2021-07

A mobile-based system for enhancing interactive communication among people in the protected area: a case study on human-wildlife conflicts management in Ngorongoro conservation area and Serengeti national park in Tanzania

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A MOBILE-BASED SYSTEM FOR ENHANCING INTERACTIVE COMMUNICATION AMONG PEOPLE IN THE PROTECTED AREA: A CASE STUDY ON HUMAN-WILDLIFE CONFLICTS MANAGEMENT IN NGORONGORO CONSERVATION AREA AND SERENGETI NATIONAL PARK IN TANZANIA

Frank Nyange

A Project Report submitted in Partial Fulfilment 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

Arusha, Tanzania

July, 2021

ABSTRACT

One of the core human rights is the right to the best possible health for humans and a balanced ecology for wildlife. Electric fences are the only way to prevent human-wildlife conflict, but they are ineffective in many countries due to the high cost of power management required to operate them. Camera trap management can help this problem, however, in underdeveloped nations like Tanzania, it fails to owe to poor GPS usage, which prevents the information from being reported to the protected area authority. The goal of this study is to create a mobile application A mobile-based human-wildlife conflict Management App) that would help to solve the human and wildlife conflicts within Tanzania's Ngorongoro Conservation Area and Serengeti National Park. Mobile application captures video from camera trap and allows to report the information to the park rangers through live chatting. Interviews, observations, and questionnaires were used to gather information. The findings suggest that 93% from interviews and observation of people thought it to be really useful for receiving video from camera trap to the mobile app and able to report information to the protected area authority. The remaining 7% were unable to fix the problem due to a lack of smartphones and poor internet access within the protected area. Within the villages, the application may be used with a smartphone and a decent internet connection. People in the protected area gave the designed system positive feedback, with 95.2% of those who completed the system evaluation agreeing that the App should be used. Further development of the application would necessitate more functionality and improved internet accessibility.

Key words: GPS, Mobile Application, Camera Trap, Conservation Area, National Park

DECLARATION

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

Frank Nyange

_____

Name and Signature of Candidate   Date

The above declaration is confirmed by:

Dr. Mussa Ally

_____

Name and Signature Supervisor 1   Date

Dr.   Silas Steven Mirau

_____

Name and Signature of Supervisor 2   Date

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the Nelson Mandela African Institution of Science and Technology, a Project entitled "*A Mobile-Based System for Enhancing Interactive Communication among People in the Protected Area: A Case Study; Human-Wildlife Conflicts Management in Ngorongoro Conservation Area And Serengeti National Park in Tanzania*" In partial Fulfilment of the Requirements for the Award of the Degree of of Master of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology.

Dr. Mussa Ally

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Name and Signature Supervisor 1   Date

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Name and Signature of Supervisor 2   Date

ACKNOWLEDGEMENTS

DEDICATION

This project report is dedicated to my parents and family, who have never doubted my abilities.

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LIST OF ABBREVIATIONS AND SYMBOLS

API	Application Programming Interface
B2B	Business to business
CSS	Cascading Style Sheet
DB	Database
EMoS	Embedded and Mobile Systems
EPRF	Elephant Proof Rail Fence
GPS	Global Positioning System
GUI	Graphical User Interface
HTML	Hypertext Markup Language
HTTPS	Hypertext Transfer Protocol Secure
HWC	Human Wildlife Conflict
ICT	Information and Communication Technology
IPC	Inter-process Communication
MVC	Model-view Control
NBS	National Bureau of Statistics
NCA	Ngorongoro Conservation Area
OTP	One -Time Password
RDBMS	Relational Database Management System
SDLC	Software Development Life Cycle
SMS	Short Message System
SNP	Serengeti National Park
SQL	Structured Query Language
TANAPA	Tanzania National Parks
TCRA	Tanzania Communications Regulatory Authority
UI	User Interface
UNESCO	United Nations Educational, Scientific and Cultural Organizational
USSD	Unstructured Supplementary Service Data
WWF	World Wildlife Fund

INTRODUCTION

1.1 Background of the Problem

The right to the best possible state of health is one of the most fundamental of all human rights (Meier *et al.,* 2005). The majority of people living in both developed and developing countries now consider mobile phones to be an essential device for their day-to-day lives (Sharples *et al.,* 2010). End of the year 2019 statistics showed that 67 percent of the world's population, or 5.2 billion people, were using some sort of mobile service (Budd *et al.,* 2020). It is anticipated that by the year 2025, there will be approximately 600 million more people subscribing to mobile services, This brings the grand total of subscribers to 5.8 billion (70% of the global population) (Lyimo, 2021). End users can reap multiple benefits from mobile technology, including improved ease and speed of communication as well as expanded opportunities.

Even though these kinds of studies have been done all over the world, they are limited in many places. In Kenya's Tsavo East National Park, lions and spotted hyenas go after large domestic animals like cattle and sheep. They only eat adults or young cattle and sheep. A four-year study found that ranches lose an average of 2.4% of their total herd each year (Patterson, 2004). India, the studies in Aravalli about Rajasthan show that it is one of the largest states in India, with about 9% of its land area covered by forests. A lot of the state is desert, and it has one of the highest numbers of animals, so there is a serious lack of biomass for local use (Aggarwal *et al.,* 2006). Effects of mining have shown negative impacts on bio-diversity and climate change as well (Khanal & Environment, 2009). On the part of wild animals, the sufferance finds expression through retaliatory response from the affected people or the accidents leading to injury or death of the animals (Sekar, 2013).

The HWC refers to interactions between wild animals and people who live in the same region, as well as the negative consequences for people, wild animals, and their habitat. The occurrence of HWC from people and to the wild animals, when human populations increased and overlap with established wildlife territory, creating a reduction of resources or life to some people and/or wild animals.

According to the World Wildlife Fund (WWF), statistics of African elephants (2018), Africa has lost 30% of its elephant over the last six years, due to poaching and in general (Ngcobo *et al.,* 2018). Tanzania has lost 60% of its entire elephant population over the last century hence, is a country

with the largest poaching threats (Lohay *et al.,* 2020). Similar declines can be observed for other key wildlife species such as giraffes and Lions according to the Red List index (2019), often human activities destroy or fragments habitats for wild plant and animal species, sometimes in irreversible pathways, while different strategies are being employed to ensure the ecosystem are balanced there is still pressure of accessing and making relevant data that can help in decision making.

An article by the ten top conservation tech innovations from 2017 highlights the contrast and effect implemented so far using these technologies (Miao *et al.,* 2017) However, few efforts have been made to bring all this information together and make it available to the most important stakeholders

The internet society is implementing community networks that are using technologies such as TV white spaces in Tanzania to provide connectivity in rural areas. This has never been explored as a possibility for networking and education in NCA and SNP area, where a knowledgeable and aware community is most strongly needed to preserve biodiversity in those iconic areas of Africa. The approach of this work provides a widespread and low-cost solution to track and monitor wildlife as well as invasive plant species.

Through the use of artificial intelligence Wild NET acts on network data and exploits available knowledge and passes this on to the relevant communities, thereby greatly contributing to long term conservation and sustainable use of natural resources.

This project intends to serve different stakeholders interacting with the ecosystem in Ngorongoro Conservation Area (NCA) and around Serengeti National Park (SNP), which are UNESCO world heritage sites and rich in biodiversity. Stakeholders include park rangers, schools and villages in and adjacent to the protected Ares, community members as well as tourists who frequent these sites.

The project will employ the Internet of Things (IoT) approach by using sensors, camera traps and a community network to provide basic information, conduct monitoring and data collection as well as education in the community. The IoT architectures can help us learn and respond to data and communication trends that are observed within the ecosystem. Particularly camera trap, collars, drones and other recent technologies that are based on the internet have helped recent research in understanding ecosystem trends in the last decades.

1.2   Statement of the Problem

Human-wildlife conflict (HWC) is on the rise in protected areas such as the Serengeti and Ngorongoro, where a growing human population overlaps with established wildlife territory. In the conservation of wildlife conflicts between human and wild animals are recognized as major issues

which leads to livestock depredation, habitat destruction, injuries and death of people and wildlife, also some special wild animals.

Peoples in the protected areas lack how to receive information from camera traps and how to send information to respective authorities for further action from rangers for protecting them against wild animals. As a result, a mobile application is being proposed as part of this project to help people in the protected area to reduce some interaction between peoples and wild animals by receiving video from camera traps and to see movements of the wild's animals near to their villages and to report the information to the rangers to the respective protected area. The app will be used to help people in the protected area reduce some interaction between peoples and wild animals by receiving video from camera traps.

1.3   Rationale of the Project

The project will deploy low-cost systems to build an information network in order to enable the community to leverage connectivity for the purpose of gaining social and economic empowerment as well as information control on key biodiversity issues such as HWC. This allows community-driven real-time promotion of touristic activities within the park through Artificial Intelligence.

1.4   Project Objectives

1.4.1   Main Objective

The main objective of this project is to design and develop a mobile-based app for human-wildlife conflict management at the Ngorongoro Conservation Area and Serengeti National Park.

1.4.2   Specific Objectives

The specific objectives of this study were:

(i)   Conduct a comprehensive analysis of the existing platforms and their limitations.

(ii)   To develop a mobile application that will receive data from camera traps

(iii)   To validate and deploy the mobile application platform

1.5   Project Questions

(i)   Are there any similar existing mobile apps?

(ii)   Who are mobile app target users?

(iii)   How does the system keep track and report user's information?

1.6   Significance of the Project

This platform dedicates to keeping monitoring the wild animals near the village and schools to avoid the death of the people, especially children who are moving around of their village for pastoralism. The Platform will reduce the death of the livestock which are attacked by wild animals near the village, this will help the livestock to have a good grazing range and increase productivity, especially milk production. The platform will help the rangers for security purposes in the way that the platform of the mobile app it gives the warning alert to the rangers and rangers take action of the alert, thus it helps in security to avoid human and wildlife conflicts. The platform will increase ecosystem and wildlife species with halt biodiversity

1.7   Delineation of the Project

This study assumes that all people in the village inside the conservation areas have a smartphone to have the ability to access the mobile app that allows them to monitor the wild animals which are moving near to their village and also the conservation authority to have good internet connectivity for access mobile application.

There are some limitations to this research. Descriptive statistics were limited by the small number of responses (15 villages and 10 schools) to NCA and SNP populations. Response rates were affected by a constrained data collection schedule because of the short timeframe for completing the analysis as part of a master's degree. Larger sample sizes should be used in future research.

CHAPTER TWO

LITERATURE REVIEW

2.1   Introduction

The purpose of this chapter is to provide an overview of the context in which this project was carried out by reviewing relevant published research (Kramer & Studies, 2018). This project proposes development mobile based human wildlife management using camera trap monitoring system in order to set foundation of the project.

2.2   Mobile Technology in Tanzania

Consumers nowadays almost always have their mobile devices with them, regardless of where they go (Viardot, 2004). It is possible for Africa's e-commerce sector to expand if certain conditions are met, including increased internet penetration and mobile technology adoption, as well as improvements in payment and distribution infrastructure (Mlelwa *et al.,* 2015). It was estimated that in January 2020, there were 44.13 million Tanzanians with mobile phone subscriptions; this figure was up 709 thousand (+1.6 percent) from January 2019, when there were 44.13 million Tanzanians with mobile phone subscriptions; and the total population of Tanzania was 75 percent of the total population at the time (Lyimo, 2021). The community has the advantage of being able to perform online services anywhere in the world as a result of the ease with which they can access the internet. According to the reports, there were 14.72 million people using the internet in Tanzania in January of 2020. The number of people using the internet in Tanzania increased by 428 thousand (+3.0 percent) from 2019 to 2020, and internet penetration reached 25 percent in January of 2020 (Khamis *et al.,* 2021). This figure was up 709 thousand (+1.6 percent) from January 2019, when there were estimated to be 44.13 million Tanzanians with mobile phone subscriptions, and the total population of Tanzania was 75% of the total population at the time. In January 2020, this figure was up from 44.13 million (+1.6 percent) in January 2019. (Tanzania Communications Regulatory Authority [TCRA], 2020). Mobile devices may contribute to cost reductions if they improve the delivery of medical care and better connect patients to the medical services they require (Santos, 2013).
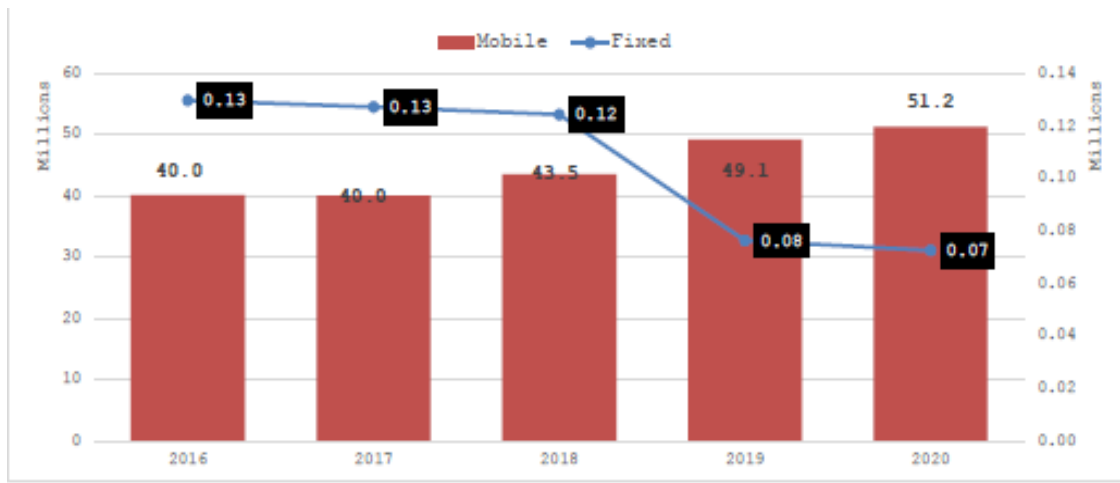
Figure 1: The country of Tanzania's penetration of both mobile and fixed lines of communication (TCRA, 2020)
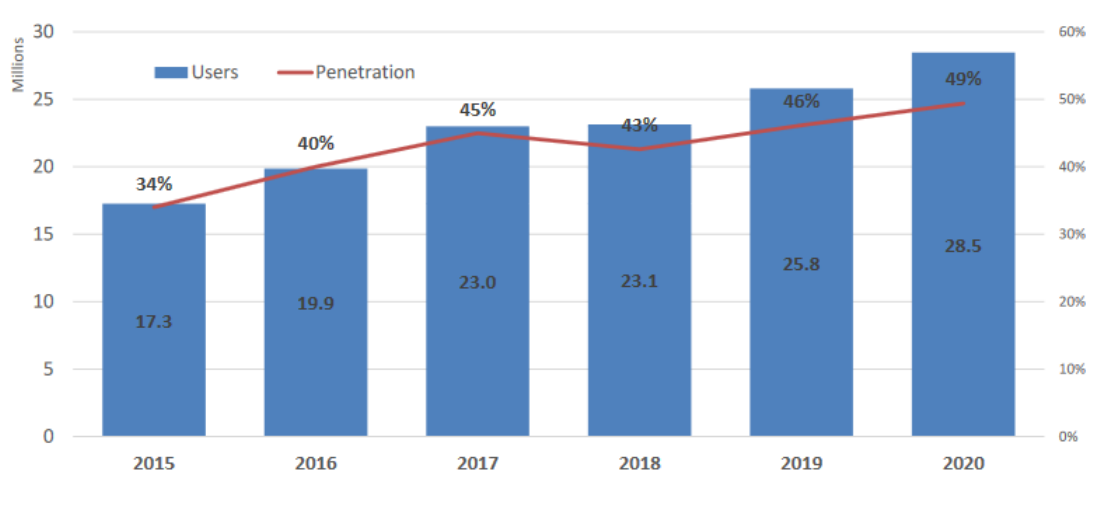
Figure 2: Users of the internet and estimates of internet penetration by December 2020 (TCRA, 2020)

2.3 Existing human wildlife mitigation techniques

2.3.1 Camera Traps in Tanzania

The use of camera trap is most popular non-invasive survey and monitoring tool in Tanzania and Africa in general. It is used by most researchers and citizen scientist to analyses the movement of wildlife sometimes to study the behaviors (Koustubh *et al.,* 2020).

2.3.2   Mitigating Human Wildlife Conflicts

The strategies to mitigate wildlife human conflict are many and some strategies include the use of wire fence to prevent animals from entering human settlement is a most popular method use in homestead especially on small body wild animals which are not able to break such fences.

Electric fence is a popular method used in major parks to prevent wildlife getting out of the park and also community members and their livestock from entering the park. Due to the cost of the power, different methods to minimize cost has been adopted including use of the collaring data to activate the power whenever the collared wildlife moves near the fence.

The other cheap option in erecting barrier is using beehive to chase away wildlife such as elephants which fears bee this system determination to be beneficial to local community since it provides alternative source of income though honey harvest. These method of controlling wildlife is laborious and cumbersome since it needs first installation and repairs of the beehive once it is operational (Aggarwal *et al.,* 2006). The study of the effectiveness of these fences has been done using camera traps and collar data to determine the behaviors of wildlife around these fences it proved to be effective especially on elephants (Branco *et al.,* 2020).

The other solution is using ultrasonic repellent to repel wildlife after detecting them (Giordano *et al.,* 2018). Different methods should be adopted since prior studies on elephants prove to habituate easily to harmless methods O'Connell-Rodwell *et al.* (2000). Continuous monitoring of wildlife has always be expensive to install and operate due to its networking requirements and its initial cost of the equipment especially remote areas with poor network coverage and low population density (Giefer & An, 2020). Therefore, we are developing low-cost camera trap to notify exact wildlife in the vicinity.

2.3.3   Studying Behaviors of the Wildlife

Behaviors of wildlife such migration of wild beast and birds requires different strategies depending on the circumstances. The researcher Znidersic use camera trap to study and monitor Lewin's Rail bird in their natural habit (Znidersic, 2017). The behavior of animals can be studied using acoustic sound recorded.

2.3.4   Mitigating Poaching and Killing of Wildlife

Camera traps has been in used to study population of wildlife such as leopard in Botswana that their population is dwindling and they should not be killed because they are causing human wildlife

conflict but they should monitor them in real-time to control them in case, they go near human settlement and prevent damages. The people should be included in making survey of wild animals to allow them make informed decision (Kaswamila, 2009). Human-wildlife conflict has always cause loss of property or life especially wildlife such as lion and elephants, the real-time detection system for intrusion to human settlement to provide alert and information (Premarathna *et al.,* 2020).

2.4   Human wildlife conflicts Management

The information received from the camera trap through images or video is observed and required action is taken. The machine learning is used to estimate population of the animal in the park. The machine learning is used to study behavior of wildlife such as in the case of studying Lewin's Rail bird by Znidersic (2017). The machine learning algorithms are capable of determining the survival rate of certain species by studying their prey predictor behaviors.

Advances in microcontroller technologies and improvement of machine learning technologies to run in smaller processors such as microcontroller has allowed to estimate population of the animals. Object detection on the microcontroller has been used as a visual based guidance to visual impaired people since it has a good accuracy in detecting objects and road (Tepelea *et al.,* 2019). Data for training will determine accuracy of the model for example. The performance of the system largely depends on the camera to be used and processing power of the microcontroller which determine speed of processing (Ghosh *et al.,* 2020). This development has enabled faster processing due to elimination of time lost during transition of data also it removes the need for computer or server to do object detection. In the interactions between peoples and wild animals, we take the different way of the taking measure how to reduce those conflicts due over population in small area. The study made by researcher Thaba Sarki, a farmer by Profession from Rapti Sonori village introduce an electric fences which it used a solar power as source of power, which it installed in their areas in order to avoiding entering of elephant and introduce an SMS based early warning system which is an effective way to avoid conflicts with elephant and other animals (Sugumar & Jayaparvathy, 2013). This mechanism seemed to work with some time but in many areas, it failed due to the absence of timely maintenance and real time consideration.

Evans and Adams (2018) reported conceptual design of the Elephant proof rail Fence (EPRF) which it help to avoid the movement of elephants into people territory and they constructed along the boundary of the forest to keep watch and guard the village against incoming wildlife in their

area This mechanism would work good due to lack of getting information to the people in the village if the wild animals are crossing the fence.

Ghana Carnivore Project by Bempah *et al.* (2019), focused critically to assess the distribution, abundance and viability of lions and other carnivores in and around Mole National Park and other key areas of Ghana, West Africa. They interviewed the people near the Mole National Park and develop the camera traps which shows the location of the wild animals in order to help people inside the park. This mechanism does not have a real time report because didn't use mobile based platform to report the information.

 Some of the related works on HWC's management of platforms are listed above. Some people are only concerned with implementing android platforms, others are only interested in applying machine learning, still others are willing to take the risk of utilizing electric fences, and still others have used IoT components like microcontrollers in order to monitor wild animals. As a result, this project proposed a mobile platform (Human wildlife conflict management mobile based) that is comprised of mobile-based applications that will link people living in the conservation area with the administrators of the conservation or parks in Tanzania.

CHAPTER THREE

MATERIALS AND METHODS

3.1   Study Area

The regions of Tanzania's Mara and Arusha National Conservation Areas (NCA and SNP) served as the study's locations. The amount of time available for the survey was limited, so the regions were selected for their convenience of access to areas that contain both wild animals and people, such as the NCA in the Arusha Region.

One of Tanzania's thirty-one administrative regions is called Mara. Musoma is the name of both the municipality and the capital of the region. The total landmass of Mara is equal to 21760 square kilometers. According to the statistics provided by the Tanzania Bureau of Statistics, the population of Mara is approximately 1.744 million (National Bureau of Statistics [NBS], 2017). Agricultural, economic, and industrial activities are also included in this definition. SNP is the location where all of the research was carried out. The SNP is located in northern Tanzania, and it became a national park in 1952. It covers a total area of 14763 square kilometers.

There are approximately 1.6 million people living in Arusha, which is the capital of Tanzania's northernmost region (NBS, 2017). Tanzania's Arusha region covers 34 526 square kilometers. Numerous well-known national parks and game reserves can be found in and around the city of Arusha, including the National Conservation Area, Arusha National Park, and Lake Manyara. The research center in NCA, which was founded in 1959, is located in NCA. The municipality encompasses a total area of 14,036 square kilometers, of which 13,460 square kilometers are land and 576 square kilometers are water; however, the conservation area only encompassed 8292 square kilometers.

3.2   Participants

A total selected 15 villages and 10 schools were interviewed where by about 10 villages at NCA and 5 village in SNP. In school were interviewed 8 schools in NCA and 2 schools in SNP. One village were interviewed for a total of about 5 hours and one school was interviewed for a total of about 3 hours. In village there were (17.4%) children (50.8%) young people and adult (31.8%) participants and in school there were student (70%) and teachers (30%). The education level of participants was (51.3%) primary level, (30.4%) secondary level, (10.2%) diploma level, (5.6%) bachelor degree and (2.5%) master's degree. Multi-stage sampling method was utilized throughout

the course of the study. Sampling method is one in which a wide sample is gradually narrowed down to a more specific one. This process is done in stages. The multi-stage sampling method is used to select samples that are concentrated in a small number of geographical areas. This approach to taking samples was selected because it helps us save both time and money (Ghaljaie *et al.,* 2017).

3.3 Methods of Data Collection

For this study, data was gathered over the span of two months, June and July 2021. We gathered information using a variety of techniques, including the ones mentioned below, as well as interviews, surveys, and observations. Quantitative and qualitative data collection methods were utilized in this study.

3.3.1 Questionnaires

Students and teachers in the schools were each given a questionnaire that consisted of ten questions to fill out on their own time and administer. We used open-ended questions as well as closed-ended questions with multiple choice options. The following topics were covered in the survey questions: awareness of the existence of apps for wildlife-people conflict management; reporting information through mobile application; the current process for reporting information; the internet availability when reporting via app versus other process; internet and time, challenges when using the application; the integrity of receiving data from camera traps; and whether or not they would like to have a mobile app for wildlife-people conflict management. The primary goal was to determine the users' and administration's level of knowledge and awareness regarding the availability of wildlife-people conflict management apps (applications), as well as other system requirements and the factors that would motivate them to use the mobile application.

3.3.2 Interviews

Structured interviews were done with randomly chosen villages and schools in order to get a better understanding of the questions asked in the questionnaire. In Appendix 1, you can find interview questions that have been used in the past.

3.3.3 Observations

After conducting the interviews, observation was carried out. The users who were given the warning alert and who reported the information to the rangers were the primary focus of this investigation. Instead of collecting data on what the participants say they do, the goal was to collect data on what they actually do. Users of the mobile app are able to send information to the administrator through live chatting in SMS and WhatsApp. Additionally, the administrator is able to determine whether or not any users who have mentioned using a mobile application are able to access that system. As an example, the camera traps send video over the internet to the cloud and then upload it to the mobile app. Users of the mobile app receive video of wild animals that pass around their village.

3.4 Data Analysis Methods

The descriptive analysis was used to analyze both the quantitative and the multiple-choice results. The results were represented in a straightforward and easy-to-understand graphical format with the help of pie charts. The tool Microsoft Excel was utilized in the execution of this strategy. The thematic analysis method, which Braun and Clarke came up with, was used to look at the free-data responses. This made it possible to find patterns (themes) in the data, analyze them, and report on them. The method of analysis known as thematic analysis was selected because of its widespread use and adaptability (Kiger & Varpio, 2020). In this method, the programming language R was utilized. The free responses were coded using a methodology known as thematic coding, and the research findings were described using a text network diagram. One person was in charge of coding the data, and that person then shared the themes with people who had similar experiences but were not interviewed. This was done to make sure that the findings were accurate.

3.5 Requirement Analysis

The purpose of requirement analysis is to make projections about the needs of end users in order to satisfy their anticipations regarding a new system (Kramer & Studies, 2018). Functional and non-functional requirements have been gathered in preparation for the implementation of the system that has been proposed.

3.5.1 Functional Requirements

The functional requirements are used to describe the developed system's performance tasks, operations, and service behaviors (Tao *et al.,* 2019). The proposed system functional requirements are broken down by the Graphical User Interface (GUI), the ability to log in and out with user authentication, the ability to search for health facilities and information about them based on keywords and distance, and the ability to get information from camera traps and send out visual reports. Table 1 lists the requirements for how the proposed system should work.

Table 1:   Functional requirements

No	Requirements	Descriptions
1	Using Firebase technology, an application can check the phone number of a user.	The user needs to be authenticated before the system will let them use the application.
2	Submit image and video data, comprising of facility's g, telephone number, user name and its email	Users, Database (DB) and HWC App should submit to and from, all essential data automatically.
3	Search receiving data facilities and its related information per village location.	Users should be able to look for information based on the village where the wild animals show up.
4	Generate new reports, feedback and complains.	New reports, feedback, and complaints from users should be generated by the system and sent to the administrator.

3.5.2   Non-Functional Requirements

In contrast to functional requirements, non-functional requirements do not address the system's core functions or the program's intended outcomes. Instead, they concentrate on the quality of the system and how it should work to meet the needs of the user (Chazette *et al.,* 2019). Table 3 shows the requirements for the proposed system that have nothing to do with how it works.

Table 2: Non-functional requirements

No	Requirements	Description
1	Security	Authenticated users should be able to access the system.
2	Performance	The system will be able to support multiple stations at the same time and handle a large number of users without fail.
3	Usability	The suggested system's usability will satisfy users, and they will be able to do a variety of jobs.
4	Efficiency	The system's tasks should be completed quickly and without wasting resources.
5	Accessibility	The system should work both when you're online and when you're not.
6	Maintainability	The application should be able to be maintained by a system administrator.
7	Interoperability	The system should support software updates and upgrades as required.
8	Recovery	The system should be resilient against damage.
9	Flexibility	The system should have the capability of adding new information as well as information related to wildlife.

3.6   Conceptual Design and Use case Diagram

3.6.1   Conceptual Design

Following the evaluation and analysis of the proposed system's functional and non-functional requirements, the conceptual design was subsequently developed. Four modules will comprise the proposed Android-based mobile application: user registration, camera trap facilities, human-wildlife information dissemination, and monitoring and evaluation.

By receiving images and videos from camera traps, users will be able to experience the features on their mobile devices via the camera trap facility module. The app will receive the data via the internet. Once users gain access to the facility dashboard, they are prompted to make a phone call, engage in live chat via Short Message Service (SMS), or engage in live chat via WhatsApp.

Users will be able to view shared information from camera traps and alert the villagers that wild animals are near their village and report to the conservation authority through the warning alerts dashboard of the proposed system.

The M&E module gives the system administrator the ability to manage application users (modify, update, or delete). Furthermore, the system administrator is in charge of entering huma-wildlife

facility details such as user name, village name, geo-coordinates, phone number, and email address. Admin will also have a routine check on the number of active users who continue to use the application, as well as live streaming of events that occur within the application.
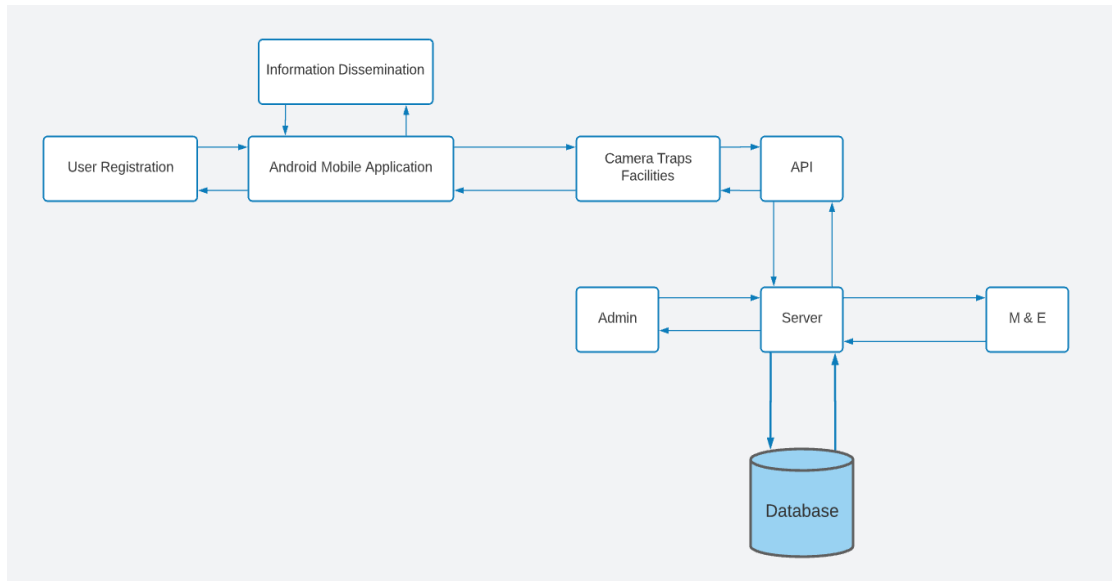
Figure 3:   **Conceptual diagram**

3.6.2   Use Case Diagram

Use case diagrams are utilized to describe system users (system actors) and their interrelationships with the system, as well as their connections. In addition, it displays user actions (processes) performed within the system (Perboli *et al.,* 2018). This study proposed a use case diagram in order to demonstrate how users interact based on the functions they perform within the proposed system. The villagers and administrator are the system's actors. The use case diagram for the proposed system is depicted in Figure 7.
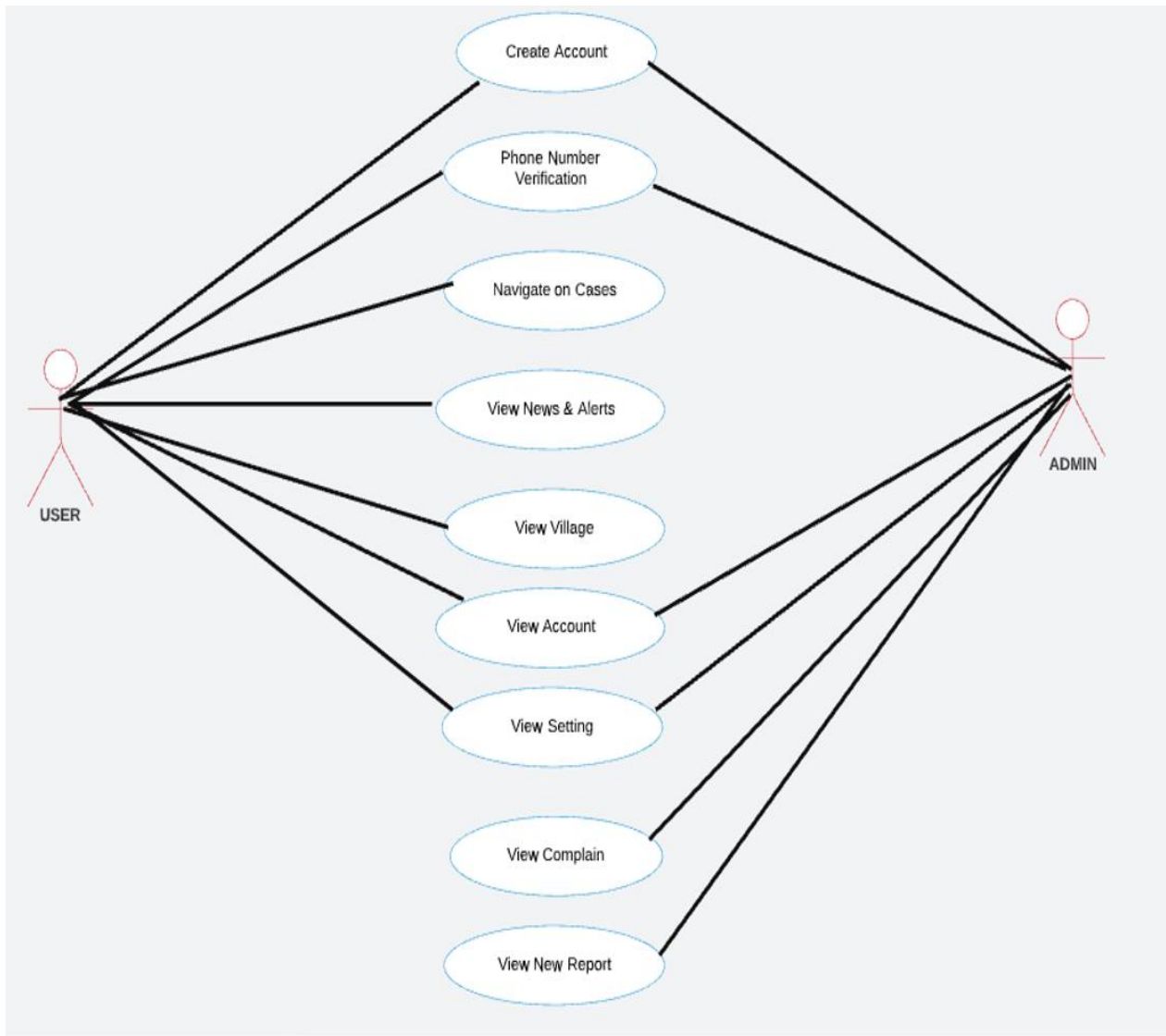
Figure 4:   **Use case diagram**

3.6.3   Flow chart Diagram

Figure 5 introduces the flowchart diagram that the present study used during development of mobile application. Therefore this was used as a roadmap to the development process.
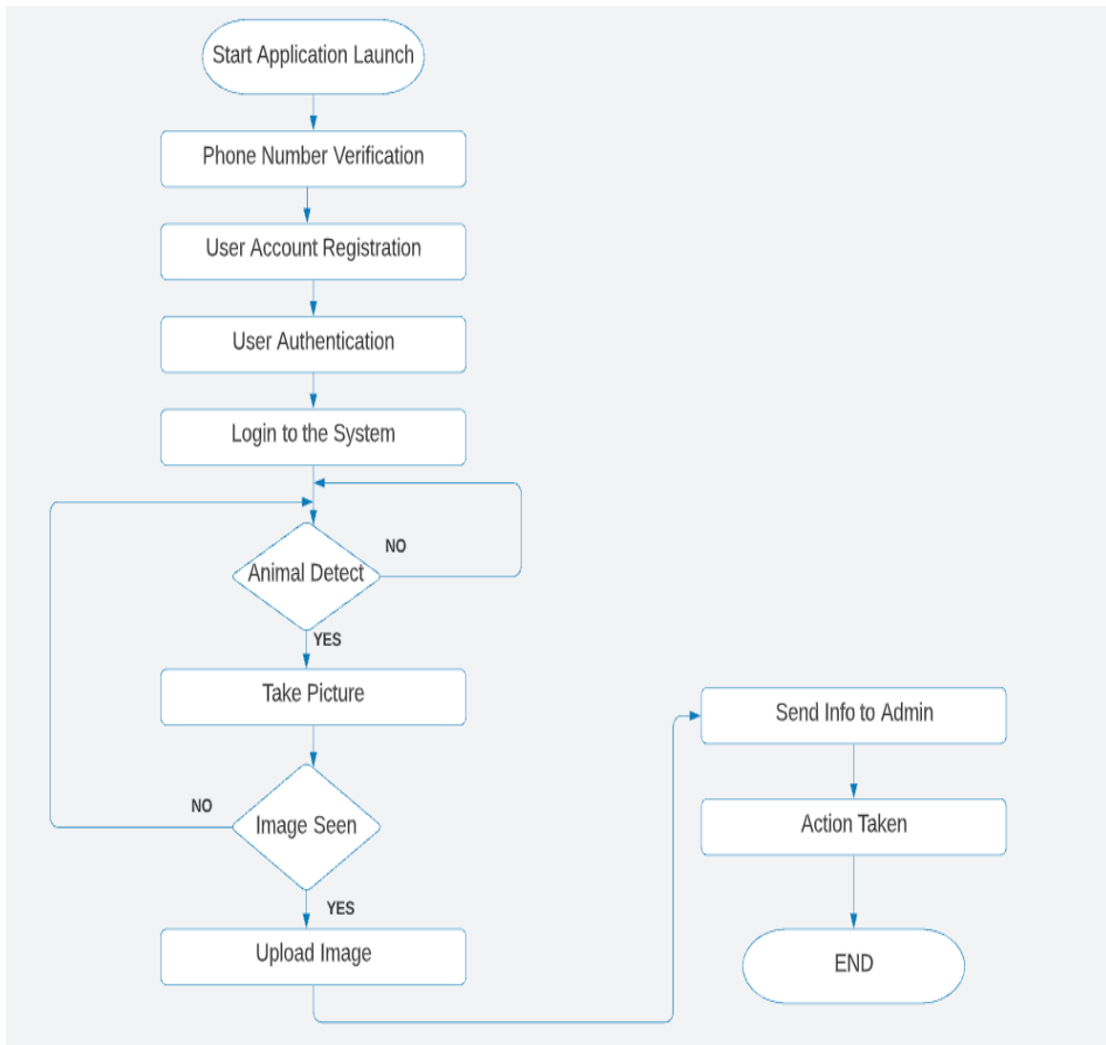
Figure 5:   Flowchart diagram of the proposed system

3.7   Mobile Application Development

The mobile app was developed using React-native, a popular Java Script-based mobile app framework that enables the creation of natively rendered applications. It simultaneously develops iOS and Android mobile applications from a single code base. This allows you to write code for a single application and distribute it across multiple mobile platforms. The benefit of using react-native is that it runs in every single native application, handles the display of user interface elements and user gestures, and provides high performance, particularly when working with rapidly changing data. The codes for mobile application development using react-native are presented in Appendix 4. Additionally, MySQL was used to create the database.

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3.7.1 Development Methodology

A "methodology" is a set of tasks that must be completed in order to convert user requirements into a software platform. In this project Incremental Model was used, which entails implementing and testing the product under development in increments. Because it can produce working software quickly and efficiently throughout the software life cycle, testing and debugging are easier, customers can adapt to each build, and initial delivery costs are lower..

(i)   This strategy is the most suitable for the undertaking because it accounts for the potential modifications to the system that may be required in the future (Hale *et al.,* 2017).

(ii)   Because potentially dangerous elements are identified and addressed during the iterative process, risk can be more easily managed.   (Stirman *et al.,* 2019).

The following processes are included in incremental models: requirement analysis, design and development, testing and verification, implementation, and ongoing maintenance. Figure 3 presents an incremental SDLC.
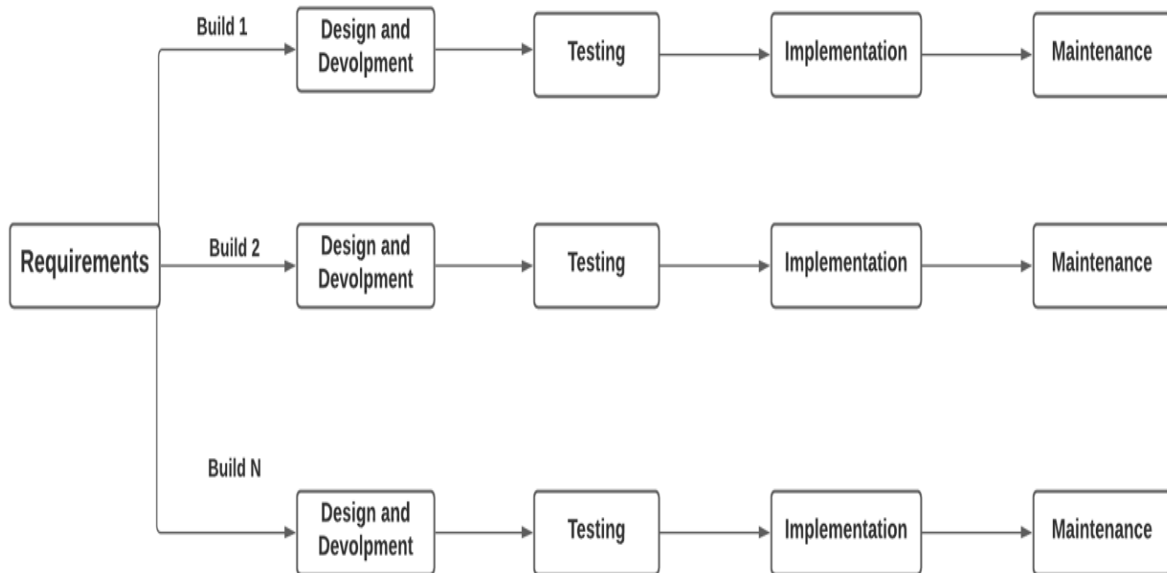
Figure 6:   Incremental system development life cycle

3.7.2   Tools and Technologies Used

The descriptions that follow will walk you through the various technologies that were applied to this project. The following software was utilized in the development of the mobile application:

(i)   Camera Traps

Camera trap is a device which capture the image and video of the wild animals and sending to the mobile app through the internet. The modern camera trap is the digital camera trap connected to an infrared sensor.

Figure 7: **Digital camera traps**

(ii) **Java Script**

JavaScript is a text-based programming language that enables the creation of client- and server-side interactive mobile applications. After HTML and CSS have been developed, JavaScript adds interactive elements to mobile.

(iii) **React- Native**

React-native is a well-known mobile app framework built on JavaScript that lets you make apps that look and work like they were made for your phone. The react-native is a framework for making

hybrid mobile apps that work on different platforms. It lets you build mobile apps for both iOS and Android at the same time using a single code base (Qadir & Cooper, 2020). This lets you write code for a single app and get a mobile app that works on many different mobile platforms. The benefit of using react-native is that it works in every single native app, handles how user interface elements and user gestures are displayed, and gives high performance, especially when working with data that changes quickly. The core of React Native is in charge of how the two threads talk to each other. It acts as a middleman between two different streams of requests and data. This method lets them talk to each other at different times, which makes sure they work well and keeps them from blocking each other's flows (Shevtsiv, 2019).

(iv)   Structured Query Language (MySQL)

MySQL is a free and open-source Relational Database Management System (RDBMS) for creating and managing databases. MySQL is used in this project because it is fast, has been demonstrated to be reliable, is simple to use, and can be used in a variety of ways.

3.7.3   Assumptions and Dependencies About How to Use a Mobile App

(i)   Users and administrator own smartphones.

(ii)   Users and administrators are able to use mobile applications.

(iii)   A strong internet connection, so that mobile apps can connect to the database and users can use it whenever they want.

3.8   System Testing and Validation

Demonstrating through empirical evidence that all software specifications have been adhered to in the correct and complete manner. Validating software also requires demonstrating that they can be linked to specific system requirements (Ambreen *et al.,* 2018). For system acceptance, validation was done by 16 different people. These were the steps for checking: Unit testing checks to see if the smallest part of a system meets the requirements set out in its API and documentation (Mens *et al.,* 2019). For system acceptance, validation was done by 16 different people. These were the steps for checking: Unit testing checks to see if the smallest part of a system meets the requirements set out in its API and documentation

Integration testing is conceptually equivalent to unit testing. When two previously tested components are combined into a single unit, the interface between them is examined Jorgensen

(2013). The purpose of integrating the mobile app was to ensure that everything was functioning properly. System testing, which is performed when all modules are in an integrated state and functioning as a single application, is performed when all modules have been integrated. System testing is performed to determine whether the system meets its functional and non-functional specifications (Jan *et al.,* 2016). The final step prior to approving a device for its intended use, user acceptance testing verifies both functional and nonfunctional requirements (Jan *et al.,* 2016). Sample Questions for System Testing Results are presented in Appendix 3.

3.9   Security

As a result of the widespread availability of smartphones on the market and the volume of sensitive data that they are able to store, cybercriminals are interested in finding ways to exploit these devices and gain access to the data they containss (Chandra *et al.,* 2014).

3.9.1   Two-factor Authentication

As a security measure, two-factor authentication (2FA) is implemented on the mobile platform. Two-factor authentication is the process by which a person requesting access must provide two connected attributes, such as something you know and either something you have or something you are, in order for an authenticating party to verify their identity (Ali *et al.,* 2020). The combination of two methods of identification increases the likelihood that a person, typically a mobile/computer user, is the legitimate owner of an identity Horvath (2019). A username and password are required when accessing the login page for this study. The user is then prompted to complete a second step of authentication by receiving a one-time password (OTP) via SMS after the server verifies these credentials. The user can create a login after adding firebase and authentication dependency to the Android application. The system should utilize firebase technology, which makes android apps faster and more efficient because it eliminates the need for PHP as a third-party language to communicate with the database and provides a secure channel for communicating with the database directly from JAVA.

The user is given access to the application once the OTP is typed correctly as depicted in Figure 8 (DeFigueiredo & Privacy, 2011).

Figure 8: **Two-Factor Authentication mechanism**

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1   Results

4.1.1   Results from Data Collection

In addition to allowing the user to access the information, the new platform system must be able to reach everyone in their villages and schools within the NCA via mobile devices, which are pervasive. The current system is incapable of reaching the end user as required; therefore, the mobile application will be the solution to the information abundance.

(i)   Knowledge Level of Mobile Applications

In addition, it was discovered that 45% of people within the conservation area own smartphones, 78% of respondents were unaware of the existence of mobile apps for wildlife-people conflict management, and 100% do not use mobile apps for resolving wildlife-human conflicts. The primary causes are the absence of smartphones, internet access, and knowledge of mobile applications. Boma leader (ID 5): "*No, I'm not certain I can use the smartphone to resolve our conflicts with wild animals in our village*."

4.1.2   Result of System Design

In this study, the design of the user interface (UI) was based on features and functionalities. The design allowing the user to login into the system. The user then navigates to the dashboard, which contains the cases (C-Traps), village and bomas, account information, and settings page. The figures below describe the various design interfaces of the application.
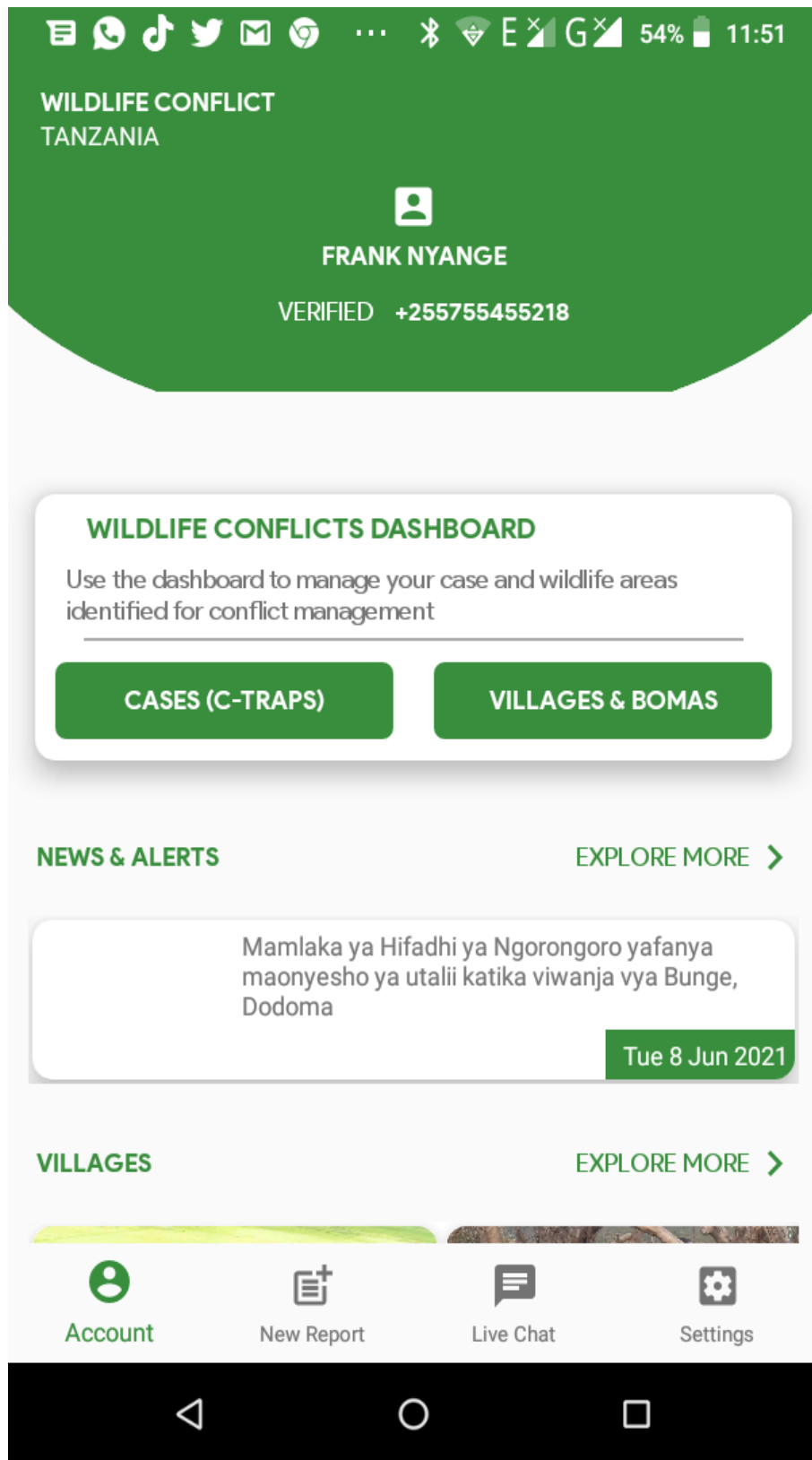
Figure 9: **Mobile application homepage**
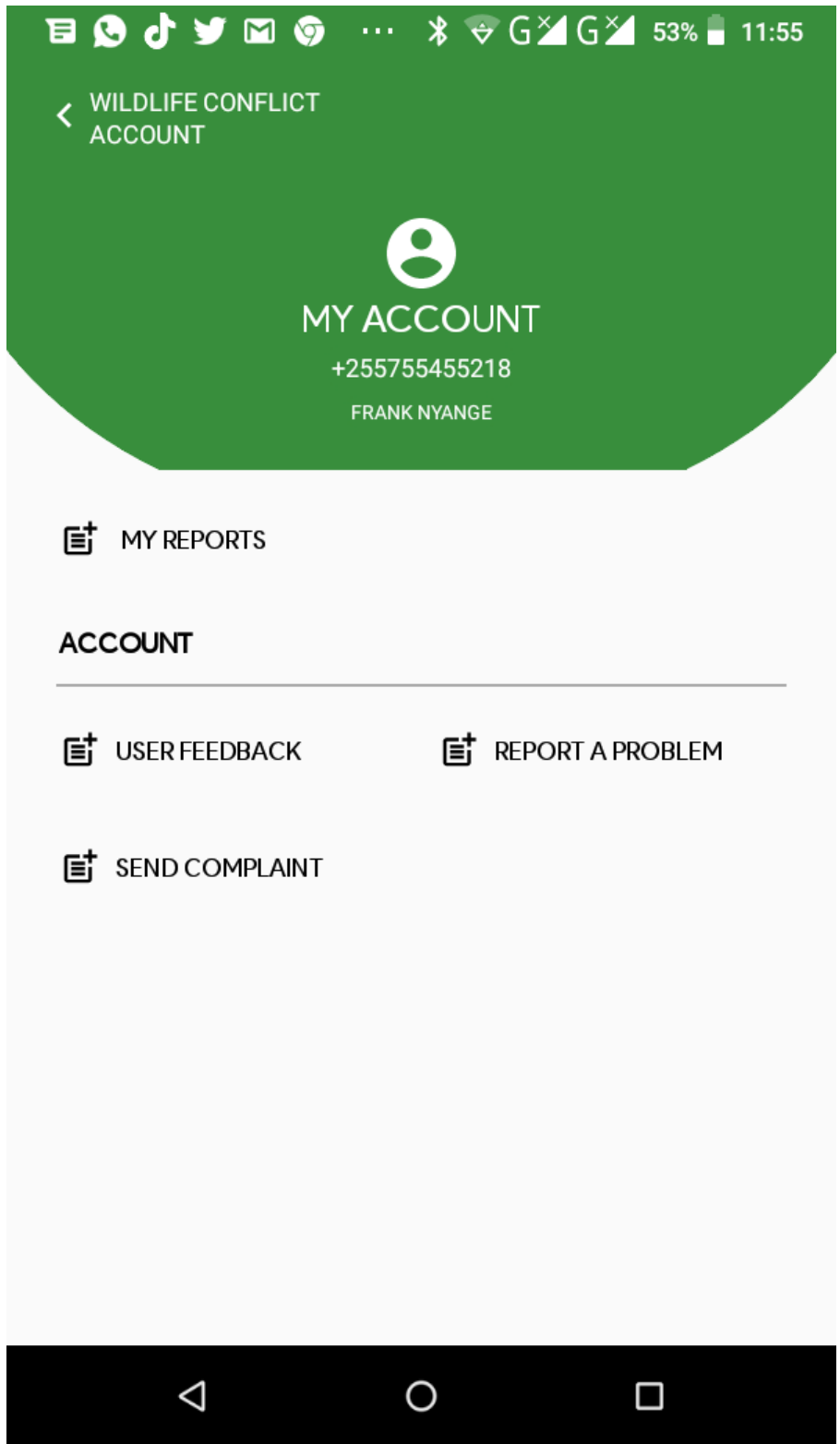
Figure 10: **Mobile application account page**
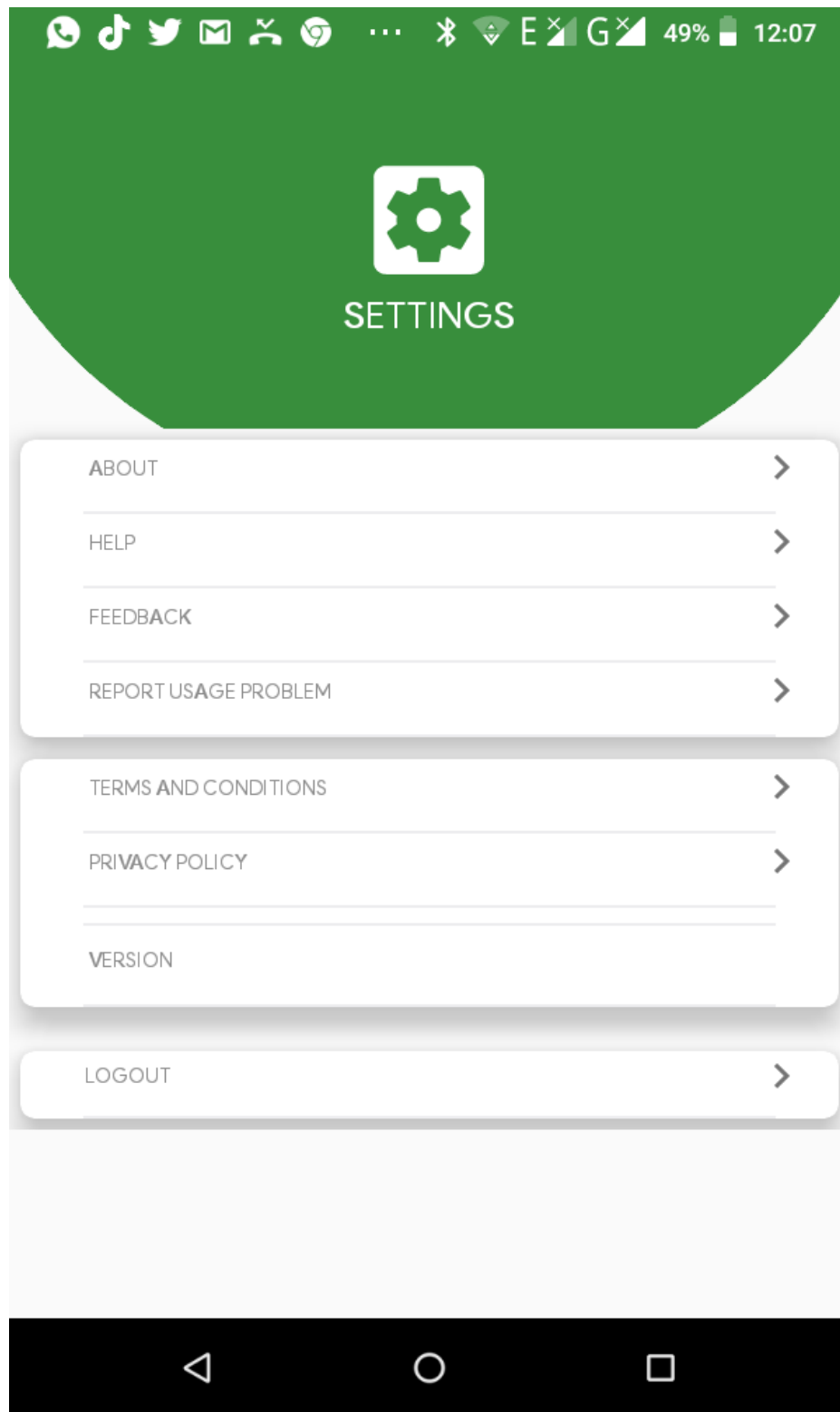
Figure 11:   Mobile application settings page

4.1.3   Result of System Design Process

The emphasis of the model variable is placed on the administration and manipulation of the database. It is constructed using a layer that acts as a buffer between the data and the client. This component supports the use of a wide variety of database formats, including MySQL, for the storage

of data. The view component is responsible for displaying the information that was obtained by the controller from the model.

View is also concerned with the generation of information and web pages. This involves the creation of a footer and a header, in addition to the uploading of data that end users can access. Finally, the control component acts as a link between the model and view components. It processes all of the logic and requests, collaborates with the Model component to manipulate data, and communicates with View components to obtain the final output. The CONTROLLER is responsible for monitoring the data that is received by the VIEW section, which includes the User interface (UI). This section receives data from external DB resources, server storage, and Google APIs.
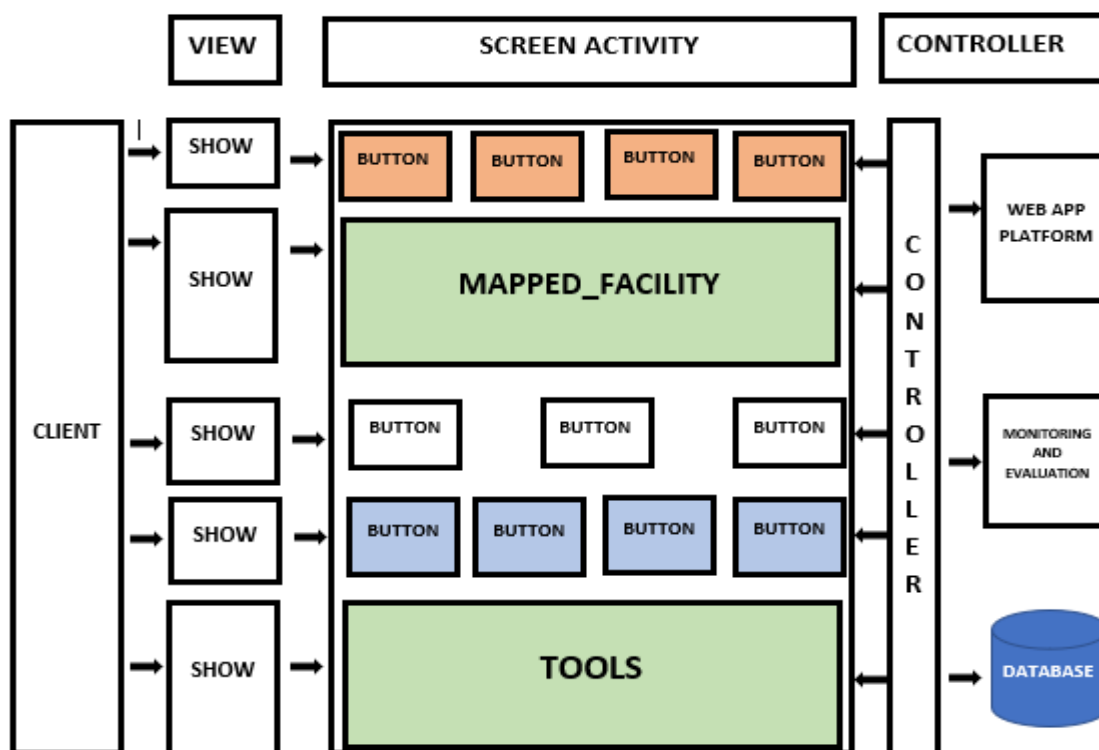
Figure 12:   Model View Controller for mobile application system

As shown in Figure 13, the MODEL section was also indicated by the conceptual framework in order to deliver a proposed plan for the development processes. In a nutshell, the conceptual framework revolves around a mobile application that provides users and the system administrator with the ability to safely register with the system and then submit data to the system database. This data includes the user's name, email address, and phone number. In addition to this, the storage server is currently functioning as the communication link between the App and the analysis tool. It is the duty of the system administrator to obtain the information from the camera traps as well as the particulars of any conflicts for the purposes of data analysis, monitoring, and evaluation.
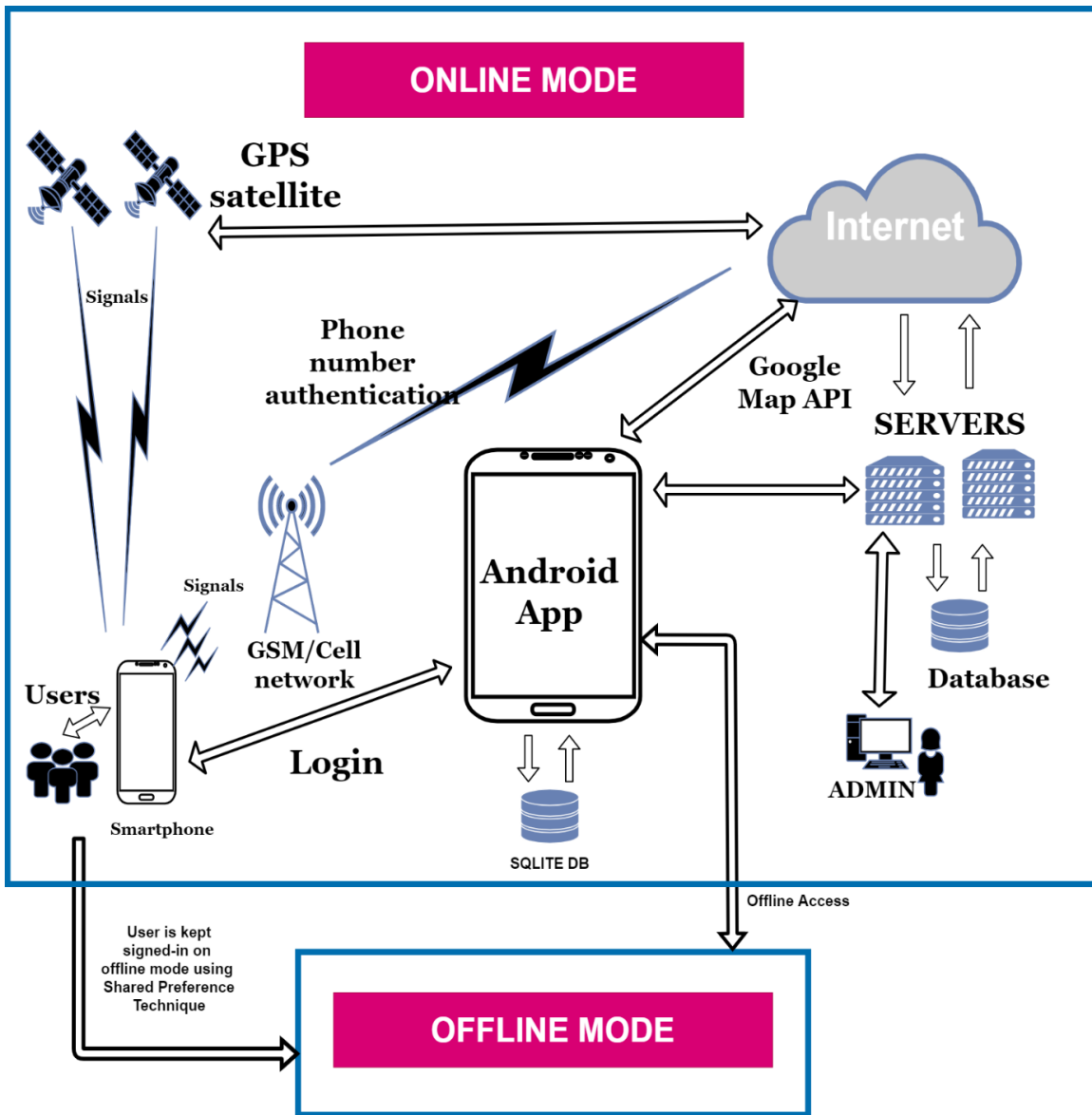
Figure 13: Conceptual Framework of the mobile application

4.1.4 Results from the Developed Human-Wildlife conflict Management Android Application

When a user visits the login page, they are required to enter both a username and a password in order to proceed. After these credentials have been validated on the server, the user will be asked to complete a second stage of authentication, which consists of receiving a one-time password (OTP) via text message (Fig. 14 and 25).
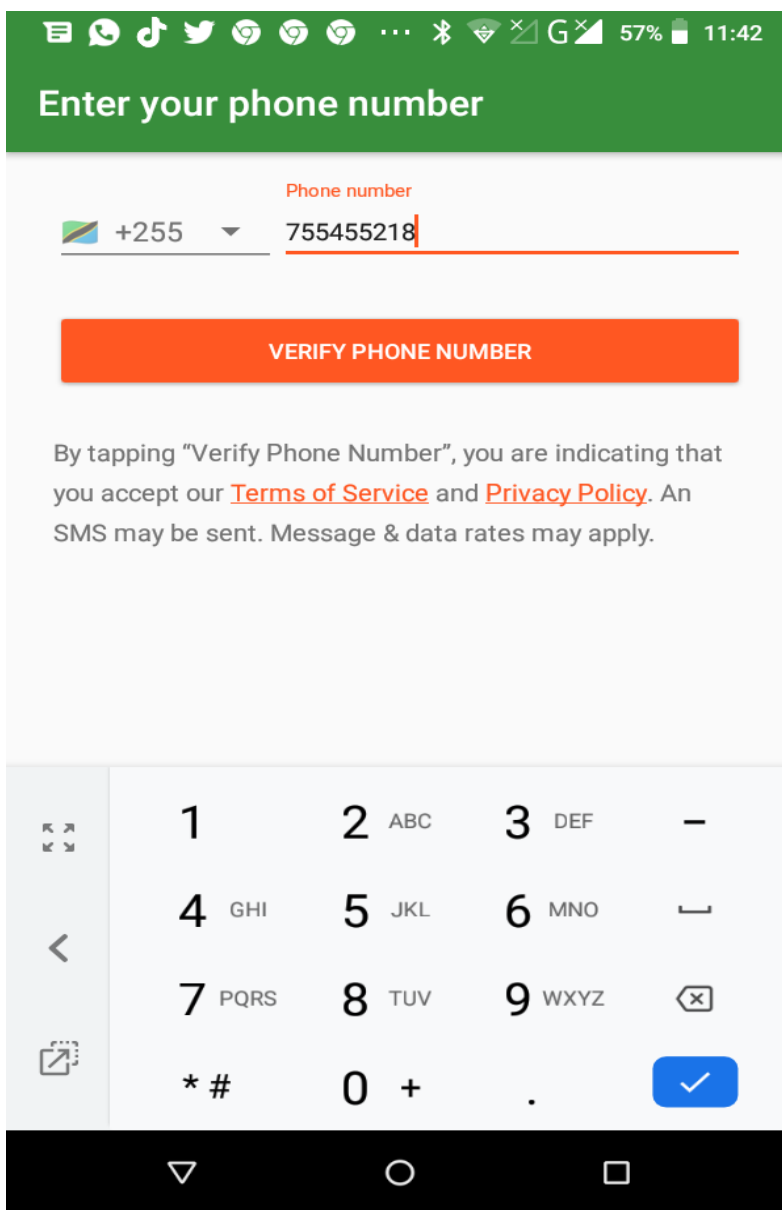
Figure 14:   **Entering phone number for verification**
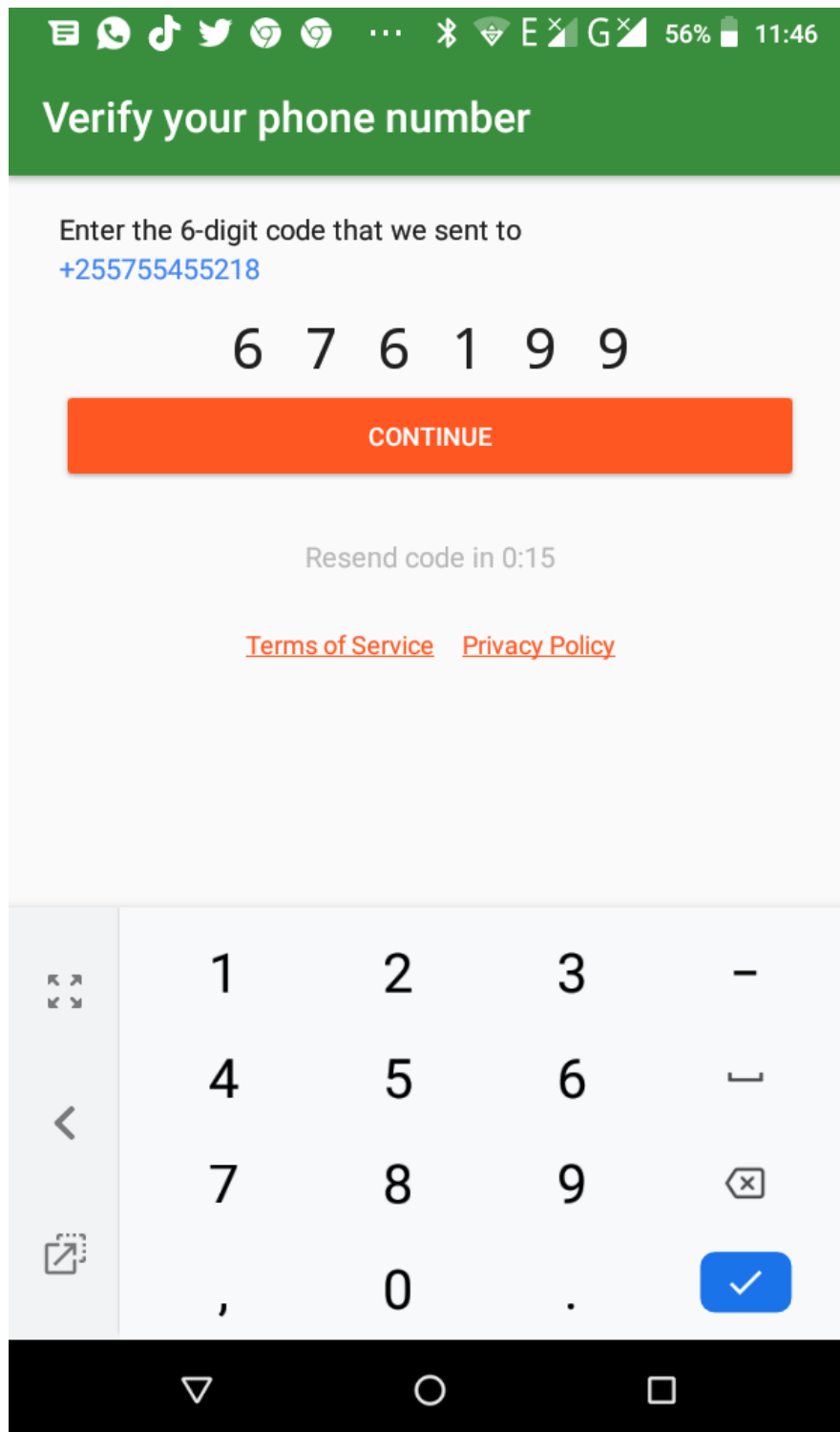
Figure 15:   Verification of phone number

After selecting the country name and country calling code, the phone number that will be used to receive the OTP is apparently required to be verified. Send it after inputting the phone number. The verification code will then be sent by SMS to the phone number you provided for verification. The phone number is validated once you enter the six-digit verification code (Fig. 16 to 23).
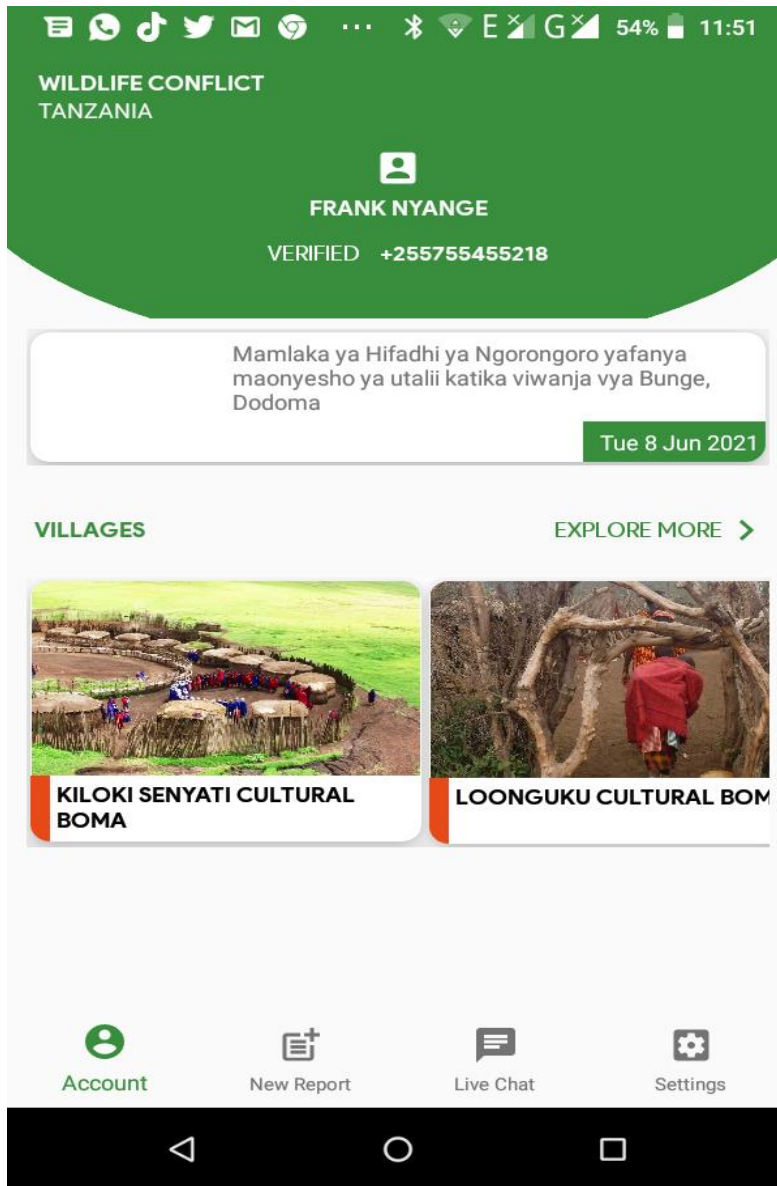
Figure 16:   **Villages in NCA**
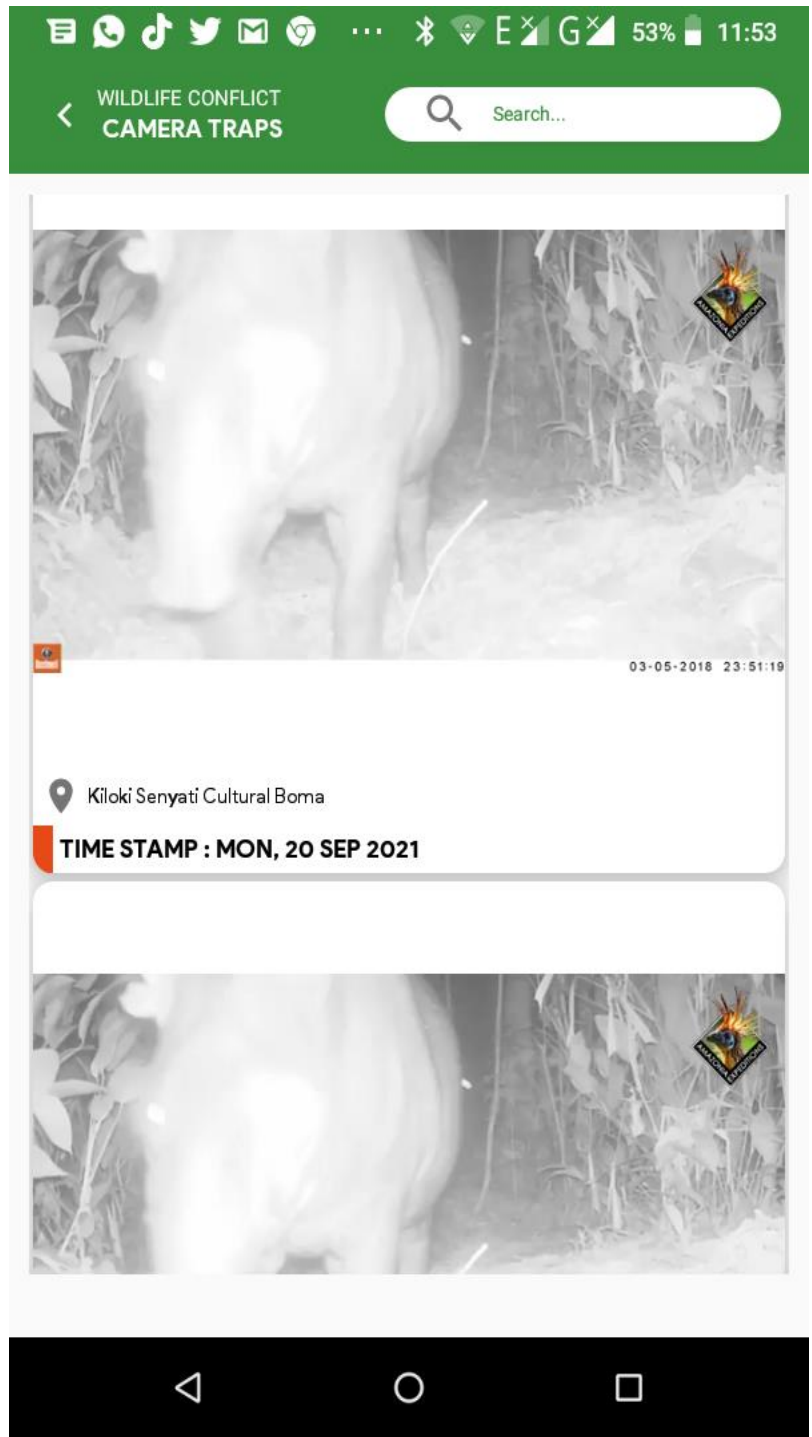
Figure 17:   **Image from Camera Trap**
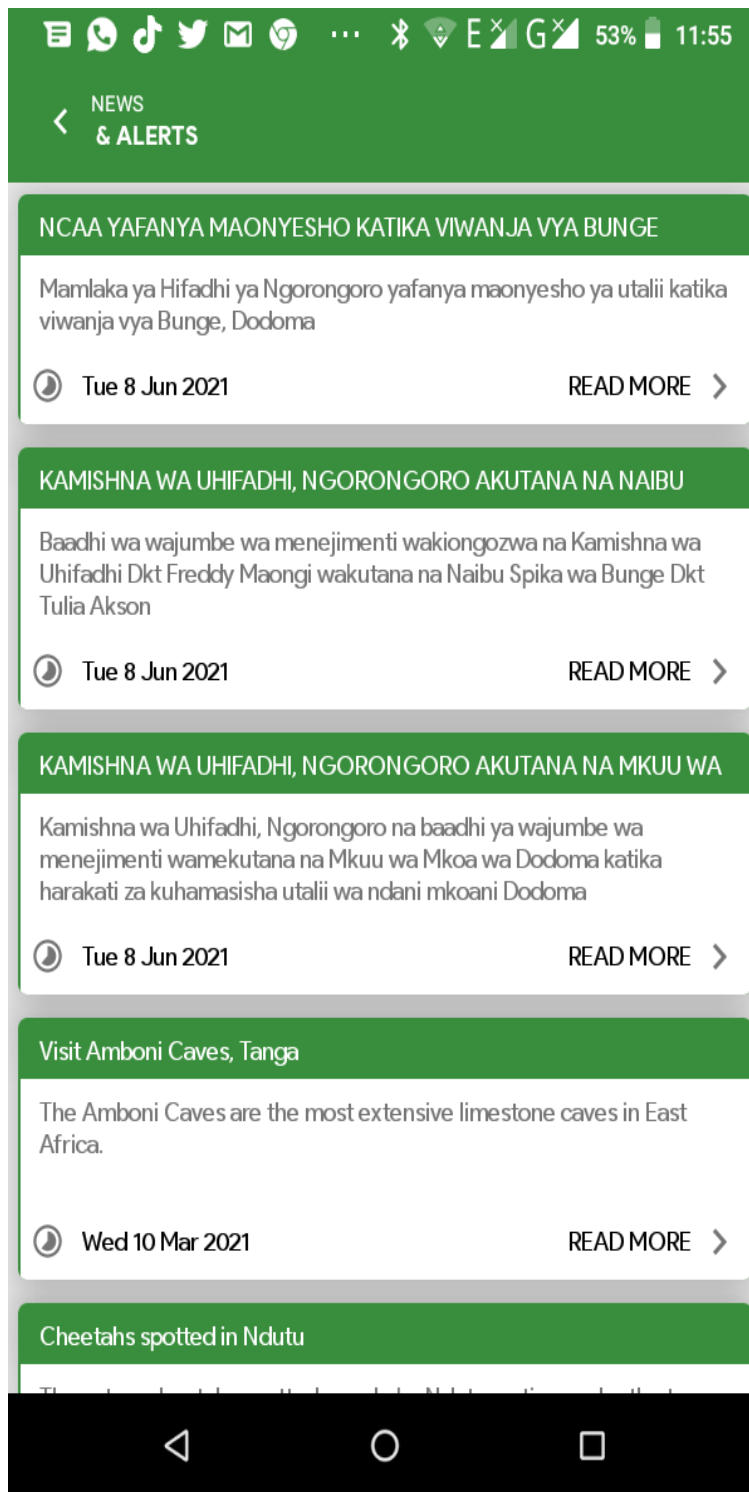
Figure 18: **News and alerts from NCA**
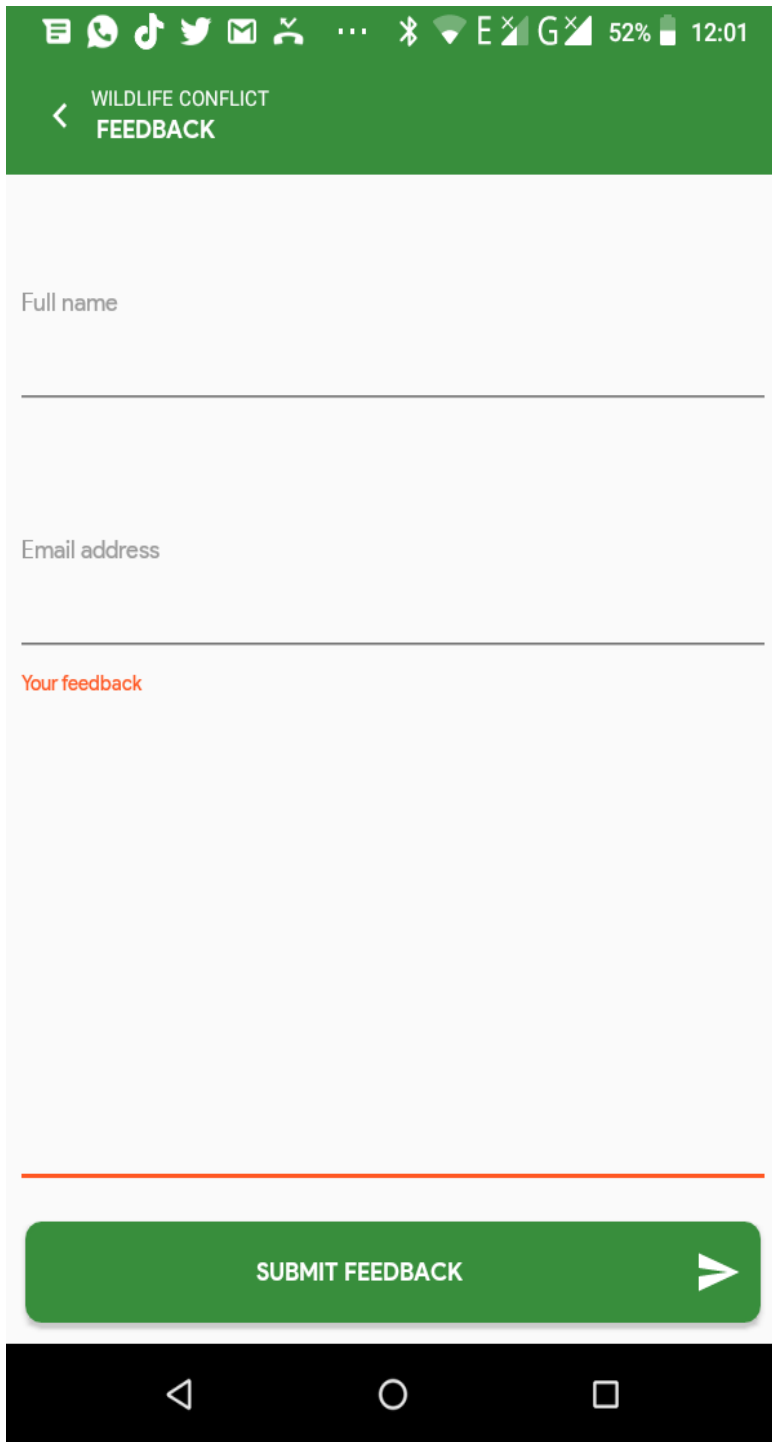
Figure 19: **Feedback page**
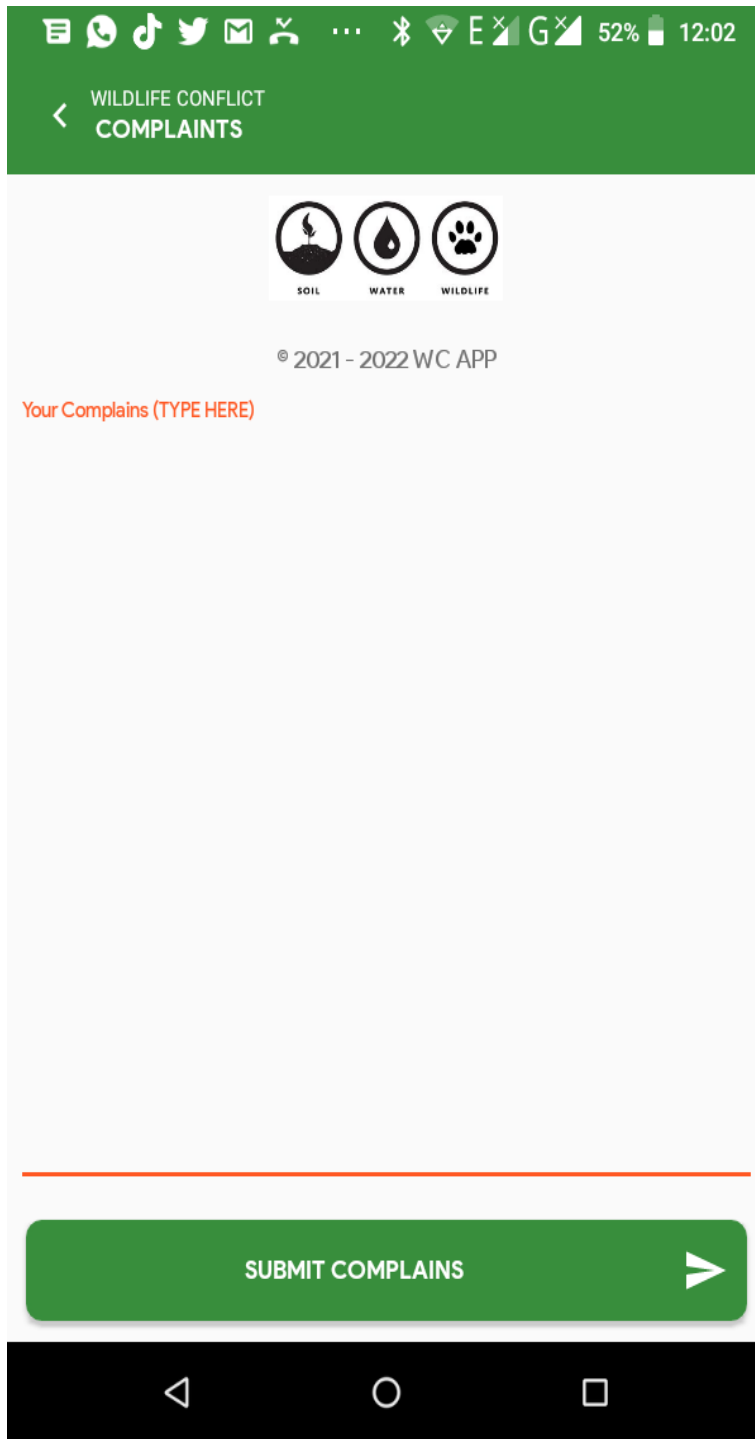
Figure 20: Complains page
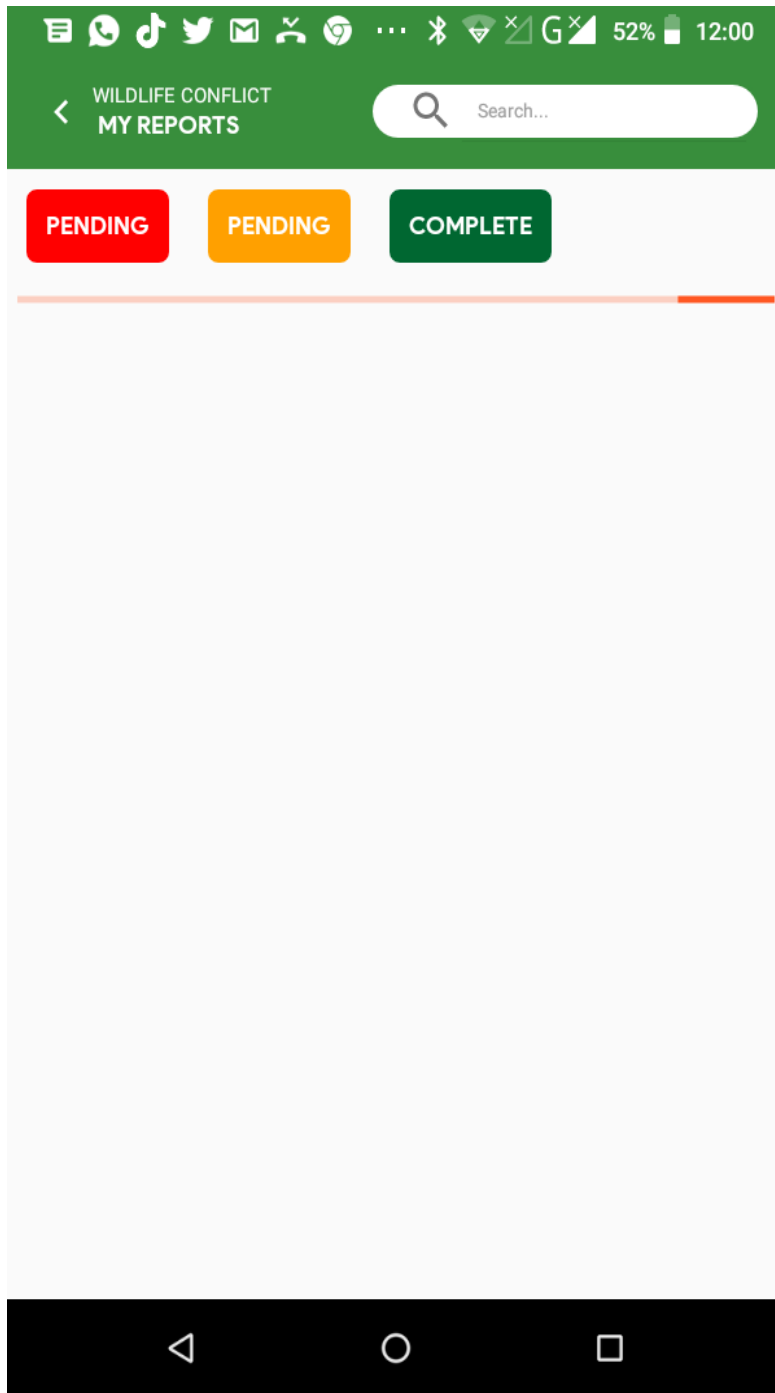
Figure 21: **Reports page**
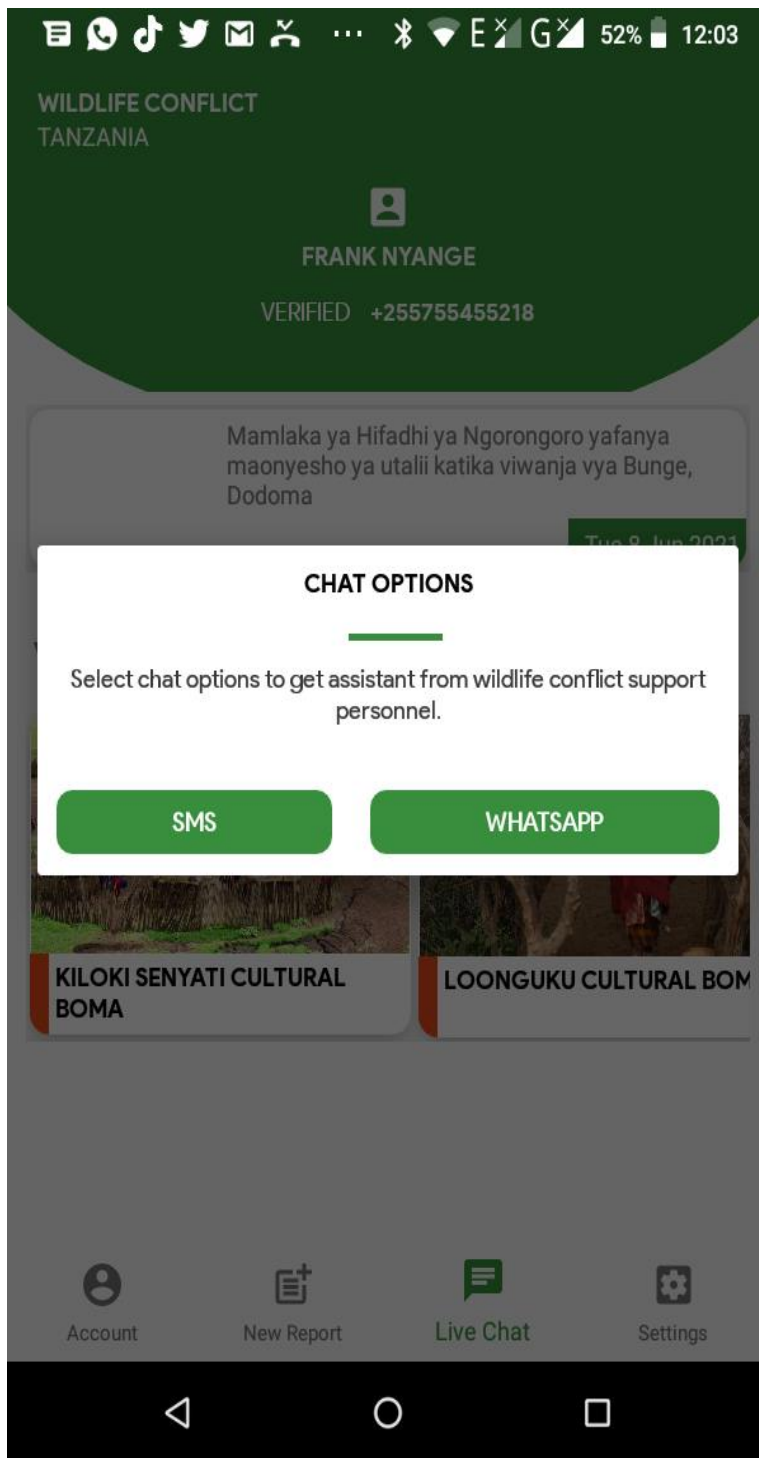
Figure 22:   **Live chat page**
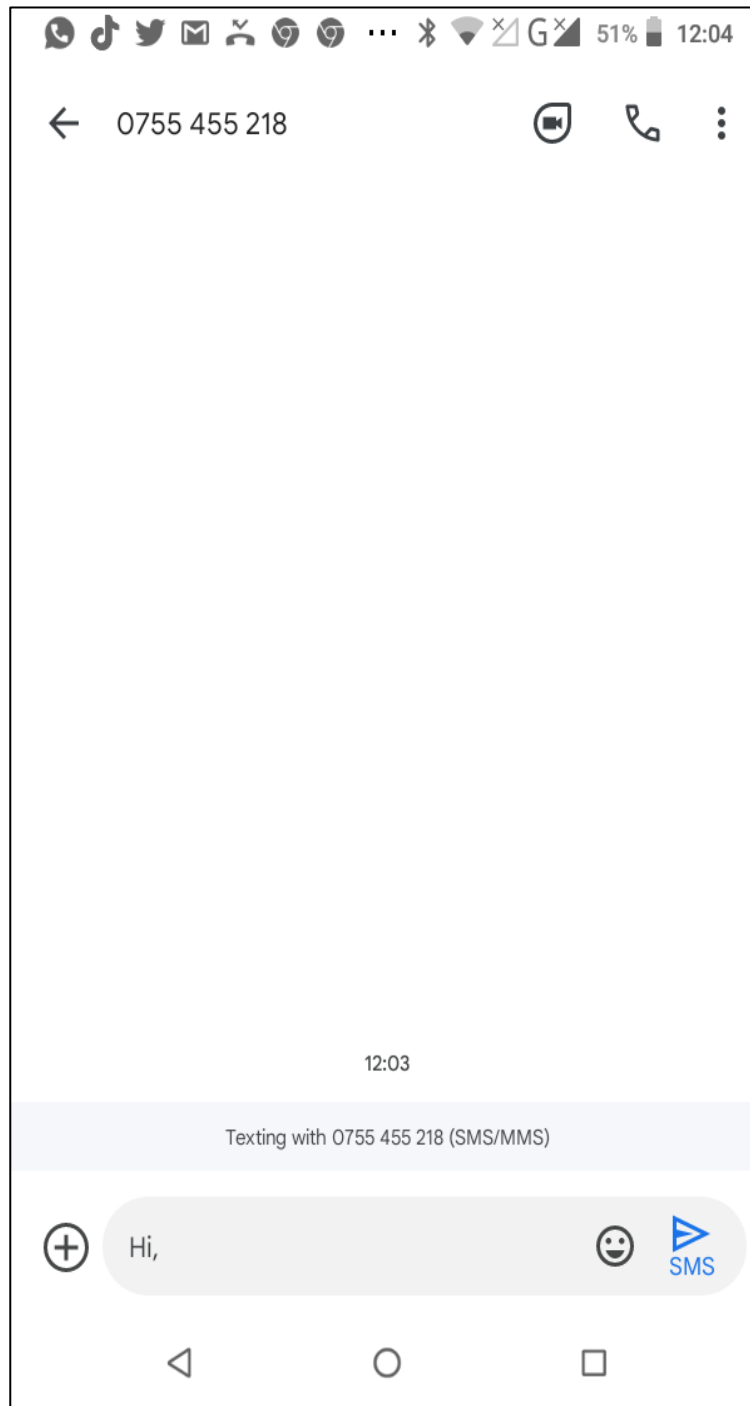
Figure 23: **Live chat through SMS**

4.1.5 Result of System Evaluation

The results that were obtained from the system evaluation check to see if the developed system actually does what the conservation area intended it to do, which is access the information and report on it simultaneously. For the purpose of system evaluation, field research was carried out using the final prototype. A conservation area and a national park were included in the study, as well as approximately ten villages in the NCA and five villages in the SNP. There were a total of 8 schools in the NCA, while there were only 2 schools in the SNP. In the village, there were

participants who were children (17.4 percent), young people (50.8 percent), and adults (31.8 percent), while in the school, there were students who made up 70 percent of the population and teachers (30 percent). The research was carried out between the months of June and August of 2021
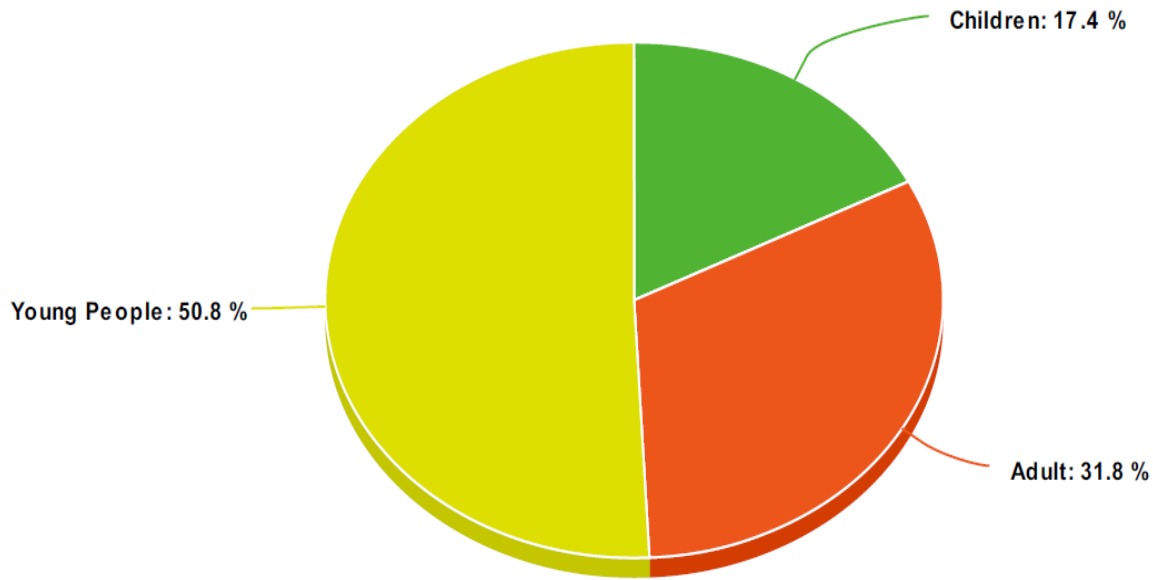
Figure 24:   Number of users NCA and SNP villages
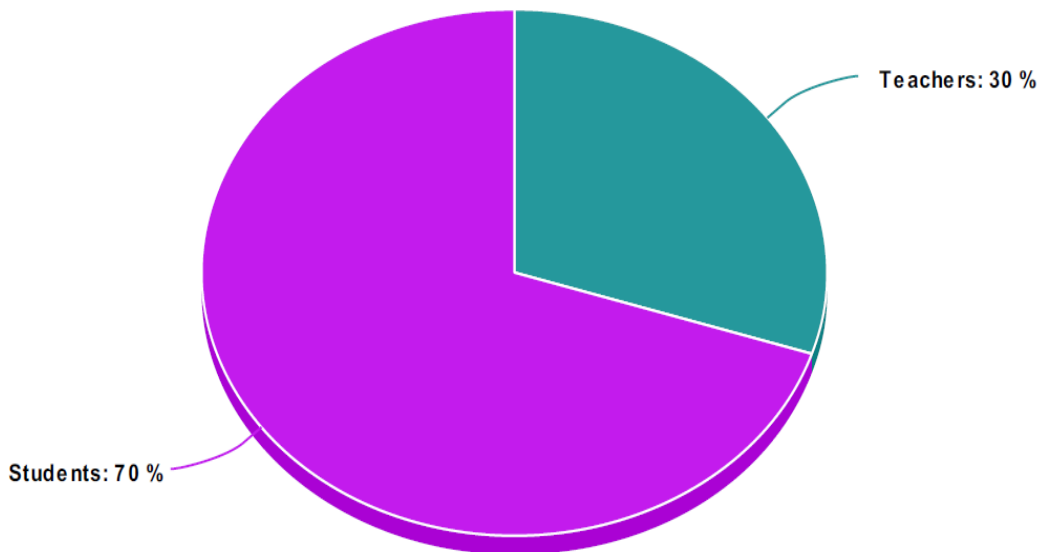
Figure 25:   Number of users in school at NCA and SNP

4.1.6   System Requirements Evaluation

The fulfillment of the functional requirements in the developed system is outlined in Table 3, which provides a concise description of the subject matter.

Table 3 presents the results of verification of system requirements, which was featured in interviews

Table 3:   **System requirements verification featured in interviews**

No	Requirements	System verification
1	The developed system should gather user 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 and name variable	The developed system has unified the fire base 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 system that has been made has both a database and a file manager as the communication subsystem so that the required data format can be managed and stored.
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 and Firebase technology
4	The developed system must protect data successfully.	This is done with a secure method that checks what the user types in, uses intents for communication between processes (IPC), encrypts data in Java, and connects with HTTPS.
5	The developed system should be flexible and user friendly.	The MVC is implemented in the developed system, and the prototype model is defined as an iterative process that receives requirements, then refines and approves those requirements for end-product artifacts. In addition, the prototype model accounts for any potential changes in requirements.

The evaluation of the system was performed after the results of the system testing were obtained when the system components responded in accordance with the requirements of the end user. The results of the testing done on the system are presented in Table 4.

Table 4: **System testing results**

No	System Requirements	Test Output
1	Users will be able to sign in and out of the system with ease provided that their phone numbers are authenticated and that they have successfully registered both their names and numbers.	Pass
2	The system shall allow users to enter the OTP for verification.	Pass
3	The system shall permit users to receive the data from camera traps and allow them to notify which kind of wild animals through image and video received.	Pass
4	The system shall allow users to reporting the information to the administrator through live charting or through SMS.	Pass
5	Users of the system should be able to access information and related information both online and offline, and the system should be designed to support this functionality.	Pass
6	The system shall allow users to have seen if the report was complete or pending.	Pass
7	Users of the system will be able to get in touch with one another via e-mail, their phone numbers, and various social media platforms like WhatsApp.	Pass
8	Users should be able to communicate any issues they're having with the app to the system.	Pass
9	Users will be able to lodge complaints through the system regarding the application.	Pass
10	Monitoring and evaluation of the application (M&E) will be possible for the Administrator thanks to this system.	Pass
11	The system must provide the Admin with the ability to generate reports based on data visualization.	Pass
12	The system shall permit user to send the feedback and the admin to receive the cases information.	Pass
13	The system shall allow users and admin to explore news and alert about conservation area from the App.	Pass

4.1.7 User Acceptance Testing Results

The user acceptance demonstrates that the requirements of the site and mobile application have been met and that they have been accepted by users. This is based on information obtained from people in the village and schools. They were unanimous in their assessment that the application was quite helpful. On the other hand, the respondents placed a high value on alterations to the mobile apps, such as the addition of a live chat, news and alert, and additional exploring options.

The user who had developed the mobile application was the one who carried out this test. This testing was used to check whether the developed application for managing human-wildlife conflicts is responding appropriately to the functional requirements. The functional requirements included user registration, user account creation, access to reporting, live chatting, and the creation of settings. The process of testing was guided by a list of question banks, from which participants could choose whether or not they strongly agreed, agreed, disagreed, or were not sure. Appendix 2 contains some examples of questions that could be asked during user acceptance testing. Table 5 can be consulted for the results.

Table 5:   User Acceptance testing results

Validation Features	Respondents			
	Strong Agree (%)	Agree (%)	Disagree (%)	Not Sure (%)
The wildlife-people conflict management Android application accomplish the requirements for solving wildlife -people conflicts	56	40	2	2
The wildlife-people conflict management. The Android application is reliable for accessing the information we require.	63	37	0	0
The user interface for Android application is interactive	70	30	0	0
My impression is that the mobile application is easy to navigate	80	20	0	0
The wildlife-people conflict management Android application will improve access to solving human-wildlife conflict service both online and offline	45	30	20	5
The mobile application will improve data visualization	68	30	0	2
The mobile app will speed up the M&E process for the most-asked-for views.	54	37	9	0
The mobile app will help keep track of how wild animals get into villages and schools.	90	10	0	0
I'm interested in using this app further.	75	25	0	0
I don't think it's necessary to help people learn how to use the system.	22	18	45	15

4.2   Discussion

Mobile-based system for improving interactive communication among people in the Protected Area is a mobile-based solution that connects people in the village and administrators, especially rangers, to reduce conflicts between people and wild animals. Because the GUI is easy to use and interactive, the system can be used to give more people and animals access to it. The improvement in technology

made it easier for users to access the internet and use the system. As a result, users will only need to connect to the internet to download the app and sign up for the system. During registration, information like the user's phone number, user name, and user email is collected to verify the user's identity in the system. At that point, files that need to be available offline will be synchronized with the permanent offline database (SQLite DB). That is to say, the internet connection will only be used to get data from the camera traps. To report information to the conservation authority, it will need an internet connection when it uses the WhatsApp platform, but we also used the USSD platform, which is an offline platform.

But the system that was made is limited by distance and geography because it only works within 10-15 kilometers from where the camera trap is to where the village is. Also, it hasn't reached everyone in the villages where indigenous people didn't have smartphones. It has reached only a few people, especially their village leaders. So, we suggest that technology be used for Unstructured Supplemental Service Data (USSD) and that the developed system be tested by everyone in the village so that they can get a warning alert through SMS and tell the Conservation authority about it.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1   Conclusion

The goal of this project report was to help people in conservation areas and national parks. According to the results of the study, most people in villages would like a mobile app that would make it easier to keep an eye on wild animals that pass by their village and report the alerts to the rangers for security services. Even though most of them don't have smartphones, the Human Wildlife Conflicts Management mobile app would be a good fit for some of them, especially village leaders (bomas).

This app lets people in villages and in the government, like park rangers, interact with it in a number of ways. For example, park rangers can receive images and videos from camera traps through the mobile app and report the information to park rangers through live chatting using SMS or WhatsApp. For real-time delivery of the report, they can also make a direct call. This app takes advantage of the fact that mobile technology and internet access are growing quickly in Tanzania. It lets users say what's wrong when they're using the app. It lets users send feedback and complaints to the administrators, and the administrators can see the new reports from users so they can take action. It lets users talk to administrators in real time through SMS and WhatsApp chat. It gives users access to news and alerts about Tanzania's national parks and conservation efforts.

Even though the wildlife-human conflict management app has some good features, some suggestions were made during the review, such as adding more villages to keep an eye on wild animals so that they don't get into fights with people.

5.2   Recommendations

The goal of this project was to use mobile technology in Tanzania to better manage the country's wild animals and reduce the number of conflicts between humans and wildlife that occur there. Finding published information on Tanzania's mobile application for the management of wildlife-human conflicts was extremely challenging. As a result, it is recommended that additional research

be conducted on the utilization of mobile apps for the management of the conflicts in order for this platform to be enhanced, and in the future, research should be conducted using a larger sample size.

In addition, when using the app, it is important to take into consideration a few issues, such as the quality of the internet connection and the percentage of residents in the village located within the protected area who own smartphones. It is recommended that governing bodies and interested parties collaborate in order to encourage the responsible and secure utilization of this management app. This could be done, for example, by assisting some people in the conservation area, particularly those village leaders, to purchase smartphones and by enhancing the accessibility of internet connections within parks and conservation areas.Finally, the Tanzania National Park (TANAPA) and Ngorongoro conservation Authority serves to provide internet access in many areas within the protected area in order to users of the mobile app to have internet connection. in order users in different village to receive video to their smartphone from camera traps and able to report to administrators.

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Appendix 1: Sample Interview Questions

1. Does the current system register the individuals who use their platform?Which format was used for registering user?
2. How does the system keep track of the information entered by users and how is it reported?
3. Describe the process that is used to collect and store data by the current system.
4. Does the existing system receive data at the appropriate time and then report on it?
5. Does the current system support real-time charting through messaging apps like SMS and WhatsApp?
6. In order to perform data visualization, which modality is utilized by the system?
7. In what kind of format does the system currently in place evaluate their data?

Appendix 2: Sample Questions for User Acceptance Validation

Validation Features	Respondents			
	Strong Disagree	Disagree	Agree	Strong Agree
The wildlife-people conflict management Android application accomplish the requirements for solving wildlife -people conflicts				
The wildlife-people conflict management Android application is reliable to information access that we will need.				
The user interface for Android application is interactive				
My impression is that the mobile application is easy to navigate				
The wildlife-people conflict management Android application will improve access to solving human-wildlife conflict service both online and offline				
The mobile application will improve data visualization				
The mobile app will speed up the M&E process for the most-asked-for views.				
The mobile app will help keep track of how wild animals get into villages and schools.				

Appendix 3: Sample Questions for System Testing Results

No	System Requirements	Test Output
1	Users will be able to sign in and out of the system with ease provided that their phone numbers are authenticated and that they have successfully registered both their names and numbers.	
2	The system shall allow users to enter the OTP for verification.	
3	The system shall permit users to receive the data from camera traps and allow them to notify which kind of wild animals through image and video received.	
4	The system shall allow users to reporting the information to the administrator through live charting or through SMS.	
5	Users of the system should be able to access information and related information both online and offline, and the system should be designed to support this functionality.	
6	The system shall allow users to have seen if the report was complete or pending.	
7	Users of the system will be able to get in touch with one another via e-mail, their phone numbers, and various social media platforms like WhatsApp.	
8	Users should be able to communicate any issues they're having with the app to the system.	
9	Users will be able to lodge complaints through the system regarding the application.	
10	Monitoring and evaluation of the application (M&E) will be possible for the Administrator thanks to this system.	
11	The system must provide the Admin with the ability to generate reports based on data visualization.	
12	The system shall permit user to send the feedback and the admin to receive the cases information.	

| 13 | The system shall allow users and admin to explore news and alert about conservation area from the App. |

Appendix 4:   Code for Phone number Verification

```xml
<?xml version="1.0" encoding="utf-8"?>

<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"

    xmlns:app="http://schemas.android.com/apk/res-auto"

    xmlns:tools="http://schemas.android.com/tools"

    android:layout_width="match_parent"

    android:layout_height="match_parent"

    android:background="#fff"

    android:gravity="center_vertical|center_horizontal"

    android:orientation="vertical"

    tools:context=".PhoneVerificationActivity"

    tools:layout_editor_absoluteY="81dp">


    <LinearLayout

        android:layout_width="match_parent"

        android:layout_height="wrap_content"

        android:gravity="center_vertical|center_horizontal"

        android:orientation="vertical">


        <ImageView

            android:id="@+id/regUserPhoto"

            android:layout_width="match_parent"

            android:layout_height="100dp"

            android:src="@drawable/wclogopro"

            app:layout_constraintEnd_toEndOf="parent"

            app:layout_constraintStart_toStartOf="parent"

            app:layout_constraintTop_toTopOf="parent" />
```

```xml
<com.google.android.material.textfield.TextInputLayout

    style="@style/Widget.MaterialComponents.TextInputLayout.OutlinedBox"

    android:layout_width="match_parent"

    android:layout_height="match_parent"

    android:layout_margin="20dp"

    android:hint="YOUR NAME (TYPE HERE)">


    <com.google.android.material.textfield.TextInputEditText

        android:id="@+id/first_name"

        android:layout_width="match_parent"

        android:layout_height="wrap_content"

        android:layout_margin="10dp"

        android:fontFamily="@font/google_sans_regular"

        android:inputType="textPersonName"

        android:textSize="12dp">


    </com.google.android.material.textfield.TextInputEditText>

</com.google.android.material.textfield.TextInputLayout>


<com.google.android.material.textfield.TextInputLayout

    style="@style/Widget.MaterialComponents.TextInputLayout.OutlinedBox"

    android:layout_width="match_parent"

    android:layout_height="match_parent"

    android:layout_margin="20dp"

    android:hint="EMAIL ADDRESS (TYPE HERE)">
```

```xml
<com.google.android.material.textfield.TextInputEditText

    android:id="@+id/txt_EmailAddress"

    android:layout_width="match_parent"

    android:layout_height="wrap_content"

    android:layout_margin="10dp"

    android:fontFamily="@font/google_sans_regular"

    android:inputType="textEmailAddress"

    android:textSize="12dp">


</com.google.android.material.textfield.TextInputEditText>
</com.google.android.material.textfield.TextInputLayout>


<LinearLayout

    android:layout_width="match_parent"

    android:layout_height="wrap_content"

    android:layout_margin="20dp"

    android:orientation="horizontal">


    <ImageView

        android:layout_width="20dp"

        android:layout_height="20dp"

        android:layout_gravity="center_vertical"

        android:src="@drawable/ic_baseline_phonelink_ring_24"

        app:tint="@color/colorBlack" />


    <TextView

        android:id="@+id/txt_VerifiedNumber"
```

```
        android:layout_width="match_parent"

        android:layout_height="wrap_content"

        android:clickable="false"

        android:ems="10"

        android:fontFamily="@font/google_sans_regular"

        android:gravity="center_vertical"

        android:padding="5dp"

        android:text="Phone number"

        android:textAllCaps="true"

        android:textColor="@color/colorBlack"

        android:textSize="12dp" />

</LinearLayout>


<LinearLayout

    android:id="@+id/checkBox7s"

    android:layout_width="match_parent"

    android:layout_height="wrap_content"

    android:layout_gravity="center"

    android:layout_margin="20dp"

    android:gravity="center_vertical|center_horizontal"

    android:orientation="horizontal">


    <TextView

        android:id="@+id/txtprivacy"

        android:layout_width="wrap_content"

        android:layout_height="match_parent"

        android:fontFamily="@font/google_sans_regular"
```

```
            android:padding="10dp"

            android:text="I agree to The HUWICOMA Terms of use and privavy policy"

            android:textColor="#3f55e2"

            android:textSize="12dp" />


    </LinearLayout>


    <Button

        android:id="@+id/BtnRegister"

        android:layout_width="match_parent"

        android:layout_height="wrap_content"

        android:layout_margin="10dp"

        android:background="@drawable/round_bt"

        android:fontFamily="@font/google_sans_bold"

        android:text="REGISTER NOW"

        android:textColor="@color/white"

        android:textSize="12dp" />

    </LinearLayout>

</LinearLayout>
```

Appendix 5: Code for sending video from camera trap

```xml
<?xml version="1.0" encoding="utf-8"?>

<androidx.cardview.widget.CardView
xmlns:android="http://schemas.android.com/apk/res/android"

    xmlns:cardview="http://schemas.android.com/apk/res-auto"

    android:id="@+id/c_view"

    android:layout_width="match_parent"

    android:layout_height="wrap_content"

    android:layout_margin="2dp"

    android:background="#e8e8e8"

    cardview:cardCornerRadius="10dp"

    cardview:cardElevation="10dp">


    <LinearLayout

        android:layout_width="match_parent"

        android:layout_height="match_parent"

        android:orientation="vertical">

        <RelativeLayout

            android:layout_width="match_parent"

            android:layout_height="wrap_content">


            <com.google.android.exoplayer2.ui.SimpleExoPlayerView

                android:id="@+id/idExoPlayerVIew"

                android:layout_width="match_parent"

                android:layout_height="300dp" />
```

```xml
<ProgressBar

    android:id="@+id/progressBar3"

    style="?android:attr/progressBarStyle"

    android:layout_width="wrap_content"

    android:layout_height="wrap_content"

    android:layout_centerInParent="true" />


</RelativeLayout>


<LinearLayout

    android:layout_width="match_parent"

    android:layout_height="wrap_content"

    android:orientation="horizontal"

    android:padding="4dp">


    <ImageView

        android:id="@+id/imageView2"

        android:layout_width="20dp"

        android:layout_height="20dp"

        cardview:srcCompat="@drawable/ic_baseline_location_on_24" />


    <TextView

        android:id="@+id/tvLocation"

        android:layout_width="fill_parent"

        android:layout_height="wrap_content"

        android:layout_weight="1"

        android:fontFamily="@font/google_sans_regular"
```
64

```
            android:gravity="center_vertical"

            android:maxLines="4"

            android:padding="3dp"

            android:paddingTop="7dp"

            android:paddingBottom="5dp"

            android:text="Village Name"

            android:textColor="@color/colorBlack"

            android:textSize="10dp" />

    </LinearLayout>


    <LinearLayout

        android:layout_width="match_parent"

        android:layout_height="wrap_content"

        android:orientation="horizontal">


        <TextView

            android:layout_width="10dp"

            android:layout_height="match_parent"

            android:background="@color/myOrange" />


        <TextView

            android:id="@+id/txt_timestamp"

            android:layout_width="fill_parent"

            android:layout_height="wrap_content"

            android:layout_weight="1"

            android:fontFamily="@font/google_sans_bold"

            android:gravity="center_vertical"
```

```xml
            android:maxLines="4"

            android:padding="3dp"

            android:paddingTop="7dp"

            android:paddingBottom="5dp"

            android:text="Village Name"

            android:textAllCaps="true"

            android:textColor="@color/colorBlack"

            android:textSize="12dp" />

    </LinearLayout>


</LinearLayout>

</androidx.cardview.widget.CardView>
```

POSTER PRESENTATION