ENHANCING ACCESS TO INFORMATION ABOUT CIVIL SOCIETY ORGANIZATIONS AND COMMUNITIES THROUGH AN INTERACTIVE ANDROID MOBILE APPLICATION

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

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ABSTRACT

Civil Society Organizations are non-governmental and not-for-profit organizations which act as a bridge between the government, society and the private sector by holding the government accountable and give a voice to the marginalized groups on issues such as education, health and other sectors. The problem in this study is that currently, the information about CSOs and their activities in East Africa cannot be found in one place online and it is inaccurate and sometimes outdated. The data collection was done through questionnaires, observations and interviews with different stakeholders in the civil society arena. In the system development phase, agile development methodology was used. The study showed that there is a gap in the availability of a single platform where different actors can readily get reliable and up-to-date information about the available CSOs of interest. The outcome of the study is the development of an interactive online directory of Civil Society Organizations. The platform is mobile based and enables CSOs to register and fill up their current details, ensuring that there is always correct and updated information. The platform is equipped with a geo-mapping facility which enables users of the system to correctly geo-locate their civil societies of interest on a map. The results of system evaluation showed that 88.125% of users were satisfied with the system basing on the evaluation criteria. The developed system will benefit stakeholders in the non-profit sector by having one platform where accurate and up-to-date information about civil societies can be easily found.

DECLARATION

I, Emil Patrick do hereby declare to the Senate of The Nelson Mandela African Institution of Science and Technology that this dissertation is my original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

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Supervisor 2	Signature	Date

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for submission to the Nelson Mandela African Institution of Science and Technology (NM-AIST) a dissertation titled: "*Enhancing Access to Information about Civil Society Organizations and Communities through an Interactive Android Mobile Application*" in fulfillment of the requirements for the degree of Master of Science in Embedded and Mobile Systems at NM-AIST.

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DEDICATION

This dissertation is dedicated to my late father Mr. Patrick Wangilisasi for his tireless efforts and sacrifices in making sure that I get a good education. This one is for you, papa!

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LIST OF ABBREVIATION AND SYMBOLS

AIDS	Acquired Immunodeficiency Syndrome
API	Application Programming Interface
APK	Android Application Package
AWS	Amazon Web Service
CBMS	Community Based Monitoring System
CG	Community Group
CRUD	Create, Read, Update, Delete
CSO	Civil Society Organization
DSRM	Design Science Research Methodology
EACSOF	East Africa Civil Society Organization Forum
EANNASO	East African National Networks Of Aids And Health Service Organization
GCWR	Golden Center For Women Rights
GSM	Global System for Mobile
GSMA	Global System for Mobile Communication
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
IVR	Interactive Voice Response
HTTPS	Hypertext Transfer Protocol Secure
ICT	Information And Communication Technologies
ISO	International Standards Organization
JSON	JavaScript Object Notation
JWT	JSON Web Token
KANCO	Kenya Aids NGOSs Consortium
K4D	Knowledge for Development
MVVM	Model View ViewModel
NGO	Non-Governmental Organization
NOSQL	Not Only SQL
RAD	Rapid Application Development
REST	Representational State Transfer
TB	Tuberculosis

UI	User Interface
UML	Unified Modeling Language
UNNGOF	Uganda National NGO Forum
UX	User Experience
XML	Extensible Markup Language
USSD	Unstructured Supplementary Service Data
VPS	Virtual Private Server

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem

Civil societies are defined by the World Bank as the diverse groups of non-governmental and not-for-profit organizations that operate in public life, express the values and interests of their members and others, based on ethical, cultural, political, scientific, religious or philanthropic considerations (The World Bank, 2020). Civil society organizations include but are not limited to labor unions, community groups, non-governmental organizations (NGOs), indigenous groups, charitable organizations, faith-based organizations, professional associations, and foundations. Civil societies can operate globally i.e. operating in multiple countries or they can be local to a particular country.

Examples of global CSOs are Amnesty International, World Wide Fund for Nature (WWF) and Save the Children. Local organizations examples are HakiElimu (Tanzania), Kenya AIDS NGOs Consortium (KANCO) and Golden Center for Women Rights (GCWR) in Uganda.

Civil societies play an important role in society by acting as an unbiased tool for collective bargaining towards an inclusive, prosperous society. According to Schwab (2012), some functions of civil societies are:

(i) Watchdog: They hold institutions to account and promote accountability and transparency.

(ii) Advocate: They raise awareness of issues and challenges in society and advocate for change.

(iii) Provision of Services: They help to deliver various services to meet needs in society in areas such as health, education, food and security. Also they implement disaster management, preparedness and responses in case of emergencies.

(iv) Provision of Expertise: They help to bring unique and expert knowledge and experience in order to shape strategy and policy. They also identify and build solutions to societal problems.

(v) Capacity Building: They provide education, training and help build capacity in various areas.

(vi) Incubator: They help in the development of solutions that may take a long time until payback is realized.

(vii) Representation: They help the marginalized and the underrepresented people get a voice.

(viii) Citizenship Champion: They encourage engagement of citizens and support the rights of citizens.

(ix) Solidarity Supporter: They promote fundamental and universal values.

(x) Defining Standards: They create norms that help to shape the market and the state activities.

The Eastern Africa National Networks of AIDS and Health Service Organizations (EANNASO) is a regional umbrella organization that brings together civil society organizations (CSO) and community group (CG) voices in order to make informed policies and improve the programming of tuberculosis (TB), Human Immunodeficiency Virus (HIV), malaria and other health issues that are present society. The EANNASO was founded in 2002. It is composed of seven national networks of AIDS and health promotion service organizations that are located in seven countries namely Kenya, Rwanda, Burundi, Ethiopia, Tanzania, South Sudan and Uganda (East African National Networks of AIDS and Health Service Organization, 2019).

The main mission of EANNASO is to serve as an organization that provides networking and engagement of civil societies and communities in the East African region. This mission is achieved through policy advocacy, knowledge management and leaning, institutional development and technical support and capacity building services that EANNASO provides to civil societies (East African National Networks of AIDS and Health Service Organization, 2020).

In spite of EANNASO being an East Africa membership organization, she sometimes works with CSOs and communities in the broader Anglophone Africa region as she is the only

surviving sub-regional TB, HIV and health network. The EANNASO's strongest niche is coordinating civil society and community expertise in order to build up on existing capacities so as to strengthen the voice of CSOs and community groups (East African National Networks of AIDS and Health Service Organization, 2019).

Currently, EANNASO is serving as the regional communication and coordination partner for the Global Fund's civil society and community group under the Community, Rights and Gender (CRG Strategic Initiative). The EANNASO provides these services for 25 Anglophone African countries namely Eswatini, Angola, Zambia, Botswana, Eritrea, Ethiopia, Gambia, Uganda, Ghana, Kenya, Lesotho, Liberia, Malawi, Mozambique, South Africa, Namibia, Nigeria, Rwanda, Sierra Leone Somalia, Zanzibar, South Sudan, Tanzania, Mauritius and Zimbabwe (East African National Networks of AIDS and Health Service Organization, 2019).

Through funding from The Global Fund, EANNASO has developed a web-based digital platform that serves as a repository for information about civil societies, community based organization and Community Based Monitoring Systems (CBMS) in Anglophone Africa. The platform can be accessed through https://map.eannaso.org/explore/. The platform has helped to make gathering, storage and sharing of information easier and convenient to all the stakeholders in the non-profit arena involved in the fight against AIDS, TB, malaria and other health related issues.

The web-based system developed by EANNASO has been a success (East African National Networks of AIDS and Health Service Organization, 2020). Despite its success, there is still room for improvement. There is a need to create a mobile platform equivalent to the existing web-based application. The mobile platform will complement the existing tool by taking advantage of inherent benefits of mobile applications over web applications (Pousttchi *et al.*, 2003). It is expected that the developed mobile application will further increase efficiency and effectiveness of information gathering, storage and sharing.

1.2 Statement of the Problem

Civil societies and other players in the non-profit sector need to leverage the current advances in digital technologies in their business operations and processes. Adoption of ICT will help in the digitization efforts in African countries which have been lagging behind in adopting

digital technologies. In line with this EANNASO through funding from the Global Fund has developed a web-based tool that maps out and gives information about functional civil societies in Anglophone Africa countries. This tool is important for providing readily accessible information about the geo-location and other relevant information about civil societies to stakeholders. Anglophone Africa countries includes the following countries Mozambique, Angola, Eritrea, Eswatini, Ethiopia, South Sudan, Gambia, Somalia, Ghana, Kenya, Lesotho, Malawi, Namibia, Nigeria, Botswana, Rwanda, Tanzania, South Africa, Sierra Leone, Zambia, Uganda, Zanzibar, Liberia, Mauritius and Zimbabwe.

Despite the huge success of the implemented digital platform as explained by EANNASO in their strategic plan of 2018-2022 (East African National Networks of AIDS and Health Service Organization, 2020), there is lack of a mobile application tool for providing the same service which is easy to access. Therefore, this project proposed the development of a mobile application for enhancing provision of information such as geo-location of civil societies in Anglophone African countries.

1.3 Rationale of the Problem

As it has been noted, EANNASO already have a web-based application for collecting, storing and sharing of information about civil societies, community groups and community based monitoring systems. However, there is a need of a mobile-based tool to assist in the similar operations in order to enhance some of the processes through the functionalities or benefits that mobile applications have over web-based tools. The most important benefits that mobile tools offer are increased security, better UI/UX and the removal of temporal and spatial restrictions on the part of users. This means that users can access and interact with the system at any time and place. Also mobile tools provide context-aware services by leveraging the embedded location sensors in the phone, giving the mobile application the ability to provide services according to the current needs or environment of the users (Pousttchi *et al.*, 2003).

1.4 Research Objectives

1.4.1 Main Objectives

The main objective of this project was to develop a mobile application that will facilitate collection, storage and sharing of information about functional Civil Society Organizations (CSOs) and Community Groups (CG) in Anglophone Africa countries.

1.4.2 Specific Objectives

The following are the specific objectives that guided in the accomplishment of the main objective:

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

(ii) To develop the proposed system.

(iii) To evaluate the developed system.

1.5 Research Questions

The main research question is how to improve access to information about civil society organizations and communities. Below are the research questions as mapped to the specific objectives:

(i) What system requirements are needed to design an information system that will enhance collection, storage and sharing of information about civil societies?

(ii) Can an information system for collection, storage and sharing of information about civil societies be developed?

(iii) Has the developed system met the requirement of enhancing collection, storage and sharing of information about civil societies?

1.6 Significance of the Study

Civil societies are an important sector of society, with many benefits (Schwab, 2012). This study is significant because it has identified a gap in the availability of information to stakeholders of this sector and the public in general. By developing this mobile platform, this study will bridge the gap in information availability about CSO and community groups.

1.7 Delineation of the Study

This study was delineated to how android smartphones can best be leveraged to scale up information about CSO and communities in Anglophone African countries. The choice of the android platform was based on statistics of smartphone usage which shows that android has a

market share of more than 75% (Statista, 2020) in Africa. In addition, the study focused on the non-profit civil society sector because that is what the case study, EANNASO, are dealing with. Lastly the platform will serve Anglophone Africa because that is what the case study EANNASO platform has.

CHAPTER TWO

LITERATURE REVIEW

2.1 Civil Societies and their Importance

Civil society can be described as the social sphere that lies between the state and the individual or household. Civil society does not have the legal or regulatory power of the state and the economic power of the business sector but it has the social power or influence of ordinary people (Knowledge for Development, 2018). Civil societies have a huge potential to complement government efforts in the fight against diseases such as AIDS, tuberculosis, malaria and other health related issues. This is because civil societies are made of the communities who are the very core of health systems. Over the years civil societies have contributed a big role to public health.

The following are the ways in which civil societies play a role in the public health arena as outlined by the World Health Organization (Knowledge for Development, 2018):

(i) Provision of Services: Enables the community to interact with public health services. This encompasses activities such as distribution of health resources such as vaccines, condoms or sanitary ware for hospitals.

(ii) Research and Dissemination of Health Information: Distribution of health information helps the public to make informed health choices. The CSOs help to implement health research and in turn the information gathered and shared helps the public to change social attitudes. In addition they help to mobilize and organize for health.

(iii) Policy Setting: They help to represent the community and public interests in policy. They promote inclusive and equity and policies that cater for the poor. They help to negotiate standards and approaches of public health, policy consensus building, policy positions disseminations and encouraging public support for policies.

(iv) Monitoring Health Care Quality and Responsiveness: This aspect involves monitoring how responsive the quality of health care services. The CSOs give a voice to marginalized groups, equity promotion, represent rights of patients in issues pertaining to health care quality and ensure patient claims and complaints are properly channeled and negotiated.

The recent continued advancement of Information and Communication Technologies (ICTs) has disrupted many sectors and the civil societies sector is no exception. The rise in ICT provides new opportunities and challenges to civil societies. One such opportunity afforded by ICTs is the ability of civil societies to transcend their geographical locations by adopting ICT in their operations. Another opportunity is a new way civil societies can gather, store and share information in the digital age (Frangonikolopoulos, 2012). The EANNASO have embraced ICT by developing a web-based application providing easy access to information about civil societies. This platform has aided multiple stakeholders in the non-profit sector to have easy access to information. Also it has enabled communities to have a tool where they can share their observations in community based monitoring activities. But the web application can still be augmented by a mobile application.

2.2 Internet Penetration in East Africa

Internet penetration has been consistently increasing in East African countries in recent years according to data from the countries' national communication authorities and the World Bank (The World Bank, 2019). For example in Tanzania, the estimated number of internet users rose from 29% in 2015 to 46% of the population in 2019 (National Bureau of Statistics, 2020). The estimated internet penetration rates for other East African countries are as follows; Kenya (85.2%), Rwanda (45.1%), Burundi (13.1%), Uganda (39.3%) and South Sudan (7.9%) as of December 2020 (Internet World Stats, 2020). In addition, mobile smartphone adoption continues to increase in East Africa. Smartphone adoption increased from 21% to 55% in East Africa from 2016 to 2020 (Global System for Mobile Communication, 2020). This increase in internet usage shows that ICT solutions, such as the one described in this paper can reach a sizable percentage of the population. Other areas, especially rural areas where there is no internet, unstructured supplementary service data applications can be developed so that those users who don't have smartphones can also access the application in their feature phones.

2.3 State of Current Platforms Offering Information about Civil Societies

In Tanzania there is an organization called Foundation for Civil Society whose mission is expressed as contribution to sustainable development of Tanzania through strengthening of civil societies, influencing and to enhance a learning culture (Foundation For Civil Society, 2020). The aim of this organization is to provide grants and capacity building services to

CSOs so as to enhance their effectiveness in enabling engagement of citizens in development processes. However, looking at their website they do not have an interactive online system to provide information about the currently available civil society organizations in Tanzania. This shows there is a gap in the utilization of ICT in enhancing the availability of information about civil societies in Tanzania.

The East Africa National Networks of AIDS and Health Services Organization (EANNASO) is another umbrella organization operating in the East Africa region. Its main mission is to drive an agenda about HIV prevention in the region. In addition they strive to empower national networks to contribute effectively in the reduction of new HIV infections, by amplifying the voice of CSOs and strengthening their pragmatic and institutional capacities (East African National Networks of AIDS and Health Service Organization, 2019). The EANNASO have an online directory of CSOs, but the directory is only limited to those CSOs that deal with HIV, malaria and tuberculosis. It is not and not an all-encompassing directory. In addition, the directory has a poor user interface and user experience (UI/UX), and is only web-based thus lacking the benefits of a native mobile application such as push notifications, direct access to mobile device sensors and ability to work in offline mode without internet (Jobe, 2013).

The Uganda National NGO Forum (UNNGOF) is an inclusive and independent national platform for NGOs and CSOs in Uganda. It is an umbrella organization whose mission is providing NGOs and CSOs a platform to share and reflect on societal issues, to shape governance and development processes in Uganda, and creating a conducive operating environment. UNNGOF was launched in 1997 and has a 650 members (The Uganda National NGO Forum, 2021). The UNNGOF also lacks an interactive online directory of NGOs and CSOs.

Another organization is the East Africa Civil Society Organizations' Forum (EACSOF) which is based in Nairobi, Kenya. It is an umbrella body of Non-Governmental Organizations (NGOs), CSOs and communities in East Africa. The mission of EASCSOF is to build a mass of knowledge and empowering civil societies in the East African region in order to enhance their capacity and confidence in raising awareness about grassroots needs in the East African integration process (East African Civil Society Organizations Forum, 2020). The EACSOF does have a good website, though it does not have a directory of the currently functional civil

societies and communities. Being an umbrella body for East African region this organization can benefit with an online directory of all civil societies and community groups in execution of its mission.

The above studied umbrella organizations in East Africa are all lacking in having a one-stop-shop where the members of the public can get quick and reliable information about CSOs. Table 1 shows features and gaps which are available in the CSO's systems that were discussed in this section. In light of these gaps, this study has proposed the implementation of an interactive geo-mapping application of civil societies for East Africa.

Table 1: Summary of Features in Studied Systems

Features	**Study 1** (Foundation For Civil Society, 2020)	**Study 2** (East African National Networks of AIDS and Health Service Organization, 2019)	**Study 3** (The Uganda National NGO Forum, 2021)	**Study 4** (East African Civil Society Organizations Forum, 2020)
Geo-Mapping Of CSO	×	✓	×	×
Display CSO in an interactive UI	×	✓	×	×
Search functionality	×	×	×	×
Users can upload CSO	×	✓	×	×
Directory contains all types of CSO	×	×	×	×

2.4 Rapid Application Design Methodology

To implement the application, Rapid Application Development (RAD) model is used. The RAD is based on agile Software Development Life Cycle (SDLC). The objective of rapid application development is to obtain software systems faster with high quality and at a relatively lower cost (Pawar, 2015). Rapid application development makes use of incremental design model and creation of prototypes to generate deliverables in each phase. This is in stark contrast with the traditional waterfall models that emphasize on strict planning and documentation of software before development begins. Prototype creation facilitates iterative development of a system. Developers do an initial investigation then develop a working prototype of the system. After that they discuss with the intended users if any enhancements are needed. This process is repeated iteratively several times until users get satisfied with the developed system. Figure 1 depicts pictorially the model of the rapid application development (Guru99, 2020)

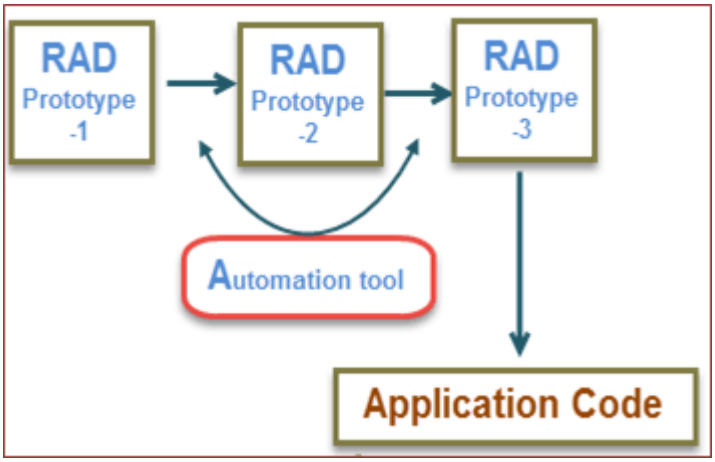

Figure 1: Rapid Application Design Methodology (Guru99, 2020)

2.5 Model View View-Model Architecture (MVVM) for Mobile Applications

The MVVM is an architecture design pattern that is recommended by Google for building robust, production quality applications. This architecture implements the principle of separation of concerns between the different modules of the mobile application. Separation of concerns achieves modularization of the application making it easy to unit-test the application. Also modularization facilitates the easy scalability of the application (Google Developer Guide, 2020).

The MVVM architecture enables an application to have two separate data sources, one local source using Room Persistence Library and another source of data is from the Web Service which is retrieved using Retrofit networking library. In this architecture all application logic resides in the ViewModel. The User Interface (UI) elements (Activity/Fragment) only have code for rendering the data to the users. The UI is completely decoupled from the business logic. Figure 2 illustrates the MVVM architecture.

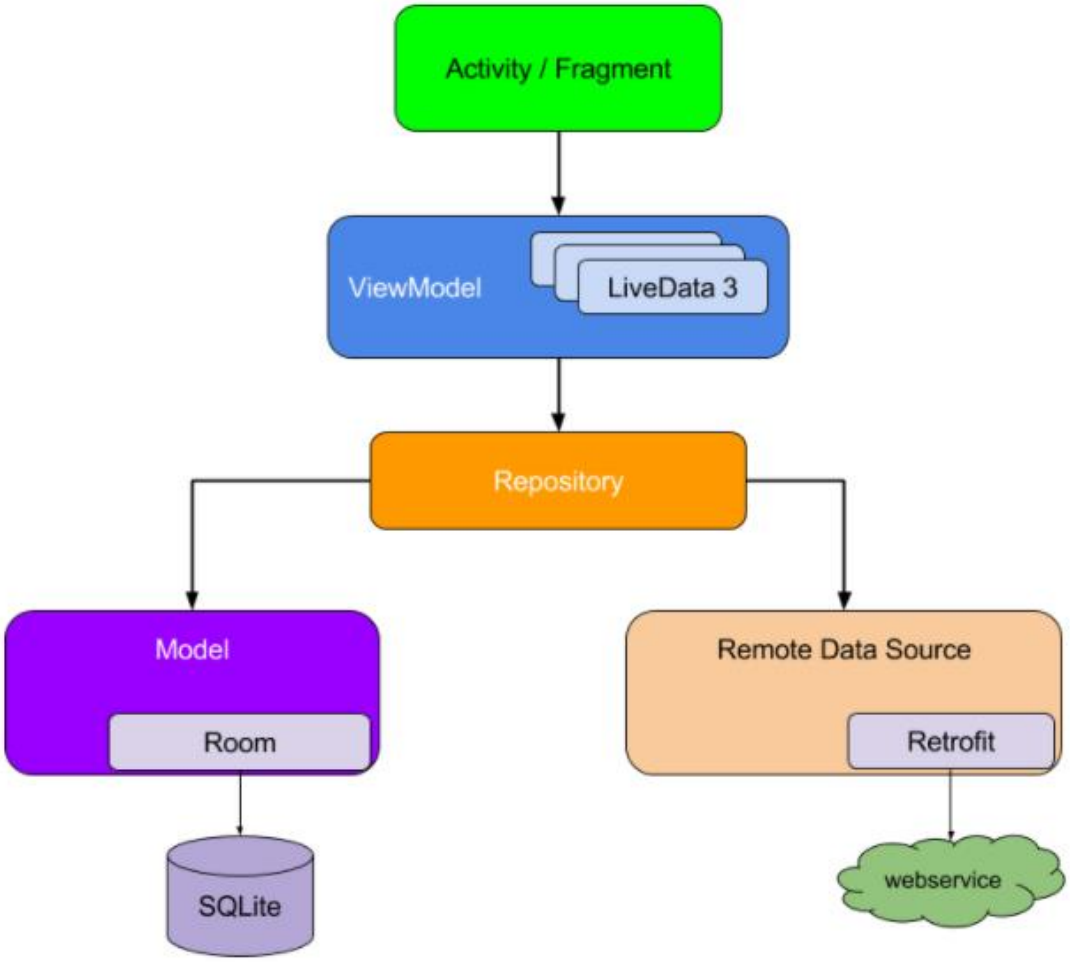

Figure 2: MVVM Architecture (Google Developer Guide, 2020)

2.6 Model View Controller Architecture

The Model-View-Controller (MVC) is an architectural pattern that separates an application into three main logical components i.e. the model, the view, and the controller. Each of these components is built to handle specific development aspects of an application. The MVC is one of the most frequently used industry-standard web development framework to create

scalable and extensible projects. It enables different developers to work on the application in parallel, thus speeding up development time.

The model corresponds to all the data-related logic of the system. This can be the data that is being transferred between the view and controller components or any other data related to business logic.

The view is used for all the UI-related logic of the application. The controller is an interface between model and view components. It processes all the business logic and incoming requests, manipulate data using the model component and interact with the views to render the final output. Figure 3 shows the MVC architecture.

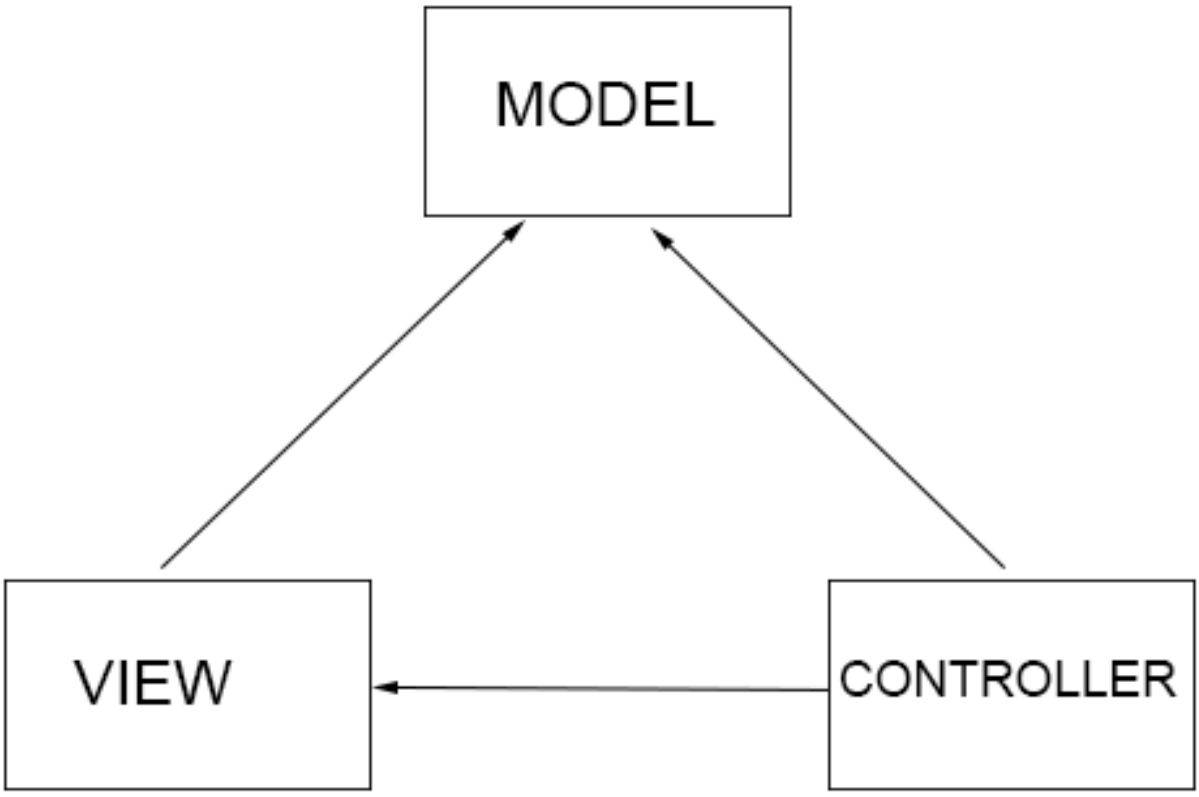

Figure 3: The MVC architecture

2.7 Conceptual Framework of the Application

Figure 4 shows the conceptual framework of the proposed application. Each component of the framework is described below.

The mobile application is the frontend which is created using Java/Kotlin languages. It displays user interfaces to the user and also interfaces with the internet by consuming a RESTFul API from the backend.

The backend of this application is made using NodeJs. NodeJS is a modern server-side runtime environment designed for making web and mobile application backends. In this application the backend is hosted on Digital Ocean which provides Virtual Private Servers (VPS) for hosting server-side applications.

The admin panel is a desktop computer which also has a connection to the RESTFul API backend. The admin has all CRUD (Create, Read, Update and Delete) credentials. This means the admin has full rights over the application; they can add, modify or delete users and content.

The MongoDB database is used to store the application data persistently. In this application, Atlas, a cloud-based MongoDB database has been used. A cloud-based database is managed by cloud providers, saving developers the hassle of managing a database.

The images of the application are stored in a third party image store managed by a company called Cloudinary. This image store is also cloud-based.

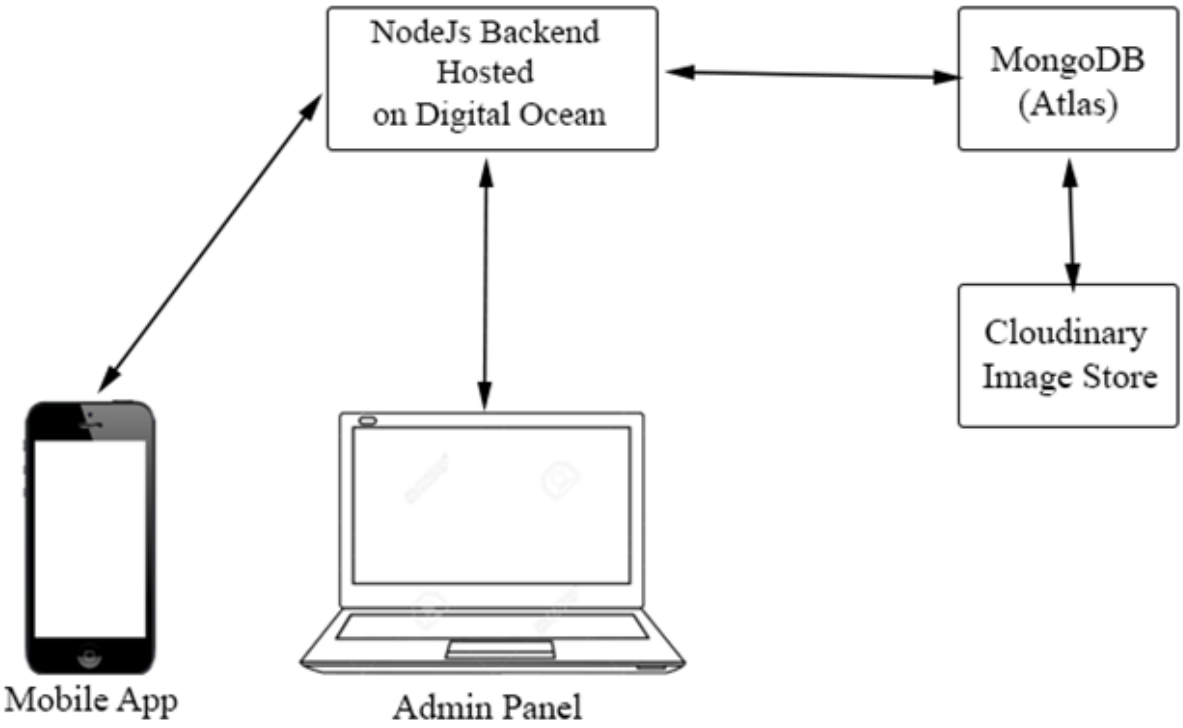

Figure 4: Conceptual Framework of the Application

CHAPTER THREE

MATERIALS AND METHODS

3.1 Research Design and Study Area

The design science research methodology (DSRM) was used in this study. The DSRM can be qualitative or quantitative or a mixture of the two. In this research DSRM was used as a qualitative research methodology. The DSRM is composed of three stages namely problem identification stage, solution design stage and evaluation and validation stage. The DSRM methodology was preferred because it is outcome-based. It offers guidelines for evaluation and iteration within the project and focuses on improving the functional performance of the interfaces (Geerts, 2011) which is the main goal of this implementation.

3.1.1 Area of Study

This study was done at the Eastern Africa National Networks of AIDS and Health Service Organization (EANNASO) in Arusha. In addition to EANNASO, further research was conducted in other CSOs located in Dodoma and Dar- Es-Salaam regions in Tanzania. The choice of these regions for the study is because they are major cities and have a substantial number of CSOs according to data from the Foundation For Civil Society (The Foundation for Civil Society, 2019) as depicted in Fig. 5.

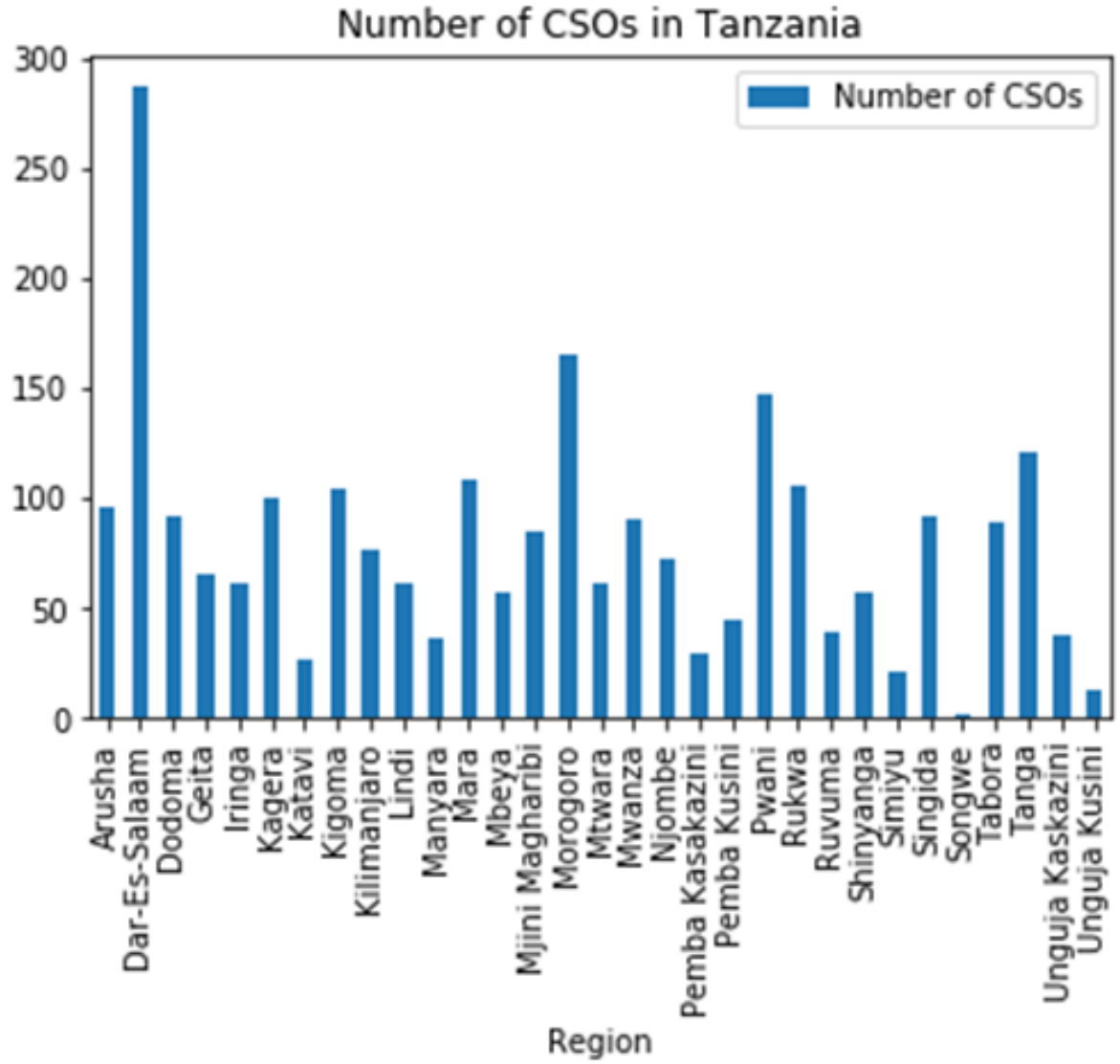

Figure 5: The number of CSO in each region in Tanzania

3.1.2 Problem Identification Stage

During the stage of identifying the problem, a literature review was first conducted to understand the current situation on how information and communication technology (ICT) is leveraged by players in the non-profit sector i.e. CSOs, community groups, NGOs etc. in streamlining their operations and strategic objectives.

In the process, physical interviews, questionnaires and observations techniques with 140 players in the non-profit sector in Arusha, Dodoma and Dar-Es-Salaam regions were conducted. The sample was chosen using non-random sampling procedure using Snowball method in which some few participants recruit more respondents among their acquaintances

to participate in the survey. The participants comprised 72 males and 68 females. The participants had an average age of 35 whereby 45% of them came from CSOs, 35% from Community groups and 20% were individuals who are in the marginalized category such as the elderly, the disabled and unemployed youths. In the interview sessions, a set of questions found in Appendix 9 were presented to the respondents.

The feedback from the questionnaires were recorded and then were tabulated to show the frequency of responses from respondents in order to determine the most persistent problems facing the current landscape of CSO as far as information is concerned. The transcribed data was then visualized in stacked bar graphs and histograms using Pandas and Matplotlib libraries of the python language. Appendix 11 shows a stacked bar graph of responses to question 14 in the questionnaire (Appendix 9). This in turn would help the study in devising the solution to address the major pain points.

3.1.3 Solution Design and Development

Rapid Application Design (RAD) methodology has been used in the development of the solution to the problem identified in this study. The RAD was used, because it offers iterative development with high quality result of information systems (Lank *et al.*, 2005). In the design and development process, the study conducted a total of five iterations in which features such as UI/UX design, application speed, scalability, security and robustness were evaluated and revisited as per user feedback on the prototypes. The prototypes were developed in Android/Java/Kotlin (frontend) and NodeJS/MongoDB (backend). NodeJs was chosen for the backend because of its high speed in serving API requests since it uses event-driven architecture and has non-blocking IO (Input/Output) (Bangare *et al.*, 2016). The MongoDB NoSQL database was chosen because it has more scalability and efficiency in storage and access of data than traditional relational databases like MySQL (Chauhan & Bansal, 2017).

3.2 Data Collection Methods and Tools

In this study, physical interviews, questionnaires and observations were used to get data from respondents. The questionnaires were in both English and Kiswahili languages as shown in Appendix 10, so the respondent could choose depending on their language proficiency. The category of questions covered by the questionnaires and interviews were demographic characteristics such as age, usage of mobile phones, usage of internet, mobile applications

awareness, and willingness to download and use mobile applications for geo-locating CSO and community groups. The respondents were assisted by the researchers in clarification of the questions if they weren't clearly understood.

3.3 Reliability and Validity of Data

Reliability and validity of data in a research indicate the quality of data obtained from the research. Reliability refers to the extent to which results can be reproducible i.e. if the research is done using the same instruments or methods by different researchers it should provide same results. Validity refers to how much the requirements of scientific research method have been followed in the process of obtaining findings.

In this research reliability and validity of data has been ensured by using a non-random sampling method in which only respondents who are related in the non-profit sector were selected using snowball method. This ensures that the respondents are indeed conversant with CSOs and communities. Another measure to enforce validity and reliability was to give respondents enough time to answer the questions and using clear language in the questionnaires.

3.4 Software Development Approach

Rapid Application Development (RAD) paradigm was used in the implementation of this application. The RAD is software development methodology based on agile methodology. It emphasizes on creation of a working prototype of the software or module then uses it to obtain feedback from intended users instead of the strict planning of requirements that is used in variants of the Waterfall model of software development.

Requirements for the first prototype were elicited from potential users of the application through brainstorming. Through brainstorming the problem can better be understood, and it gives the developers and the users a feeling of collective ownership (Paetsch *et al.*, 2003). The first session of brainstorming was done at EANNASO which lead to development of the initial prototype. Further sessions of brainstorming were done with other stakeholders in different CSOs and community groups. After each brainstorming and testing session, some changes were incorporated into the development of the application.

3.4.1 System Modeling

Unified Modeling Language (UML) was used to pictorially present the different use cases of the developed application. The UML provides different language tools that help to enable communication among stakeholders, to describe the interrelationships between different software components, requirements gathering, representation of software requirements, and automatic generation of code (Bhuiyan *et al.*, 2018). In the development of this application, Microsoft Visio software was used to generate the use case diagrams.

3.4.2 Developed Application Usability Testing and Evaluation

Usability testing is a method of evaluating a product or service by having it tested by intended representative users. It is a reliable way to estimate users' subjective satisfaction with systems (Wichansky, 2000). The International Standards Organization (ISO) recommends effectiveness, efficiency and satisfaction as the three metrics to be used in testing an application's usability. Effectiveness is measured by the completion rate of tasks, which is the ratio of number of tasks completed successfully to the total number of tasks undertaken. Efficiency is a measure of the time taken to finish a task. Users' satisfaction is determined through standardized questionnaires that measure satisfaction of how easy to use the application (Alturki *et al.*, 2017). The questionnaires are normally dispensed after the usability testing sessions. A set of 8 questions as found in appendix 9 were developed and respondents chose their responses.

The process of usability testing and evaluation involved 35 volunteers. 20 were from CSOs and community groups and 15 from marginalized population. Their phones were installed with the Android Application Package (APK) file after extraction from Android Studio. The version of the operating system of their phones was verified to make sure that they have the minimum API level requirement of the application i.e. API 21 (Lollipop). A demonstration of how the application works was given to the volunteers before they started testing. Then the volunteers interacted with application with as many features as possible. After the testing phase, the volunteers were given the questionnaire to fill out their responses on the different questions.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 The Proposed Functional and Non-functional Requirements

System requirements are the descriptions of what the system should do i.e. the services that it provides and the constraints on its operation (Sommerville, 2011). There are two types of requirements namely functional and non-functional. Functional requirements are statements of services the system should provide, how the system should react to particular inputs, and how the system should behave in particular situations. Non-functional requirements are constraints on the services or functions offered by the system. Non-functional requirements often apply to the system as a whole, rather than individual system features or services (Sommerville, 2011).

The results of interviews and questionnaires conducted to players in the CSO arena led to the following functional and no-functional requirements as depicted in Table 2 and Table 3 respectively.

Table 2: Functional Requirements

SN	Requirements	Description
1	Display up-to-date information about CSO/Community in an intuitive and interactive UI/UX	Users should be able to browse the directory of CSOs on their mobile devices in a well presented UI/UX.
2	Collect and upload details of CSO/Community Group to the backend so that it can be displayed in the platform	CSO/Community Groups should have the ability to enter their information and send it to the system in order for it to be displayed in the platform for everyone to see.
3	Search CSO per keyword	There should be a search bar where users can enter keywords to search data.
4	Display CSO location on a map	Users should be able to locate the CSOs on a map, and be able to get directions on how to physically locate the CSOs.

Table 3: Non Functional Requirements

SN	Requirements	Description
1	Security/Authentication	Authenticated users should be allowed to access the systems APIs. Also user passwords should be salted and hashed instead of being stored in plain text in the database.
2	Privacy	The system should not share user data without express consent. In addition, the system should request for user's consent before collecting sensitive data such as a user's location.
3	Accessibility	The system should be easily accessible and usable.
4	Maintainability	The system should be easily maintainable.
5	Scalability	The system should be designed in such a way that when users increases, the system can also be scaled up to accommodate the increased number of users. This has been achieved by reducing coupling between the different modules of the system.

4.2 Results of System Design Process

The system has been designed following the client-server model. Based on the analysis of the requirements, the server (backend) has been designed following the Model View Controller (MVC) model because of the inherent benefits of this model such as enabling scalability, maintainability and robustness of software. Additionally, MVC makes reuse of code possible and enables different developers to develop the system in parallel. With MVC pattern, parts of the system can be modified without affecting the system as a whole (Leff & Rayfield, 2001).

The frontend has been developed in Android using Java/Kotlin following the Model View View Model (MVVM) pattern which is the recommended architecture for building robust, production-quality applications. The MVVM architecture implements the principle of separation of concerns between the different modules of the mobile application. Separation of concerns achieves modularization of the application making it easy to scale, read and unit-test the application (Google Developer Guide, 2020). Figure 6 shows the architecture of the whole system i.e. frontend (MVVM) and backend (MVC). In the frontend, the

Activity/Fragment is responsible for presenting the UI to the user. The ViewModel is responsible for providing data to the UI. The Repository is a mediation layer that selects whether to pull data from the local database or making an API call to the remote data source (webservice). The SQLITE database is a local store of data on the mobile device. The transfer of data between the mobile frontend and the backend is accomplished using JSON (JavaScript Object Notation) format. In the backend the Controller is responsible for receiving and sending responses to API calls. The Model is a schema describing the structure of data and the View is a presentation layer that displays data to the user.

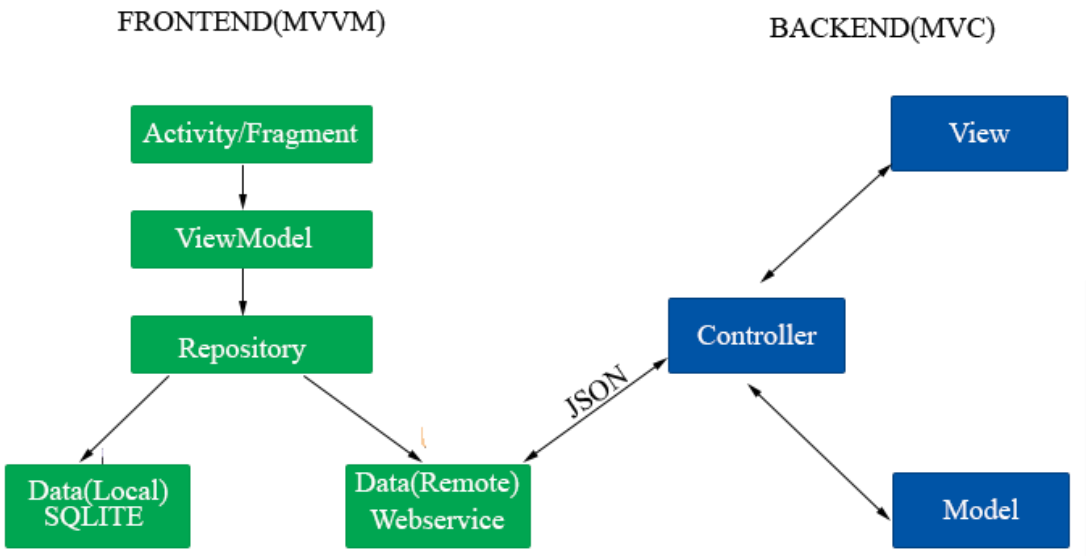

Figure 6: Proposed System Architecture

The following are the features of the proposed system:

(i) An android mobile application which will be responsible for providing a UI/UX for the user to interact with the system. The mobile application renders a view that displays all the CSOs in the system. It provides a form that users can use to upload information about CSOs. In addition, it senses the user's location (after requesting for permission from the user) and displays map view that shows all CSOs. The mobile application also provides search functionality.

(ii) A backend which is written in NodeJs using express framework. It is hosted in a cloud application hosting service called Digital Ocean. The backend implements a RESTful API that provides routes that serve HTTP requests from the mobile frontend in the JavaScript Object Notation (JSON) format.

(iii) A database for storing CSO information. The database used by the system is a MongoDB NOSQL document based database. This system uses MongoDB Atlas which is a database as a service (DbaaS) hosted in the cloud on Amazon Web Service (AWS). Images and other media of the system have been hosted on Cloudinary platform which is a cloud service for hosting and transforming images and videos.

(iv) An administration panel that is web based which is developed using ReactJs frontend library. The ReactJs library has the benefit of saving time of development and minimize the effort to maintain code (Le & Tran, 2020). The panel enables an administrator who has full rights of create, read, update and delete (CRUD) as well as to manage users and content of the system.

4.3 Use Case Modeling of the Application

Use case diagrams are used to show how one or more actors interact with the system. Use case diagrams depict what the system can do, i.e. how user inputs are handled in relation to the system's functional requirements (Bittner, 2003). In this application three actors were identified i.e. user, admin and Oauth Provider.

Users of the system interact with the mobile frontend. They can pull all data about CSOs, they can search data according to key queries such as country, region, CSO focus area etc. In addition, CSO/Community stakeholders can register to the system and upload information about their particular CSO by filling a form. The data is sent to the backend and stored securely in a cloud based MongoDB database via a NodeJs backend. In addition users can also geo-locate CSOs in an interactive Google map. The map also integrates Google's direction API that enables users to get estimated distance, time and directions to reach a particular geo-location (Google Developer Guide, 2021). There is an administrator who has all Create, Read, Update and Delete (CRUD) privileges of the backend. The admin manages users and content. Lastly there is an Oauth Provider who is an external entity that provides authentication services. For this application the authentication provider in use is Google's Ouath2 service. Figure 7 shows the use-case diagram of the system.

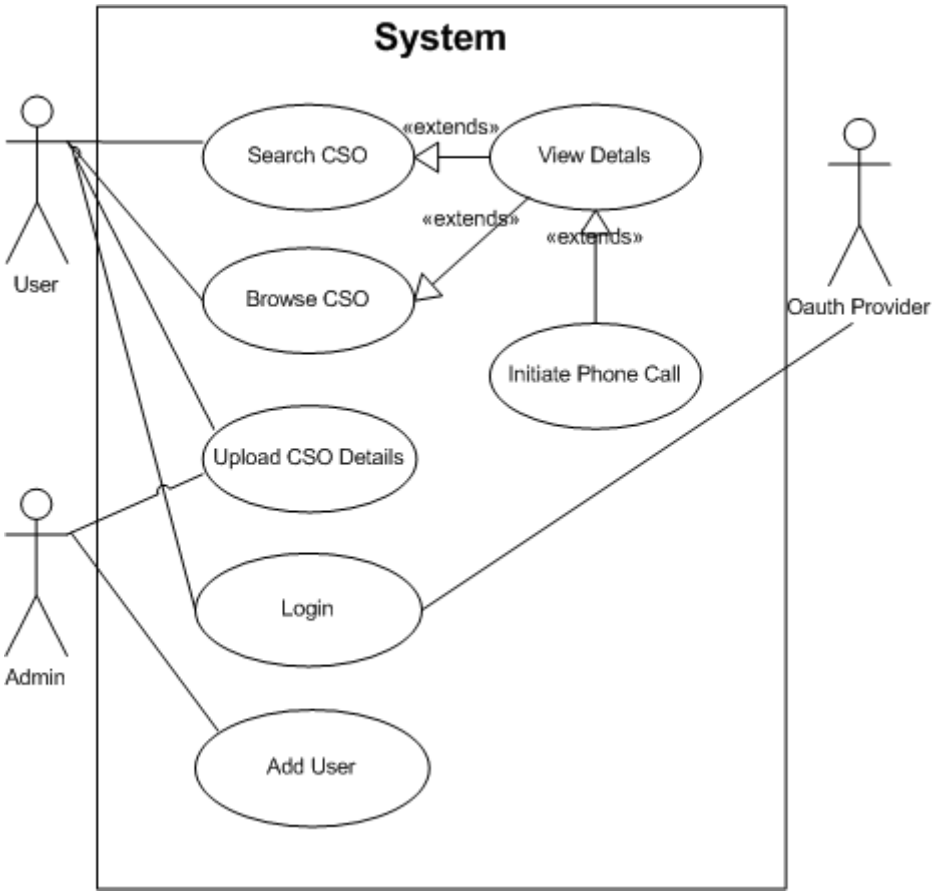

Figure 7: Use Case Diagram of Developed System

4.4 Data Flow diagram

A data flow diagram represents the processes, data stores, and external entities in a business or other system and the connecting data flows (Aleryani, 2016). Data flow diagram can also be described as a graphical depiction of the flow of information in an information system. There are different levels of data flow diagrams depending on details. The first level is called context-level diagram which shows the whole system as an overview and how data flows between the different actors. The next level is called level 1 and contains more details. Subsequent levels are called level 2, 3 etc. each with more details than the previous level. Figure 8 shows the context-level diagram of the CSO mobile application. Data flow from user to the system is authentication details for login or registration. In addition user can upload their CSO details to the system. They can also browse and search CSO details from the system. Another data flow is from the administrator of the system. The admin has full CRUD permissions so they can send and retrieve data from the system.

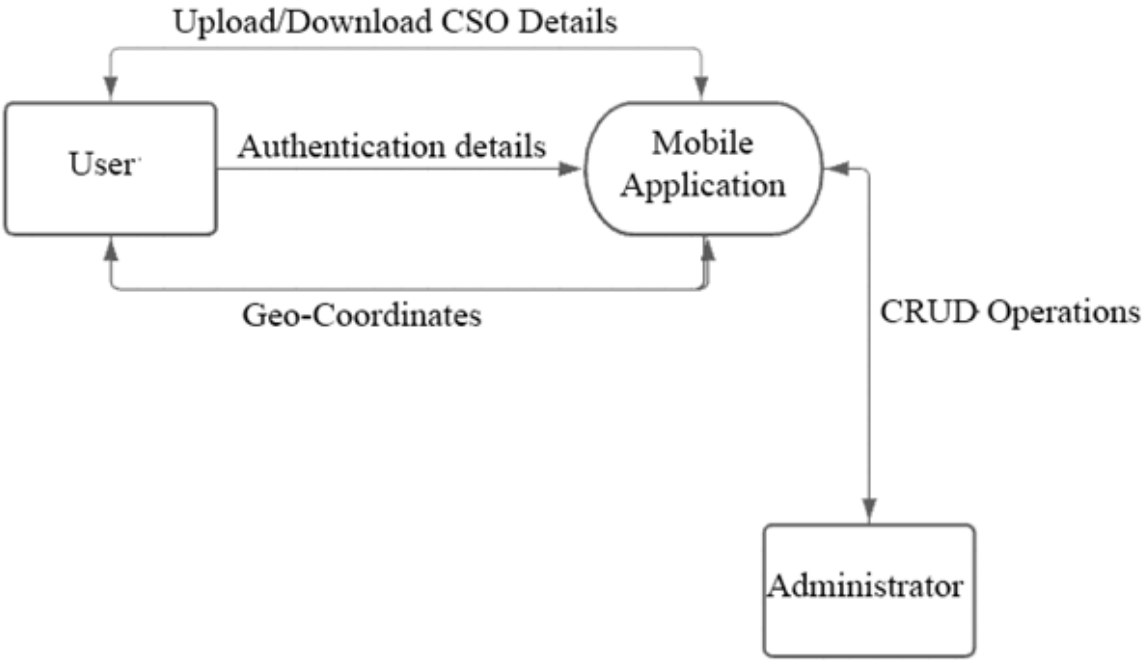

Figure 8: Context-Level Data Flow Diagram of the Developed System

4.5 System Security

The security of the system has also been taken into consideration. All communication between the frontend and backend is secured using Secure Hypertext Transfer Protocol (HTTPS). The HTTPS is a protocol that is used to secure user data between a client and web server (Goodrich & Tamassia, 2011). The HTTPS is necessary to prevent phishing and man-in-the-middle attacks.

User passwords are stored in the database securely by using salting and hashing techniques. Passwords are not stored in plain text as this would compromise the system since any attacker who gains access to the database could read them. Instead passwords are salted in 10 rounds and hashed using bcrypt security nodejs module. The bcrypt is a scheme for hashing passwords. It is based on the Blowfish Block Cipher (Alabaichi *et al.*, 2013). The bcrypt standard is resistant to brute-force attacks and greatly improves the security of a system (Malvoni & Knezovic, 2014).

User authentication is implemented using the JSON Web Token scheme (JWT). The JWT is a standard used to create access tokens for an application (Jones *et al.*, 2015). The workflow of JWT begins with the client sending login or registration details to the REST API of the server. Once the server receives the username and password, it generates a token that certifies

the user identity, and sends it to the client. The client stores this token and on subsequent requests, the client will append the token with the request back to the server. On receiving the request with the correct appended token, the server will know that the request comes from an authenticated client and not a fake client. In this application the JWT token is stored on the android mobile application using Jetpack Data Store (Google Developer Guide, 2019).

4.6 System Requirement Evaluation

Table 4 describes how the system requirements have been fulfilled by the designed system.

Table 4: System Requirement Verification

Requirement	System Verification
The system developed must have the ability to display up-to-date information about CSO/Community in an intuitive and interactive UI/UX.	The developed system displays the CSOs stored in the database on a recyclerview UI element. Recyclerview is view with good aesthetic UI and is memory efficient as it automatically recycles views.
The developed system must be able to collect and upload details of CSO/Community Group to the backend so that it can be displayed in the platform.	The system has a form UI element that enables the user to fill in information about their CSO and send the data to the backend and database. The frontend uses Retrofit networking library to communicate with the backend.
The developed system must be able to display CSOs location in a map.	The system has integrated Google Map functionality that displays the CSOs as markers on a map. An info window displays the information of each CSO on clicking it. In addition, the user can get direction to CSO of choice; this functionality leverages Google's direction API.
The developed system should secure user data effectively.	This is achieved by installing an SSL certificate on the server. The certificate enables encryption of all HTTP communication between client and server using HTTPS protocol. In addition, all passwords are not stored as plain text. They are salted and hashed using bcrypt blowfish algorithm then stored in the database. Some APIs are also protected using tokens and only accessible after a user is successfully authenticated.
The developed system should be simple, scalable and maintainable.	The developed system has achieved these requirements by adopting the MVVM and MVC models in the frontend and backend respectively. These paradigms enhance code readability and modularization, making the application easy to maintain and to grow as users increase.

4.7 Overall System Evaluation

Figure 9 shows the overall results of system evaluation. The system was evaluated by giving a number of users questionnaires with a set of questions and tabulating the frequencies of their answers. The evaluation process involved a total of 35 users; whereby 20 users were from CSOs and community groups and 15 from marginalized communities answered a set of eight questions about the system as shown in Appendix 9. The results show that on average 88.125% of users granted positive reviews of the developed system in accordance to different criteria such as its ease of use (usability), accessibility, security, speed, availability and enhancement of information availability of CSOs. The remaining average of 11.875% represents users who were unsure of some of the meaning of the concepts like security, availability and accessibility. Hence, the study received less numbers of users who were not satisfied with the system's performance. In some of the issues clarification and training were carried out in order to assist the unsatisfied users with proper and clear explanation or information.

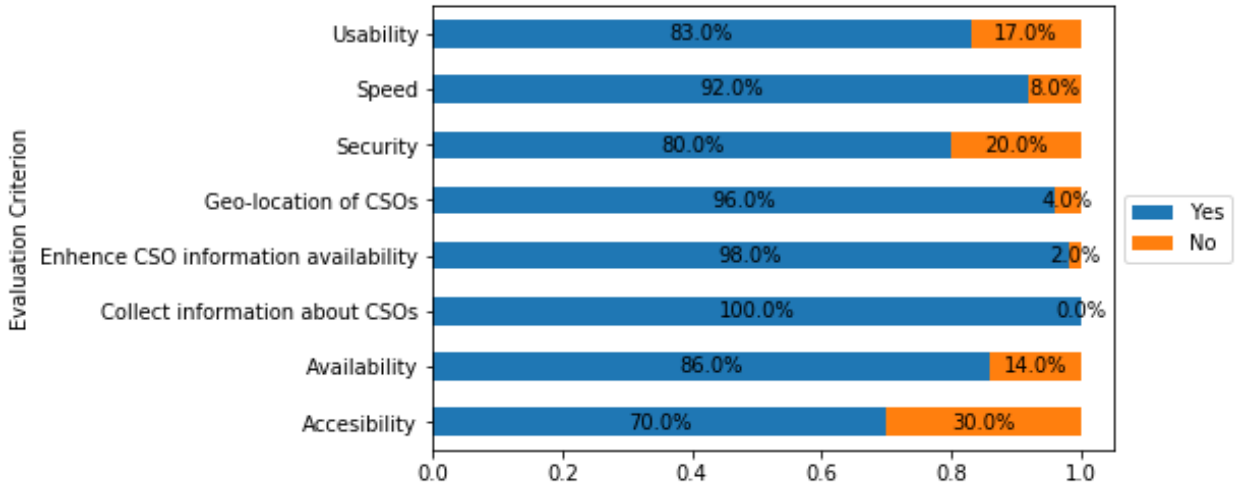

Figure 9: Results of System Evaluation

4.8 Application Software Testing

Software testing is a method of finding errors in an application or program. It ensures that the application functions according to the requirements(Everett & McLeod Jr, 2007). There are three kinds of tests namely unit testing, system testing and integration testing. Unit testing is done at the unit level while integration testing tests the integrated units of a module. System testing is done to test the overall functionality of the system.

In the development of this application unit testing was done automatically to each unit by scripts generated by JUnit available on Android Studio (Google Developer Guide, 2018).

4.9 Some User Interface Screenshots of the Application

User interfaces provide the first point of interaction between the users and the system. They are an important component of an application because they give the first impression of what the app can do to the user. Appendix 1-8 show some UI screens of the application.

Appendix 1 shows the application dashboard. When the user first opens the application they are presented with this screen. It has buttons which enable the user to navigate to other parts of the application.

Appendix 2 shows the Login UI screen. This screen is presented to the user if they are not logged-in or registered and they want to upload their CSO details. Using this screen they can choose to login with their e-mail and password or using Google login system.

Appendix 3 shows a UI screen that presents all CSOs to the user. The screens are presented in a memory-efficient recyclerView UI element. Also there is a search bar at the top of the recyclerView that enables the user to search CSOs per keyword.

Appendix 4 shows the detail screen for each CSO. The user is navigated to this screen when they click any CSO in the screen shown in appendix 3. This screen also has contacts and geo-location of the CSO.

Appendix 5 shows CSOs represented as markers on a Google map. Each marker's spatial position corresponds to the CSO's latitude and longitude. Each marker has click listener attached to it. On clicking each marker, a bottom-sheet dialog is displayed which has the detailed information of that CSO. In addition, the user can launch another activity from clicking the marker which will show the direction to reach the CSO.

Appendix 6 shows the UI screen that is used by users of the application to upload their CSO details. The screen has several text inputs, image selection functionality and functionality for the user to get their current geographical coordinates from their phone's location data.

Appendix 7 shows the UI screen that enables the user get directions to their CSO of choice.

Appendix 8 shows the UI screen with CSO details. It shows how the contact and geo-location data as it appears to the user.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

In this section the conclusion of this study is presented. The objective of this study was to develop an interactive mobile application for enhancing availability of information about CSOs and communities. This objective was broken down into three specific objectives.

The first specific objective was to identify the requirements. Through visiting various CSOs and other stakeholders in Arusha, Dodoma and Dar-Es-Salaam and reading various literatures it was determined that there was a gap in the availability of a single platform which is up-to-date where players can get information easily about CSOs. The process of collecting requirements involved physical interviews, questionnaires and observations techniques with 140 players in the non-profit sector in Arusha, Dodoma and Dar-Es-Salaam regions were conducted. The sample was chosen using non-random sampling procedure using Snowball method. The data was analyzed using Pandas and MatplotLib libraries of the Python programming language.

The second specific objective was to design and develop the mobile application. This objective was conducted successfully using modern recommended best practices of software development. For the frontend MVVM pattern of android software development was used. For the backend MVC pattern was used as explained in the Methods section.

The third specific objective was to evaluate the developed application. This objective was also conducted successfully in which both software testing methods and user evaluation was used. The evaluation process involved 35 volunteers. Twenty were from CSOs and community groups and 15 from marginalized population. Their phones were installed with the application APK file after extraction from Android Studio. The results show that on average 88.125% of users granted positive reviews of the developed system in accordance to different criteria such as its ease of use (usability), accessibility, security, speed, availability and enhancement of information availability of CSOs.

This application will add great value to the non-profit sector practitioners as it will improve efficiency and effectiveness of stakeholders in carrying out their duties. For instance by using

this platform, donors like Global Fund or German International Cooperation will have access to correct and updated information at their fingertips. This will in turn help them to make informed decisions on which CSO to contact and eventually fund. Also marginalized populations e.g. albinos will have a reliable platform where they can easily get information about CSOs that may help them to raise issues on their behalf. This in turn will help the society as a whole get closer to attaining the lofty goal of having a fair, just and inclusive society.

5.2 Recommendations

Policy makers and other practitioners will benefit from using this application as it will provide an accurate and up-to-date repository of data about CSOs and Communities. Using this data they may better plan how resources geared to this sector can be allocated.

The non-profit sector is an important sector in society as explained in the introduction section of this study. Therefore, people need to have awareness and easy access to CSO and community groups by using state of the art technologies like mobile applications. The authors recommend that this application to be further developed and equipped with more features in the future and deployed on the Google Play Store. Also the authors recommend a similar application to be developed for users who use iPhones and deployed on the apple play store in order to widen the reach of the application.

As further studies, the application can be integrated with chat feature to enable easy communication between practitioners. Artificial Intelligence (AI) model can also be introduced in the backend to help to detect inappropriate words and/or images uploaded to the system without the physical intervention of an administrator as is the case now.

Also Unstructured Supplementary Service Data (USSD) can be considered to be integrated in order to cater for users who don't have smartphones.

Lastly addition of Interactive Voice Response (IVR) application to the application in the future will add value in the collection and processing of data.

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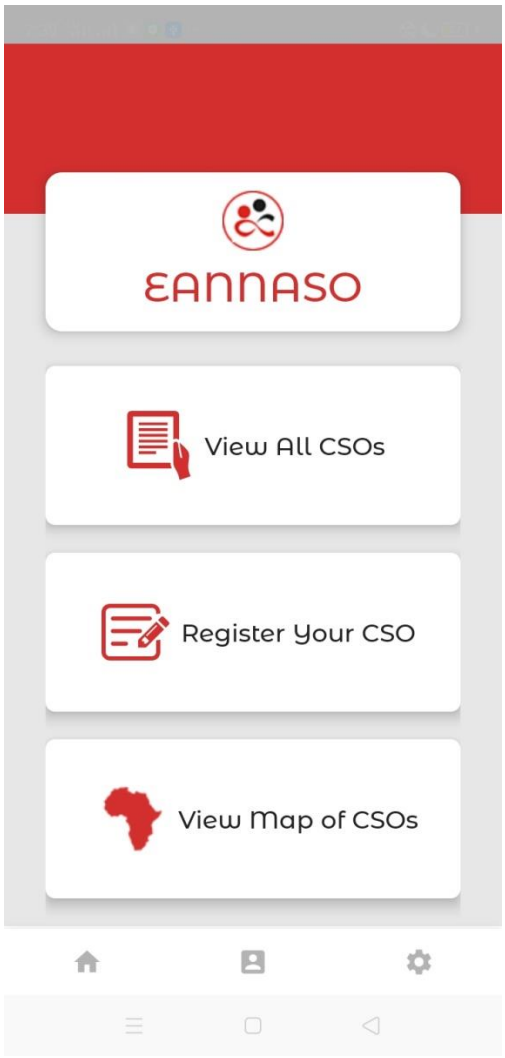
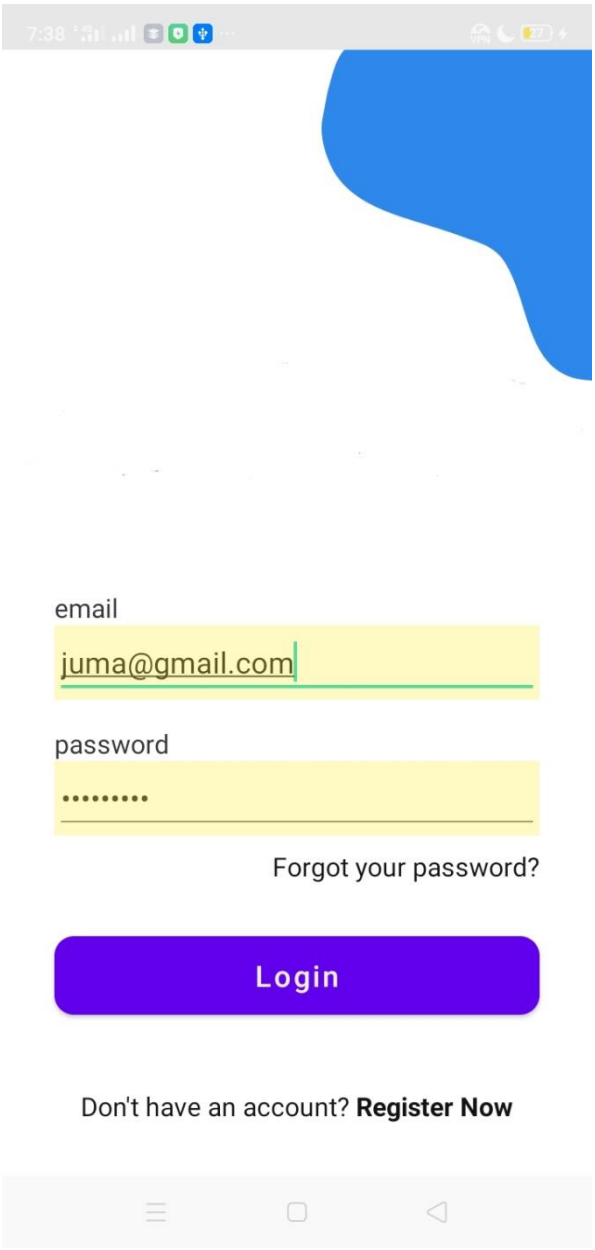
APPENDICES

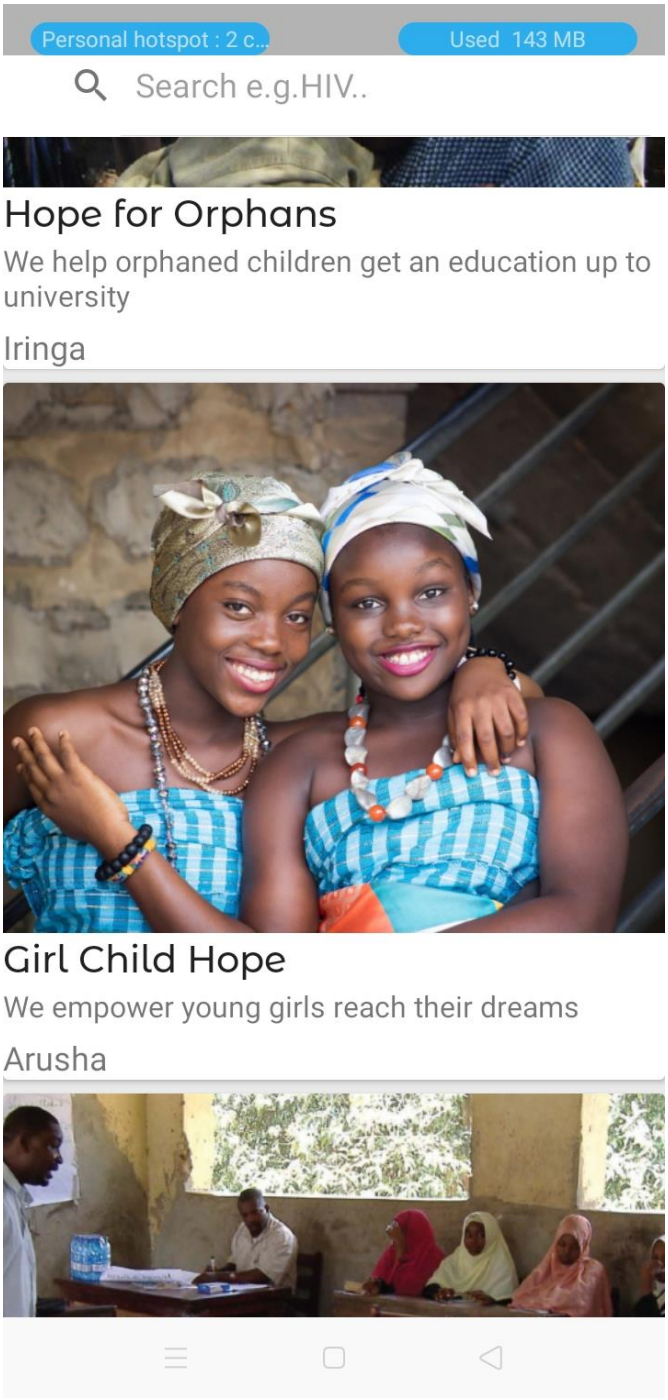
Appendix 1: Dashboard of the Application



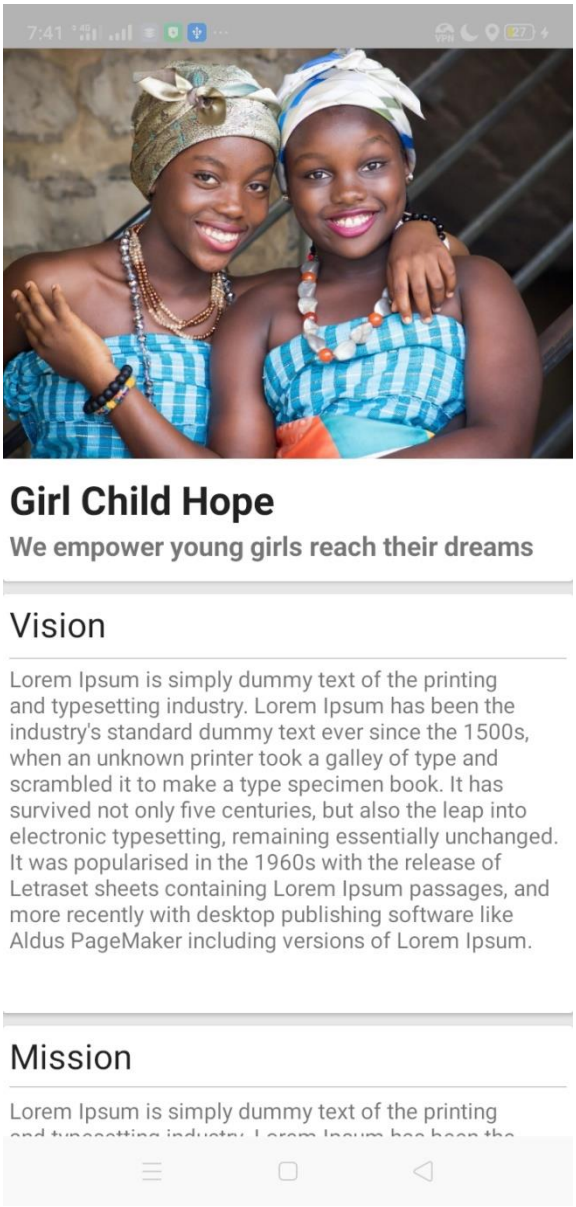
Appendix 2: Login Screen



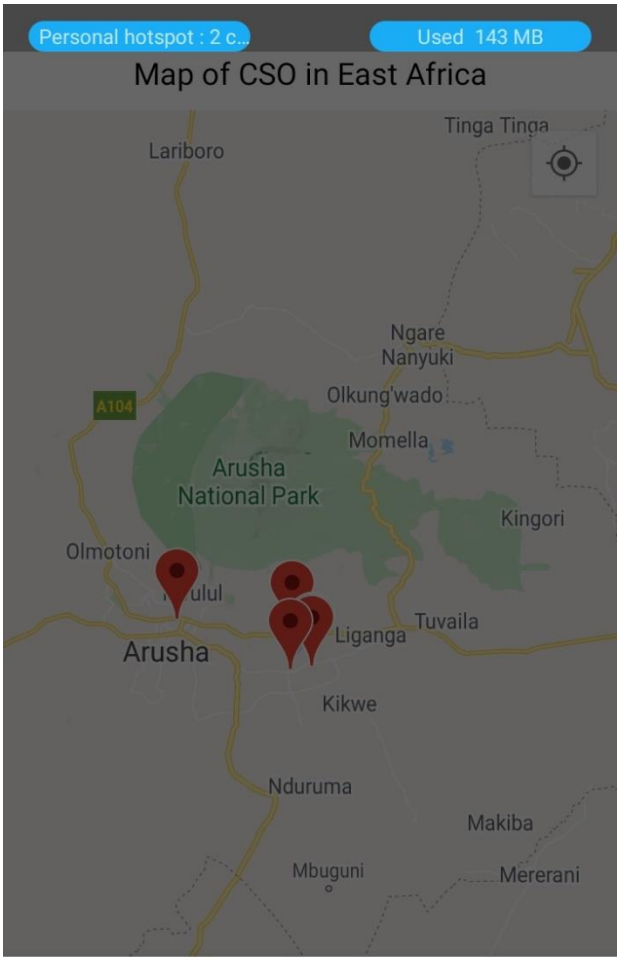
Appendix 3: Screen Showing CSOs



Appendix 4: CSO Details Screen

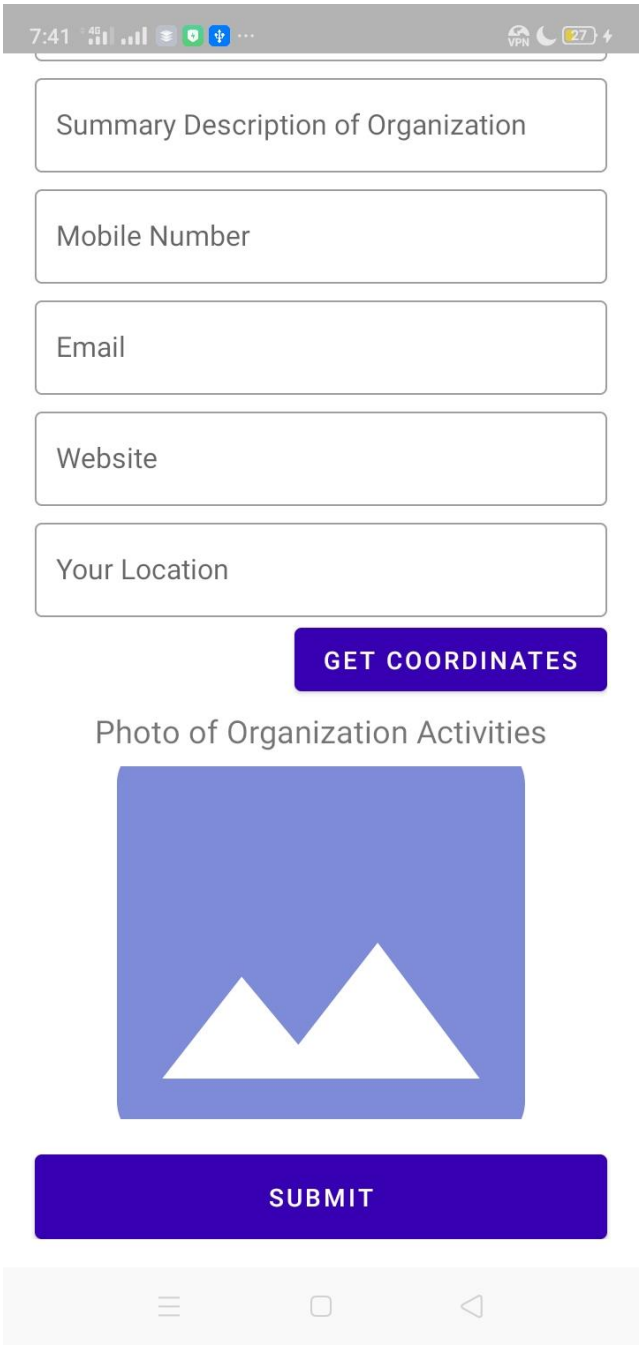


Appendix 5: CSO Geo-Location

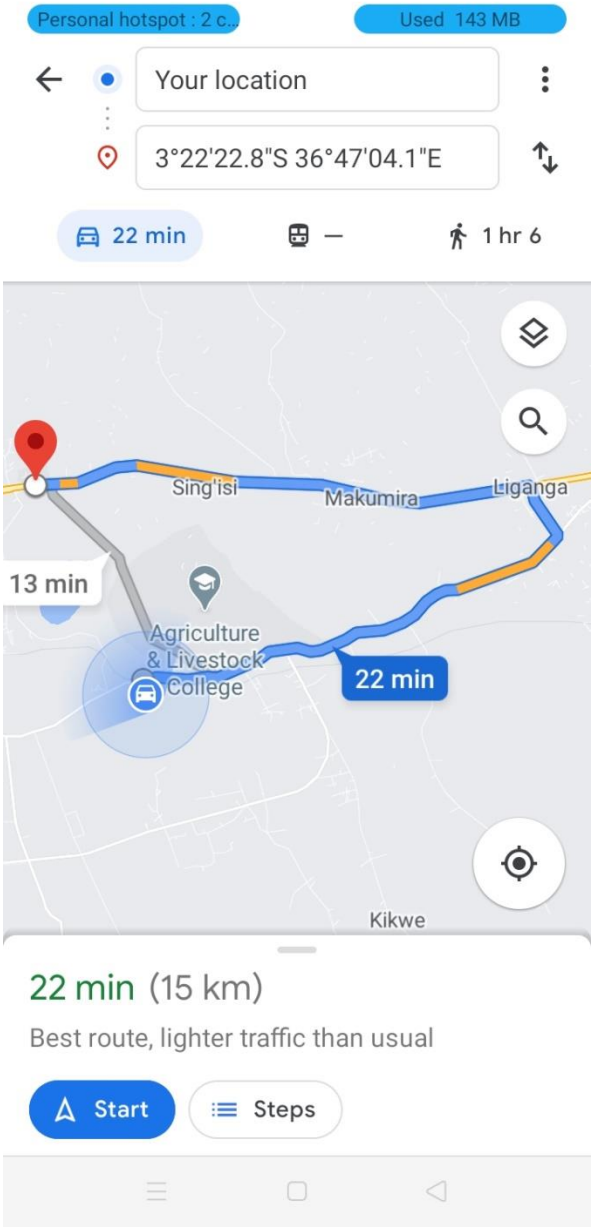


Name	Movement for Youth
Phone	+255743434751
Email	wangilisasi@gmail.com
Region	Mwanza

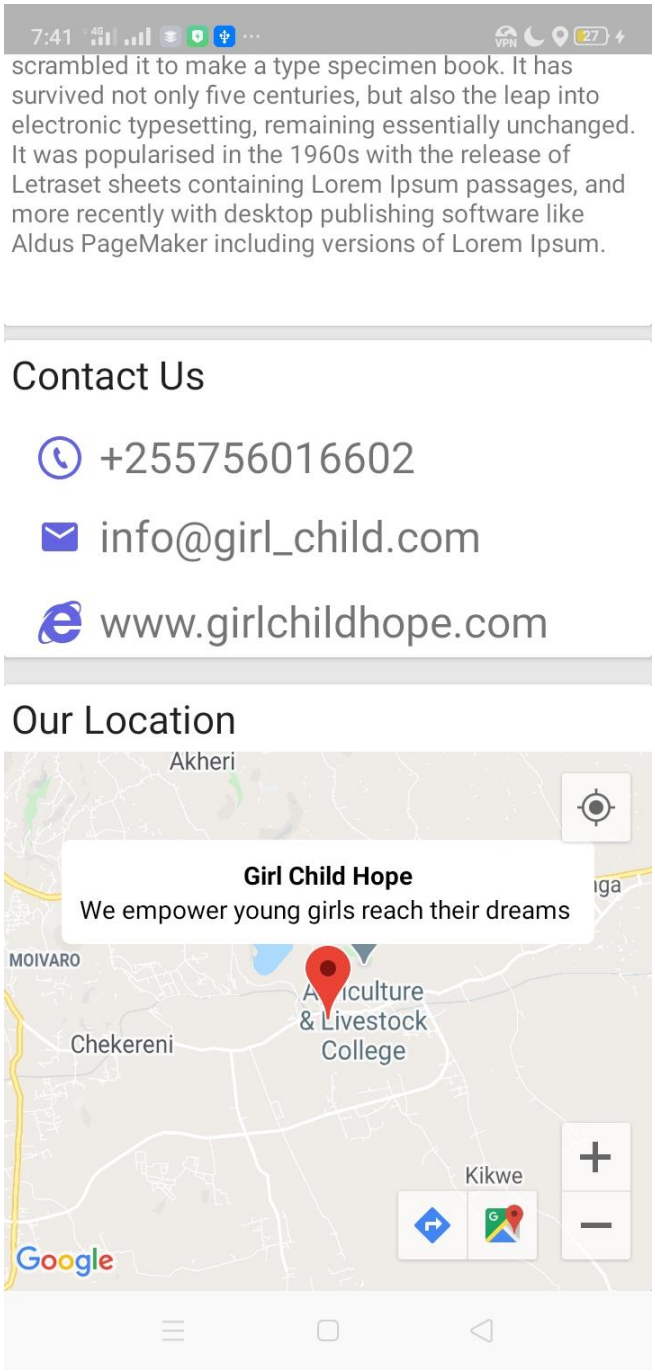
Appendix 6: CSO Upload Screen



Appendix 7: Directions to CSO



Appendix 8: Location and Contacts of CSO



Appendix 9: Research Questionnaire

1. What is your age?

   ☐

2. Do you own a smart phone?

   ☐ Yes

   ☐ NO

3. What is the Operating System of your smartphone?

   ☐Android

   ☐IOS (iPhone)

   ☐Other

4. Do you use internet in your smartphone?

   ☐Yes

   ☐No

5. Are you aware about mobile applications and how to download them?

   ☐Yes

   ☐No

6. Do you know any Civil Society Organization or Community Group?

   ☐Yes

   ☐No

7. Have you ever wanted information about activities of a Civil Society Organization or Community Group but did not know where to look?

   ☐Yes

   ☐No

8. Have you ever needed contacts of CSO/Community Group and failed to get one?

   ☐Yes

   ☐No

9. Have you ever obtained information about a CSO/Community Group but later found out that the information is outdated or inaccurate?

   ☐Yes

   ☐No

10. Do you know any online platforms where you can get information about Civil Societies or Community Groups?

    ☐Yes

    ☐No

11. If you are a leader/owner of a CSO, have you ever wanted to publish/publicize your CSO and its activities but failed to find a suitable platform to do so?

    ☐Yes

    ☐No

12. In your opinion, how can we enhance accessibility to information about CSO/Community Groups?

13. Do you think a mobile application with information and location about CSO/Community Groups will help to solve some of the challenges you are facing?

☐Yes

☐No

14. If a mobile application for Civil Societies is developed, what features would you like it to have?

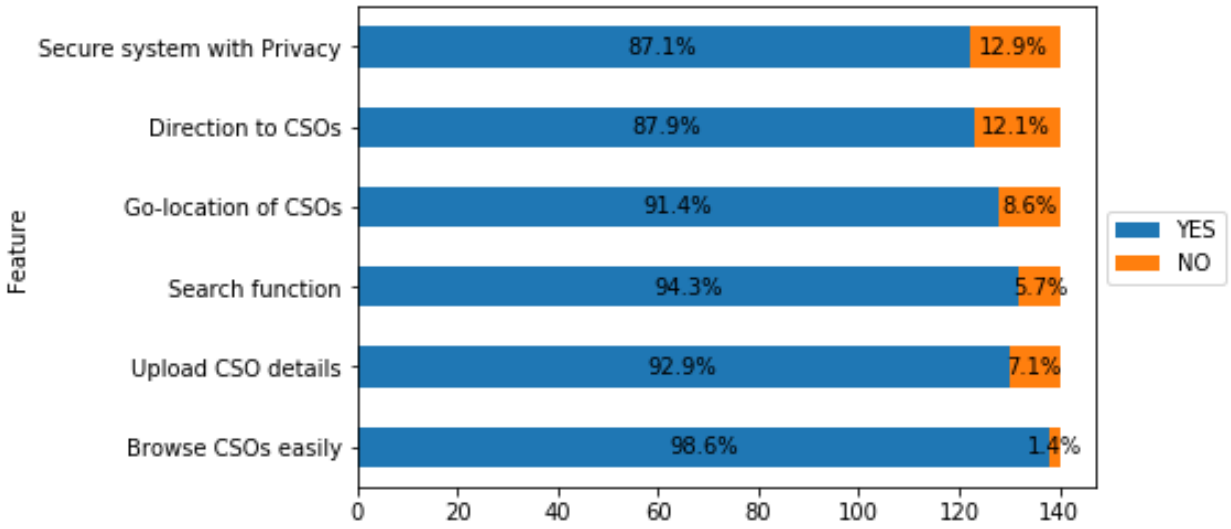
	Feature	✓for Yes ✗ for No
1	Browse CSOs easily	
2	Upload CSO details	
3	Search function	
4	Geo-location of CSOs	
5	Direction to CSOs	
6	Secure system with Privacy	

15. What other features would you like the system to have? Write below

Appendix 10: Mobile Application Evaluation Form

Question	YES	NO
Is the application easy to learn and use?		
Is the application fast?		
Do you feel that the application is secure?		
Is the Geo-location feature working well?		
Do you feel the application will enhance information availability about CSO?		
Can you upload CSO details?		
Is the application available any time?		
Is the application accessible?		

Appendix 11: Stacked Bar Graph of Responses to Question 14 in the Questionnaire



RESEARCH OUTPUT

Emil Patrick <patricke@nm-aist.ac.tz>

JSEA: Acceptance Letter for Paper ID: 9302870

1 message

jsea@scirp.org <jsea@scirp.org> Fri, May 7, 2021 at 9:37 AM

To: patricke@nm-aist.ac.tz, shubi.kaijage@nm-aist.ac.tz, judith.leo@nm-aist.ac.tz

Dear Dr. Emil Patrick,

Greetings from Journal of Software Engineering and Applications.

This is to inform you that your paper entitled "Design of an interactive geo-location mobile application for Civil Societies in East Africa" has been accepted for publication.

This manuscript will be ready for publication if the following three procedures can be completed **within a week:**

Step 1: Complete the Copyright Transfer

Step 2: Make Payment for Article Processing Charge **$899**. (The payment information shown in your user center is the only correct and certified information; please do not be misled by other uncertified payment notification.)

Step 3: Revise the paper according to the comments on the system and Format it in our template, and Upload revised version in Word format through the system. Please highlight the revisions in red color in the updated version and send us a response letter on the comments if available. (The template and review comments are available on the system. Please send the reformatted file via email if the size of it is more than 4MB.)

Please login to the online system with your account and password to view all the information. Please feel free to contact us if you have any question.

Best regards

Editorial Assistant

Sally Lee

JSEA Editorial Office

THE NELSON MANDELA AFRICAN INSTITUTION OF SCIENCE AND TECHNOLOGY
Emil Patrick[1], Dr. Judith Leo[2], Dr. Shubi F. Kaijage[3]

ENHANCING ACCESS TO INFORMATION ABOUT CIVIL SOCIETY ORGANIZATIONS AND COMMUNITIES THROUGH AN INTERACTIVE ANDROID MOBILE APPLICATION

INTRODUCTION

Civil Society Organizations (CSOs) can be described as the social sphere that lies between the state and the individual or household.

The CSOs help the society in various ways such as giving a voice to the marginalized, service delivery, policy advocacy and acting as a watchdog.

OBJECTIVES

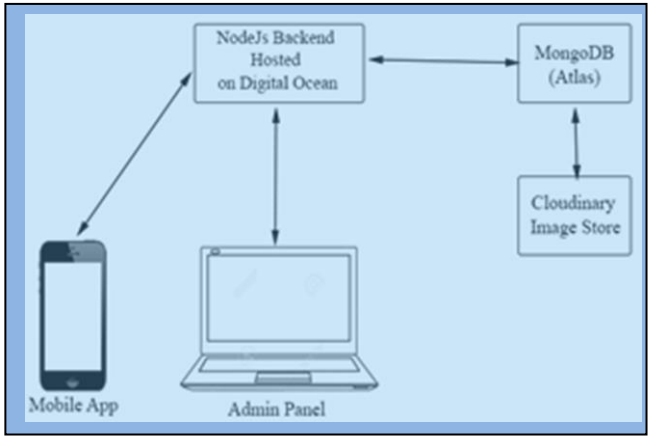
MAIN OBJECTIVE

To develop a mobile application that will facilitate collection, storage and sharing of information about functional Civil Society Organizations in Anglophone Africa countries.

SPECFIFIC OBJECTIVES

(i) To analyze the requirements for the proposed system.
(ii) To develop the proposed system.
(iii)To evaluate the developed system.

CONCEPTUAL FRAMEWORK



METHODOLOGY

The design science research methodology (DSRM) was used in this study. The DSRM is composed of three stages namely problem identification, solution design and evaluation and validation stage. DSRM methodology was preferred because it is outcome-based. The DSRM focuses on solving societal problems by creating artifacts e.g. process, method or a piece of software.

RESULTS