the government is mandated to expand infrastructure in rural areas".

Another respondent highlighted:

"For historical reasons the Ethiopian government is very controlling… opening up the telecoms sector is complex as the government would be giving up its ability to control the media for political purposes… in fact in 2016 the government blocked news websites and social media in its efforts to control widespread protests".

6.5.4. Relevance of using open standards, data, sources, and innovation

Respondents were asked whether they followed an open approach to digital development, given that it can *"help increase collaboration in the digital development community and avoid duplicating work that has already been done"* (Digital Principles, 2019).

Several respondents used open source software[3] and content because it is the preference of the MOH and is more cost effective:

"The main benefits of often software is that the government won't have recurring licensing fees for using the software, and they are able to properly own, manage and run the software. It's already a requirement the MOH has made that software run nationally needs to be open source… the MOH has been burnt before by projects using apps that have fixed recurring costs for licenses that they just couldn't manage".

One respondent highlighted:

"We have implementations in a quiet a few countries but the differences in that code is almost minimal, it is just the content and maybe the name of the app of the colour. This means that if an organisation does development work on the app, that gets spread to all the different countries, so it lowers the cost quiet a lot. I think that is one of the reasons why ministries are going with opensource apps, in line with the Principles for Digital Development approach".

Another respondent stated: *"If you don't use open source software you cannot reuse the app for other healthcare verticals… for example, you can't copy and reuse the app for pregnant mothers in order to target teenagers… so it ends up being costly".*

6.6. Evidence of cost-effectiveness

Like in many other countries, there was ample consensus amongst respondents that evaluating the impact of mHeath apps on healthcare outcomes is difficult.

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[3] Open source software is software with source code that anyone can inspect, modify, share, and enhance because its design is publicly available (Open Source, 2019).

Several respondents highlighted how it is difficult to isolate mHealth impacts: *"When you have a lot of other projects working in a similar area all offering trainings around similar things it is very difficult to differentiate what improvement is attributable to one app"*.

Another respondent stated: *"Evaluating the impact on maternal health from HEWs using the app is hard…. the government is doing work to mobilise the community, so we are simply contributing to the existing system"*.

A further challenge related to long-term nature of educational apps:

> *"When you are implementing long term trainings the impact takes a lot of time to filter through… if a grant is for a year or two the impact on maternal mortality will not be measurable within that time frame… you require over 5 years"*.

Another respondent referred to the lack of technical expertise within the donor:

> *"The donor didn't have much experience with digital, so they wanted us to specifically have health outcomes of the training… but it was still quite a preliminary thing and we were really just talking about user acceptance and feasibility of using these apps"*.

A further challenge related to the fact that maternal mortality can be influenced by multiple factors: *"There are many factors that influence maternal mortality: even though there is a training app for health workers there might not be an ambulance to take the woman to hospital or there might not be drugs"*.

High health worker attrition was a further challenge:

> *"High attrition makes impact difficult to measure so you need to be very time specific if you want to measure the effect for one year… also make an agreement with the authorities to not move the health workers during that time"*.

To mitigate the barrier of lack of evidence of impacts one respondent highlighted:

> *"You need to find proxy indicators for the number of lives saved. We used knowledge and skills as a proxy… but then it depends on the donor. If you are working with a donor who is research orientated they will have people on the board saying, «you can't measure impact like that» but if you are applying for a donor who is not that research oriented then you really need to talk to their sense"*.

6.7. Sociocultural aspects at household level

6.7.1. Women's attitudes towards the healthcare system

Attitudinal barriers were identified by some respondents as an impeding factor that hinders the very utilisation of ANC services that mHealth apps seek to increase: *"Pregnant mothers don't give birth at health centres because of cultural issues… they have misguided information regarding diseases and spirits"*.

Another respondent stated: *"Most women deliver at home but the MOH and partners are working to create awareness about institutional delivery… but cultural barriers are still there"*.

One respondent highlighted how cultural issues are particularly relevant in remote areas: *"The HEP has changed community attitudes but in some remote pastoralist areas like Afar and Somali there are still very deeply rooted social and gender norms which influence ANC usage and facility delivery"*.

These views validate UNFPA's study findings regarding the fact that the vast majority of women with home deliveries see institutional delivery as "unnecessary" and "not a customary practice" (UNFPA, 2012).

6.7.2. Role of gatekeepers

Respondents agreed that "gatekeepers" such as husbands and mothers play an influential role on ANC take up and facility delivery: *"In some areas the mothers and grandmothers of pregnant women delivered at home and they say, «why do you go to the health care facility since I gave birth at home to you and your siblings? »"*.

Another respondent stated: *"If you want to have an impact it is important to involve men and give them information on the importance delivering at a health facility"*.

The EDHS underscores the views above: of the married women aged 15-49, only 15% of them made decisions about their own health care by themselves (CSA and ICF, 2017, pp. 281), whereas for 66% of women decisions regarding their own health care were made jointly with their husband (CSA and ICF, 2017, pp. 281), and for 18% of women the husband decided (CSA and ICF, 2017, pp. 281).

6.7.3. Addressing cultural barriers

To address cultural barriers respondents suggested different strategies: *"We created awareness at the facility level and at the community level… for mothers we explained how the mHealth system would help identify them and swiftly bring them to the facility if complications arise"*.

One respondent highlighted *"It is important to work on this from many different angles as the problem of home delivery can't be solved by just sending a text message… if you want to have impact you have to have a community approach"*.

Another respondent stated: *"NGOs play a crucial role in creating awareness. Sensitisation activities should take place in spots visited by pregnant women: water and food collection points - including markets- and places of worship"*.

Several respondents highlighted the role of community health workers at breaking down attitudinal barriers: *"Their role is very important since they are closest to the community. If you train them to solve pregnant mothers' healthcare problems, then you can gain the trust of pregnant mothers' in the healthcare system."*

Another respondent stated: *"Pregnant mothers must understand the benefits of using the app, but the agent of change is the community health worker, she is the «salesperson» of the app"*.

Respondents also suggested two-way communication models: *"When people feel that there is someone behind the app who really cares they are more willing to engage than when they just receive a reminder message"*.

One respondent also cited: *"We have tried to make that facility delivery is more acceptable by the community by incorporating the traditional and cultural practices especially at the health facility level"*.

6.7.4. Low female literacy rate at household level

Low female literacy rate was seen by respondents as a major barrier for the adoption of a mHealth, but only for mHealth apps targeting pregnant mothers with messages since majority of health workers are literate. The 2016 EDHS underscores these views: it found that 48% of women in Ethiopia had no formal education (CSA and ICF, 2017, pp.34), although education in urban areas is better than in rural areas (57% of women aged 15-49 in rural areas had no formal education against 16% of urban women [CSA and ICF, 2017, pp.34]). To curb this barrier programs adapted the service delivery channel (section 6.2.3) and placed greater emphasis on pictorial content.

6.8. Content creation

6.8.1. High variation in languages across Ethiopia

Respondents agreed it is important to tailor the content of the apps to the local context to ensure adoption: *"For each country we translated the training material for health workers in the mHealth app, adapted the animations, and changed the clinical guidelines"*.

At household level there was ample consensus that app content creation is a barrier given the high variability of languages: *"There are around 80 languages in Ethiopia… when targeting pregnant mothers, you need to have the app in at least in Amharic, Oromo, Tigrinya, Somali and Afar to increase utilisation"*.

At the health worker level language was not necessarily as issue for mHeath apps providing official training material to community health care workers:

> *"The MOH requires that all training manuals are provided in English, but they recognise that health workers' English is not up to that level so even if the material is in English the trainer will be spending time explaining things in the local language which is a bit of an issue"*.

For mHealth programs providing refresher training material to health care workers several respondents noted how the language issue varied across the hierarchy ladder in the healthcare system:

> *"For frontline care workers such as midwifes and nurses you can design the content in English and customise the pictures to the context… midwifes and nurses all speak partly English because their education is in English, so all the clinical terms are easier to understand in English rather that in their own language"*.

However, for apps targeting community health workers one respondent stated: *"Community health workers and HEWs are literate in their own language and their English is not that good, so it is much better to have the content in different languages"*.

To curb the challenge of having to translate the content into many languages one respondent cited: *"Having more multimedia type content helps… at the same time even if you still have a lot of content in English you can relatively straight forward subtitle them in the local language"*.

6.8.2. Compliance with the national curriculum of health workers

There was ample consensus amongst respondents about the importance of aligning mHealth app content with the national curriculum of health workers:

"Our intention was to have one app that you can change the language for each country but not the content because it was WHO aligned. But it proved that all countries even though they followed WHO guidelines they still have their national guidelines adapted. We had many discussions, but it is crucial to comply with the national guidelines because you can't implement if you don't have the health authorities go ahead. I have experienced this in all the countries, but Ethiopia stands out".

Another respondent explained how alignment with the national curriculum was an important consideration from the point of view of app sustainability:

"Ethiopia is much more advanced than other countries since it is one of the only countries where they have very formal approved national curriculum for the whole of their HEWs… creating a new curriculum when there is already a national one in place seemed to us a bit crazy since it limited our ability to scale up".

6.9. Partnerships

6.9.1. Partnerships with the government

On the topic of partnerships, there was ample consensus around the importance of involving the government: *"At the MOH there is a technical working group for coordinating mHealth and implementing partners and donors are members of that technical group…. the MOH makes sure NGOs are communicating".*

One respondent stated: *"In Ethiopia involving the government is key. The Midwifes Association is also partly government, so it is a good partner to have because they know the government very well".*

6.9.2. Partnerships amongst implementers

One respondent highlighted:

"the ecosystem of mHealth apps for maternal health in Ethiopia is still rather fragmented; it is mostly limited to pilot testing in very localized places and some programs only recently started to scale up… We should increase collaboration between partners to gather feedback, share knowledge on how to improve, avoid duplication, and complement each other".

One respondent stated: *"We partnered with other organisations which already had people on the ground and knew what was going on… but a lot of organisations implementing these mobile learning applications in Ethiopia don't have the experience of implementing these mobile learning applications".*

One respondent stressed the importance of conducting a stakeholder analysis:

"You need to pin down what area of health is your app under and then make a stakeholder analysis to find out who is in Ethiopia… along with the government, look at UN agencies working in the same field and NGOs to find out what they are doing. If you don't have presence in the country it is good to team up or at least get somebody from Ethiopia to navigate this because it is a maze of different ways of going".

6.9.3. Partnerships with Ethio Telecom

Respondents were not aware of partnerships between Ethio Telecom and mHealth apps. Several respondents doubted Ethio Telecom would be interested in partnerships with mHealth apps: *"In Ethiopia there is only one operator - Ethio Telecom- and it has no economic incentive to offer lower rates to mHealh apps"*. Another respondent stated: *"It must be really hard to work with Ethio Telecom because of it being a monopoly… we avoided that because we haven't been doing SMS. Our app runs over just using the mobile data network, so we don't need to set up a specific arrangement with the MNO to try negotiate rates for bulk SMS sending".*

However, one respondent noted: *"I think Ethio Telecom would be interested in subsidizing mHealth apps as part of its mission to support society. Maternal health is a very sensitive issue and it must be addressed by all government entities".*

7. Conclusion and recommendations

The study supports the view of the **great potential** of **mHealth apps** to **improve maternal health** outcomes in Ethiopia. However, the research findings also show that **significant barriers hinder** successful **implementation**. Amongst these are majority of barriers to implementation of mHealth apps identified by WHO and ITU in its global surveys, most **notably**: **financial**, **infrastructure**, and **evidence** of **cost effectiveness**.

Nevertheless, **aassessing barriers** to implementation of mHealth apps for maternal health in Ethiopia requires **distinguishing** between programs that engage with pregnant women at **household level** against programs that target **health workers**, as not all barriers are observed across both groups.

Finding **funding** is perhaps the **most significant barrier** for mHealth apps willing to achieve scale in Ethiopia. Factors such as rigorous **impact evidence**, **alignment** with **national priorities** and the **SDG** agenda, on the ground **partnerships**, having a **strong team** of **local experts**, and developing mHealth apps that are **not RMNCH specific** are regarded as **key success factors** to secure **funding**.

Lack of **adequate infrastructure** is also problematic and becomes an even greater barrier when mHealth apps are used in **humanitarian settings** affected by conflict. The **absence of electricity** for charging is a persistent **issue** for mHealth apps for maternal health in Ethiopia. Using **solar chargers** has been shown to **mitigate this barrier** although they might be **expensive** or **not available** in rural areas. **Low internet connectivity** in rural areas is also an important barrier which calls for the **design of mHealth apps** that can be **used offline** or require **minimal internet** connectivity.

Evaluating impact of mHeath apps on healthcare outcomes is an important **challenge** in Ethiopia**,** yet it is often a **pre- requisite** before the international donor community or the government **commit to invest**, creating a chicken and egg situation. Using **proxies** such as **knowledge and skills** to measure the impact of the mHealth app on the number of lives saved has been shown to mitigate this barrier to some extent.

At household level implementers must take into careful consideration the **low mobile penetration and engagement** as well as the significant **gender gaps in mobile ownership** in rural areas. The **mobile affordability issue** faced by women calls for developing **low-cost** or **free-of-charge mHealth apps** to avoid leaving behind poor and marginalised mothers. Ethiopia's **five to one communist system** is a **cost-effective mechanism** than can also be used to transmit messages to mothers who don't own a mobile phone. At the **HEW** level, the **high mobile penetration** is a factor that may justify investment in mHealth apps for maternal health.

Sociocultural aspects at **household level** still **influence use of ANC** and institutional delivery in Ethiopia, suggesting the importance of **education campaigns** at the community level to **create awareness** of the benefits of mHealth apps for maternal health. The **role of "gatekeepers"** in Ethiopia cannot be understated given the **influence** of **husbands** on women's healthcare decisions. As a result, and like many other countries, gatekeepers should be included as a **target audience** in the mHealth app.

Ethiopia has an **eHealth strategy** which aims to improve access, quality, and efficiency of its health systems through mHealth (WHO, 2014) and has made **strides** in **getting** its **ICT policies together**. However, it still **lags regional peers** in areas such as a **strong leadership and commitment** to mHealth. In addition, it lacks a **sound legal framework** for mHealth apps given the government's track record in cutting off internet access.

The **lack** of an **enabling environment** for **private sector telecom** companies owing to the **state monopoly** is problematic for mHealth apps. The state monopoly **curtails innovation**, **restrains competition**, and results in **higher MNO costs** than in neighbouring countries.

Developing **open source software** is an important consideration in Ethiopia, given the **MOH's preference for** mHealth apps running on this type of software as **it avoids** having to pay **recurring licensing fees** for using the software. In addition, open source software supports mHealth **app sustainability** since development work on the app gets spread to all the different countries, thereby **lowering the cost** for implementers.

At the human resource level, **computer literacy** is barrier, particularly at the **HEW level**. However, regular **training** and **mentoring** has been shown to address this issue. **Resistance to change** sometimes occurs, particularly for mHealth apps focused on **data collection and monitoring**. Providing **training** to health workers so that they **understand the benefits** of using the mHealth app is a good strategy to **mitigate such issue.** In contrast**, attitudinal barriers do not occur** that often for mHealth apps used for training health workers although health workers require **time to adapt**, particularly the elder.

Content creation is an issue, particularly at the household level since the **high variability of languages** in Ethiopia means that the app content must be translated into at least five languages. At **health worker level**, the **language barrier varies** across the **hierarchy ladder** in the healthcare system.

Compliance with the **national curriculum of health workers** is not only crucial to get **approval from the authorities**, but also an important consideration from the point of view of **app sustainability** as it avoids having to duplicate the content that is already available in Ethiopia.

Involving the **government** since inception is key for **successful implementation** given its role in coordinating mHealth apps in Ethiopia. It is also recommended to conduct a stakeholder analysis to identify potential on the ground partners such as the Midwifes Association.

Based on the above findings, recommendations have been developed for stakeholders of mHealth apps in Ethiopia.

Recommendation for the technical group for mHealth:

- **SMS costs** and **network charges** are a significant **cost component** which limits the ability of mHealth apps in Ethiopia to reach scale. The absence of **partnerships** with **Ethio Telecom** calls for the technical working for mHealth to **negotiate rates** for bulk **SMS sending** and **network costs** on behalf of its members.[4]

Recommendation for the government:

- Neither **development** partners nor the **government** have the **financial capacity** to fund mHealth apps given the substantial upfront investments required. This scenario suggests the adequacy of establishing **public-private partnerships** or **fostering social entrepreneurship[5].** However, to attract the private sector the government must create a **favourable operating** and **regulatory environmen**t, including a predictable legal framework for the telecoms sector.

Recommendations for the donor community:

- A significant proportion of **innovations fail,** and early impact validation is often challenging. However, donors must be willing to **take on the risk** to **fund novel** or unproven mHealth apps that have the **potential** to fuel **widespread social benefit**. Without their seed funding, these innovations cannot first survive and then scale up.

- Often **grants do not adapt** to the **funding requirements** for mHealth apps; they are either too large at first or provide no reassurance over the funding available in the medium-term. Therefore,

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[4] The four largest MNOs in South Africa gave substantial discounts to the mHealth app MomConnect on SMS costs after extensive negotiations (Barron, P., Peter, J., LeFevre, A.E., Sebidi,J., Bekker, M., Allen, R., Parsons, A.N., Benjamin, P., and Pillay, Y., 2018)

[5] *"The objective of a social businesses is to achieve a social goal… however, the company must cover all costs and make profit, at the same time it achieves the social objective, such as, healthcare for the poor"* (Yunus Centre, 2019).

it would be desirable that more donors offer a **tiered funding model** for mHealth apps like United States Agency for International Development (USAID's) grant Development Innovation Ventures (DIV).

Recommendation for NGOs:

- The study shows the multiplicity of pilot projects in Ethiopia, some with little integration with existing national health information architectures. This calls for greater **coordination** among development partners and the use of **open source training platforms** to **avoid duplication** of mHealth apps and to facilitate the work new implementing partners seeking to launch mHealth apps in Ethiopia.

- Evidence of impact is often a prerequisite to secure donor or government funding. Focusing on impact evaluation since day one may mitigate funding barriers, while at the same time more published evaluations would help NGOs venturing into the mHealth in Ethiopia identify best practices and earmark problematic areas during the implementation phase.

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9. **Appendix**

A. **Ethiopia's performance in delivering the MDG goals and selected HSTP/ SDG 3 targets**

Healthcare Indicator	Baseline *	Latest **	Planned target (FY 2020)
Maternal mortality ratio (per 100,000 live births)	**1,400**	**412**	**199**
Deliveries attended by skilled health personnel (%)	n. a	72.7	90
Under-five mortality rate (per 1000 live births)	205	67	30

Neonatal mortality rate per 1000 children	n. a	29	10
Deaths due to HIV (per 100 000 population)	131.7	54.6	n. a
Deaths due to malaria (per 100 000 population)	42.5	16.4	n. a
HIV incidence rate (%)	n. a	0.03	0.01
Detection rate of all forms of tuberculosis (%)	n. a	61.3	87
Under-5 Stunting rate (%)	n. a	34.4	26

Source: WHO and UN partners (2015), NPC (2017)

*Note: *Year 1990 for under-five mortality and maternal mortality; year 2000 for other indicators; **year 2012 for deaths due to HIV and malaria; year 2016 for other indicators.*

B. Framework for analyzing the determinants of maternal mortality McCarthy and Maine (1992)
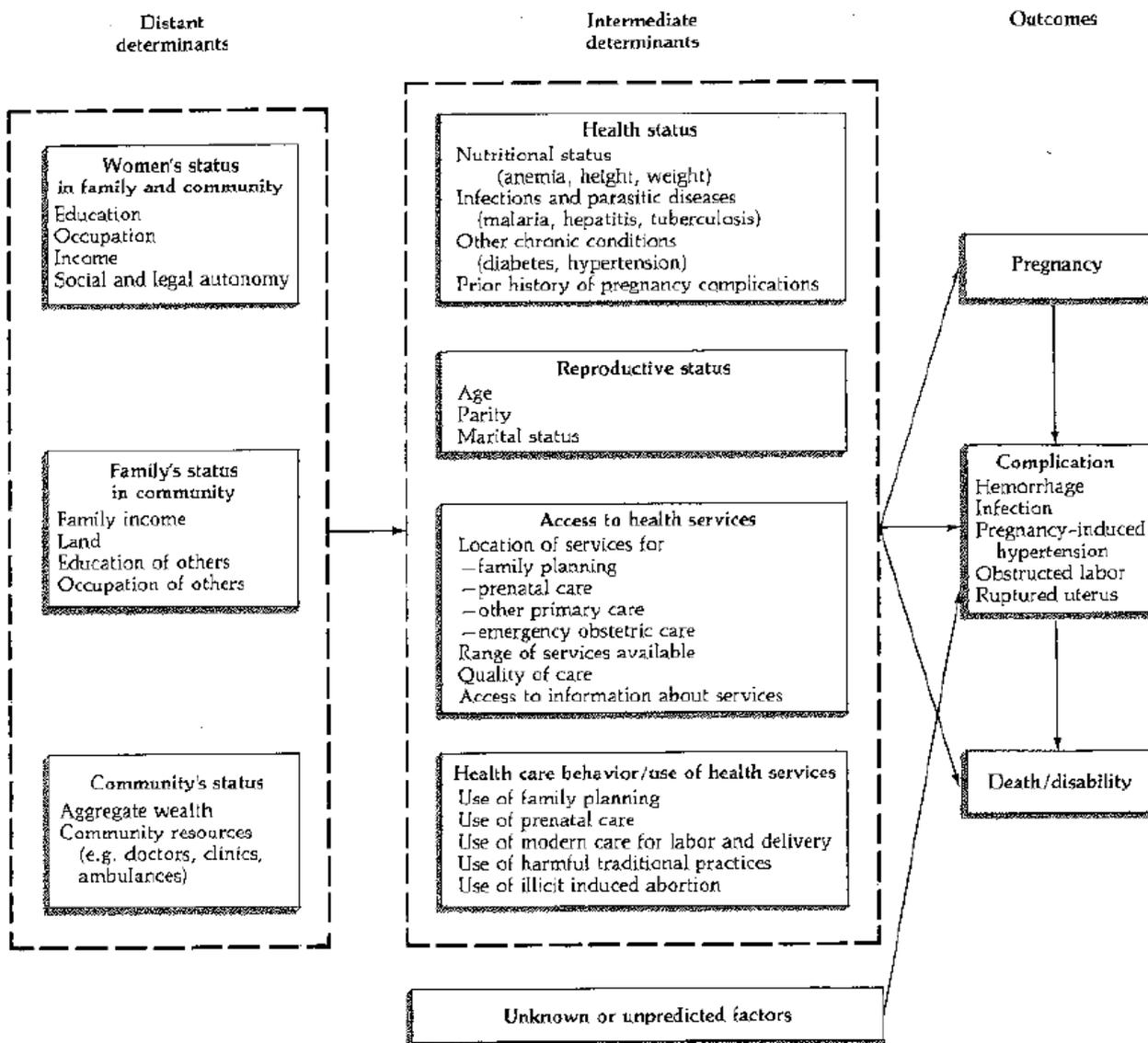
Source: McCarthy and Maine (1992)

C. The three delays model Thaddeus and Maine (1994)
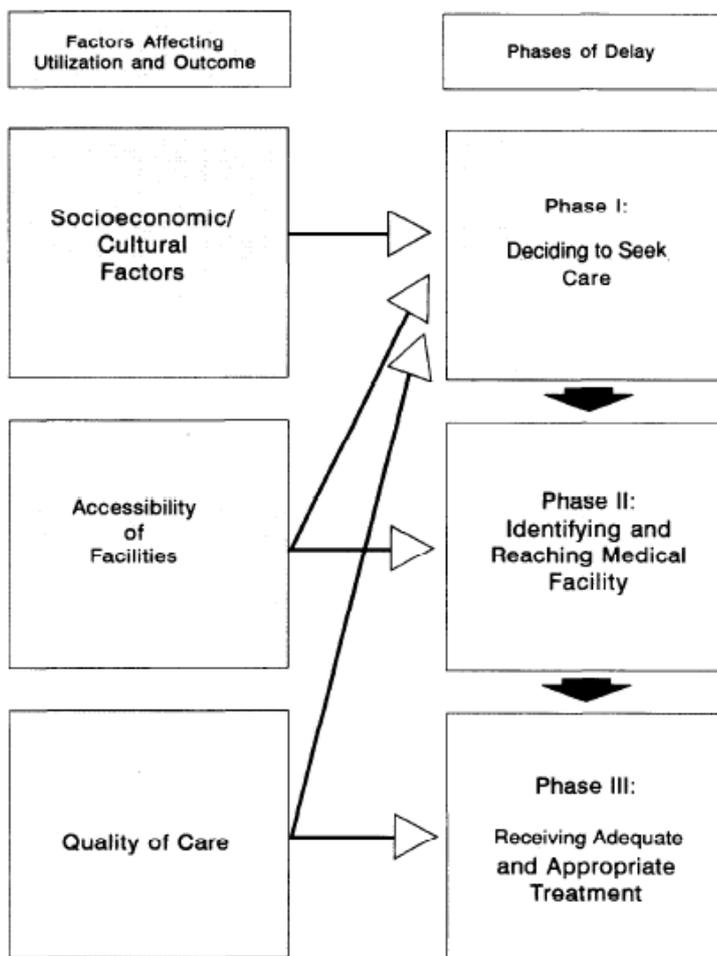
Source: Thaddeus and Maine (1994)

D. Structure of the Ethiopian health service delivery system

"The Ethiopian health service is structured into a three-tier system; primary, secondary and tertiary level of care. The primary level of care includes primary hospital, health centre and health post. The health centre (HC) and health posts (HPs) provide services to approximately 25,000 people altogether. A HC is staffed with an average of 20 staff and provides both preventive and curative services. It serves as a referral centre and practical training institution for HEWs. A HC has an inpatient capacity of 5 beds. A primary hospital provides inpatient and ambulatory services to an average population of 100,000. In addition to what a HC can provide, a primary hospital provides emergency surgical services, including caesarean sections and gives access to blood transfusion service.".
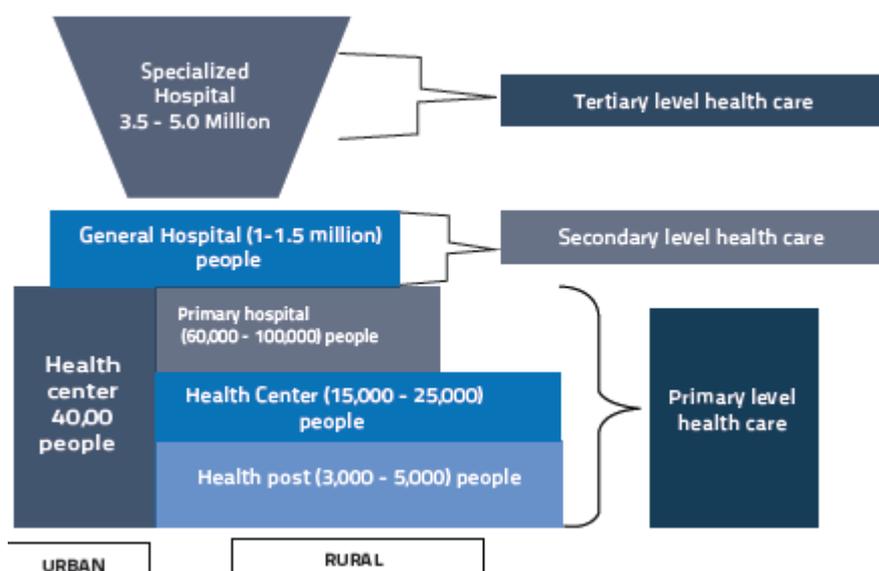
Source: MOH (2015)

E. mHealth apps for maternal health in Ethiopia

Name of mHealth app or Project Title	Organisation	mHealth Strategy (as per Labrique et al. [2013])
Frontline SMS- Pregnancy	Technology for Change International	Client education & behaviour change communication (BCC); Registries and vital events tracking; Data collection and reporting; Electronic health records; Electronic decision support; Provider work planning and scheduling; Human resource management.
Ethiopia mHealth Project	Ministry of Health, Federal Democratic Republic of Ethiopia	Registries and vital events tracking; Electronic health records; Human resource management
Maternal and Child Health Integrated Program	Jhpiego	Registries and vital events tracking; Electronic health records; Electronic decision support; Provider work planning and scheduling; Human resource management
Enat Messenger	Clinton Health Access Initiative	Registries and vital events tracking; Electronic health records; Human resource management; Provider work planning and scheduling; Data collection and reporting;
OppiaMobile	Funders: UKAID, DFID, mPowering Frontline Health Workers; Lead coordinator and implementing partners: Jhpiego, United States of America	Provider training/ education; Human resource management
Last 10 Kilometres	Bill and Melinda Gates Foundation	Human resource management; Data collection and reporting;
Safe Delivery App	Maternity Foundation	Provider training/ education
Mobile Health for Improved Maternal and Child Health Services Utilization	Amref Africa	Registries and vital events tracking; Electronic health records; Human resource management; Provider work planning and scheduling; Data collection and reporting;
ChildCount+	Millennium Villages Project	Registries and vital events tracking; Electronic health records; Human resource management;

		Provider work planning and scheduling; Data collection and reporting; Electronic decision support

Source: GSMA (2019), mHealth Knowledge (2019), Amref (2018), CHMI (2019)

F. Interview script: NGO and mHealth app developer

Note: Many of the barriers were identified by country programs in the publication titled "Lessons from Country Programs Implementing the Mobile Alliance for Maternal Action Programs in Bangladesh, South Africa, India and Nigeria, 2010–2016" (USAID, 2016).

Research project title: Assessing the barriers to implementation of mHealth innovations to improve reproductive, maternal, newborn and child (RMNCH) health in Ethiopia.

The purpose of this interview is to take a deep dive into the barriers to implementation of mHealth innovations to improve RMNCH health in Ethiopia and understand strategies to address them. My goal is to gain an in-depth understanding of the challenges faced by project teams so that Spanish NGOs looking at funding mHealth programs for RMNCH in Ethiopia can capture these lessons learned during the design and implementation phase. The interview is structured into seven broad themes: Contextual Environment, Partnerships, Financial Health, Technology & Architecture, Operations, Monitoring and Evaluation, and System-Level Factors.

If it is okay with you, I will be tape-recording our conversation since it is hard for me to write down everything while simultaneously carrying an attentive conversation with you. Nonetheless, all personal information, including your name, address, and answers will be kept strictly confidential and will not be shared with any person or group. Your participation is voluntary, and you may refuse to answer any questions you do not wish to answer. The responses collected from this interview will be summarized and no individual person will be knowingly identifiable from the summarized results.

Thank you for taking the time to talk with me today.

Laura Colina

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PROJECT BACKGROUND (to be filled in by interviewee/ researcher)

- **Program title:**
- **Program status:**
- **Developers:**
- **Key funders:**
- **Length of implementation:**
- **Geographic coverage:**
- **Total subscribers:**

- **Project summary:**
- **Languages and dialects:**

1.1. CONTEXTUAL ENVIRONMENT

These questions cover country context factors which may impede implementation of mHealth innovations for RMNCH in Ethiopia.

1. Do you think the **low mobile penetration and usage** in Ethiopia is an issue for mHealth apps and how can we avoid leaving behind poor women who don't own a mobile phone?
2. Is the **gender gap in mobile ownership** in Ethiopia a meaningful barrier to the adoption of mHealth innovations for RMNCH? How might this barrier be addressed?
3. Do **attitudinal barriers** influence mHealth adoption in Ethiopia (e.g. women in rural areas might perceive institutional delivery as unnecessary)? How might this barrier be addressed?
4. Is the **low female literacy rate** in Ethiopia a meaningful barrier to the adoption of mHealth products for RMNCH? How can an app be designed to address this challenge?
5. In your view, do **"gatekeepers"** such as fathers play an influential role on mHealth product adoption in Ethiopia?
6. How does the **timing and frequency** of SMSs delivered influence mHealth product adoption in Ethiopia?
7. Is **content creation and management** a challenge for scaling up mHealth products for RMNCH in Ethiopia because language, culture and habits vary significantly enough from one location to another that elements such as message language, content, terminology and voice tone must be tailored with every expansion?
8. How important is to include **content/ protocols/ terminologies approved by health bodies** such as WHO to enhance mHealth product adoption by health care workers/ government bodies?
9. Is the **limited computer literacy** of community health workers and their limited previous experience in using mobile phones for health-related services a barrier to the usage of mHealth products for RMNCH? Which strategies might address this issue?
10. Do you think health workers in Ethiopia have the **capacity to undertake user registration or training** given their tight schedules? Do **health workers** in charge of enrollment/registration at health facilities, or enrolled into training courses complain about this being **additional workload**?
11. Which specific barriers might emerge when mHealth apps for maternal health are used in **humanitarian contexts** in Ethiopia?

1.2. PARTNERSHIPS

These questions cover barriers to establishing strong and sustainable partnerships required for successful mHealth products.

1. Which **partnerships must be established** for successful mHealth innovations for RMNCH in Ethiopia?
2. Out of those partnerships identified as key to successful mHealth products in Ethiopia, which are more **challenging to secure and sustain** in the long-term and which factors undermined their effectiveness?

1.3. FINANCIAL HEALTH

These questions relate to financial barriers, including challenges that may arise when mHealth apps transition from short-based grant financing to long-term modes of sustainable financing.

1. Did you face **funding barriers** when setting up the program?
2. Which country context factors influenced your **payer model** and was it challenging to find entities willing and able to pay for the service?
3. What is the project's **long-term approach to scaling up** (e.g. government adoption, commercial adoption) and which factors did you take into consideration to decide on the most appropriate long-term approach to sustainability?
4. From your experience, which **major cost component** limits the ability to rapidly scale up an mHealth program for RMNCH in Ethiopia?
5. In your view, which is the most **cost-effective channel** to reach scale mHealth program for RMNCH in Ethiopia?

1.4. TECHNOLOGY & ARCHITECTURE

These questions cover common technological difficulties such as network coverage, power outages, and issues relating to increases in data loads, facilitating ease of data storage and retrieval, and managing data exchange in low-connectivity settings.

1. Which **message delivery channel** does your app use and which country context factors influenced your decision? Which is the most appropriate message delivery channel for apps targeting mothers versus health extension workers?

2. Is limited **mobile network coverage** in Ethiopia a meaningful barrier to the implementation of mHealth applications? How is the app designed to manage frequent interruption in network connections?

3. Is the **lack of electricity** a meaningful barrier to the implementation of mHealth applications? If yes, how is the app designed to manage frequent interruption in electricity for charging?

4. Which **user interaction model** does the app use (e.g. two-way communication vs. one-way communication; pull messaging vs. push messaging). In your view which model is best suited for RMNCH mHealth apps aiming to achieve scale, sustainability and impact in Ethiopia?

5. Is the mHealth product **adapted for and integrated into** (or can be if be) the existing health services and ICT systems of the ministry of health and what are the benefits/ challenges in doing so?

6. Do you use **software and hardware technologies** developed in-house, or as provided by an external company and which country context factors influenced your decision?

7. Do you work with **aggregators** that already had relationships with MNOs and what are the benefits and challenges of doing so?

8. Does the application have features that aim to improve **data accessibility and quality** and is ensuring data quality and accessibility a challenge and why?

9. Was **data transmission and storage** a challenge at some point?

10. How do you ensure **data security and data privacy** and was this a challenge?

1.5. OPERATIONS

These questions cover issues that may arise during the implementation phase.

1. Which **customer enrolment strategy** did you use, and which key challenges did you encounter to enrollment at scale?

2. Assuming the program procured new devices to health workers, was **device retention and misuse** a challenge and which procedures did you adopt to prevent this?

3. Is it challenging to find **appropriate expertise** to fill key leadership positions that support operations as they scale up?

4. Was **project team member retention**, particularly health care worker retention, a challenge and which strategies were adopted to prevent this?

5. Is preventing the **fabrication of data** a persistent challenge for digital records? Which mechanisms are in place to avoid fraudulent reporting, particularly in motivational schemes that reward health care worker performance based on success in reaching targets?

6. Did you carry out **outreach and sensitization** activities with the stakeholder and community groups involved in the scaling up process? Was it challenging to gain community support for your mHealth product?

7. Do you undertake **end user** (health care worker) **and secondary user** (health care worker supervisors) **training**? To what extent to you think such training is key to the successful adoption of mHealth products in Ethiopia?

1.6. MONITORING & EVALUATION

1. Do you regularly collect and **analyze operational data** as a means of monitoring the project and identifying gaps impeding fidelity of evaluation? Did challenges arise during the collection of such data?

1.7. SYSTEM LEVEL FACTORS

These questions emphasize issues beyond the immediate control of a project, such as data standards and existing eHealth polices.

1. Is there a supportive **regulatory framework** for the development of mHealth products in Ethiopia? In particular, is adherence to eHealth **security standards for data collection, transmission and storage** a challenge?

2. What is your opinion on the **policy environment** in Ethiopia with regards to the existing national eHealth strategy and the national health information system?

3. Was it difficult to **register the app** and was **corruption** a persistent challenge?

G. Interview script: Midwife

Interview Script: Assessing the barriers to implementation of mHealth innovations to improve reproductive, maternal, newborn and child (RMNCH) health in Ethiopia

My name is Laura Colina and I am an International Development Student from ICADE. I am writing my dissertation about the barriers to implementation of mHealth innovations to improve RMNCH health in Ethiopia. The purpose of this interview is to take a deep dive into such barriers and understand strategies to addresses them. My goal is to gain an in depth understanding of the challenges faced by project teams so that Spanish NGOs looking at funding mHealth programs for RMNCH in Ethiopia can capture these lessons learned during the design and implementation phase. The interview is structured into six broad themes: Contextual Environment, Content, Partnerships, Financial Health, Technology & Architecture and Operations.

If it is okay with you, I will be tape-recording our conversation since it is hard for me to write down everything while simultaneously carrying an attentive conversation with you. Nonetheless, all personal information, including your name, address, and answers will be kept strictly confidential and will not be shared with any person or group. Your participation is voluntary, and you may refuse to answer any questions you do not wish to answer. The responses collected from this interview will be summarized and no individual person will be knowingly identifiable from the summarized results.

Thank you for taking the time to talk with me today.

Laura Colina

1.1. CONTEXTUAL ENVIRONMENT

These questions cover country context factors which may impede implementation of mHealth innovations for RMNCH in Ethiopia.

1. Is the **gender gap in mobile ownership** in Ethiopia a meaningful barrier to the adoption of mHealth innovations for RMNCH? How might this barrier be addressed?
2. Do **attitudinal barriers** influence mHealth adoption in Ethiopia (e.g. women in rural areas might perceive institutional delivery as unnecessary or not common practice; there is lack of trust in the healthcare system)? How might this barrier be addressed?
3. Is the **low female literacy rate** in Ethiopia a meaningful barrier to the adoption of mHealth products for RMNCH? How can an app be designed to address this challenge?

4. In your view, do "**gatekeepers**" such as husbands play an influential role on mHealth product adoption in Ethiopia?

5. How might **timing and frequency** of SMSs delivered influence mHealth product adoption in Ethiopia (e.g. there are preferred time slots for message delivery that radically increase rate of listening)?

6. Is the **limited computer literacy** of community health workers and their limited previous experience in using mobile phones for health-related services a barrier to the usage of mHealth products for RMNCH? Which strategies might address this issue?

7. How do midwifes **perceive the use of mHealth applications** (e.g. as a means of ensuring good follow up, good accountability tool for providing evidence that they have provided care to patients, etc.)? Which strategies can be used to **foster their buy in/ encourage them to adopt mHealth apps**?

8. Do you think health workers in Ethiopia have the **capacity to undertake user registration or training** given their tight schedules? Do **health workers** in charge of enrollment/registration at health facilities, or enrolled into training courses complain about this being **additional workload**?

9. Which **other factors may hamper adoption** of mHealth innovations by health workers? E.g. There is lack of support when a question emerges with the mHealth app, there is no technical support when hardware, software or connectivity problems arise, training tools have not been developed or are not appropriate for the users' literacy and content knowledge etc.

1.2. CONTENT

These questions cover factors relating to the content of mHealth innovations for RMNCH in Ethiopia.

1. Considering Ethiopia's healthcare challenges, which **mHealth applications** are **more relevant** in Ethiopia? a) mHealth apps designed to train health extension workers (HEWs); b) mHealth apps designed to reach out with pregnant women with health promotion messages and appointment remainders; c) mHealth apps used for diagnosing and treatment (e.g. tele- stethoscope); d) mHealth apps used for remote data collection and remote monitoring?

2. Which key **stakeholders** should be involved in **content creation** and management?

3. How important is to include **content/ protocols/ terminologies approved by health bodies** such as WHO to enhance mHealth product adoption by health care workers/ government bodies?

4. Is **content creation and management** a challenge for scaling up mHealth products for RMNCH in Ethiopia because language, culture and habits vary significantly enough from one location to

another that elements such as message language, content, terminology and voice tone must be tailored with every expansion?

1.3. PARTNERSHIPS

These questions cover barriers to establishing strong and sustainable partnerships required for successful mHealth products.

1. In your view which **partnerships must be established** for successful mHealth innovations for RMNCH in Ethiopia?
2. Does the Ethiopian Midwives Association actively participate in existing **eHealth/mHealth working groups** or eHealth/mHealth national-level meetings?

1.4. FINANCIAL HEALTH

These questions relate to financial barriers, including challenges that may arise when mHealth apps transition from short-based grant financing to long-term modes of sustainable financing.

1. In your view, are **pregnant mothers willing to pay** to receive health related messages on their phones?
2. In your view, are **health care workers willing to pay** to receive educational messages on their phones?
3. Do you think the **government is willing to adopt and subsidize** mHealth programs for RMNCH at a national scale?

1.5. TECHNOLOGY & ARCHITECTURE

These questions cover common technological difficulties such as network coverage, power outages, and issues relating to increases in data loads, facilitating ease of data storage and retrieval, and managing data exchange in low-connectivity settings.

1. Which **message delivery channel** (SMS, voice) is most appropriate to reach **pregnant mothers or health workers**? Which country context factors should be taken into consideration (e.g. literacy level, mobile phone ownership, usage patterns) etc.?
2. Is limited **mobile network coverage** in Ethiopia a meaningful barrier to the implementation of mHealth applications?
3. Is the **lack of electricity** a meaningful barrier to the implementation of mHealth applications?

4. Which **user interaction model** (e.g. two-way communication vs. one-way communication; pull messaging vs. push messaging) is best suited for RMNCH mHealth apps aiming to achieve scale, sustainability and impact in Ethiopia?

5. Do you think pregnant mothers might be reluctant to enroll in mHealth programs due to **data security and data privacy** concerns?

1.6. OPERATIONS

These questions cover issues that may arise during the implementation phase.

1. Which **customer enrolment strategy for pregnant mothers** (e.g. facility-based registration, community agents, self-registration, combination of methods etc.) do you think is best to reach scale and impact in Ethiopia? Which key challenges might an mHealth program encounter to enrollment at scale (e.g. enrolling in health facilities meant not reaching poor women who did not attend antenatal care visits)?

2. In your view, what are **advantages and disadvantages of procuring new devices** to health workers, instead of using their personal phones of health workers in Ethiopia?

3. Assuming, a new mobile phone is given to a health worker, could **device misuse** occur (e.g. health workers download games, watch YouTube videos, etc.) and which procedures could prevent this?

4. Assuming, a new mobile phone is given to a health worker, might **mobile device retention** be challenging (e.g. health workers may lose their phones, some may not return them when they leave the area, etc.). Which procedures might prevent this?

5. Do you think **project team member turnover** could be a challenge, particularly health care worker turnover? Which strategies might prevent health care worker turnover?

6. Is preventing the **fabrication of data** a persistent challenge for digital records? Which mechanisms could be put in place to avoid fraudulent reporting, particularly in motivational schemes that reward health care worker performance based on success in reaching targets?

7. In your view, is it important to carry out **outreach and sensitization activities** with the stakeholder and community groups involved in the scaling up process (e.g. CBOs, community council, government representatives, other NGOs) of mHealth products? Do you think it might be challenging to gain community support for an mHealth product for maternal health in Ethiopia?

8. Do you think **end user** (health care worker) and **secondary user** (health care worker supervisors) **training** is key to the successful adoption of mHealth products in Ethiopia? Which aspects should be covered during training sessions? (E.g. Training on the device, training on the content, training on the benefits, etc.).

H. Interview script: Government

Research project title: Assessing the barriers to implementation of mHealth innovations to improve reproductive, maternal, newborn and child (RMNCH) health in Ethiopia.

The purpose of this interview is to take a deep dive into the barriers to implementation of mHealth innovations to improve RMNCH health in Ethiopia and understand strategies to address them. My goal is to gain an in-depth understanding of the challenges faced by project teams so that Spanish NGOs looking at funding mHealth programs for RMNCH in Ethiopia can capture these lessons learned during the design and implementation phase. The interview is structured into six broad themes: Contextual Environment, Partnerships, Financial Health, Technology & Architecture, Operations, and System-Level Factors.

If it is okay with you, I will be tape-recording our conversation since it is hard for me to write down everything while simultaneously carrying an attentive conversation with you. Nonetheless, all personal information, including your name, address, and answers will be kept strictly confidential and will not be shared with any person or group. Your participation is voluntary, and you may refuse to answer any questions you do not wish to answer. The responses collected from this interview will be summarized and no individual person will be knowingly identifiable from the summarized results.

Thank you for taking the time to talk with me today.

Laura Colina

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1.1. CONTEXTUAL ENVIRONMENT

These questions cover country context factors which may impede implementation of mHealth innovations for RMNCH in Ethiopia.

1. Considering Ethiopia's healthcare challenges, **which mHealth applications** for RMNCH are **more relevant** in Ethiopia? i) mHealth apps designed to train HEWs; ii) mHealth apps designed to reach out with pregnant women with health promotion messages and appointment remainders; iii) mHealth apps used for diagnosing and treatment; iv) mHealth apps used for remote data collection and remote monitoring.
2. Is the **gender gap in mobile ownership** in Ethiopia a meaningful barrier to the adoption of mHealth innovations for RMNCH? Are there government schemes in place to increase female mobile ownership?

3. Do **attitudinal barriers** influence mHealth adoption in Ethiopia (e.g. women in rural areas might perceive institutional delivery as unnecessary)? How might this barrier be addressed?

4. Is the **low female literacy rate** in Ethiopia a meaningful barrier to the adoption of mHealth products for RMNCH? How can an app be designed to address this challenge?

5. In your view, do **"gatekeepers"** such as fathers play an influential role on mHealth product adoption in Ethiopia and therefore should be included as a target audience of the app?

6. Is **content creation and management** a challenge for scaling up mHealth products for RMNCH in Ethiopia because language, culture and habits vary significantly enough from one location to another that elements such as message language, content, terminology and voice tone must be tailored with every expansion?

7. How important is it to include **content/ protocols/ terminologies approved by health bodies** such as WHO to enhance mHealth product adoption by health care workers/ government bodies?

8. Is it necessary to **comply with the Ministry's national curriculum** in order to be granted a license to operate an mHealth app designed to train health extension workers in Ethiopia?

9. Is the **limited computer literacy** of community health workers and their limited previous experience in using mobile phones for health-related services a barrier to the usage of mHealth products for RMNCH? Which strategies might address this issue?

10. Do you think health workers in Ethiopia have the **capacity to undertake user registration or training** given their tight schedules? Do **health workers** in charge of enrollment/registration at health facilities, or enrolled into training courses complain about this being **additional workload**?

11. Do you think specific challenges may emerge when mHealth apps for RMNCH are used in **humanitarian and fragile settings** affected by conflict in Ethiopia?

1.2. PARTNERSHIPS

These questions cover barriers to establishing strong and sustainable partnerships required for successful mHealth products.

1. In your view which **partnerships must be established** for successful mHealth innovations for RMNCH in Ethiopia?

2. To what extent is the government and Ministry of Health positioned at the forefront of in-country coordination for mHealth (e.g. the Ministry coordinates mHealth working groups and mHealth national-level meetings; it promotes mHealth apps; it negotiates discounted SMS rates on behalf of mHealth operators, etc.)?

1.3. FINANCIAL HEALTH

These questions relate to financial barriers, including challenges that may arise when mHealth apps transition from short-based grant financing to long-term modes of sustainable financing.

1. In your view, do mHealth apps for maternal health face **funding barriers** in Ethiopia? Which funding model is most suitable for mHealth apps willing to achieve scale in Ethiopia (e.g. donor, government, private sector, blended finance)?

2. Is the Ministry of Health willing to provide funding and which **evaluation criteria** do you use to assess potential applicants (e.g. i) rigorous evidence of impact; ii) cost-effectiveness; iii) scale up potential; iv) sustainability potential after donor funding has ended; vii) capacity and track record of the team testing or implementing the proposed intervention; viii) alignment with national health priorities; etc.).

3. Which **long-term approach to scaling up** (e.g. government adoption, commercial adoption) is most appropriate for mHealth apps looking to achieve scale and sustainability in Ethiopia? What are the main barriers that prevent the adoption of mHealth products by the Ministry of Health and integration with the health system?

4. Which **payer model** (e.g. end user pays, MNO pays, etc.) is most appropriate for apps willing to achieve long-term sustainability in Ethiopia?

5. From your experience, which **major cost component** limits the ability to rapidly scale up an mHealth program for RMNCH in Ethiopia?

6. In your view, which is the most **cost-effective channel** to reach scale mHealth program for RMNCH in Ethiopia?

7. From a financial health perspective, what are the pros and cons of having only **one state-owned telecom operator** in Ethiopia (eg.it is less/ more difficult to negotiate discounted call rates)?

1.4. TECHNOLOGY & ARCHITECTURE

These questions cover common technological difficulties such as network coverage, power outages, and issues relating to increases in data loads, facilitating ease of data storage and retrieval, and managing data exchange in low-connectivity settings.

1. In your view, which country context factors should be taken into consideration when deciding on the most appropriate **message delivery channel** in Ethiopia?

2. Is limited **mobile network coverage** in Ethiopia a meaningful barrier to the implementation of mHealth applications? How might this change with the partial privatization of Ethio Telecom?

3. Is the **lack of electricity** a meaningful barrier to the implementation of mHealth applications? Is increasing access to electricity in rural areas a strategic priority area for the government?

4. Do you prefer to work with mHealth apps that use **open source software or proprietary software**? What are the pros and cons of each?

5. Can existing mHealth products for RMNCH be **adapted for and integrated into** the existing health services and ICT systems of the ministry of health? What are the benefits/ challenges in doing so?

6. In your view, do existing mHeatlh apps for maternal health find it difficult to ensure **data security and data privacy** in Ethiopia?

1.5. OPERATIONS

These questions cover issues that may arise during the implementation phase.

1. Which **customer enrolment strategy** (e.g. self-registration, facility-based registration, etc.) is most appropriate to enrollment at scale?

2. Is it challenging to find **appropriate expertise** to fill key leadership positions that support operations as they scale up?

3. Is **project team member retention**, particularly health care worker retention, a challenge for Ethiopia's health care system?

4. Is preventing the **fabrication of data** a persistent challenge for digital records? Which mechanisms are in place to avoid fraudulent reporting, particularly in motivational schemes that reward health care worker performance based on success in reaching targets?

1.6. SYSTEM LEVEL FACTORS

These questions emphasize issues beyond the immediate control of a project, such as data standards and existing eHealth polices.

1. How does mHealth fit into the principles and guidelines of the **national eHealth strategy**? Are **mHealth** products for maternal health part of the **health system priority** areas?

2. How do you expect the **regulatory framework** for the development of mHealth products to evolve?

3. How do you expect the **policy environment** with regards to the existing national eHealth strategy and the national health information system to evolve?

I. Interview script: MNO

Interview Script: Assessing the barriers to implementation of mHealth innovations to improve reproductive, maternal, newborn and child (RMNCH) health in Ethiopia

My name is Laura Colina and I am an International Development Student from ICADE. I am writing my dissertation about the barriers to implementation of mobile health (mHealth) innovations to improve RMNCH health in Ethiopia. The purpose of this interview is to take a deep dive into such barriers and understand strategies to addresses them. My goal is to gain an in depth understanding of the challenges faced by project teams so that Spanish NGOs looking at funding mHealth programs for RMNCH in Ethiopia can capture these lessons learned during the design and implementation phase. The interview is structured into five broad themes: Contextual Environment, Partnerships, Financial Health, Technology, and System-Level Factors. The interview should take about 40 minutes to complete.

If it is okay with you, I will be tape-recording our conversation since it is hard for me to write down everything while simultaneously carrying an attentive conversation with you. Nonetheless, all personal information, including your name, address, and answers will be kept strictly confidential and will not be shared with any person or group. Your participation is voluntary, and you may refuse to answer any questions you do not wish to answer. The responses collected from this interview will be summarized and no individual person will be knowingly identifiable from the summarized results. Responses to questions may be quoted, but without identifying the individual source.

Thank you for taking the time to talk with me today.

Laura Colina

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1.1. CONTEXTUAL ENVIRONMENT

These questions cover country context factors which may impede implementation of mHealth innovations for maternal health in Ethiopia.

1. In your view is the **low mobile penetration rate** in Ethiopia is barrier to the expansion of mobile apps? How do you expect the mobile penetration rate in Ethiopia to evolve in the next 5 years?
2. In your opinion are **gender gaps in mobile ownership** a meaningful barrier to the adoption of mobile apps targeting women? Does Ethio Telecom have schemes in place to target this untapped market, particularly women in rural areas?

3. In you view, is the **low female literacy rate** in Ethiopia a meaningful barrier to the adoption of mobile apps? Which strategies might help address this issue (e.g. apps with more focus on pictorial content that improves understanding)?

4. In your opinion, should "**gatekeepers**" (e.g. fathers, mothers in law) be included as a secondary target audience in the mHealth product because they play an influential role on mHealth product adoption in Ethiopia?

5. From your experience, how does the **timing and frequency** of SMSs delivered influence mobile app adoption in Ethiopia (e.g. there are preferred time slots for message delivery that radically increase rate of listening; there are regulations that curtail evening hours for calls, etc.)?

6. From your experience is **content creation and management** a challenge for scaling up mobile services because in Ethiopia language, culture and habits vary significantly enough from one location to another that elements such as message language, content, terminology and voice tone must be tailored with every expansion?

1.2. PARTNERSHIPS

These questions cover barriers to establishing strong and sustainable partnerships required for successful mHealth products.

1. Are you aware **of existing partnerships** between Ethio Telecom and mHealth applications for maternal health in Ethiopia?

2. In you view, which **factors** would be taken into consideration by Ethio Telecom when assessing whether to partner with an mHealth product for maternal health (e.g. return on investment, ability to enhance brand awareness, entry into new customer segments, etc.).

3. Does Ethio Telecom actively participate in existing eHealth/mHealth **working groups** (online or country) or eHealth/mHealth national-level meetings?

1.3. FINANCIAL HEALTH

These questions relate to financial barriers, including challenges that may arise when mHealth apps transition from short-based grant financing to long-term modes of sustainable financing.

1. In your view, would Ethio Telecom be willing to **subsidize the cost** of existing mHealth apps (e.g. an mHealth app in South Africa reached an agreement with the local MNO to lower the SMS cost)?

2. In your opinion, would Ethio Telecom be interested in **adopting and buying** successful mHealth apps for maternal health?

3. In your view, which is the most **cost-effective channel** to reach scale mHealth program for RMNCH in Ethiopia (e.g. SMS display a fixed cost per user whereas for a mobisite the cost per user decreases as user base increases)?

4. Do you expect the partial **privatization** of state-owned Ethio Telecom to spur competition and lower operating costs for mHealth providers?

1.4. TECHNOLOGY & ARCHITECTURE

These questions cover common technological difficulties such as network coverage, power outages, and issues relating to increases in data loads, facilitating ease of data storage and retrieval, and managing data exchange in low-connectivity settings.

1. In your opinion which **message delivery channel** is more appropriate for mobile apps targeting women (e.g. SMS, voice, website optimized for viewing on mobile phones, etc.) and which country context factors would you consider (e.g. literacy level, mobile ownership, usage patterns, etc.)?

2. How do you expect **mobile network coverage** in Ethiopia to evolve in the medium term? Do you expect the privatization of Ethiopia's state-owned telecommunications company to spur competition and prompt operators to expand network coverage?

3. Is the **lack of electricity** a meaningful barrier to the expansion of mobile services in Ethiopia? If yes, which strategies might be adopted to manage frequent interruption in electricity for charging?

4. What do you think is best for mHealth apps, **software and hardware technologies** developed in-house, or as provided by an external company and which country context factors might influence the decision?

5. Do you think **free technology platforms** such as WhatsApp and Facebook messenger are an option in Ethiopia to drive down program costs eliminating the need to pay high rates to MNOs and mobile aggregators for per-message delivery?

6. Do you think it might be challenging for mHealth apps to comply with **data security and data privacy** standards in Ethiopia?

7. Do you think it might be challenging for mHealth apps to ensure **data transmission and data storage** in Ethiopia? E.g. processing capacity is inadequate, latency of the data center is inappropriate, bandwidth for data transmission is not sufficient, it is difficult to adhere to government requirements on data storage and hosting, etc.

8. Is it challenging to find **appropriate technical expertise** to fill key leadership positions that support operations at Ethio Telecom?

1.5. SYSTEM LEVEL FACTORS

These questions emphasize issues beyond the immediate control of a project, such as data standards and existing eHealth polices.

1. Do you think the existing **regulatory framework** in Ethiopia is a barrier/supportive to the development of mHealth products?
2. In your view, is adherence to eHealth **security standards for data collection, transmission and storage** a challenge?
3. What is your opinion on the **policy environment** in Ethiopia with regards to the existing national eHealth strategy and the national health information system?

J. Interview script: Hospital manager

Interview Script: Assessing the barriers to implementation of mHealth innovations to improve reproductive, maternal, newborn and child (RMNCH) health in Ethiopia

My name is Laura Colina and I am an International Development Student from ICADE. I am writing my dissertation about the barriers to implementation of mobile health (mHealth) innovations to improve RMNCH health in Ethiopia. The purpose of this interview is to take a deep dive into such barriers and understand strategies to addresses them. My goal is to gain an in depth understanding of the challenges faced by project teams so that Spanish NGOs looking at funding mHealth programs for RMNCH in Ethiopia can capture these lessons learned during the design and implementation phase. The interview is structured into six broad themes: Contextual Environment, Partnerships, Financial Health, Technology, and System-Level Factors. The interview should take about 40 minutes to complete.

If it is okay with you, I will be tape-recording our conversation since it is hard for me to write down everything while simultaneously carrying an attentive conversation with you. Nonetheless, all personal information, including your name, address, and answers will be kept strictly confidential and will not be shared with any person or group. Your participation is voluntary, and you may refuse to answer any questions you do not wish to answer. The responses collected from this interview will be summarized and no individual person will be knowingly identifiable from the summarized results. Responses to questions may be quoted, but without identifying the individual source.

Thank you for taking the time to talk with me today.

Laura Colina

1.1. CONTEXTUAL ENVIRONMENT

These questions cover country context factors which may impede implementation of mHealth innovations for (reproductive, maternal, newborn and child health) RMNCH in Ethiopia.

1. Is the **gender gap in mobile ownership** in Ethiopia a meaningful barrier to the adoption of mHealth innovations for RMNCH? How might this barrier be addressed?
2. Do **attitudinal barriers** influence mHealth adoption in Ethiopia (e.g. women in rural areas might perceive institutional delivery as unnecessary)? How might this barrier be addressed?
3. What do you think is the **main barrier to facility delivery assisted** by skilled health professionals (cultural aspects, lack of access, etc.)?

4. Is the **low female literacy rate** in Ethiopia a meaningful barrier to the adoption of mHealth products for RMNCH? How can an app be designed to address this challenge?

5. In your view, do **"gatekeepers"** such as fathers play an influential role on mHealth product adoption in Ethiopia?

6. How might **timing and frequency** of SMSs delivered influence mHealth product adoption in Ethiopia?

7. Is **content creation and management** a challenge for scaling up mHealth products for RMNCH in Ethiopia because language, culture and habits vary significantly enough from one location to another that elements such as message language, content, terminology and voice tone must be tailored with every expansion?

8. How important is it to include **content/ protocols/ terminologies approved by health bodies** such as WHO to enhance mHealth product adoption by health care workers/ government bodies?

9. Is the **limited computer literacy** of community health workers and their limited previous experience in using mobile phones for health-related services a barrier to the usage of mHealth products for RMNCH? Which strategies might address this issue?

10. Do you think health workers in Ethiopia have the **capacity to undertake user registration or training** given their tight schedules? Do **health workers** in charge of enrollment/registration at health facilities, or enrolled into training courses complain about this being **additional workload**?

11. Considering **Ethiopia's healthcare challenges**, which mHealth applications do you think are **more relevant** in Ethiopia? 1) mHealth apps designed to train HEWs; 2) mHealth apps designed to reach out with pregnant women with health promotion messages and appointment remainders; 3) mHealth apps used for diagnosing and treatment; 4) mHealth apps used for remote data collection and remote monitoring.

1.2. PARTNERSHIPS

These questions cover barriers to establishing strong and sustainable partnerships required for successful mHealth products.

1. In your view which **partnerships must be established** for successful mHealth innovations for RMNCH in Ethiopia?

2. Out of those partnerships identified as key to successful mHealth products in Ethiopia, which could be more **challenging to secure and sustain** in the long-term and which factors might undermine their effectiveness?

1.3. FINANCIAL HEALTH

These questions relate to financial barriers, including challenges that may arise when mHealth apps transition from short-based grant financing to long-term modes of sustainable financing.

1. Do you face **funding barriers** for healthcare programs in Ethiopia?
2. Which country context factors might influence the **payer model** (e.g. end user pays; mobile network operator pays: government pays, etc.) and do you think it might be challenging to find entities willing and able to pay for the service?
3. Which **long-term approach to scaling up** (e.g. government adoption, commercial adoption) do you think is most appropriate long-term approach to sustainability?

1.4. TECHNOLOGY & ARCHITECTURE

These questions cover common technological difficulties such as network coverage, power outages, and issues relating to increases in data loads, facilitating ease of data storage and retrieval, and managing data exchange in low-connectivity settings.

1. In your view which **message delivery channel** (e.g. SMS, voice, etc.) is most appropriate in Ethiopia and which country context factors might influence the decision (e.g. voice messages might be more appropriate for illiterate populations)?
2. Is limited **mobile network coverage** in Ethiopia a meaningful barrier to the implementation of mHealth applications? How is the app designed to manage frequent interruption in network connections?
3. Is the **lack of electricity** a meaningful barrier to the implementation of mHealth applications? If yes, how is the app designed to manage frequent interruption in electricity for charging?
4. Which **user interaction model** (e.g. two-way communication vs. one-way communication; pull messaging vs. push messaging) is best suited for RMNCH mHealth apps aiming to achieve scale, sustainability and impact in Ethiopia?
5. What might be the benefits and challenges of **adapting and integrating mHealth** apps into the existing health services and ICT systems of the ministry of health?
6. Do you use **software and hardware technologies** developed in-house, or as provided by an external company and which country context factors influenced your decision?
7. Do you work with **aggregators** that already had relationships with MNOs and what are the benefits and challenges of doing so?

8. Is it challenging to ensure **data transmission and storage** and **data security and data privacy** in Ethiopia?

1.5. OPERATIONS

These questions cover issues that may arise during the implementation phase.

1. Which **customer enrolment strategy** do you think is most effective for enrolment at scale: facility-based registration, communality agents, self-registration, or a combination of methods?
2. Assuming an mHealth app procures new devices to health workers, might **device retention and misuse** be a challenge and which procedures did you adopt to prevent this?
3. Is it challenging to find **appropriate expertise** to fill key leadership positions that support operations?
4. Is **health care worker retention** a challenge and which strategies do you adopt to prevent this?
5. Is preventing the **fabrication of data** a persistent challenge for digital records? Which mechanisms are in place to avoid fraudulent reporting, particularly in motivational schemes that reward health care worker performance based on success in reaching targets?
6. Do you think it is important to carry out **outreach and sensitization** activities with the stakeholder and community groups involved in the scaling up process? Might it challenging to gain community support for and mHealth product?
7. To what extent to you think **end user** (health care worker) **and secondary user** (health care worker supervisors) **training is** key to the successful adoption of mHealth products for maternal health in Ethiopia?
8. Is **corruption** a persistent challenge in your day to day job as hospital manager?

1.6. SYSTEM LEVEL FACTORS

These questions emphasize issues beyond the immediate control of a project, such as data standards and existing eHealth polices.

1. Is there a supportive **regulatory framework** for the development of mHealth products in Ethiopia? In particular, is adherence to eHealth **security standards for data collection, transmission and storage** a challenge?
2. What is your opinion on the **policy environment** in Ethiopia with regards to the existing national eHealth strategy and the national health information system?

K. Profile of informants

	Profession	Type of mHealth app (if applicable)	Location	Stakeholder	Interview Mode
1.	Maternal health program manager	Provider work planning and scheduling; data collection	Ethiopia	NGO	Skype
2.	Telemedicine program manager	N.A	EU	NGO	Face-to-face
3.	mHealth program manager	Provider training and education	European Union (EU)/ Ethiopia	NGO	Skype
4.	Maternal health program manager	Provider work planning and scheduling; data collection	Ethiopia	NGO	Skype
5.	Maternal health program manager	Provider training and education; client education communication	Ethiopia	NGO	Skype
6.	mHealth app advisor	Provider training and education	EU/ Ethiopia	mHealth app provider	Skype
7.	mHealth app advisor	Provider training and education	EU/ Ethiopia	mHealth app provider	Face-to-face
8.	Hospital manager	N.A	EU / Ethiopia	Health center	Face-to-face
9.	Public sector worker	N.A	Ethiopia	Government	Skype
10.	Midwife	N.A	Ethiopia	User	Skype
11.	Electrical engineer	N.A	Ethiopia	MNO	Skype

L. Research methodology

1. Select the research topic (criteria: relevance, feasibility, appropriateness, etc)

2. Narrow the research topic: exploratory interviews with two doctors and background reading on the topic

3. Identify the problem & define research goals (overall and specific)

4. Construct hypotheses; selection and definition of research variables

5. Conceptual framework and literature review

6. Re-define specific research goals

7. Define research strategy: qualitative

8. Select research method: interviews combined with use of secondary sources

9. Design interview script and identify informants

10. Validate script with tutor

12. Fine tune interview script based on tutor's feedback

13. Conduct interviews with all informants

14. Data analysis & data triangulation with different sources

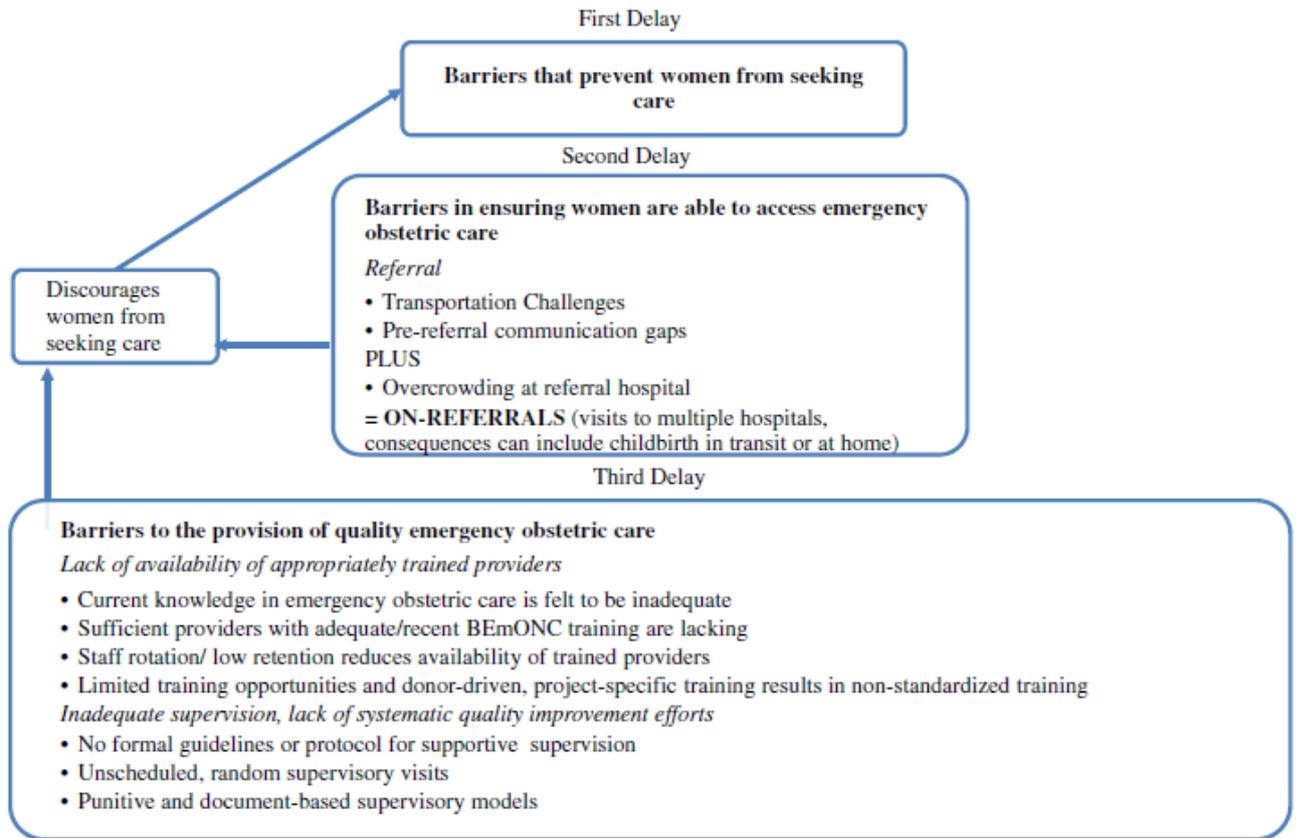| 15. Draw empirical conclusions and develop recommendations |
| --- |

Source: Adapted from Muñoz, Cabezas Valencia and Sotillo Lorenzo (2010)

M. EDHS: Selected results regarding maternal health care

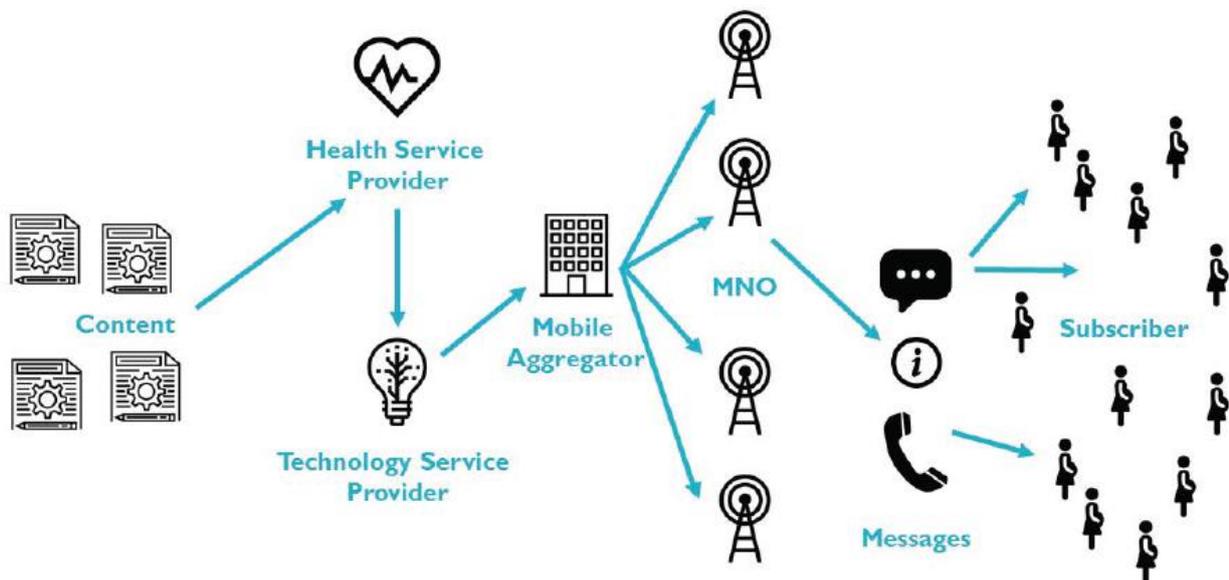|	National	Urban	Rural
ANTENATAL CARE COVERAGE (ANC)			
Timing and number: Had no ANC visits	37%	10%	41%
Timing and number: Had more than four ANC visits as recommended by WHO	32%	63%	27%
Skilled provider: Received any ANC from skilled provider	62%	90%	58%
COMPONENTS OF ANC			
Blood pressure measured	75%	91%	72%
Blood sample taken	73%	95%	68%
Urine sample taken	66%	92%	60%
Nutritional counselling	66%	75%	64%
Informed about pregnancy complications or danger signs	45%	60%	42%
DELIVERY SERVICES			
Delivered in health facility	26%	79%	20%
Mothers who attended more than four ANC visits and delivered in a health facility	56%	N/A	N/A
Mothers with no ANC visits who delivered in a health facility	8%	N/A	N/A
Mothers with more than secondary education who delivered in a health facility	92%	N/A	N/A
Mothers with no education who delivered in a health facility	16%	N/A	N/A
Skilled Assistance during delivery (inc. doctor, nurse, midwife, health officer, and health extension wo	28%	80%	21%
Birth attended by traditional birth attendant	42%	12%	46%
Mothers who attended more than four ANC visits and delivered with a skilled attendant	58%	N/A	N/A
Mothers with no ANC visits and delivered with a skilled attendant	10%	N/A	N/A
POSTNATAL CARE			
Postnatal check up within two days after birth	17%	45%	13%
Mothers who delivered in a health facility and received postnatal check up within 2 days after birth	42%	N/A	N/A
Mothers who did not deliver in a health facility and received postnatal check up within 2 days after birt	2%	N/A	N/A
PROBLEMS IN HEALTHCARE ACCESS			
Getting permission to go for treatment	32%	15%	37%
Getting money for treatment	55%	35%	61%
Distance to health facility	50%	17%	60%
Not wanting go alone	42%	21%	48%

Source: Adapted from CSA (2017)

N. Delay phases and barriers to the provision of quality emergency obstetric care, as identified by healthcare providers in Addis Ababa, Ethiopia (adapted from Thaddeus & Maine, 1994)
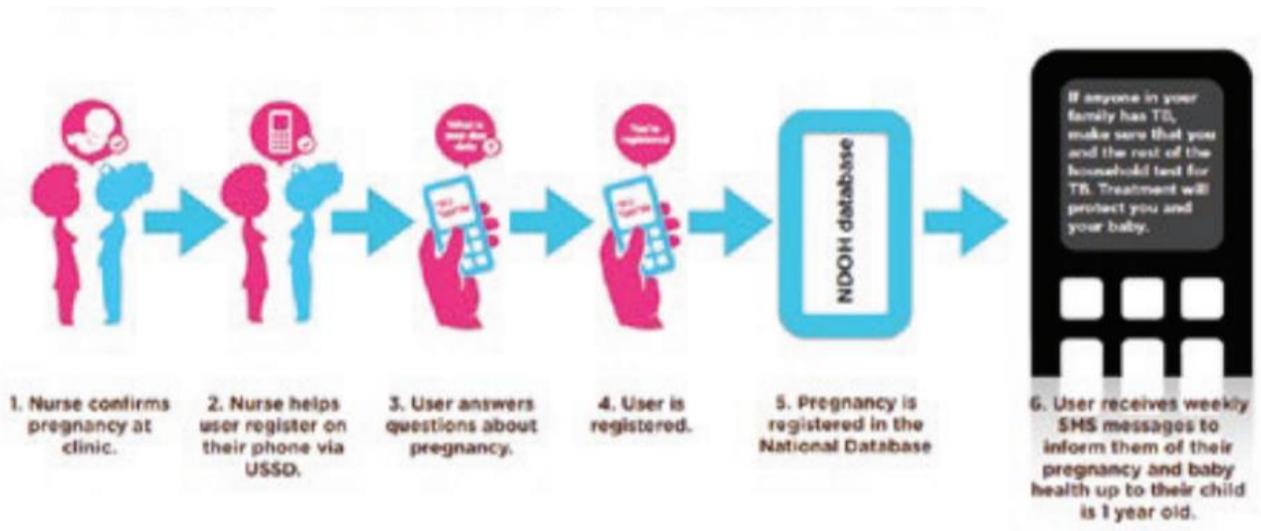

First Delay

Barriers that prevent women from seeking care

Second Delay

Barriers in ensuring women are able to access emergency obstetric care

Referral
• Transportation Challenges
• Pre-referral communication gaps
PLUS
• Overcrowding at referral hospital
= **ON-REFERRALS** (visits to multiple hospitals, consequences can include childbirth in transit or at home)

Discourages women from seeking care

Third Delay

Barriers to the provision of quality emergency obstetric care

Lack of availability of appropriately trained providers

• Current knowledge in emergency obstetric care is felt to be inadequate
• Sufficient providers with adequate/recent BEmONC training are lacking
• Staff rotation/ low retention reduces availability of trained providers
• Limited training opportunities and donor-driven, project-specific training results in non-standardized training

Inadequate supervision, lack of systematic quality improvement efforts

• No formal guidelines or protocol for supportive supervision
• Unscheduled, random supervisory visits
• Punitive and document-based supervisory models

Source: Austin et al. (2015)

O. mHealth app example: Client education communication (1)

Content

Health Service Provider

Technology Service Provider

Mobile Aggregator

MNO

Messages

Subscriber

Source: WHO (2015)

P. mHealth app example: Client education communication (2)

1. Nurse confirms pregnancy at clinic.
2. Nurse helps user register on their phone via USSD.
3. User answers questions about pregnancy.
4. User is registered.
5. Pregnancy is registered in the National Database
6. User receives weekly SMS messages to inform them of their pregnancy and baby health up to their child is 1 year old.
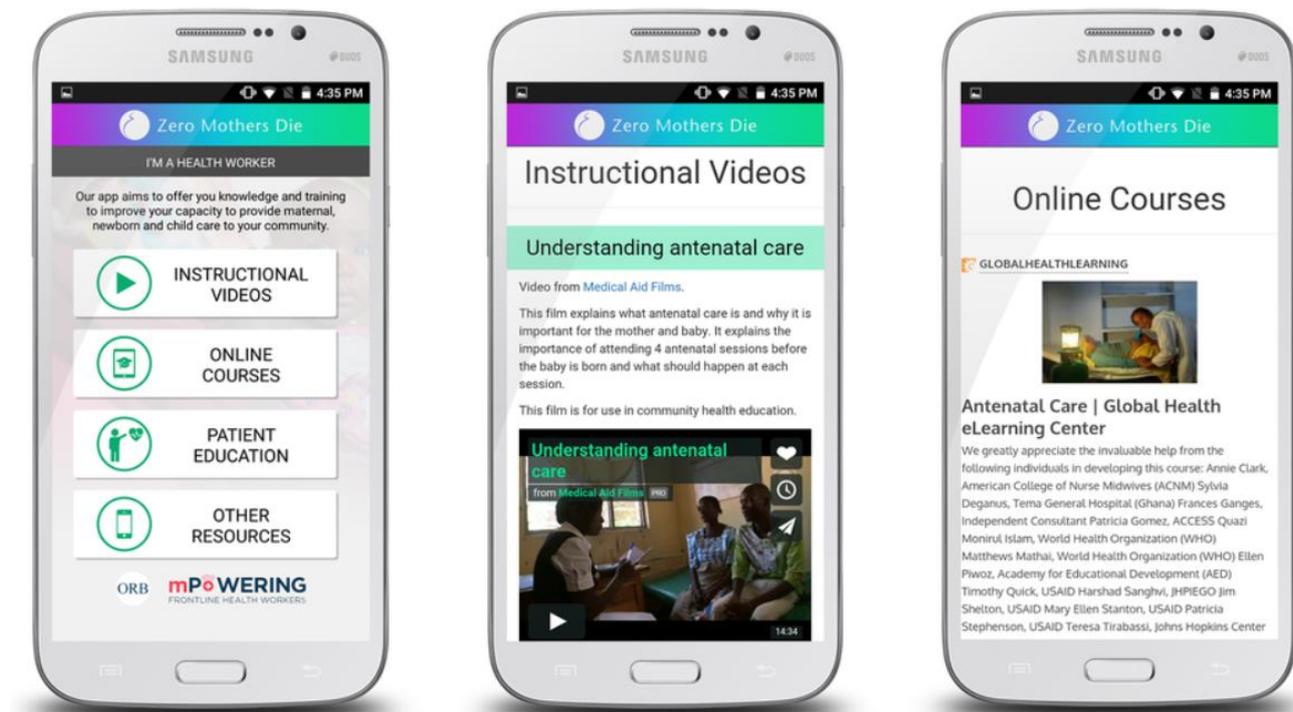
Source: Levine, Corbacio, Konopka, Saya, Gilmartin, Paradis, and Haas (2015)

Q. mHealth app example: Provider work planning and scheduling, registries and vital events tracking, electronic health records, data collection and reporting and **human resource management**

1 Collects data
HC Operator
Form
2 Store data
Visit pregnant women
4
6
Visit pregnant women
HEW
Mobile telephone
3 Transmitted data
5 Notification reminders
Modem
Pregnant Women Database
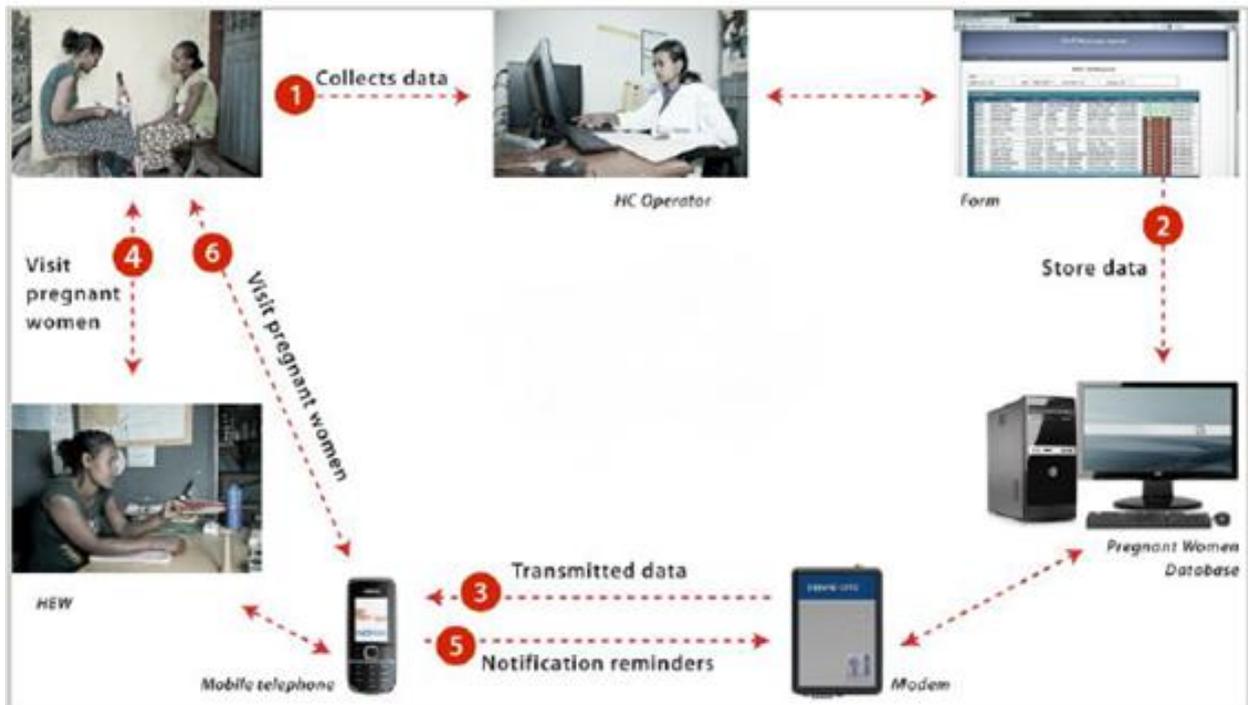
Source: Mendoza, Okoko, Morgan, and Konopka (2012)

R. mHealth app example: Provider training and education

Source: Zero Mothers Die (2019)