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Scaling up access to health services beyond Tanzania and Kenya borders through wananchi afya digital mobile application

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SCALING UP ACCESS TO HEALTH SERVICES BEYOND TANZANIA AND KENYA BORDERS THROUGH WANANCHI AFYA DIGITAL MOBILE APPLICATION

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A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology

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ABSTRACT

Health services play an important role of assisting people who seek medical attention within the society. It can be argued that a healthy society can bring forth sustainable economic development to its full potential while an unhealthy society cannot. However, a free movement of people, labor and right to residence which was built across East Africa (EA) borders enabled Tanzania and Kenya borders to have enormous interactions. Subsequently, increase the risk of highly communicable diseases such as Tuberculosis and Sexually transmitted infections in such a way that medical attention is unavoidable along the borders. The evolution of smartphones and propagation of mobile applications (App) in 1990s have marked new opportunities for healthcare centers and medical education. Statistically, Android Operating System (OS) owns 83% of Africa's mobile OS market. In addition, Tanzania Communications Regulatory Authority (TCRA) and Kenya Digital have reported over 25.79 million and 22.86 million of internet users respectively, which is equivalent to 46% and 43% of internet penetration year 2020. This discloses the need for Android Mobile Application in order to improve access to health services and related-information both online and offline using Swahili and English language and integrate it with monitoring and evaluation (M&E) tool to monitor the most requested viewed content and measures change over time on existing health facilities to citizens and residents that travel across Kenya and Tanzania borders. The developed system received positive feedback from EA citizens and residents where 90.2% of the system evaluation conducted agreed upon App usage.

DECLARATION

I, Happyness Alexander, do hereby declare to the Senate of Nelson Mandela African Institution of Science and Technology that this final project report is my own original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

Happyness Alexander		30-07-2021
Candidate Name	**Signature**	**Date**

The above declaration is confirmed by:

Dr. Shubi Kaijage		30-07-2021
Supervisor Name	**Signature**	**Date**

Dr. Judith Leo		4th August, 2021
Supervisor Name	**Signature**	**Date**

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CERTIFICATION

I, the undersigned certify that I have read and hereby recommends for acceptance by The Nelson Mandela African Institution of Science and Technology, a project entitled, "Scaling Up Access To Health Services Beyond Tanzania And Kenya Borders Through Wananchi Afya Digital Mobile Application" in partial fulfillment of the requirements for award of the degree of Masters of Science in Embedded and Mobile Systems.

Dr. Shubi Kaijage		30-07-2021
Supervisor Name	**Signature**	**Date**

Dr. Judith Leo		4th August, 2021
Supervisor Name	**Signature**	**Date**

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DEDICATION

I sincerely dedicate my dissertation work to my adored husband Mr. Baraka Issa Mwasandube and my son Ombeni, for your loyalty in accomplishing my Master's degree.

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LIST OF ABBREVIATION AND SYMBOLS

AOS	Android Operating System
API	Application Programming Interface
APP	Application
BPO	Business Process Outsourcing
CBMS	Community Based Monitoring System
CC	Cloud Computing
CDF	Consultative Dialogue Framework
COVID-19	Coronavirus Disease 2019
CSO	Civil Society Organizations
CSV	Comma-Separated values
DB	Database
DVM	Dalvik Virtual Machine
EA	East Africa
EAC	East Africa Community
EANNASO	The Eastern Africa National Networks of AIDS and Health Service Organizations
GIS	Geographical Information System
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit
GSM	The Global System for Mobile Communications
GUI	Graphical User Interface
GPRS	General Packet Radio Service
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus Infection
HIV/ AIDS	Human Immunodeficiency Virus Infection and Acquired Immunodeficiency Syndrome
ICT	Information and communications technology

IDE	Integrated Development Environment
IIDEA	Incubator for Integration and Development in East Africa
iOS	iPhone Operating System
IoT	Internet of Things
JDK	Java Development Kit
JRE	Java Runtime Environment
JSON	JavaScript Object Notation
KSH	Kenyan shillings
LBS	Location Based Services
M&E	Monitoring and Evaluation
OS	Operating System
PC	Personal Computer
PHP	Hypertext Preprocessor
PNT	Positioning, Navigation, and Timing
PSO	Private Sector organizations
RDBMS	Relational Database Management System
SDK	Software Development Kit
SDLC	Software Development Life Cycle
SHA	Secure Hash Algorithm
SMS	Short Message Service
SRHR	Sexual and Reproductive Health and Rights
STIs	Sexually Transmitted Infections
TB	Tuberculosis
TCRA	Tanzania Communications Regulatory Authority
TSH	Tanzanian Shillings
TCP/UDP	Transfer Control Protocol/ User Datagram Protocol

USSD	Unstructured Supplementary Service Data
WHO	The World Health Organization
Wi-Fi	Wireless Fidelity
XML	eXtensible Markup Language

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem

East African (EA) partner states have made important steps towards building a strong economic block that will strengthen development and boost the regional economy. To achieve full socio-economic benefits of a well-integrated economy, all actors such as government agencies, development associates, the private sector, civic society and community groups need to play a significant role in harnessing their individual creativity towards making integration not only a reality but meaningful. In this perspective, the EA partner states through various articles of the East African Community (EAC) treaty such as article 127, 128 and 129 have been obligated to create an enabling environment for private sector and civil society to actively participate on strengthening the regional integration process (East African Community [EAC], 1999).

Moreover, the EAC Council of Ministers in November 2012 approved for the EAC Consultative Dialogue Framework (CDF) which provides the structured dialogue between EAC, Private Sector organizations' (PSO), Civil Society Organizations (CSO) and other groups as provided under Articles 127, 128 and 129 of the EAC Treaty so as to harness their innovation towards supporting the regional integration. With free Movement of Persons, Labor and Right of Residence led to the enjoyment of Freedoms and Rights in the Common Market Protocol. Apart from Food Security, Climate Change Mitigation and Adaptation and Competitiveness in finance, they also discussed on the Information and communications technology (ICT) issues specifically on Mobile Commerce and Business Process Outsourcing (BPOs) (Turner, 2006).

Considering huge challenge that face border communities due to the lack of an effective health system, hence the EAC secretariat with support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) developed an innovative tool called the Incubator for Integration and Development in East Africa (IIDEA). This instrument provides a framework upon which private sector, civil society and community groups are able to design and implement small-scale innovative projects such as the proposed mobile application (App) that ensure good health and well-being of both East Africans and non-state actors. Consequently, the EAC partner states will be substantially assisted to enable people's participation in expanding regional economic and integration.

Since 1990s, the evolution of technology has resulted to the enormous growth of smartphones and the propagation of mobile phone Apps (Farkade & Kaware, 2015). Since the first release of Android Software Development Kit (SDK) in 2008, has marked new opportunities for healthcare centers and medical education (Abel *et al*., 2015). As healthcare community and policy makers discover how Apps can improve the access of health services, facilities and related information, consequently developers emerge with the growing number of Apps to the market. The significance of such android App made full use to make up the knowledge and distance gap between citizens (users) and health facilities, on top of that they provide faster and adequate medical services at appropriate time (Bansal, 2016).

Based on the benefits of mobile app, this project has proposed to develop a mobile App which will be used by border communities for improving access to health services and information on existing health facilities, type of health services provided and other health information for border communities, citizens and residents that travel across EAC partner states specifically Kenya and Tanzania. In addition, the mobile App will be integrated with monitoring and evaluation (M&E) tool in order to monitor the most requested and viewed content and measures charge over time.

1.2 Statement of the Problem

Health services are essential elements for proper functioning of any society; an unhealthy community cannot bring forth its full potential in economic production and sustainability. However, with free movement of people, labor and right to residence across the East Africa region, has made towns at the borders busy in trading of goods and services. This scenario does not come as a surprise, a built-in foundation has enabled people crossing border towns with ease exchange of wares ranging from fast moving consumer goods to long-lasting heavy-duty to motor vehicle parts being traded on a daily basis across borders. With enormous interaction, the risk of communicable diseases such as Tuberculosis (TB) and Sexually Transmitted Infections (STIs) are very high in such a way that medical attention is unavoidable along the borders (Eastern Africa National Networks of AIDS and Health Service Organizations [EANNASO], 2019).

The study conducted across Kenya and Uganda borders (Busia border), notices common practice for residents of Busia in Uganda side departing from their own country in order to access specialized services at the Busia district hospital in Kenya. Such services include the X-

ray and TB services that are not available at their health centers in the Uganda side. The presence of Busia district hospital with specialized health services supports residents of Uganda living at the border to access such services rather than travel several kilometers to Tororo in their own country (Allen, 2013).

Despite the positioning, navigation, and timing (PNT) services that have been installed at border communities, still lack of essential system that integrate and locate essential health facilities and services across border communities. Hence, this project proposes the development of a mobile App which will be used by boarder communities for improving access to health services and information on existing health facilities, type of health services provided and other health information for border communities, citizens and residents that travel across EAC partner states specifically Kenya and Tanzania.

1.3 Rationale of the Study

Android Operating System (AOS) devices have higher consumer demands than other devices combined in last decade. The Global Mobile Market reported in 2018 that the number of smartphone users in Kenya is 10 668 000 and Uganda is 6 922 000 which corresponds to 20.9% and 15.6% of smartphone penetration. The Kenya Digital data has reported that there were 22.86 million internet users equivalent to 43% of internet penetration by January 2020. In addition, the total number of mobile connections in Kenya is 52.06 million equivalents to 98% of the total population by January 2020 (Kemp, 2020). Furthermore, the study on "Mobile Penetration and Growth in Kenya" made by GeoPoll on June 2020 has reported that there is 119.9% of Kenyan mobile penetration which has grown to 10% from the earlier period (Kibuacha, 2021).

Tanzania Communications Regulatory Authority (TCRA) in Tanzania has reported to have 25 794 560 of internet (smartphone) user respective to 46% of internet penetration as compared to the 29% statistics of 2013. Figure 3 has demonstrated the estimated number of internet users and the penetration to the market (Tanzania Communications Regulatory Authority [TCRA], 2020). However, up to September 2020, Google Play store has over three million and forty thousand Android apps published (Department, 2021). On top of that in 2019, Google Play Store users worldwide downloaded eighty-four billion mobile Apps, up from 67 billion Apps in 2017. Moreover, Google Play Store generates significant downloads than the Apple App

Store, as it is available for a wider range of devices than Apple's closed iPhone Operating System (iOS) ecosystem, which is only available for Apple devices (Research, 2021).

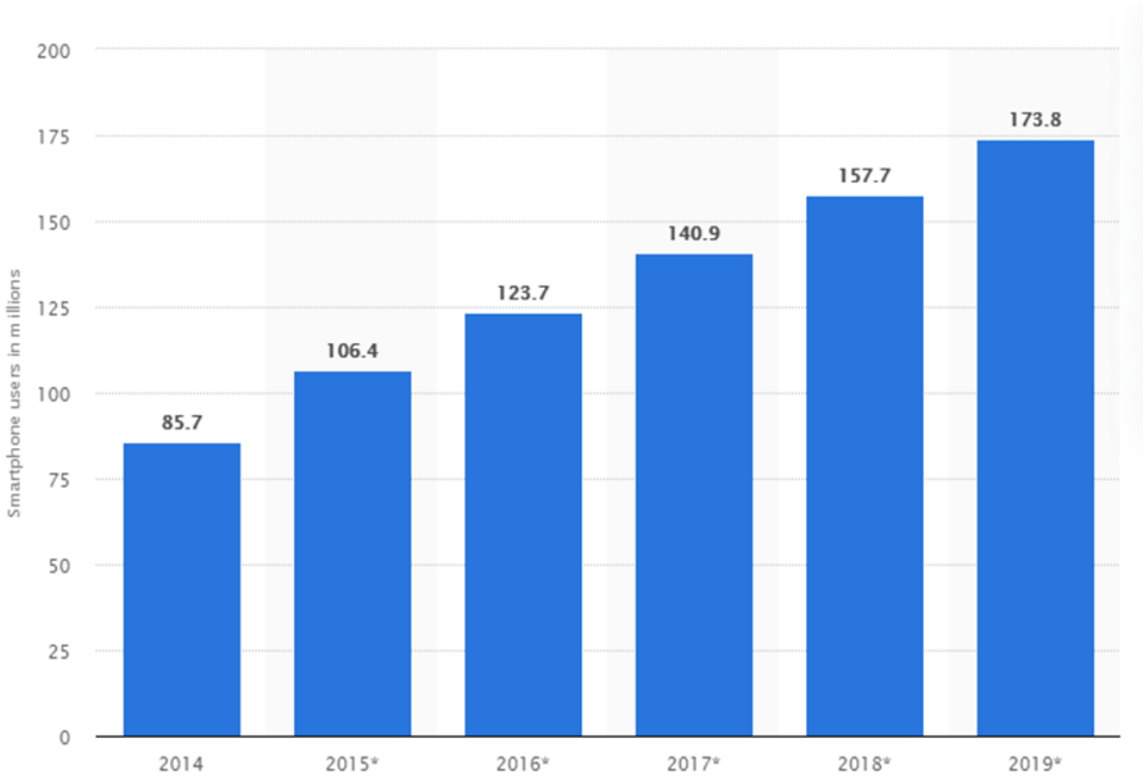

Figure 1: Smartphone Penetration in Middle East and Africa (Department, 2015)

Despite the smartphone penetration and large percentage (83%) that Android Operating System (OS) has over others in the Africa's mobile OS Market January 2021 (O'Dea, 2021); Fig. 2, still EAC and its partner states haves not taken initial step to invent an integrated mobile App solution that will enable citizens to actually locate the health facilities around the border communities and receive required health assistance effectively (EANNASO, 2019).

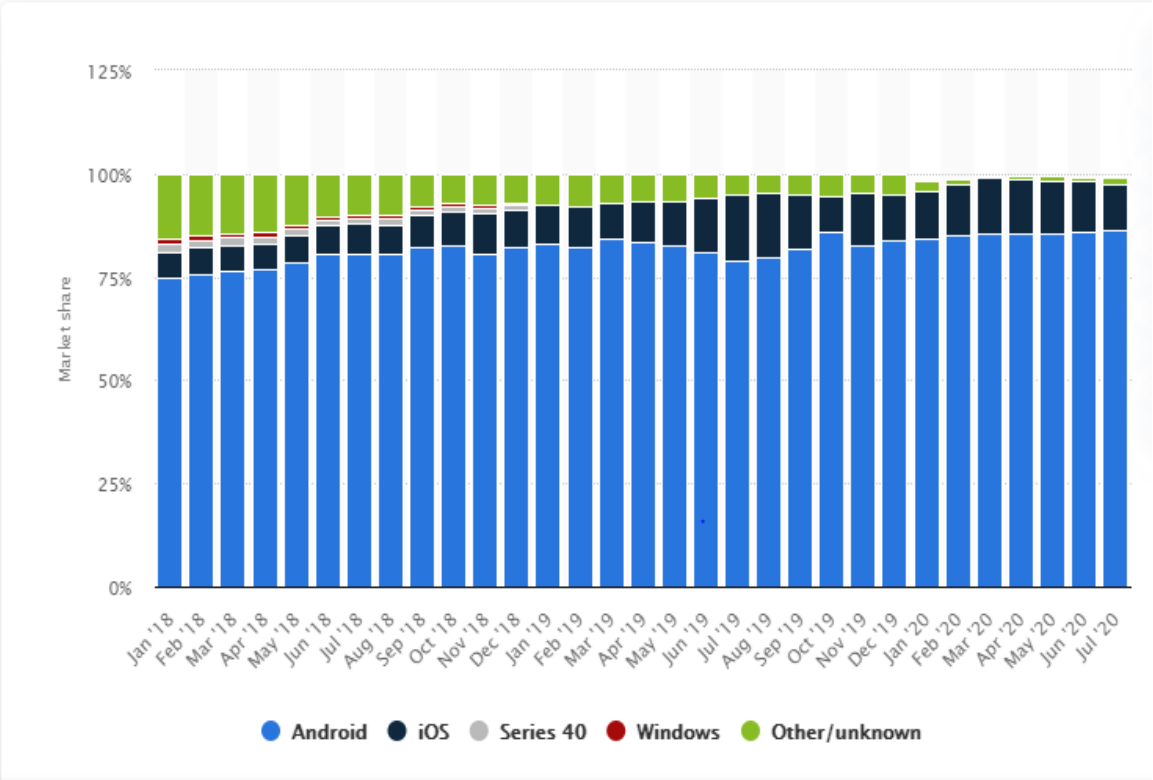

Figure 2: Market Share of Mobile Operating Systems in Africa from Jan 2018 to Jul 2021(O'Dea, 2021)

6.2 INTERNET SERVICES

6.2a Estimate of Internet Users

Year	2014	2015	2016	2017	2018	2019
Users	14,217,311	17,263,523	19,862,525	22,995,109	23,142,960	25,794,560
Penetration	29%	34%	40%	45%	43%	46%

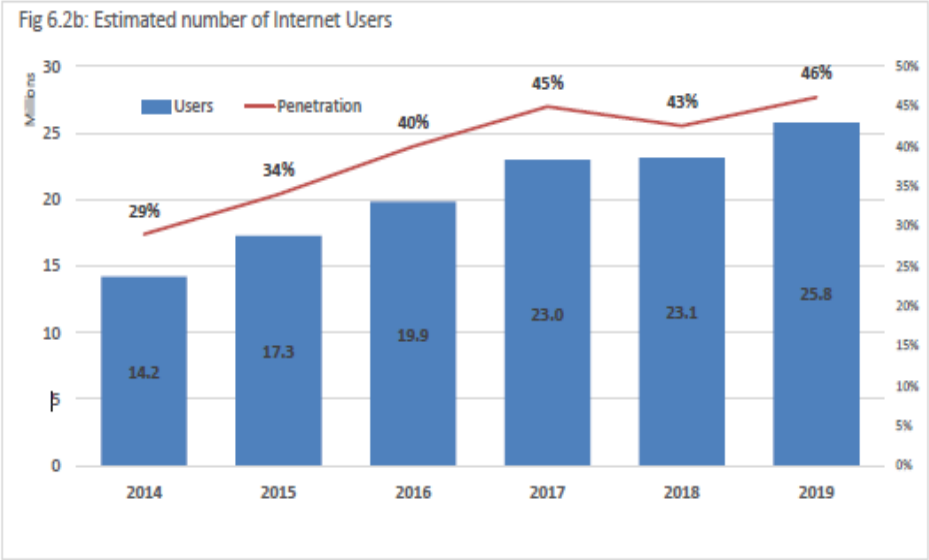

Figure 3: Penetration rate of Voice Telecom and Internet Service in Tanzania from 2013 to 2019 (TCRA, 2020)

Currently, the existing mobile applications and websites developed for a particular health facility is actually servicing patients independently, also these health facilities have not sorely emerged under one platform to assist patients on locating health facilities that provide the same medical services and related information.

Border communities interact both socially and economically. Normally, there is massive daily movement of people and goods from one country to another. It is common to find that residents of one country cross the border to seek essential health services from the other side of the border where such services are not easily available within their own border health facilities or where such services are far away from their location. However, it is yet not uncommon to find that people travel far distances in their own countries looking for health services instead of crossing the border to access such services in the neighboring country. This is mainly attributed to a lack of information on the existence of the services they are in need of in the neighboring country forcing them to take such long journey.

In this regard I see this as a knowledge gap where communities lack the right information on existing health services near to them be it within their own countries or across borders. For this reason, brings the innovation to develop a mobile Application which will provide health services information available within border towns on a timely manner.

1.4 Objectives of the Study

1.4.1 General Objective

The main objective is to develop an Android Mobile Application for improving access to health services and related-information both online and offline using Swahili and English language and integrate it with monitoring and evaluation (M&E) tool to monitor the most requested viewed content and measures change over time on existing health facilities to citizens and residents that travel across Kenya and Tanzania borders.

1.4.2 Specific Objectives

(i) To analyze requirements for develop the proposed system (App).

(ii) To develop the proposed Android Mobile Application platform and integrate it with monitoring and evaluation (M&E) tool to monitor the most requested and viewed content and measures change over time.

(iii) To validate the online and offline access to the developed system.

1.5 Research Questions

This project aims to respond to the following questions:

(i) What are the requirements for developing an Android App?

(ii) Are the health facilities easily accessible in online and offline mode?

(iii) What are the design features for development of the proposed Android Mobile Application platform which will be integrated with monitoring and evaluation (M&E) tools in order to monitor the most requested and viewed content and measure charge over time?

(iv) Is the developed system working as anticipated?

1.6 Significance of the Study

The system is beneficiary to both travelers and residents since it provides online and offline access to specialized health facilities located beyond Tanzania and Kenya borders within 370 kilometers range. Also, enables the dissemination of health-related information such as Malaria, Human Immunodeficiency Virus Infection (HIV), TB and Covid-19 pandemic. Further, the system displays list of tourist attractions, the exchange rate between country currencies and types of vaccinations essential to enter Tanzania or Kenya. This system cut-off unnecessary transport cost searching for nearby health facility, it eases administration duty through monitoring and evaluation process.

1.7 Delineation of the Study

This Android mobile system is recommended not only for Tanzania and Kenya borders but also on every border country in Africa. In addition, travelers need to be aware of the specialized health services in country of their visit while facilitate residents from both countries to know the nearest health facility around them despite the country of their origin. The system has made health-related information available online to user globally but health facilities are limited to geographical location that is around Tanzania and Kenya borders within 370 kilometers.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of the Study

Android Operating System (AOS) technology has transformed health services to patients who seek medical attention suffering from communicable and non-communicable diseases. In addition, the evolution of Apps in market have broaden opportunities for patients, health care centers, facilities and policy makers towards societal provisions of digital solution. Several authors and researchers have diversified their studies into variety of technologies such as Internet of Things (IoT), Global Position System (GPS), Geographical Information System (GIS), The Global System for Mobile Communications (GSM) and Cloud Computing (CC) to serve the purpose on health facilities. However, other authors integrated their AOS studied to Web based technology in order to ease their study process. Most of AOS studies were time saving, location independent and localization of data on health services.

2.2 Contributions of Web-based Platform on Health Services

The study made to the Ministry of Health in Zambia by Mushonga *et al.* (2017) observed the necessity to develop a system for mapping health facilities using GIS technology which became the web decision support system (DSS) tool. This system performs monitoring and reporting which enables public sectors to access information on health facilities' current position respective to the services offered. This study has not given user access to offline services.

The study made by Leo (2019) has emphasized on Climatology aware to residents in Kilimanjaro, Tanzania. They implemented the web-based Health Management Information System (HMIF) which integrated a Mobile App for tracking patients affected by cholera. Authors described how GPS and GIS technologies were used in Smartphone devices and HMIF respectively to gather and disseminate the current position of patients. This study has not given the offline services to users who face internet connection barriers.

2.3 Contributions of Android Operating System Application on Health Services

The study made by Muhammad (2012) elevated awareness and significance of ICTs in healthcare. They assessed and classified the existing tracking devices used by elderly people, and indicated the possible solution through performance analysis. They suggested on the

current tracking technologies to be used such as RFID, GPS, GMS and General Packet Radio Service (GPRS) (Munir & Mäkelä, 2012). This study has not given user access to offline services.

The study made by Sumiati (2018) was focused on improving quality of health services by utilizing Information Technology to process various types of medical information. Despite the device development using hardware and software technology still there was a need for a smartphone application which would monitor and diagnose patients using wireless technology. Telemedicine system came to improve patient's health condition at home using Biosignal sensor device that transmit patient's health data through cellular network or internet network for storage within the server, whenever requested by doctors in hospitals will easily be accessed using personal computer (PC) or smartphones (Sumiati & Sigit, 2018). This study has not given user access to offline services.

The study made by researchers in Indonesia wanted to reduce complexity on health information access using android application to Merauke Regency community. They located necessary health facilities and infrastructure required by the community on a map using Geographical Information System (Loppies *et al*., 2018). This study has not prioritized internet limitations faced by user while accessing online services.

Researchers in their study have found means of tracking specialized doctors and locate specialized health facility near users who seek medical consultations using an App (Sharma, 2018). On the other hand, others developed an App that locate the nearest hospital within five kilometers using GPS (Wasim *et al*., 2015). This study has not covered the offline services mode.

Daryl Abel proposed mobile application for setting appointments with the doctor and medical advisors (Abel *et al*., 2015). Moreover, Ayushi improved a medical health App by enhancing dissemination of medical information to user such as locating the nearest hospitals, laboratories, chemists (pharmacy/medical stores) using GPS technology through mobile networks services. This study facilitated communication between doctors and patients in short time (Bansal, 2016). This study has not covered the offline services mode to the facilities limited with internet connections.

Rameswari and Divya reviewed the study on smart health care monitoring system using Mobile App, they aimed at assessing the existing technology in location-based services for health care

and proposed the latest technologies for future findings and implementations (Rameswari & Divya, 2018). Furthermore, research done by Mirza developed a healthcare App that benefit patients and medical professionals to support rapid access to health information specifically, in emergency situations (Baig *et al*., 2015). Others have embedded Android healthcare application to the cloud using Cloud computing. It successfully upgraded patients' records and store medical imaging (Mallikarjuna & Arun, 2018). Their studies have not considered the offline service mode.

Table 1: Review of Other Research Works of Health Services

Functionalities/ Paper	Challenge	Platform Used	Purpose of the Study	Technology used	Country (Study area)
Mushonga *et al*. (2017)	Assist ministry staffs of health to locate the district facilities.	Web platform	Web-based Mapping of district health facilities	GIS	Zambia
Sumiati and Triono (2018)	To improve quality of health services by utilizing ICT to process various types of medical information	Android Mobile application (Native App)	Quality access of remote health services to patients.	Communication network (wireless), an App and ICT	Indonesia
Loppies *et al*. (2018)	Complexity on information access by community of Merauke Regency.	Android Mobile application (Native App)	Easy access to information needed by community of Merauke Regency	Android OS, GIS and Google map	Indonesia
Sharma *et al*. (2018)	Doctors Nearby provides medical solutions in real time, for Emergencies and appointments by direct call to the reception.	Android Mobile application (Native App)	Tracking the specialized doctors and health facility	GPS	India
Wasim *et al*. (2015)	Search the nearest specialized hospital.	Android Mobile application (Native App)	Tracking the specialized doctors and health facility within five kilometers	RFID, GPS, GMS and GPRS	Pakistan (Karachi)
Abel *et al*. (2015)	Health care centers in Fiji use a manual paper-based filing System.	Android Mobile application (Native App)	Electronic Medical Record System in an Outpatient environment.	Short Message Service (SMS)	Fiji
Aldabbagh (2014)	People got to wrong direction (route) in an unknown location while traveling.	Android mobile application (Native App)	Provides to user the opportunities such as insert, delete and assess exact	Google Maps APIs and Google Direction APIs	Iraq

Functionalities/ Paper	Challenge	Platform Used	Purpose of the Study	Technology used	Country (Study area)
			locations on a map.		
Bansal (2016)	Patients access to the nearest medical services at appropriate time	Android Mobile application (Native App)	Locating the nearest health facility, laboratories and pharmacy	GPS and mobile networks services	India
Rameswari and Divya (2018)	Patient security and information insurance.	Android Mobile application (Native App)	location-based services for health care	ICT, IoT and WLAN	India
Baig *et al*. (2015)	Frequency of data collection and transmission.	Android Mobile application (Native App)	Dissemination of health information on emergency situations	Electrodes wearable sensors, GSM and GPRS	USA
Mallikarjuna and Arun (2018)	Health-care information management duration and nature of monitoring alerts periodically or continuously.	Android Mobile application (Native App)	Improve storage of patient records and medical imaging	Cloud Computing	India

2.4 Establish the Gap

The mindset of tracing and tracking who we are or where we came from, has progressively become a question rather than a prior given (Ernste *et al*., 2009). The contributions made by researchers above have shown the need for ubiquitous technology contribution to health services. They successfully developed their studies that brought impacts to their society daily. Nevertheless, it might be argued that unavailability of mobile application that serves border communities and beyond (Allen, 2013), which can be accessed both online and offline using Swahili and English language; that gap minimized awareness to health services acquisition to citizens, residents and travelers across Tanzania and Kenya borders. This is either limited to access on internet connections or unawareness to geographical locations of existing health facilities.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area and Scope of the Project

The study was conducted to residents, travelers and border communities at Tanzania and Kenya borders. One of the scope to this project is to transform the web-based platforms called "*East Africa Wananchi Digital Health Platform"* (*Geo Locate the Nearest Health Facility*, 2019) into an Android mobile application. On the other hand, the project will locate health facilities on a Google Map at a distance of 370 kilometers from Tanzania and Kenya borders and will disseminate the health-related information. In addition, the project will list vaccines required to enter either Tanzania or Kenya, will include tourist attractions while visiting both countries. Also, presents the exchange rate feature for currency conversion. On top of that, the project will be available both online and offline using Swahili and English language. Last but not least, a M&E tool will be integrated to the App for data visualization purposes.

Figure 4: Map for Tanzania and Kenya Borders which Pointing Namanga Border Crossing (Google, 2021)

3.2 Data Collection Methods

In order to attain the development of an Android mobile application that suits border communities regarding health service and related information from specialized health facilities, therefore data was gathered using system review and interview.

3.2.1 System Review

The motive for choosing this tool was to know the context of the current web-based platform, how it functions so as to construct interviewing questions (Glinz *et al*., 1986). The existing

system had the primary goal "of improving access to health services and information for border communities, citizens and residents that travel across EAC partner states specifically Kenya and Tanzania" with the following specific objectives, one, to develop and manage a digital health services platform. Two, to disseminate information on essential health and third is to develop a mechanism for Community Based Monitoring System (CBMS) to enable citizens engage with service providers on quality of services provided (EANNASO, 2019). Daily system review was conducted in order to identify not only the functional and non-functional requirements of the proposed system but also the key performance indicators for system M&E.

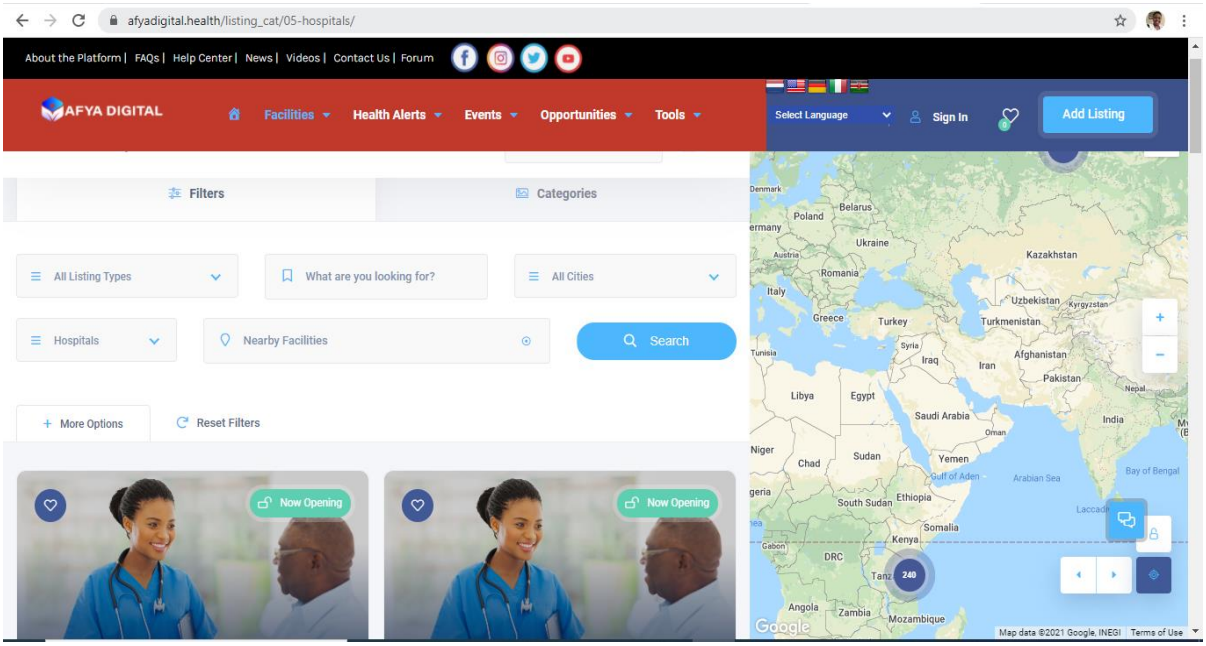

Figure 5: The East Africa Wananchi Digital Health Platform (*Geo Locate the Nearest Health Facility*, 2019)

3.2.2 Interview

This process involved the IIDEA project members who are responsible for the existing web-based platforms "East Africa Wananchi Digital Health Platform". The structured interview modality as per (Glinz *et al*., 1986) was carefully chosen following the to-down managerial structure so that to obtain the original idea intended to serve border communities across Tanzania and Kenya borders. Moreover, the interview was conducted to the project members to substantiate the current system performance.

3.3 Requirement Analysis

Requirement analysis is designed to project the requirements of end-user to meet their expectations from the new system (Przybilski & Tuunanen, 2007). For implementing the proposed system, both functional and non-functional requirements were gathered.

3.3.1 Functional Requirements

The performance task, operation and service behaviors of the developed system are described using functional requirements (Becker *et al*., 2019). Functional requirements for the proposed system are categorized according to Graphical User Interface (GUI), login and logout functionalities accompanied by user authentication, Search health facilities and its related information per keywords and distance, and submission of health facility details and generation of visual reports. Table 2 illustrate the functional requirements for the proposed system.

Table 2: Functional Requirements for the Proposed System

No	Requirements	Descriptions
1	User's phone number verification within an application using Firebase technology.	The system should authenticate user to use the application.
2	Submit health facility data, comprising of facility's geo-coordinates, telephone number, country and its category.	Users, Database (DB) and Afya Digital App should submit to and from, all essential data automatically.
3	Search health facilities and its related information per keywords and distance.	The system should allow users to search for data by keywords and distance range from its current position.
4	Generate visual reports.	The system should generate visual reports like Comma-Separated values (CSV) files, map-based and graphical reports which contain geographical location, active users, daily user engagement and users' App retention.

3.3.2 Non-Functional Requirements

Non-functional requirements are neither responsible with the fundamental functions of the system nor with what program should do, rather concerned with quality and how the system

should perform to satisfy the end user (Glinz, 2005). Table 3 demonstrate the non-functional requirements for the proposed system.

Table 3: Non-functional Requirements for the Proposed System

No	Requirements	Description
1	Security	The system should permit only authenticated users to access health facility and related information.
2	Performance	The system will support numerous stations concurrently and handle many users without disappointment.
3	Usability	Users will be satisfied by the usability of the proposed system and be able to fulfil several tasks.
4	Efficiency	The system should perform its tasks effectively without time or energy wastage.
5	Accessibility	The system should be accessible both online and offline mode, while allowing the mapped health facilities on a Google map to be easily located even if there is unavailability of internet connection.
6	Maintainability	System administrator should be able to maintain the application.
7	Interoperability	The system should permit software updating and upgrading whenever necessary.
8	Recovery	The system should be able to recover from damages
9	Flexibility	The system should be able to add new health facilities and related health information before and after the deployment to Google Play Store.

3.4 Conceptual Design

After the assessment and analysis of functional and non-functional requirements for the proposed system, consequently the conceptual design was developed. The proposed Android-based mobile application will contain four modules; the user registration module, mapped facility module, health information dissemination module and Monitoring and Evaluation (M&E) module.

In mapped facility module, user will be able to experience the view of facilities not only on a Google map but also on a list both online and offline. All facilities have been tracked at distance of 370 kilometers from Tanzania and Kenya borders, they have been evaluated to be equipped with all specialized health services. Once users get access to facility dashboard, they are prompted to make a call via smartphones and show the route to location of such facility on Google map by tracking user's current position.

Health alerts dashboard of the proposed system is responsible for health information dissemination module, user will be able to view the shared information concerning the HIV/AIDS, TB, Malaria and Covid-19 updates on disease spread and number of deaths from such diseases. They are aimed at raising awareness to the society so that they will know the how to take precautions. Moreover, the system displayed various vaccines required for a person to enter Kenya or Tanzania, such vaccines like anti-malaria, yellow fever and hepatitis A vaccines. Apart from the health-related information, other displayed information like exchange rates for currency conversion and tourist attractions found in both countries.

The Monitoring and Evaluation (M&E) module allows the system administrator to manage (modify, update or delete) application users. Also, system Admin is responsible for inserting health facilities' details such as; name of the facility, location, geo- coordinates, phone number, email and website (if any). In addition, Admin will have a routine check on the number of active users who retain the application usage, and streaming live the events that are happening within the app.

The proposed system will use the existing web-based platforms called "*East Africa Wananchi Digital Health Platform"* (*Geo Locate the Nearest Health Facility*, 2019) which is used for Android mobile App development but with technology replacement from GIS to GPS. The system will adopt user-friendly property in such a way that it requires fewer professional skills to understand how it works. The system Admin is required to update the Google Play Store and online server whenever there is a new release to the latest version of the proposed system.

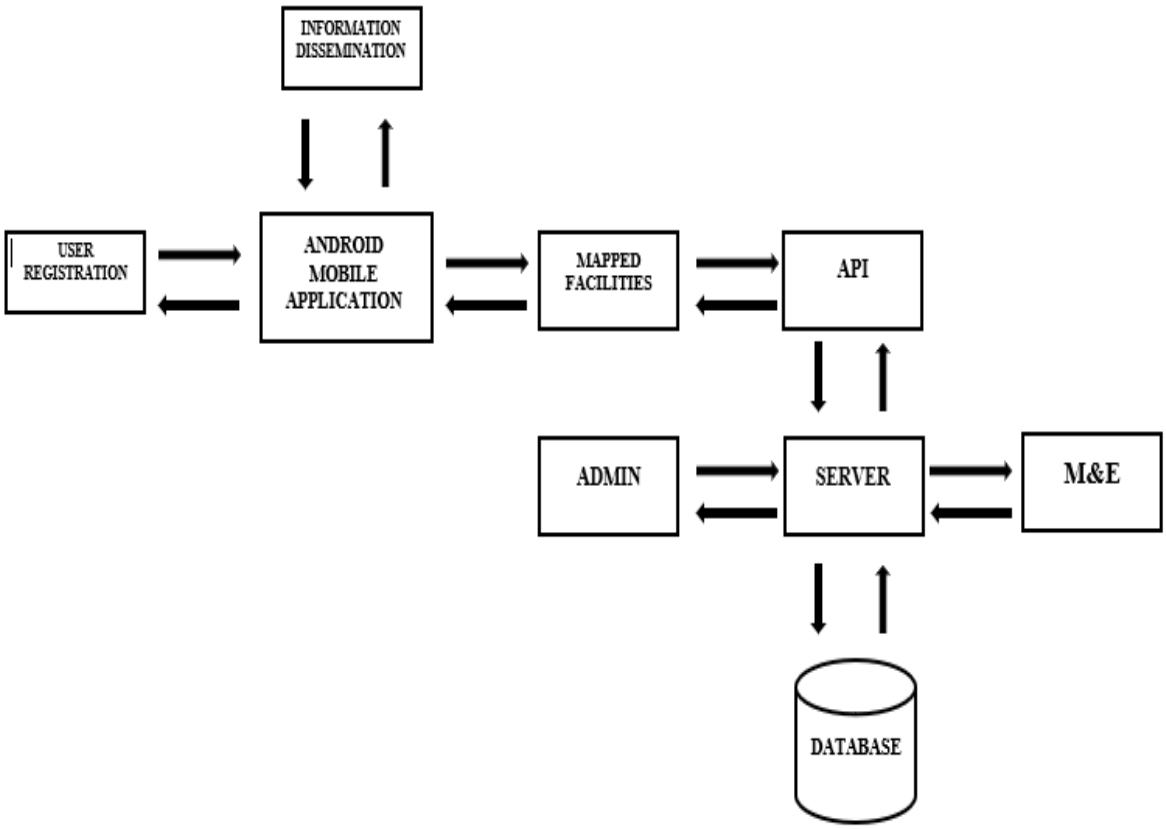

Figure 6: Conceptual Diagram

3.5 Use Case Diagram

Use case diagram is used to describe system users (system actors) and how they interrelate with the system, also indicates connection between them. Moreover, it demonstrates actions (processes) performed by user in the system (Aleryani, 2016). This study proposed use case diagram so that it can show users how they interact based on their functions perform within the proposed system. Those actors are residents, travelers, border communities and administrator. Figure 7 shows the use case diagram of the proposed system.

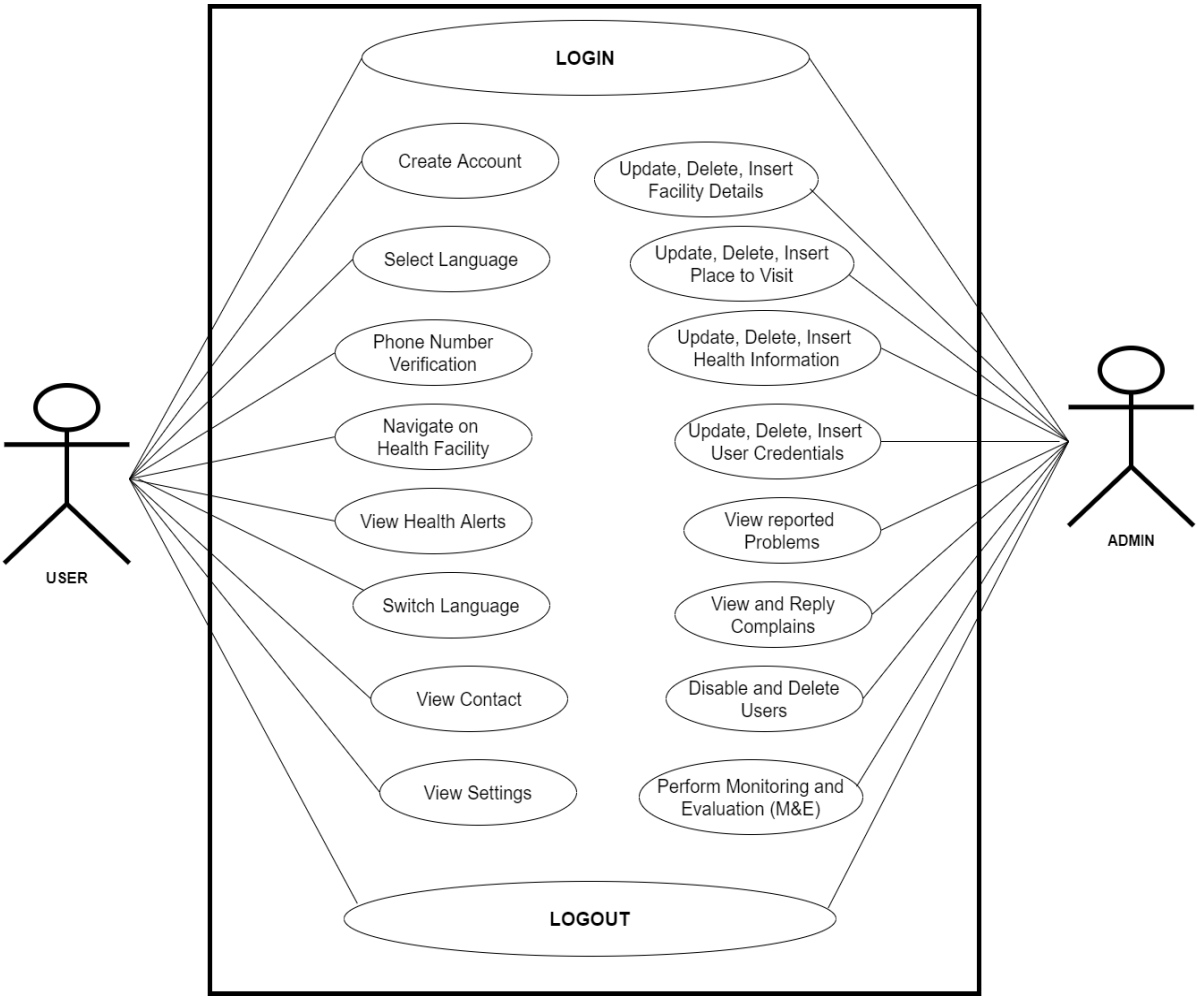

Figure 7: Use case Diagram of the Proposed System

3.6 Data Flow Diagram (DFD)

The study presented the DFD in order to show the flow of data between actors and the system components like user registration, facilities, mapped facilities, travel guide, tools and events, health alerts, contacts, settings and M&E (Ibrahim & Yen, 2010). Figure 8 shows the data flow diagram for the proposed system.

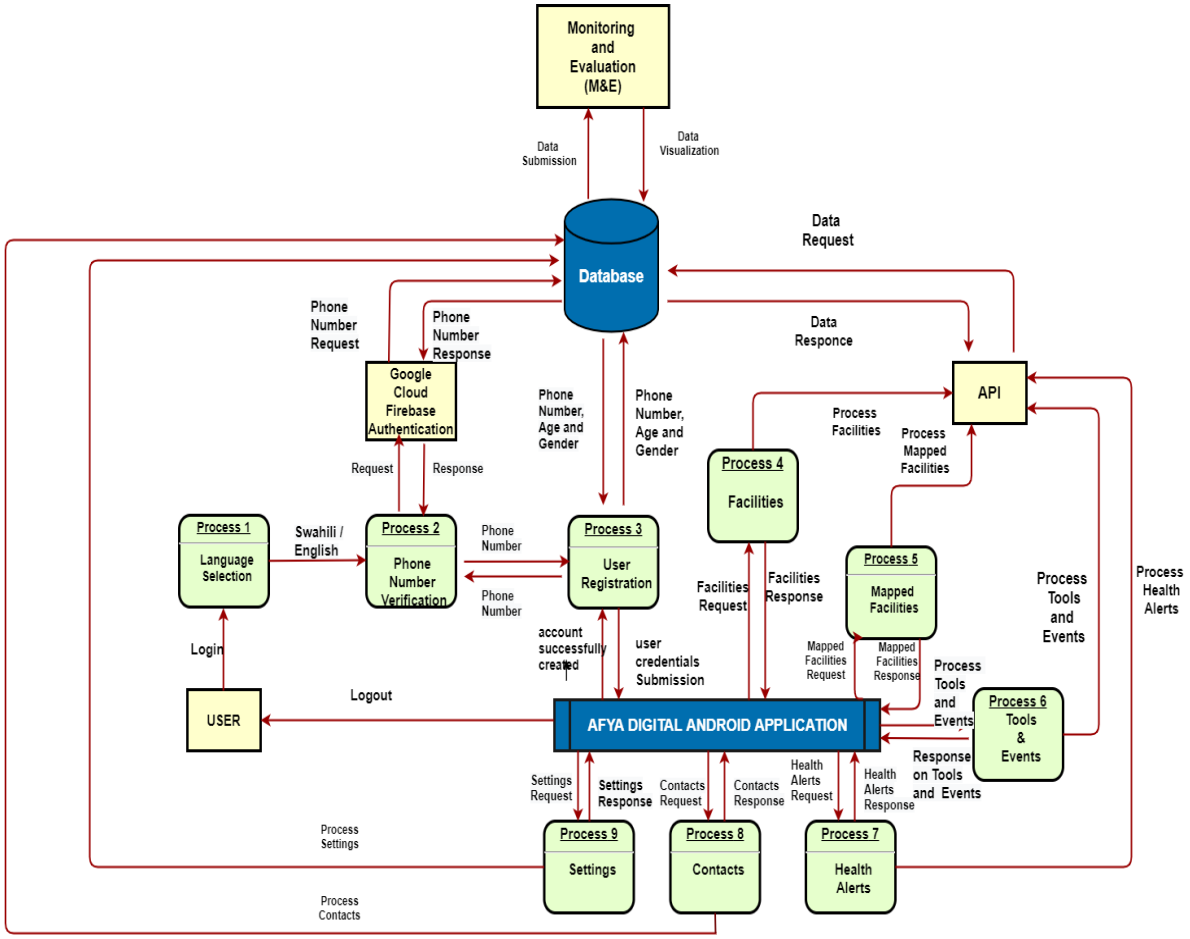

Figure 8: Data Flow Diagram of the Proposed System

3.7 AFYA Digital Mobile Application Development for Scaling Up Access to Health Services Beyond Tanzania and Kenya Border Communities

The proposed App adapted the prototype model as illustrated on Fig. 9, it's an iterative process that receives health facility requirements, refine and approve them for application end product. Moreover, prototyping accommodates any fluctuation in requirements, thus allows flexible in its design and development (Nacheva, 2017). A total of twelve iterations were conducted. In addition, the App Graphical User Interface (GUI) was designed by fragments, layouts and string using the Extensible Markup Language (XML).

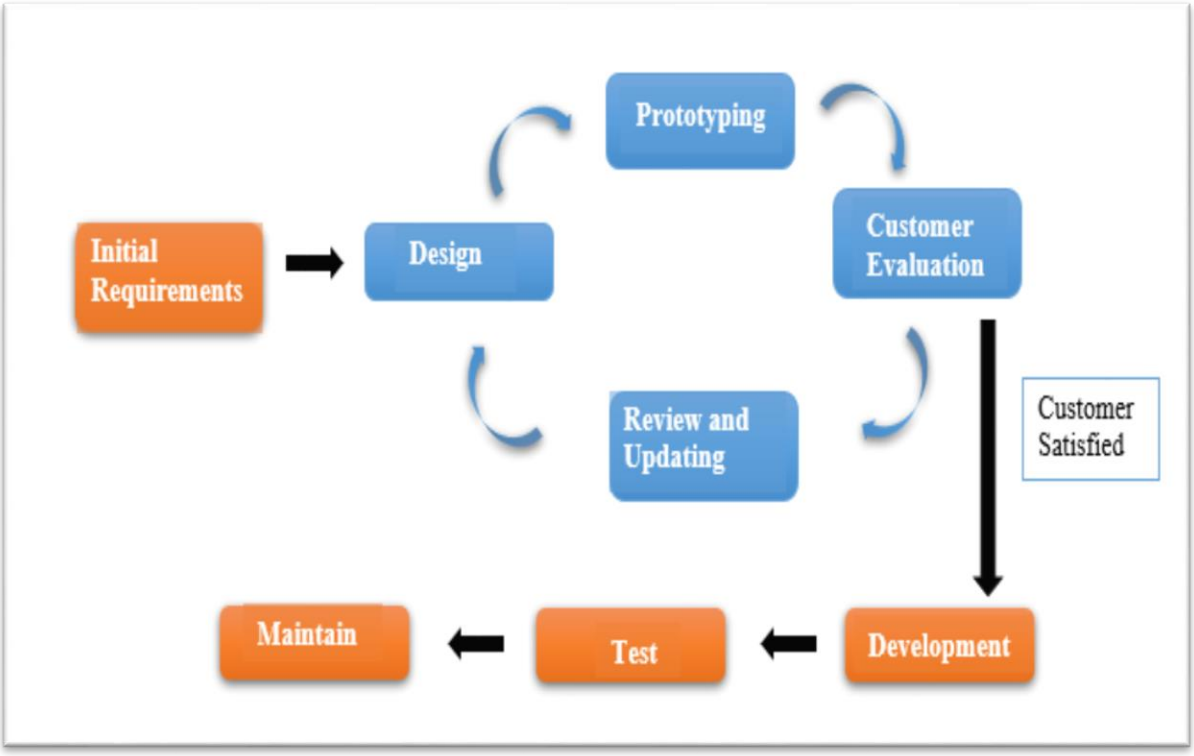

Figure 9: Prototype Approach Diagram

The development of this study mainly focused on improving access to health service through mapping of health facilities on a map using Android App. Locating the health service is implemented by integrating the Google Maps enabled by Google Maps API key to the Mobile App. This process is supported with a library offered by Google Play Service for using maps after registering an application on the Google Developer Console (Konarski & Zabierowski, 2010). The significance of the location APIs is to facilitate awareness to an App with automated location tracking, geofencing, and activity recognition. Dependencies (*implementation 'com.google.android.gms: play-services-maps:16.1.0'*) and permissions were added to build.gradle module and Manifest file respectively, refer to Fig. 10. Therefore, health facility details are fed to MySQL database with facility name, location, phone number, website (if any), facility's coordinates and country. Also, the mobile App will design an interface for the map to display facilities on it which is completed by (a) the mobile App should send a request to the server for health facilities details using the Hypertext Preprocessor (PHP) API Scripts and (b) the server should respond to the application's request on health facilities by retrieving them using the JavaScript Object Notation (JSON) format (Sarkar *et al*., 2019). Afterwards, user will be able to track health facility's location online using internet connection either by Wi-Fi (Wireless Fidelity) or mobile data (bundles) from user's current position. On the other hand, the offline access of health facilities is made possible without using internet connections, that

task is completed by SQLite database (DB) embedded with the Android OS (Javed *et al*., 2020). This DB has the ability to synchronize data stored in live DB (cPanel) from online to offline mode, synching process is enabled by getWritableDatabase function (*SQLiteDatabase db = this. GetWritableDatabase () ;)* which transfer the stored data on a live DB to SQLite DB (a permanent offline DB) to match the prerequisite of an App. Whenever new facilities are added to the live DB, the SQLite DB has the responsibility to delete the existing DB and generate a new one by using (*database. Delete (TABLE_NAME_FACILITIES, null, null) ;).*

```
<uses-permission android:name="android.permission.ACCESS_FINE_LOCATION"/>
<uses-permission android:name="android.permission.ACCESS_WIFI_STATE" />
<uses-permission android:name="android.permission.INTERNET"/>
```

Figure 10: Permissions

In order to increase wide range of users across Tanzania and Kenya borders, the significant feature of language selection is added to AFYA Digital Android. The development of language option was fulfilled by having two string folders, first, carries the English (the default) version of the App and second, carries the Swahili version of it. To get Swahili translation, the developer is required to follow the procedure below:

Choose ModuleName > go to resource (res) folder > go to values folder > right click on String> opt for value resource file> fill the new resource file > Localize the country code and select language of your choice> e.g., Swahili

The reason for opting these languages is that, English and Swahili language are mostly spoken to EA citizens as their first and second language though French is viable to be added to the application to suit the French speaking countries.

World Bank defined monitoring as:

> *"a continuing function that aims primarily to provide ... an ongoing intervention with early indications of progress, or lack thereof, in the achievement of results"; it defines evaluation as "the systematic and objective assessment of an on-going or completed project, program, or policy, and its design, implementation and results" (p. 1). The academic and "gray" literatures abound with texts, trainings, manuals, and guidelines for "M&E" and refer to similar activities as "performance monitoring";*

> *"implementation monitoring"; "process monitoring"; "planning, design, monitoring, and evaluation"; "program monitoring and evaluation"; and more. In fact, the two spheres of activity very broadly referred to as "M&E" must be mutually dependent parts of a whole"* (Curry, 2019. p147).

The M&E tool is implement using Firebase technology, Firebase is a web application platform that offers built-in functionality for high-quality apps. It stores data in JSON format, also is referred as the backend of a system. Available services provided by Firebase are Firebase Cloud Messaging, Real-time DB, Firebase Storage, Firebase Test Lab for Android, Firebase Crash Reporting, Firebase Notifications, Firebase Analytics and Firebase Auth service. Firebase Analytics offers perception into app usage. The SDK has the feature for capturing events and properties on its own and also allows getting custom data (Khawas & Shah, 2018). In addition, Firebase Auth provides the backend services, simple-to-use SDKs, and immediate User Interface (UI) libraries to authorize clients over an application. It supports several authentications such as phone number, email id/ passwords, Google or social media accounts like Facebook, Twitter and Google GitHub. Users can be allowed to sign in to a Firebase app either by using Firebase UI as a complete drop-in authentication solution or by using the SDK to manually integrate one or a few sign-in techniques (Chatterjee *et al*., 2018). This study opts for phone number authentication to authorize user to login to the system. In order to perform data visualization on Firebase, first the project is created within firebase console later on uploaded to Google Cloud using the application package.

3.7.1 Android Architecture

This study adopted AOS for mobile application which uses Android Studio IDE (Integrated Development Environment) editor and Android SDK tool for development. Before Android Studio installation, one needs to be sure that have first installed Java Runtime Edition (JRE) followed by Java Development Kit (JDK) 6 or higher version which serves as the java platform tools with required libraries. Android is an organized software stack which includes applications, an operating system, run-time environment, middleware, services and libraries. Figure 11 presents the stack layers which contains elements within that are tightly integrated to provide the optimal application development and execution environment for mobile devices. The application framework use activity manager, resource manager, package manager, system view and location manager so as to utilize the libraries and compile the codes using Android runtime. In libraries layer there is SQLite which supports a relational database (Suhas-Holla,

2012). At the lowest position of the Android software stack found a Linux Kernel, it delivers preventive multitasking to low-level core system services like process, power and memory management. Also, provides drivers for hardware such as device display, Wi-Fi, camera and audio (Li, 2014).

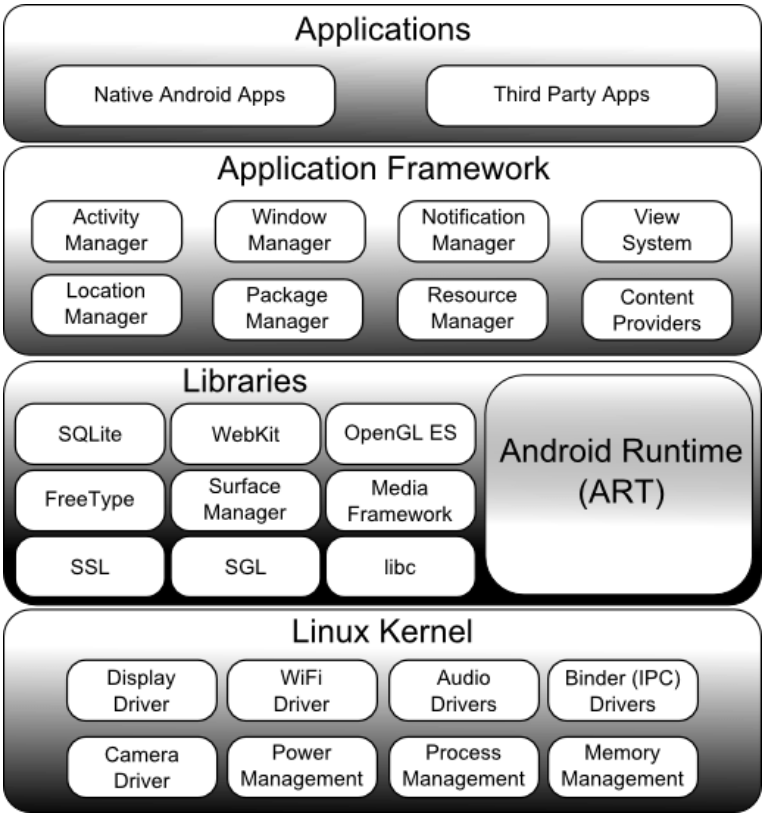

Figure 11: Android Architecture (Smyth, 2016)

3.7.2 System Components

(i) Language Selection

The App set two language options (Swahili and English) which give room to users who are not comfortable with either English or Swahili to confidently use the language of their choice. The system will opt to deploy another language whenever there is need for it.

(ii) User Registration and Authentication

Residents and travelers across Tanzania and Kenya borders are users to the App. Firstly, User needs to be authenticated through phone number verification supported by Google cloud Firebase technology, that process will be useful for the M&E process using Firebase services. Secondly, user will also be registered using the gender and age details which are then stored to

the MySQL database and login to the system. Application user will remain login until they he/ she decides to logout of the App.

(iii) Mapping of Health Facilities

Mapped facilities component retrieves facilities on a Google map implemented by Google map API. In order to locating health facilities and track user's current position, GPS technology embedded in AOS Smartphones is required, this process is supported by GPS satellite to an App.

(iv) Travel Guide

Travel guide component consists of three menu such as Vaccination, Place to visit and Exchange rates. The application users (travelers and residents) across Tanzania and Kenya borders will see the shared health information on "Vaccination" category which displays the anti-malaria, yellow fever and hepatitis A vaccines; in "Place to Visit" category, user will navigate on the list of most famous tourist attraction in both countries, few have been displayed. These attractions can be accessed online only. Last but not least, the "Exchange Rate" category aimed at informing users on several exchange rates for different currencies that is from EURO, POUND and DOLLARS to Tanzanian Shillings (TSH) and Kenyan Shillings (KSH).

(v) Health alerts

This component mainly focused on displaying the health information statistics of various diseases such as HIV, TB, Malaria and Coronavirus Disease 2019 (Covid-19) how widely spread and number of deaths caused by each disease.

- HIV- presents the widely affected and deaths of people from HIV
- TB- presents the widely affected and deaths of people from TB
- MALARIA- presents the widely affected and deaths of people from Malaria
- COVID-19 pandemic - presents the widely affected and deaths of people from Covid-19 pandemic

(vi) System Administrator

Admin is tasked to insert, delete, update or create a new facility on a map through database. Also, responsible for deleting and disabling user accounts as a result of any unusual activity

occurred within an application. In addition, the Admin is the overall in charge entire system and is required to analyze activities and requests done by user from the App.

(vii) Monitoring and Evaluation Tool

The tool is responsible for data visualization where the administrator takes control over the authorized user to the application accomplished by Firebase Authentication. Admin will be able to view and streamline events done by active users who retain the application usage, also check for the most request page attended by different uses.

(viii) Contacts

Here, application users are able to contact directly the platform via email, phone number or by searching their location. Moreover, users can get additional information from the Application's social media platforms such as Facebook, Twitter and Instagram.

(ix) Settings

Under, Application users get clarification and how to share their views and experience from the App. These healthful features are sending user feedbacks and filing complaints if any, about and Privacy Policy features, last but not least if Help section of an App. Also, users can send an invitation to friends and families to inform them on this App.

3.7.3 System Flowchart

This section demonstrates how the system works using flowchart diagram. The presentation starts from where the application program launches, then follows phone number verification and user registration up to system navigation till he/ she logout of the system. Figure 12 illustrates on the System flowchart.

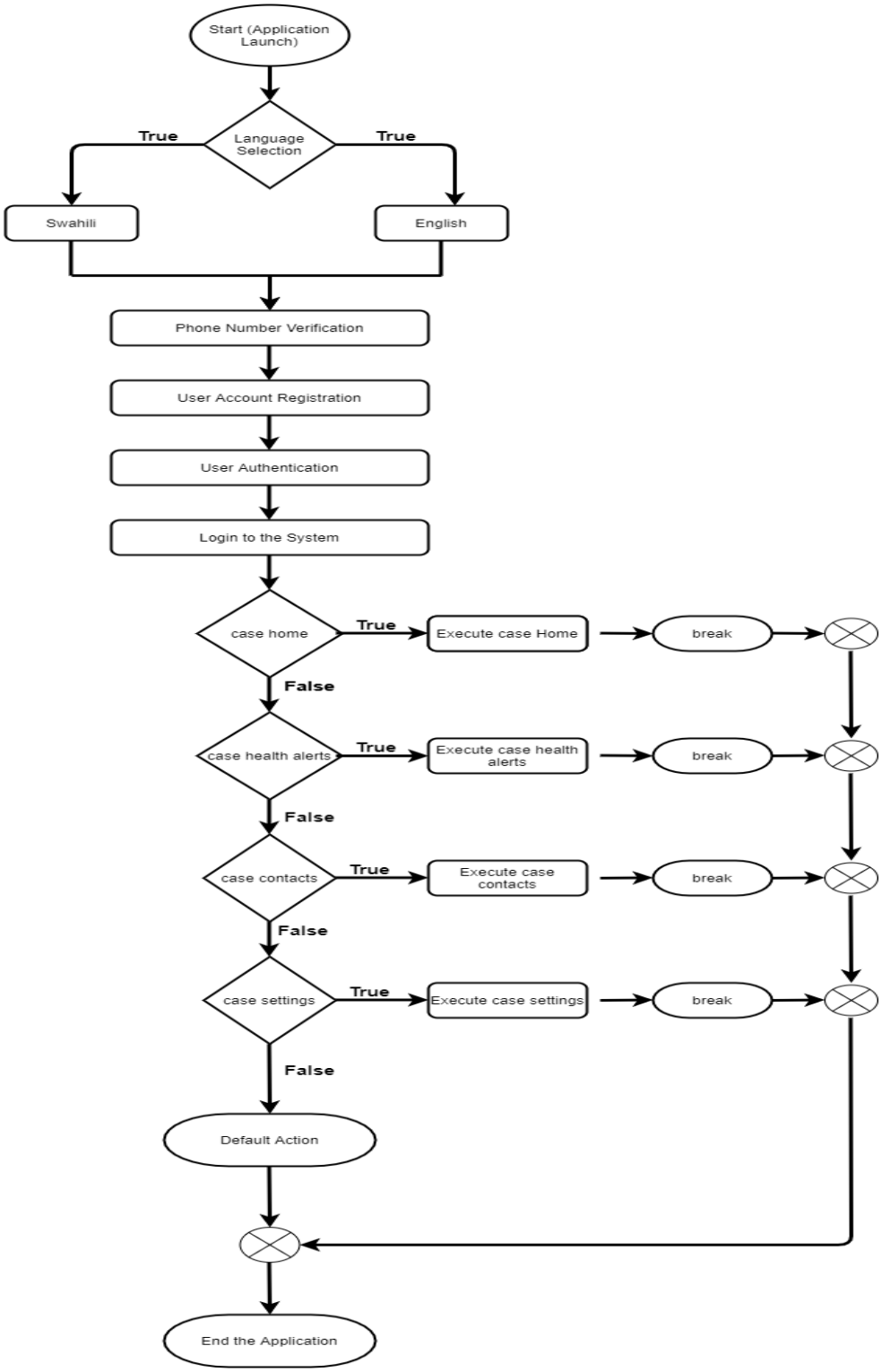

Figure 12: System Flowchart

Moreover, the system application has subsections like home, health alerts, contacts and settings. Figure 13 demonstrate the home section which has components within such as the facilities, mapped facilities, travel guides, events and tools. In addition, Fig. 14 describes the health alerts components which are TB, HIV, Malaria, Covid-19 and News.

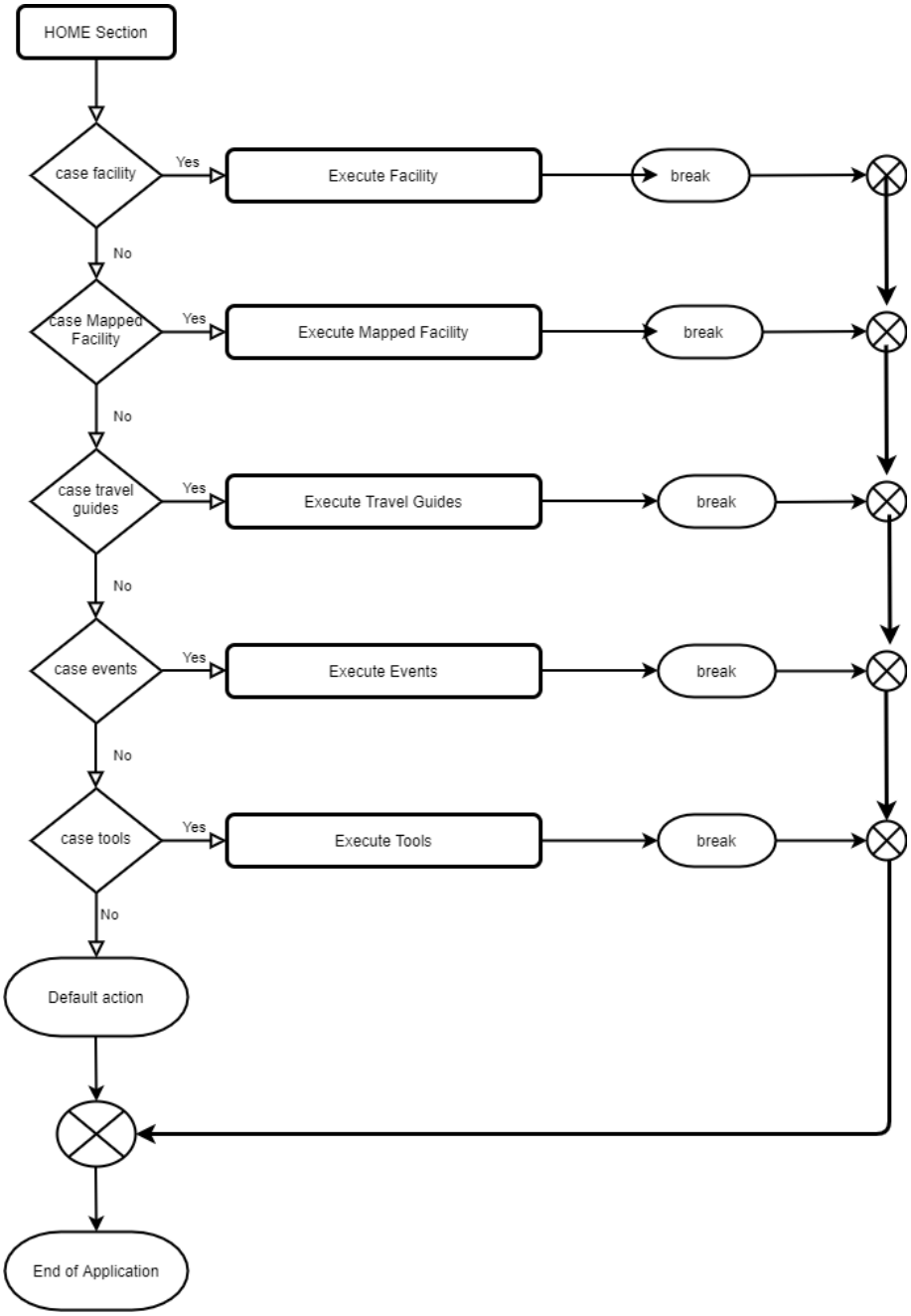

Figure 13: AFYA Digital Home Section Flowchart

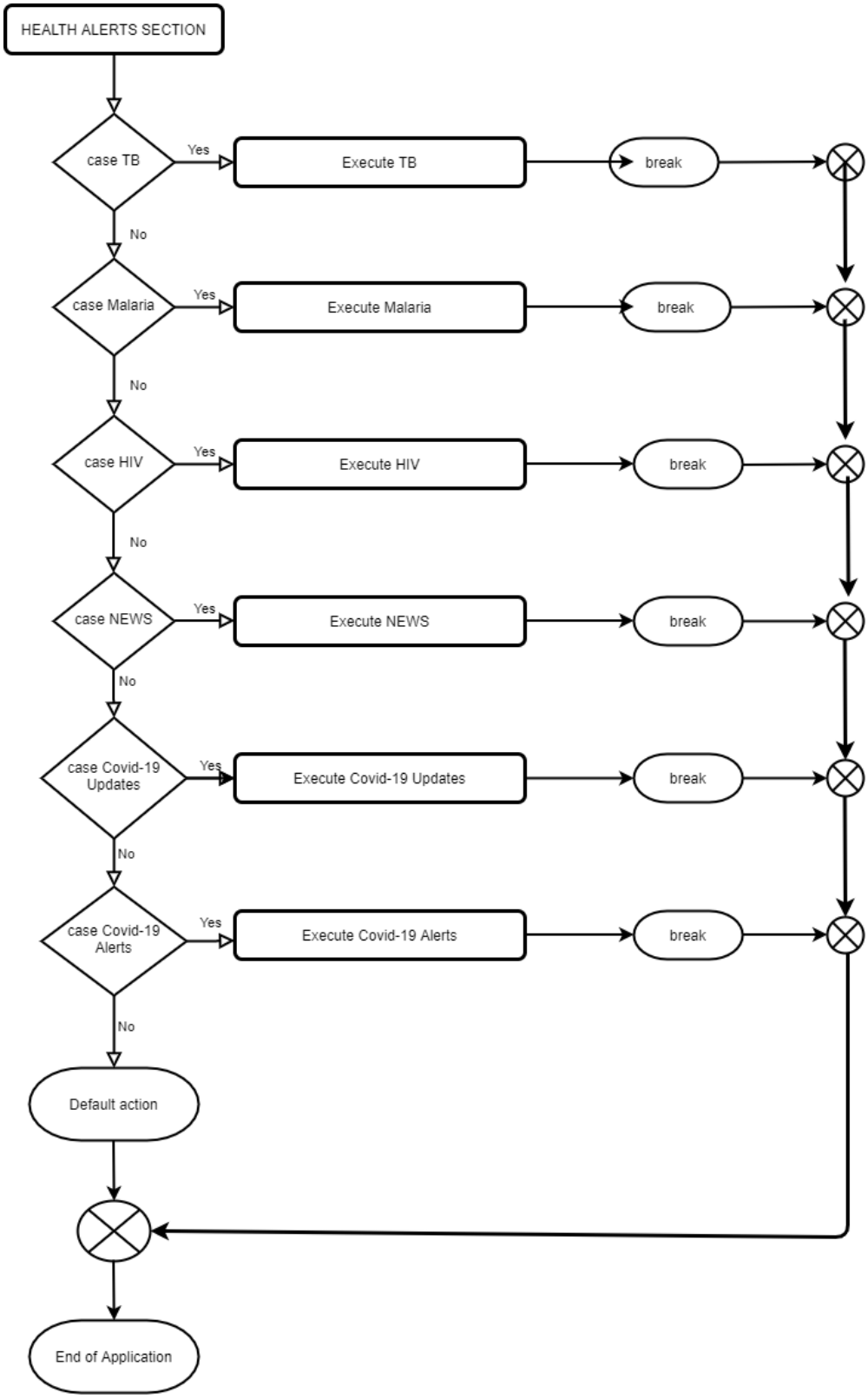

Figure 14: Health Alerts Section Flowchart

3.8 Tools and Technologies in System Implementation

While developing the proposed system, several tools and software technologies were used. These tools and software technology listed below were used for this system implementation.

3.8.1 Android Operating System Smartphones

Android Operating System (AOS) devices in association with Open Handset Alliance (OHA) have edged through an open-source platform with licenses agreement supported by Google Inc. (Farkade & Kaware, 2015). Also, they have higher consumer demands than other devices combined in last decade. The statement is validated by January 2018 to July 2020 statistics provided by the Global market share for mobile operating system which indicated that over 83% of Africa's mobile OS Market has been secured by AOS (O'Dea, 2021).

3.8.2 Global Position System embedded in Android Operating System Devices

Global Position System (GPS) is accurately defined as a navigation system that relies on satellite signals to indicate in object location (Wasim *et al*., 2015). Today, more than one billion smartphones, tablets, cameras, and other GPS-enabled mobile devices have been activated. Devices that use GPS receive signals from special satellites that orbit the Earth twice a day at an altitude of 13 000 miles to locate user's current and exact position using trilateration process with a minimum of 24 satellites are required for the GPS to function.

3.8.3 Google Map Application Programming Interface and Software Development Kit for Mobile

The Google Maps Platform is established with APIs and SDKs that permits designers and developers to insert Google Maps into mobile applications and web pages, or retrieving information from Google Maps. The Maps SDK for Android can add maps in accordance to Google Maps data to the mobile application (Konarski & Zabierowski, 2010). In addition, the API holds access to Google Maps servers which enhance data downloading with response to map retrieval in several gestures.

3.8.4 Integrated Development Environment (IDE)

The IDE used for thus study is Android Studio which is the official IDE for Google's AOS. This IDE is a free open-source which contains features that simplify the coding (programming)

process while developing an App. Android studio was not the only editor used for coding the Android-based mobile application, Eclipse IDE can work too (Verma *et al*., 2018). The reason of choosing Android Studio over Eclipse is because of the user interface, gradle integration, advanced Java code Auto-Completion, system stability and project workflow.

3.8.5 MyStructured Query Language (MySQL)

MyStructured Query Language is a freely available Relational Database Management System (RDBMS) which uses Structured Query Language (SQL) for database manipulate (adding, accessing and managing content in a database) at the backend of the system. It handles complex and traffic database commands (queries) to support the system administration by engaging various techniques (Yan & Chen, 2011). The MySQL operates smoothly with PHP scripting language for generating API which bridge communication between the App and the system server. Also, it is reliable, powerful and scalable since it can be installed and work with any operating system (OS). It is reliable with quick query processing, effortlessness and flexibility of use. MyStructured Query Language advantages like data security, on-demand scalability and high performance. During this study, the MySQL database was used to assist data storage, retrieve and data management. Moreover, MySQL provides varieties of access privileges and encrypted password to the database creator to enhance security (Aldabbagh, 2014).

3.8.6 The cPanel Server

The cPanel is substantially a Linux-based web hosting used as the control panel to simplify server management. It provides a graphical interface and automation tools designed to manage domains, organize files, give access to databases, preferences, metrics, security, software and email modules (Kundar *et al*., 2018).

3.9 System Testing and Validation

Testing is intended to show what a program is intended to do and to realize program defects before it is put into use. In this study, the system testing and validation was performed to meet its functionalities and user's requirements as per organizational goals when deployed to a conducive environment. Moreover, system validation was tasked to check the presence and absence of errors in coding (Abildinovaa *et al*., 2016). During the development of the AFYA Digital mobile application, different testing procedures were taken for performance and system validation as described in the next segments.

3.9.1 Unit Testing

Unit testing focuses on testing independent program units or module functionalities. In other words, it is the defect testing process where individual components are tested in isolation. The software developer is required to separate and test each module if it works correctly and meet user requirements. Unit testing determines the early detection of bugs that reduces the fixing and maintaining cost whenever bugs are founds rather than found during the user acceptance testing or system testing which would be costly (Kim *et al*., 2009). In this study, unit testing was applied to different modules of AFYA Digital App, such as the language selection, user registration, health facilities and alerts categories, travel guide, contacts and settings.

3.9.2 Integration Testing

Integration testing occurs after merging interactive modules (object classes) to a single component which have been unit tested, also validate whether the combined modules function precisely as intended (Deka *et al*., 2017). In this study, the integration testing was conducted during user registration while login to the system, in M&E when active users can be tracked in accordance to activities done within the application. Further, integration testing was employed on mapped facilities on a Google map while making a call or showing the route directed to such facility.

3.9.3 System Testing

The study performed system testing in order to check the emergent behavior of a system. In addition, system testing checks for the components' compatibility, interaction and exact data transfer at the right time across their interfaces. System testing tests the emergent behavior of a system. Consequently, the test aimed at uncover any system detects.

3.9.4 User Acceptance Testing (UAT)

User Acceptance Testing (UAT) is a kind of testing performed by the end user (client) in order to accept or verify the system before taking it to production phase (Suman & Sahibuddin, 2019). The UAT is done in the last phase of testing after unit, integration and system testing are done (Scherr *et al*., 2018). In this study, UAT was done to validate the AFYA Digital mobile App if it met the project's requirements to Tanzania and Kenya border communities. Users have managed to test for language selection (Swahili and English) and switch them

successfully, also were able to register to the App using phone number verification and login to the system. In addition, users managed to have access on health information and health facilities both online and offline; they were able to make a call and navigate facilities on a map.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results from Data Collection

The executive director and the IIDEA project members for the existing East Africa Wananchi Digital Health Platform responded that:

> *"There is a need to reach the large group of people from border communities using the mobile devices which are ubiquitous. Moreover, the system should be able to allow user to access health services whether are online or offline from internet connections*"

They suggested that because it seems the currents system has not reached end user as required. Hence the mobile application will reach more user with information richness.

4.2 Result of System Design

In this study, UI design was developed based on features and functionalities. The design mainly focused on giving access to user to register and login to the system, have access to dashboard (home) where he/ she can select any button from the App. Further, user navigate through the health alerts, contacts and settings page. Figure 15 to Fig. 18 below describes various design interfaces of the App.

Figure 15: Home Page

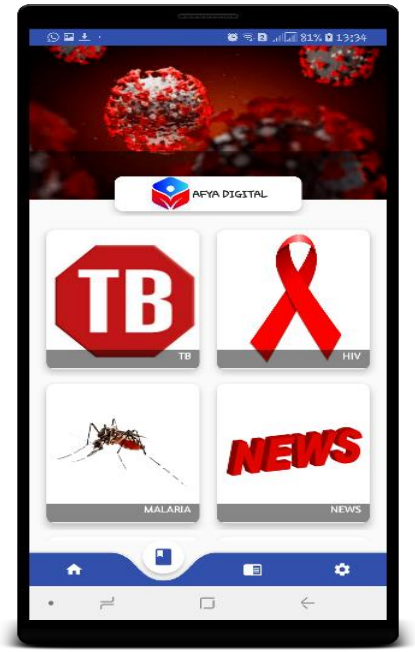

Figure 16: Health Alerts Page

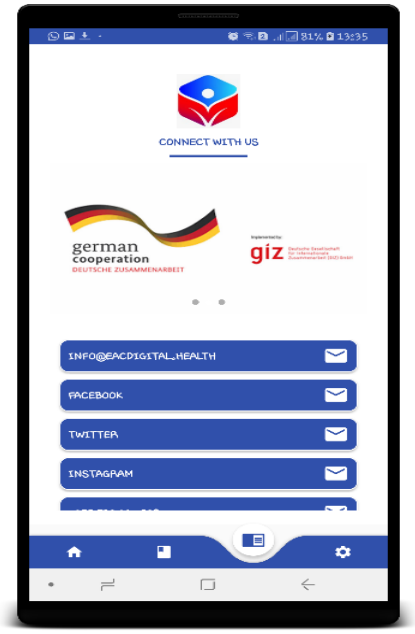

Figure 17: Contact Page

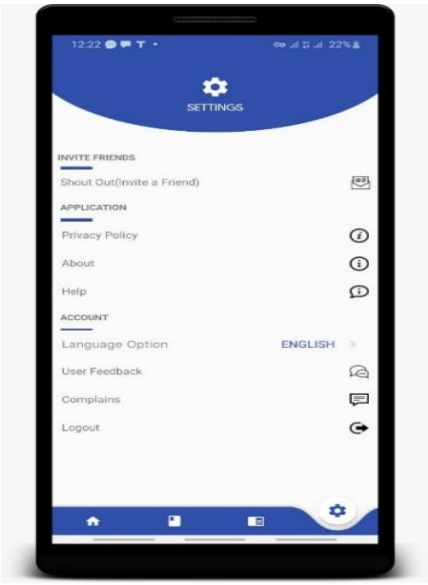

Figure 18: Settings Page

4.2.1 Result of System Design Process

The system has adopted a client-server model which operates Model View Controller (MVC) domain as a result of the requirements received. Model View Controller is a design pattern regularly used for developing user interfaces, structure it and assist on the development of the proposed system. The MVC for Mobile Application have parallel needs such as access to internal DB management system, web platform service and reusable components without affecting the whole system (Sokolova *et al*., 2013). Figure 19 illustrate the MVC for the proposed system where CLIENT module represents user like travelers and residents across Tanzania and Kenya borders and a system administrator. In addition, the VIEW section comprises of the UI which receiving data from both external DB resources, server storage and Google APIs monitored by the CONTROLLER.

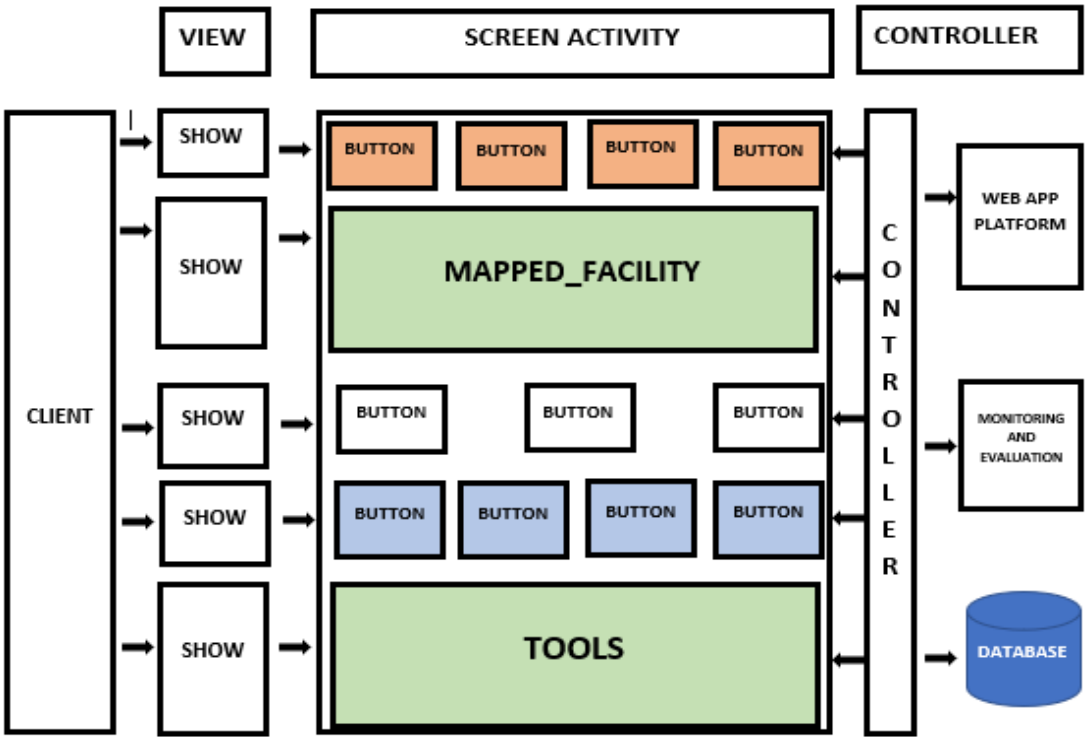

Figure 19: Model View Controller for Mobile Application System

The MODEL section was furthermore indicated by conceptual framework in order to deliver a proposed plan for development processes as shown in Fig. 20. In brief, the conceptual framework involves a mobile application which enables the residents and travelers to securely register to the system, and then submit data such as residents/ traveler's age, gender and phone number to the system DB. Moreover, the storage server is acting as the communication link between the App and the analysis tool. The system administrator is responsible for feeding the geo-location coordinates and health facilities' details for analyzing data, monitoring and evaluation purposes.

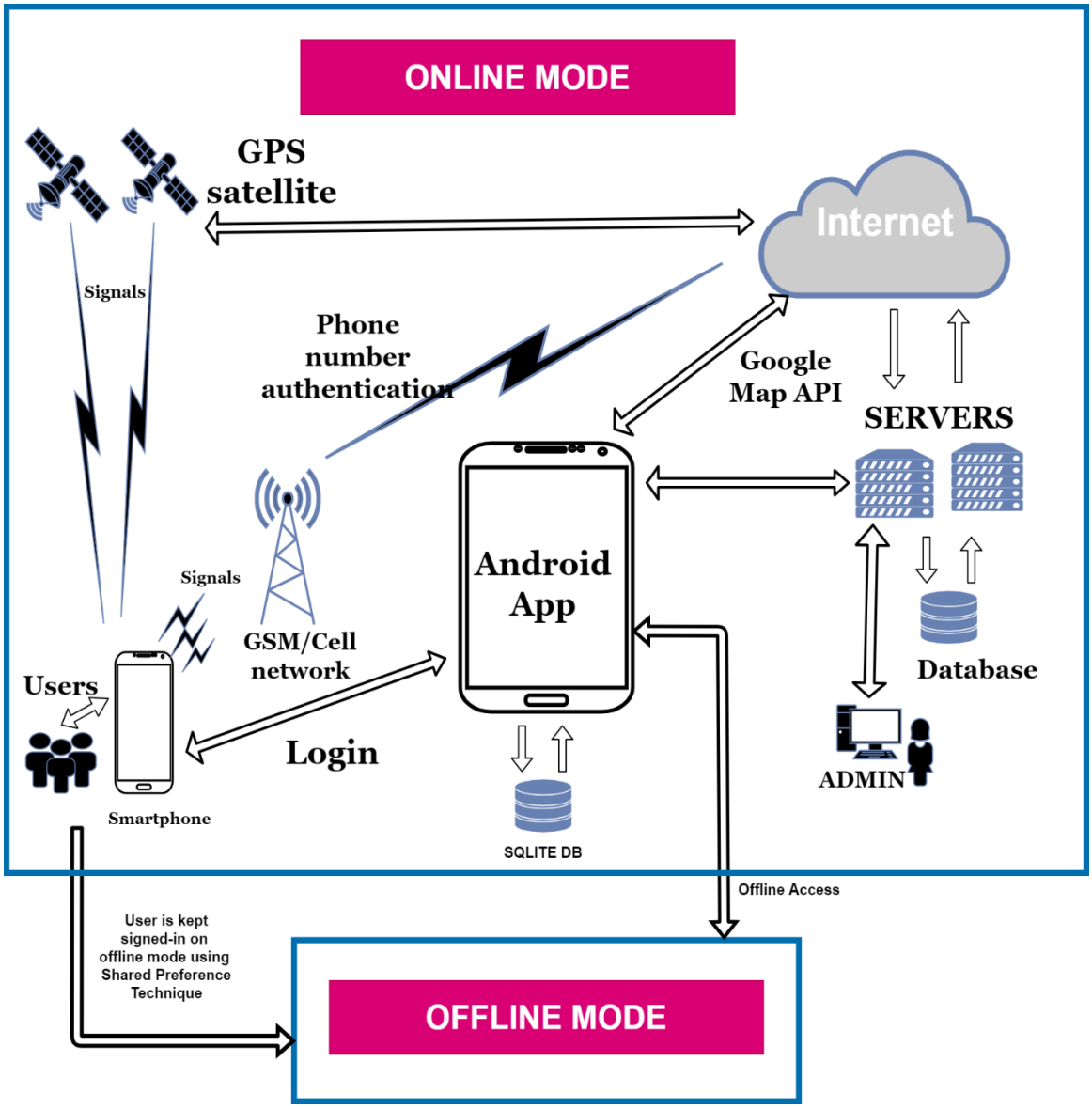

Figure 20: Conceptual Framework of the Mobile Application

4.3 Results from the Developed AFYA Digital Android Application

The subsection describes the results obtained from the development of AFYA Digital Android App which are categorized into language selection section, user registration section, health facilities section, health information dissemination section and monitoring and evaluation section. Moreover, results of each subsection will cover the online and offline functionalities of AFYA Digital App.

4.3.1 Language Selection Section

On this section, user is prompted to select language soon after the application's launch. Afterwards, user will choose language (Swahili or English) then will be instructed to registration by verifying their credentials to the application. Consequently, language selection will dominate information provided by the App. However, user can make changes on language selection both online and offline mode (that is, on presence or absence of internet connections) within settings section of the bottom navigation. Figure 21 to Fig. 24 describes the language selection process within an App.

Figure 21: Language Options

Figure 22: Language Selection

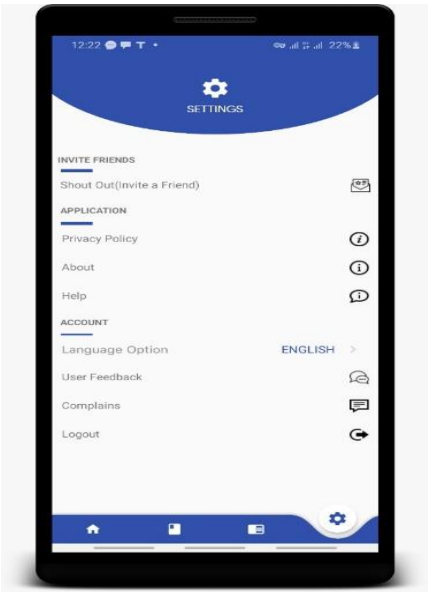

Figure 23: Selected English Language

Figure 24: Selected Swahili Language

4.3.2 User Registration Section

User registration section follows after the language selection as explained on previous section. The registration process is significant because it enables user to have an account and be authorized to use the system. First, user is required to abide to the terms and condition of the organization, then will be directed to phone number verification. Phone number verification is done online since user is required to enter phone number which will be synched and verified by Google Cloud web platform (Firebase) so that Short Message Service (SMS) code can be

sent to user's smartphone for verification. In addition, user will submit age and gender data to complete the registration online. These data will be submitted to the system database for demographics purposes. Last but not least, user will successfully login to the application. The application will keep user login using Shared Preference property on the phone number until is logout of the system. Figure 25 to Fig. 28 describes the whole process.

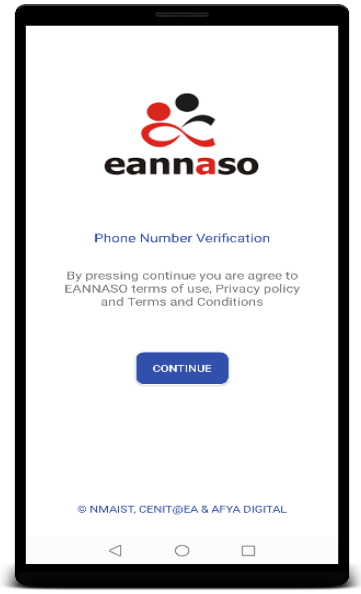

Figure 25: Phone Number Authentication

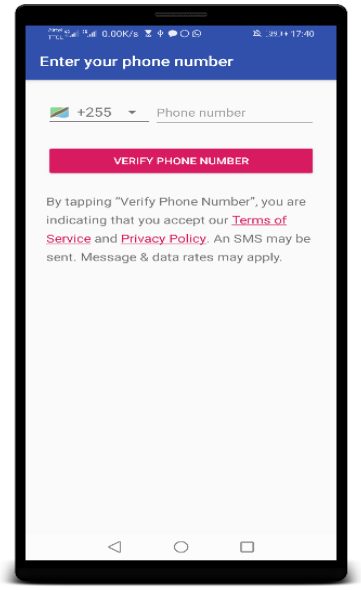

Figure 26: Verifying Phone Number

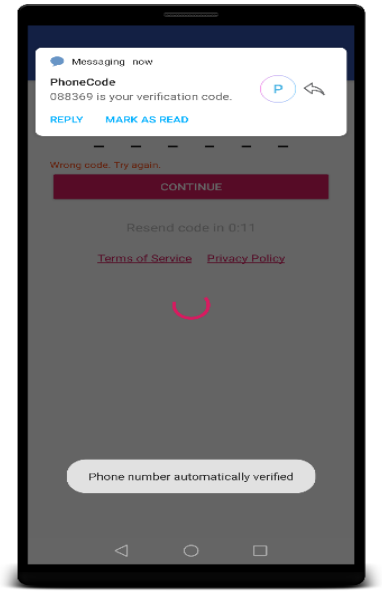

Figure 27: Phone Code Matching with the App

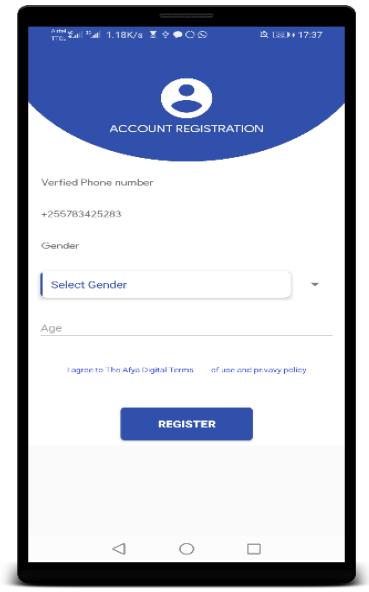

Figure 28: User Account Registration

4.3.3 Health Facilities Section

User will have a choice to select either facilities or mapped facilities from the application dashboard, these procedures are encountered to retrieve details in AFYA Digital App. Firstly, the App sends a request to the cPanel server to attain all information about the selected health facility by sending the directoryID of the selected health facility to the server. Secondly, the server through PHP API script receives the request and send feedback from MySQL database entry to client in JSON format. Consequently, on facilities category one, the list of CardViews carrying facilities details will appear and show two options to user which are make a direct call

to the facility or get the location on Google map. Also, on mapped facilities category displays the facility locations on a map; with a single click to a facility, the dialog box will be displayed showing “show route” and “call”. The above functionalities of the AFYA Digital App are crucial, they can be accessed both online and offline mode by users whenever seek for medical attention. However, with exception to “show route” function, that can only be accessed online since the App requires permission to user’s current location on Google Map access. (Aldabbagh, 2014). Figure 29 to Fig. 32 illustrate the online functionalities applied to health facilities section.

In addition, the AFYA Digital offline functionalities are performed when a user has no access to internet connections on App, and the following notification written “No internet connection. Continues to explore offline” will alert user that he or she is in offline mode. Figure 29 and Fig. 30 demonstrate the offline mode as applied to health facilities section.

Figure 29: List of Facilities

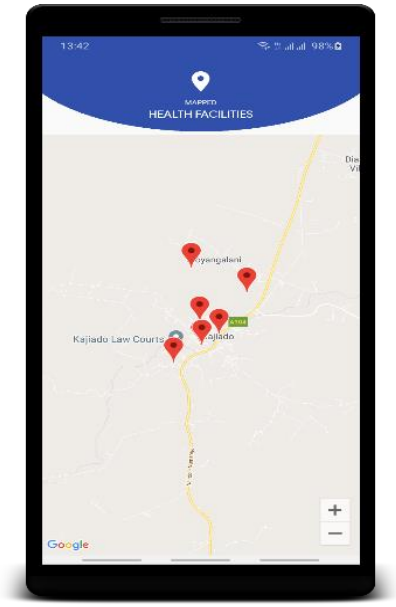

Figure 30: Mapped Facilities

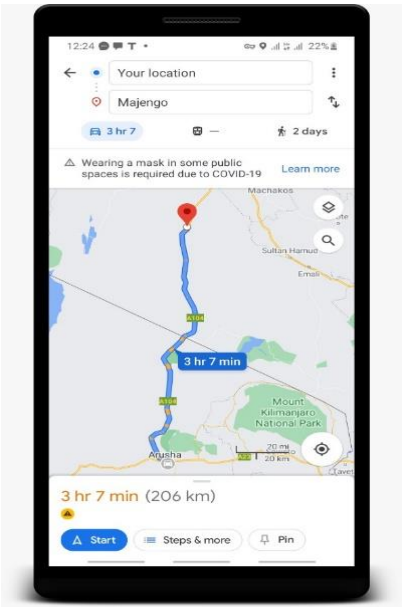

Figure 31: Show Route

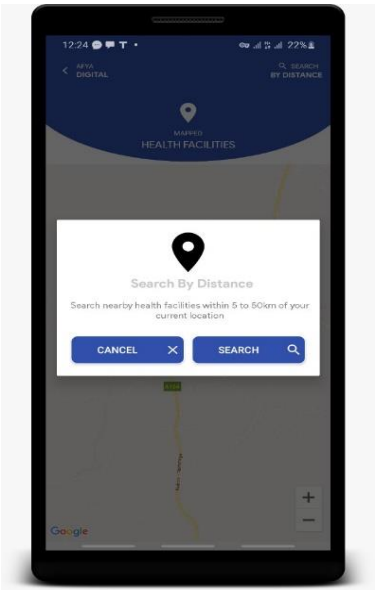

Figure 32: Search by Distance

4.3.4 Health Information Dissemination Section

This section displays the online health information access based on TB, HIV, Malaria and Covid-19 from the global repositories; these data are not only useful to border communities and health practitioners but also to policy makers. Once user is login to the system then are able to access the health alerts section of the bottom navigation, there will be a display for the disease information discussed above. The statistical data on death and rate of spread for such diseases will increase awareness to user to protect himself/ herself and others from being affected. Figure 33 to Fig. 35, presents the graphical demonstrate on Covid-19, TB and HIV information.

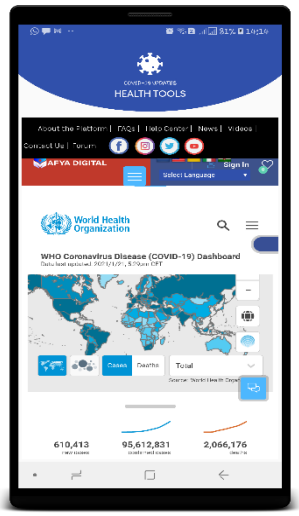

Figure 33: COVID-19 Health Information

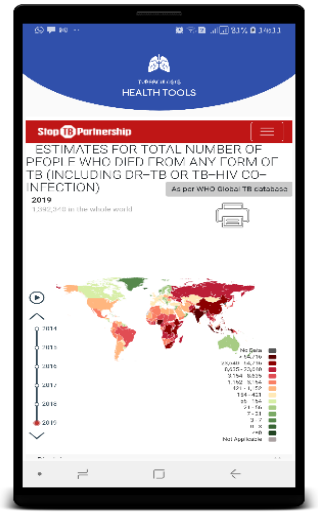

Figure 34: TB Health Information

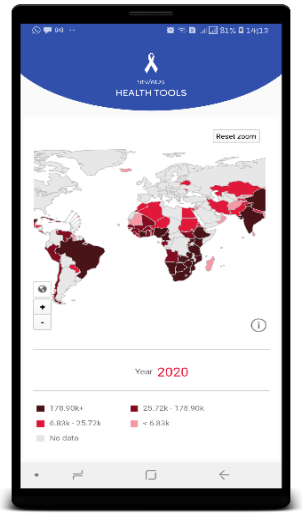

Figure 35: HIV Health Information

4.3.5 Monitoring and Evaluation (M&E) Section

The M&E section is Admin's monitoring environment for evaluating the system. This section involves a web application platform which is integrated to AFYA Digital App mainly focused on data visualization. It presents the list of authenticated users to the system; Fig. 36 demonstrates the analysis of authenticated user between December 2020 and April 2021. Also, in Fig. 37 and Fig. 38 indicate the analysis of active users who also retain the application usage while Fig. 39 and Fig. 40, illustrate location of registered user and devices used while login and navigate on the application pages, data were analyzed between March 2021 to April 2021. Lastly, Fig. 41 demonstrate the analysis of the most requested views (application's UI) from the App. Therefore, data generated can be extracted through Excel file (.xlsx) and CSV files (.csv). The visualized data will only be accessed online.

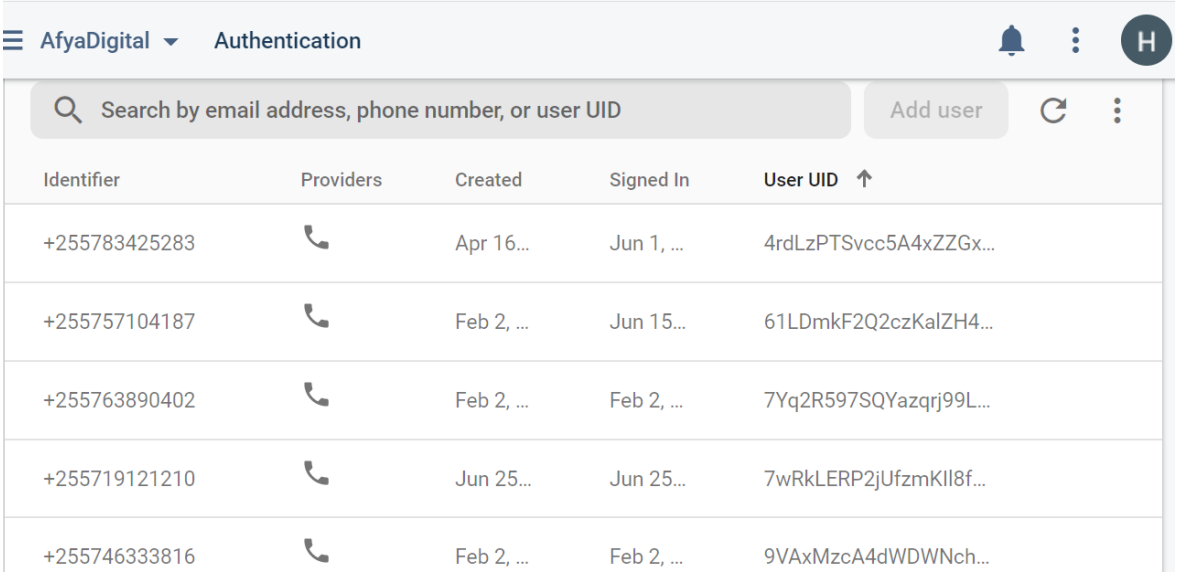

Figure 36: Analysis of Authenticated User between December 2020 and April 2021 (AFYADigital, 2021b)

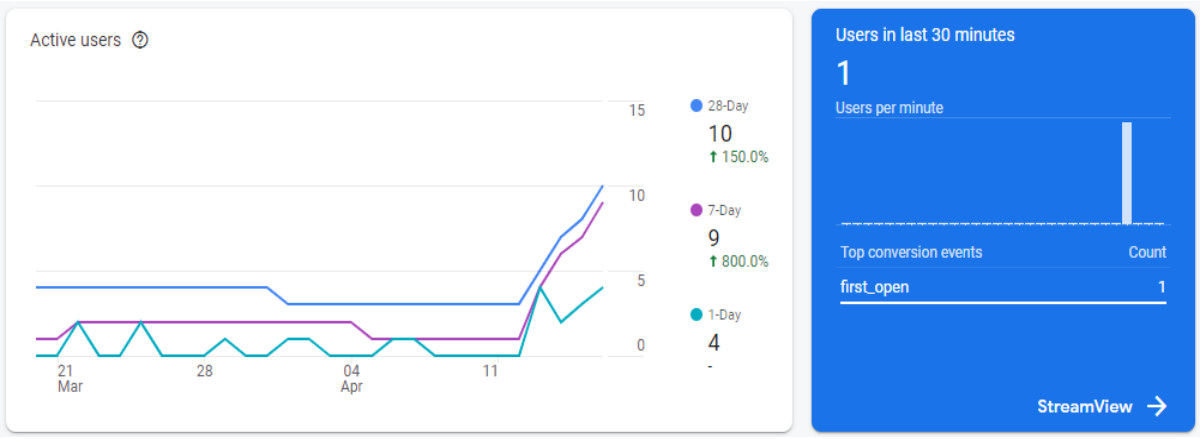

Figure 37: Analysis of Active User between March 20, 2021 and April 15, 2021 (AFYADigital, 2021a)

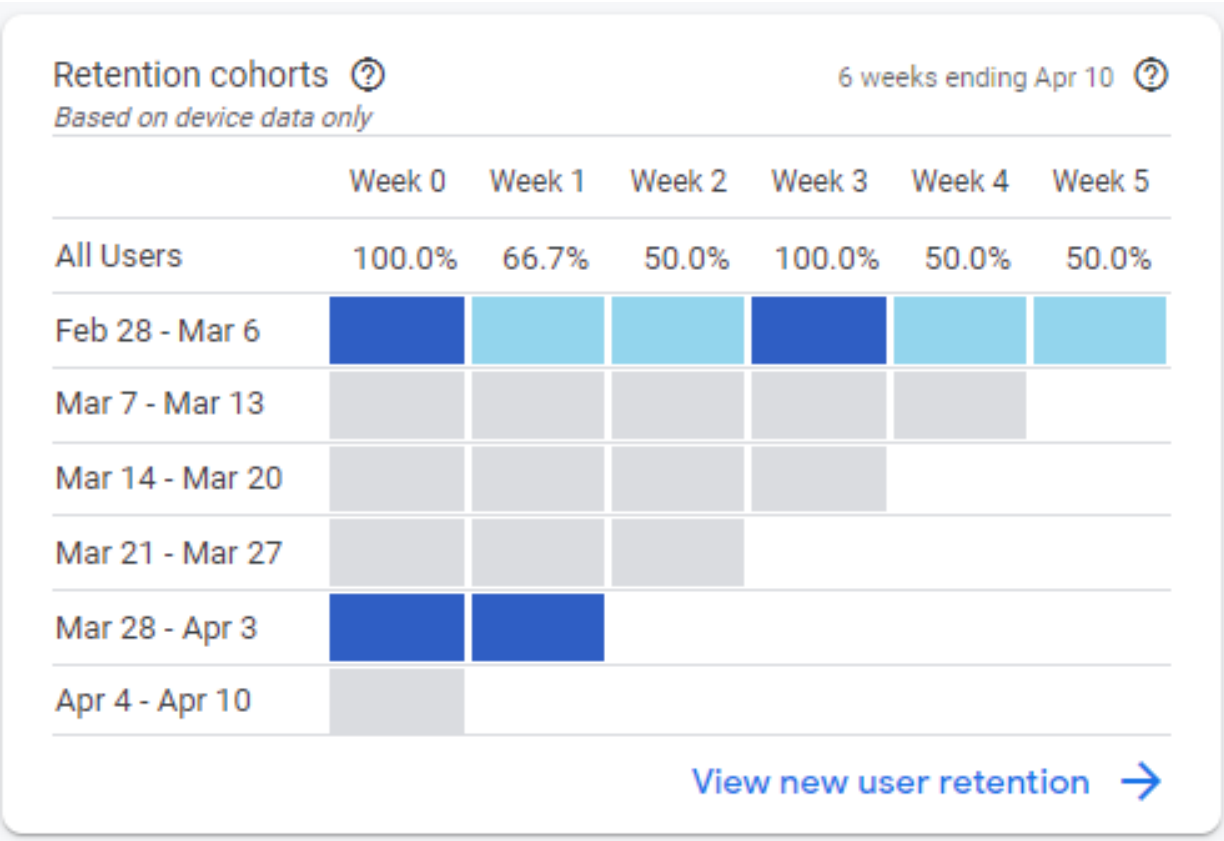

Figure 38: Analysis of Retention Cohort between February 28, 2021 and April 10, 2021(AFYADigital, 2021c)

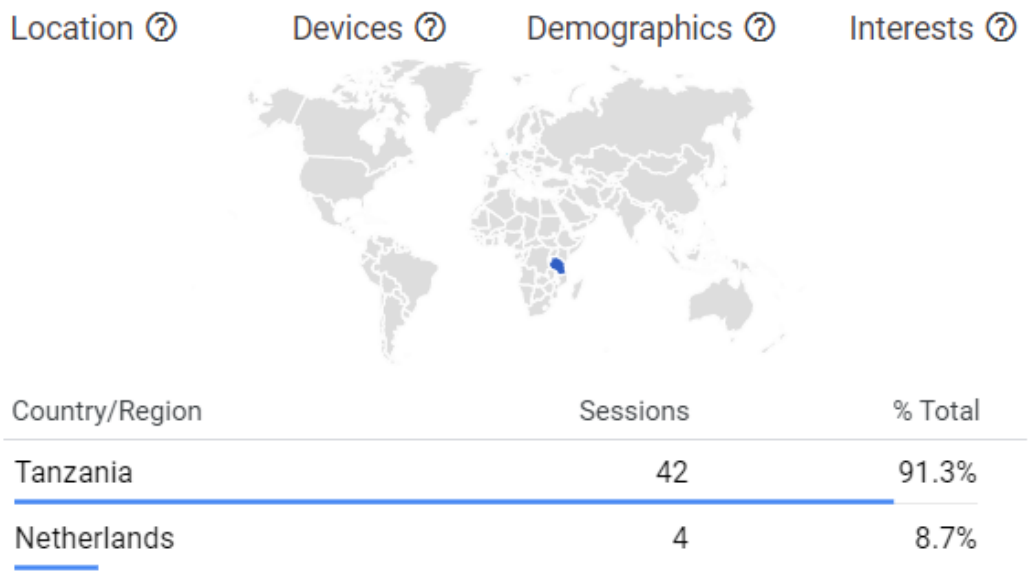

Figure 39: Demonstration of Registered users' Location (AFYADigital, 2021a)

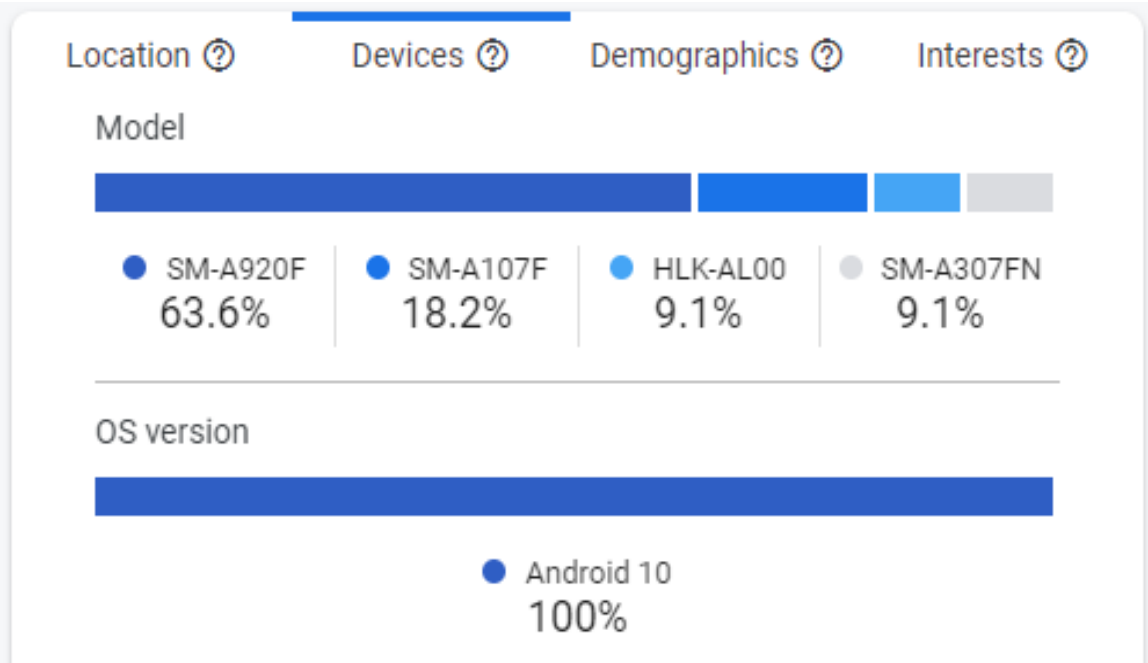

Figure 40: Analysis of Devices used by Registered Users (AFYADigital, 2021a)

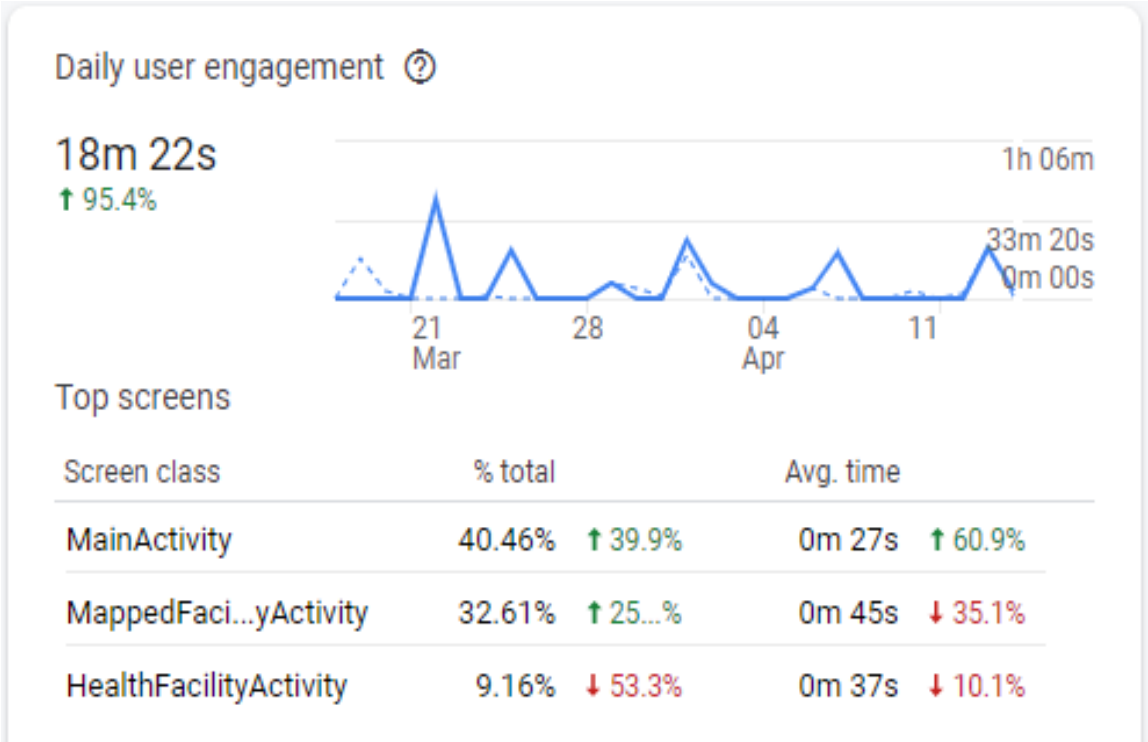

Figure 41: Daily User Engagement on Most Requested View

4.4 Result of System Evaluation

On this section presents the results obtained from system evaluation, also checks whether the developed system actually does what it was intended for scaling up access to health service organization.

Field study was conducted using the final prototype, for system evaluation. The study consisted of 37 East African's (EA) citizens and travelers from six partner states who reside in Arusha and at Namanga borders of Tanzania and Kenya (EAC, 1999). These citizens consisted of 15 males and 22 females at 41% and 59% respectively, refer to Fig. 43, with an average age of 31 years old. The statistics of EA partner states participation to the system is as follows, Southern Sudan, Burundi, Rwanda, Uganda, Kenya and Tanzania has 3%, 5%, 11%, 19%, 24% and 38% respectively, refer to Fig. 42. The study was conducted between December 2020 and March 2021.

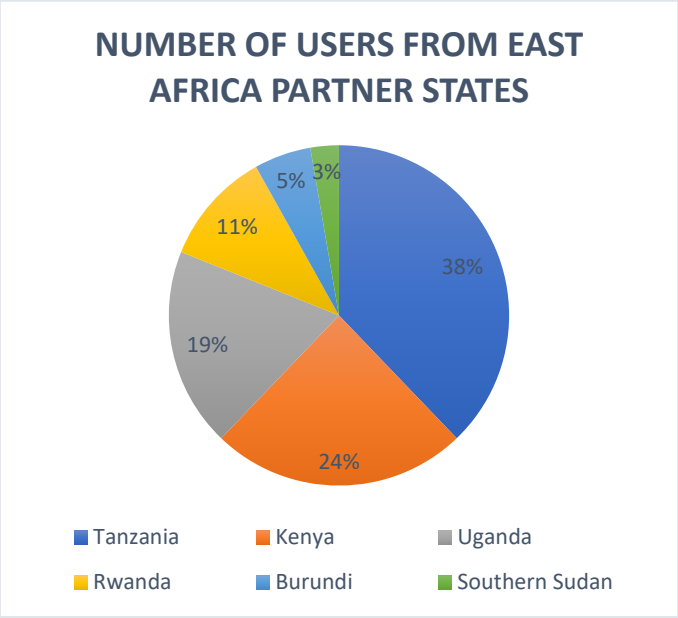

Figure 42: Number of Users from EA Partner States who Evaluates the App

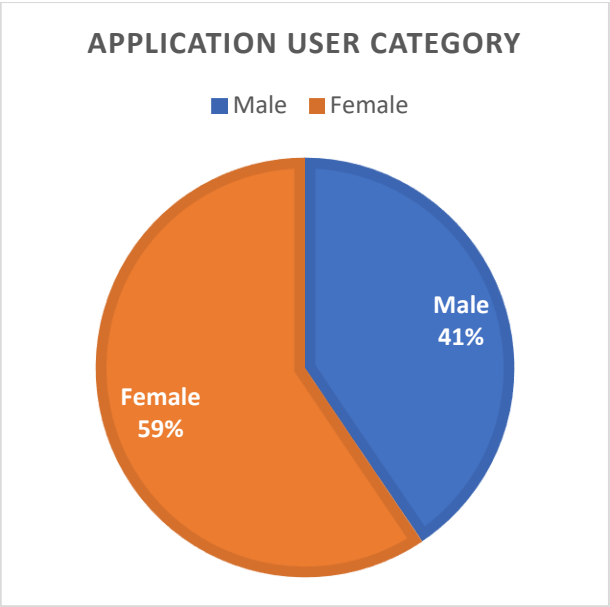

Figure 43: Analysis in Accordance to Gender

4.5 System Requirements Evaluation

4.5.1 System Requirements Evaluation

Table 4 describes, in brief, the accomplishment of the functional requirements in the developed system.

Table 4: System Requirements Verification Featured in the Interview

No	Requirements	System verification
1	The developed system should gather health facility's details such as name, telephone number, email, website (if any), location and geo-coordinates. Also, the App should be able to collect users' phone number, age and gender variable.	The developed system has unified the firebase technology with an AOS to collect the required data for the analysis into platform, where the appropriate data collection and analysis is unavoidable.
2	The developed system is required to produce essential data format and store data attained.	The developed system consists of DB, and file manager as the communication subsystem to control and store the required data format.
3	The developed system must be able to manipulate the received data and produce the analyzed data report format.	The developed system has combined cutting-edge technology such as mobile App, Firebase technology and GPS in the control module for timely monitoring and evaluation.
4	The developed system must protect data successfully.	This is accomplished through secured approach such as user input validation, use of intents for to inter-process communication (IPC), data encryption in Java and HTTPS connection.
5	The developed system should be flexible and user friendly.	The developed system implements the MVC and prototype model is defined as an iterative process that receives requirements, refine and approve them for end product artifacts, also it accommodates any fluctuation in requirements.

The system evaluation was conducted following the system testing results obtained when system components respond according to end user requirements. Table 4 shows the result obtained from system testing.

Table 5: System Testing Results

No	System Requirements	Test Output
1	The system shall permit users to sign-in and sign-out if the phone number is verified and if age and gender have been successfully registered.	Pass
2	The system shall allow users to select language successfully.	Pass
3	The system shall permit users to access health facilities details and allow them to make a call or show the route from the current user position.	Pass
4	The system shall allow users to navigate the health facilities on a Google map and show the route from the current user position.	Pass
5	The system shall permit users to access health facilities and related-information both online and offline.	Pass
6	The system shall allow users to access health related information.	Pass
7	The system shall permit users to make contact through email, phone number and social media platform	Pass
8	The system shall allow users to report a problem about the app.	Pass
9	The system shall allow users to submit complaints about the app.	Pass
10	The system shall permit Admin to perform monitoring and evaluation (M&E) of the App.	Pass
11	The system shall allow Admin to generate report from data visualization.	Pass
12	The system shall permit Admin to add or update health facilities and health information.	Pass
13	The system shall allow Admin to disable or delete users from the App.	Pass

4.6 User Acceptance Testing Results

User acceptance test was conducted by user to the developed mobile application. This testing checks for whether the functional requirements for the developed AFYA Digital Android application are responding accordingly, the functional requirements included the language selection, user registration, user account creation, access of health facilities online and offline, navigation of the mapped facilities on a Google map and able to show the route to a facility from the user's current position and the monitoring and evaluation (M&E). The testing process

was directed by a list of question banks where by users can either choose strongly disagree, disagree, agree or strongly agree. For results, refer to Table 6.

Table 6: User Acceptance Testing Results

Validation Features	Respondents			
	Strong Disagree	Disagree	Agree	Strong Agree
The AFYA Digital Android application accomplish the requirements for improving access to health service projects	0	0	4	33
The AFYA Digital Android application is reliable to information access that we will need	0	0	6	31
The user interface for The AFYA Digital Android application is interactive	0	0	1	36
The AFYA Digital Android application will improve language selection	0	0	3	34
The AFYA Digital Android application will improve access to health service both online and offline	0	0	2	35
The AFYA Digital Android application will improve data visualization	0	0	3	34
The AFYA Digital Android application will scale up M&E process of the most requested views on time	0	0	5	32
The AFYA Digital Android application will assist on health service access to border communities, residents and travelers.	0	0	2	35
I'm interested to proceed using this App.	0	0	0	37
I think there is no need to have training support to use the system	0	0	3	34

4.7 Discussion

The developed Afya Digital application has fulfilled all requirements needed by border communities. The system is suitable to scale up access to health services because of user friendly and interactive GUI. The reason for its suitability is the accomplishment of the required goal on health services where health-related information is demonstrated and health facilities are easily accessed in online and offline mode. The technology improvement removed barrier to internet accessibility to use the system, consequently, user will only access internet connection when downloading the App and during user registration where data like phone number, age and gender are collected for the user's authentication in the system. At that stage, files needed in offline mode will be synched to the permanent offline database (SQLite DB). That is to say, the internet connection will only be used while updating or adding health facilities to the system. Moreover, the system has successfully been integrated to M&E tool produce data visualization reports in Excel and CSV formats.

However, the developed system is limited to distance and geographical factors since its coverage is within 370 kilometers from Tanzania and Kenya borders. Also, it has not covered the very interior parts of EA partner states where there was unavailability of smartphone devices to indigenous people. Therefore, we, recommend technology to extend to Unstructured Supplementary Service Data (USSD) usage and enable evaluation to the developed system in a wide range of EA partner states.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This dissertation aimed at improving access to health services beyond Tanzania and Kenya borders, that include mapping of the nearest health facilities both online and offline, dissemination of health-related information from global repositories, also listing vaccines required to enter Tanzania or Kenya such as Anti-malaria, Yellow-fever, Hepatitis A, Covid-19 Test. Since both countries encourage tourism, therefore it includes the exchange rate feature for currency conversion and showcasing the tourist attractions when visiting either Kenya or Tanzania. However, the system saw the significance of deploying language options such as Swahili and English to ease information access to users.

However, data from user, heath facilities details and related information have been gathered and stored to a live database which enables data synchronization for both online and offline. Android application package (.apk file) has been used by M&E tool for data visualization on users' validation and authentication, also retrieves active users who are daily engaged with and retain the App usage based on their smartphone. Lastly, application performance will be tested based on functional and non-functional requirements.

The developed system indicates not only a substantial digital solution to residents and travelers crossing borders but also to system Admin for ease data visualization. Considering the system's security where the application signing-key certificates such as message direct (MD-5) certificate fingerprint, Secure Hash Algorithm-1 (SHA-1) and SHA-256 certificate fingerprint has been used as the generated encryption standards, interoperability and performance, system maintenance becomes less complex to system Admin.

5.2 Recommendations

The demand of a centralized health service system which serve the needs of EA citizens within the region and across borders is very high due to the fact that there are multiple mobile apps that meet different purposes and increase storage space to user's smartphones. In order to minimize further development of such apps within EA region and border towns, therefore this Mobile Application is recommended for use.

Due to the limitation of time, the developed system has not covered the very interior (rural) areas where inhabitants have no possession of smartphones devices, hence USSD technology could be useful to promote access to health services. Also, the developed system requires access and validation to national and international health insurances to be used in different health facilities so that it fastens the doctor's appointment and reduce unnecessary queue during visitation. Moreover, the system to be efficient and broadly used, it needs prediction algorithms that will detect which specialized doctor is essential to that patient when submitting their preliminary details.

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APPENDICES

Appendix 1: Sample Interview Questions

1. Does the existing system register their platform users?
2. Which format was used for registering user?
3. How does the system keep track of user's activities operated within?
4. How does the current system collect and store data?
5. Does the current system display and store data at the right time?
6. Does the current system have language selection options?
7. Which modality used by the system to perform data visualization?
8. Which format does the existing system evaluate their data?

Appendix 2: Sample Questions for User Acceptance Validation

Validation Features	Respondents			
	Strong Disagree	**Disagree**	**Agree**	**Strong Agree**
The AFYA Digital Android application accomplish the requirements for improving access to health service projects				
The AFYA Digital Android application is reliable to information access that we will need				
The user interface for The AFYA Digital Android application is interactive				
The AFYA Digital Android application will improve language selection				
The AFYA Digital Android application will improve access to health service both online and offline				
The AFYA Digital Android application will improve data visualization				
The AFYA Digital Android application will scale up M&E process of the most requested views on time				
The AFYA Digital Android application will assist on health service access to border communities, residents and travelers.				
I'm interested to proceed using this App.				
I think there is no need to have training support to use the system				

Appendix 3: Sample Questions for System Testing Results

NO	System Requirements	Test Output
1	The system shall permit users to sign-in and sign-out if the phone number is verified and if age and gender have been successfully registered.	
2	The system shall allow users to select language successfully.	
3	The system shall permit users to access health facilities details and allow them to make a call or show the route from the current user position.	
4	The system shall allow users to navigate the health facilities on a Google map and show the route from the current user position.	
5	The system shall permit users to access health facilities and related-information both online and offline.	
6	The system shall allow users to access health related information.	
7	The system shall permit users to make contact through email, phone number and social media platform	
8	The system shall allow users to report a problem about the app.	
9	The system shall allow users to submit complaints about the app.	
10	The system shall permit Admin to perform monitoring and evaluation (M&E) of the App.	
11	The system shall allow Admin to generate report from data visualization.	
12	The system shall permit Admin to add or update health facilities and health information.	
13	The system shall allow Admin to disable or delete users from the App.	

Appendix 4: Code for Phone number Verification

```
package eannasoapp.org.afyadigitalapp;
import androidx.annotation.Nullable;
import androidx.appcompat.app.AppCompatActivity;
import es.dmoral.toasty.Toasty;
import android.app.Activity;
import android.content.Context;
import android.content.Intent;
import android.content.SharedPreferences;
import android.os.AsyncTask;
import android.os.Bundle;
import android.util.Log;
import android.view.View;
import android.widget.Button;
import android.widget.Toast;
import com.firebase.ui.auth.AuthUI;
import com.firebase.ui.auth.IdpResponse;
import com.google.firebase.auth.FirebaseAuth;
import com.google.firebase.auth.FirebaseUser;
import org.apache.http.HttpResponse;
import org.apache.http.NameValuePair;
import org.apache.http.client.entity.UrlEncodedFormEntity;
import org.apache.http.client.methods.HttpPost;
import org.apache.http.impl.client.DefaultHttpClient;
import org.apache.http.message.BasicNameValuePair;
import java.io.BufferedReader;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.util.ArrayList;
import java.util.Collections;

public class PhoneVerificationActivity extends AppCompatActivity {
    String verified_phonenumber;
```

```
    SharedPreferences sharedpreferences;
    public static final String MyPREFERENCES = "NumberVerificationPrefs";
    public static final String verify_number = "number_verified";
    SharedPreferences.Editor editor;
    private static final int RC_SIGN_IN = 101;
    Button otp_form_feedback;

    SharedPreferences mySharedPreferences_reg;
    SharedPreferences.Editor editor_reg;
    public static final String SUCCESSREG_PREFERENCES = "REG_001";

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_phone_verification);
        sharedpreferences = getSharedPreferences(MyPREFERENCES,
Context.MODE_PRIVATE);
        if (sharedpreferences.contains("verifiedphone")) {
            startActivity(new Intent(getApplicationContext(), RegistrationActivity.class));
            finish();
        }
        otp_form_feedback = findViewById(R.id.otp_form_feedback);
        otp_form_feedback.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {
                verifyUsersPhonenumber();
            }
        });
    }

    public void verifyUsersPhonenumber() {
        Intent intent = AuthUI.getInstance().createSignInIntentBuilder()
                .setIsSmartLockEnabled(true)
```

```
            .setAvailableProviders(Collections.singletonList(
                    new AuthUI.IdpConfig.PhoneBuilder()
                            .build()))
            //.setTheme(R.style.LoginTheme)
            .setLogo(R.drawable.ic_blur_on_black_24dp)
            .setTosAndPrivacyPolicyUrls("https://bit.ly/2VJMHs8",
"https://bit.ly/2VJMHs8")
            .build();

        startActivityForResult(intent, RC_SIGN_IN);
    }



    @Override
    protected void onActivityResult(int requestCode, int resultCode, @Nullable Intent data)
{
        super.onActivityResult(requestCode, resultCode, data);
        if (requestCode == RC_SIGN_IN) {
            IdpResponse idpResponse = IdpResponse.fromResultIntent(data);
            if (resultCode == RESULT_OK) {
                // Successfully signed in
                final FirebaseUser user = FirebaseAuth.getInstance().getCurrentUser();
                //showAlertDialog(user);
                Toasty.success(getApplicationContext(), "Successfully Verified",
Toast.LENGTH_LONG, true).show();
                verified_phonenumber = user.getPhoneNumber();
                sharedpreferences = getSharedPreferences(MyPREFERENCES,
Activity.MODE_PRIVATE);
                editor = sharedpreferences.edit();
                editor.putString("verifiedphone", verified_phonenumber);
                editor.commit();
                Log.e("testcode ", " Successfully");
                Log.e("testcode ", verified_phonenumber + " Successfully");
```

```
            new CheckUserExists().execute();

        } else {
            Toasty.success(getApplicationContext(), "Phone Verification Failed",
Toast.LENGTH_LONG, true).show();
            Log.e("testcode ", "Phone Verification Failed: ");

        }
    }
}


String myresult;

class CheckUserExists extends AsyncTask<String, Void, String> {

    @Override
    protected String doInBackground(String... arg0) {
        // TODO Auto-generated method stub

        try {
            DefaultHttpClient httpclient = new DefaultHttpClient();
            HttpPost httppost = new
HttpPost("https://agilemobiletech.com/afyadigital/checkexists.php");
            // Add your data
            ArrayList<NameValuePair> nameValuePairs = new
ArrayList<NameValuePair>(1);


            nameValuePairs.add(new BasicNameValuePair("phonenumber",
verified_phonenumber));
            httppost.setEntity(new UrlEncodedFormEntity(nameValuePairs));
            HttpResponse response = httpclient.execute(httppost);
```

```
            InputStream inputStream = response.getEntity().getContent();

            BufferedReader rd = new BufferedReader(new InputStreamReader(
                    inputStream), 4096);
            String line;
            StringBuilder sb = new StringBuilder();

            while ((line = rd.readLine()) != null) {
                sb.append(line);
            }
            rd.close();
            myresult = sb.toString();
            inputStream.close();
        } catch (Exception e) {
            Toast.makeText(PhoneVerificationActivity.this, "Error inside set:" + e.toString(),
Toast.LENGTH_LONG).show();
        }
        return myresult;

    }

    @Override
    protected void onPostExecute(String result) {
        // TODO Auto-generated method stub
        super.onPostExecute(result);
        Log.e("profile6767", "myresult " + myresult);
        if (myresult.equals("noprofile")) {

            startActivity(new Intent(getApplicationContext(), RegistrationActivity.class));
            finish();
        } else {
            String[] details = myresult.split("#");
            mySharedPreferences_reg =
getSharedPreferences(SUCCESSREG_PREFERENCES, Activity.MODE_PRIVATE);
```

```
            editor_reg = mySharedPreferences_reg.edit();
            editor_reg.putString("phonenumber", details[0]);
            editor_reg.putString("genderselected", details[2]);
            editor_reg.putString("age", details[1]);
            editor_reg.apply();
            Toasty.success(getApplicationContext(), "Account exist. You can continue",
Toast.LENGTH_LONG, true).show();

            startActivity(new Intent(getApplicationContext(), MainActivity.class));
            finish();

        }
          }
    }
}
```

Appendix 5: Code for Online Mapping of Health Facilities

```
package eannasoapp.org.afyadigitalapp;
import org.json.JSONArray;
import org.json.JSONException;
import org.json.JSONObject;
import java.io.BufferedInputStream;
import java.io.BufferedReader;
import java.io.IOException;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.net.HttpURLConnection;
import java.net.MalformedURLException;
import java.net.URL;
import java.util.ArrayList;
import java.util.List;
import java.util.Locale;
import java.util.Random;

public class MappedFacilityActivity extends AppCompatActivity implements
OnMapReadyCallback {
    WebView webViewMainSite;
    ProgressDialog dialog;
    MapView myMapView;
    private GoogleMap gmap;
    private List<Getter_Directory> customList_directory;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_mapped_facility);
        myMapView = findViewById(R.id.mapView);
        myMapView.onCreate(savedInstanceState);
        myMapView.getMapAsync(this);
```

```
SQLiteHandlerAfya sqLiteHandler = new SQLiteHandlerAfya(MappedFacilityActivity.this);
customList_directory = sqLiteHandler.getAllFacilitiesMapped();
Log.e("customList_directory45", customList_directory.size() + "");
LinearLayout linear_search = findViewById(R.id.linear_search);
linear_search.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
        final Dialog dialog = new Dialog(MappedFacilityActivity.this);
        dialog.requestWindowFeature(Window.FEATURE_NO_TITLE); //before
        dialog.setContentView(R.layout.search_dialog);

dialog.getWindow().setLayout(android.app.ActionBar.LayoutParams.MATCH_PARENT, ActionBar.LayoutParams.WRAP_CONTENT);

        Button btn_search = dialog.findViewById(R.id.btn_search);
        Button btn_cancel = dialog.findViewById(R.id.btn_cancel);
        btn_search.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View view) {
                dialog.dismiss();
                Intent intent = new Intent(getApplicationContext(), MappedFacilityByDistanceActivity.class);
                startActivity(intent);
            }
        });
        btn_cancel.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View view) {
                dialog.dismiss();
            }
        });
```

```
            dialog.show();
        }
    });

}

@Override
protected void onResume() {
    super.onResume();
    myMapView.onResume();
}

@Override
protected void onPause() {
    super.onPause();
    myMapView.onPause();
}

@Override
protected void onDestroy() {
    super.onDestroy();
    myMapView.onDestroy();

}

@Override
public void onLowMemory() {
    super.onLowMemory();
    myMapView.onLowMemory();

}
private boolean haveNetworkConnection() {
    boolean haveConnectedWifi = false;
    boolean haveConnectedMobile = false;
```

```
        ConnectivityManager cm = (ConnectivityManager) getSystemService(Context.CONNECTIVITY_SERVICE);
        NetworkInfo[] netInfo = cm.getAllNetworkInfo();
        for (NetworkInfo ni : netInfo) {
            if (ni.getTypeName().equalsIgnoreCase("WIFI"))
                if (ni.isConnected())
                    haveConnectedWifi = true;
            if (ni.getTypeName().equalsIgnoreCase("MOBILE"))
                if (ni.isConnected())
                    haveConnectedMobile = true;
        }
        return haveConnectedWifi || haveConnectedMobile;
    }

    @Override
    public void onMapReady(GoogleMap googleMap) {
        Log.e("coordinates7878", "customList_directory: " + customList_directory.size());

        gmap = googleMap;
        gmap.setMinZoomPreference(12);
        gmap.setIndoorEnabled(true);
        UiSettings uiSettings = gmap.getUiSettings();
        uiSettings.setIndoorLevelPickerEnabled(true);
        uiSettings.setMyLocationButtonEnabled(true);
        uiSettings.setMapToolbarEnabled(true);
        uiSettings.setCompassEnabled(true);
        uiSettings.setZoomControlsEnabled(true);
        uiSettings.setZoomGesturesEnabled(true);
        MarkerOptions markerOptions = new MarkerOptions();

        for (int z = 0; z < customList_directory.size(); z++) {

            String coordinates = customList_directory.get(z).getCoordinates();
```

```
            Log.e("coordinates5656", "coordinates " + coordinates);
            String[] zz = coordinates.split(", ");
            float myLat = Float.parseFloat(zz[0]);
            float myLong = Float.parseFloat(zz[1]);
            Log.e("coordinates7878", "myLat:" + myLat + "myLong:" + myLong);
            LatLng ny = new LatLng(myLat, myLong);
            markerOptions.position(ny).title(customList_directory.get(z).getName());
            //+ "\n\n" + customList_directory.get(z).getCategory() + "\n\n" +
customList_directory.get(z).getRegion() + "," + customList_directory.get(z).getCountry()
            gmap.addMarker(markerOptions);
            gmap.moveCamera(CameraUpdateFactory.newLatLng(ny));
        }
        gmap.setOnMarkerClickListener(new GoogleMap.OnMarkerClickListener() {
            @Override
            public boolean onMarkerClick(Marker marker) {
                SQLiteHandlerAfya sqLiteHandler = new
SQLiteHandlerAfya(MappedFacilityActivity.this);
                String details = sqLiteHandler.getFacilitiesDetails(marker.getTitle());
                String[] dz = details.split("#");

                Log.e("details45", details + "");
                Log.e("details45", dz[5] + "");
                String[] coord = dz[5].split(", ");
                Log.e("details45", coord[0] + "");
                Log.e("details45", coord[1] + "");

                final Dialog dialog = new Dialog(MappedFacilityActivity.this);
                dialog.requestWindowFeature(Window.FEATURE_NO_TITLE); //before
                dialog.setContentView(R.layout.facility_dialog);

dialog.getWindow().setLayout(android.app.ActionBar.LayoutParams.MATCH_PARENT,
ActionBar.LayoutParams.WRAP_CONTENT);

                final TextView txt_name = dialog.findViewById(R.id.txt_name);
```

```
final TextView txt_details = dialog.findViewById(R.id.txt_details);
txt_name.setText(dz[1]);
txt_details.setText("Loc : " + dz[2] + "," + dz[6] + "\n\n" + "Cat : " + dz[7] + "\n\n");
Button buttonCall = dialog.findViewById(R.id.buttonCall);
Button buttonShowRoute = dialog.findViewById(R.id.buttonShowRoute);
buttonCall.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
        if (dz[3].equals("")) {
            Toasty.warning(getApplicationContext(), "Phone number not available",
Toast.LENGTH_LONG, true).show();
        } else {
            Intent intent = new Intent(Intent.ACTION_DIAL, Uri.fromParts("tel", dz[3],
null));
            startActivity(intent);
        }
    }
});
buttonShowRoute.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {
        dialog.dismiss();
        String uri = String.format(Locale.ENGLISH,
"http://maps.google.com/maps?daddr=%f,%f (%s)", Float.parseFloat(coord[0]),
Float.parseFloat(coord[1]), dz[1] + "");
        Intent intent = new Intent(Intent.ACTION_VIEW, Uri.parse(uri));
        intent.setPackage("com.google.android.apps.maps");
        startActivity(intent);
    }
});
dialog.show();
marker.showInfoWindow();
return true;
}
```

```
        });
    }
}
```

Appendix 6: Code for Offline Mapping of Health Facilities

```
package eannasoapp.org. afyadigitalapp;
import android.content.ContentValues;
import android.content.Context;
import android.database.Cursor;
import android.database.sqlite.SQLiteDatabase;
import android.database.sqlite.SQLiteOpenHelper;
public class SQLiteHandlerAfya extends SQLiteOpenHelper {

   String TABLE_NAME_FACILITIES = "healthy facilities";
   protected Context context;
   public SQLiteHandlerAfya(Context applicationcontext) {
      super(applicationcontext, "afyadigitaldb.db", null, 1);
      this.context = applicationcontext;
   }
   //Creates Table
   @Override
   public void onCreate(SQLiteDatabase database) {
      String query_facilities;
      query_facilities = "CREATE TABLE " + TABLE_NAME_FACILITIES + "( id
TEXT, name TEXT, region TEXT, phonenumber TEXT, website TEXT, coordinates
TEXT, country TEXT, category TEXT)";
      database.execSQL(query_facilities);
   }
  @Override
   public void onUpgrade(SQLiteDatabase database, int version_old, int CurrentVersion) {
      String query_facilities;

      query_facilities = "DROP TABLE IF EXISTS " + TABLE_NAME_FACILITIES;
      database.execSQL(query_facilities);
      onCreate(database);
   }
   public void InsertFacilities(String id, String name, String region, String phonenumber,
```

```
String website, String coordinates, String country, String category) {
        try {
            SQLiteDatabase db = this.getWritableDatabase();
            ContentValues row = new ContentValues();
            row.put("id", id);
            row.put("name", name);
            row.put("region", region);
            row.put("phonenumber", phonenumber);
            row.put("website", website);
            row.put("coordinates", coordinates);
            row.put("country", country);
            row.put("category", category);

            long chk = db.insert(TABLE_NAME_FACILITIES, null, row);

            if (chk != 0) {

            } else {
                Toast.makeText(context, "Sync Failed. Try Restart the App",
                        Toast.LENGTH_LONG).show();
            }
        } catch (Exception e) {
            // TODO: handle exception
        }
    }
    public List<Getter_Directory> getAllFacilities(String category) {
        List<Getter_Directory> notes = new ArrayList<>();

        // Select All Query
        String selectQuery = "SELECT  * FROM " + TABLE_NAME_FACILITIES + "
where category = '" + category + "';";

        SQLiteDatabase db = this.getWritableDatabase();
        Cursor cursor = db.rawQuery(selectQuery, null);
```

```
        if (cursor.moveToFirst()) {
            do {
                Getter_Directory note = new Getter_Directory();
                note.setId(cursor.getString(cursor.getColumnIndex("id")));
                note.setName(cursor.getString(cursor.getColumnIndex("name")));
                note.setRegion(cursor.getString(cursor.getColumnIndex("region")));

note.setPhonenumber(cursor.getString(cursor.getColumnIndex("phonenumber")));
                note.setWebsite(cursor.getString(cursor.getColumnIndex("website")));
                note.setCoordinates(cursor.getString(cursor.getColumnIndex("coordinates")));
                note.setCountry(cursor.getString(cursor.getColumnIndex("country")));
                note.setCategory(cursor.getString(cursor.getColumnIndex("category")));
                notes.add(note);
            } while (cursor.moveToNext());
        }
        db.close();
        return notes;
    }
    public void deleteAllTableDataFacilities() {
        SQLiteDatabase database = this.getWritableDatabase();
        database.delete(TABLE_NAME_FACILITIES, null, null);
    }
}
```