M-health application for community health volunteer's data collection: a case of Makueni County

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Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

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SUPERVISOR'S DECLARATION

This research thesis has been submitted for review with my approval as the supervisor.

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Approval

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Abstract

The Community Health Strategy in Kenya was introduced to strengthen linkages between communities and the formal health system. However, one of the major drawbacks has been reporting. The manual process for capturing data using Ministry of Health registers by Community Health Volunteers have presented challenges in accuracy, completeness and timeliness of health data from Community Units which has a negative impact in health service delivery due to the delays in quality data reaching the health facilities. The healthcare industry is undergoing a major paradigm shift due to the rapid advances and developments in mobile technology, mHealth that use mobile devices and other wireless technology in medical care. This research focuses on using the dynamic system development methodology to develop a mobile application that will be used by the Community Health Volunteers to collect health data from the household. Data collection will involve both primary and secondary sources which will include literature review and questionnaires. The findings of the research established that the application addresses challenges faced by the manual data collection, the manual register takes 4 weeks be delivered to the health facility using the mobile application it takes only minutes for the data to be availed. Above 93% the respondents indicated that the application assists in improvement in accuracy and 100% of the respondents indicated that the application contributes in collecting complete data, thus contribute to improvement of service delivery to the community. The application should be scaled-up and deployed to all counties in the country.

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List of Abbreviations/Acronyms

Amref	-	Amref Health Africa
CBHIS	-	Community Based Health Information System
CHC	-	Community Health Committees
CHEW	-	Community Health Extension Worker
CHU	-	Community Health Unit
CHV/Ws	-	Community Health Volunteers/Workers
CU	-	Community Units
GOK	-	Government of Kenya
HIS	-	Health Information System
M-Jali	-	Mobile Jamii Afya Link
MMR	-	Maternal Mortality Rate
MOH	-	Ministry of Health
SDG	-	Sustainable Development Goals
UHC	-	Universal Health Coverage
WHO	-	World Health Organization

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Dedication

This thesis is dedicated to my wife, children, siblings and parents who have inspired me to advance academically and for my employer Amref Health Africa for the support and financial assistance.

Chapter 1: Introduction

1.1 Background of the Study

The Constitution of Kenya (2010) provides for every citizen the right to the highest attainable standard of health. It further guarantees the right to health including reproductive health services. Schedule 4 of the constitution assigns to the County Governments the function of delivering health services and to the National Government the functions of stewardship for the health policy including standards and guidelines.

According to the United Nations Sustainable Development Goal 2015 - 2030 Goal 3 "seeks to ensuring healthy lives and promoting the well-being for all at all ages which is essential to sustainable development". Major progress have been achieved in increasing life expectancy and decreasing some of the common killers linked with child and maternal mortality, and increasing access to hygienic water and sanitation, reducing malaria, tuberculosis, polio and the spread of HIV/AIDS. Nonetheless, many extra efforts are wanted to fully eradicate a vast variety of ailments and deal with many unique continual and rising health disorders. (United Nations [UN], 2016)

The Kenya Health Policy (2012 –2030) provides guidance towards the improvement of the overall status of health in Kenya in line with the Constitution that was enacted in 2010, Vision 2030 and global commitments. Its aim is to "attain the highest possible health standards in a manner responsive to the population needs", in line with the goals of Universal Health Coverage which is shaping the global health agenda, emphasizing that "all people, regardless of their socio-economic status, should have access to the health services they need".

The Health Sector Strategic and Investment Plan (2013 - 2017) makes available the objectives, health sector medium term focus and priorities to empower it move towards attainment of the health goals as defined in the constitutional and strategic imperatives. Outputs in health relate to efforts to increase access to services, demand for service and quality of services, these embody the expected implications of any investments in health, which when achieved should provide the required service delivery outcomes the health sector desires. At the core of Health Service delivery is the Household.

The health system in Kenya is currently struggling to cope with requirement of quality health care services and rising cost, against a shortage of experienced human resource for health. This falls short of the health sector vision(s).There is therefore a dire need to create better ways and means of closing the gap between vision and reality. The e-Health strategy strives to set in motion the process of closing this gap by harnessing Information and Communication Technology for improving healthcare delivery together with other ongoing efforts (Ministry of Health [MOH], 2011).

There ought to be a principal shift in the best way information is accessed and shared across the health platforms. It is thus vital for healthcare stakeholders to shift from a reliance on instruments such as pen, paper and human memory to an environment where, care providers, consumers and health care personnel can reliably and securely access and share health information in real time across geographic and health sector boundaries. E-Health provides a concrete way to achieve this end that is tried and tested (MOH, 2011).

According to Braa & Sahay (2012) "Health Information Systems in developing countries comprise of many thousands of health workers, who are engaged in routine collecting, registering, collating, and reporting of data in a large number of formats". The data and information is evaluated and used in a variety of ways by different people, to make informed decision aimed in improving health services delivery.

1.2 Statement of the Problem

According to World Vision (2015) "Living in a rural area of Kenya can be deadly, especially for a pregnant mother or very young child, and much of Kenya is rural. 75% of Kenya's population live in rural areas and Kenya is a global health workforce crisis country", The ratio of health care providers and the population is dire since for each 10,000 people, there are only 8.6 nurses and midwives and 1.9 doctors. When a health care provider is urgently needed in Kenya, such as during a difficult labour, infection, or high fever there may be none.

"The work towards better health service delivery is challenged by the need for and lack of availability of better data (e.g. morbidity data, primary care data, integration of data from social health insurance, data on social or community care, economic data) and standards, as well as collection methods" (World Health Organization [WHO], 2015).

Delays in data reaching the Health decision makers at the Sub County level has a negative impact in health service delivery at the community level, In Kenya, Maternal mortality and child mortality rates are extremely high (MOH, 2014).

1.3 Research Objectives

i. To identify health indicators required to be collected.
ii. To identify challenges with existing data collection methods.
iii. To review existing Mobile Health architectures.
iv. To develop the mobile application for collecting health data.
v. To test the mobile data collection application.

1.4 Research Questions

i. Which health indicators are required to be collected?
ii. What are the challenges with the existing data collection methods?
iii. Which Mobile Health Architecture exist?
iv. How will the mobile application be developed?
v. How can the mobile application be tested?

1.5 Significance of the Study

There is inadequacies in consistency, coverage and accurate use of tools thus raising concerns on completeness of the data. The monthly data collection coverage was reported at 24%, whereas monthly CHVs reporting rate at 57% which are low. Whereas better access to information confirms improved decision making at community level, untimely, incomplete reporting results into late decision making and consequent late intervention towards avoidance of certain outbreaks that could have otherwise been prevented earlier. (Kagiri, Waiganjo, Orwa, and Ngechu, 2015)

Availability of reliable and timely health information is considered as an essential foundation influencing public health action as well as strengthening the health systems however, building an effective strong health system in Kenya has over the years been hindered by geographical disparities, financial burden, and social-cultural barriers making health care provision difficult. Having a robust health information system has shown great potential with regard to the attainment of health related objectives by ensuring presence of

information useful for health monitoring, evaluation and improvement of healthcare service delivery. CHVs collect health status data and account for services offered at house hold level which is later used for dialogue to make informed decisions and actions by relevant stakeholders at all levels to promote improvement in health status. The use of manual reporting forms increases frequency of errors, high workload (Kagiri et al., 2015)

To draw full benefits and value from health information systems, and increase user confidence in its conclusion the data should be of high quality, useful and available for decision making, the data should be accurate, reliable and timely, reflects true measure, is trusted and is up to date. (Canada Institute of Health Information [CIHI], 2013)

The study seeks to develop a mobile solution to automate the collection of household health data using an android application to address the challenges of accuracy, completion and timeliness attributed to the current manual data collection using paper registers and contribute to improvement of health service delivery to the community.

1.6 Research Scope and Limitations

The study is aimed at developing a mobile application using android platform in automation of Ministry of Health paper based data collection tools the Household Register, Service Delivery Log book, Treatment and Tracking Register and Referral form which are used by Community Health Volunteers to manually collect data.

The limitations of the study are constraints of time and resources to fully test the solution with a larger sample size.

Chapter 2: Literature Review

2.1 Introduction

Public Health Data is any data relating to the health of populations, and encompass several classes Individual, Aggregate and Community Level. The requirement to collect and access data is built into the essential services of public health, the collected population health data is used for service delivery and also in assessing the quality of preventable services delivered or reviewing if the population are eligible to participate in other public health programs (Magnuson & Paul, 2013)

New sources of data with each patient's interactions with the health care system allow us to learn from, and improve, acquiring value from this new data depends on collecting the right data once as part of the care process and converting it into actionable information to support the health system. The process of collecting data on one occasion and making it available as suitable for secondary use by the health system reduces duplication of effort, optimizes current processes, and leverages investments being made in e-Health systems (CIHI, 2013).

Mobile Health guarantees new remote diagnostic, monitoring, and data collection techniques, augmenting the efficiency of existing systems. When it comes to empowering the population, mobile technologies offer a means of delivering public education and health campaigns via texts or voice messages sent to mobile devices and smart phones. Mobile technology also increases the opportunity of remote diagnosis by allowing patients and community workers to communicate with hospitals or healthcare activities via text or phone, maximizing the time of specialists and reducing travels to the hospital for patients. (The Boston Consulting Group [BCG], 2012)

2.2 Key Indicators for Community Health Volunteer Data Collection

2.2.1 Community Health Volunteers

The Ministry of Health in Kenya uses the following paper based registers to collect Health data from the households using Community Health Volunteers (CHV's) who are defined by Ministry of Health as Female and/or male individuals chosen by the community and trained to address health issues of individuals and communities in their respective

localities, working in close relationship with health facilities and acts as a catalyst and a change agent to enable people to take control and responsibility of their own health achievement efforts. (MOH, 2014)

Community Health Volunteers operate at the community level of the health structure in Kenya a four-tier system based system that comprises of the following, the community, primary care, primary referral and tertiary referral as shown on Table 2.1, The focus of community services is creating appropriate demand for services, while the focus of primary care and referral services is responding to this demand. The community services entails all community based demand creation activities organized around the Comprehensive Community Strategy defined by the Health Sector. (MOH, 2012a)

Table 2.1 Tiers and Level of Care (MOH, 2012a)

Policy tiers of care	Corresponding levels of care, at beginning of policy	Desired levels of care, by end of policy
Tier 1: Community	Level 1: Community	Level 1: Community
Tier 2: Primary care	Level 2: Dispensary / clinics Level 3: Health Centres	Level 2: Primary care facilities
Tier 3: Primary referral	Level 4: primary care hospitals Level 5: Secondary care hospitals	Level 3: County hospitals
Tier 4: Secondary/tertiary referral	Level 6: Tertiary care hospitals	Level 4: Regional & National referral hospitals

Community Health Volunteers is a person that is trusted and respected in the community. CHV's are chosen by the community members and are the initial point of contact for many within the health system. They are part of the community and so they familiar with the people and cultures, they carry important health knowledge, skills, and tools into communities and households and are key to saving lives, preventing disease, and helping the community members to attain their full potential and flourish.
(World Vision[WV], 2015)

2.2.2 MOH 513 Household Register

The household register is a record where major household events or services at the household are registered after every six months The Head of the Household responds by giving detailed information about the household. The basic information collected is factual data on what was identified in the household. Basically the tool collects information for

individual members as well as collective information for the entire household. The Household register should be updated with information from the household at the beginning and after every six months. It should be submitted to the Community Health Extension Worker (CHEW) immediately after completion of household registration.

Data collection indicators are Household Level Indicators (Household Number, Access to Safe Water, Use of Treated Water, Hand Washing Facilities, Functional Latrine Use, Refuse Disposal Facility). Individual Level Indicators (Date of Data Collection, Individual Code, Name of Household Member, Age Sex, Relationship to HHH, Orphan, Has Birth Certificate, In School, Pregnant, Mother and Child Health Booklet, ANC, Delivered by Skilled Birth Attendant, Exclusive Breastfeeding, Using Family Planning Methods, Penta1Given, Penta 3 Given, Measles Given, Fully Immunized ,Vitamin A given ,Children aged 6-23 Months receiving 3 or more food groups three times a day, Severely Malnourished (MUAC indicating Red),Moderately Malnourished (MUAC indicating Yellow), LLIN use ,Known Chronic Illness, Cough (2 Weeks and above), Knows HIV Status, Disability, Date of Death).

2.2.3 MOH 514 Service Delivery log Book

The Service Delivery Log Book is a diary that is used to collect information from the household during the period of offering a health service, health messages or defaulter traced. It provides the numerator for measuring the effort of the Community Health Volunteer (CHV). The basic information collected is factual data based on what was done or identified in the community, among households and/or individual (s) served. The Service Delivery Log Book measures the actual CHV's effort and should be written or filled during the household visit and should be submitted to the CHEW for summarization by 2nd of the following month.

Data to be collected are Basic Information (Date, Village Name, Household number, Name of household member) Mother Information ,Pregnant woman counselled on Individual Birth Plan (IBP),Woman delivered by unskilled attendant, Woman delivered by skilled attendant, New born that are seen at home that were delivered within 48 hours, Mothers who gave birth are advised on Exclusive Breast Feeding (EBF),Woman 15-49yrs provided with Family Planning commodities by CHVs. Child Information Child 0-59

months who is participating in growth monitoring, Child between 6-59 months with MUAC (Red) indicating severe malnutrition, Child between 6-59 months with MUAC (Yellow) indicating moderate malnutrition, Child between 12-59 months dewormed.

Referral Information where Pregnant woman are referred for ANC, Pregnant women who are referred for skilled delivery, Woman who are referred for family planning services, Home delivery referred for Post Natal Care (PNC) Services, Child 0-11 months referred for immunization, Child 6-59 months referred for Vitamin A supplementation, Cough more than 2 weeks referred, Referred for HIV Counselling and Testing (HCT), Elderly (60 +) referred for routine health check-ups, "Known cases of chronic illness referred

Defaulter Information (ANC defaulter referred, Immunization defaulter referred, TB treatment defaulter traced and referred, ART defaulter traced and referred, HIV exposed infant (HEI) defaulters traced and referred). Death Information (Number of deaths in the month). Household Information (Household Number, Household has a functional latrine in use, Household with hand washing facilities, Household using treated water)

2.2.4 Community Treatment and Tracking Register

The Community Treatment and Tracking Register is a diary that is used to record the information on Integrated Community Case Management (ICCM) and other service deliveries during the household visitation. The basic information recorded is factual data based on what was assessed or treated through the CHV kits in the community, among households and/or individual (s) served. The Community Treatment and Tracking Register should be written or filled during the household visitation. The register is treatment for under 5s during household visits. For those above 5 years, pre-referral treatment given should be documented. The Community Treatment and Tracking Register should be submitted to the CHEW for summarization by 2nd of the following month.

Data to be collected are Basic Information (Date of Data Collection, Name of Patient Patient Contact - Phone No.,Household Number, Sex, Age, Slept under LLINs last night, Exclusive Breastfeeding). Assessement for Treatment (Illness Duration in days), less than 14 days of Diarrhoea, Temperature, , Less than 7 days Fever RDT done, Fever less than 7 days RDT +ve, Fast breathing). Referrals (Cough for 14 days or more, Diarrhoea for 14 days

or more, Blood in stool, Fever for 7 days or more (RDT+or -or not done), Convulsions, Not able to drink or feed at all, Vomits everything,Chest in-drawing, Unusually sleepy or unconscious, Yellow on MUAC, Red on MUAC, Swelling of both feet, Immunization required, New-born danger signs present.

Treatment/Management (ORS (20.5g/ltr); Sachets, ZINC (20mg)' Tabs, AMOXYCILLIN (125mg/5mls) Bottle, ACTs (6s), ACTs (12s), ACTs (18s), ACTs (24s) Albendazole (ABZ) Tabs, Paracetamol Tabs, Tetracycline Eye Ointment (TEO) 1% tube, Injuries and wounds, Counselled, Treated within 24 hrs of illness onset). Outcome (Date of 1st Follow up, Referral compliance within 24 hours, Referral compliance more than 24hrs Adverse Drug Reaction (ADR), Defaulted on Treatment or referral, Recovered, Died)

2.2.5 MOH 100 Community Referral Form

The form is used to refer a household member to a link health facility for further diagnosis and treatment, the form captures the patient details, the name of the community unit the CHV referring the patient, the link facility also refers the patient back to the community using the same form with instructions of interventions to be undertaken.

Data required to be captured Date, Name of Patient, Sex, Age, Time of Referral, Name of Community Unit, Name of Link Facility, Reasons for Referral, Main Problem, Treatment given, CHV referring, Mobile no., Village/Estate, Sub Location, Location, Receiving Officer, Profession, Action Taken, Referral back to the Community (Name and Mobile No. of Officer referring the Patient back, Name and Mobile No. of CHV receiving the Patient, Follow up information.

2.3 Challenges in paper based Health Data Collection

The Community Health Volunteers (CHVs) use the following manual registers, MOH513 household register biannually in collecting baseline health and demographic data of the households. They fill MOH514 service delivery log book each month for all services offered during the month. They then submit their MOH514 registers to the Community Health Extension Worker (CHEW) to execute data quality checks, aggregation and summarization of the data and submit to upper levels for uploading in district health information system (DHIS) and the chalkboard. (Kagiri et al., 2015).

2.3.1 Challenges of Accuracy

Health sector stakeholders rely on the right data being available to make decisions about treatment and delivery of health services, the superior the quality of the data, the more informed the decisions they can make. In any case, over all varieties of health systems, precise high quality health data are not accessible when and where they are required this lack of information can lead to ineffectual or risky delivery of services, destitute patient choices and squandered resources. Successful management of health information could be a prerequisite to realize person treatment and meeting populace health management objectives, beside those for the entire health system performance (World Economic Forum [WEF], 2011)

2.3.2 Challenges of Completeness

According to Rao (2012) In the developing world economic barriers affect the collection of health data and reporting. These barriers obstruct the endeavors of making strides in health services delivery such as moving forward get health data and reporting systems to empower compelling data driven choice and policy for health benefit. Need of resources such as human resource make the exertion of collecting and reporting health data awkward and so causes irregularity and under reporting of health data.

2.3.3 Challenges of Timeliness

Imperative statistics on vital life occasions including births and deaths empower checking predominance of disease and generally health status, create programs to progress public health, and assess the adequacy of those interventions, These data offer assistance to measure the effect of health insurance, access to care, and prenatal care on birth results and screen deaths due to harm, cancer, heart illness, diabetes, and other conditions these information are imperative to understanding health and improving it. As such, numerous data clients, health care providers, public health experts, researchers, and policymakers require that the data are vigorous, precise, and convenient to maximize their utility. A major concern communicated by data users is that imperative statistics are not timely enough to meet their needs. (National Association for Public Health Statistics and Information Systems [NAPHSIS], 2013)

2.4 Mobile Health - mHealth

mHealth was defined as wireless telemedicine involving the utilization of mobile telecommunications and multimedia innovations and their integration with versatile healthcare delivery systems. Since then it has come to include any utilization of mobile technology to address healthcare challenges such as access, quality, affordability, coordinating of resources, and behavioural standards as shown in Figure 2.1. A few of the innovations carrying mHealth data by means of mobile devices are GSM, GPRS, 3G, and 4G-LTE mobile phone systems; Wifi and WiMAX computer-based innovations and Bluetooth for short-range communications. (World Bank [WB], 2012)

Figure 2.1 Mobile Key to solving health Challenges (BCG, 2012)

2.4.1 mHealth Drivers in Sub-Sahara Africa

2.4.1.1 Upsurge in mobile connectivity and developments in technology

Though the telecommunication markets within the developed world are getting to be saturated, mobile technologies in Africa are advancing quickly from basic communication devices into service delivery platforms. Sub-Sahara Africa has one of the least developed infrastructures within the world but its mobile network coverage is exceptionally high. Progressed network coverage, the launch of 3G and of 4G , in conjunction with the conceivable outcomes given by WiFi, have expanded mobile network in Sub-Sahara Africa. (Crul, 2014)

2.4.1.1.1 Number of Mobile Subscribers

According to the Communication Authority of Kenya (2017) The mobile market within the nation has maintained an upward drift within the quarter under audit (July – September 2017) the number of mobile subscriptions stood at 41.0 million up from 40.2 million reported during the preceding quarter, stamping a development of 1.9 per cent. The net increments in mobile subscriptions were recorded at 768,831 within the period.

2.4.1.1.2 Mobile Network Coverage and Traffic

During FY 2017/18 in the first quarter the mobile penetration rose by 1.7 percentage to reach 90.4 percent from 88.7 percent recorded during the past quarter. The entire volume of activity originating from mobile networks was 11.0 billion minutes up from 10.6 billion minutes recorded within the past quarter. On-net mobile activity rose by 4.0 per cent to enlist 9.9 billion minutes from 9.5 billion minutes reported within the past period. Essentially, off net activity expanded by 3.5 per cent to post 1.14 billion minutes from 1.10 billion minutes recorded during the going before quarter. In this way, Minutes of Use per Month rose to 90.1 per cent during the quarter under survey from 88.4 per cent recorded within the past quarter (CA, 2017)

2.4.1.1.3 Mobile Data/Internet

The request and take-up of data/Internet services has kept an upward direction quarter on quarter as seen during the period under audit. The number of data/Internet subscriptions expanded by 4.3 percent to stand at 30.8 million from 29.6 million subscriptions posted in the final quarter. Hence the assessed number of data/Internet clients grew by 12.5 percent to stand at 51.1 million subscriptions hence translating to a Web infiltration of 112.7 percent during the quarter under audit. Mobile data subscriptions contributed 99 percent of the whole data/Internet subscriptions as has been the standard. The number of mobile data/Internet subscriptions increased by 4.1 percent amid the quarter under survey to reach 30.6 million from 29.4 million subscriptions recorded during the past quarter. (CA, 2017)

2.4.1.1.4 Smart Phones in the Kenyan Market

Reduction in normal cost of a smartphone is the foremost critical move driver for the democratization of smartphones. Over the final five a long time the cost of a smartphone has

reduced by more than half from 231 dollars in 2013 to 97 dollars in 2016. Usually to a great extent quickened by Chinese brands within the space for example Infinix, Tecno & InnJoo entering into the space with high specifications phones and diminishing costs. The most reduced cost smartphone as of now sold on Jumia is the X-Tigi P3 a 4 inch phone at 2,799 Kshs. Cheap Smartphone entrance will continue to extend as more Kenyans become aware of the benefits of connectivity and local operators provide them more reasons to put come onboard (Jumia, 2018)

2.4.2 Improve access to basic health care

The weak health care system, weak infrastructures and reduction in international funding are barriers against Sub-Sahara African countries improving their populations' health status. The larger part of patients in Sub-Saharan Africa have exceptionally limited or no access to health care clinics and essential health care services. For decades individuals have been attempting to create sustainable arrangements to unravel this life threatening issue and spare millions of lives. Small advance has been made to date and since this is often a complex issue the world has been incapable to realize genuine victory. (Crul, 2014)

The shortage of well-educated health care professionals is a serious problem. The public system is heavily underfunded and poor management of health care professionals and the inability to provide high-quality training causes low staffing levels. The inadequate infrastructure in Sub-Sahara Africa means health care staff has to work under difficult conditions. Travel distances are long and the buildings in rural areas are poorly maintained, while disease surveillance, drug supply systems, pharmaceutical management and drug stock management are weak. (Crul, 2014)

2.4.3 Positive economic developments

The positive economic development in Sub-Sahara Africa is a driver for stakeholders to create mHealth solutions. Africa is projected to be the fastest growing countinent in the world. Especially economies in East, West and Southern Africa are showing positive GDP growth rates. Ease of doing business is improving and employment rates and access to credit increases rapidly in the regions. The health care expenditure is expected to rise as the economy grows.(Crul, 2014)

2.5 mHealth Applications

With rising request for a wide extend of healthcare specialists from doctors and medical attendants to specialists, paramedics, and dieticians, supplementing the education of these experts is another range in which mobile communications can play a vital part. Figure 2.2 shows the seven categories of mhealth Applications and Figure 2.3 shows the benefits of mHealth (BCG, 2012)

	mHealth category	Description
Information	Public information/ education	• Active spread of health information to general public • Help lines for medical and health questions
	HC worker information/ education	• Remote education for aspiring healthcare personnel • Up-to-date information/guidance to healthcare work force
	Public wellness	• Applications to improve public wellness by encouraging improved diet, physical activity, quitting smoking, etc.
Record/ access data	Public health surveillance/tracking	• Surveillance and tracking of disease outbreaks and epidemics • Monitoring of pollution levels
	Remote data recording/access	• Recording/accessing patient journal data remotely • Supply chain management, e.g., authentication of medicine
Medical services	Diagnostic and treatment support	• Mobile telemedicine, consultations between healthcare professionals, decision support systems
	Patient monitoring/ compliance management	• Monitoring patient health condition and treatment compliance • Alarm systems for individuals in need of clinical care

Figure 2.2 Seven categories of mHealth applications (BCG, 2012)

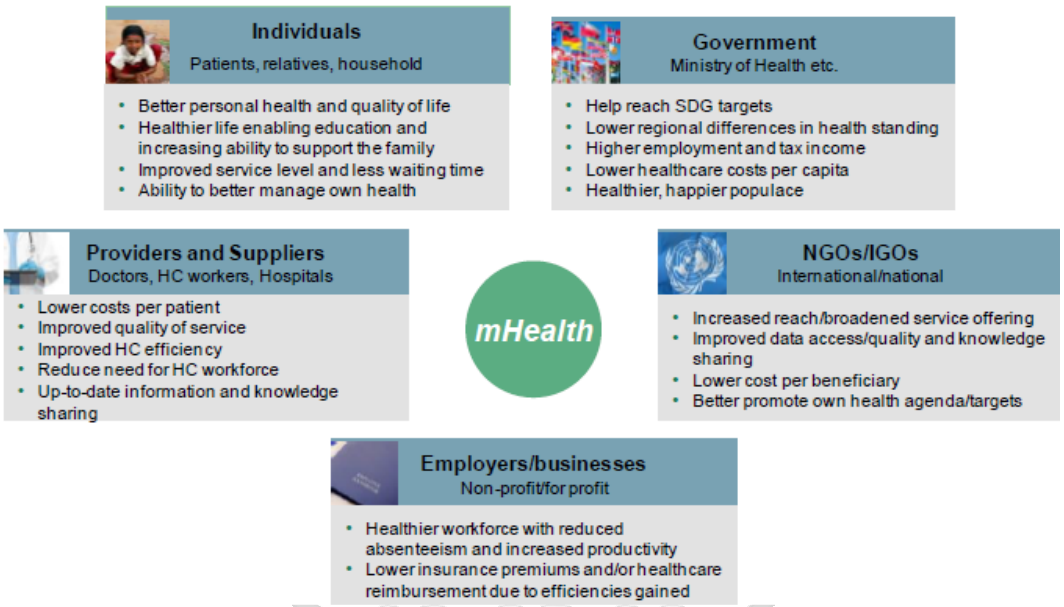


Figure 2.3 Stakeholders Benefits from mHealth (BCG, 2012)

2.5.1 mHealth Challenges and Solutions

In spite of the increase in demand, mHealth solutions comes with some drawbacks.

2.5.1.1 Confidentiality of data

Security and safeguarding of individual data are self-evident concerns for the Healthcare industry since compliance with the Health Protections Portability and Accountability Act is basic. Extra issues emerge when brand harm happens due to ineffectively created or executed mobile applications. In case they come up short clients are likely to become baffled and rapidly lose interest within the application. Mobile health needs appropriate regulation, clear rules, and policies to guarantee Ensured Health Data information (PHI) is taken care of correctly. Agreeing to the Healthcare Information and Management Systems Society, less than 30 percent of offices have mobile device utilization policies and 75 percent of mobile health clients search personal health information. (Modi & Mohanty, 2015)

2.5.1.2 Market volatility

Advertise conditions in the market and the issue of devices advancing quickly. Buyer habits moreover alter quickly, and request can be inconsistent, based on most recent patterns. As both components are beyond the payer's control, it is paramount to remain current and refresh applications regularly. (Modi et al., 2015)

2.5.1.3 Innovation

Whereas mobile devices offer numerous ways for healthcare payers to get connected with patients, such advancements are at times not exploited. Creating innovative thoughts requests the most extensive conceivable interest and a culture that appreciates the idea that not all thoughts will succeed. Innovation is troublesome because it requires that organizations go past the 'me too' approach. (Modi et al., 2015)

2.5.1.4 Integration with existing IT systems

With the advancement and utilization of mHealth, healthcare organizations ought to guarantee that these mobile applications and innovations are integrated with existing health ICT systems and standards. For that to happen, most recent mHealth technologies got to be appropriately researched and all gaps during integration should be resolved.
(Modi et al., 2015)

2.6 mHealth Architectures

2.6.1 A mHealth Architecture for Diabetes Self-Management System

Figure 2.4 depicts the diabetes self-management architecture. The designed architecture comprises of five components: an acquisition component, a mobile client, a cloud-based decision support, a patient portal, and a provider portal. Physiological data are acquired by means of sensors and are transferred to the mobile device, which is at that point transferred to the cloud in real time. Decision Support Systems component within the cloud analyze the information and give feedback to the patient. In the event that an irregular circumstance is identified, a caution is sent to the patient and to their registered clinicians. The data is additionally stored within the patient's portable device in this way they may access it at any time. Patients can moreover see their information, create the summary report, communicate with clinicians, and analyze their overall condition through the patient portal. Clinicians use the provider portal to screen and analyze the patient's condition, and to supply therapeutic counsel. (El-Gayar,Timsina & Nawar, 2013)

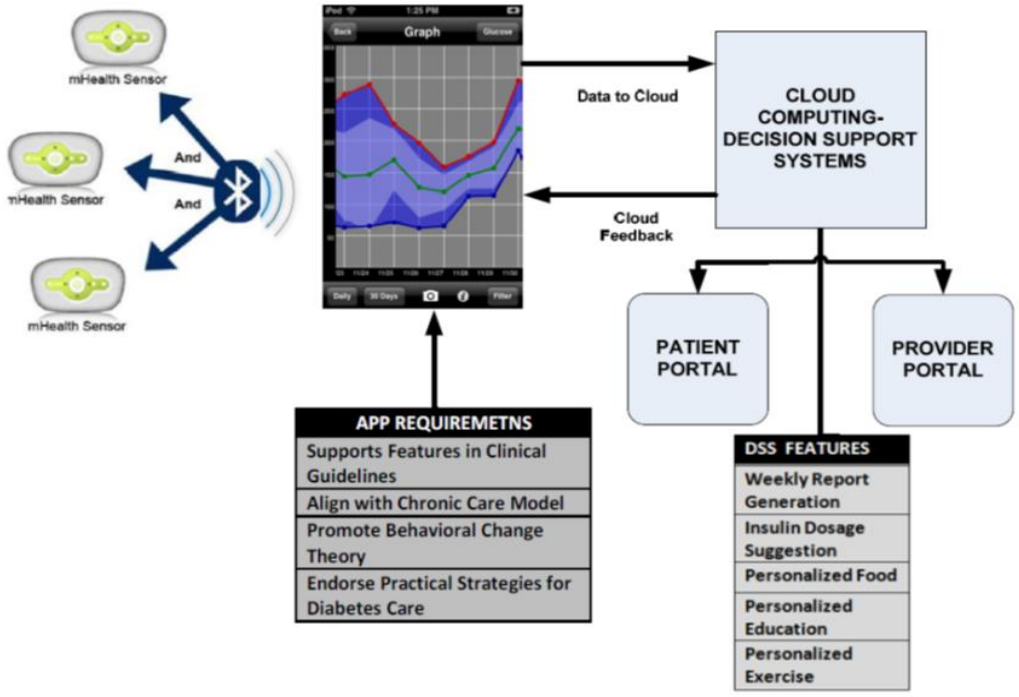


Figure 2.4 Architecture for Diabetes Self-Management (El-Gayar et al., 2013)

The architecture permits the automated data acquisition from the sensor gadgets to the diabetes mobile device utilizing BluetoothTM technology. The automatically transferred data incorporates physical movement, weight, blood glucose, blood weight, and diet. For the most part, three methods are utilized to measure physical movement: work out logs, heart rate estimation, and accelerometers to degree the development. The mobile client supports two sets of features. The primary set of features of diabetes self-management incorporates checking physical movement, diet, blood glucose, diet, and. While, the secondary set of features incorporates weight, blood weight, instructive materials, communication with a doctor through email; long term complication management facilities (foot care, eye care, immunization); integration with social organizing sites such as Facebook, Twitter; integration with cloud system; alert facilities; labeling of information recorded; and security that matches the HIPPA standards. (El-Gayar et al., 2013)

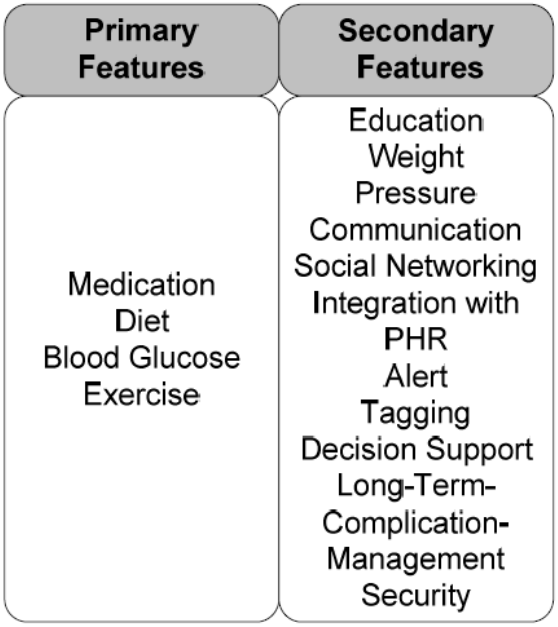


Figure 2.5 Features of Smartphone Application (El-Gayar et al., 2013)

2.6.2 A High Level Reference Architecture for Mobile Health

The GSMA recognises that the mobile ecosystem ought to characterize a reference design that will back the mobile health space and integrate into its current systems as shown in Figure 2.6. This architecture ought to focus on three key areas naming characterize the existing capabilities that the mobile industry can bring to mobile health solutions, highlight the benefits of working specifically with a mobile operator instead of an 'over the best provider' and how a mobile operator is separated from a conventional healthcare ICT provider and create an architecture that would empower mobile operators to support the mass space deployment of mobile health products, services and devices. (Groupe Speciale Mobile Association [GSMA], 2011)

This architecture ought to too give details around direction on how to integrate a mobile health solution into mobile operators' current network architectures, indicate the distinctive components of a mobile health solution in conjunction with the critical information around the laws and regulation that each of the components will be subjected and improved to develop the layout prerequisites for a mobile health gateway and its capabilities and assess the current capabilities that can be upgraded to support new value add services for healthcare solutions (GSMA, 2011)

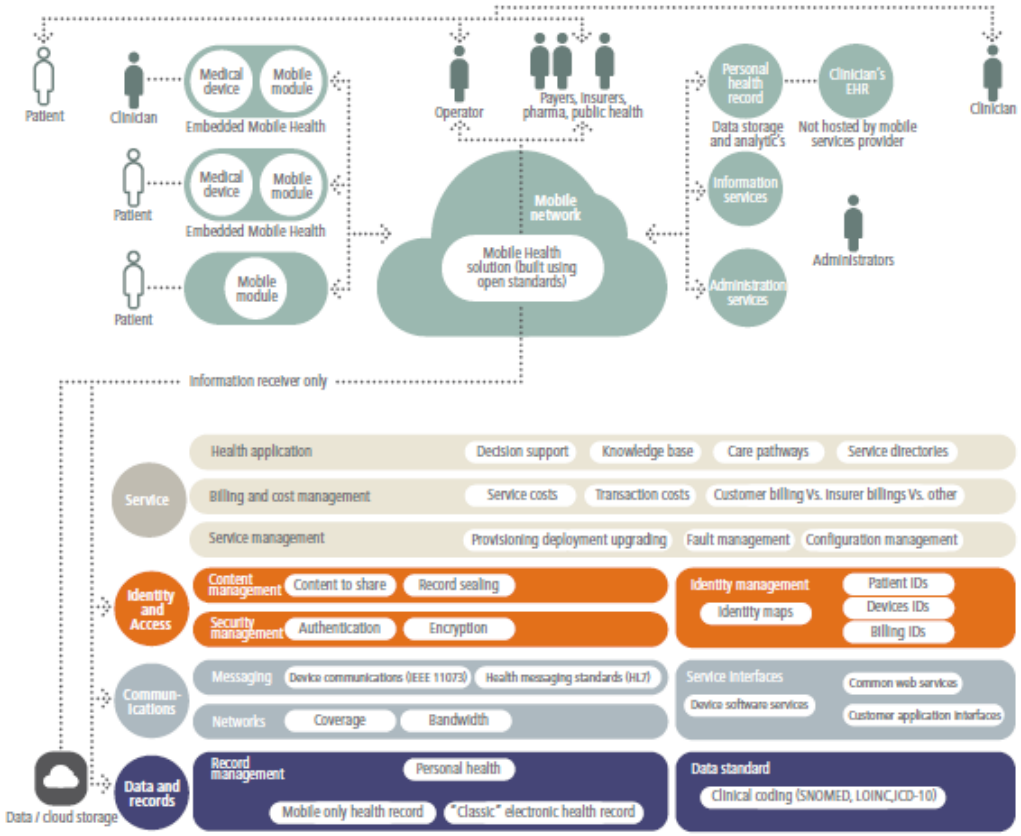


Figure 2.6 High Level Reference Architecture for Mobile Health (GSMA, 2011)

2.6.3 SAGES mHealth Architecture

Suite for Automated Global Electronic bioSurveillance (SAGES) architecture has been designed on a model of supporting full end-to-end cellular communications for data collection. It consists of three major components, a mobile data collection platform, a mobile data getting stage and an extract, transform, and load (ETL) process as shown in Figure 2.7 The information collection stage, mCollect, is an Android application that has been created on top of the open-source ODK Collect system. It gives customized form-based information collection and in this way can support the collection of both individual patient data and aggregate condition counts. The ODK brand offers tools that can be utilized to create custom forms tailored to the requirment of distinctive reporting locales, and these forms can be shared among all of the users of mCollect as portion of a SAGES deployment. mCollect incorporates a few mechanisms for data validation and quality assurance, which fulfills the prerequisite at the point of data entry. (Poku & Katz, 2014)

Broad work was done to make a multipart SMS protocol, which permits for sending data in amounts that would something else be as well expansive to package into a single SMS message (ordinarily constrained to 140 characters). Due to the privacy issues related to open transmittal of sensitive health information, a capability for sending and accepting encrypted and multipart SMS messages was created. The system supports Advanced Encryption Standard 128-bit symmetric key encryption. (Poku et al., 2014)

The data receiver application, mReceive, has been designed to support deployments where at minimum 2G cellular data connection is accessible. For this use case, it has been executed as an application on top of the open-source RapidAndroid system. mReceive runs on an Android phone that's tethered through universal serial bus to the OpenESSENCE workstation, web system that gives information warehousing, analysis, and visualization capabilities. This framework was expanded in a design comparable to that utilized for the mCollect application, adding the multipart SMS and data encryption capabilities. In addition, an automation suite was built into the application, empowering mReceive to repackage and send out data received in a form appropriate for utilization by the ETL process. (Poku et al., 2014)

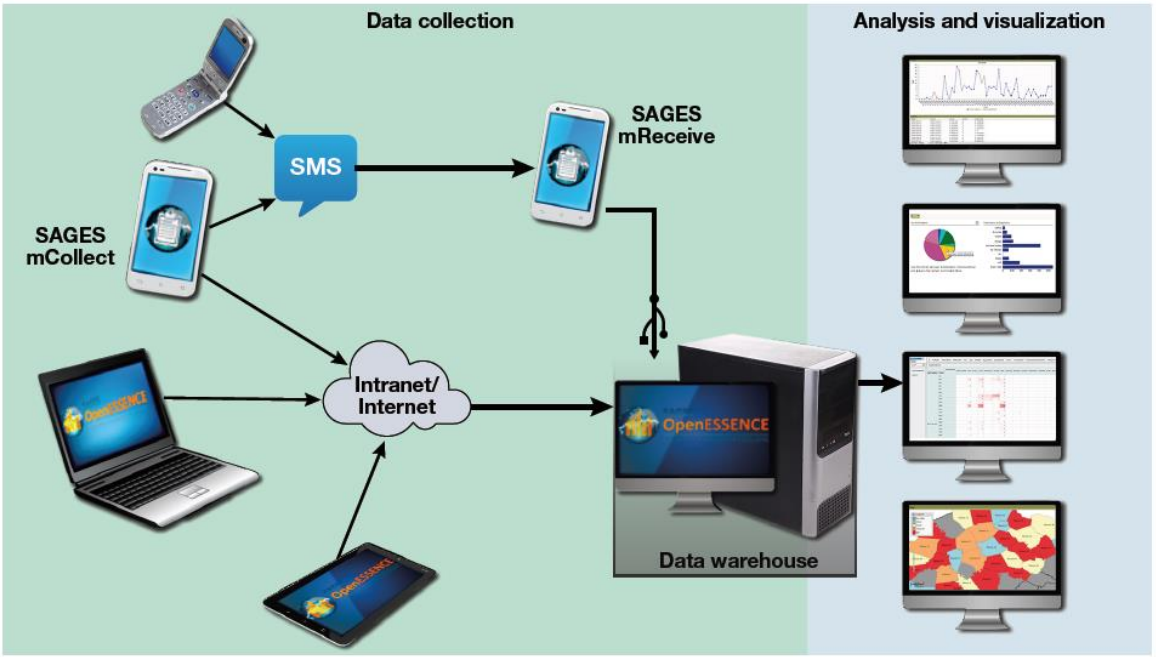


Figure 2.7 SAGES High-Level Architecture (Poku et al., 2014)

2.6.4 Architecture for Monitoring and Assessing Environmental Exposure

The mMamee platform takes after a client-server architecture as shown in Figure 2.9, utilizing smart-phones and a sensing infrastructure over a cloud as shown in Figure 2.8 The sensing system is conveyed at the urban environment for recording surrounding conditions, such as temperature, humidity, CO2 within the air, and level of noise in the city , as well as particular lists of contamination in private environments, such as the quality of consumable water and percentage of dust within the atmosphere. This data is collected in a self-organized and automated manner over wireless systems and is occasionally transferred within the Urban Detecting database system. The management of the Urban Sensing database system depends on cloud services, which embrace the design principles of OpenStack cloud operating system and the Open Cloud Computing Interface (Karagiannaki, Chonianakis, Patelarou, Panousopoulou and Papadopouli, 2015)

The mMamee client is deployed on ordinary smartphones and is able to capture every day movement of maternal women, by every so often recording their area inside the urban environment utilizing either conventional sensors GPS or IP-based localization , permitting the individuals to complete an appropriately formed questionnaire, related to their day by day habits, at a time of their own comfort. These sources of heterogeneous data are combined at a cloud-based server, comprised of advanced components, responsible for taking care of security and privacy issues, as well as for extracting, analyzing and storing potential sources of contamination, encompassing conditions, and high-level semantics on day by day habits. Particularly, multivariate analysis on urban and residential data is utilized for extracting potential sources of pollution. (Karagiannaki et al., 2015)

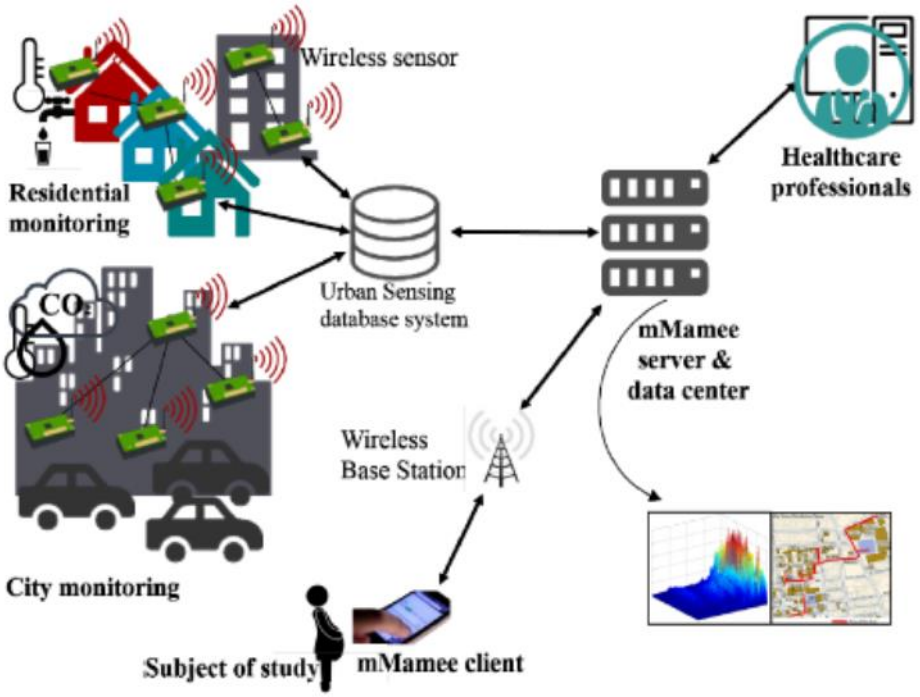


Figure 2.8 The mMamee architecture (Karagiannaki et al., 2015)

The results are correlated to users day by day movement, based on time and location information. The refined information is accessible to the healthcare experts via secured web services, for advance classification and generation of long-term profiles of environmental exposure to maternal women. The mMamee platform embraces a structured design approach, based on which the sensing technology is decoupled from the remaining of the platform. As such, the basic perspective for the architecture of mMamee is the accessibility of streams of urban sensing data, and not the hardware subtle elements of basic sensing infrastructure, given that urban information are accessible on a remote database system, the platform contributes on its intelligence, and program components for customary smartphones for the integration of raw streams of urban data with eloquent input given by the users (Karagiannaki et al., 2015)

The eloquent input is within the shape of reactions to an on-line questionnaire, available at any time over smartphones. The substance of the questionnaire, go well past the dietary habits of the subjects and cover viewpoints related to the conditions of residential pollution way of life choices quality of consumable and cooking water, and quality of beauty care products utilized amid pregnancy. The presence of such a questionnaire permits the

system to record in a basic way the every day schedule of women in maternity, without abusing their privacy by continuous monitoring of their activities (Karagiannaki et al., 2015)

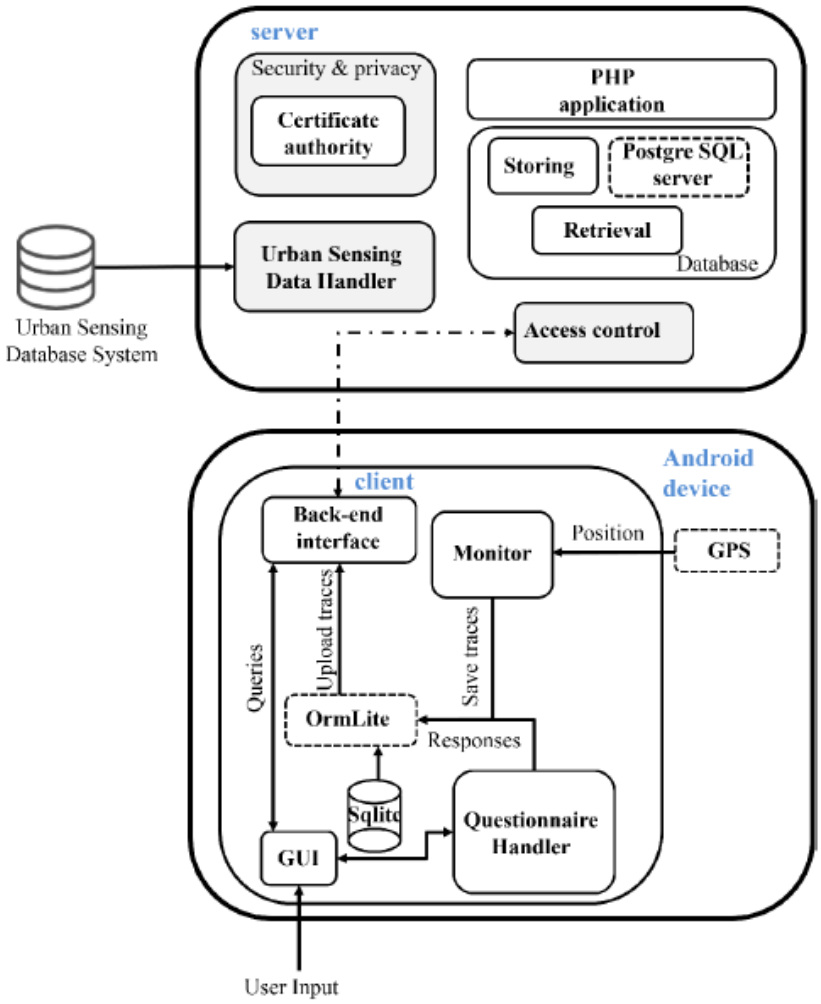


Figure 2.9 The mMamee client-server architecture (Karagiannaki et al., 2015)

The adopted client-server design guarantees the strong operation of the proposed platform, offering usefulness for addressing security and privacy perspectives that cannot be offered with peer-to-peer approaches, as well as for utilizing advanced strategies for metadata examination and control. More particularly, the center of mMamee depends on the client-server engineering of the u-map framework. The u-map may be a user-centric crowdsourcing-based suggestion system that empowers a client device running on a smartphone to observe the infrastructure of different services and collect opinion scores/feedback from users about their perceived quality of involvement for that service. The activities running at the front-end of the deployed client prototype is shown in Figure 2.10. (Karagiannaki et al., 2015)

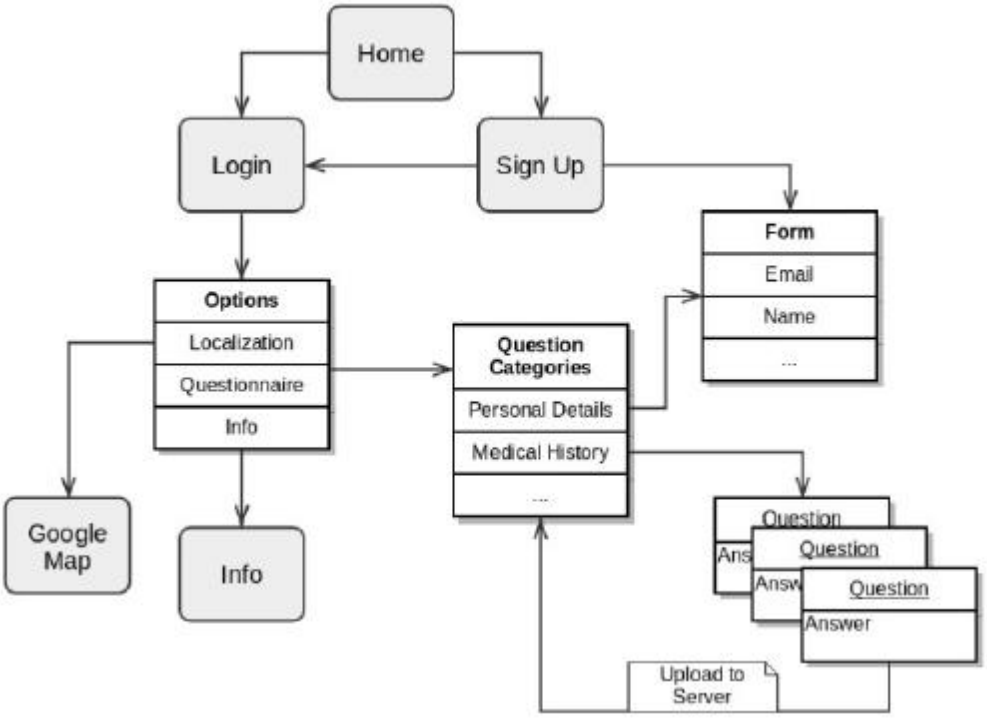


Figure 2.10 Activities of the mMamee client front-end Architecture (Karagiannaki et al., 2015)

2.7 Research in implementations of Mobile Technology in Data Collection

2.7.1 An M-Education Prototype for Data Collection: A Case of Teachers Service Commission – Kenya

According to Muthangya (2014) data collection in government supported schools in Kenya through existing Education Management Information Systems is still to a great extent paper based as data is collected through Data Return Forms comparable to questionnaires and afterward keyed into systems for analysis and reporting. This process takes time and inevitably results to an information gap in the Education sector. The research aimed at realizing the utilisation of mobile phone applications to gather and display real time data on the actual state of individual government supported schools and learning institutions in Kenya. It included an audit of existing information collection strategies and open source mobile phone application systems that informed the improvement of the M-Education application prototype.

The research concluded that the comprehension of mobile phone based data collection and reporting systems are attainable in collection of data in other sectors is noted and execution of such systems within the education sector in Kenya is fundamental and cannot be assumed. Current paper-based data collection and reporting strategies utilized

within the sector are obsolete as they make an information gap which impairs data driven planning and decision making which is a misfortune within the education sector. This hence call for utilization of accessible technologies such as the ones reviewed in the study to improve effectiveness and relevance of information systems in changing business environment in-line with different sectors. (Muthangya, 2014)

The limitation identified was that the M-Education prototype was developed based on the necessities accumulated from a sample of respondents inside Nairobi District in Kenya. This may not be a reflection of the complete state of the nation and other developing nations that confront the same challenges. Moreover, the M-Education prototype as it were works on android and apple based mobile phones. The current module was as it were been tried to work on the google Cloud service. For the application to be effective there's require for application advancements that don't drop beneath the scope of the current study. (Muthangya, 2014)

2.7.2 Mtafiti- A Mobile Based Micro Work Research Data Collection System

According to Otogo (2015) research data collection methods involve collection of data through research clerks who contact the respondents. This is through paper or an automated tool like a mobile phone. This model of data collection poses the problem of introducing interference in the research data collected by the research clerks. The interference can be mainly through the research clerk influencing the respondent's response or the research clerk modifying the responses received. The model also lacks proper ways of ensuring that the response given is actually from a valid respondent and not the research clerk's own personal composition, the research was to develop a mobile research data collection system that does away with the interference attributed to the research clerks.

The research concluded that Research is an important contributor to our socioeconomic growth as a country and the quality of any research finding is heavily reliant on the data used for that research and when technology is used for research data collection can greatly enhance the validity of the data collected, reduce the cost of data collection and ensures extensive coverage to the right respondents. However this has not been realised despite the present automation that has been seen in research data collection. This creates the need for a better implementation of research data collection that leverages in totality

power of the near ubiquitous mobile phones while ensuring the expected benefits of research automation are realised. (Otogo, 2015)

His consideration for future work included the system implementation in Kishwahili. This will serve to ensure reach to the many Kenyans who are not very conversant with English as a language and also to provide a more user-friendly implementation of the system, research study that will be advanced to implement a voice implementation of the research data collection system. This will give the user a platform for keying in phone key inputs in response to voice prompts. (Otogo, 2015)

2.7.3 A Compression-Based Mobile Data Collection System: A Test Case With Climatepal Project

According to Ruto (2014) the use of mobile phones for quick-time data collection is increasing rapidly around the world. Mobile-based data collection has proven to be a more efficient tool to perform data collection activities. While current mobile data collection solutions provide the necessary requirements for data collection, they are inefficient in terms of network bandwidth consumed during data transmission, especially when collecting significantly large amounts of data from a large population and a large number of surveyors. This is because as quantity of data increases, this increases the amount of data bandwidth, increasing the time it takes to upload surveys, data bundles consumed and stretches local memory which is limited. There is need to solve these problems through implementation of more efficient data collection systems. His study aimed at developing a mobile data collection application that utilizes data compression methods in order to improve data collection efficiency.

In conclusion Ruto (2014) indicated that he was able to identify a variety of existing mobile data collection tools. The most popular and useful tools were selected and investigated in the context of efficiency of data bundle and data used. The mobile tool chosen for implementation was mobile-web. It was identified as a suitable data collection tool and was implemented using HTML5 which has a variety of useful functionalities and applications. It includes geolocation location tracking and WebSQL for offline storage of data, played a vital role in strengthening the functionality of the system. The system is also flexible in that it is compatible across all platforms that are able to run HTML5 on their

native browsers he was able to was able to identify LZW algorithm as a suitable tool for mobile client-side compression for compression. The application was able to significantly reduce the data for local storage and uploading optimization

Future research and further improvements can be made to the implemented system as new the technologies emerge. While mobile-web technologies are limited to the phone's browser, more technologies are emerging whereby web-applications are becoming more and more powerful and can access and make use of other hardware components that may be useful for collection of multimedia information such as use of the camera or use of the speaker for voice/sound recording. Further research also needs to be done on how client-side data storage can be encrypted made more secure without negatively impacting performance due to limited processing capabilities. These improved technologies will make data collection for projects more detailed and accurate giving a more realistic outlook of what is happening on the ground. (Ruto, 2014)

2.7.4 A Proposal of a Mobile Health Data Collection and Reporting System for the Developing World

According to Shao (2012) Collection of Data is one of the critical components of public health systems. Decision, Policy makers, and health service providers require accurate and timely data in order to make strides in the quality of their services. The quickly developing utilization of mobile technologies has expanded weight on the requirement for mobile-based data collection solutions to bridge the data gaps within the health sector of the developing nations. The research examined existing health data collection systems and the accessible open source tools that can be utilized to progress these systems. He proposed a model utilizing open source information collection systems to test their possibility in making strides the health data collection within the developing nation setting. His area of concentration was on the statistical health data, which are made available to secondary health facilities from primary health facilities.

The study concluded that the proposed prototype has been developed to test the appropriateness and convenience of the accessible mobile and open source technologies in moving forward the reporting process. The evaluation indicated that the proposed prototype appears to be appropriate for moving forward the health data collection and reporting

systems within the developing nations. In any case, there's a requirement for additional study to assess the prototype in a real health environment based on information from the health data experts to design the solution to meet their requirements. (Shao, 2012)

Limitation of the study is that the proposed model has been developed basing on the prerequisites from secondary sources such as literature, in this manner it might not be deployed straightforwardly within the field or maybe it can be utilized to demonstrate the common process of the health data reporting utilizing mobile technology. Besides, the proposed model works as it were on Android based mobile phones and the current organization module has been tried to only work on Google Cloud. For the model to be successful on the field there's a requirement for a series of field tests and alterations that don't drop beneath the scope of the study. (Shao, 2012)

Further studies in the area of focus may endeavour to develop the proposed prototype utilizing information and requirements from the primary sources. Such works may center on improving health data visualization to progress the analysis process. The health data analysis process might moreover be progressed in such a way that a few of the decisions to be automated can be based on the collected data and integration of various heath data systems to prevent duplication of data and preserve the consistency of reports. (Shao, 2012)

2.7.5 A Mobile Solution for Road Accident Data Collection and Presentation

According to Derdus (2014) A basic key to support road safety management is accident data. Subsequently, it is vital to construct a road accident database and information retrieval system as a principal asset in moving forward road safety. Since the accident database should hold solid information, precise strategies for data collection must be put in place. Access to such data is imperative since it empowers road safety stakeholders to define sound safety measures, and assess those measures that are already available. His study centred on improving accident data collection by employing a smart mobile based application. That strives to improve data collection, whereas supporting mobility, ubiquity and precision.

In his conclusion he demonstrated that the application is able to take photographs of the accident scene, which keeps prove of the degree of harm, as well as video and voice of eye witness. In addition, the interface of the application is very intuitive because it gives recognition as opposed to recall. Input is minimum due to utilization of the autofill feature, certain pieces of information is pulled from the server by use of already uploaded data. As a result, errors coming about from data section are limited and speed of accident data recording expanded. All the information collected by the application is at that point sent to a central server over a 3G network. The application has a web interface for office based staff, who can utilize Google maps to recognize accident hotspots by mining area data from the database. Accident location information is uploaded on Google outline markers to attain this purpose. This can be a premise of recognizing accident hotspots, and based on information accessible, sound measures can be taken. (Derdus, 2014)

He recommended that the value of the solution can be achieved if backed by government initiative in an endeavour to have accurate accident information for progressed road safety this requires policy enacted by the key partners and government. He realized that accurate accident information is an critical asset in tending to road safety challenges, he shown that future investigate ought to center on elective situating innovations such as GSM, Inquire about has to be done on the utilize of GIS for mapping to complement utilize of external services such Google maps, There's have to be inquire about on best ways of transporting compressed mixed media information on 3G systems to avoid data loss due to frail connection and there's need for more study about on information analytics, which can help to extract sensible patterns from the accident database when there's sufficient availability of data. (Derdus, 2014)

2.7.6 A Mobile-Based Data Collection System for Researchers

According to Chemwolo (2014) data collection by utilization of questionnaires is the foremost well known strategy of data collection. Paper-based data collection is inclined to challenges such as the reality that it is tedious, insecure and is vulnerable to data inaccuracies. Her research was based on a prototype meeting the identified requirements and addressing gaps in existing .The prototype allows researchers to create questionnaires using a web-based application and to publish them to respondents through two channels: web and mobile application. The target respondents can then respond to the surveys using either a

web application or a mobile application. Researchers are able to collect data in offline mode when there is no network connectivity. The application also shows a map of the locations that data collectors visited. It makes use of end-to-end encryption to protect data. The dynamic nature of questionnaires has been catered for by allowing hiding of questions that are not applicable based on previous answers. It allows for encoding of questions and possible answers at questionnaire creation time and provides for downloading of collected responses in CSV format.

In conclusion a prototype was designed, implemented and tested. Some of the features that the prototype supports include offline data collection, end-to-end encryption and maps of data collection locations visited. One of the features that had been identified as a gap and that the prototype supports is configuration of open-answer questions for automatic classification/coding. The prototype also supports linking of different questionnaires so that the next questionnaire is automatically opened based on what answers that have been entered in another questionnaire. Piloting exercise and result from the survey indicate that the prototype is fit for use in a data collection exercise. (Chewolo, 2014)

Future work will involve focus on more advanced ways of coding open-answer responses such as by use of machine learning. Development of the system on other mobile software platforms such as Apple iOS operating system can also be undertaken. (Chewolo, 2014)

Chapter 3: Research Methodology

3.1 Introduction

This study used current mobile technological trends to automate data collection by developing a mobile application that aims at addressing the existing challenges of using paper based registers to collect data that have a negative impact on health service delivery to the community. The mobile application was designed to address issues of timeliness, completeness and accuracy of data that will contribute to improvement of service delivery since the data that will be generated with facilitate better and timely decision making on health interventions at the community level. The chapter highlights the methodology used to address the research objectives.

3.2 Feasibility

The research aimed at developing a mobile application to automate collection of health data that is done by the Community Health Volunteers, who currently use paper based registers to collect data manually.

3.3 Research Design

The research was based on applied research, since it aimed at finding a solution for an immediate problem confronting the health sector using manual methods in data collection, by automating health data collection at the community level and making strides on accuracy, completeness and timeliness of getting information that will inform on health interventions at the community level.

3.4 Location of Study

The research was conducted in Makueni County

3.5 Target Population and Sampling

The number of CHV's in Makeuni County is 4,092 (Makueni County Health Strategic and Investment Plan, 2013-2017) who serve a Community Unit of 1,000 households, each CHV is assigned 20 households.

To represent the larger group accurately this research will use the Yamane's formula to get the sample for use. Yamane's formula

$$n = \frac{N}{1 + N(e)^2}$$

Equation 3.1 Yamanes Formula

Where: N = Total population; n = Number of samples; e = Error tolerance

Using a confidence level of 80 % ,e=0.2 with a total population N= 4,092 Community Health Volunteers the sampe size will be 25 Community Health Volunteers

3.6 Data Collections and Procedure

Secondary Data sources were used to collect data and the paper based data collection tools Household Register MOH513, Service Delivery Log Book MOH514, Treatment and Tracking Register and Referral form MOH100 will be used as inputs for the application to be developed. More information more information was obtained by consulting the Community Health Volunteers to obtain requirements for automation.

Questionnaires were administered to gather information on the suitability and usability of the application for collecting household health information and to ascertain if the objectives of the automation were met.

3.7 System Analysis and Design

The system was designed using Data Flow Diagrams, Use Case Diagrams System Sequence Diagram, Class Diagrams ,Database Schema which includes ERD, to capture all the key indicators and information as per the requirements of the manual CHV's registers, Android Studio was used to develop the data collection application that will run on a mobile device.

3.8 System Implementation

The application was built on Android Studioutilizing the dynamic system improvement an agile software development technique that is an iterative, incremental approach that provides a four-phase framework consisting of feasibility and business study,

functional model or prototype iteration, design and build iteration and Implementation, each phase relies on several different activities and techniques as shown in Figure 3.1

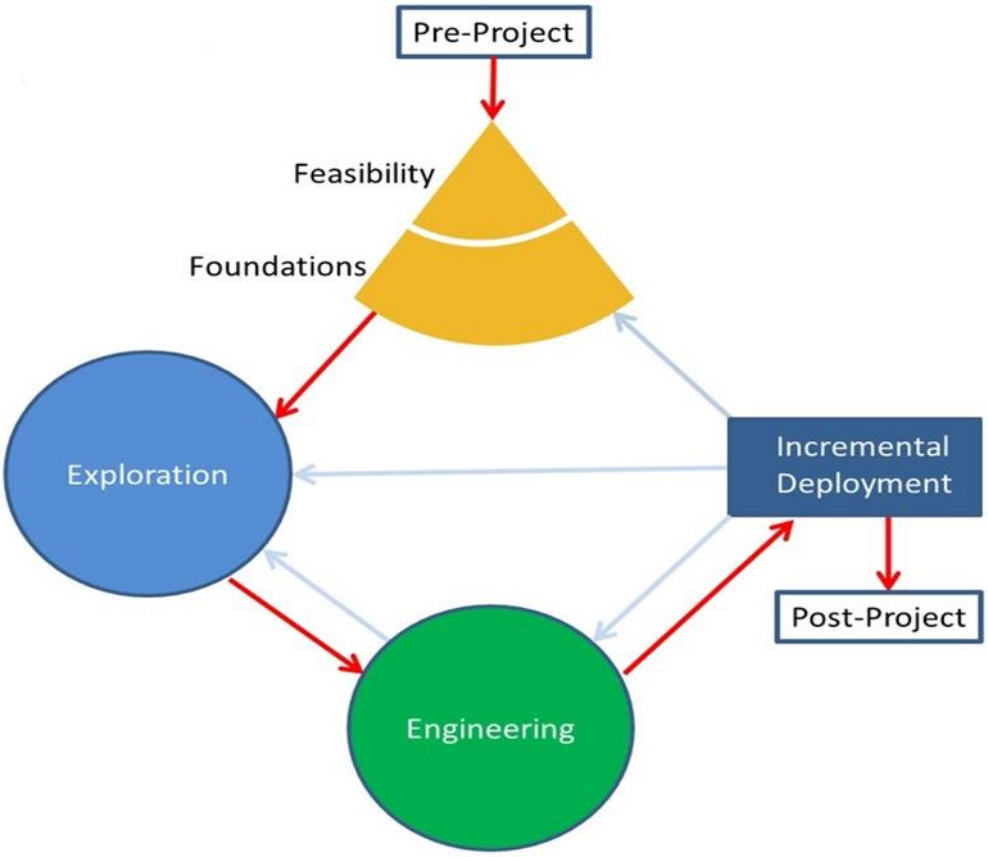


Figure 3.1 Dynamic System Development method

3.9 System Testing

The automated data collection application was tested by the Community Health Volunteer/Worker to ascertain that all data required is correctly and completely captured by the mobile application.

3.10 System Evaluation/Validation

The application was evaluated against the paper based data collection tools used by the Community Health Volunteers and questionnaires were used to determine if the application met the objectives it was designed to accomplish namely accuracy, completeness and timeliness.

3.11 Data Analysis

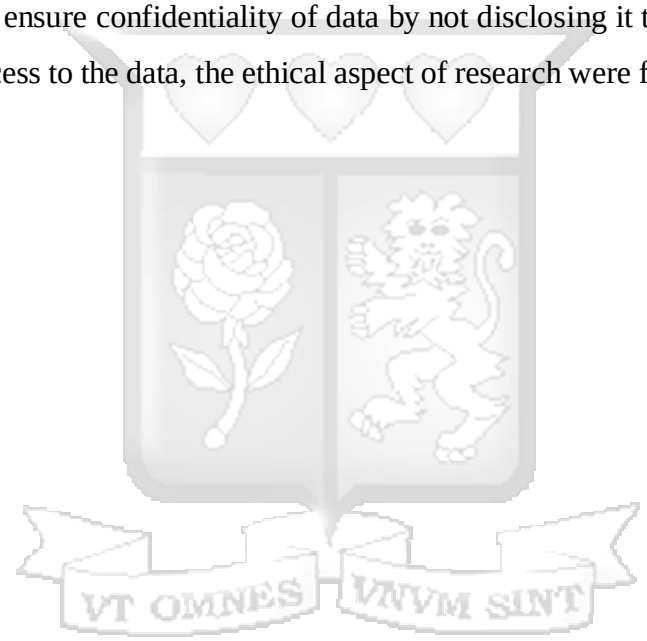
Microsoft Excel 2013 was used to analyze the data collected through questionnaires.

3.12 Research Quality

Research standards to guarantee quality within the study were followed in order to ensure quality in the research were adhered to in order to ensure validity, objectivity, and reliability of the research. Ensuring that accurate data that is clear, concise, valid and verifiable is collected and presented towards meeting the objectives of the research.

3.13 Ethical Considerations

The research used data collected from the mobile device that contains the household health status, I will ensure confidentiality of data by not disclosing it to any third party that should not have access to the data, the ethical aspect of research were followed very strictly.



Chapter 4: System Analysis and Architecture

4.1 Introduction

The development of the application involved analysis of the requirements of the mobile application and the design of the proposed solution to address the research objectives.

4.2 System Analysis

The mobile application was designed to collect the same indicators and information that the Community Health Workers collect using the paper based registers, MOH 513 Household Register, MOH 514 Service Delivery Log Book, Treatment and Tracking Register and MOH 100 Referral Form.

4.3 System Design

4.3.1 Level 1 Data Flow Diagram

Level 1 DFD showing the flow of information for the mobile application as shown in Figure 4.1 The CHV registers households and collects health indicators that is recorded in the Household register, provides service that is recorded in the service delivery log book, provides treatment which is recorded in the Treatment and tracking register, refers member to the health facility where they are received by the CHEW after which they are referred back to the community after treatment, the information is recorded in the referral register

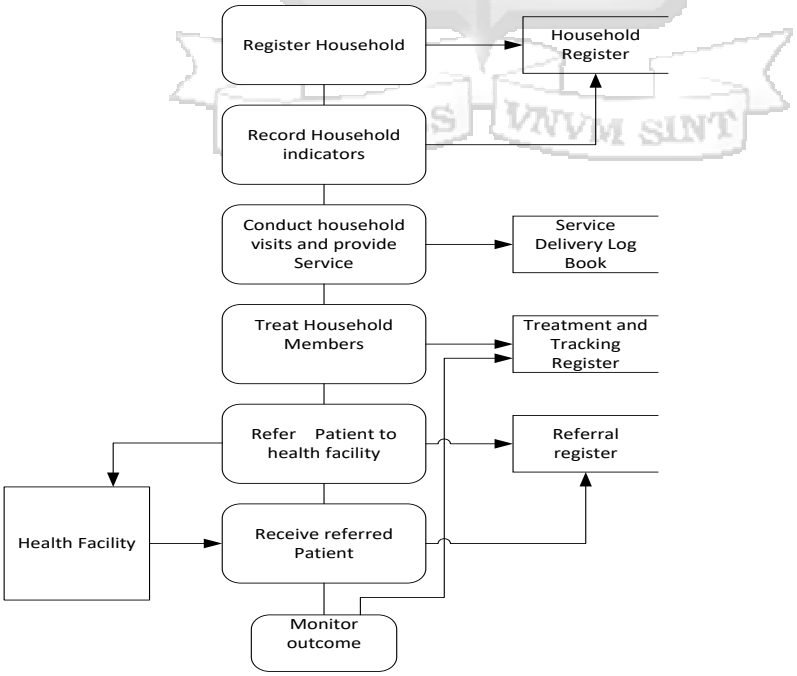


Figure 4.1 Data Flow Diagram

4.3.2 Use Case Diagram

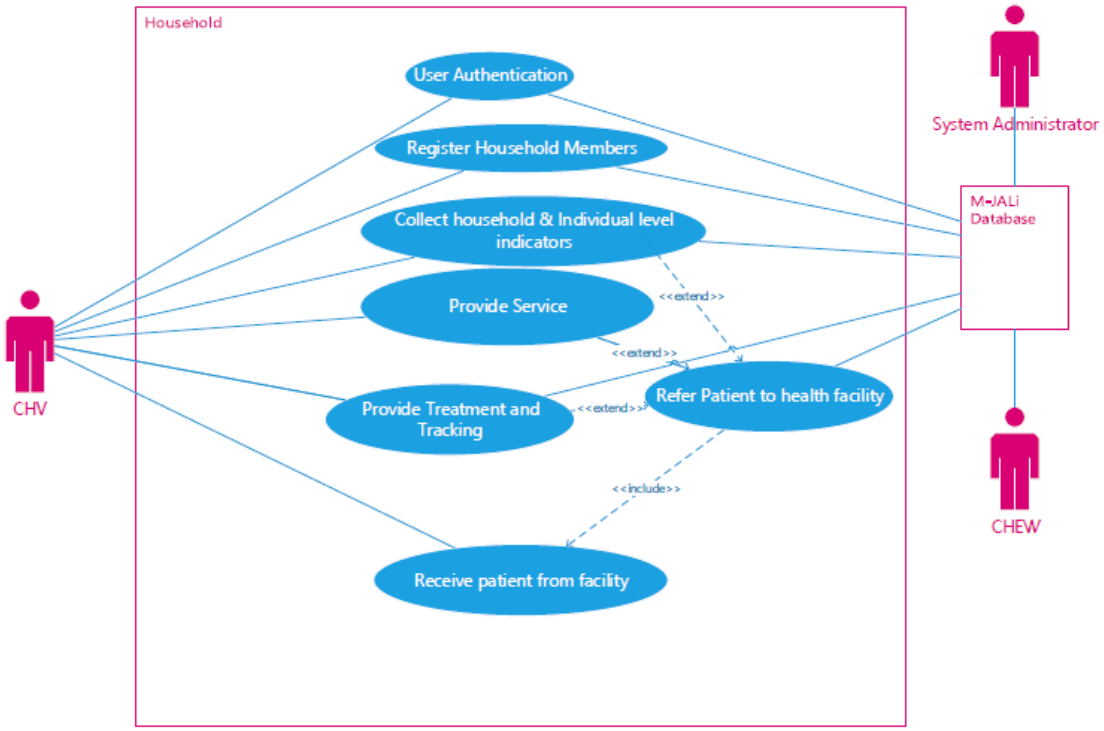


Figure 4.2 Use Case Diagram

Use Cases for the mobile application Table 4.1 and Appendix 5,6,7,8,9,10 and 11

Table 4.1 The Main Use Cases

Actor	**Use Case**
System Administrator	Manage Users Maintain Audit Trail View Reports
Community Health Volunteer	Register Household Members Collect Household Data Provide Health Services Provide Treatment and Tracking Refer patients to a Health Facility
Community Health Extension Worker	Manage Referrals View Reports
M-Jali Database	Manage and Store Data

System administrator creates accounts on the M-Jali web application for the CHV to use for login to the mobile application, the CHV uses the credentials provided to access the mobile application and create own PIN. The CHV registers new Household members, collects data for both the Household and Individual members, provides health services to the Household members, provides treatment by administrating drugs, first aid and the inventories are tracked, refers Household members to a health facility and the member is received by a CHEW who refers the member back to the community after treatment, The data collected by the mobile application is uploaded to the M-Jali database which also holds user data credentials.

4.3.3 Sequence Diagram

Figure 4.3 Shows the sequence diagram of the system with object interactions arranged in time sequence. It portrays the objects and classes involved within the data collection and the sequence of messages exchanged between the objects required to carry out the functionality of data collection via the mobile application.

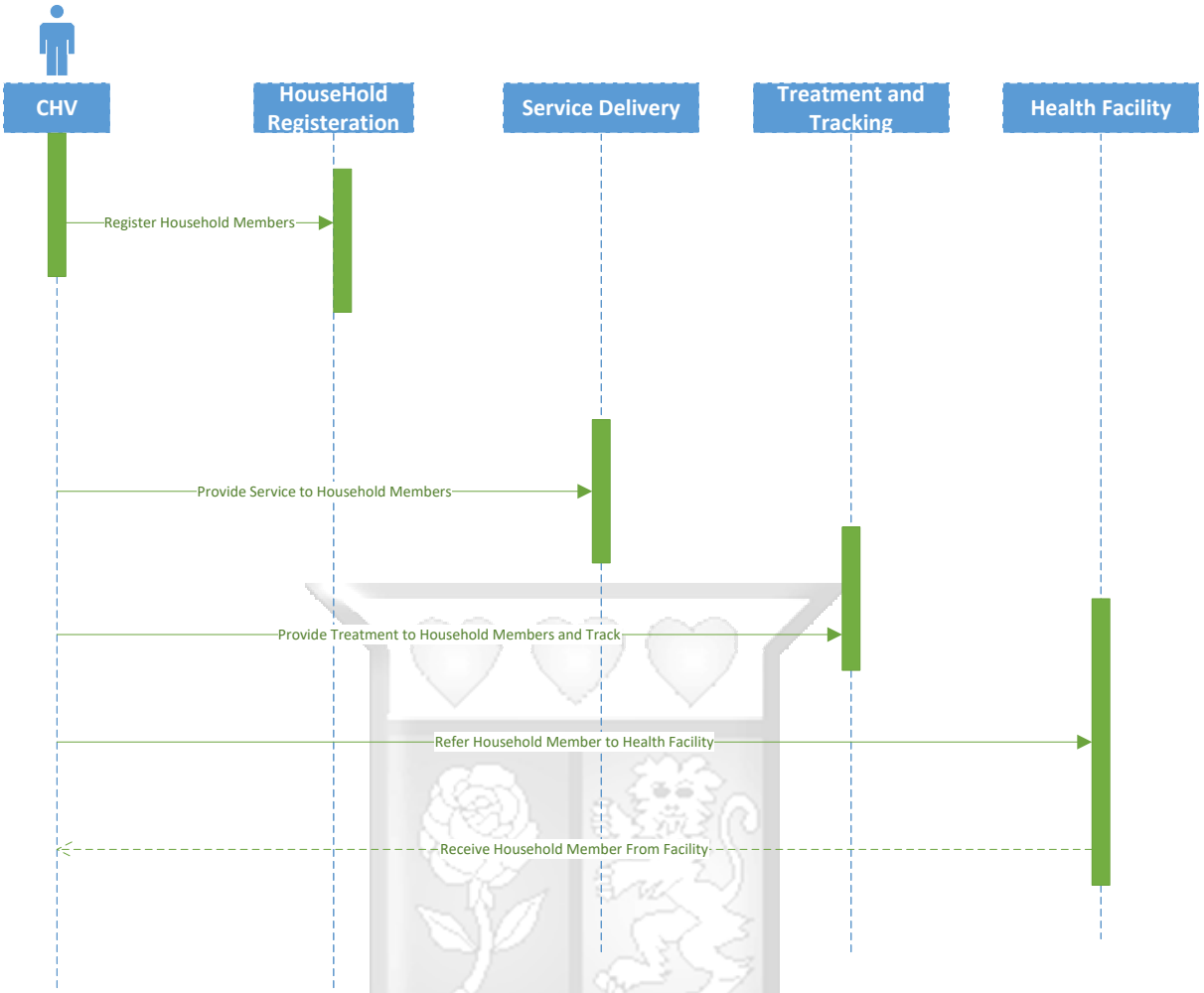


Figure 4.3 Sequence Diagram

4.3.4 Class Diagrams

Figure 4.4 Shows the class Diagram of the mobile application, that illustrates the relationships and dependencies among classes which defines the methods and variables in an object.

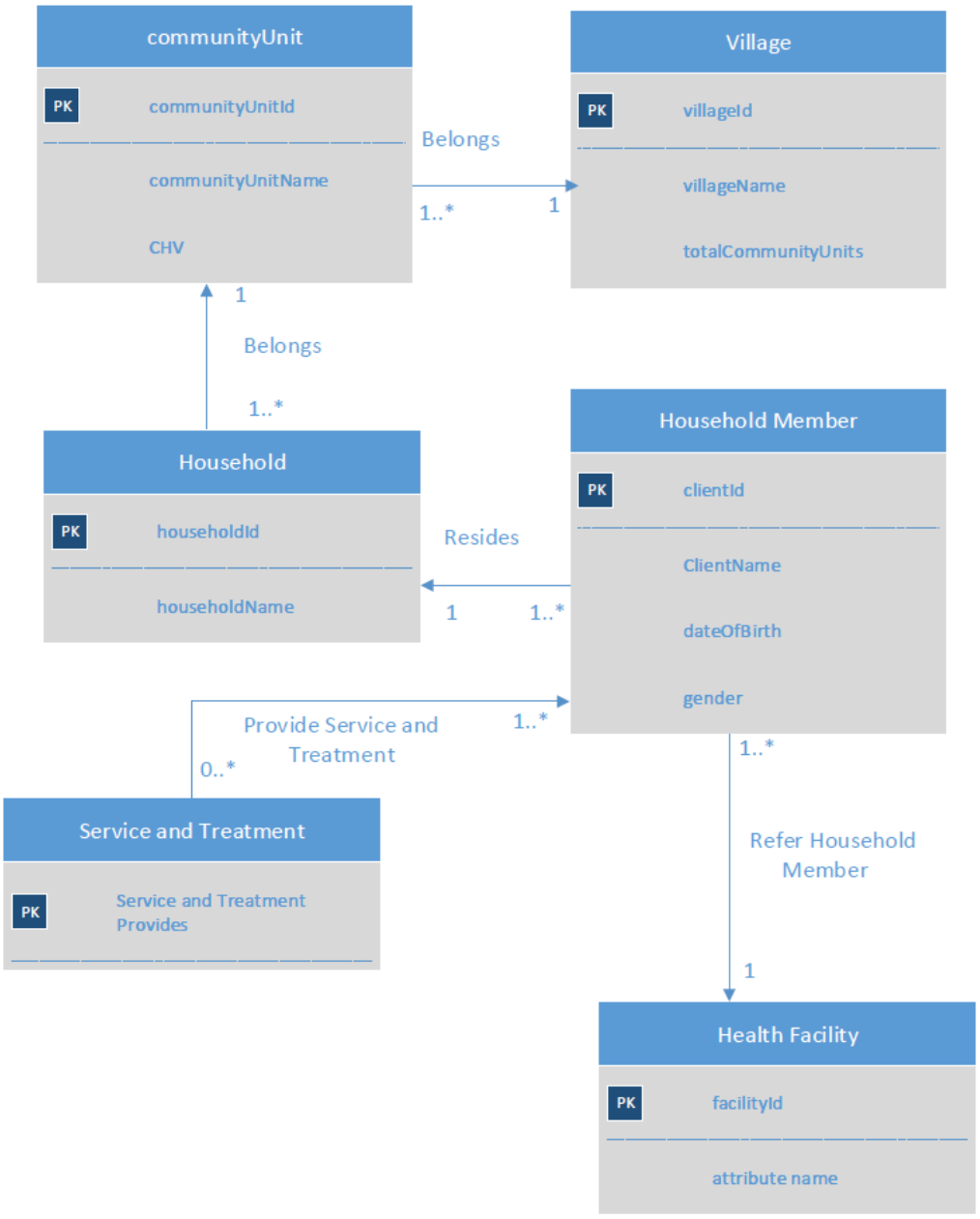


Figure 4.4 Class Diagram

4.3.5 Database Schema which includes ERD

Figure 4.5 Shows the Database Schema that includes ERD that shows the logical view of the database and illustrates the information system's entities and their relationships.

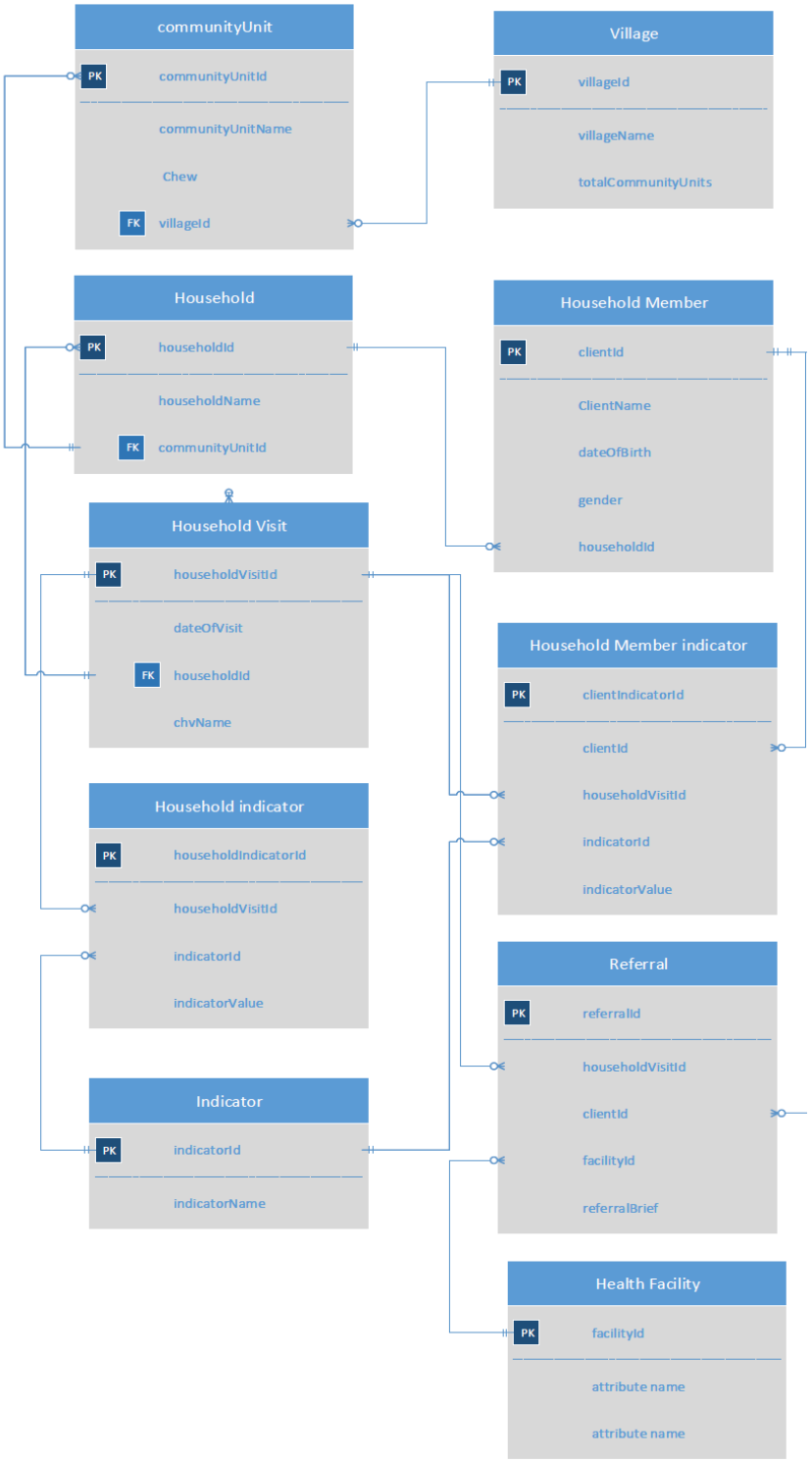


Figure 4.5 Database Schema that includes ERD

4.4 System Architecture

The Mobile application communicates with the database through a web API, as shown in Figure 4.6 the database is used to create user accounts of the mobile application and the collected data is uploaded to the database once GSM network has been established.

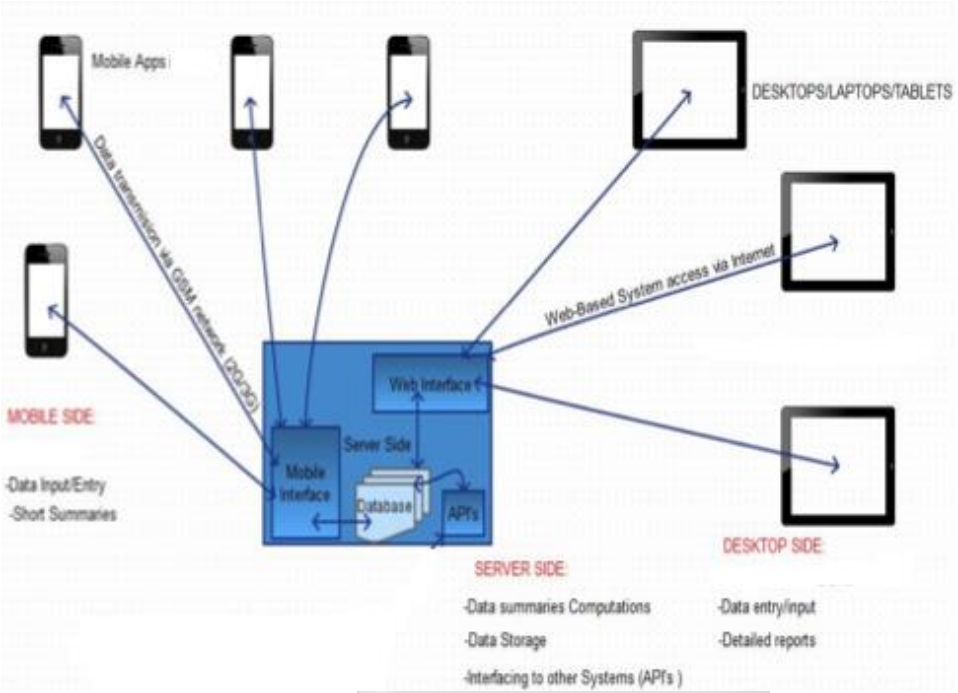


Figure 4.6 System Architecture of the Proposed System

4.5 API Methods between the Database and Mobile application

The following web API methods are used to interact with the android application. The web services are as described below with the relevant URL, consume method and expected results. The services also describe the expected response from every call and the format.

4.5.1 Authentication

URL:/login
Method: POST
Parameters:
: phone
: password
Response:
: login

4.5.2 Get villages in a Community Unit

URL:/village
Method: GET
Parameters:
: cu
Response:
: village

4.5.3 Get households

URL:/getHouseholds
Method: GET
Parameters:
: village
: page
Response:
: households

4.5.4 Get Referrals

URL:/referrals
Method: GET
Parameters:
: cu
Response:
: List of referral forms

4.5.5 Get Counter Referrals

URL:/referrals/counter
Method: GET
Parameters:
: chw
Response:
: List of referral forms

4.5.6 Get update fetched

URL:/referrals/fetched
Method: GET
Parameters:
: id
Response:
: referralform

Chapter 5: System Implementation and Testing

5.1 Introduction

The mobile application is built using Android Operating System(OS) and can runs on devices that have Android 2.3 to the most recent due to the upward, Android platform is easy to use and learn for a user compared to other platforms such as RIM and Symbian based OS. Android OS has a more advanced phone data storage SQLite database that is able to store large amounts of data on the phone hence reducing the need for continuous data availability in areas where network coverage may be a problem. The OS is able to run background services with ease and the cost of Andriod devices keeps reducing.

5.2 System Implementation

The system handles authentication at two levels when accessing the mobile app. The CHV's have to be added via the web in M-Jali application which hosts the database, before they can login. They use phone number and an encrypted password, plus a pin as shown in Figure 5.1 and Figure 5.2.

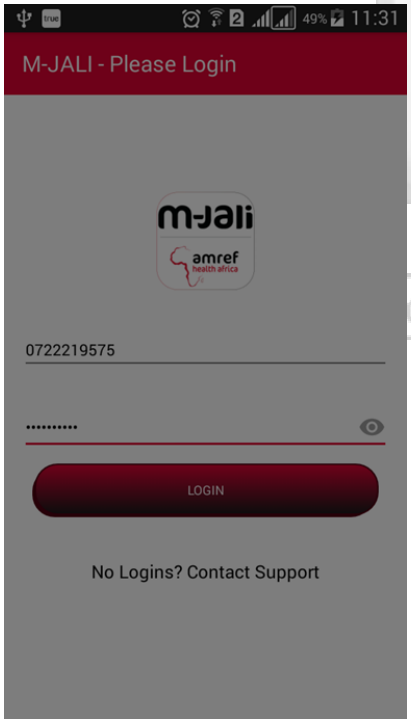


Figure 5.1 Login Screen

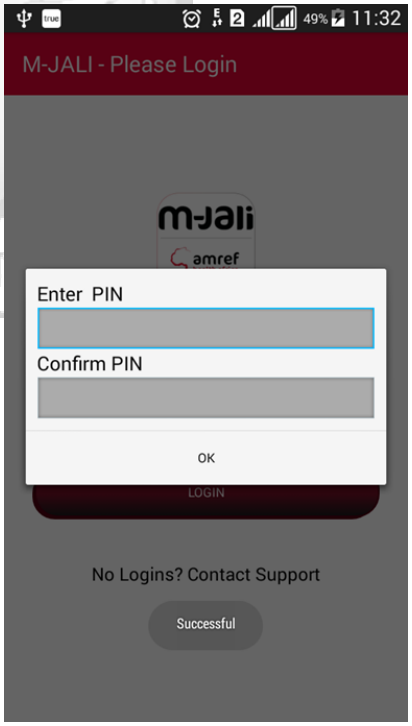


Figure 5.2 Pin Entry Sreen

The home screen of the application contains menus for all data entry forms as shown in Figure 5.4 which is available after selecting the village where data will be collected as shown in Figure 5.3.

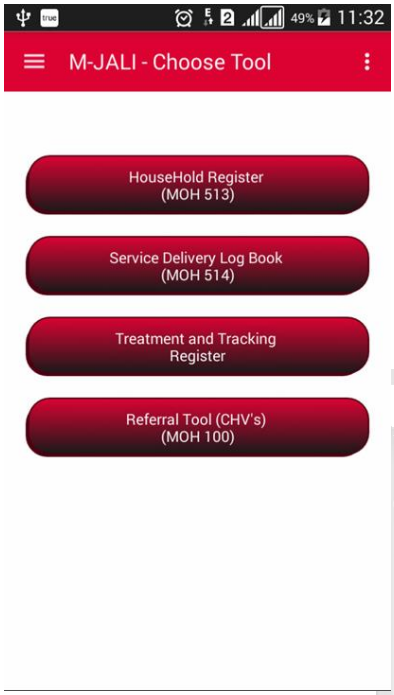


Figure 5.3 Select Village Screen

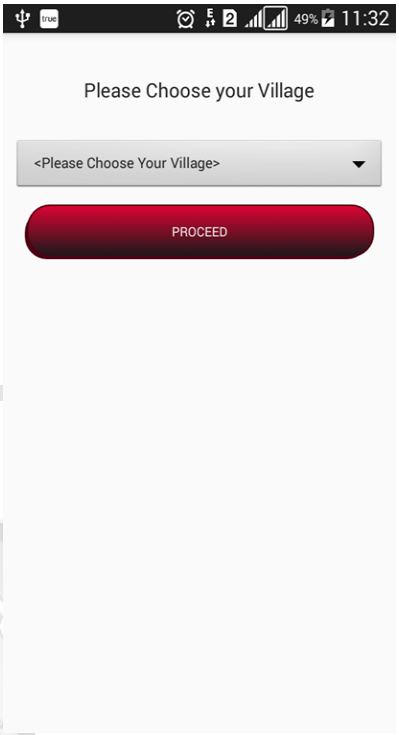


Figure 5.4 Main Menu Sreen

Household Register MOH-513 The application is able to send data from data capture location at household level in real-time when network coverage is available. In cases when network is not available, the application is able to keep detecting the internet availability and synchronize the data once it's online. The application is able to retrieve the current information about a Households data, demographics and diseases/disability for the user to update hence making it easy for the user to fill information and confirm improvements in the general health of a household.

The application allows creation of a new Household as well as new individuals in a new household as shown in Figure 5.5. This helps to keep the community unit updated on new and incoming individuals and households. The Household register has menu for Household data as shown in Figure 5.6 and Individual Indicators. Figure 5.7 shows the Household member screen where a member can be added, Figure 5.8 shows a system

prompts on the life status of the member, Figure 5.9 the system prompts if the member has relocated, Figure 5.10 and Figure 5.11 shows the individual data to be collected, Figure 5.12 and Figure 5.13 relates to data entry required for Female gender displaying the system skip logic feature, Figure 5.14 the system prompts one to ensure they have collected all the data, displaying the system feature of ensuring all data is captured.

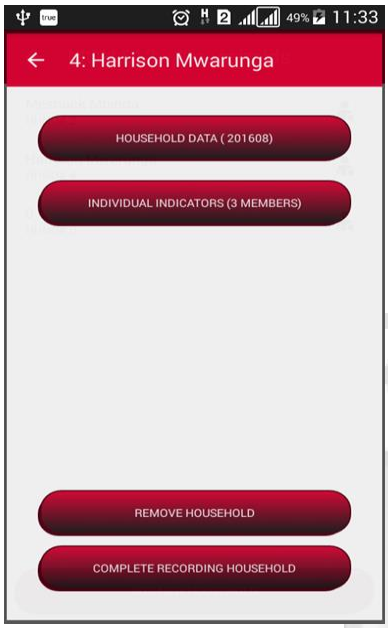


Figure 5.5 Household register main screen

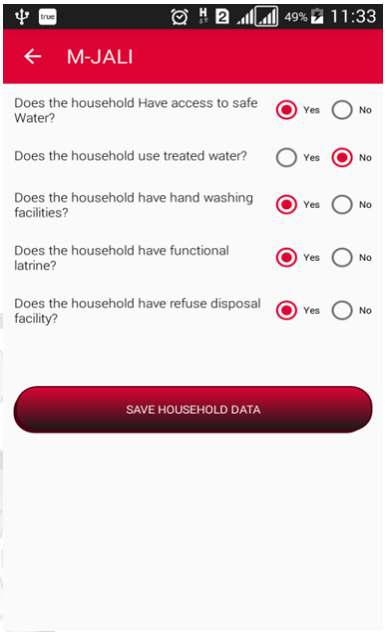


Figure 5.6 Household Data Sreen

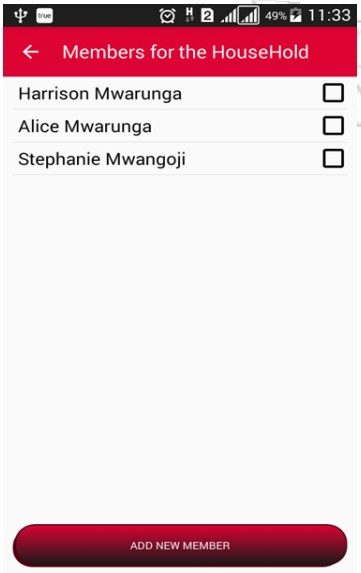


Figure 5.7 Household Member Screen

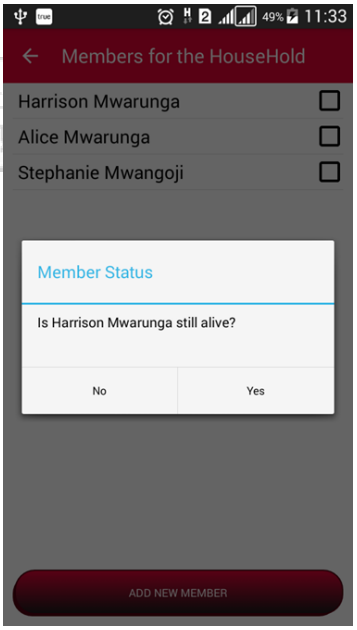


Figure 5.8 Query on Member Life Status

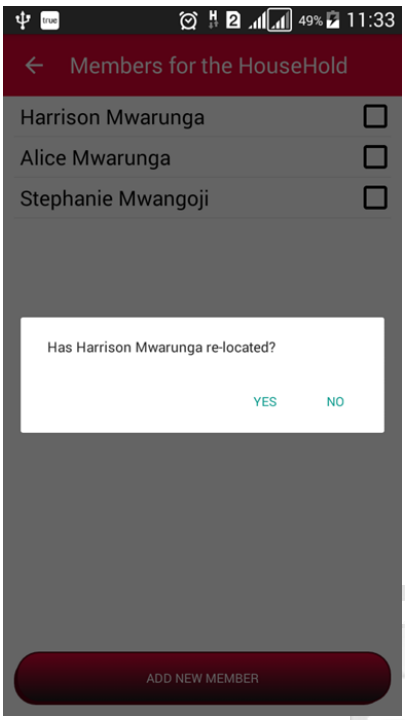


Figure 5.9 Query on Member re-location

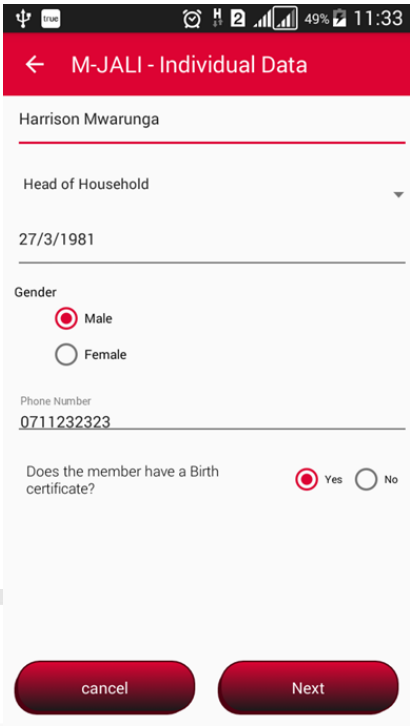


Figure 5.10 Individual Data Entry

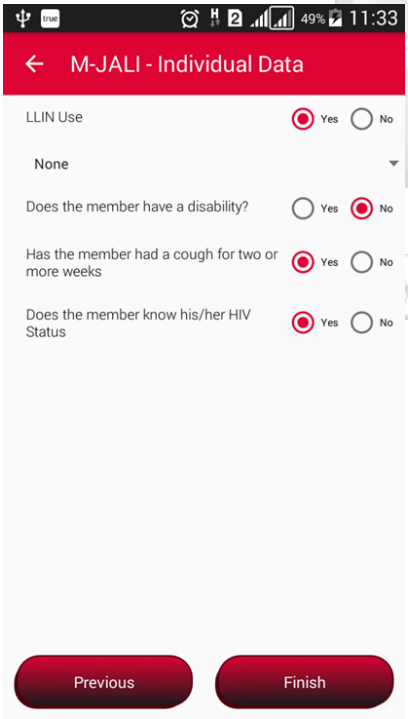


Figure 5.11 Individual data

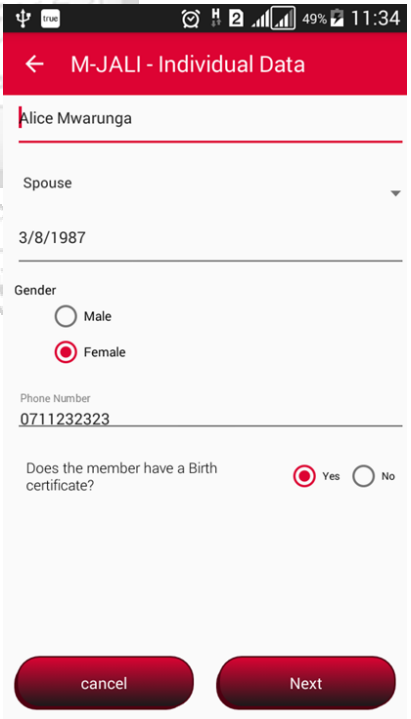


Figure 5.12 Individual Data - Female

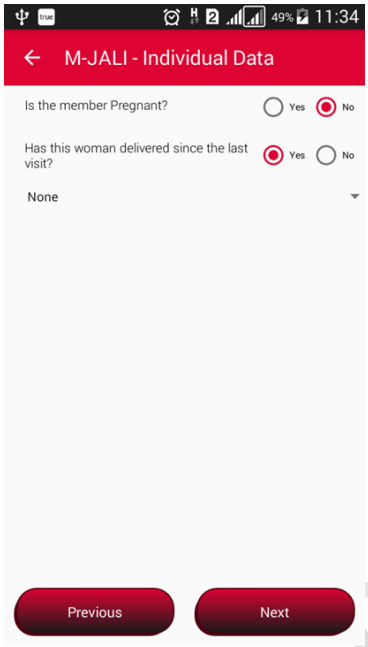


Figure 5.13 Female Indicators

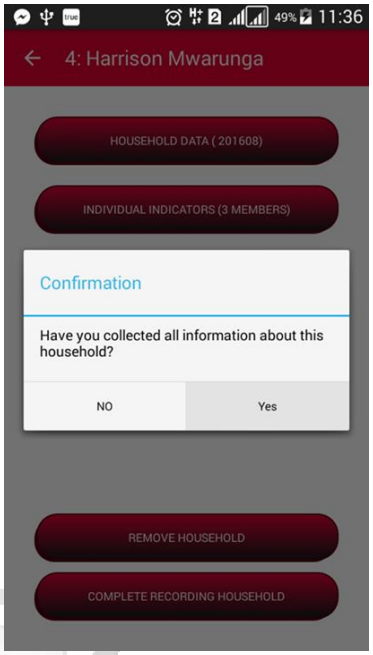


Figure 5.14 Completion Notification

MOH-514 (Service Delivery Logbook) The application is able to retrieve the households in a particular village that is in a certain CU. The application allows user to record all the information related to service delivery such as IBP plans, ANC, PNC, immunizations and growth monitoring as shown in Figure 5.15 and Figure 5.16. This information is submitted to the database for analysis in real time.

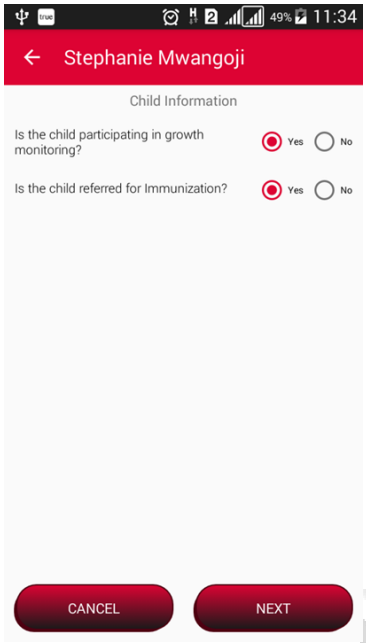


Figure 5.15 Child Information

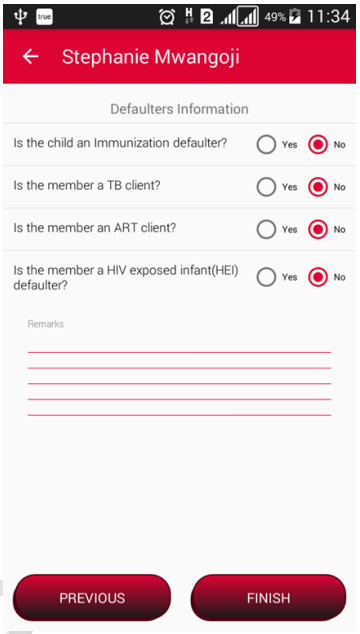


Figure 5.16 Defaulter Information

Treatment and Tracking tool helps in tracking the treatment offered to children under 5 years. The main aim of this tool is to ensure that all the supplies given to the CHV via CHV kits can be accounted for and any post-referral treatment given is noted. Figure 5.17 shows the Treatment and Tracking main screen, Figure 5.18 shows the entry screen for the household member assessment that captures the child illness details in terms of days ill, Temperature, if the child is breast feeding and the breathing condition, Figure 5.19 shows the screen that captures details on fever, Figure 5.20 shows the screen that captures details on Cough and Diarrhoea, Figure 5.21 shows the screen that captures reasons for referral and Figure 5.22 shows the screen that captures details on treatment and management provided to the household member

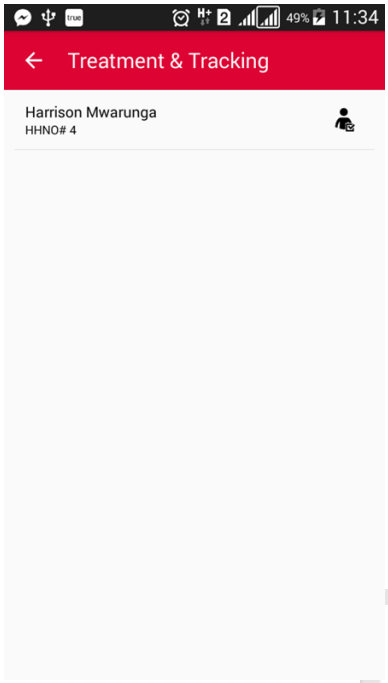


Figure 5.17 Treatment and Tracking Screen

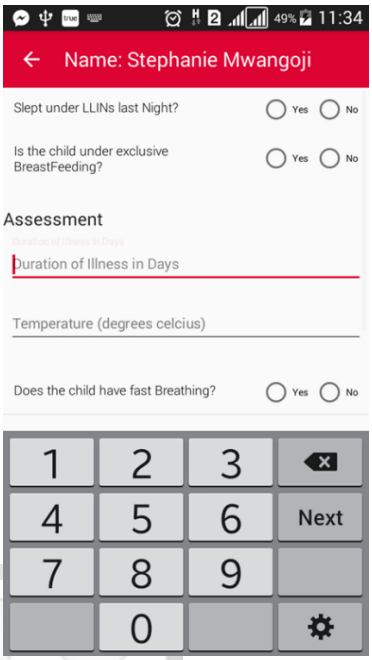


Figure 5.18 Ill member entry screen

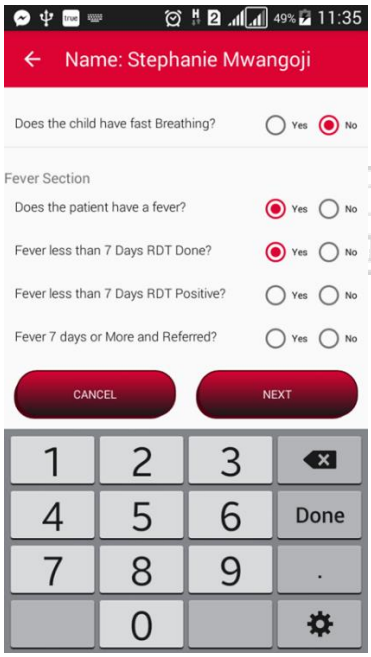


Figure 5.19 Fever Screen

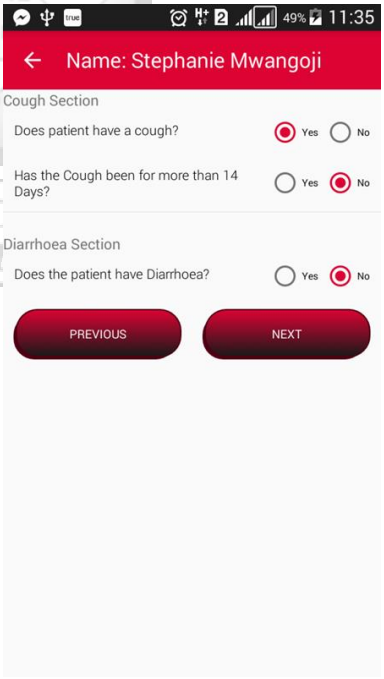


Figure 5.20 Cough and Diarrhoea Screen

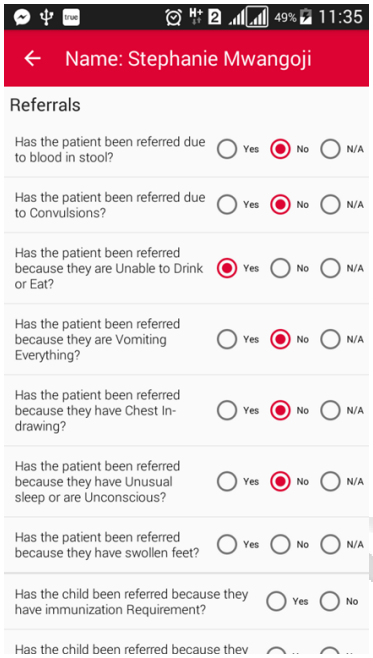


Figure 5.21 Referrals Screen

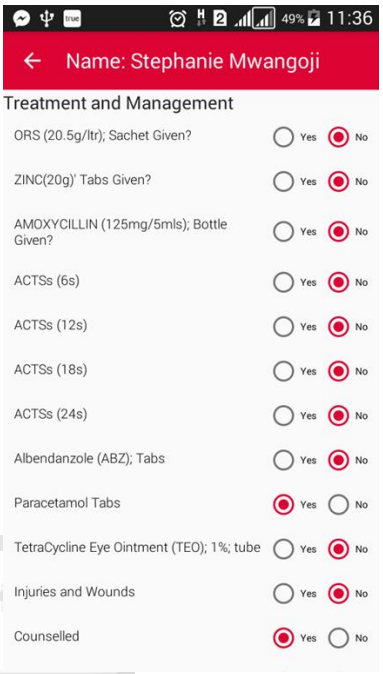


Figure 5.22 Treatment and Management Screen

MOH-100 (Referral Form): Used to post referrals to the nearest health facility and the Community Health Extension workers (CHEW) are able to view and respond to the referral and hence closing the referral loop. Push Notifications are used in delivering counter referral notices back to the CHV's from the CHEW's. Figure 5.22 shows the referral main screen where referrals are initialized, Figure 5.22 shows the screen that captures the member being referred by capturing the name, Gender and Date of Birth, Figure 5.25 shows the screen used to capture symptoms or problem that necessitate the referral, Figure 5.26 shows the screen used to capture any treatment or first aid administered to the household member, Figure 5.27 shows the screen used to provide comments from the CHV and Figure 5.28 shows the prompt from the system if one does not provide complete details on referral module.

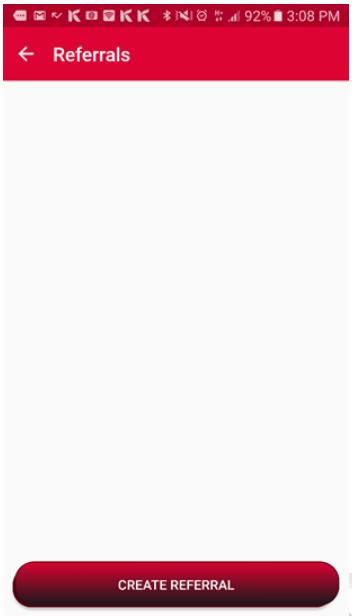


Figure 5.23 Referral Module

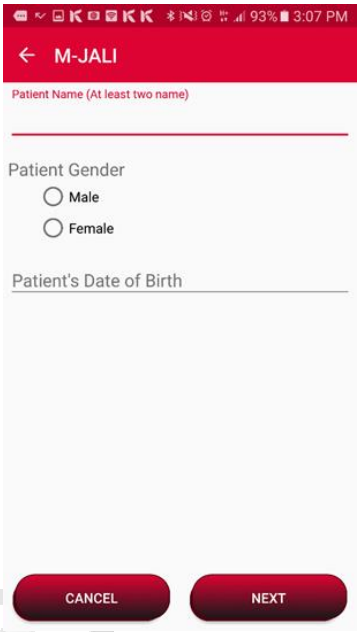


Figure 5.24 Patient details screen

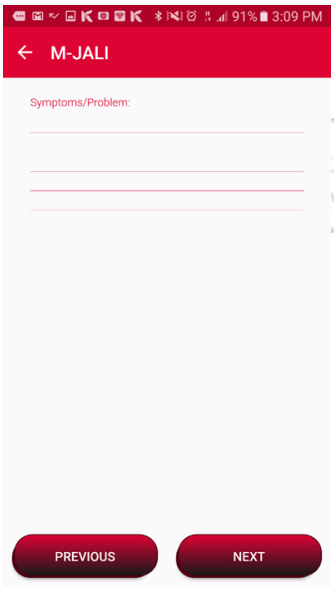


Figure 5.25 Symptoms/Problem Screen

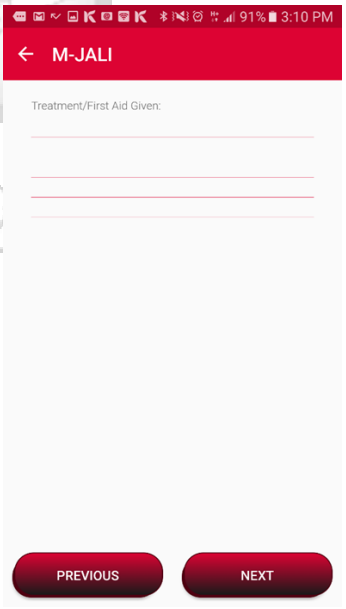


Figure 5.26 Treatment/First Aid Screen

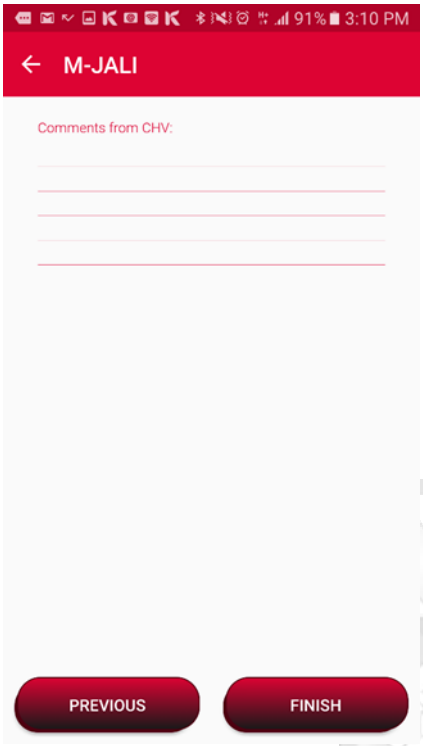


Figure 5.27 CHV comments screen

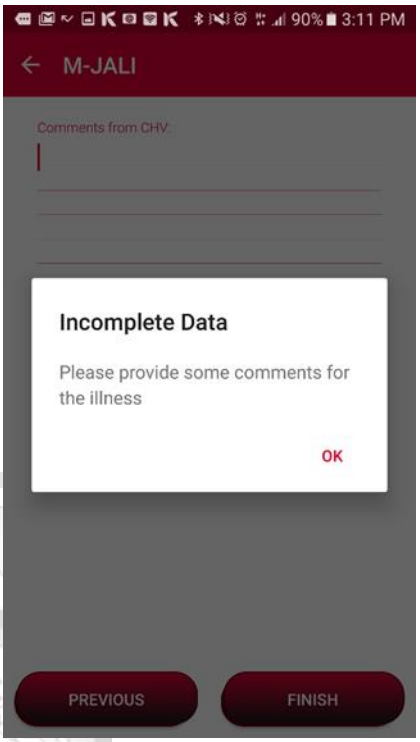


Figure 5.28 System notification on completeness

5.3 System Testing

The mobile application was built in an iterative process using reusable and independently testable units/modules, regular integration tests were done to ensure that the final product full cycle could start being technically visible from the start to the end. This allowed for detection of bugs from the beginning and sort them in the highly iterative development cycles, The final tests were successful for each module.

The Community Health Volunteers based in Makueni County, Kathonzweni were trained on how to use the mobile application to collect health data from the household, after the data collection exercise a questionnaire was administered to determine the useability of the application and to find out if the objectives of the research were met.

5.4 Application Testing Results

5.4.1 Mobile application login process.

As shown in Figure 6.1, 100% of the respondents agree that the login process is straight forward as shown in Figure 5.29 , they could login into the application without any issues. An indication that the application login process is easy as well as secure since they use a pin to gain access to the application

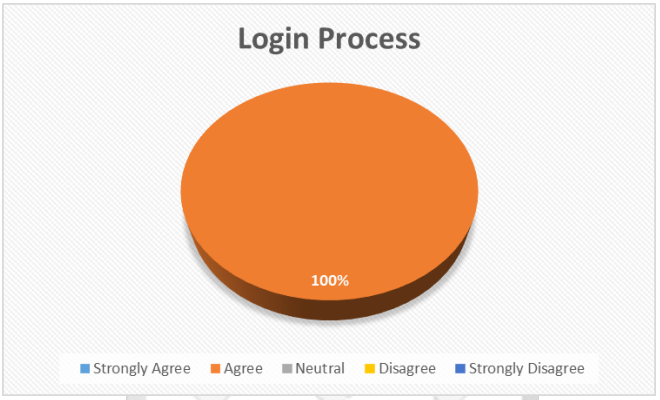


Figure 5.29 Response on the login process

5.4.2 Labelling of Menu Items

As shown in Figure 5.30, 13% of the respondents strongly agree and 87% agree that menu items labelled appropriately making them well understood, the labelling reflects what is captured in the manual registers making the learning curve short.

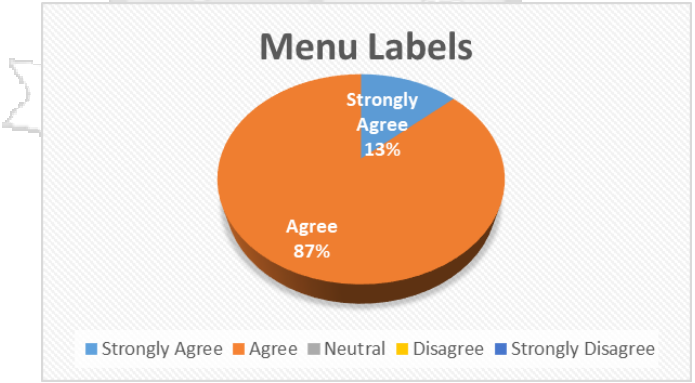


Figure 5.30 Response on labelling of menu items

5.4.3 Arrangement of Menu items

As shown in Figure 5.31, 20% of the respondents strongly agree and 80% agree that the menu items are well arranged to allow for ease of navigation within the mobile application, that contributes to the speed that the CHV's collect data thus improving on the time it takes for the data collection to be completed.

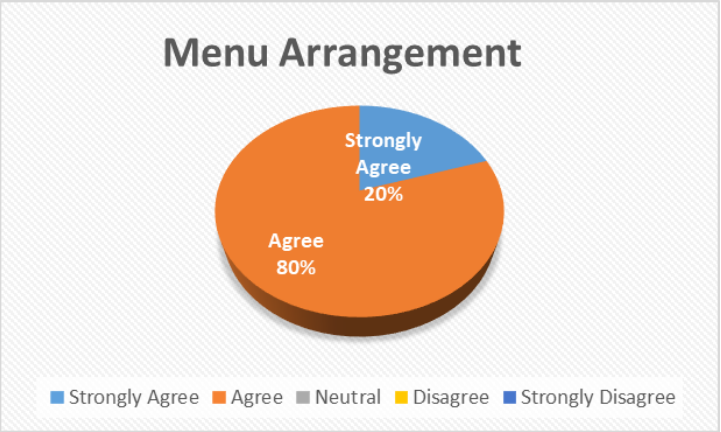


Figure 5.31 Response on arrangement of menu items

5.4.4 Automation of Manual Registers on the mobile application

As shown in Figure 5.32, 13% of the respondents Strongly Agree and 87% Agree that the manual data collection registers are captured well by the mobile application, and they are able to relate what is provided on the mobile phone with the manual registers, thus it assists in adaption and take up of the mobile application to execute their assignments.

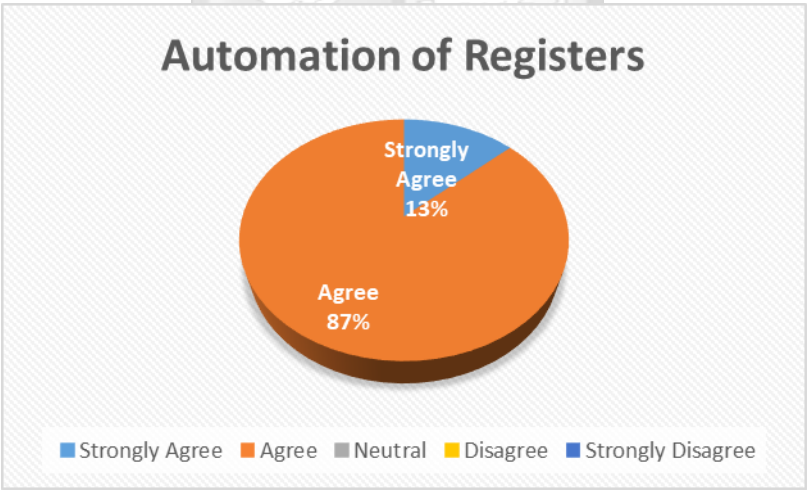


Figure 5.32 Response on automation of manual register

5.4.5 Capturing of Data required to be collected

As shown in Figure 5.33, 93% Agree that the data required to be collected is captured by the mobile application while 7% Disagreed indicating that some data to be collected are not detailed when collecting information on household indicators for sanitation, the application does not provide detailed selection. An indication that completeness of data collection improves

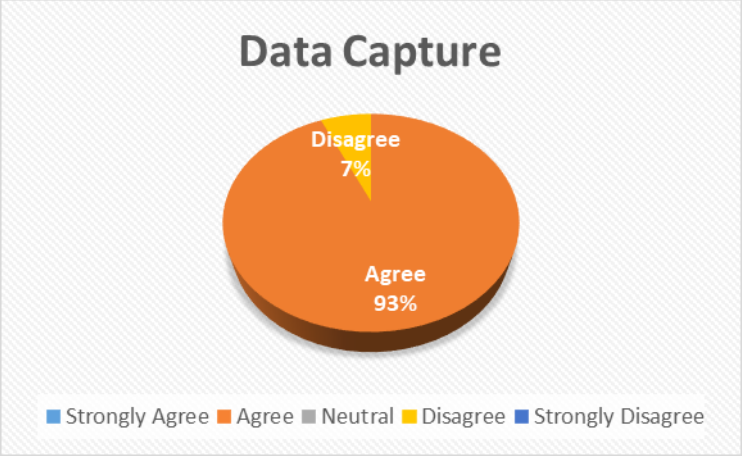


Figure 5.33 Response on capture of required data

5.4.6 Mobile Application easy to use

As shown in Figure 5.34, 27% of the respondents Strongly Agree and 73% Agree that the mobile application is easy to use, an indication that they are comfortable in using the application.

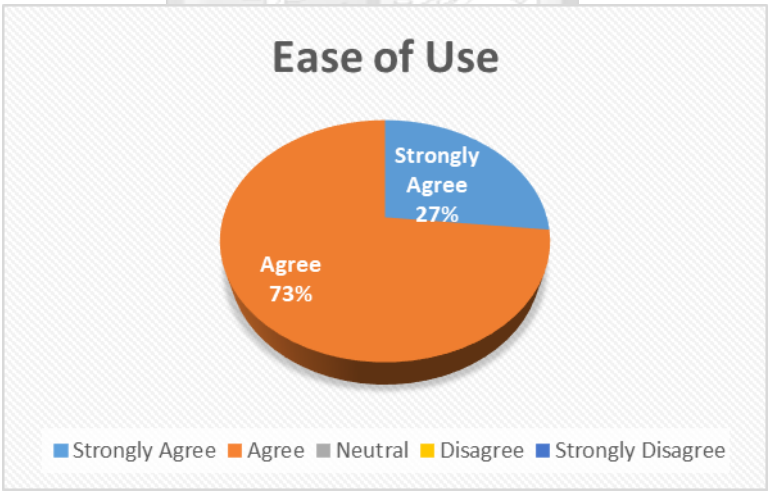


Figure 5.34 Response on easy of use

5.4.7 Improvement on the time it takes to collect data

As shown in Figure 5.35, 46% of the respondents Strongly Agree, 47% Agree and 7% Neutral, the 7% indicated that the application can add items without them selecting for example adding multiple households. This is an indication that use of the mobile application to collect data has improved when compared with using the manual registers.

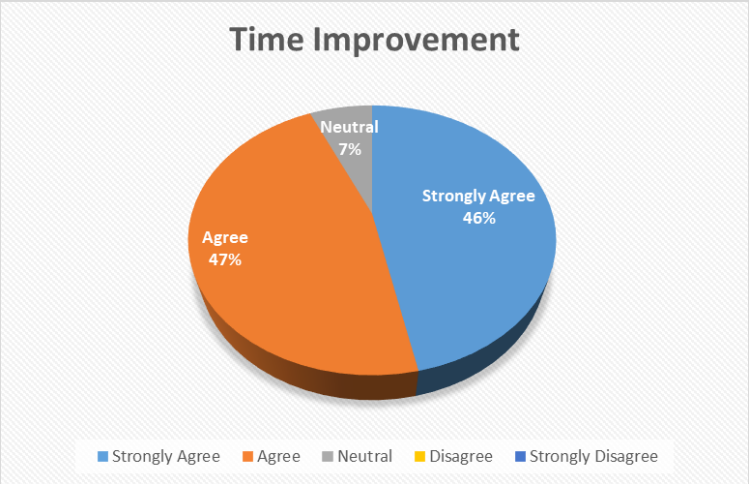


Figure 5.35 Response on time improvement on data collection

5.4.8 Improvement on completion of data collection

As shown in Figure 5.36,100% of the respondents Agree that the mobile application improves in ensuring all data required is collected, contributing to the objective of completeness of data collected, the application only allows upload of data when all data per member is collected thus improving on completeness of data collected.

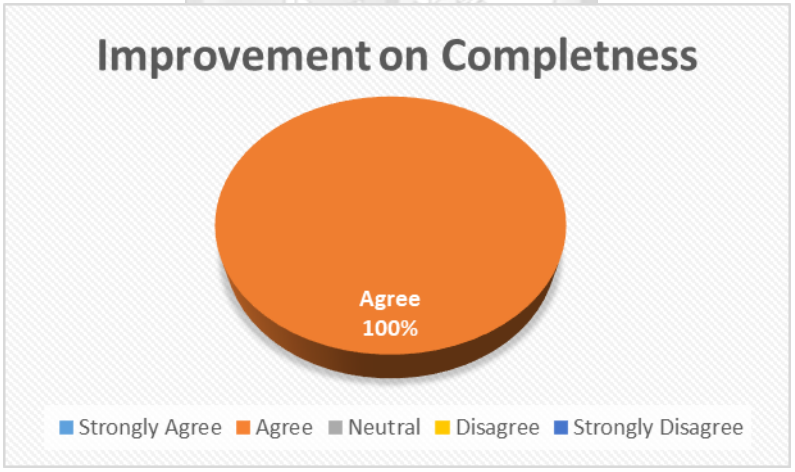


Figure 5.36 Response on improvement on completeness of data collection

5.4.9 Improvement in accuracy of data collection

As shown in Figure 5.37, 7% of the respondents Strongly Agree and 93 Agree that the mobile application has improved on accuracy of data collection, this is an indication that the objective of accurancy of data collection has been addressed by the application since skip logic is applied.

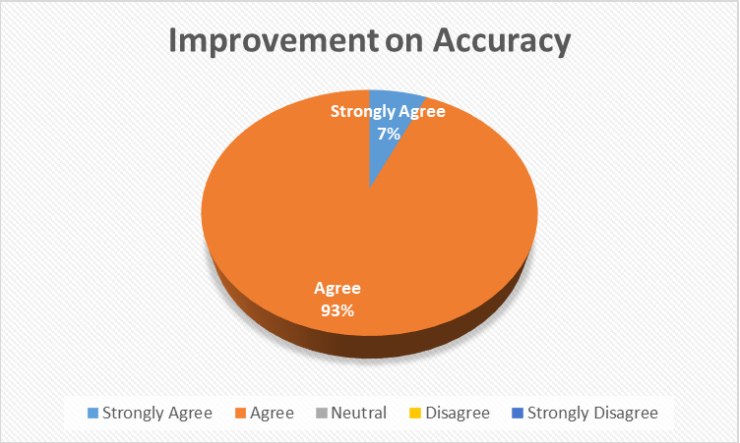


Figure 5.37 Response on improvement in accuracy of data collection

5.4.10 Recommendation on deploying the mobile application

As shown in Figure 5.38, 80% of the respondents Strongly Agree and 20% Agree that the mobile application should be deployed to all counties in Kenya.An indication of user acceptance of the mobile application and advocacy for the solution to be deployed to all counties in Kenya so that the CHV's and by extension the community can benefit.

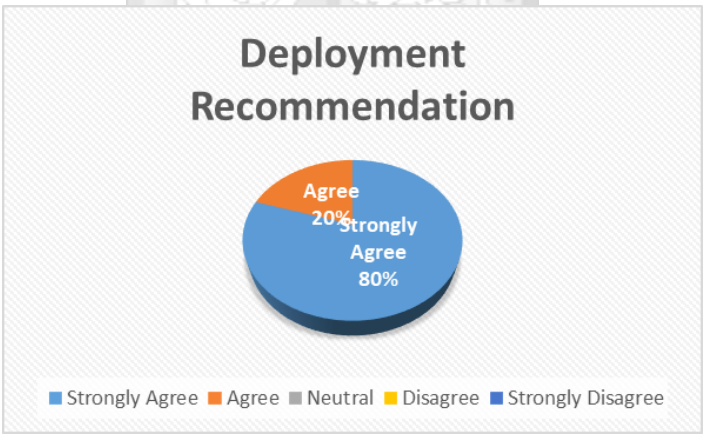


Figure 5.38 Response on recommendation of the mobile application

5.4 Findings from Application Testing

5.4.1 Interface

The mobile application interface is user friendly from the login screen which the respondents indicated that the process is straight forward and they are able to login without any issues, the menu items are well labelled and arranged making it easier to understand the application and navigate easily making the learning curve short. The interface has greatly contributed to the adaption of the mobile application were above 87% agree and 13% Strongly Agree that the manual registers are captured well on the application.

5.4.2 Accuracy

Above 93% the respondents indicated that the application assists in improvement of acccurancy in data collection since the menu items are well labelled and that the manual registers are well captured on the mobile application, skip logic is applied, subsequent screens reflect on previous selection, if one select a household member as a man, women or child the next screen will display indicators related to each, this highly improves on the accuracy of the data collected and highly reduces errors.

5.4.3 Completeness

100% of the respondents indicated that the application contributes in collecting complete data, one cannot submit the data if they have not completed filling the indicators, the application will prompt one to finalize collection before submitting. 93% indicated that the data required to be collected is captured on the mobile application and that the manual registers are captured well on the mobile application.

5.4.4 Timeliness

The issue of time has been addressed on two levels, the respondents are able to collect data faster as compared to using manual registers and they are able to transmit the data real time depending on network coverage to the Community Health Extension Workers at the health facility. 73% Agree and 27% Strongely agree that the application is easy to use and are comfortable using it, which contributes to the time it takes to collect data.47% agree and 46% strongly agree that the application has resulted in improvement on time it takes to collect household data.

Chapter 6: Discussions

6.1 Introduction

The mobile application is a solution for improving collection, analysis and dissemination of community data. It incorporates a mobile application for capturing data from the household level and transmitting it to a web-based database. The mobile application automates data collection of the following manual registers, Household Register, Service Delivery Logbook, Treatment and Tracking and Referrals. The findings from the responses provided establish that the mobile application addresses the challenges related to manual data collection which include accuracy of the data collected, completeness of data ensuring all vital data is collected and timely nature, how fast the data collected reaches the formal health care.

6.2 Paper Based collection of Data

From the reviewed literature, collection of data using paper based tools have several challenges, According to Shao (2010) the practice of collecting health data through paper based strategies where physical forms are filled with data and collected manually results to the transcription of data for analysis being troublesome and lead to low quality of data particularly when the information volume is huge. Moreover, the supervision of numerous information collections from different areas is troublesome and may lead to expansive time slack for information to be accessible for usage. With paper-based strategies, information accuracy and consistency in reporting is troublesome to maintain. The impediments of resources such as human resources and the growth of populace within the creating world put health data laborers in tedious circumstance of managing with huge volumes of data through paper-based strategies. With paper based strategies, it is difficult for the health service providers to track health data from inaccessible health facilities. This may lead to delays in generation of critical reports that might offer assistance to decision makers and policy makers in moving forward the health agenda.

6.2.1 Inaccurate Data

“Accurate high quality health data are not available when and where they are needed this lack of data can lead to ineffective or unsafe delivery of services, poor patient choices and wasted resources”. (WEF, 2011) Accurate data in the heath sector is very vital attributing to correct diagnosis and intervention, inaccurate data can lead to death.

6.2.2 Incomplete Data

"Incomplete reporting results into late decision making and subsequent late intervention towards prevention of certain outbreaks that could have otherwise been prevented earlier". (Kagiri et al., 2015). To make an informed decision data has to be complete and unambiguous

6.2.3 Delayed Data

"A major concern expressed by data users is that vital statistics are not timely enough to meet their needs. Often these critical outcome measures are not made available for more than a year or even longer after the data year ends". (NAPHSIS, 2013). The reasons for data delays are complex, and established within the complexities of the data collection process itself For health data to be valuable it ought to be made available in a timely way to empower decision makers make suitable health measures and intervention, time is continuously of an essence in issues relating to health

6.3 Automation of data collection

The automation of data collection using mobile application addresses the objective of the research, which were improving accuracy, completeness and timely transmission of data, According to the CIHI (2013) "To draw maximum benefits and value from health information systems, high-quality data that is useful, integrated across the care continuum and relevant to decision-making must become more widely available", the data ought to be accurate, reflects the reality it was planned to measure, Reliable, can be trusted; Timely, is current sufficient for the expected utilization and is accessible to those authorized to utilize it when they got to utilize it" and Comparable, standardized so that it can stream from one area to another and keep up its meaning, and/or it can be amassed or linked with other information to extend users' confidence within the conclusions drawn from it.

6.4 The features of the mobile application that address the research objectives

6.3.1 Skip Logic and menu presentation

The feature also known as conditional branching determine what question or screen the CHV sees next depending on how they answer the current question. Skip logic creates a custom path through the mobile application that varies based on the selections. Figure 5.12 shows that when a female member is selected the screen that is displayed next Figure 5.13 displays the indicators related to a female, thus narrows to specific as opposed to a form that

has indicators for all gender, the menu items are also well labelled reflecting the manual registers and are well understood which also contributes to accuracy of data collection.

6.3.2 Control on completion of data collected

The application prompts one if they have completed to collect data as shown in Figure 5.14 and one cannot proceed if some critical selection or fields are not filled as shown in Figure 5.28 this contributes to ensuring complete data is collected and submitted.

6.3.3 Data can be transmitted in real-time

The application allows for real time transmission of data where network coverage is available, contributing to timely availability of data to the decision makers. The menu items are well arranged making the application easy to navigate which also contributes to faster collection of data compared to filling paper based registers. It took 4 weeks for the manual registers to be presented at the health facility, using the mobile applications the data is uploaded within minutes.

6.5 Limitations of the mobile application

The mobile application only runs on Andriod platform thus limiting the types of mobile phone that the application can be deployed on, the application captures the key data required to be capture thus it does not include all data to be captured on the paper registers, and upload of data requires an area with mobile coverage. The input process is manual, which can contribute to inaccuracy of data collected.

6.6 Contribution of the Study

The mobile application could be used in all counties in the country to improve on health data collection in terms of accuracy, completeness and timely availability of household health data to the formal health sector where decisions on health for the community are made and to inform interventions required for each household, thus improving on health service delivery, proper use of commodities including drugs.

Chapter 7: Conclusions and Recommendations

7.1 Conclusion

The process of collecting data using manual register is prone to delays in getting the data to the decision makers thus intervention measure are not put in place on time that leads to health complications and death. Improvement in delivery of Health services to the community and providing universal health coverage relies on the data that is collected to inform health interventions which should be accurate, complete and timely which will highly contribute to precise timely targeted interventions and improvement of resource utilization, containing epidemics.

As per the questionnaire feedback on mobile application the automation of the manual data collection process address the challenges of time since it takes less time to collect and upload the data, accuracy since the application employees skip logic and completeness of data since the application prompts one if they have not completed filling in all data required.

7.2 Recommendations

Adaption of the mobile application for all counties in the country to collect household health data will contribute to the improvement of health service delivery since the data will be more accurate, complete and will be made available to the decision makers for any health intervention required and referrals ensuring the community health needs are addressed in a timely manner and also the required commodities are available for treatment, The mobile application will also increase the motivation of CHV to collect data since they will be provided with mobile devices, and the workload will reduce, they will not be required to carry paper based registers, the cost of printing paper based registers will be eliminated and the monies can be used for other important needs of the communities.

7.3 Suggestions for further research

Further research can be done to improve accuracy, completeness, timeliness and availability and security of heath data.

i. Research Artificial Intelligence can be applied to automatically collect health data at the household level with minimal or no human intervention and transmit the information to the facility, county and national level. The field of Artificial intelligence that can be

applied include use natural language processing and robotics to load the data to the mobile application without human intervention.

ii. Research can be done on Internet of Things (IoT). IoT devices can be used to enable remote health monitoring and emergency notification systems. These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized implants. Specialized sensors can also be equipped within living spaces to monitor the health and general well-being of household members.

iii. Research on blockchain technologies can be pursued to address challenges derived from advancement of technology which include security and confidentiality of sensitive health data which might have great impact to the health service.

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Appendices

Appendix 1 MOH 513 – Household Register

Household register is a tool to determine overall health status in a community, The register is updated every 6 months June and November to know the changes that happen during the 6 months and assess success and challenges of CHV's activities, After filling the register for all households the completed forms are submitted to CHEW who will compile the data from all the CHVs and summarize to give the status of the households within the community unit which they share with CHVs as well as Community Health Committees (CHC) for further action

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MINISTRY OF HEALTH

Community Health Services
"Afya Yetu, Jukumu Letu"

HOUSEHOLD REGISTER
MOH513

NAME OF CHU:		COUNTY:	
MCHUL CODE:		SUB COUNTY:	
LINK FACILITY:		DIVISION:	
NAME OF CHV:		LOCATION:	
NAME OF VILLAGE:		SUB LOCATION:	
START DATE:		END DATE:	

1. Household Number _____

Household Register

MOH513

A: Date of Data Collection (Record as DD/MM/YY e.g. 31/07/14)	B: Individual Code	C: Name of Household Member	D: Age in Completed Years /Months /Days	No. of HH Members per Age Cohort 1=0-28 days 2= 29 days-11 months 3=12 -59 months, 4=5-12 years, 5=13-24 girls, 6=13-24 boys, 7=25-59 years, 8=60 years and above	E: Sex (M/F)	Relationship to HHH 1= HHH, 2= Spouse, 3= Child(B), 4= Child (R), 5= Grandchild, 6= Brother/Sister, 7= Others	G: Orphan (✔/X/NA)	H: Birth Certificate (✔/X)	I: In School (✔/X/ NA)	J: Pregnant (✔/X/ NA)	K: Mother and Child Health Booklet (✔/X/ NA)	L: ANC (at least 4 visits) (✔/X/NA)	M: Delivered by Skilled Birth Attendant(✔/X/ NA)	N: Exclusive Breastfeeding (✔/X NA)
Total														

Household indicators	✔
2. Access to safe water (✔/X)	
3. Use of Treated Water (✔/X)	
4. Hand washing facilities (✔/X)	
5. Functional Latrine use (✔/X)	
6. Refuse Disposal Facility (✔/X)	

DEATHS

Date of Death	Individual Code	Name of Household member	Age	Sex	Comments e.g. neonates or dead before household registration
AD	B*	C*	D*	E*	AE

B*, C*, D* and E* contain data similar to be B, C, D and E respectively.

Household Register

MOH513

O: Using Family Planning Methods 1= Modern, 2= Traditional/Natural 3= None 4=N/A	P: Penta 1 Given (✔/X/ NA)	Q: Penta 3 Given (✔/X/ NA)	R: Measles Given (✔/X/ NA)	S: Fully Immunized (✔/X/ NA)	T: Vitamin A Given (✔/X/ NA)	U: Children 6-23 months receiving 3 or more food groups three times a day (✔/X/ NA)	V: Severely Malnourished ((MUAC indicating Red) (✔/X/ NA)	W: Moderately Malnourished (MUAC indicating Yellow) (✔/X/ NA)	X: LLIN use (✔/X)	Y: Known chronic illness 0=None, 1=Diabetes, 2=Cancer, 3=Mental illness, 4=Hypertension, 5=Chronic Respiratory Diseases, 6=Other	Z: Cough (2 Weeks and above) (✔/X)	AA: Knows HIV Status (✔/X/NA)	AB: Disability 0=None, 1=Visual, 2=Hearing, 3=Speech, 4=Physical, 5=Mental, 6=Other	Others ( )	AC: Other specific remarks

DEATHS

Date of Death	Individual Code	Name of Household member	Age	Sex	Comments e.g. neonates or dead before household registration
AD	B*	C*	D*	E*	AE

B*, C*, D* and E* contain data similar to be B, C, D and E respectively.

Appendix 2 MOH 514 - Service Delivery log Book

The Community Health Volunteers Service Log Book is a diary that the CHV uses to record information from the household during their visit as they give messages and services, The basic information collected is accurate on what was done or identified in the household served, The Log Book measures the actual CHV's effort which should be written or filled during the household visit. The Log book should be submitted to the CHEW for summary every month by the end of the month.

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Community Health Services
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SERVICE DELIVERY LOG BOOK
MOH514

NAME OF CHU:		COUNTY:	
MCHUL CODE:		SUB COUNTY:	
LINK FACILITY:		DIVISION:	
NAME OF CHV:		LOCATION:	
NUMBER OF HH:		SUB LOCATION:	
START DATE:		END DATE:	

MOH514

					Mother						Child			
Date of Data Collection (Record as DD:MM:YY e.g. 09/07/14	Village name	Household number	Name of household member	Pregnant (✓/X/N/A)	Counselled on Individual Birth Plan (IBP) (✓/X/N/A)	Delivered by unskilled attendant (✓/X/N/A)	Delivered by skilled attendant (✓/X/N/A)	New-born visited at home within 48 hours of delivery (✓/X /N/A)	Mother with newborns counselled Exclusive Breast Feeding (EBF) (✓/X/N/A)	Woman 15-49 yrs provided with Family Planning commodities by CHV (✓/X/N/A)	Child 0-59 months participating in growth monitoring (✓/X/N/A)	Child 6-59 months with MUAC (Red) indicating severe malnutrition (✓/X/N/A)	Child 6-59 months with MUAC (Yellow) indicating moderate malnutrition(✓/X/N/A)	Child 12-59 months dewormed(✓/X/N/A)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Total														

HOUSEHOLD LEVEL INDICATORS					
Date of Data Collection	Village Name	Household Number	Household has a functional latrine in use (✓/X)	Household with hand washing facilities (✓/X)	Household using treated water (✓/X)
AG*	AH*	AI*	AJ	AK	AL

Service Delivery Log Book

MOH514

Referrals										Defaulters					Death	Remarks
Pregnant woman referred for ANC (✓/X/ N/A)	Pregnant woman referred for skilled delivery(✓/X/ N/A)	Woman referred for family planning services(✓/X/ N/A)	Home delivery referred for Post Natal Care (PNC) Services(✓/X/ N/A)	Child 0-11 months referred for immunization (✓/X/ N/A)	Child 6-59 months referred for Vitamin A supplementation(✓/X/ N/A)	Cough more than 2 weeks referred (✓/X/ N/A)	Referred for HIV Counselling and Testing (HCT)(✓/X/ N/A)	Elderly (60 or more) referred for routine health check-ups(✓/X/ N/A)	Known cases of chronic illness referred a=Diabetes b=Cancer c=Mental illness d=Hypertension e=Others (specify) f=None	ANC defaulter referred(✓/X/ N/A)	Immunization defaulter referred (✓/X/ N/A)	TB treatment defaulter traced and referred(✓/X/ N/A)	ART defaulter traced and referred(✓/X/ N/A)	HIV exposed infant defaulters traced and referred (✓/X/ N/A)	No. of deaths in the month a=0-28 days b= 29 days-11 months c= 12-59 months d=Maternal e=Other deaths	Remarks / Other services
P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF

HOUSEHOLD LEVEL INDICATORS

Date of Data Collection	Village Name	Household Number	Household has a functional latrine in use (✓/X)	Household with hand washing facilities (✓/X)	Household using treated water (✓/X)
AG*	AH*	AI*	AJ	AK	AL

AG*, AH*, AI* contain data similar to A, B and C respectively.

Appendix 3 Treatment and Tracking Register

The tool helps in tracking the treatment offered to children under 5 years, record details of all cases seen and managed by a CHV at community level and to ensure all the supplies given to the CHV via CHV kits can be accounted for and any post-referral treatment given is noted.

Community Treatment and Tracking Register

Referrals									Treatment/Management													Outcome							
Vomits everything (✓)		Chest in-drawing (✓/✗/ N/A)	Unusually sleepy or unconscious (✓/✗/ N/A)	Yellow on MUAC (✓/✗/ N/A)	Red on MUAC (✓/✗/ N/A)	Swelling of both feet (✓/✗/ N/A)	Immunization required (✓/✗/ N/A)	New-born danger signs present (✓/✗/ N/A)	ORS(20.5g/ltr); Sachets (✓/✗)	ZINC (20mg)' Tabs (✓/✗)	AMOXYCILLIN (125mg/5mb); Bottle (✓/✗)	ACTs (6s) (✓/✗)	ACTs (12s) (✓/✗)	ACTs (18s) (✓/✗)	ACTs (24s) (✓/✗)	Albendazole (ABZ); Tabs (✓/✗)	Paracetamol; Tabs (✓/✗)	Tetracycline Eye Ointment (TEO); 1%; tube (✓/✗)	Injuries and wounds (✓/✗)	Counselled (✓/✗)	Treated within 24 hrs of illness onset (✓/✗)	Date of 1st Follow up (✓)	Referral compliance within 24 hours (✓/✗)	Referral compliance more than 24hrs (✓/✗)	Adverse Drug Reaction (ADR) (✓/✗)	Defaulted on: 1=Treatment; 2=referral	Recovered (✓/✗)	Died (✓/✗)	Remarks
V		W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX

Appendix 4 MOH 100 Community Referral Form

The CHV completes a CHV Referral Form and gives it to the sick person to take to the health facility, or accompanies the sick person with the Referral Form to the health facility.The sick person or CHV requests the health worker to complete the Referral Form, and gives Section B back to the patient to return to the CHV, after they have been treated.

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MOH 100: COMMUNITY REFERRAL FORM

Community Health Services
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SECTION A: Patient /Client Data		
Date:	Time of referral:	
Name of the patient:		
Sex: Male ☐ Female ☐	Age:	
Name of Community Health Unit:		
Name of Link Health Facility:		
Reason(s) for Referral		
Main problem(s):		
Treatment given:		
Comments:		
CHV Referring the Patient:		
Name:		Mobile No:
Village/Estate:		Sub Location:
Location:		
Name of the community unit:		
Receiving Officer:		
Date:	Time:	
Name of the officer:		
Profession:		
Name of the Health facility:		
Action taken:		
SECTION B : Referral back to the Community		
Name of the officer:	Mobile No:	
Name of CHV:	Mobile No:	
Name of the community unit:		
Call made by referring officer: Yes: ☐ No: ☐		
Kindly do the following to the patient: 1. 2. 3.		

Official Rubber Stamp & Signature _____

Appendix 5 The Manage User Use Case

ID	**UC1**
Title	Manage Users
Description	Create and Delete Users
Actor(s)	System Administrator
Pre-Condition	The Administrator logs into the system
Post-Condition	Users successfully created and deleted
Main Success Scenarios	i. The administrator creates user account ii. The Administrator edit user account iii. The administrator delete user account

The administrator creates, edits and deletes users in the database

Appendix 6 Register Household Members Use Case

ID	**UC2**
Title	Register Household Members
Description	Create , Update and delete household members
Actor(s)	Community Health Volunteer
Pre-Condition	The CHV manages to log to the mobile application
Post-Condition	Household members successfully created
Main Success Scenarios	i. The CHV creates the household members ii. The CHV update Household members details iii. The CHV deletes household members

The CHV creates, updates details or deletes household member

Appendix 7 Collect Household and Individual Members Data Use Case

ID	**UC3**
Title	Collect Household and Individual Data
Description	Collect data for the household and individual
Actor(s)	Community Health Volunteer
Pre-Condition	The CHV manages to log to the mobile application
Post-Condition	Household data is captured on the mobile phone and uploaded to the M-Jali database
Main Success Scenarios	i. The CHV collects data related to the household ii. The CHV collect health data relating to the individual household members iii. The data is uploaded to the M-Jali Database

The CHV collects data related to the household and members of the household and uploads the data to the database.

Appendix 8 Provide Health Services Use Case

ID	**UC4**
Title	Provide Health Services
Description	Provide Health Services to members of the household
Actor(s)	Community Health Volunteer
Pre-Condition	The CHV manages to log to the mobile application
Post-Condition	Health services provided is captured on the mobile phone and uploaded to the M-Jali database
Main Success Scenarios	i. The CHV provides service to members of the household ii. The CHV records the services offered on the mobile application iii. The data is uploaded to the M-Jali Database

The CHV provides service to the household members and records the services offered, the data is uploaded to the database.

Appendix 9 Provide Treatment and Tracking Use Case

ID	**UC5**
Title	Treatment and Tracking
Description	Treatment of Household members and tracking commodities
Actor(s)	Community Health Volunteer
Pre-Condition	The CHV manages to log to the mobile application
Post-Condition	Household data is captured on the mobile phone and uploaded to the M-Jali database
Main Success Scenarios	i. The CHV administers treament ii. The CHV records the commodities used to provide treatment. iii. The data is uploaded to the M-Jali Database

The CHV administers treatment to under 5 years and records the commodities used, the data is uploaded to the database

Appendix 10 Refer Patients to a Health Facility Use Case

ID	**UC6**
Title	Refer Patient to a Health Facility
Description	Refer Patient to a Health Facility for futher treatment and monitoring
Actor(s)	Community Health Volunteer
Pre-Condition	The CHV manages to log to the mobile application
Post-Condition	Referral data is captured on the mobile phone and uploaded to the M-Jali database
Main Success Scenarios	i. The CHV refers a patient to a Health Facility for further treatment and monitoring. ii. The CHV collects health data relating to referral of patients. iii. The data is uploaded to the M-Jali Database

The CHV updates patient data and refers the patient to the health facility, the data is uploaded to the database

Appendix 11 Manage Referrals Use Case

ID	**UC7**
Title	Manage Referrals
Description	Manage Referrals to the Health Facility and back to the community
Actor(s)	Community Health Extension Worker
Pre-Condition	The CHEW manages to log to the mobile application
Post-Condition	The Referral management data is captured on the mobile phone and uploaded to the M-Jali database
Main Success Scenarios	i. The CHEW receives the patient in the Health Facility ii. The CHEW refers the patient back to the community iii. The CHEW loads the referral information to the mobile application iv. The data is uploaded to the M-Jali Database

The CHEW receives the patient in the health facility and refers the patient back to the community after treatment, the data is uploaded to the database

Appendix 12 Questionnaire

Questionnaire for use of M-JALi mobile application to collect household Data

The survey is undertaken to determine the usability of the mobile application and establish if the research objectives were addressed.

Question 1: Is the mobile application login process straight forward?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Question 2: Are the menu items labelled appropriately making them well understood?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Question 3: Are the menu items well arranged to allow for ease of navigation?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Question 4: Are the manual data collection registers captured well by the mobile application?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Question 5: Does the mobile application capture all the data required to be collected?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

If Not Kindly Specify:

_____

Question 6: Is the mobile application easy to use?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Question 7: Does the mobile application improve on the time it takes to collect data?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Question 8: Does the mobile application improve in ensuring all required data is collected?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Question 9: Does the mobile application improve on the accuracy of data collection?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Question 10: Do you recommend the mobile application to be used by other Counties in Kenya?

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Thank you for taking part in the survey.