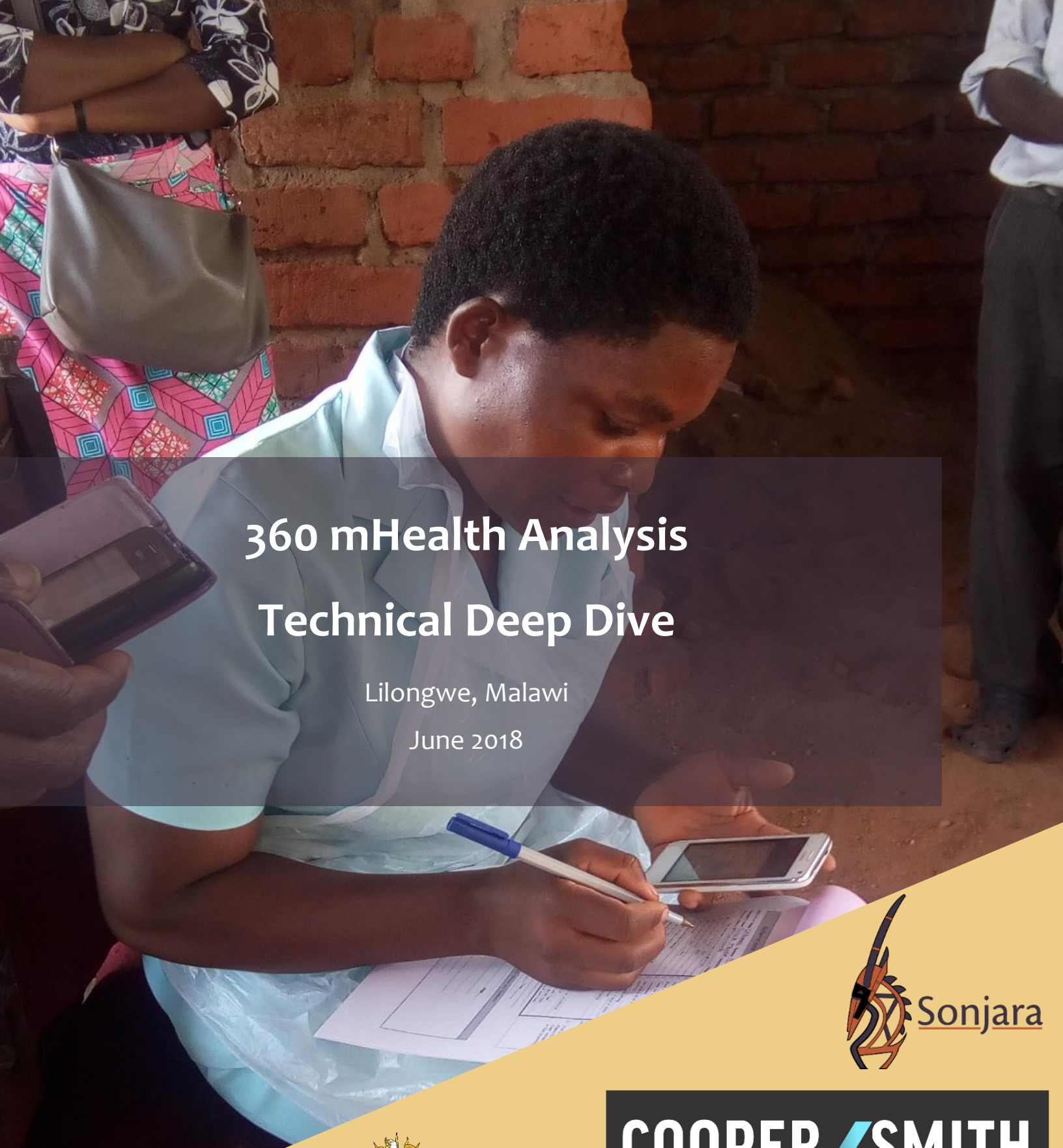

360 mHealth Analysis

Technical Deep Dive

Lilongwe, Malawi

June 2018

Sonjara

COOPER/SMITH

KUUNIKA

Data for Action

UNITY AND FREEDOM

1 CONTENTS

2 LIST OF FIGURES

3 ACRONYMS

AWS: Amazon Web Services

Apps: Mobile applications

BSD: Berkeley Software Distribution -Open source license

CBMNH: Community Based Maternal and Neonatal Health

CBFP: Community Based Family Planning

CHW: Community health Worker

CMED: Central Monitoring and Evaluation Division

CSV: Comma separated values

DDE: Demographic Data Exchange

DEHO District Environmental and Health Office

DHAMIS: Demographic HIV and AIDS Management information system

DHIS2: District Health Information System Version 2

DVC: Digital Village Clinic

eCCM: electronic Community Case Management

ECHS: Essential Community Health Services

EHP: Environmental and Health Program

EMRs: Electronic Medical Records

FP/RH: family planning/reproductive health

GoM: Government of Malawi

GNI: Gross National Income

GWAN: Government Wide Area Network

HMIS15: Health Management Information System Form 15

HSA: Health Surveillance assistant

IMCI: Integrated Management of Childhood Illness

ISPs: Internet Service Providers

JHUCCP: Johns Hopkins University, Center for Communication Programs

JSON: JavaScript Object Notation

LAHARS: Local Authority HIV and AIDS Reporting System

LTE/4G: 4th generation of data technology for wireless networks

ICT/IT: Information and Communications Technology

iOS: iPhone operating system

MDG: Millennium Development Goals

MNCH: maternal, newborn, and child health

MoH: Ministry of Health

MP: Millennium Promise

MSH: Management Sciences for Health

MVP: Millennium Villages Project

NGOs: Non-governmental organizations

ODCs: Other direct Costs

ODK: Open Data Kit

ONSE: Organized Network of Services for Everyone

OVC: Orphans and Vulnerable Children

PHI: Personal Health Information

RDBMS: Relational Database Management System

SIM: Smart card inside a mobile phone

SHSAs: Senior Health Surveillance Assistants

SMS: Short Messaging System

TNM Telekom Networks Malawi

WASH: water, sanitation, and hygiene

XDMX: Distributed Multi-head X server

XML: Extensible Markup Language

4 INTRODUCTION

Digital technologies, such as mHealth applications, are a rapidly growing part of global health initiatives to improve health systems though the applied use of data. Malawi has seen an explosion in the use of mHealth applications over the past 10 years, with many making significant impacts on healthcare in the country. However, there has also been a fragmentation of the applications and a need for improvements in governance, interoperability, and sustainability.

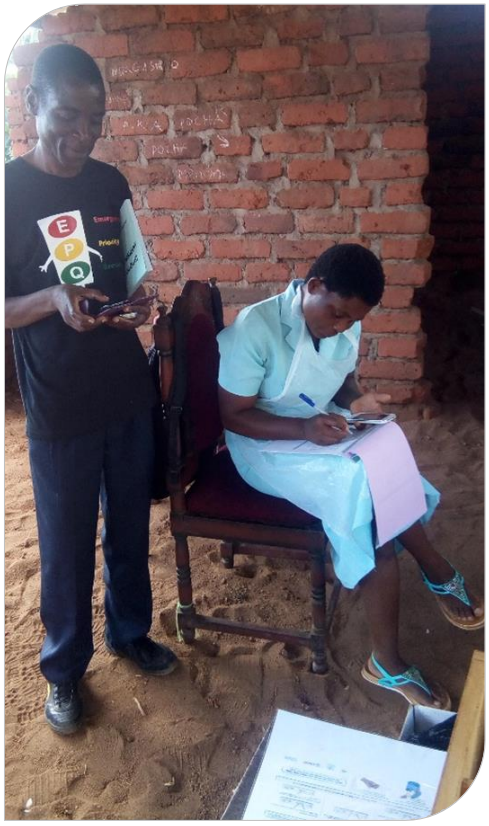

Figure 1: Image of HSA and Supervisor using the D-Tree App

Cooper/Smith has hired Sonjara to provide mobile health application expertise to conduct a 360 assessment of mobile health applications in Malawi. This activity is funded by the Bill & Melinda Gates Foundation's Kuunika Project to provide analysis to the Government of Malawi on the management of mobile health applications. This report will contribute to a larger team analysis and cataloging of current mHealth applications used in Malawi, and it will inform the upcoming eHealth Strategy analysis.

This report contains:

1. In depth technical specification analysis of five mHealth applications (apps) which support the National Government's Community Health Strategy to find best practices and lessons learned.
2. Common findings across all applications reviewed, including benefits, infrastructure and challenges.
3. Recommendations for the mHealth Technical Working Group, the Government of Malawi and other stakeholders on next steps on how mobile health applications can support and be integrated into the larger eHealth Strategy.

5 METHODOLOGY

5.1 mHealth Apps

The five applications reviewed in this document are:

- Community Health Tracker: Chancellor College/DHIS2 Data Tracker
- Digital Village mHealth Project: D-Tree/Mango Logic
- Millennium Village Project: Millennium Promise/CommCare
- One Community: Johns Hopkins University, Center for Communication Programs (JHUCCP)/CommCare
- Supporting Life: Luke International/Custom App

Additionally, the team performed a high-level review of Organized Network of Services for Everyone (ONSE)/CommCare as an activity which is still in the planning stage but could have a significant impact on the mHealth landscape. The team also looked at cStock as a potential model for sustainability and interoperability, and looked at other eHealth implementations such as Demographic HIV and AIDS Management Information System (DHAMIS), Demographic Data Exchange (DDE), and DHIS2 (District Health Information System Version 2).

5.2 Methodology

5.2.1 SELECTION OF THE FIVE APPS

After the close of the mHealth survey, the above five mHealth Apps were selected by the Kuunika team and Ministry of Health, based on the following criteria:

1. Are in current use (pilot stage or beyond), or recently closed;
2. Used a smartphone and an app (i.e. not 100% SMS based);
3. Focus on the community health level, working and supporting healthcare workers at that level;
4. Have a significant number of users.

The team also looked at diversity in terms of software platform and location.

5.2.2 METHODOLOGY

The methodology used for the deep dive is a combination of qualitative and quantitative, using the following information sources:

1. **Key Informant Interviews**: The team interviewed over 50 individuals in Malawi, US and other locations in person and by phone. These interviews were held with project teams (including their IT staff when possible), partners in the district facilities or MoH, MoH representatives from the Central Monitoring and Evaluation Division

(CMED), Integrated Management of Childhood Illness (IMCI), Community Health, and mHealth team. The interview guide and sampling overview can be found in Annex 1: Full Methodology and Workplan

2. **Observations/Site Visits**: The team was able to conduct three site visits for the three apps that are currently in use (of the two others, one is in its pilot phase and one is no longer in operation). Two of the site visits directly observed users of the app interacting with community level beneficiaries, and one was a demonstration by field level staff. These site visits were complemented by focus group discussions with these community health workers, supervisors, community village volunteers, and district health officers on their interactions with the mHealth app.
3. **Code Demonstrations:** In three cases, the team was able to observe demonstrations of how the code is used, maintained and updated (one of the cases covered the code base for two applications, so these demonstrations covered four of the five apps).
4. **Code and Document review**: The team was able to review the code itself for three platforms and had a detailed discussion/demonstration with the lead developer for the fourth.
5. **Cost Scenario**: The team, in partnership with HealthEnabled, created a costing scenario questionnaire for each of the selected projects to complete, which informed the costing scenario section, along with the information collected by the mHealth Survey. A copy of the questionnaire can be found in the Annex 1.
6. **mHealth 360 survey:** The team used the results of the mHealth survey extensively during the assessment as well as in the write up of this report.
7. **Additional Documents and Research:** The team also reviewed existing mHealth and eHealth strategy documents provided from the MoH, and existing registries and data collection tools. The team also performed online research on Malawian (health, economics, electricity and internet) to provide a context for the findings. A full list is in the Annex 1.

6 MALAWI CONTEXT

Malawi, with its current estimated population of over 18 million, faces many challenges, including high population density, low income, poor health and education rates, and an unstable infrastructure. Internal transportation is challenging due to the hilly terrain and poor road infrastructure.

Gross national income (GNI) per capita is estimated by the World Bank at $320 in 2016, the poverty ratio at 50%, and life expectancy is 62.5 as of 2015. However, despite these numbers, the statistical capacity of the country (i.e. the ability to capture and use high quality statistical data) is estimated to be 77% for 2017. [1]

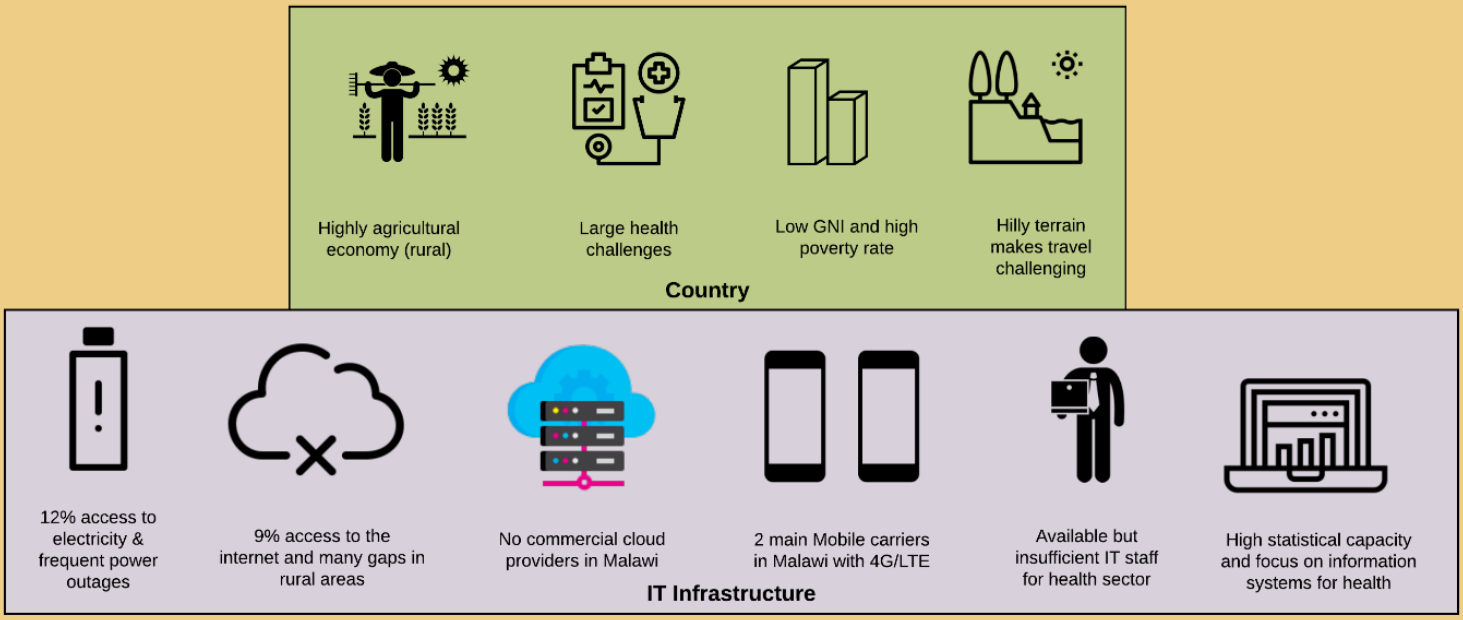

Figure 2: Diagram of Malawi Context

[1] https://data.worldbank.org/country/malawi

7 IT CAPACITY IN MALAWI TO SUPPORT MHEALTH

7.1 Electricity

Electricity access is low (12% average and 5% for rural populations) and unstable.[2] Most Malawians have created methods of coping with poor access to electricity through the use of power banks, solar chargers, and charging stations for mobile devices and lighting, as well as setting up processes that allow for long power outages. [3]

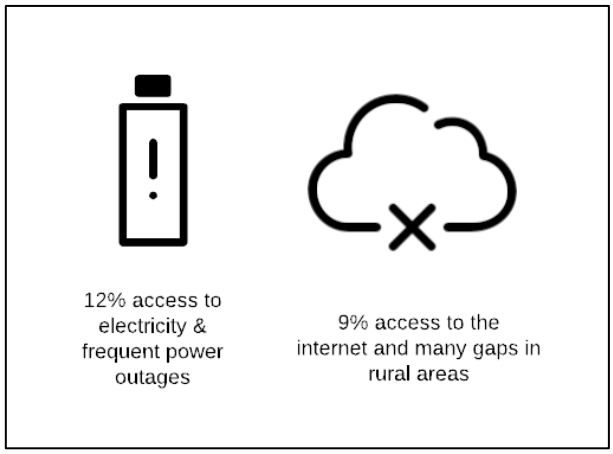

Figure 3: Malawian Internet and Power Situation

7.2 Internet

Internet access is also very low (about 9%), and predominately accessed via mobile phones – Malawi has a subscription rate of about 40 per 100 people, meaning most people with access have multiple accounts, due to the poor internet connectivity issues. [4] [5] While 4G/LTE connectivity is officially available, and 4G supporting SIM cards are being sold in Malawi, access to 4G is sporadic and inconsistent. Most Malawians have also created methods to cope with the inability to access the internet or cell phone lines consistently. [6]

7.3 Mobile Phone Infrastructure

There are two main mobile phone/data providers in Malawi: AirTel and Telekom Networks Malawi (TNM). Both currently offer LTE services as of early 2018.

A SIM card costs about 500 Kwacha ($0.69) and is not regulated - SIM cards can be purchased on the street with no identification required. Access to mobile money accounts does require a national ID or passport number to enter in the information; however, there is no confirmation process/identity check outside of the system verification. Also, mobile money is nascent in Malawi; translating airtime into money is challenging, and most stores

[2] https://www.usaid.gov/powerafrica/malawi
[3] Observations
[4] https://data.worldbank.org/country/malawi
[5] Observations
[6] Observations

do not currently take mobile money, though there are increasing numbers in Lilongwe and Blantyre.[7]

7.4 Data Costs

Price per KB averages about MK30, or US$0.04 but depends on different deals and bundles. TNM offers 512MB of data for 15 days at MK2000 (US$2.78)[8] and AirTel offers 300MB for 7 days for MK1000 ($1.39)[9]. Both AirTel and TNM offer smart bundles and discounted data for bulk purchases, time period downloads (such as after midnight) and connection to WhatsApp and Facebook. For example, TNM offers monthly 500MB to access WhatsApp for MK560 (US$0.78).

7.5 Devices

Mobile devices such as smartphones and tablets are readily available in Malawi; the preference is for Android devices as they are significantly cheaper and more widely available than iOS devices.

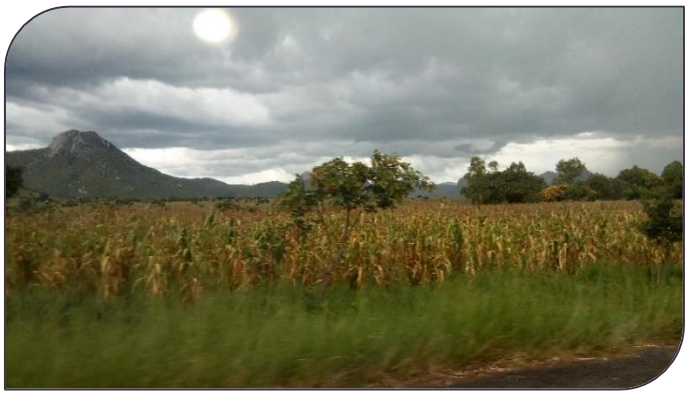

Figure 4: Road to Dedza

7.6 Human Resources

While there have been many efforts by the National Government and private sector advocacy groups to improve the number of ICT professionals in the country[10], there is still a mismatch between the number required and the availability of staff. Some Malawians interviewed stated that there were a growing number of information and communication technology (ICT) professionals graduating from universities and certification programs; however, their lack of experience, a preference for international IT professionals and companies, and low salaries for local hires within many non-ICT focused Non-Governmental Organizations (NGOs) and the Government of Malawi (GoM) for IT staff lead to many not being available to support the growing need within the public health sector.[11]

[7] Observations
[8] http://www.tnm.co.mw/smart-data
[9] http://www.africa.airtel.com/wps/wcm/connect/AfricaRevamp/Malawi/home/personal/internet/bundles/New-PaNet-Offer
[10] http://www.malawi.gov.mw/index.php?option=com_content&view=article&id=66
[11] Interviews

7.7 Hosting and Cloud Services

As of the writing of this report, there were no commercial cloud service providers[12] in Malawi; while multiple internet service providers (ISPs) offer hosting of servers and applications, none would meet the internationally accepted definition of a cloud service provider, similar to an Amazon Web Services (AWS) or Azure service.

In addition, due to Malawi's power and internet infrastructure issues, it would be challenging for a commercial vendor to offer this level of support in country without significant investment and/or high cost to the clients.

The Government of Malawi has recently invested in the development of a Government Wide Area Network (GWAN) to host government IT servers.[13] This service was described as a "server farm", where different parts of the GoM could host their own servers in the GWAN.

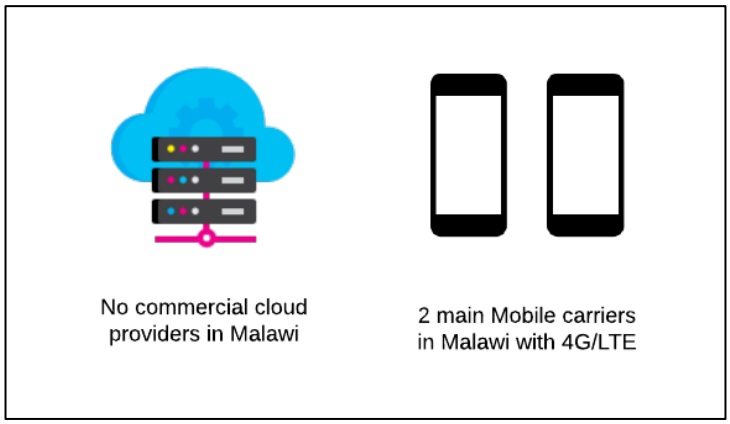

Figure 5: Hosting and Internet Situation in Malawi

In addition, different parts of the Ministry of Health (MoH) and partners have established in-house hosting for health data; examples include hosting of the National Instance of the DHIS2, the cStock Server, the DDE (Demographic Data Exchange, managed by Baobab for the GoM), and the DHAMIS (Department of HIV and AIDS Management Information System). [14]

[12] Cloud computing offers additional scalable services such as software as a service, platform as a service, and infrastructure as a service, that traditional hosting does not.
[13] http://www.malawi.gov.mw/index.php?option=com_content&view=article&id=66
[14] Interviews

8 MHEALTH IN MALAWI

8.1 History

Malawi has a rich history of using mobile devices to tackle health issues; from cStock to current decision tree tools, different districts in Malawi have been using mHealth since before 2010.[15] [16] There is an informal universal agreement that mHealth tools are essential for the MoH to tackle its pressing health priorities, especially due to its infrastructure challenges (transportation, internet and electricity) at the community level.

However also universally agreed was the current fragmentation of the mHealth implementations in Malawi, with cStock given as the notable counter-example. Many interviewed mentioned overlaps in services and lack of coordination between partners working in the same or close districts. There is a widespread concern that HSAs are given multiple devices to manage the different apps that are being provided by partners.[17]

8.2 Funding Sources for Implementation

mHealth activities are nearly exclusively funded by international donors such as UNICEF and USAID and implemented through NGO partners and universities. The funds are primarily provided through grants and cooperative agreements with these organizations. Funding is generally on three to five-year timescales with continuation not guaranteed beyond the initial program scope. Activities are primarily project based and are focused on geographical areas and health topics, such as IMCI or HIV; many activities are limited in scope by donor priorities or funding requirements.

8.3 mHealth Platforms

All but one of the mHealth Apps reviewed used existing mobile software platforms, i.e. a configurable software system designed to develop unique mobile applications to collect and manage data. The three main platforms explored in this report are CommCare, MangoLogic, and DHIS2's Data Tracker, plus a custom app built by University College of Cork. Other mHealth platforms active in Malawi but not reviewed include RapidSMS/RapidPro, Open Data Kit (ODK) and MedicMobile. CommCare is managed by Dimaji (US based for-profit), MangoLogic by Things Prime (Swiss based for-profit), DHIS2 by the Department of

[15] GSMA Country Feasibility study 2014
[16] Interviews
[17] Multiple interviews: a concrete example was not discovered; however, this perception is widespread and as a result, must be taken seriously as a concern.

Informatics, University of Oslo (Norwegian University), RapidSMS/RapidPro by Unicef (UN based donor), ODK by the Department of Computer Science and Engineering, Univeristy of Washington (American University), and MedicMobile is managed by MedicMobile (a US based non-profit). All but MangoLogic are open source and have repositories on GitHub.

Software Platforms vs. Custom Software

A software platform is distinct from custom software in the following ways. Custom software is built explicitly for one purpose. A software platform allows a client to build an app for a range of configurations for different purposes and goals. Another distinction between a platform and custom code is that an outside firm or organization maintains the core platform code and infrastructure, and makes available to clients copies of the code, web interfaces and other configuration tools, so that clients can create their own customized apps. These firms often offer design, hosting and support services to clients, in cases where clients do not have or do not want to configure the app themselves.

Using an existing platform supported by an existing form increases scale and stability of apps built with the platform, as well as reducing cost. However, interoperability between apps built on the same platform especially data collected by them) rarely occurs organically, due to the ability to configure the platforms to the unique needs of the clients.

8.4 Government of Malawi mHealth Strategy

The Government of Malawi, in partnership with donors and other stakeholders, has put increasing focus on the use of ICTs – especially mobile devices - in addressing the pressing issues related to health in Malawi. Foundational strategies which document the approaches currently used by the MoH include:

- eHealth strategy
- The 2015 National Health Information Policy
- The 2017 National Community Health Strategy

Most notably for this report, the National Community Health Strategy explicitly includes ICTs as a key tool to address community health improvement, including harmonization of the data management processes to improve data quality while also reducing workload for community health workers, and provide avenues for reporting and feedback to the communities on health

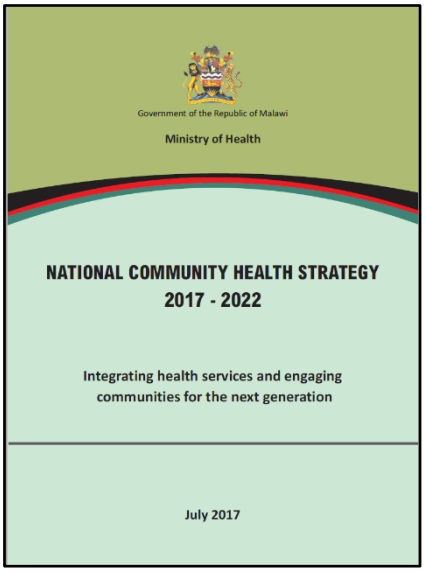

Figure 6: Cover page of the National Community Health Strategy

situations. The strategy includes the goal that by 2022, 50% of HSAs of Community Health Teams (CHTs) will be using mHealth for integrated service delivery, data collection, and supervision.[18]

8.5 Existing Activities Related to eHealth

To support the national health strategy, there are multiple activities within the MoH to help coordinate and harmonize eHealth (especially mHealth) in Malawi. The following are the three activities the team reached out to as part of this Deep Dive; there are multiple other providers involved in eHealth.

8.5.1 KUUNIKA PROJECT

The Kuunika project, funded by the Bill and Melinda Gates foundation, is focused on improving data driven decisions in order to positively impact health outcomes in Malawi. Activities include this research into mHealth, along with developing health data systems, data use, and data governance. Activities include designing and supporting the migration of the DHAMIS for the HIV office in order to create a central repository for patient level HIV information in Malawi and developing a mobile application for DHA quarterly supervision. The project is also leading on the development of a mobile application for the Local Authority HIV and AIDS Reporting System (LAHARS) and plans on launching several more mHealth projects over the next 4 years.

8.5.1.1 mHealth Survey

This report is part of a larger analysis into mHealth in Malawi, kicked off by the mHealth 360 analysis. Some key findings from that report include:

1. Since 2007, 31 mHealth have been deployed in Malawi to date, with an average project lifespan of 5 years. 2 new projects have been added each year.
2. mHealth is geographically mature, with every district in Malawi having had at least 5 mHealth projects, and 2 districts having 13 projects each (Blantyre and Zomba).
3. Smartphone apps are growing in usage across the country, especially to address more complex interactions. SMS is still popular for broadcast communication and basic transactions such as cStock.
4. mHealth applications are widespread in the country but not evenly distributed geographically nor in health topics. The majority of mHealth projects work in the areas of maternal and reproductive health, infant and child health and community health. Underserved areas are HIV, tuberculosis, chronic diseases, vaccines & epidemiology.

[18] National community health strategy 2017-2022, July 2017 GoM/MoH

8.5.2 BAOBAB HEALTH TRUST (BHT)

Baobab Health Trust, a local Malawian NGO focused on data and health, is part of the Kuunika project as well as other initiatives supporting improvements in the data management of the MOH. Key activities include the Demographic Data Exchange (DDE), which is pulling data from Electronic Medical Records (EMRs) into a central repository for a centralized source of patient transaction level data.

8.5.3 ONSE PROJECT

The Organized Network of Services for Everyone's Health (ONSE) project, funded by USAID and implemented by Management Science for Health, is rolling out an integrated mHealth app in 16 districts in Malawi. Based on CommCare, this app will address reproductive health/family planning (RH/FP), maternal, newborn, and child health (MNCH), malaria, and water, sanitation, and hygiene (WASH).

9 SUMMARY PER APP

The following are summary statements of each of the five apps included in the technical deep dive assessment, plus the ONSE app which was just starting to be rolled out in Malawi as the team was performing its data collection.

Please note that many of these organizations also work or have worked in other districts; the current list of districts is restricted to those where the current mHealth apps are being deployed.

The following summaries are in the order reviewed by the team.

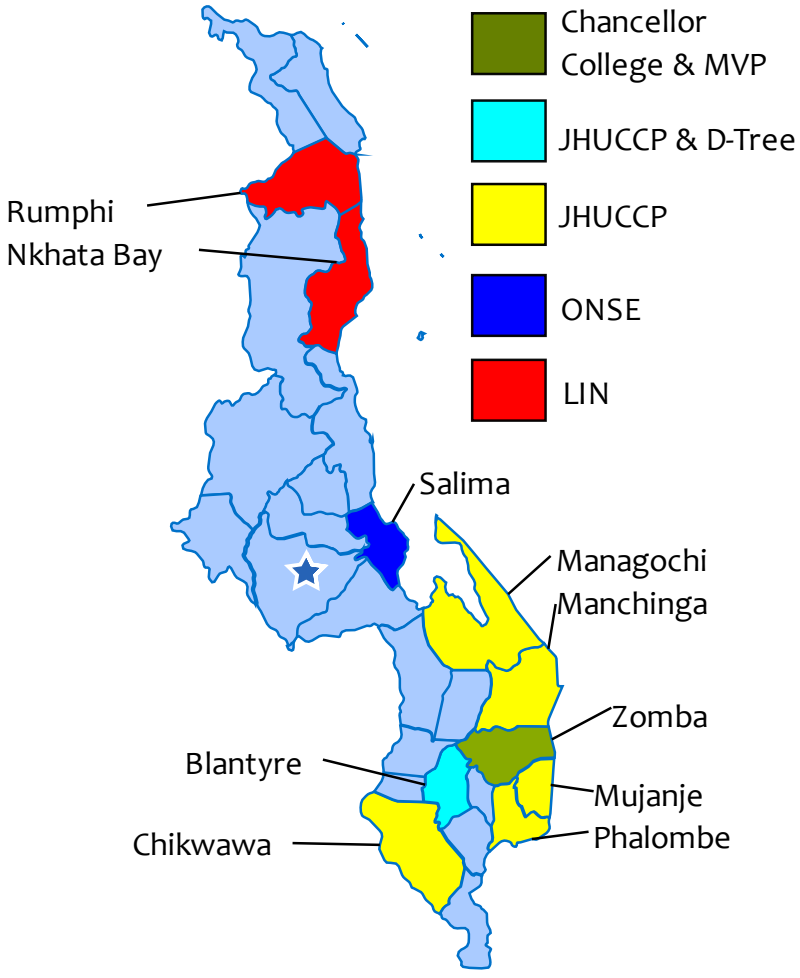

Figure 7: Locations of mHealth Apps reviewed

Community Health Tracker: Chancellor College/DHIS2 Data Tracker

9.1.1 OVERVIEW

Description: The Community Health Tracker app is part of a suite of apps under development by University of Malawi Chancellor College, in partnership with the University of Oslo. The app is designed as a decision-tree diagnostic support tool with data gathering capabilities, targeted for use by HSAs. The app has the following programs configured: Community Tracker; Household Tracker; Person Tracker; Water Sources Tracker. The app has a web back-end for health program metadata configuration, including workflow and decision-support configuration, and an Android app for end-users. The App is currently in the final stages of development. Multiple rounds of field tests have been conducted in Zomba by software developers from the University of Oslo and University of Malawi - Chancellor College.

Other apps in the suite include:

- mHealth4Afrika - a lean EMR, with a tablet-based app front-end, that integrates medical sensors for body temperature, blood pressure, heart rate, blood oxygen level and glucometer. The mHealth4Afrika app is developed as part of a regional collaboration in the mHealth4Afrika consortium (http://www.mhealth4afrika.eu).
- NeoCare - A lightweight facility-level EMR for supporting neonatal care.

All the apps are based around the DHIS2 platform. A perceived benefit of this approach is the potential for simplified interoperability with upstream DHIS2 databases, such as the MoH national instance.

9.1.2 LEADERSHIP

Project Team: Lead, Dr. Tiwonge D. Manda, University of Malawi - Chancellor College, University of Oslo.

Stage of Activity: Piloting, beta tests of app.

9.1.3 SCOPE

Management of Childhood Illnesses (IMCI), Sanitation/WASH.

Locations: Zomba

9.1.4 TECHNOLOGY

Platform: DHIS2 Data Tracker with Angular.JS.

Device Requirements: Android 4.0.3+.

Software Architecture: AngularJS/Android Client, Java-based DHIS2 server.

Data Model: DHIS2 operates using a Star Schema.

9.1.5 SECURITY AND PRIVACY PROTECTIONS:

- Username/Password protected access to app.
- Multi-level role-based access.
- Database encryption on personal identifiers.

9.1.6 ORGANIZATION AND GOVERNANCE

Roll out: Uses MoH existing HSAs and other staff infrastructure.

Management: TBD.

Ease of Adapting Protocols, Data Items: Experience with DHIS2 configuration is required in order to build workflows in DHIS2. Some customization of the AngularJS app has been necessary to improve the user experience.

9.1.7 HUMAN RESOURCES NEEDED

Training: Training HSAs on the app, optimizing user experience for ease of use.

Maintenance: DHIS2 system management expertise.

Small Updates/Improvements: Simple form and data structure updates possible through DHIS2 form configuration interface. Customized user interface updates require angular.js developer, for the web app. Customized UI updates for the Android app would require an Android developer.

9.1.8 DATA QUALITY AND COVERAGE

Data Coverage: Currently focused on all services provided by HSAs. Piloting in one area.

Data Timeliness: Supports offline work mode and data storage, with occasional syncing with a server when the user has network access.

Data Interoperability: The DHIS2 platform has a robust API, for third-party software integration. The solution also supports data import/export through CSV, XML, JSON, and XDMX. Two points of high interoperability potential – uses existing MoH protocols which have defined indicators for HSAs to report (via HMIS15 or Form 1A/1B), as well as uses DHIS2 as the database.

Data Validation: built into the data collection (acceptable ranges, etc.)

9.1.9 DATA USAGE

Data Used for:

1. HSA data collection as part of their work.

2. Available for analysis by different parts of MoH.

Standard Reports: TBD

9.1.10 BUSINESS PROCESS

Scaling - Geographic: The platform is designed to be used in multiple countries.

Scaling – Topic/functionality: The platform is designed to be expandable to new protocols and new service offerings.

Potential Usage: Breathing and heart rate sensors and other medical devices can be integrated into the app.

9.1.11 ECONOMIC

Licensing: Open source. DHIS2 and related apps are released under the BSD (i.e. open source) license.

Software Costs: none.

ODCs (other direct costs): Outside the scope of the project.

Cost of Scaling: $4,400,392.50

Sustainability Approach: Building local capacity for app development, implementation, and support through the university and partnership with MoH. Actively looking for external financing to support project activities.

Digital Village mHealth Project: D-Tree/MangoLogic

9.1.12 OVERVIEW

Description: The Digital Village Clinic (DVC) is a community-based decision support mobile application running on android phones, integrating health service packages offered by trained community health workers called Health Surveillance Assistants (HSAs) and Senior Health Surveillance Assistants (SHSAs).

The DVC has integrated: Community Integrated Management of Child Illnesses (cIMCI), Community Based Maternal and Neonatal Health (CBMNH), Community Based Family Planning (CBFP) and cStock. The DVC can switch ON/OFF any of the above based on the HSA's profile. The SHSA version of the DVC has the supervisory checklists for the aforementioned programs and is used by the HSA supervisors to perform routine supervision to the HSAs, supporting the HSAs in specifically identified gaps. The SHSA version of the DVC also has the digital health troubleshooting and resolving component which supports the HSA supervisor to troubleshoot and resolve any issues that an HSA may be experiencing. It thus promotes immediate support to the HSA within their locality. The tool is being implemented in the Essential Community Health Services (ECHS) project with Save the Children in Blantyre.

9.1.13 LEADERSHIP

Project Team: Christopher Kulanga, D-Tree International.

Stage of Activity: Active.

9.1.14 SCOPE

Number of Users: 143 HSAs, 38 SHSAs, 7 district coordinators

Users: HSAs, Supervisors, Facility Coordinators

MoH EHP/Health Protocols: Community Integrated Management of Child Illnesses (cIMCI), Community Based Maternal and Neonatal Health (CBMNH), Community Based Family Planning (CBFP) and cStock.

Locations: Blantyre.

9.1.15 TECHNOLOGY

Platform: MangoLogic (D-Tree configuration)

Device Requirements: Android based mobile devices for HSAs and HSA Supervisors, dedicated cloud server infrastructure.

Software Architecture: Java-based Android App, Java-based Mangologic server. Databases used include Firebase (for scalable app data capture), Neo4J Graph Database and MySQL.

Data Model: Entity modelling, configured by app developer during app workflow definition.

9.1.16 SECURITY AND PRIVACY PROTECTIONS

- Local data storage is encrypted and protected by username and password. Confidentiality in information storage and ease in accessing information were mentioned by HSAs interviewed.
- Multi-level role-based access permissions for accessing data on the dashboard.
- Cases can be transferred between HSAs and HSAs can be reassigned to different districts while maintaining the case statistics per village clinic.

9.1.17 ORGANIZATION AND GOVERNANCE

Roll out: Coordination between D-Tree and district health program staff.

Management: Coordination between D-Tree and district health program coordinators.

Ease of Adapting Protocols, Data Items: MangoLogic system is designed to allow users to build app workflows with little-to-no programming experience. Data models can easily be extended, and workflows can be configured to match standard protocols.

9.1.18 HUMAN RESOURCES NEEDED

Training: HSA supervisor app is used as a mentorship tool for newly trained HSAs as well as reporting technical issues to program team. D-Tree Training Courses offered include:

- Training of Trainers course from D-Tree to build capacity of partner team and ministry of health who in turn train the HSAs and SHSAs.
- Peer support/champion training to SHSAs to support their respective HSAs within their localities.
- Intensive remote support from D-Tree for 3 months after capacity training,
- Ongoing remote support for minor application or deployment changes training materials for HSAs and supervisor training.

Maintenance: Platform is maintained by MangoLogic as part of the service.

Small Updates/Improvements: Can be performed by staff with minimal coding skills. Need to be trained on MangoLogic and have strong logical skills.

9.1.19 DATA QUALITY AND COVERAGE

Data Coverage: Immunization records, agile team task reporting, agile guideline changes. Community Case Management (CCM, also called cIMCI), CBMNH, Family Planning, C-Stock which is for stock management system for number of drugs available specifically for iCCM conditions:

- Malaria (LA, Paracetamol);
- Malaria Rapid Diagnostic Tests;
- Diarrhea Zinc and oral rehydration salts (ORS);
- Eye problems (eye ointment);
- Family planning (Depo Provera, condoms, and pills); and
- fast breathing.

Data Interoperability:

- DHIS-2 integration pilot in progress.
- cStock integrated into app workflow.

Data Timeliness: real time due to regular syncing.

Data Validation: Data is derived directly from diagnostic protocols, with validation for entered data points.

9.1.20 DATA USAGE

Data Used For: reduction of mortality in children under 5 due to malaria, pneumonia, diarrheal disease, dehydration, acute or chronic malnutrition or similar ailments, maternal & child health tool supporting the reproductive health cycle, neonatal assessments after delivery, maternal care for family planning & birth planning.

Standard Reports:

- Dashboards & on-device reporting (data analytics to facilitate supervision and program management) HSA overview -> Active HSAs, visits per HSA, New clients per HAS.
- For Community Case Management Heat map of locations of people who have tested positive for disease.
- Dashboard of child danger sign statistics by category.

9.1.21 BUSINESS PROCESS

Scaling - Geographic: MoH (IMCI unit, CMED, Community Health Services and Reproductive Health Directorate) has expressed interest and intent to implement the Digital Village Clinic on a National Scale.

Scaling – Topic/Functionality: D-Tree's goal is to adapt the Digital Village Clinic in order to fully encompass all aspects of the HSA workflow in Malawi, with integrated decision support and reporting tools in order to provide an alternative to paper-based protocols and reports.

Potential Usage: Envisioned to support all HSAs and Supervisors.

9.1.22 ECONOMIC

Licensing: MangoLogic is a Closed Source, proprietary system owned by Things Prime GMBH and licensed to D-Tree. The developer has indicated that they are open to Share Source licensing or Code Escrow agreements to offset concerns about long-term access to the codebase.

Software Costs: Mangologic is free for non-profits and governments. ThingsPrime does not charge licensing fees. The time budgeted for consultants includes developer time to support a scale up and server maintenance costs.

ODCs: Devices, solar chargers for mobile phones, data bundles, power banks.

Cost of Scaling: $2,539,208 to nationwide roll out.

Sustainability Approach: The sustainability approach involves building the capacity of the Ministry of Health, District Health Management teams and local technology companies in order to manage and maintain the system independent of D-Tree or Things Prime. D-Tree is a finalist for a Saving Lives at Birth grand challenge to support programmatic and technical capacity building for these groups.

Millennium Village Project: Millennium Promise/CommCare

9.1.23 OVERVIEW

Description: Millennium Promise Alliance Inc., (MP) started its operations in Malawi in 2006 with the Millennium Villages Project (MVP) in Zomba – Mwandama Millennium Village. The Project was formulated with central focus on delivery of Millennium Development Goals (MDGs) and the promotion of human security in impoverished rural areas through community-based investments and capacity building. The Project offers a bold, innovative model for helping rural African communities lift themselves out of extreme poverty. It was a "proof of concept" for accelerating practical interventions needed to achieve the MDGs by 2015. The current version of the app is implemented in CommCare, replacing previous implementations based on ChildCount and OpenMRS.

9.1.24 LEADERSHIP

Project Team: Abigail Simkoko, Frank Gondwe Millennium Promise Malawi.

Stage of Activity: Active.

9.1.25 SCOPE

Number of Users: 183

Users: Community Health Workers/Health Surveillance Assistants (HSAs).

MoH EHP/Health Protocols: Reproductive Maternal Newborn and Child Health (RMNCH), Vaccine Preventable Diseases, Malaria, Community Health.

Locations: Mwandama, Zomba.

9.1.26 TECHNOLOGY

Platform: CommCare (Millennium Promise dedicated instance).

Device Requirements: Android.

Software Architecture: Android Java client, CommCare server (Python, Django).

Data Model: XML-extended tables with XPath querying for custom fields.

9.1.27 SECURITY AND PRIVACY PROTECTIONS

- CommCare app provides data storage encryption. Username/password protected access.
- Multi-level role-based access.

9.1.28 ORGANIZATION AND GOVERNANCE

Roll out: as part of the larger health service delivery activity, in coordination with local government.

Management: Transitioned from MP managed to local health office management.

Ease of Adapting Protocols, Data Items: Protocols configurable in CommCare via web interface. Easily deployable to client apps via regular sync.

9.1.29 HUMAN RESOURCES NEEDED

Training: HSAs and supervisors are trained on using the tool by the District/MP.

Maintenance: Performed by MP Global.

Small Updates/Improvements: Can be performed by staff with minimal coding skills. Need to be trained on CommCare and have strong logical skills.

9.1.30 DATA QUALITY AND COVERAGE

Data Coverage: IMCI health protocols.

Data Timeliness: Real time due to regular syncing.

Data Interoperability: None.

Data Validation: Built into the app.

9.1.31 DATA USAGE

Data Used For: Case management, regular reporting.

Standard Reports: Case management, regular reporting.

9.1.32 BUSINESS PROCESS

Scaling - Geographic: Unlimited.

Scaling – Topic/Functionality: Potential.

Potential Usage: Unknown.

9.1.33 SCOPE

Number of Users: 183

Users: Community Health Workers/Health Surveillance Assistants (HSAs)

MoH EHP/Health Protocols: Reproductive Maternal Newborn and Child Health (RMNCH), Vaccine Preventable Diseases, Malaria, Community Health

Locations: Mwandama, Zomba

9.1.34 ECONOMIC

Licensing: Open Source (BSD & Apache v2), (Millennium Promise specific instance).

Software Costs: None (covered by MP/Open source).

ODCs: Devices, data bundles, power banks. Most of the resources like phones and data bundles are donations from the project's partners.

Cost of Scaling: None, no funding currently.

Sustainability Approach: Implementation in collaboration with District Environmental and Health Office (DEHO) has been helpful because the intervention has already been adopted by Zomba DEHO and they have come up with a draft concept note for scaling up the intervention in the whole district. Currently supervision is done by the government.

One Community: JHUCCP/CommCare

9.1.35 OVERVIEW

Description: One Community (One C) is an integrated HIV activity that aims to mitigate the impact of HIV and prevent new infections among targeted Malawian priority populations to enable them to achieve their maximum potential as individuals and citizens of Malawi. One C uses a comprehensive community platform to deliver targeted and integrated HIV care and support, impact mitigation, combination prevention, and capacity building/system strengthening activities. This is to be achieved through three key result areas:

- Utilization of high-quality HIV prevention, care, and support improved.
- Adoption of behaviors that reduce HIV transmission, acquisition and mitigation impact increased.
- Capacity of Malawian structures to lead, coordinate, and implement HIV prevention, care and impact mitigation responses are strengthened.

DREAMS activities are an integral part of the Orphans and Vulnerable Children (OVC) program and implemented in all the districts with increased coverage in Blantyre, Zomba and Machinga. The One Community app is implemented in CommCare, with customization provided by DiMagi.

9.1.36 LEADERSHIP

Project Team: Glory Mkandawire, JHUCCP Malawi.

Stage of Activity: Active.

9.1.37 SCOPE

Number of Users: 487.

Users: Community Workers, Field Workers.

MoH EHP/Health Protocols: None – partners with the MoG and uses new protocols specific to the activity to serve OVC.

Locations: Blantyre, Chikwawa, Machinga, Mangochi, Mulanje, Phalombe, and Zomba.

9.1.38 TECHNOLOGY

Platform: CommCare for HIV Referral application, ODK for risk assessment.

Device Requirements: Android Tablets.

Software Architecture: Android client, CommCare server hosted on CommCare HQ cloud offering.

Data Model: XML-extended database tables with XPath querying for extended fields.

9.1.39 SECURITY AND PRIVACY PROTECTIONS:

CommCare app provides encrypted storage for local data. Username/Password controlled access. Multi-level role-based access. Device level encryption and locked down tablets.

3 levels of opt-in consent built in to registration workflow:

- Participation in program
- Storage of electronic records
- Notification via SMS

9.1.40 ORGANIZATION AND GOVERNANCE

Roll Out: OneCommunity staff manage roll out of the app and changes to staff.

Management: OneCommunity staff oversee app usage and technical support.

Ease of Adapting Protocols, Data Items: Protocols configurable in CommCare via web interface. Easily deployable to client apps via regular sync.

9.1.41 HUMAN RESOURCES NEEDED

Training: provided by OneCommunity as part of the overall training on how to provide referral services.

Maintenance: Provided by DiMagi.

Small Updates/Improvements: Can be performed my staff with minimal coding skills. Need to be trained on CommCare and have strong logical skills.

9.1.42 DATA QUALITY AND COVERAGE

Data Coverage: Limited to basic case management of social and medical referrals. The app is not used for formal data reporting. There is discussion of expanding to fuller case management in the future.

Data Timeliness: Real time due to regular syncing.

Data Interoperability: None.

Data Validation: Imbedded in the app.

9.1.43 DATA USAGE

Data Used for: Tracking HIV service referrals status.

Standard Reports: Lists of referrals, status, total served.

9.1.44 BUSINESS PROCESS

Scaling - Geographic: Unlimited capacity

Scaling – Topic/Functionality: Unlimited capacity

Potential Usage: Expand to broader case management.

9.1.45 ECONOMIC

Licensing: Open Source (BSD & Apache v2).

Software Costs: CommCare licensing model.

ODCs: Devices, data bundles, power banks.

Cost of Scaling: TBD.

Sustainability Approach: TBD.

Supporting Life: Luke International/Custom App

9.1.46 OVERVIEW

Description: The Supporting LIFE consortium ran a community clinical trial in two districts to assess the added value of a purpose-developed electronic Community Case Management (eCCM) Application on under-5 referral, re-consultation and hospitalization rates. This was the first large-scale trial evaluating the value of an electronic mobile application version of CCM. The focus of the clinical trial was to investigate the impact of the eCCM Application with paper-based CCM, compared to using paper CCM alone.

9.1.47 LEADERSHIP

Project Team: Hsin-Yi LEE, Luke International.

Stage of Activity: Closed.

Language: English, Chichewa, Tumbuka, Tonga.

9.1.48 SCOPE

Number of Users: 102 (none currently).

Users: HSAs, Supervisors.

MoH EHP/Health Protocols: Integrated Management of Childhood Illnesses (IMCI), Community Health.

Locations: Nkhata Bay, Rumphi.

9.1.49 TECHNOLOGY

Platform: Custom Android App.

Supporting Life app: http://www.supportinglife.eu/the-sl-app.html

Device Requirements: Used on Android devices with OS 3.0 Honeycomb or above, with minimum screen 4.5 inches processing quad core processor ROM: 4GB Ram: 1GB.

Software Architecture: Java Android App, Java Server, Relational Database.

Data Model: Academic customized data model.

9.1.50 SECURITY AND PRIVACY PROTECTIONS

Patient records cannot be retrieved from mobile device after they have been submitted, however authorized users can access de-identified data on ww.sI-technology.eu site.

Research was performed under College of Medicine, Malawi; University of Washington, USA; and Imperial College London, UK with Ethics Board review.

9.1.51 ORGANIZATION AND GOVERNANCE

Roll Out: Project team managed.

Management: Project team managed.

Ease of Adapting Protocols, Data Items:

Very challenging – protocol was hard coded into the app.

9.1.52 HUMAN RESOURCES NEEDED

Training: Training materials includes videos for frontline healthcare workers.

Malawi eHealth Courses -> ICT professionals & Health Workers (nurses, clinicians, lab tech etc.).

Week long course with 20 HSAs -> Traditional class structure, blended learning structure

Maintenance: Project system admins provided.

Small Updates/Improvements: Project system admins provided.

9.1.53 DATA QUALITY AND COVERAGE

Data Coverage: Follows the GoM IMCI/CCM protocol.

Measuring breathing rate is the only vital sign that HSAs are required to measure to assess sick children under 5, the SL breath counter is a breathing rate tool embedded within the SL app. Breathing rate is to test for pneumonia.

Increased Adherence to CCM protocol (no way to jump questions) CCM FORMS captured. Captures Socio-demographic information, clinical information and clinical measurements.

Data Timeliness: Real time due to regular syncing.

Data Interoperability: None.

Data Validation: Built into the app.

9.1.54 DATA USAGE

Data Used For: case management and data collection

Referral rates at index visit, re-consultations to village clinics, hospital admissions, barriers and facilitators to parents/caregivers of sick children accessing healthcare services, financial and time related costs to parent/caregivers with presenting to health care services.

Standard Reports: Based on data captured, it recommends a treatment to HSAs.

9.1.55 BUSINESS PROCESS

Scaling - Geographic: None.

Scaling – topic/functionality: None, but the experience will apply to the development of Malawi's integrated community health information system.

Potential Usage: Currently the HSAs fill out their monthly report from their Village Clinic Register and manually enter data into the DHIS2 system at district level. SL app COULD automate the process but due to the nature of the project (Research), this function was not developed/enabled.

9.1.56  ECONOMIC

Licensing: None

Software Costs: The cost of the app is free, and available at supportinglife.eu.

ODCs: Devices, solar power chargers, data bundles, power banks.

Cost of Scaling: N/A.

Sustainability Approach: None – short term activity which phased out.

ONSE Health - Mobile Village Tool Kit: Management Sciences for Health & DiMagi/CommCare

The team also reviewed the ONSE Health application as it is going to be rolled out in the majority of districts in the next few years. However, it was not deployed at the time of the data collection, so it was not eligible to be included in the deep dive.

9.1.57 OVERVIEW

Description: ONSE Health - Health systems strengthening: The successful scale-up of quality, accessible, high-impact interventions in ICCM, MNCH, FP/RH, malaria, WASH, and nutrition at the facility and community levels depends heavily on sound governance, management, and leadership at the district level, as well as reliable platforms for community engagement and feedback. Other requirements are a functioning health information system with continual data analysis and use, trained staff, a supportive supervision system, excellent district implementation planning and management of resources, and a well-designed and functioning service network involving close coordination with partners. The MSH-led consortium will apply its extensive experience in Malawi and elsewhere in strengthening health systems and services at the district level and below. The CommCare-based mHealth platform, MVTK, is a platform aimed at HSAs at Community levels with supervision done at facility level.

9.1.58 LEADERSHIP

Project Team: MSH (prime) and DiMagi (mHealth lead).

Stage of activity: Design, implementation and deployment (iterative release).

Language: English.

9.1.59 SCOPE:

ICCM, CBMNC and FP case management in HSAs catchment area, data collection and monthly consolidation of data, HSA Supervision. V2 scope will include WASH, Nutrition, EPI and Childhood TB components, as well as facility and district level reports.

Number of Users: 200.

Users: HSAs, Supervisors.

MoH EHP/Health Protocols: ICCM, CBMNC, FP (Version 1), Childhood TB, Nutrition, WASH, EPI (Version 2).

Locations: Salima (April 2018).

9.1.60 TECHNOLOGY

Platform: CommCare.

Device requirements: Android Smartphone, 2GB RAM.

Software Architecture: Android Java app, CommCare HQ hosted server (Python/Django).

Data Model: XML extended tables with XPath querying.

Organization and governance

Roll Out: MSH & DiMagi.

Management: MSH & DiMagi.

Ease of Adapting Protocols, Data Items: MoH, MSH & DiMagi.

9.1.61 SECURITY AND PRIVACY PROTECTIONS

- CommCare app provides encrypted local data storage.
- Username/Password protected access to data.
- Multi-level role-based access.

9.1.62 ORGANIZATION AND GOVERNANCE

Roll out: MSH & DiMagi.

Management: MSH & DiMagi.

Ease of adapting protocols, data items: MoH, MSH & DiMagi.

9.1.63 HUMAN RESOURCES NEEDED

Training: To be provided to HSAs by district MoH staff (administrated through Training of Trainers, facilitated by DiMagi).

Maintenance: Maintenance provided by DiMagi & MSH district staff.

Small updates/improvements: Can be performed by MoH staff with minimal coding skills once hand-over is completed. Need to be trained on CommCare and have strong logical skills.

9.1.64 DATA QUALITY AND COVERAGE

Data coverage: IMCI, CBMNC and FP in 16 districts.

Data timeliness: Real time due to regular syncing.

Data interoperability: DHIS2 (v2).

Data Validation: Built into the app.

9.1.65 DATA USAGE

Data used for: Case management and data collection by HSAs.

Standard Reports: v2.

9.1.66 BUSINESS PROCESS

Scaling - Geographic: Can scale to entire country.

Scaling – topic/functionality: Can add more protocols.

Potential Usage: Integrated Community Health.

9.1.67  ECONOMIC

Licensing: Open Source (BSD & Apache v2).

Software Costs: CommCare licensing model.

ODCs: Phones and data.

Cost of Scaling: Training & phones.

Sustainability approach: MoH involvement and ownership, financial plan past ONSE mandate.

10 FINDINGS

The team was able to look across all five applications and ONSE[19], where information was available, and identify common themes which are outlined below.

Please note that community health workers can refer to HSAs but also to One Community's various field level staff implementing their programs. Four of the five apps (plus the ONSE app) were part of mHealth projects which replicate existing MoH service delivery activities using mHealth applications. The fifth, One Community, provides data to the GoM outside of their app, using ODK for data collection. The following will refer to ALL apps reviewed unless explicitly stated otherwise in the text.

10.1 Identified Benefits

> *I like the mHealth App because I can show a video to a mother about why it is important to sleep under a bed net. I can tell her, but when she sees the video, she really believes it.* - HSA

The team was able to capture common benefits identified by the different teams of the mHealth applications, most of which confirm experiences in other countries. Universally, interviewees were very positive about the impact of mHealth on the work of the community health workers and the health system in general; interviewees identified a number of common benefits they had seen from mHealth activities.

[19] ONSE was included in this assessment, even though it was not originally part of the apps selected for the deep dive, as it is poised to become a major player in Malawian mHealth for community level service delivery, replacing and/or supplementing the work of several of the mHealth activities reviewed, and, by project end, will be established in the majority of districts in Malawi. In addition, the ONSE app is developed in the CommCare platform, which is also used by two of the five apps in the deep dive.

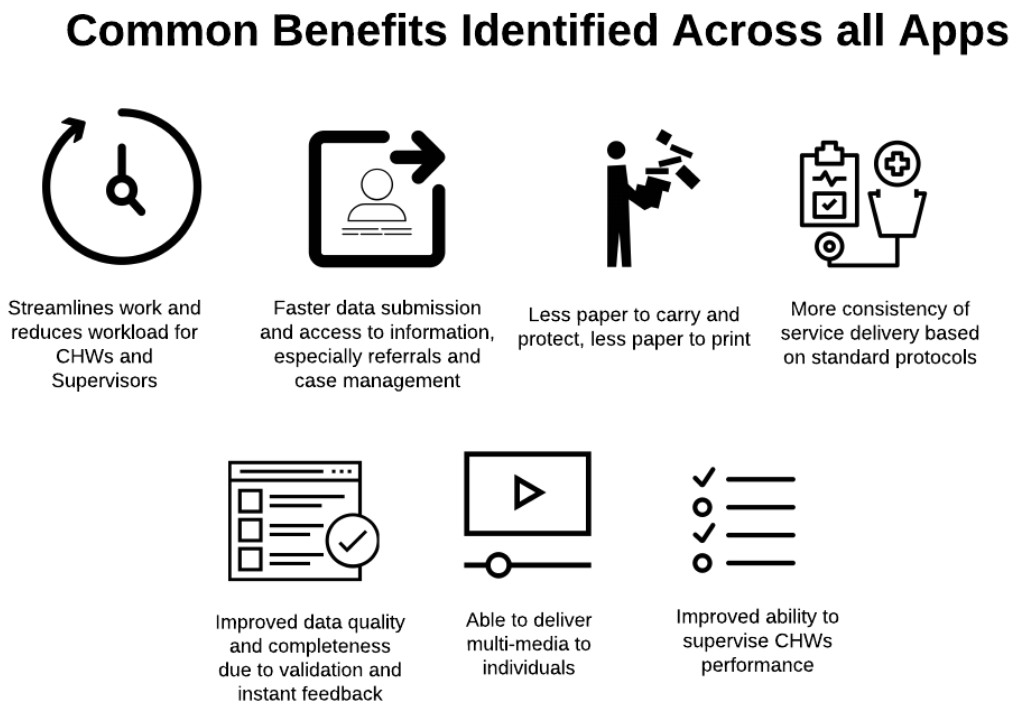

Figure 8: Common Benefits Identified across all Apps

There was a widespread sense that the quality of health services was improved by mHealth applications which guided CHWs through existing protocols; having inbuilt decision trees and validation confirmed in real time improved the accuracy of the service delivery as well as of the data collected. The CHWs felt that the applications made it easier for them to do their jobs as they had less to remember and keep track of. They also reported that the apps reduced and streamlined their work, and made data collection easier and more accurate, a belief reiterated by supervisors and district level staff (two groups whose responsibilities included review and approval of submitted data). It was commonly acknowledged that data quality increases when the digital tool follows the existing service workflow and generates the service data without requiring explicit data entry or much additional work.

In addition, other benefits were identified by those interviewed. The depth of the collected digital data was acknowledged to be much greater and richer than paper forms that the apps had replaced, especially in operational data (e.g. time stamps, location tracking, usage patterns). The perception by Community Health Workers and Health staff is that the speed of data submission and sharing was greatly improved, as well as ease of tracking the status of a patient's case or referral requests. In the One Community case, having built in informed consent processes in the app helped ensure patient confidentiality was regularly attended to by staff.

For staff who often have to walk long distances, reduction of paper to carry and track was noted as a major benefit – they could leave the paper registers at home and complete them when they finished their visits for the day. Supervisors and facility coordinators mentioned that the apps's operational data made it easier to manage CHWs' performance; the dashboards plus detailed audit data made it clear which CHWs were not delivering services adequately, who were not reporting for duty, or whose paper reports were incomplete or inaccurate. Finally, several CHWs noted that being able to provide multi-media (photos, videos, audio) content was an effective way to communicate with caregivers and patients.

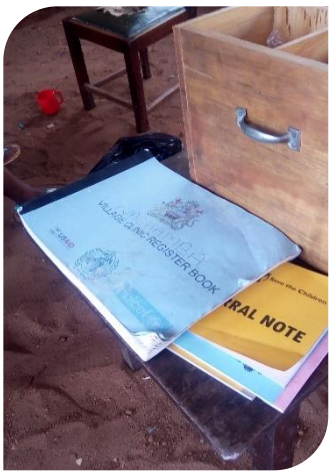

Figure 9: Image of a village health register and a village clinic box

10.2 mHealth Activity Components

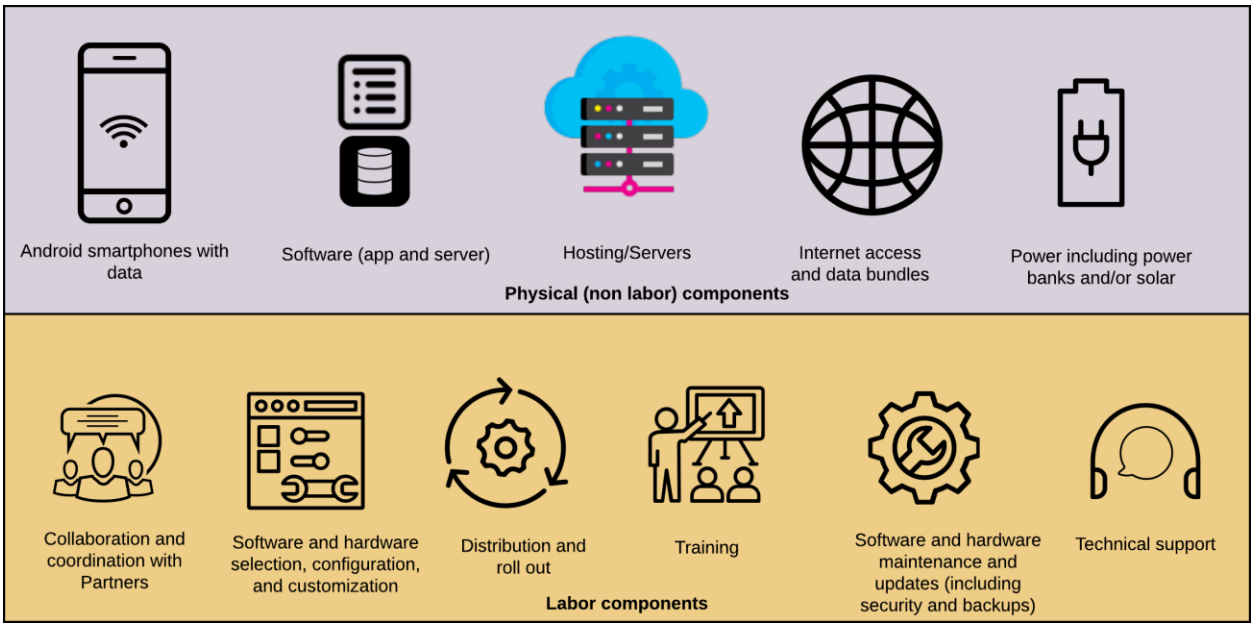

Figure 10: Standard Components Across all Apps

All of the activities reviewed used mHealth tools as part of their larger delivery of services. Across all mHealth activities, there were standard non-labor and labor-based components, which were essential for project implementation. For example, all of the activities required devices to be supplied to the health workers; none formally offered a "bring your own device" (BYOD) approach, due to concerns for device performance and security. All activities but one used smartphones as their preferred devices; One Community used Android tablets which did not include phone features such as dialers, which they mentioned as a limitation they would not replicate.

All projects required internet access for their apps to sync (ideally daily or more often) with the cloud servers (based outside of Malawi), and all projects provided data bundles to the field level workers for this syncing. The bundles ranged in size from 200MB a week to 500MB a month.

As power is a widespread problem in Malawi, all activities provided alternative power – solar chargers, power banks or a combination.

In addition, there were many common labor components to designing, implementing and maintaining an mHealth activity. All activities spent significant time on coordination and collaboration with GoM partners, especially at the field level. The selection and set up of the hardware and software also took significant time. The actual distribution of the devices and roll out to the different districts was also a common component, as was multi-day training for CHWs, supervisors and facility coordinators on how to implement mHealth activities, including basic device use, management and troubleshooting of the apps and devices.

As activities were underway, ongoing support for the devices, software, and implementation was required, including updating protocols if needed, and replacing/updating devices or software. Technical support was an important component, especially due to the high turnover of health staff in many districts; project staff would need to make sure the new CHWs, supervisors, and/or facility coordinators had the correct access and understanding on how to use the mHealth assets.

10.3Software Architecture

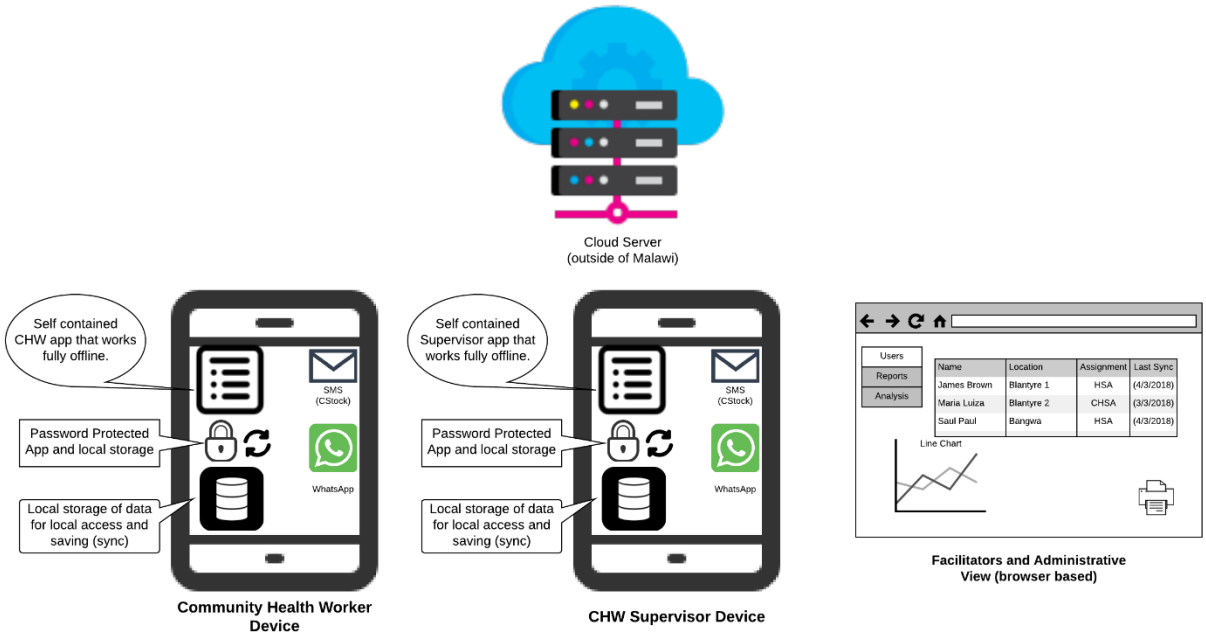

Figure 11: Standard App Configuration

The team also found a high level of commonality in the overall architecture of the systems, varying only in the maturity of the apps. All apps included a community health worker level interface for data collection based on the service delivery protocols; some also included more detailed decision tree management tools for service delivery. The more mature apps also included more robust supervisor management views and facilitator/administration tools.

All mHealth projects deployed Android apps to the devices, which could be updated via the data sync. All apps worked fully offline, with a daily or so sync of data collected; a local data store on the device provides storage of all data for offline usage. The apps also updated the data held on the phone for case management and referral information, allowing the field health workers to find patient records and receive updates via the devices.

> *We have a little song we like to sing. Sync, sync, sync, then sync some more. Sync, sync, sync, then go to bed.* – Community health supervisor

All but one of the activities allowed downloading and usage of WhatsApp, as it is a popular communication platform for CHWs to share information. Most of the apps also integrated either formally or informally with cStock, the MoH SMS based Commodities stock application.

All apps had username and passwords to protect patient information; however only one activity also had device level encryption enabled. That activity also locked down the devices so no outside downloads were authorized. None of the activities had anti-virus software installed on their devices.

10.4 Software Platform Features

Despite some differences in underlying technologies, the software platforms used to implement all the apps utilized the same basic architectural pattern.

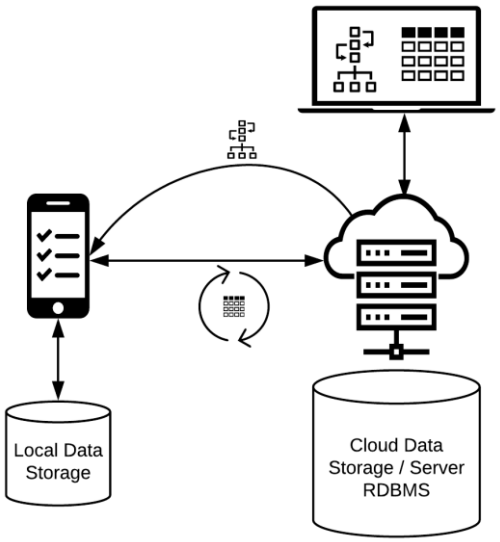

Figure 12: Common Software Platform Architectural Pattern

The platforms all provided a web-based interface for designing the workflows.

In addition to the app features, the software platforms are used to create and manage the apps on the devices as well as to store the data and track performance. Each platform also offers server defined workflows, which are based on user role. These soft workflows can be reconfigured and provided to client software on mobile devices remotely and configured through sets of rules that can be pushed to the device without a full app update. This system makes efficient use of available bandwidth. The software installed on devices then interpret the rules and render the workflow and user interface on the device, store data locally, sync to server, and update/refresh rules when needed.

The odd-one-out from this approach was LIN's Supporting Life App which was developed as a prototype activity with a hard-coded workflow and

> *I compare the paper forms to the data on the website because the website is usually correct. We have a real problem of workers submitting incomplete forms, so the website is useful to make sure the data is right.* – District HMIS

data structure. This was found to be problematic even within the limited timeframe of the research activity and delayed the activity by six months due to the need to update the protocol after the MoH issued a revision.

10.5 Data Flows

Four of the five apps were part of mHealth projects which replicate existing MoH service delivery activities, and therefore, provide data directly to the MoH. In the four apps, HSAs used the device to capture information that would also go into the Village Health Register (for Village Clinics) or at the facility register. HSAs would routinely use their devices to complete daily and monthly reports, such as the Form 1A for Village Clinics, or to provide inputs to the HMIS15.

Supervisors also reported using their supervisor views to review the Form 1A data for accuracy. If all of their HSAs were part of the mHealth activity, they could also sometimes look at aggregate reports across HSAs to complete their Form 1B, or to complete their reporting for facility reports.

HMIS and District staff explained that they also compare the paper forms submitted to them by the different health workers to the facilitators dashboard for accuracy and completeness. As they can also drill down to specific worker performance, the dashboards make it easy for them to see if any worker's data could be questionable.

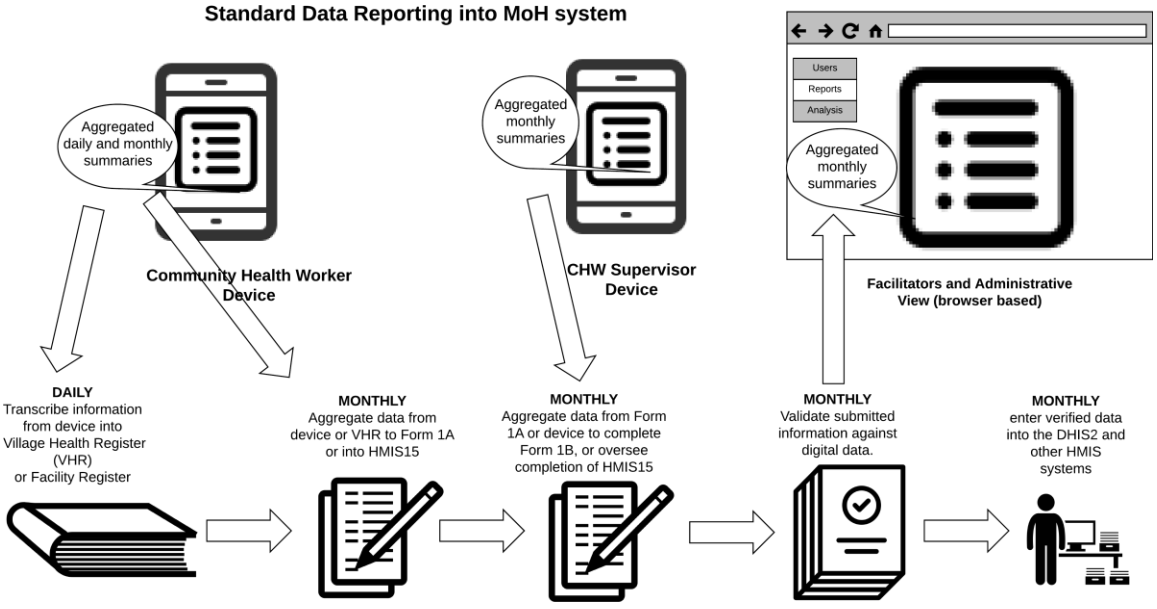

Figure 13: Common Data Workflows to MoH data systems

10.6 Common Challenges

Across all the projects common challenges were identified, which the team grouped into explicit challenges (i.e. widely and clearly identified by interviewees) of Infrastructure, Usage, and Coordination, and implicit challenges of Security and Privacy Protection. Explicit challenges were those which interviewees mentioned with minimal prompting and were clearly front of mind. Implicit challenges were those which were identified when the team asked specific questions related to these issues and uncovered issues that were not at the forefront of discussion.

10.6.1 EXPLICIT CHALLENGES

10.6.1.1 Infrastructure

Unsurprisingly, power and internet connectivity were cited as common challenges with the mHealth activities. As most community health workers live in the areas where they work, and Malawi has little electricity in rural areas, most workers said they use charging stations, power banks and/or solar panels to keep their devices charged. However, field workers reported only getting a few hours of usage out of a device before needing to recharge, most likely because they are unable to charge the devices fully.

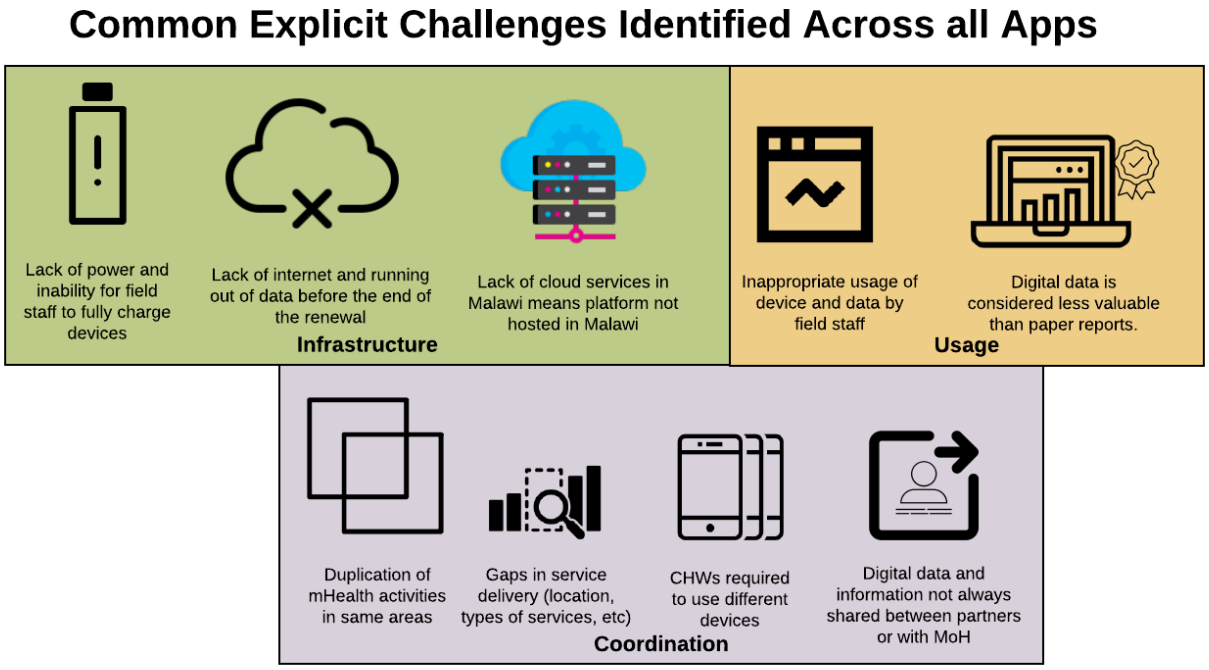

Figure 14: Common Explicit Challenges

Internet connectivity was a less pressing concern as the devices could store multiple days of data between syncs, and all but one activity had devices that could sync over 2G (Edge). However, time sensitive information, such as referrals, could be delayed when the internet was unavailable. Community workers running out of data before the renewal period was also a commonly stated issue, though there were frequent suspicions that workers used the data for personal reasons.

The final infrastructure issue is that while the Government of Malawi has an explicit policy of health data being hosted in Malawi, none of the applications primarily hosted their production data in Malawi. The reason was that Malawi does not currently offer commercial cloud-based services, and the software platforms used perform better with these service offerings.

10.6.1.2 Usage of Devices

As mentioned above, there was a common concern that health workers are using the devices, especially the data, for personal usage, such as WhatsApp and Facebook. Another challenge is that WhatsApp is used by various staff for both personal and professional

purposes; HSA WhatsApp groups have been created for mass communication between HSAs and Supervisors in some districts. Most community workers do not want to have two devices (one for personal and one for professional) but they do acknowledge that the device is for professional purposes.

A final challenge mentioned was that digital data is not considered official; within some in administration there is still a preference for paper. This cultural preference was clear when we asked if documents could be transmitted digitally rather than transcribing the information into registers and forms. Various staff mentioned that while they like that idea, the digital copy is not considered equivalent to the paper form when it comes to formal submission of reports. One interviewee mentioned that concerns about the digital data disappearing after project close out reinforced this reliance on paper forms.

10.6.1.3 Coordination of mHealth in Malawi

> *We need to have apps that work for the HSAs. I don't want the HSAs to have to manage 20 devices just to do their jobs!* – MoH Staff

Additional challenges identified by many interviewees included concerns about duplication of effort combined with gaps in services. There was a widespread sense (some of which was confirmed by the mHealth registration) that some districts and health areas received multiple mHealth activities, while others receive none. The specter of HSAs having to juggle multiple devices, one per project app, was used as an example of a negative outcome, though the team could not confirm this actually had occurred in the projects included in this analysis or through stakeholder interviews.

Finally, all of the activities stated they neither formally or consistently received nor shared data with other mHealth activities, including when a project closed out and a new mHealth activity replaced theirs; though there were cases of informal sharing of experience, these tended to happen at the personal level.

10.6.2 IMPLICIT CHALLENGES

10.6.2.1 Sustainability after the project

One major concern voiced by activity and district staff was the potential ending of donor funding for a specific activity and the impact on the mHealth activity; two of the activities (D-Tree and Millennium Promise) were facing this risk, and one (LIN Supporting Life) had already experienced it.

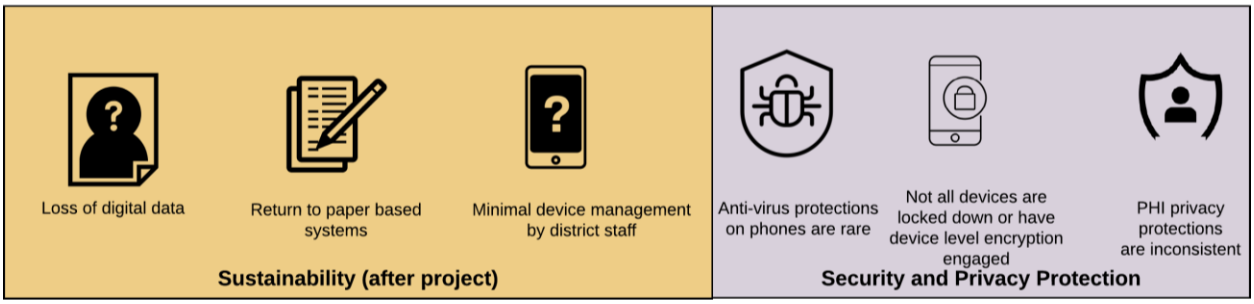

Figure 15: Common Implicit Challenges

Most of the staff interviewed had not explicitly explored the impact of ending the activity on the district or region; when asked to do so, three main questions emerged:

1. What happens to the digital data after the project ends?
2. Will the project area have to return from digital data collection to paper based?
3. What happens to the devices?

In the case of LIN[20] and presumably in the cases of MP and D-Tree should they close out, the digital data was not transferred or made accessible to the MoH or the district where the data was collected after the period of performance, and as of this assessment, there were no plans to make this data available. D-Tree, which has been working in some parts of Malawi since 2011, is currently closing out in three districts, to be replaced by ONSE's app; the team asked both D-Tree and ONSE about the plans for transferal of this historical data, and both organizations did not currently have plans to do so.

In addition, in the case of LIN, the Supporting Life app was removed from the devices (which were left in the possession of the HSAs). The district where the app was deployed went from having a digital data collection and analysis tool and infrastructure for a specific protocol to one where HSAs had to return to paper only systems. During focus groups with field workers for other activities, the team asked about the impact on them of losing the mHealth app; the HSAs and district staff were very bothered by this potential and were adamant that it could not happen. The district staff who had used the Supporting Life app expressed frustration that the app was no longer available for use, and that they had to return to paper forms.

Another challenge is that the management of the devices is not continued after project close out. Currently, the implementing partners track and manage the devices during project activities; however, transferal of this management to district health staff is incomplete.

[20] One of the restrictions on LIN in the Supporting Life project was that as part of a formal research study, the entire activity was under the auspices of an institutional research board, with strict rules about data management after the project. One requirement was that all copies of the app had to be removed from the field, as the activity was no longer able to be actively managed by the research team.

Several district health staff mentioned they should be tracking who has devices and that they needed help with developing a device management system.

10.6.2.2 *Security and Privacy Protection*

Only one activity (One Community) explicitly mentioned security and privacy protection as part of their design approach, presumably because they are dealing with a high stigma illness. One Community also had incorporated informed consent questions, including the right to capture information digitally, into the app's delivery of services. All of the activities, when asked, did mention their security and privacy protection approaches, including access controls based on user roles, username and passwords, and staff training on confidentiality.

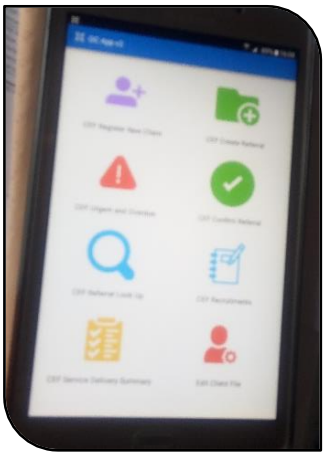

Figure 16: One Community App on Tablets

The team however discovered that in the field, data protection requirements for digital systems which manage personal health information (PHI) were not always fully understood and there were misconceptions around risk from viruses and privacy breaches. None of the activities had anti-virus software installed, only one activity encrypted at the device level, and only one locked down the device to prevent the installation of unverified apps. [21]

10.7 Other Observations

In addition to the above, the team found other common assumptions and patterns of implementation behavior that were consistent across the activities and discussions with staff.

10.7.1 COST ASSUMPTIONS

10.7.1.1 *Open Source is often seen as "free"/underestimating the real costs of mHealth*

The team explored the cost components of existing activities, including all the aspects outlined in the above section. One pattern found was a reliance on "Open Source" software [22]as a cheaper or free option. Those with more experience in deploying mHealth solutions

[21] Some IT staff did discuss some of the challenges of locking down phones; many had found that locking phones was highly resisted by the field staff, who sometimes found ways to work around the locks. They also found that locking phones made updates and interoperability with other software harder to manage.

[22] Open Source refers a licensing model where the source code is publicly available, combined with an open license where the copyright holder allows usage, modification, and derivative works of the source code. https://opensource.com/resources/what-open-source

did understand the full cost of ownership of an mHealth application included much more than the software.

10.7.2 DATA MANAGEMENT

10.7.2.1 Conflation between platform and data

When discussing options for sustainability and scale, the team found most interviewees did not distinguish between the platform (i.e. the software) and the data that the platform collected. In addition, there were several assumptions that if the platform was the same, the data would automatically be interoperable; however, three of the apps reviewed all used the same platform, but none of the data is currently interoperable due to different configurations and focus areas.

Platform vs Data

A common misunderstanding in ICTs is the conflation of "platform" vs. "data", especially when discussing sustainability or scale. It is important to realize that platform and data are and should be viewed as separate, and the data is the asset with the continuing value. Platforms are a way to collect, store, and interact with data; however, platforms age and become obsolete as the technology continues to evolve. Data should be able to live beyond and outside of the platform used to capture it.

To make sure this happens, platforms must be able to generate and share interoperable data that follows common standards for structure and quality; in this way, the data will continue to be used as a benefit long after the initial investment is complete. In practice 'open data' is more significant than 'open source'.

10.7.2.2 Interoperability of data or platform not currently planned for by anyone

Four of the five activities were implementing the same main protocol, reporting on the same indicators for the same government forms. This means the data collected is likely highly interoperable by default. Making the data between mHealth activities deploying the same protocol actually interoperable is technically feasible and should be fairly straight forward; however, there were no plans to do so in current or future activities. Development and governance of data interoperability does incur a cost, and in resource-limited projects is often a secondary concern.

10.7.2.3 Minimal data combinations

One benefit of interoperable data is the ability for the data to be co-mingled and layered with other data sources. However, mHealth data generated by these activities is not currently widely used in combination with other data sets, such as Measure DHS data, WHO or World Bank data, Google maps, and MoH data sources.

10.7.2.4 Data ownership vs data possession vs data access

Universally, everyone asked was very clear that the ownership of all digital data collected by the mHealth apps rests with the Government of Malawi. However, as mentioned above, in not one case does the Government of Malawi have full possession or full access to the data. In cases where the activity is underway, specific government staff have mediated access to the data; in cases where activities are closed, this access is removed and there are no plans for providing the Government with possession of the data.

10.7.3 DESIGN ISSUES - HUMAN CENTERED DESIGN VS. HEALTH TOPIC FOCUS

Due to funding priorities, mHealth activities are centered around standard health protocols in vertical programs (IMCI, Reproductive health, etc.). However, HSAs deliver services across these health protocols in horizontal programs. District health staff identified areas where additional mHealth apps would be extremely useful (such as vaccination coverage), but with the siloed nature of project funding it is unclear if implementing partners are able to create new apps. In addition, while commitment to usability by community health workers is high, the health protocol focus means that apps are not always designed to be streamlined with each other or focus on ease of use by field staff. Also, while involving field staff in the design was identified as important, it was not always accomplished, probably due to cost or timing.

10.7.4 INTEGRATION WITH CONSTITUTIONAL PROTECTIONS

A final observation was that none of these activities seemed explicitly aligned with the Constitutional rights to Privacy, to development (which includes healthcare) or rights to access of information, or with explicit government policy related to these rights, such as the Open Government Partnership. For example, a lot of highly personal health information is being collected and managed by Implementing Partners on citizens of Malawi. While there are no allegations of wrongdoing by these partners, there are also no explicit guidelines provided by the Government of Malawi of what information can and cannot be collected and in what format (i.e. should certain data be anonymized at collection?), what privacy protections are required, appropriate and inappropriate uses of this information, and what publication and sharing obligations the Implementing Partners have.

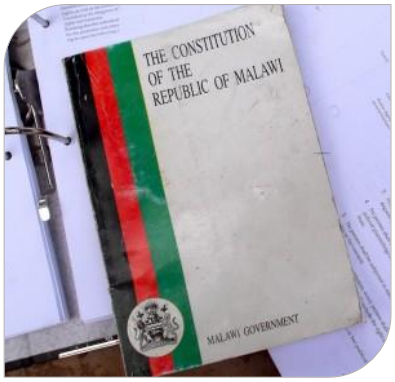

Figure 17: Constitution of Malawi (Marabi Post 2017)

11 CONCLUSIONS

11.1 SWOT: Current mHealth Context in Malawi

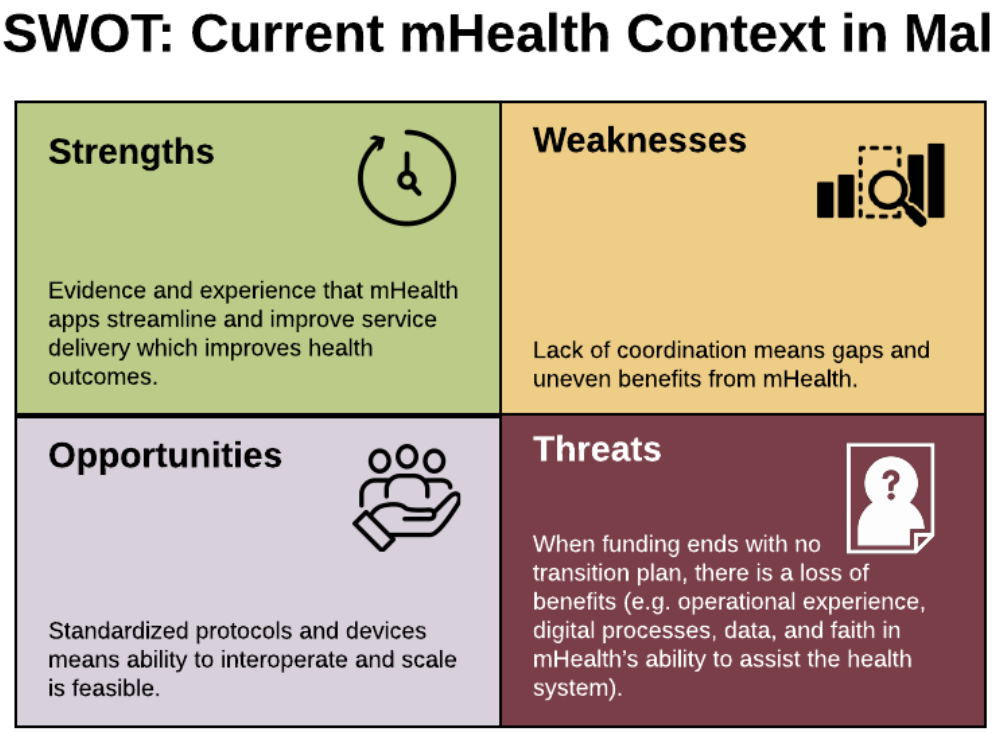

Figure 18: SWOT Analysis of mHealth Context

11.2 Project Level Best Practices identified

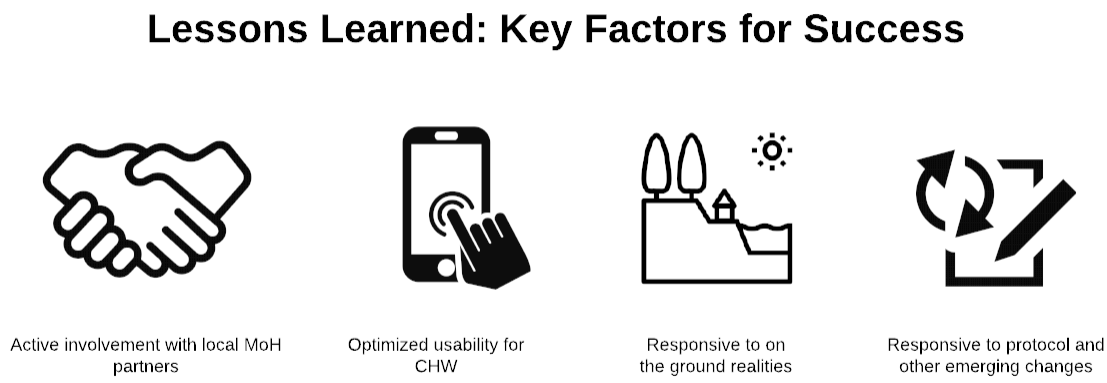

Figure 19: Project Level Best Practices

11.2.1.1 Active involvement of local government partners from the beginning

Activities saw increased engagement and ownership of the mHealth activity when it was integrated into existing district level government tasks, such as job descriptions, training, supervision responsibilities, data collection.

11.2.1.2 Optimize the usability of the app for the front-line workers

When the data collection was integrated into the normal workflow for health workers, reduction in workload and improvements in data quality were seen. In addition, providing many points of instant validation and support (help text, definitions, videos) also helped with service quality. In addition, when the apps were designed based on the normal CHW workflow (and not by sector), additional benefits of reduced workload, improved service delivery and data reuse were seen.

11.2.1.3 Apps need to be responsive to on the ground realities

mHealth apps must work fully offline and sync when data is available, and the apps/devices must not use a lot of power. Data bundles must be provided to CHWs and other app users in order to sync and submit data. Supplemental power, via solar chargers or power banks are essential, but power banks work best as a power supplement.

Projects must try to find a balance between locking down devices for security and device management and the usability of device by CHWs for communication and other tasks.

11.2.1.4 App platforms must be responsive to changes on the ground

As protocols change frequently and the user experience must be responsive to on the ground realities, so the app must be easily reconfigurable and redeploy-able. Platforms should include workflow management which can be deployed to apps without requiring a full download (which uses a lot of data). Ideally, platform configuration should be managed through a non-code interface so that health staff can directly build the workflows and decision trees themselves.

11.3 National Level Lessons Learned

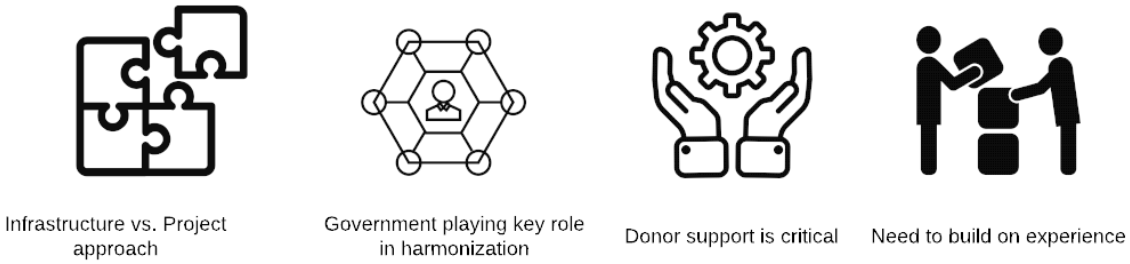

Figure 20: National Level Lessons Learned

11.3.1.1 Project approaches undermine investment in infrastructure

Due to the nature of program design and implementation, current projects are focusing on their period of performance and specific scope of their grants or contracts and meeting the requirements of donors. This exclusive focus on the individual projects undermines the ability for these investments to build out the mHealth infrastructure in Malawi, without explicit requirement, guidance and standards managed by the Ministry of Health.

One concrete example of this conclusion is the lack of device standards and the tendency to issue a new device per activity. The widespread concern about HSAs needing multiple devices and the fact that once a project ends, devices are often not tracked by local government, speaks to the fact that there is no national standard for mHealth devices or device management infrastructure in place.

11.3.1.2 Government of Malawi is a critical leader in harmonization

As a result of the above, the Government of Malawi has a critical role in harmonizing these programs to meet the broader strategic goals of community health in Malawi.

11.3.1.3 Donor support is key

Donors can provide support and backup for the government standards and are looking for guidance from Government on how their investments can be more sustainable and impactful.

11.3.1.4 Building on experience

Due to the longstanding history of some partners with mHealth in Malawi, as well as similar experiences in other countries, there is an opportunity for the Government of Malawi to help coordinate best practices and lessons learned across Malawi and other countries.

12 RECOMMENDATIONS

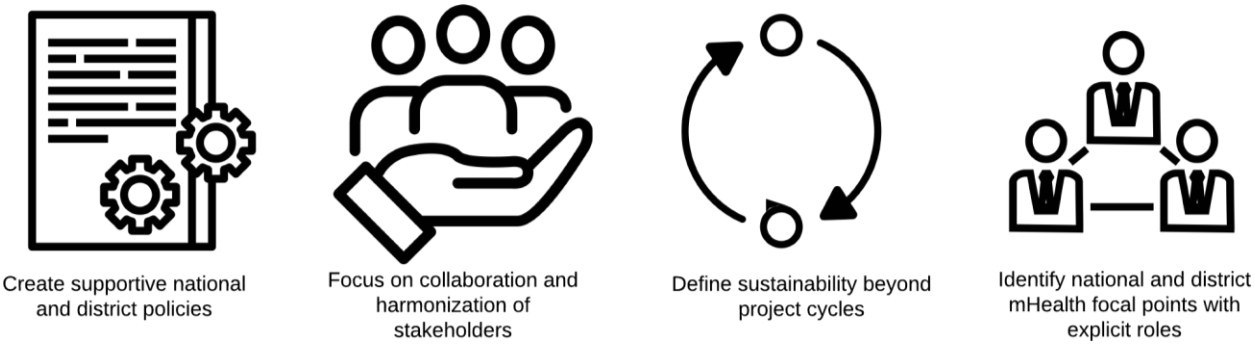

Figure 21: Recommendations

12.1 Policy

- Goal – harmonization of all mHealth activities for broad benefit across Malawi.
- Digital first as a goal means digital copies must be equivalent in value to paper.
- Clarifying data access and possession requirements.
- MoH to engage with donors and project managers to work towards interoperability of data, and to ensure transfer of data and experience between projects closing and those starting.
- Sync data protection policies with legal requirements (i.e. right to privacy).
- Platform vs data- retaining access and usage of data is paramount. Platform is the method to collect and use the data.
- Enforcement mechanisms.

12.2 Coordination and Harmonization

- MoH organize a meeting with all the donors active on mHealth in the country to present requests from the Government of Malawi for future work in this area.
- Creation of a standardized data model (so the data can be usefully combined).
- Standardized use of unique identifiers for patients.
- Indicators around open data /interoperability of data.
- All projects are required to share experience and data with others in the district/country.

12.3 Sustainability

- Explicitly shift from project mindset to infrastructure development approach.
- Start with device harmonization and standards, and support deployment of apps onto existing devices. Support district level device management processes.

- Require close cooperation with MoH staff (especially in districts): more engagement leads to more ownership.
- Prioritize highly configurable system that do not require developers.
- Make sure data is structured for interoperability across platforms/copies stored on MoH servers.
- Investigate negotiating in bulk for key costs (data, devices, hosting), and explore methods with Airtel and TNM, such as reverse billing or zero-rating for data connections to the server or national WAN 'Closed User Group'.

12.4 mHealth Focal Points at National

- Track all mHealth applications in Malawi, by sector and location.
    - Manage process for annual registration and compile annual mHealth report.
    - Capture lessons across all mHealth and share with other activities and groups.
- Create and update national mHealth standards for partners and donors to follow.
    - Set Data Security, Data Protection and Privacy requirements.
    - Ensure compliance with open data policies.
- Work with donors and partners to coordinate and prioritize districts and health sectors which need mHealth support.
- Help partners select existing mHealth platforms and approaches and advocate for District priorities.
- Support development of policy and processes to support mHealth nationally (such as validity of non-paper records).
- Support interoperability and usage of mHealth data at different levels, including developing standards and processes necessary to achieve interoperability.
- Support Districts in implementing mHealth/negotiating with partners or vendors.
- Lead negotiator for key vendors.
- Educate National level staff on mHealth and advocate for mHealth when appropriate.

12.5 mHealth Focal Points at District

- All partners register mHealth activities with District & share list with national focal point.
- Adapt national standards to District requirements
    - Make sure selected platforms meet national standards/District specifications.
- Train and support HSAs in using mHealth.
- Capture lessons across all mHealth activities in district and share with other activities and groups.
- Educate District staff on mHealth and advocate for mHealth when appropriate.

12.6 Suggested mHealth Data Architecture

Integrate mHealth data into the existing data architecture infrastructure and patterns of DHIS2, the DHAMIS and DDE, with copies of mHealth case management data being stored in country on a server which can then provide data analytics ability.

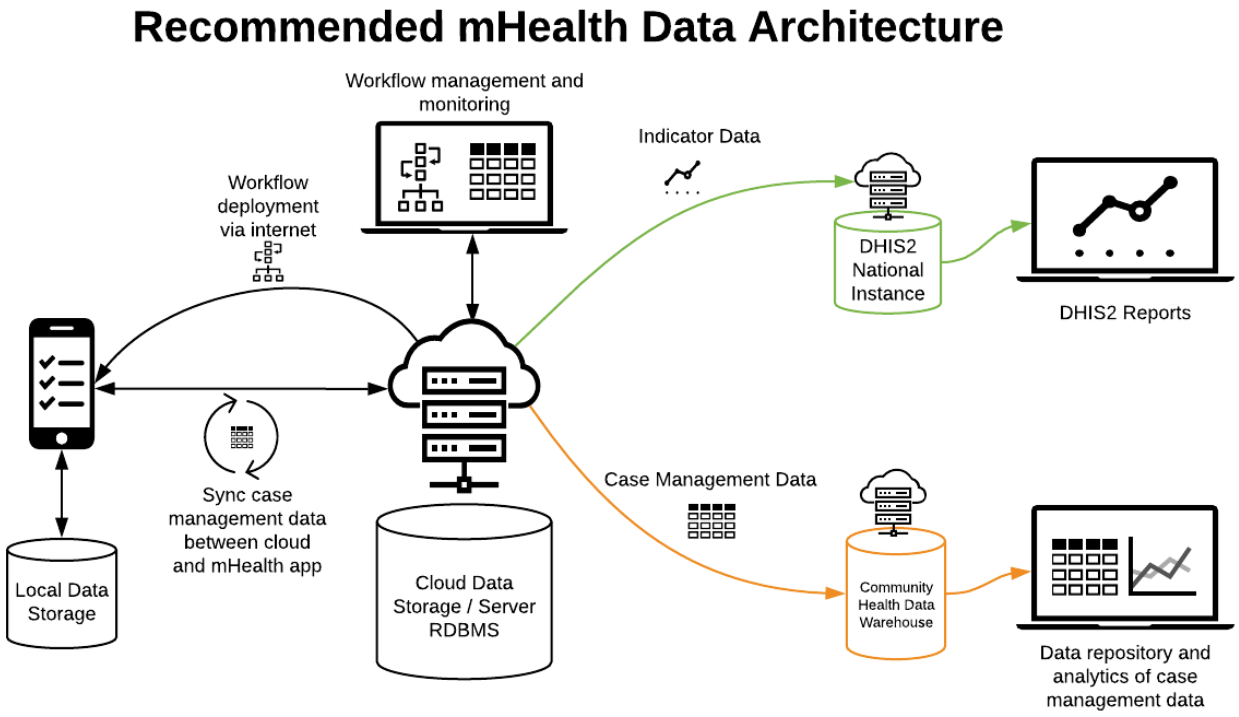

Figure 22: Suggested mHealth Data Architecture