ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

FACULTY OF COMPUTER and MATHEMATICAL SCIENCES

DEPARTMENT OF COMPUTER SCIENCE

Mobile Based Road Traffic Accident Reporting System

By

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A Project report submitted to the School of Graduate Studies of Addis Ababa University in partial fulfilment of the requirements for the Degree of Master of Science in Computer Science

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LIST OF ACRONYMS AND ABBREVIATIONS

API	Application Programming Interface
FK	Foreign Key
GIS	Geographic Information System
GPRS	Jeneral Packet Radio Services
GPS	Global Positioning System
GSM	Global System for Mobile
IDE	Integrated Development Environment
IIS	Internet Information Service
JDO	Java Data Object
ODK	Open Data Kit
PK	Primary Key
RTAR	Road Traffic Accident Reporting
SDK	Software Development Kit
UML	Unified Modeling Language
URL	Uniform Resource Locator
VCT	Voluntary Counselling and Testing
XML	eXtensible Markup Language

ABSTRACT

Reliable and accurate data are needed to correctly identify problems, risk factors and priority areas so as to formulate strategy and set targets. Addis Ababa Traffic Police Commission is responsible for collecting and reporting of every accidents occurring on the roads of the city. Whenever an accident occurs on the roads of the city, a police officer from the Commission collects the details of the accident using a paper based form at the accident place. This manual paper based approach of collecting accident details makes it difficult to perform the activities of generating different reports and other analysis activities on the accident data collected using the paper based form.

The use of mobile data collection system for collecting and reporting road traffic accidents occurring on the roads of the city and sending the completed record data via the mobile network to a scalable web application, simplifies the activities of generating different reports related to the submitted record data. In addition, the client application i.e. the mobile side application, runs on an android mobile phone and integrates the ability to include location data in the collected data detail so that users can visualize the exact location where the respective accident has occurred using the Google Earth.

The system is developed using the open source Open Data Kit (ODK) for implementing the underlying framework of the system.

Keywords: Mobile data collection, Road accident reporting system, Road accident database, Mobile traffic accident collection

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND

A road traffic accident is the general name given to any type of accident that occurs when a road vehicle (including motorcycles, bicycles, cars, heavy trucks, etc) collides with another vehicle pedestrians, animals, or geographic or with any obstacle which can result in injury, property damage, or death [7].

Although road traffic accident is a major global public health problem, most of it occurs in low and middle-income countries including Ethiopia. Pedestrians and passengers of commercial vehicles are the most in danger in Ethiopia, whereas in high-income countries crashes involve primarily privately owned vehicles with the driver being the main car occupant injured or died [1**].**

Road accident in Ethiopia is one of the worst accident records in the world and Addis Ababa, the capital city of Ethiopia with a higher number of vehicles, takes the highest number of the total accidents that occur in every year. Every year, around 300 people are died on the Addis Ababa roads and 1500 are lightly and seriously injured [7].

Reliable and accurate data are needed to correctly identify problems, risk factors and priority areas so that to formulate strategy, set targets and monitor performance. Ongoing, data-led diagnosis and management of the leading road traffic injury problems enables appropriate action and resource allocation. Without this, there will be no significant, sustainable reductions in exposure to crash risk or in the severity of crashes [5].

Basic information on road traffic crashes and injuries is collected every day in most countries. Police officers write reports on reported crashes. The main purpose of documenting this information is usually to assist an agency in carrying out its specific function – investigation, law enforcement, provision of health care. While such information may be useful to individual agencies, it cannot be used for identifying risks, selecting interventions, or measuring outcomes at an aggregate level unless is it properly coded, entered in a computerized database system, processed, analyzed and disseminated [5].

Most of the traffic accidents result from human error and carelessness on the part of the derivers or pedestrians. However, the probability of occurrence, and its severity, can often be reduced by the application of proper traffic control devices, and good roadway design features. The success or failure of such control devices and design specifications however, depends extensively upon the analysis of traffic accident records at specific locations. It has long been recognized that the most effective means towards accident reduction lies in a systematic and scientific approach based on the use of accurate and reliable traffic accident data, but the quantity of data important for the analysis are not always sufficient [14].

Mobile data collection automates traditional paper-based processes resulting in a faster, more accurate and cost-efficient way to collect data. This results in minimized delays between data collection and processing i.e. forms can be sent and stored in server almost real-time and reduced resources to perform processes i.e. data entry and filing activities are automated.

With the ever mounting need to accurately represent field assets, particularly within organizations GIS and enterprise databases, better field data leads to better office data. Many organizations have faced common problems in getting better data from the field. Some of the common shortcomings faced with paper based workflows include: redundant data entry, no GPS/Geospatial data collected, difficult and costly to get this information into the GIS/Enterprise system. With a digital based data collection system, these inefficiencies can be addressed and the productivity and quality of the data increased [13].

1.2 PROBLEM OF STATEMENT

Road traffic accidents occurring on roads are generally the results of many different factors affecting the vehicle(s). For example, an accident could be the result of a driver going too fast (in excess of the speed limit), on an inadequately maintained section of the road, in the vehicle's mechanical problem. These all factors and description of a road traffic accident also illustrates that an accident can be of interest to different agencies; the traffic police if the vehicle is going too fast, the road authority if the road is poorly maintained, and the educational department for lack of awareness of safety measures.

Unfortunately, the current system of accident recording system of the Addis Ababa City Traffic Police Commission is fully manual and paper based and as a result the accident information available is incomplete and not been utilized to full extent for performing different traffic accident analyses that can provide facts as a guide for different agencies to contribute in the reduction of the traffic accident in the city by performing what they are responsible.

To get all these information so that the respective stakeholder can take some intervention measure to reduce the number of accidents that occur in the city, the accident data must be systematically recorded and the locations of the accidents should be correctly referenced. There is a need for better information of the circumstance of accidents, especially with regards to location in order to come up with a general picture of the data.

1.3 OBJECTIVES

1.3.1 General Objective

The general objective of this project is to develop a mobile-based road traffic accident reporting system for traffic accidents occuring on the roads of Addis Ababa city.

1.3.2 Specific Objectives

The specific objectives of the project are:

- Study and analyze the current system of recording the road traffic accidents occurring on the roads of the city and then collect the necessary data so as to undertake the system requirement analysis.
- Conducting literature review that includes different works done on road traffic accident recording, and the different methods used to perform road traffic accident analysis.
- Study and explore the ODK tools set so as to build a data collection form or survey; collect the data on a mobile device and send it to a server.
- Developing the system

1.4 SCOPE OF THE PROJECT

The system application developed will mainly be used by the Addis Ababa City Traffic Police Commission to record the details of traffic accidents occurring on the roads of Addis Ababa city and to generate and view different reports. The other stakeholders can log into the system using the URL address of the web application to generate and view different reports in which they are

concerned so that they can take some intervention measures; for instance, the Ethiopian Road Authority, one of the stakholders, can log into the system to get some helpful facts for the purpose of maintaining the safety of the roads.
The mobile side application of the system runs only on mobile phones with android platform.

Due to time constraint, users of the system can only view the submissions of traffic accident data using the Google Earth; as a result, currently the system does not include other GIS operations.

1.5 METHODOLOGY

1.5.1 Data Collection

To achieve the general objective of the system, different data are collected using different approaches. The data that are collected mainly includes the different forms used currently for collecting each traffic accident detail as well as the different methods and approaches currently used to generate different reports and analysis activities performed by Addis Ababa City Traffic Police Commission.

1.5.2 Tools and Techniques

We used different tools for the accomplishment of the project. We used Microsoft office applications to prepare the documentation and rational rose is chosen as a UML tool for system analysis and design phase since this tool has fully object oriented feature that helps for the preparation of system design document (SDD). The web application of the system is developed by Java Server Pages and Servlets, and the Open Data Kit (ODK), which is a free and open-source set tools which help implementing mobile data collection solutions [4] is used for implementing the mobile side application, Eclipse Galilio 3.6 is used as an IDE for developing the system, Android SDK is used to provide the necessary APIs, and the Google App Engine is used for hosting and testing the application.

1.6 APPLICATION OF THE PROJECT

Using the system, traffic police officers with the android mobile phone with the application installed on it, can open the application to collect traffic accident detail and send the detailed data to the server side application of the system so that it is accessed through the web application. The developed system automates the current fully paper based manual recording and anlysis system

of the Addis Ababa City Traffic Police Commission to record and store traffic accident related data detail so that a complete and reliable traffic accident data is available for performing different operations that helps for the reduction of road traffic accidents that occur in the city. The system also enables to capture and store a geospatial data for each accidents occuring so that it can be shown on the Google Earth.

Using the system a user can also generate different reports in a printable form that can be used by different stakeholders which would help them scientifically plan and implement appropriate intervention measures to reduce traffic accidents and enhance roads.

1.7 OUTLINE OF THE DOCUMENT

This project report document contains six chapters including this chapter one. The next chapter i.e. chapter two discusses about the litrature review and related work which introduces the reader the background litrature and other research work that are persistent to the project. Chapters three and four are system analysis and system design; each stating about the current system and the proposed new system respectively. Chapter six is about the conclusion and some possible future work of the system.

CHAPTER TWO: LITRATURE REVIEW AND RELATED WORK

2.1 LITRATURE REVIEW

2.1.1 Mobile Data Collection

The advent of mobile technology (e.g. handheld computer, mobile phones, and portable GPS receivers etc.), Geospatial Information Systems (GIS) and convergence of voice and data over wireless networks (GSM, GPRS, 3G, Wireless LAN, and Bluetooth etc.) have led to an explosion of a wide range of mobile applications. These applications include mobile internet browsers, Location Based Services (LBS), mobile multimedia, "real-time" field data collection for resource management, and so on [11]**.**

Mobile devices have shown great promise for improving the efficiency and effectiveness of data collection in resource-poor environments. Compared to a traditional process that relies on paper-and-pencil forms with subsequent transcription to a computer system, mobile devices offer immediate digitization of collected data at the point of survey. This allows for fast and automated data aggregation. It also improves adherence to complex or context-dependent questionnaires, as the device determines which questions should be answered or skipped [11].

2.1.2 Benefits of mobile data collection

Mobile data collection [3] has a number of advantages over paper, including richer data, more accurate data, faster reporting, and enhanced data security.

Richer Data: Mobile data collection goes beyond the limitations of paper. The other activities like take a picture of an event, collect a GPS coordinate, record audio and video can be collected as well as part of the data detail.

More Accurate Data: This is accomplished through the ability to enforce real-time data entry checking.This checking may be in the form of checking value ranges (e.g. was the value entered within a valid minimum and maxim range) or checking the format of the entered data (e.g. does the phone number include an area code). But the greatest accuracy gain is produced through the limitation of transcription errors by not needing to re-enter data from paper forms into a computer system.

Faster Reporting: Mobile survey software saves valuable time. Imagine conducting a mobile survey without the delays of printing and shipping paper forms. You do not need to worry about paper forms being lost or damaged in transit. With mobile survey software, you do not need to re-enter data into a computer because its digital to start with. So there are no reporting delays.

Enhanced Data Security: While some will claim that there is nothing safer than printed materials, this is not always the case. Consider a situation where you must ship paper forms to/from under developed countries, where such shipments may be lost in transit, stolen, damaged or held up by corrupt customs authorities. Mobile survey forms that are communicated over the Internet eliminate these data security problems.

In the developed world, data is easy to collect. Be it electronic medical records, embedded traffic sensors, even internet services, the ability to easily tap into this data can produce incredible results including earthquake sensing, traffic mapping, and even communities formed around diseases [2].

In developing regions [14], the lack of reliable power, ubiquitous connectivity and technical expertise makes it difficult to collect data. Currently, most organizations collect data on paper forms despite well documented inefficiencies including the physical collection of the paper, data transcription errors and low availability of data once collected. Additionally paper forms simply do not offer the richness and depth information that is often needed to make data driven decisions.

The surge of cell phone usage and their infrastructure in developing regions [13] has led to great excitement for using mobile devices to address current gaps in data gathering. In addition to the variety of data (text, photos, location, photos, audio, and video) that can be gathered, mobile devices have proven to be dramatically faster in both collecting the data and making it available to decision make. Moreover, mobile devices can be less expensive and less error prone than pen and paper.

The ability to collect data in the developing world is the key to the success of many organizations. The lack of good infrastructures presents an opportunity for mobile and cloud technologies to enable data collection [16].

2.1.3 ODK (Open Data Kit)

ODK is [4] a set of an open source tools, developed at the University of Washington and Massachusetts Institute of Technology in 2009; designed to empower users to build information services for developing and deploying a mobile based data collection for developing regions to help organizations collect, aggregate, and visualize their rich data. ODK currently consists of different tools and among these tools; ODK Collect and ODK Aggregate are used in this project.

ODK Collect is a mobile platform that renders complex application logic and supports the manipulation of data types that include text, location, images, audio, video, and barcodes. It is designed based on the android platform. It allows users to download forms from the ODK Aggregate server through their android based mobile so that they can fill forms, save forms, and submit the filled forms.

ODK Aggregate provides a server that supports data upload, storage and transfer in the "cloud" as well as on local servers. It is designed to run on the Google App Engine, a web server provided from the Google as well as it can also run on a localhost.

2.1.4 Road Accident Database

An accident database is needed [2] for accurate assessment of the road safety situation. In order to be useful, the data need to cover and include data on casualties and the circumstances of the accident. This will help organizations that are able to contribute to safety improvement to devise and implement appropriate measures designed to combat specific problems.

The main processes involved in producing an accident database include an accident reporting and recording system, storage and retrieval system, an analysis system, and an effective dissemination system.

The data collected for all recorded accidents need to answer the following questions [2]:

- where accidents occur
- when accidents occur
- who was involved
- what was the result of the collision

- what were the environmental conditions, and
- how the collision did occur

KEY COMPONENTS

There are four basic components to the way an accident data system operates, as follows:

- accident reporting and recording system
- accident data storage and retrieval system
- accident analysis system, and
- dissemination of data.

2.1.5 Accident Reporting And Recording System

A prerequisite to improve road safety is to have a comprehensive road accident database and analysis system. Collections of quality, accurate and reliable data that are collected over a period of time are needed in order to understand the factors influencing the arising figures of road accidents and injuries. In addition, advanced road accident analysis system is needed to help strategies road safety initiative as well as inculcate better understanding of road accident causation [8].

Accident Data Storage/ Retrieval

Irrespective of whether the accident data are stored in a manual, micro-based, or mainframe based storage system, the data must be easy to store and retrieve as needed. The true benefits of the data are not being harnessed unless it can be retrieved easily for analysis. The data structure has to be such that information stored on individual accidents can be retrieved either as a single record or in combination with other records. This permits different analysis to be carried out more easily, and permits more useful annual reports to be produced.

Accident Data Analysis

Traffic police authorities will need to produce certain standard tables regularly (monthly or at least annually for an annual report), but the software must also be flexible enough to allow non-standard cross-tabulations to be produced easily with any combination of data filters for specific studies or to provide rapid answers to different queries.

Dissemination

In order to create a widespread awareness of road safety, it is important to publish annual reports showing clearly the magnitude and nature of safety problems, not least to justify adequate funding and resources to combat these problems. Road safety is a problem that requires activity in many different sectors for improvements to be achieved. Annual police accident reports need to be distributed widely to all agencies with responsibilities in road safety and with the ability to influence road safety. It is important, therefore, that the relevant accident database is made readily accessible to all organizations able to contribute to improving safety. This means setting up a mechanism whereby these organizations receive updated data regularly.

2.1.6 Accident Location Referencing

An important detail, which is unfortunately often neglected by many police authorities, is a precise and easily-computerized accident location system. When a roads authority is considering how to tackle accident problems at the local level, it is not possible for it to focus initially on the worst sites (in order to obtain the greatest potential saving in accidents) or ultimately to evaluate the effect of its action unless it can be certain that all accident locations have been correctly pinpointed over a network. In order to implement the efficient safety measure and to eliminate the concrete faults on the road network or its particular stretch the accurate location of relevant accidents is needed in the first step.

GPS (Global Positioning System) is [12] the most fast, accurate and cheap system of identification of accident locations. This method uses the localization in the geographic coordinates. Its advantages being recognized as GIS are getting widely used. The method is suitable for safety analysis issues - road accident locations and spots with high accident concentration can be easily identified. It enables the most precise examination of the accident causes and its circumstances. For this purposes mobile GPS devices having sufficient accuracy to obtain the location data and to transfer them to a server can be used.

2.2 RELATED WORK

This part contains some of the projects done using mobile application for collecting data and somewhat related to our work.

2.2.1 Mobile-Based Voluntary Counselling and Testing Data Collection System

This system is developed [6] to help the services of the voluntary counselling and testing centres, work on health services related to HIV/AIDS found in many parts of Ethiopia.

The system is a mobile-based application using ODK based system used for collecting the details of each VCT tests by the health worker at the different VCT Centres found in the country by the health worker at the respective centre with the help of a mobile phone. The system has two components; a mobile application and a server side application. The mobile application is used to collect the related details of data about each VCT tests. The collected data is submitted to the server side application which is a web application through the GPRS mobile network. Since the server side application of the system is a web application, the submitted data about each VCT test can be accessed by the users of the system.

2.2.2 KoBo Project

KoBo [17] was developed by experienced researchers from the Berkeley Human Rights Centre and the Initiative for Vulnerable Populations; specifically to answer real world limitations in administering large scale population surveys in the field.

The system is a mobile based application using ODK digital data collection to capture the opinions and attitudes of individuals in countries affected by war and mass violence.

The researcher with the research interest designs a survey instrument, which is just a series of questions and designs forms in an XML format. In addition, timestamps and GPS-based location stamps are also integrated; this means that the principal investigator knows where and when every survey was collected as well as how long the survey took. The principal investigator can review daily data dumps, looking for errors or irregularities. Using the post processor, the researcher pulls completed survey data from the phones, and exports all the data that can easily be imported into most database and analyses software packages so that to analyze the data and generate different reports.

CHAPTER THREE: SYSTEM ANALYSIS

3.1 CURRENT SYSTEM

The Addis Ababa City Traffic Police Commission is responsible for the collection and reporting of every traffic accident occurring on the roads of the city. The traffic police officer collects the details of the accident by arriving at the place where the accident has occurred. The current system can be systematically described by categorized into the following:

3.1.1 Accident Data Recording

The current system follows a paper based approach to record the details of every road traffic accident. The details of the accident about the respective road traffic accident occurred includes about the vehicle(s) involved, the road at which the accident has occurred, and the person or animal died or injured or the level of the property damage because of the respective accident. The traffic police officer records all these details with a paper form and observes and collects the necessary information at the scene of the accident so as to decide the causes of the accident.

The paper form used to record the details about the respective accident contains different fields describing about the driver(s) of the vehicle(s), the road, the injured or died individuals (including pedestrians, passengers, and drivers), and the cause of the accident.

The following table contains those all fields/data items used to capture the details of every traffic accident occurring on the roads of the city. These data items are taken from the form used currently for recording traffic accident detail.

Table 3.1: The data items of the form used in the current system

R.No.	Fields (Data Items)	R.No.	Fields (Data Items)
1	Accident Hour	19	Road Surface Type
2	Accident Day	20	Road Surface Condition
3	Accident Month	21	Light Condition
4	Accident Year	22	Weather Condition
5	Driver Name	23	Vehicle's Moving Type (Maneuver)
6	Driver Age	24	Accident Type
7	Driver Sex	25	Accident Severity
8	Driver Level of Education	26	Collision Type
9	Driver-Vehicle-Relationship	27	Driver's Contributing Condition
10	Driver's Driving Experience	28	Property Damage Estimation

11	Vehicle's Category	29	Victim Name
12	Vehicle's plate No.	30	Victim Age
13	Vehicle's Ownership Type	31	Victim Sex
14	Vehicle's Service Age	32	Pedestrian Maneuver
15	Vehicle's Deflect	33	Traffic Police Officer Name
16	Road Separation		
17	Road Way Alignment		

3.1.2 Accident Geo-referencing

The current system doesn't use any GPS enabled devise that can capture the geo-reference data of the accident that shows where the respective accident has occurred exactly on the roads of the city. Currently, what the Addis Ababa City Traffic Police Commission does to record some data so that to reference the accident location is using area names that are thought to be familiar and common.

3.1.3 Data Storage

As it is stated above, the current system is totally manual and paper based and the detailed data about every road traffic accident is recorded using paper forms and all these paper forms are packed with file cabinet boxes so that they are kept on shelves.

3.1.4 Data Exchange

Road traffic accidents occurring on roads are generally the results of many different factors affecting the vehicle or vehicles. For example, an accident could be the result of a driver going too fast (in excess of the speed limit), on an inadequately maintained section of the road, in a vehicle's mechanical problem. These all factors and description of a road traffic accident also illustrates that an accident can be of interest to different agencies. As a result, currently the Addis Ababa City Traffic Police Commission exchanges the respective traffic accident data with the different stakeholders using different hard copied paper based reports.

3.1.5 Analysis and Reporting

Sine the current system is manual and paper based approach, whenever one wishes to perform different operations like generating different reports on the basis of different filter conditions; like on the basis of time, date, week, month, year, or on the basis of the type of vehicles, type of

injury, etc, one has to manually explore and access the different folders containing the different paper forms filled with details of the respective road traffic accident data.

3.2 THE PROPOSED SYSTEM

3.2.1 Overview of the System

To automate the current manual and paper based approach of road traffic accident data recording method of the current system so that the data available is complete and be utilized to full extent to perform different traffic accident analysis that can provide facts as a guide for different agencies to make some intervention measures and contribute in the reduction of the traffic accidents occurring in the city, we proposed a new system of recording and reporting road traffic accident data using a mobile application system.

Whenever an accident occurs on the roads of the city, the traffic police officer uses his/her android based mobile phone to open the application to download the digital forms each with the necessary fields to collect the details of the accident and send the filled forms to the remote road traffic accident data server. The application also integrates the ability to capture geographic coordinate data as part of the accident detail.

All the analysis and other operations related to road traffic accident data are performed by logging to the remote web application. The web side application of the system is designed to be accessed by legitimate users i.e. by the administrator and other access allowed users that own account and wish to generate and view different reports in which they are concerned from the collected road traffic accident data.

3.2.2 Functional Requirements

The functional requirements of the Mobile-Based Road Accident Reporting System are categorized into the following modules:

- Form Submission Management Module
- Utility Management Module
- Views Management Module

Form Submission Management Module

This component of the system handles and enables the management of the following activities:

- Download forms from the remote server of the system to the mobile application.
- Fill/Save/Review/Edit/Send form data to the remote server of the system.
- Receive and save form submission data sent from the mobile application of the system.

Utility Management Module

This module component of the system handles and enables the following activities:

- Creating user accounts
- Editing user accounts
- Delete user accounts
- Login/logout users to/from the system

Views Management Module

This module of the system handles and enables the following activities:

- View the different submissions sent as form data from the mobile application part of the system.
- Generate and view different summarized reports
- Display and locate the exact location of each traffic accident record using the Google Earth.

3.2.3 Non-Functional Requirements

The non-functional requirements of the system are stated as follows:

User Interfaces and Human Factors

The system has two main groups of users. The first group consists of those police officers responsible for the collection of the details of each road traffic accident, and the other group is those that own user account so that they can log into the system over the Internet to access the system and perform the activities of generating and viewing reports as well as perform some resource management activity. The police officer that uses the mobile application to connect and download forms, fill forms, edit form data, and send filled forms will have easy and simple to interact user interfaces. For those users that interact with the system over the Internet will have

also simple and easy web application interface that will be easily accessed through a web browser.

Documentation

Documentation will be available on how to make use of the system and it covers all use cases of the application, the user interface, and how it is to be utilized in conjunction with the rest of the application. The target audiences of the documentation are; the police officers who are using the mobile side application of the system and those who are assigned to handle the resource management, and those responsible for generating of the different reports.

Hardware/Software Consideration

The client side of the system is supposed to run and access by android based platform mobile phones.

Error Handling

There are two components that interact with the system; the application that runs on the android mobile phone and the web application that runs on a web server. These are subject to various errors. The police officer who is responsible for capturing the details of each traffic accident using the mobile application makes request for downloading the different forms from the main road traffic accident data server. These forms contain different text boxes, check boxes, radio buttons, combo-boxes, and the likes in which some of these are mandatory and some are optional. In case the police officer jumps the mandatory fields without filling during recording details, system should pop up a message to fill those mandatory fields.

Appropriate error messages should be displayed when attempts are made to undergo unauthorized operations like:

- Login with a fake username and/or password to get unauthorized access of the system both on the mobile and web side applications of the system.
- Users trying to login to the web side application of the system with a role in which they are not.

System Modifications

The system is developed in such a way that in the future whenever a new functionality from the system is needed, this can be achieved easily by adding the new feature to the current system with only some simple modifications of the whole system.

Security Issues

The administrator of the system is responsible for managing and controlling the security of the system. Access to different parts of the system should require authorization like:

- Access to the central road traffic database should be controlled.
- No external user view and modify submissions of the different road traffic accident data

3.3 THE ANALYSIS MODEL

This is an overview of the entire system described in terms of use case model, object model which is described in terms of a class diagram and dynamic model (sequence diagram).

3.3.1 Use Case Model

This part contains the actors involved in the system and how they are interacting with the system. Accordingly, the following actors are identified making some interaction with the system.

Table 3.2: Actors of the system

Actor	Description
Police Officer	The person responsible for recording the details of each road traffic accident occurring on the roads of the city
System User	The person responsible for handling form submissions, and viewing and generating of different report.
System Administrator	Responsible for administrating users and as well as managing resources of the system.
Registered Users	Stakeholders in the reduction of the road traffic accidents occurring in the city and that owns user name and password so that they can login to the system to view reports
Visitor	Any visitor who wants to get the detail of traffic accidents occurred at the current date.

3.3.2 Use Case Diagram

The Figure 3.1 below shows the class diagram of the system.

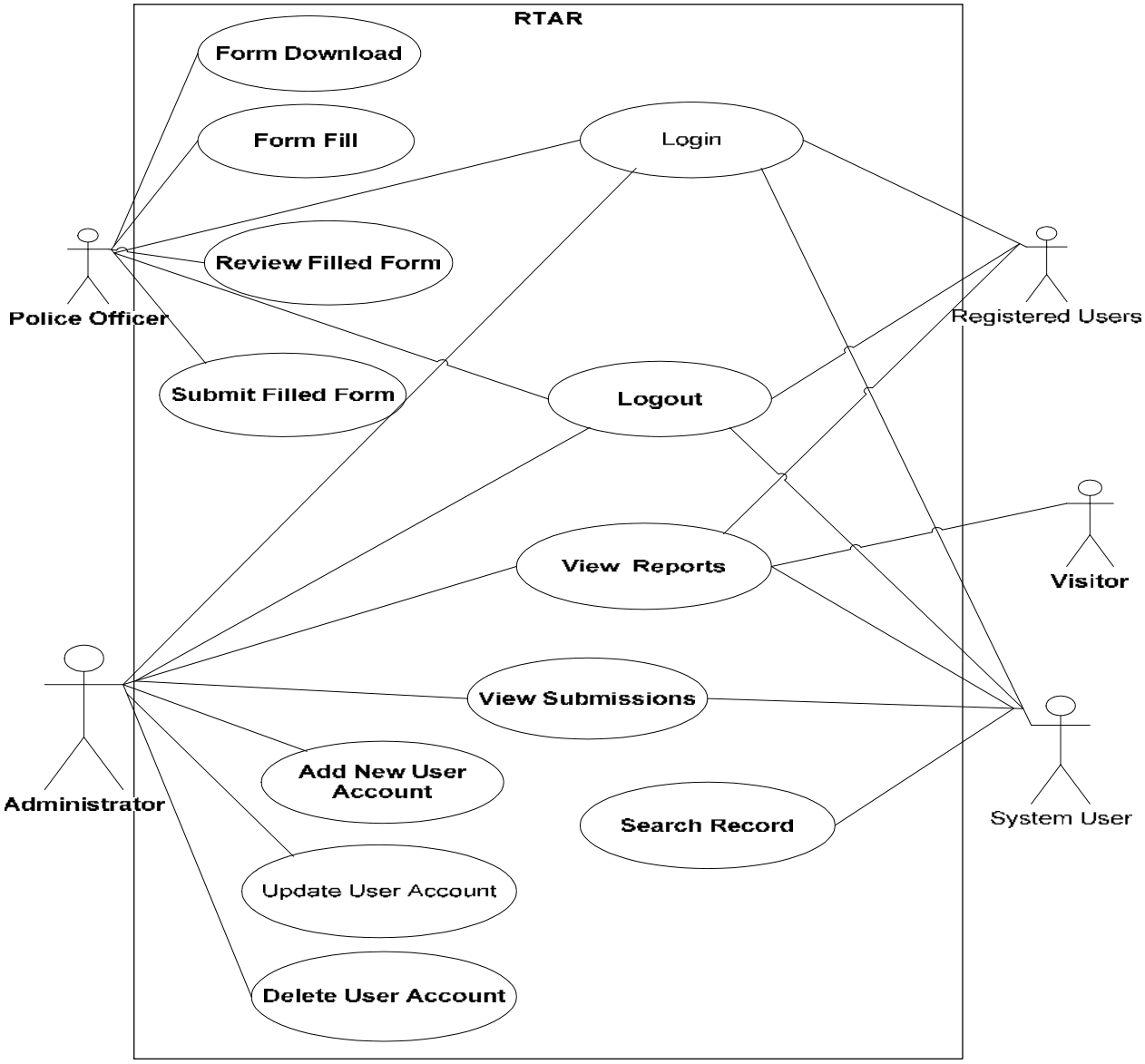


Figure 3.1: Use Case Diagram

3.3.3 Use Case Description

This part presents the description of each of the identified use cases of the system. This is presented as follows:

Use Case Name	**Form Download**
Participating Actors	Police officer
Description	Allows a legitimate police officer to download a form from the main server
Precondition	The police officer is logged in
Flow of Events	1. The police officer selects the tab “Manage files and data” 2. The system displays the available forms. 3. The police officer selects the forms to download. 4. The police officer selects the tab “Add the Selected Files” 5. The system acknowledges the download.
Post-condition	A new form is downloaded
Use Case Name	**Form Fill**
Participating Actors	Police officer
Description	Enables the police officer to record whenever a road traffic accident occurs
Precondition	The police officer is logged in and the form is downloaded
Flow of Events	1. The police officer selects the tab “Enter New Data”. 2. The system displays the downloaded form. 3. The police officer selects the form going to be filled. 4. The police officer selects the check box “Save as complete” (A1) 5. The system acknowledges the saving of the filled form
A1	1. The police officer uncheck the “Save as complete ” check box
Post-condition	A form filled with records
Use Case Name	**Review Filled Form**
Participating Actors	Police Officer

Description	The police officer can review the filled form before submitting to the main road traffic accident data server.
Precondition	The police officer is logged in.
Flow of Events	1. The police officer selects the tab "Review Filled Forms". 2. The system displays the available filled forms not yet submitted. (A1) 3. The police officer does the revision 4. The police officer selects the "save as complete" check box. 5. System acknowledges
A1	1. System displays "Nothing to Display" message
Post-condition	Form is reviewed.
Use Case Name	**Submit Filled Form**
Participating Actors	Police Officer
Description	Enables the Police Officer to send filled forms to the main server
Precondition	The police officer is logged in
Flow of Events	1. The police officer selects the tab "Submit Filled Forms". 2. System displays the filled forms. (A1) 3. Police officer selects the filled form. 4. Police officer selects ""Send Data" button. 5. System acknowledges the submission.
A1	1. System displays "Nothing Available to submit" message if there exists nothing.
Post-condition	Filled forms are submitted to the main server.
Use Case Name	**View Reports**
Participating Actors	Administrator, System user, External user, User
Description	Enables to generate and view different reports
Precondition	Actor is logged in
Flow of Events	1. Actor selects on "view Reports" tab from the navigation menu bar. 2. System displays "Report View Main Page" with different

	filtering and analysis criteria. 3. Actors click the link with respective report name. 4. Actors enter their interest of filleting criteria. 5. System displays the result. (A1)
A1	1. System displays “No records” message if there exists nothing.
Post-condition	The respective report is displayed.
Use Case Name	**View Submissions**
Participating Actors	Administrator, System User
Description	Enables the administrator to view submissions for a given form.
Precondition	Administrator is logged in
Flow of Events	1. Administrator selects on “View Submissions” tab from the navigation menu bar. 2. System displays “Submissions Displaying page”. 3. Administrator selects the form name to display its submissions with the selected year and month. 4. System displays the result.[A1]
A1	1. System displays “No submission” message.
Post-condition	Submission results are displayed.
Use Case Name	**Update External User Account**
Participating Actors	Administrator
Description	Enables to create new external user accounts.
Precondition	Administrator is logged in
Flow of Events	1. The administrator selects on “Manage Users” tab from the navigation menu bar. 1. System displays “User Management page” 2. Administrator presses “Display All Users” button. 3. System displays all available registered users. (A1) 4. Administrator gets the external user from the list displayed and clicks the “Edit” link. 5. System displays “Edit User Page” with the respective user

	account detail. 6. Administrator makes the updating and presses the “Edit” button.
A1	1. System displays “No available registered users” message if nothing is available.
Post-condition	User profile is updated.
Use Case Name	**Add New Account**
Participating Actors	Administrator
Description	Enables to create new external user account.
Precondition	Administrator is logged in
Flow of Events	1. The administrator selects on “Manage Users” tab from the navigation menu bar. 2. System displays “User Management page”. 3. Administrator fills the form with the respective account information and presses on the “Create” button. 4. System acknowledges.
Post-condition	A new external user account is created.
Use Case Name	**Delete Account**
Participating Actors	Administrator
Description	Enables to remove already registered external user account.
Precondition	Administrator is logged in
Flow of Events	1. The administrator selects on “Manage Users” tab from the navigation menu bar. 2. System displays “User Management page”. 3. Administrator clicks the “Display All Users” button. 4. System displays all registered available users. (A1) 5. Administrator gets the external user from the list displayed and clicks the “Delete” link. 6. System acknowledges the delete activity..
A1	1. System displays “No available registered users” message if nothing is available.

Post-condition	A user account is removed.
Use Case Name	**Login**
Participating Actors	All system users
Description	Enables users to get the permission to access the system.
Precondition	Must be a registered user.
Flow of Events	1. User opens the system 2. User enters the required information and presses the "Login" button. 3. System verifies the user. 4. System allows the user to get access. (A1)
A1	1. System displays appropriate error message. 2. Go to step 1.
Post-condition	User is logged into the system.
Use Case Name	**Logout**
Participating Actors	All system users
Description	Enables one to leave the system
Precondition	User is logged in
Flow of Events	1. User presses the "Logout" tab from the navigation menu bar. 2. System displays the home page of the system.
Post-condition	User is logged out.

3.3.4 Class Diagram

This part presents the class diagram that shows the classes of the proposed system with their attributes, methods, and the associations that exist among the classes as shown in Figure 3.2 below.

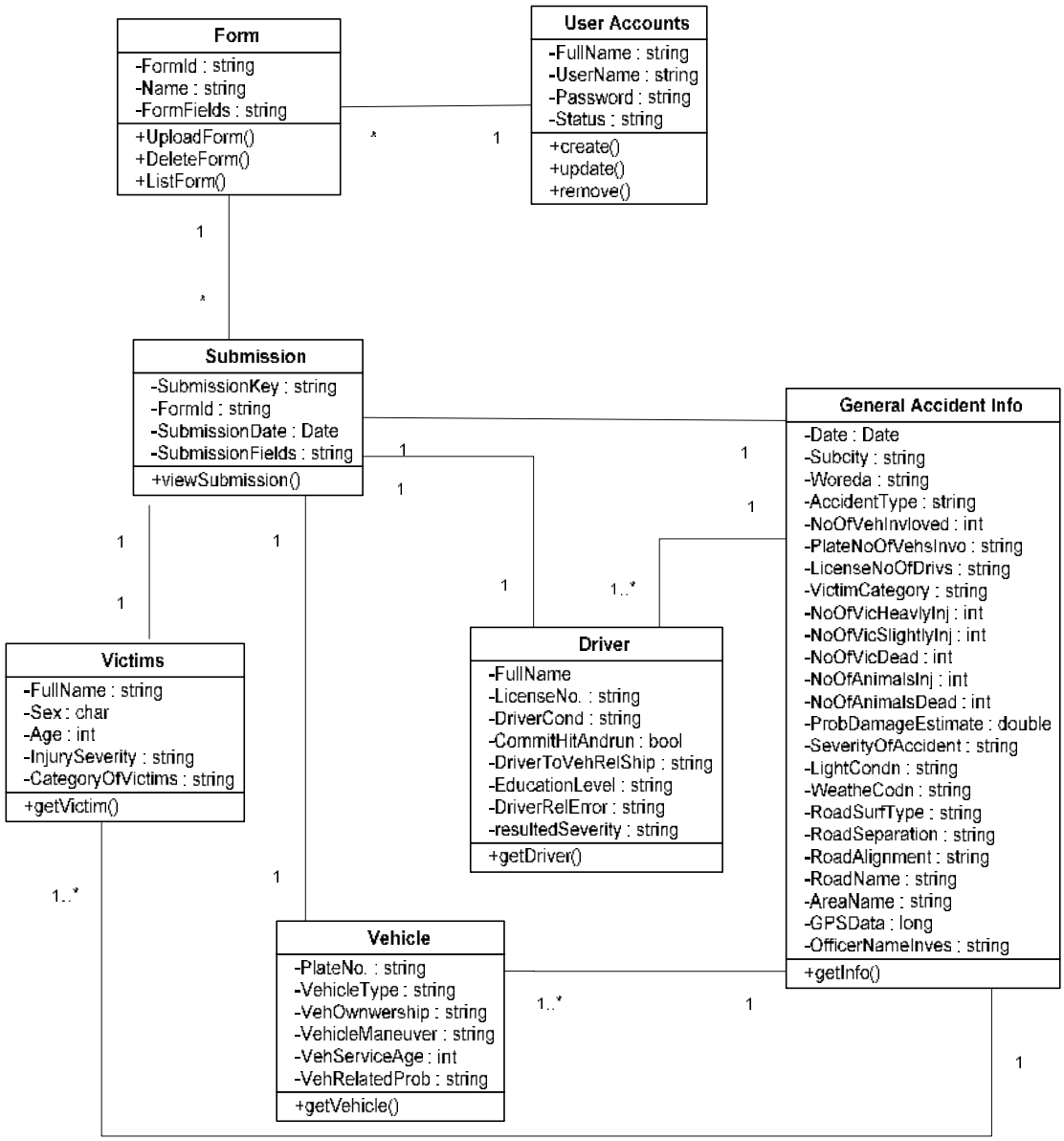


Figure 3.2: Class Diagram

3.3.5 Sequence Diagram

This part presents the sequence diagrams that show the interaction among the objects in the system. This is presented by the figures shown from Figure 3.3 to Figure 3.11 below.

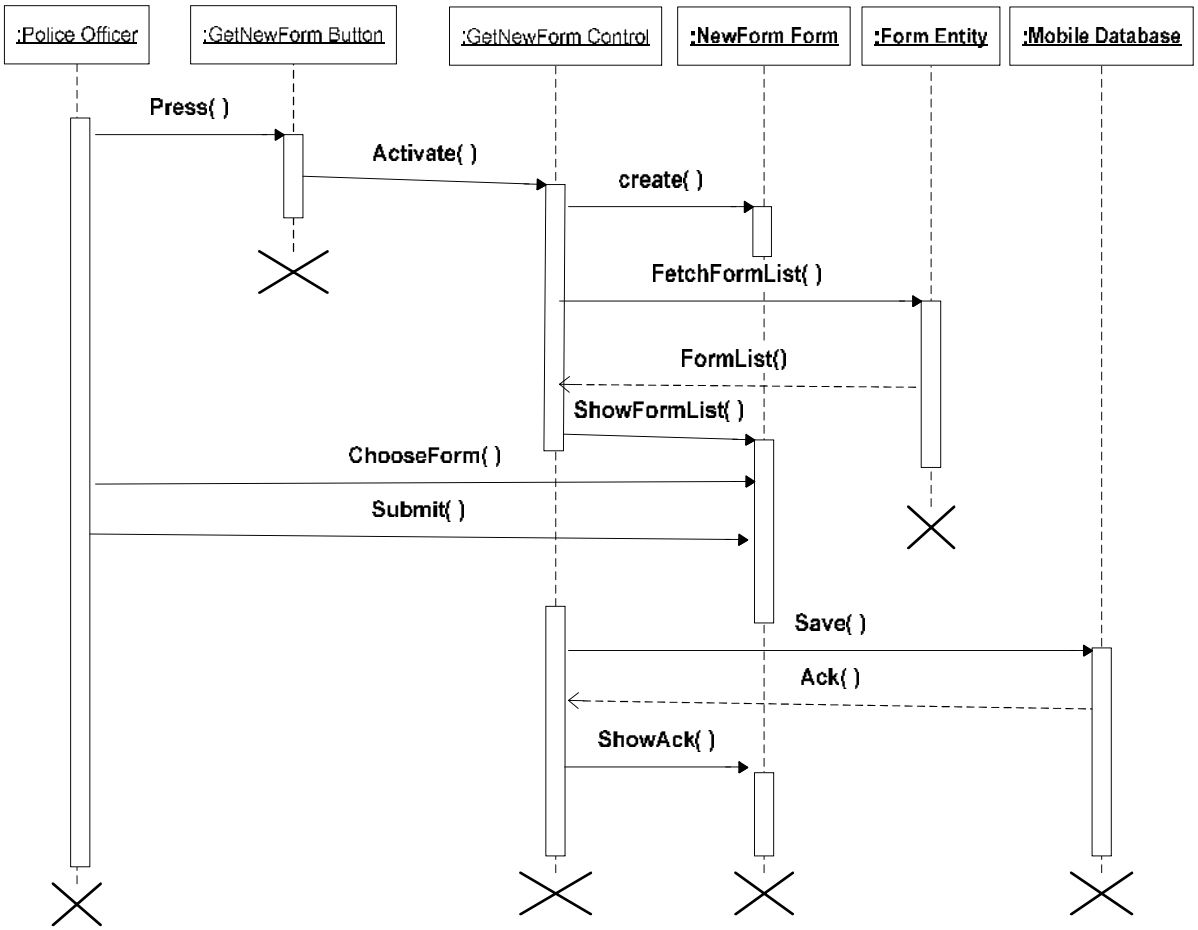


Figure 3.3: Form Download Sequence Diagram

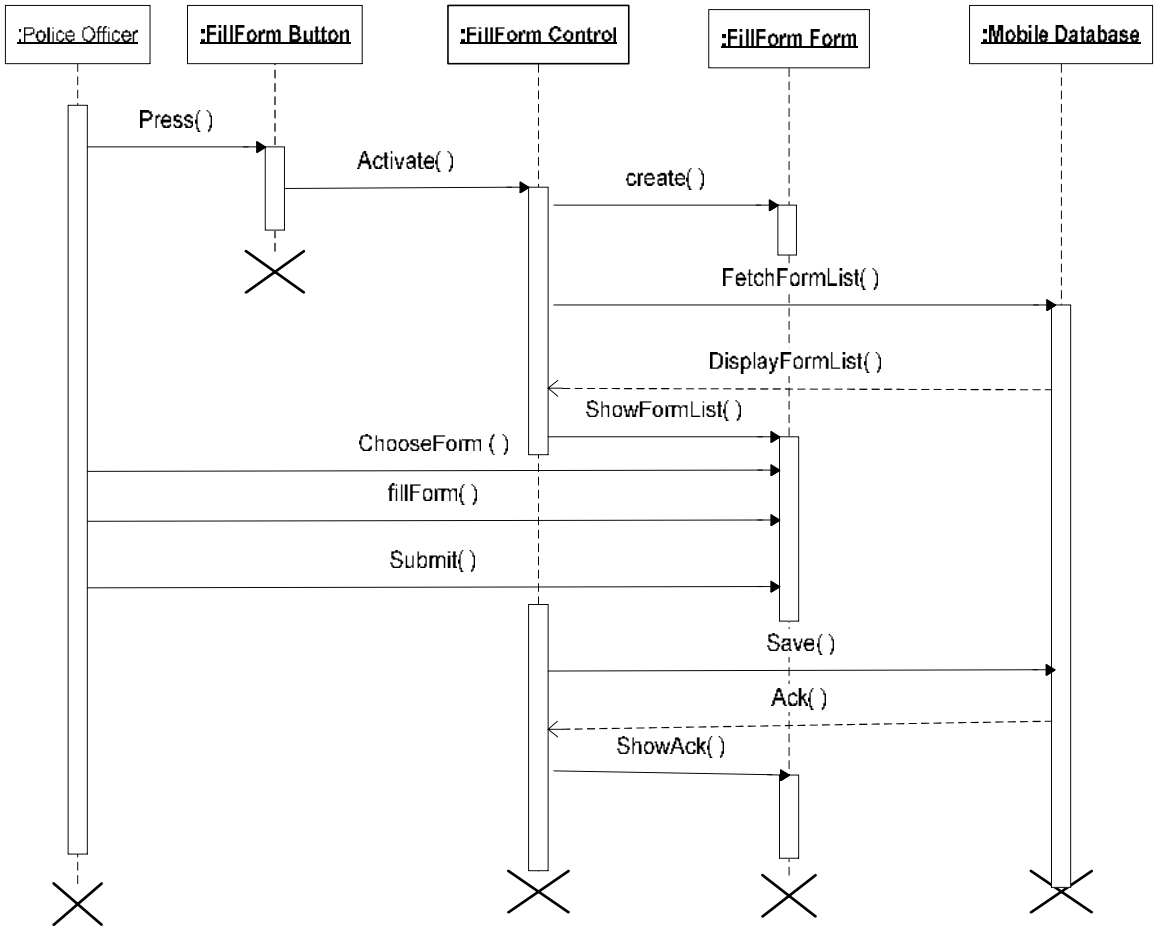


Figure 3.4: Fill Form Sequence Diagram

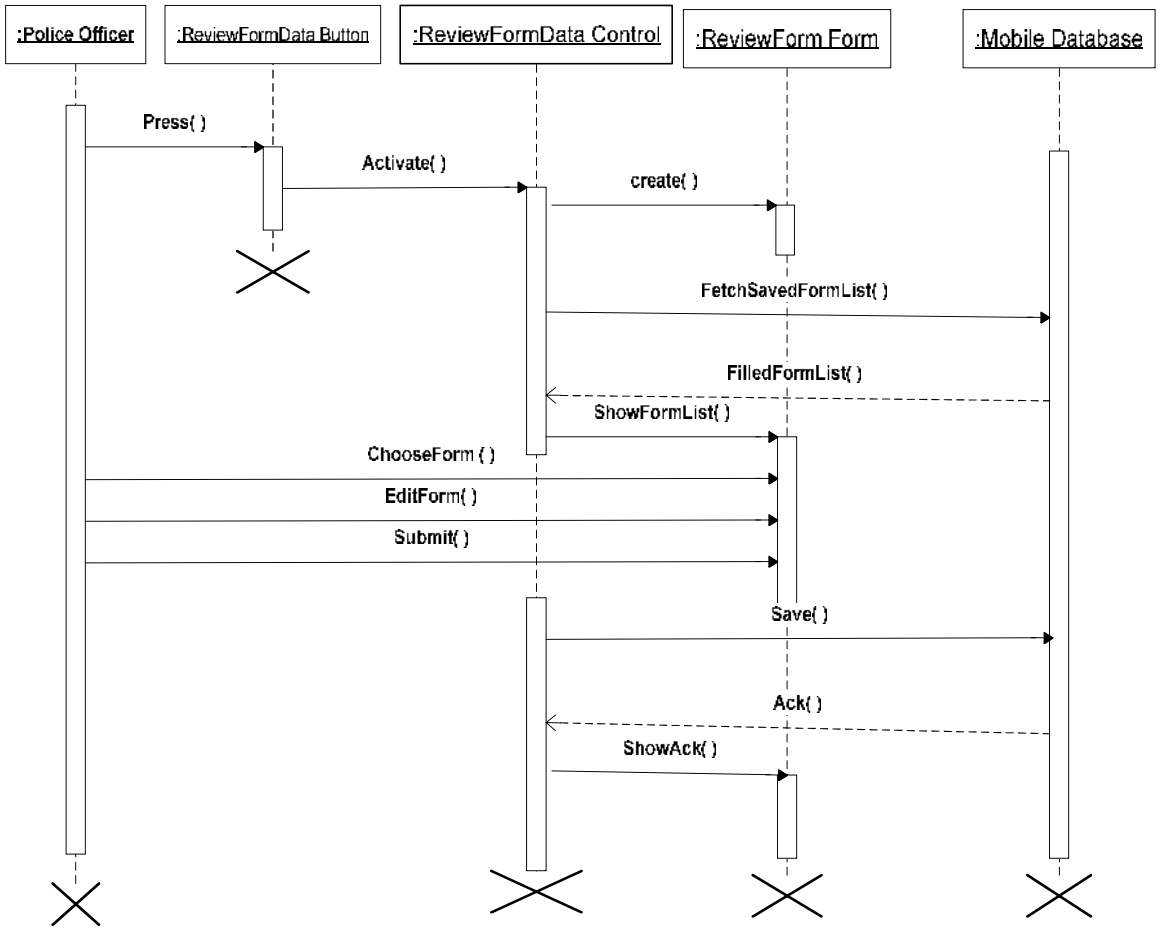


Figure 3.5: Review Filled Form Sequence Diagram

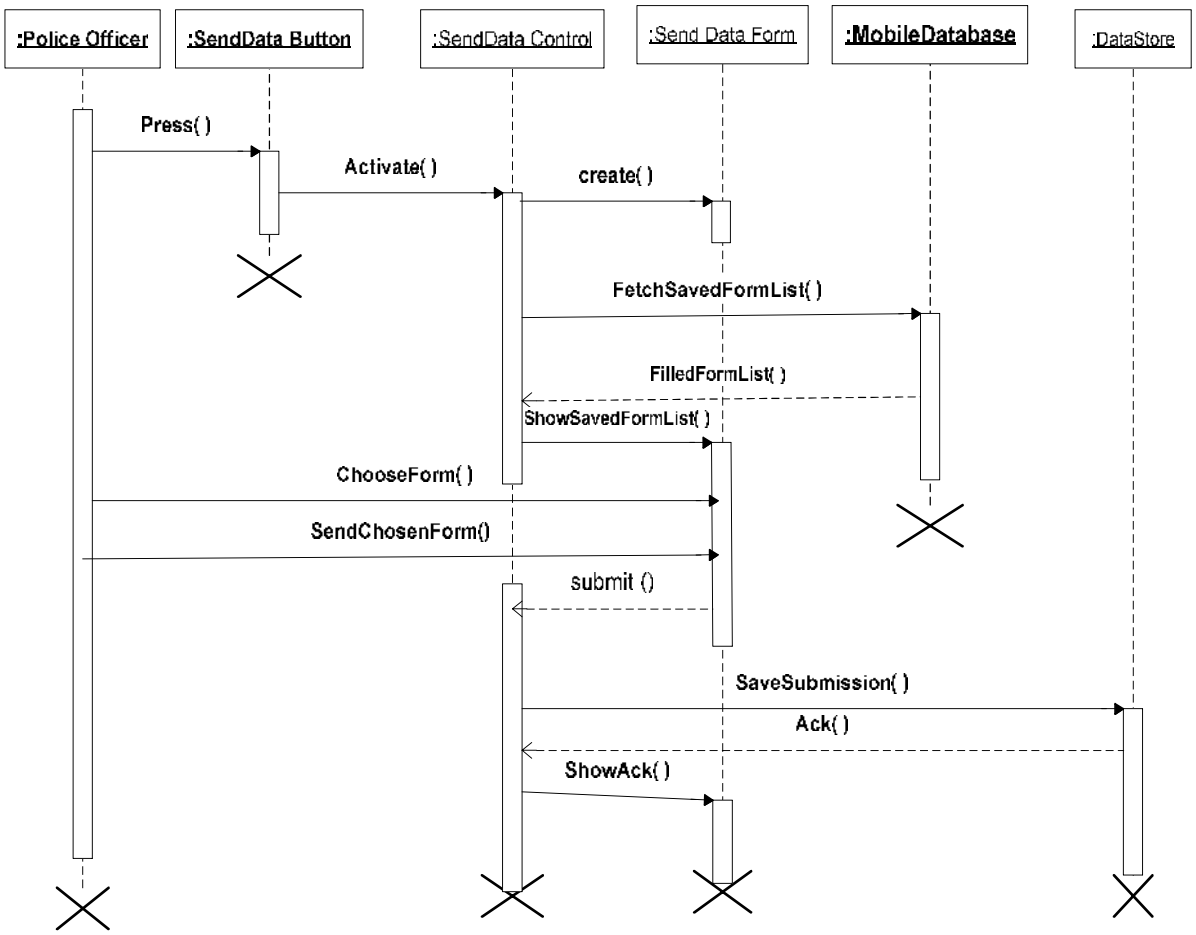


Figure 3.6: Send Filled Form Sequence Diagram

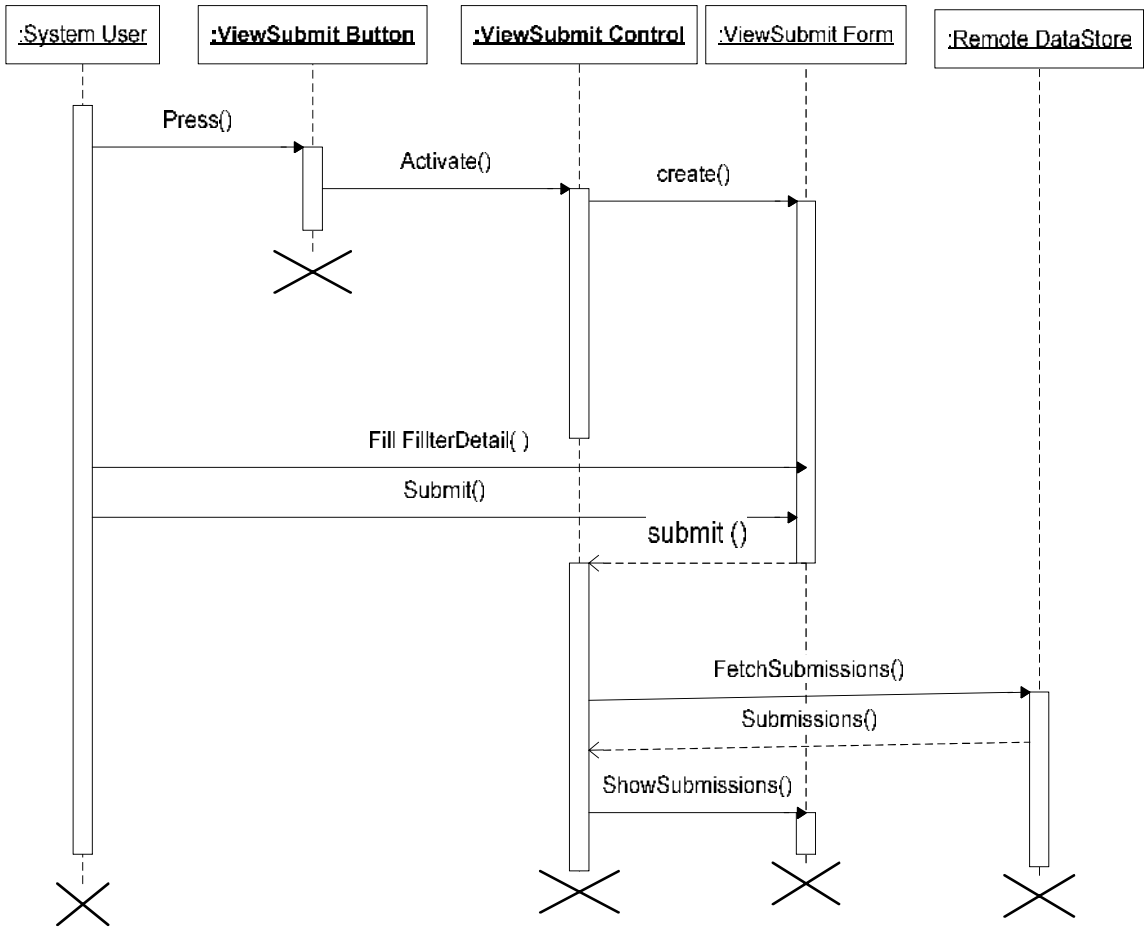


Figure 3.7: View Submissions Sequence Diagram

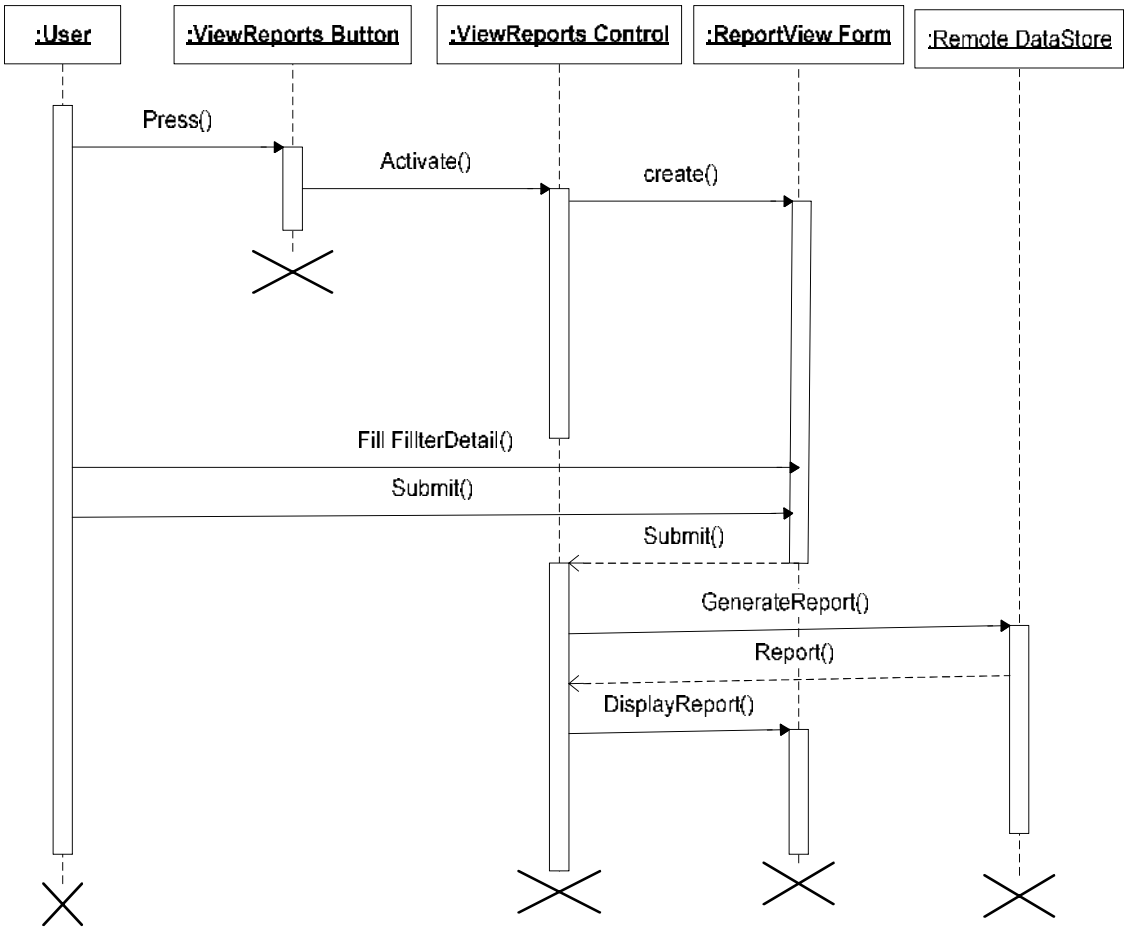


Figure 3.8: Report Generation Sequence Diagram.

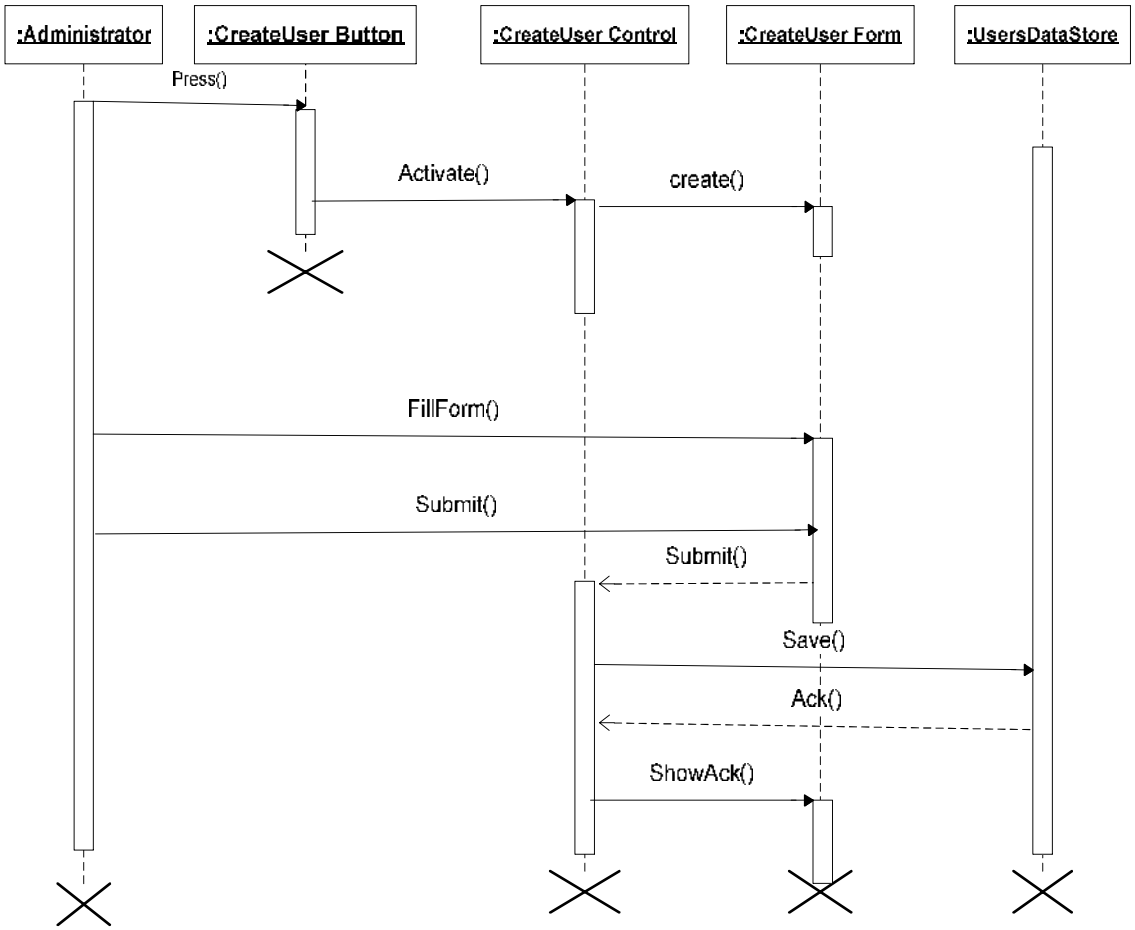


Figure 3.9: Create New User Sequence Diagram

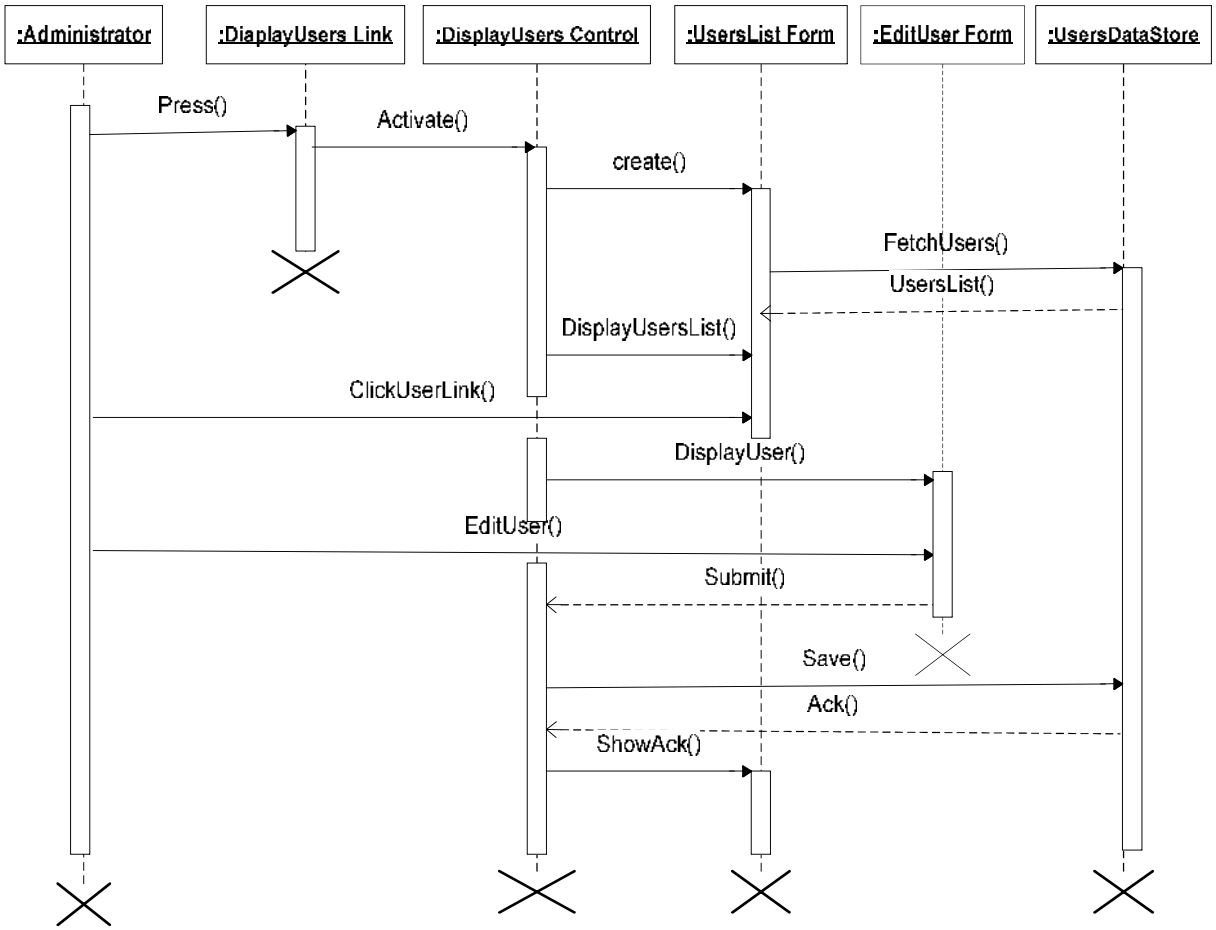


Figure 3.10: Edit User Sequence Diagram

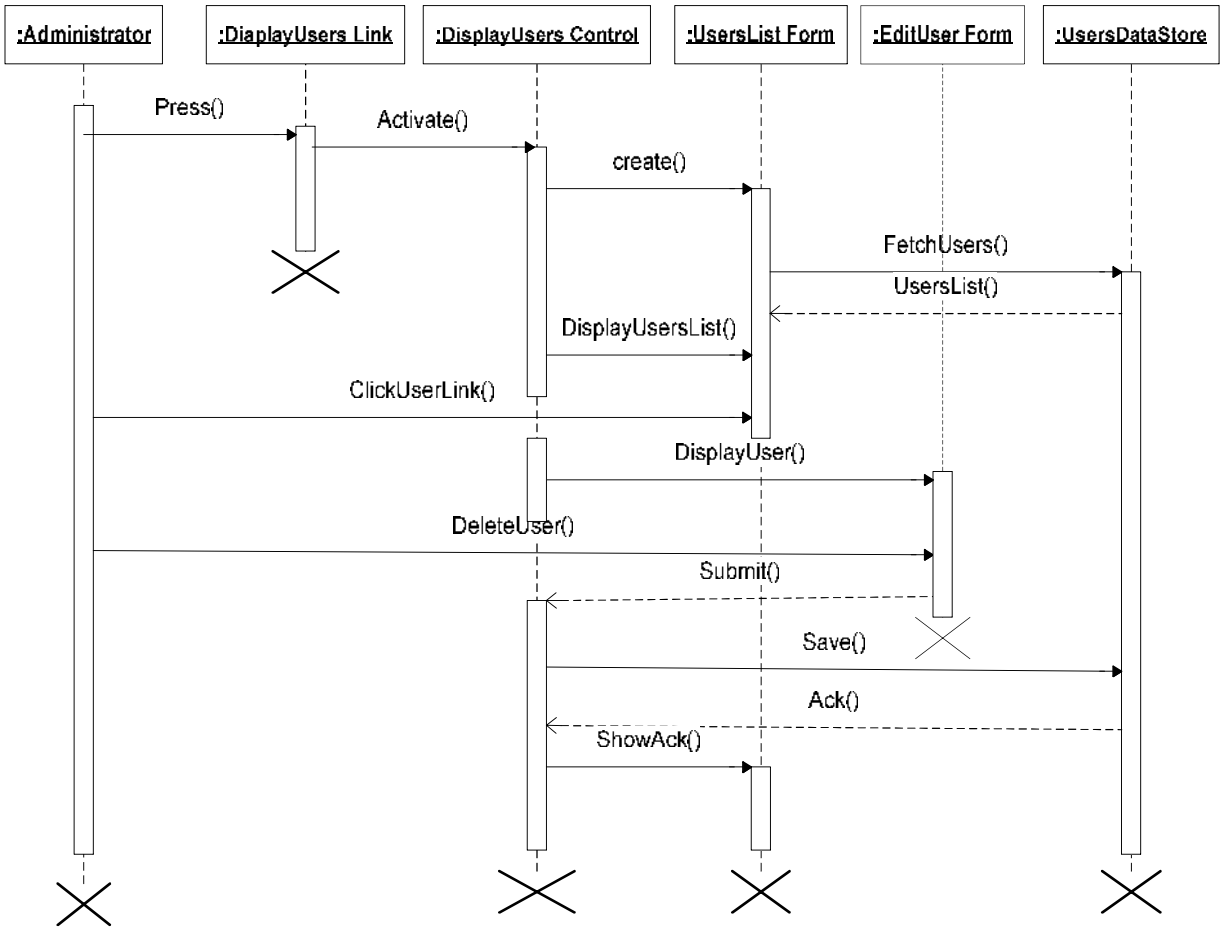


Figure 3.11: Delete User Sequence Diagram

CHAPTER FOUR: DESIGN OF THE SYSTEM

4.1 PURPOSE

This part presents the descriptions of the activities carried out during the design phase for the Mobile Based Road Traffic Accident Reporting System. First, it describes the primary design goals set for the project. Next, it describes the system in terms of subsystem decomposition, hardware/ software mapping, and persistent data management.

4.2 DESIGN GOALS

Table 4.1: Dependability criteria

Design criterion	Definition
Robustness:	All user input is highly controlled by how the input is submitted to the system. Inputs from both the client mobile application and server side web application come mostly as some form of graphical units such as checkboxes, radio buttons, combo boxes, etc in such a way that users can easily submit it. Thus minimizes invalid user input.
Availability:	The System should be available for twenty four hours of a day so that police officers can download forms and send submissions at any time as well as users can view and generate reports.
Security:	The system should also be designed to prompt the mobile application with password and the web application with user name and password. This provides security in such a way that unauthorized users can not have access to the system's resources

Table 4.2: Maintenance Criteria

Design criterion	Definition
Extensibility:	Additions of functionality would require minimal adjustment. Functionality of additional classes such as different other reports not included currently in the system and some other functionalities, would be added and the GUI is updated by adding an additional button or some

	other link to activate the functionality of the new class.
Modifiability:	Modifying any part of the system is economical as the system is developed in an object oriented programming language.

4.3 THE PROPOSED SYSTEM GENERAL ARCHITECTURE

As shown in the Figure 4.1 below, the system has three major components; the mobile client, the web server, and the web client. The mobile client is the client side of the system that runs on the android mobile phone. Police officers at traffic accident occurrence location can open the application to download forms, fill, and submit the traffic record data to the server side of application of the system. The server side application of the system resides on a web server. The web client component of the system represents the users of the system that can access the server side application of the system through a web browser.

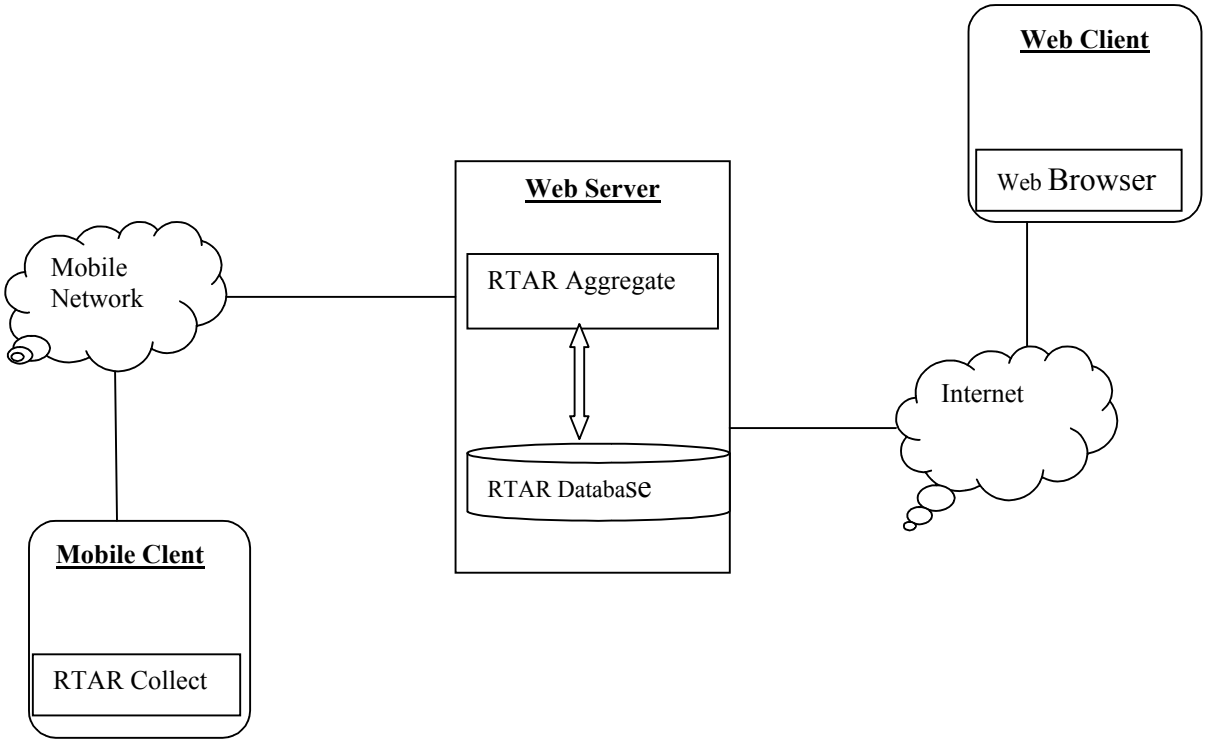


Figure 4.1: Proposed System Architecture

4.4 SUBSYSTEM DECOMPOSITION

The Mobile-Based Road Traffic Accident Reporting System provides different services. To effectively provide these services as per the goals specified, the system is decomposed into different main subsystems. The Figure 4.2 presents the subsystems in the form of a layered architecture.

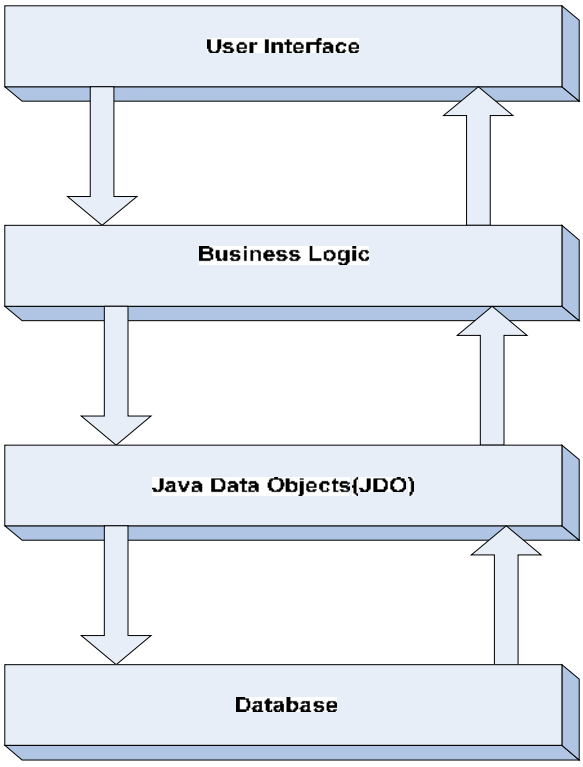


Figure 4.2: Layered Architecture of the System

The graphical user interface layer: This is the layer on which all the user interface codes are implemented, which are responsible for the appearance of the user interface and as well it is responsible for the general control structures of the entire system and the interfaces between the user and the system.

Business Logic Layer: This is the layer at which the business logic of the system is implemented. The business logic layer implements all the functional requirements without the user interface component of the system. The business logic layer of the system, have the following subsystems:

- ✓ Form submission management subsystem
- ✓ Utility management subsystem
- ✓ View management subsystem

Java Data Objects (JDO) Layer: This is the layer responsible for connecting the database with the business logic layer of the system. Java Data Objects (JDO) is a standard interface for storing objects containing data into a database. The standard defines interfaces for annotating Java objects, retrieving objects with queries, and interacting with a database.

Database Layer: The system will be using an App Engine datastore for its persistent data storage.

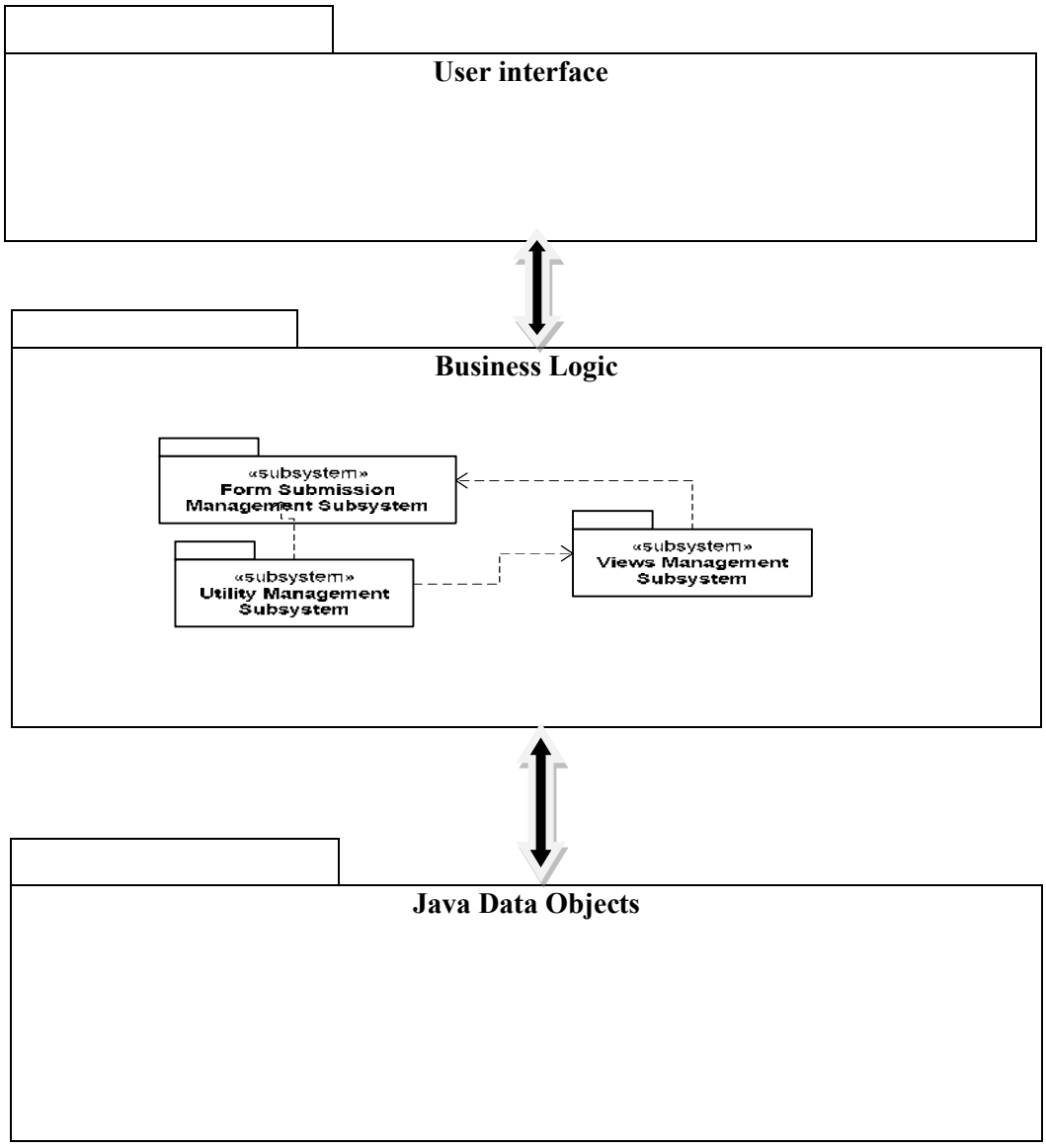


Figure 4.3: Layers Relationship

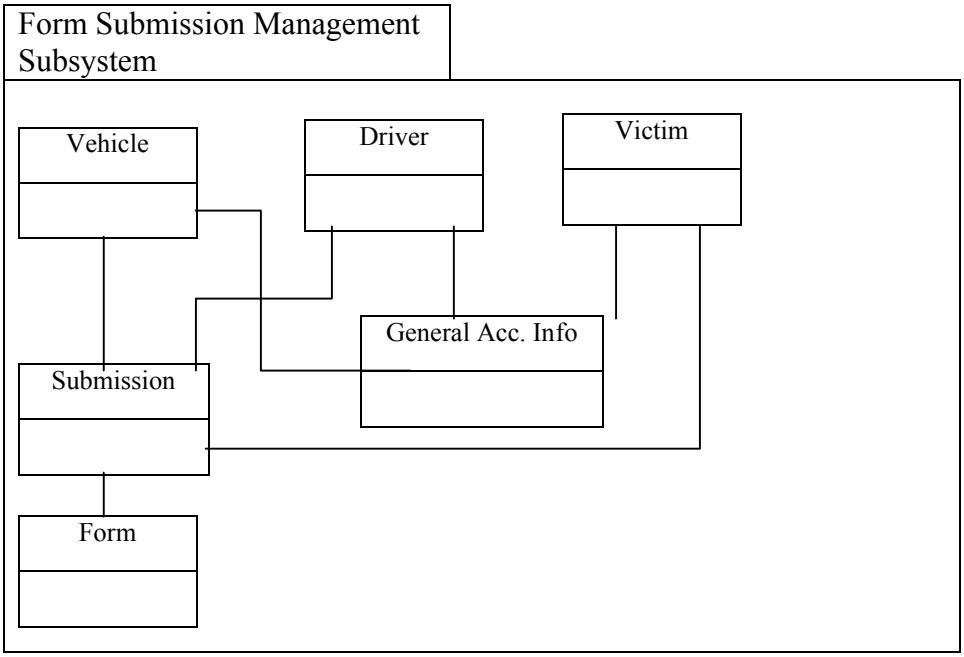


Figure 4.4: Business Logic Layer

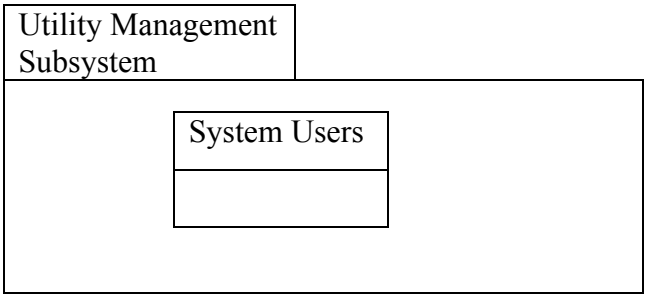


Figure 4.5: Utility Management Subsystem

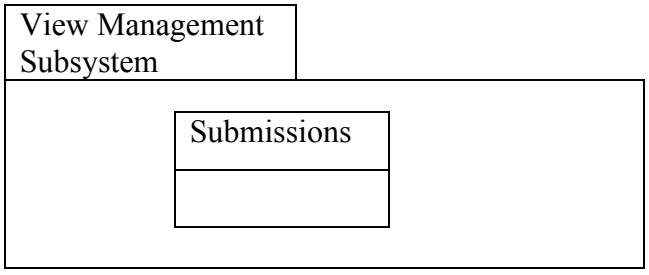


Figure 4.6: View Management Subsystem

4.5 HARDWARE /SOFTWARE MAPPING

This section shows the relationship among the nodes and the independent components in the system. The deployment diagram shown in Figure 4.7 below shows the nodes and components of the system. The diagram includes a mobile application deployed on a mobile device, the web application server where all the business logic functionalities are deployed on, and the database server. As the system is a web based, the client nodes will have web browser component, and that of the web server will have IIS.

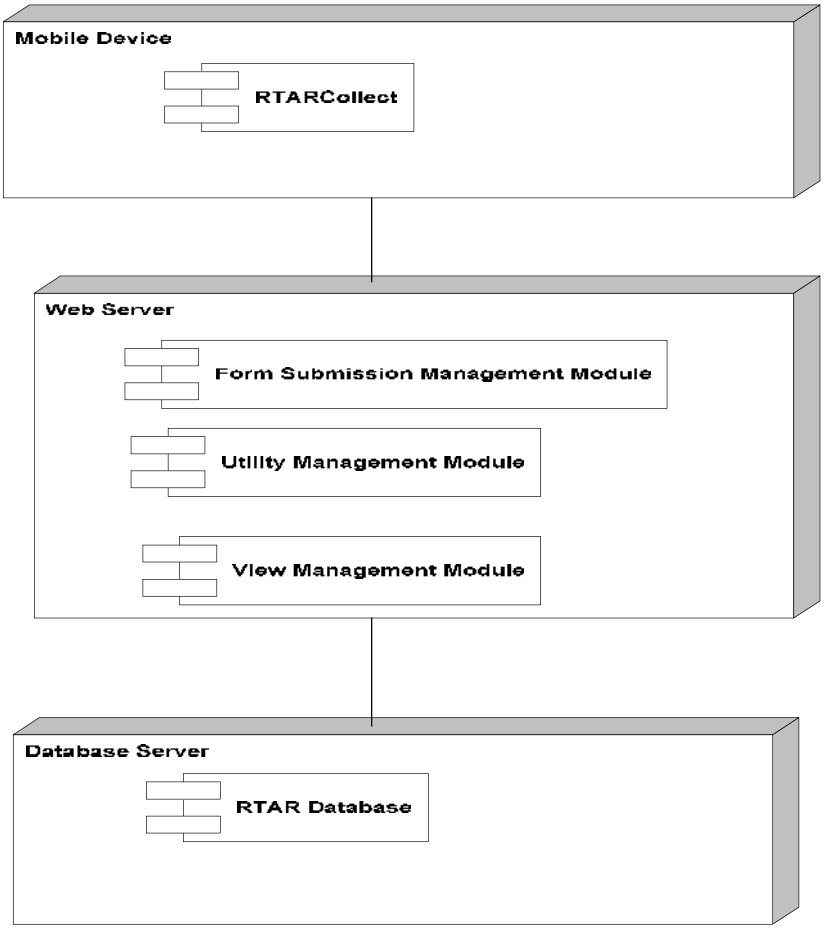


Figure 4.7: Deployment Diagram

4.6 PERSISTENT DATA MANAGEMENT

System User <<table>>	Type
FullName	Varchar
UserName << PK>>	Varchar
password	Varchar
Role	Varchar

From <<table>>	Type
FormName	Varchar
FormId <<PK>>	Varchar
FormHeaders	varchar

Submission <<table>>	Type
SubmissionId <<PK>>	Varchar
FormId << FK>>	Varchar
SubmissionFields	-

Victim <<table>>	Type
FullName	Varchar
Sex	char
Age	int
InjurySeverity	Varchar
VictimCategory	Varchar

Vehicle <<table>>	Type
plateNo. <<PK>>	Varchar
vehicleType	Varchar
vehicleOwnership	Varchar
vehRelatedProblems	Varchar

Gen_Acc_Info. <<table>>	Type
Date	date
subCity	Varchar
woreda	Varchar
accidentType	Varchar
noOfVehsInvolved	int
palteNoOfvehInvolved <<FK>>	Varchar
licenseNoOfDrivInvolved <<FK>>	Varchar
victimCategory	Varchar
noOfVicDead	int
noOfVicSeverlyInjured	int
noOfVicSlightlyInjured	int
noOfAnimalInjured	int
noOfAnimalsDead	int
proprtyDamageEst.	Decimal
weatherCond.	varchar
roadSurfType	varchar
roadSepartionType	varchar
roadAlignment	varchar
roadSurfCond.	varchar
areaName	varchar
GPSReading	long
officerName	varchar

Driver <<table>>	Type
fullName	Varchar
licenseNo. <<PK>>	Varchar
Age	int
drivingExprience	Varchar
injurySeverity	Varchar
victimCategory	Varchar
commitHitRun	Varchar
driverRelatedProblems	Varchar

Figure 4.8: Database Diagram

CHAPTER FIVE: IMPLEMENTATION

This part of the document states about the various tools used to develop and implement the system.

5.1 DEVELOPMENT ENVIRONMENT

Eclipse Galileo 3.6

We used the Eclipse Galileo 3.6 as an IDE for the development of the system.

Java Server Pages (JSP) and Servlets

JSP and Servlets are used to develop the server side application of the system, which is a web based one.

Open Data Kit (ODK)

The ODK is used as a framework for the development of the system.

Java Data Objects (JDO)

Java Data Objects (JDO) [15] streamlines development by providing Java-centric mechanisms for making objects persistent, and standard APIs for connecting application code with underlying persistent datastores.

Android SDK

Android is [10] a software stack for mobile devices that includes an operating system, middleware and key applications. The Android SDK provides the tools and APIs necessary to begin developing the application on the Android platform using the Java programming language.

Google App Engine

Google App Engine enables [18] to build and host web apps on the same systems that power Google applications. App Engine offers fast development and deployment; simple administration, with no need to worry about hardware, patches or backups; and effortless scalability. Thus, we used the Google App Engine to host the application and test it.

5.2 THE PROTOTYPE

The Mobile Based Road Accident Reporting System is composed of the mobile application that runs on an android mobile phone and a web application that is used to access the submissions from the mobile application. This section of the document presents the brief description of these applications.

5.2.1 The Mobile Side Application

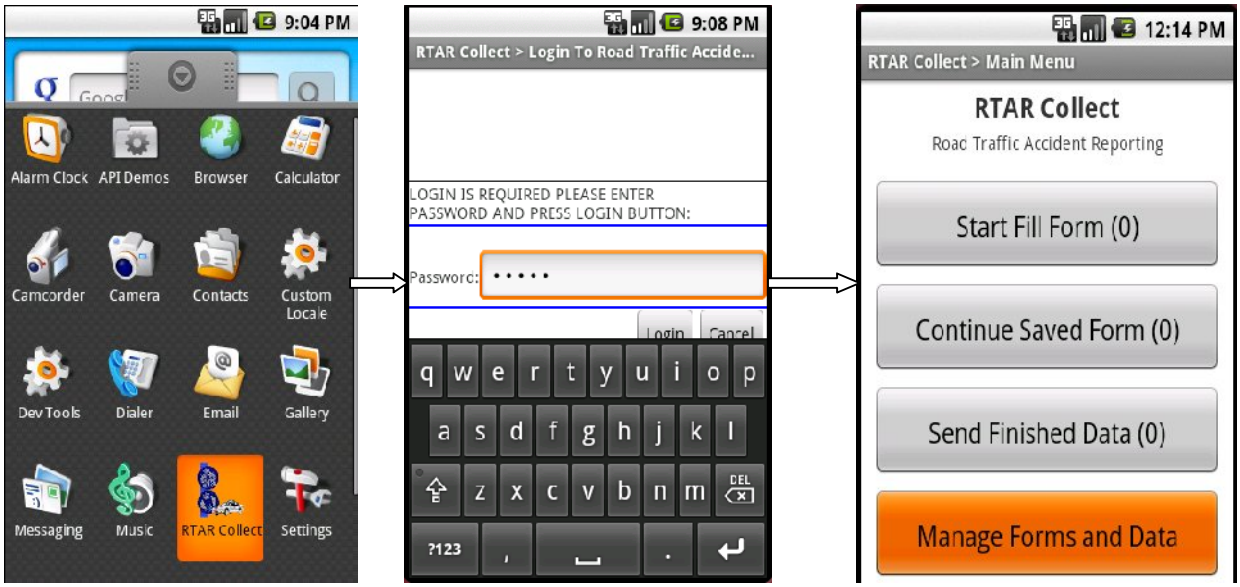


Figure 5.1: Successful Login

When the police officer opens the mobile application, a window to login is displayed so that the police officer enters a password to access the application. If the password entered is valid password, the police officer gets the main menu window of the application as shown in Figure 5.1 above. The main menu window contains four buttons; Manage Forms and Data, Start Fill Form, Continue Saved Form, and Send Finished Data. The Manage Forms and Data button is used to start the activities of downloading forms as well delete previously downloaded and saved forms. When the Manage Forms and Data button is pressed, the window shown in Figure 5.2 is displayed; which contains list of forms already downloaded previously. It also contains a button to start downloading of new forms from the server.

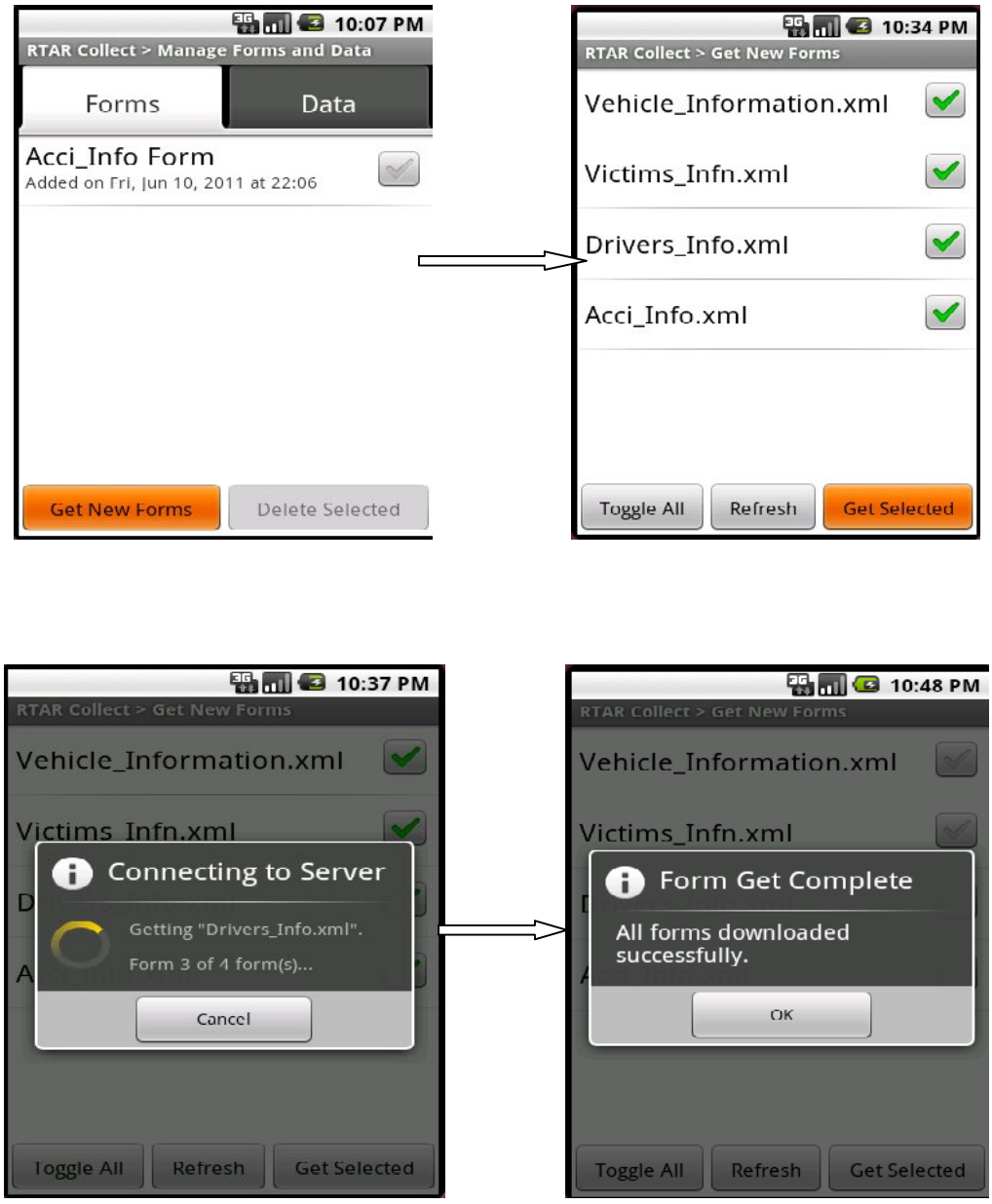
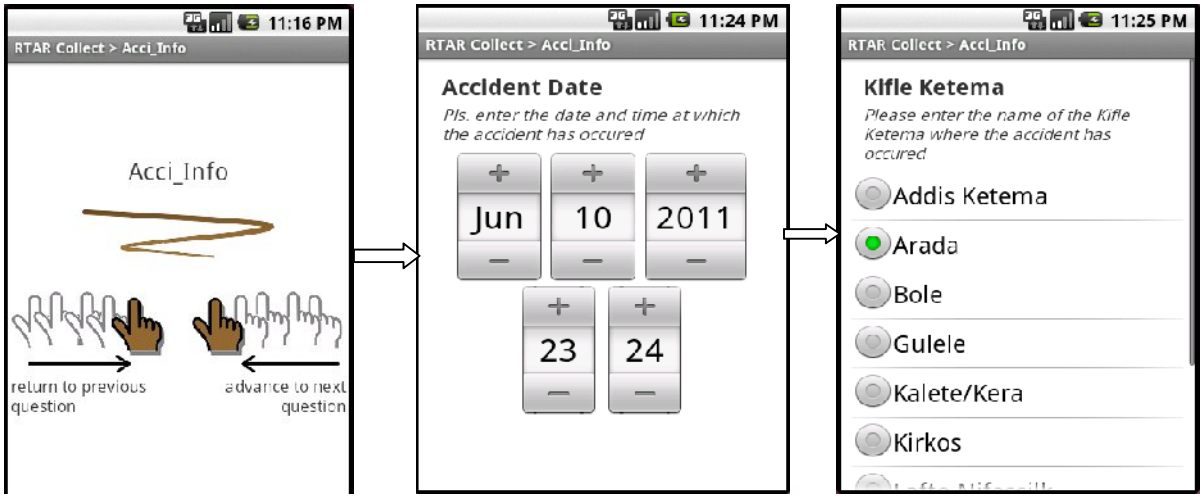


Figure 5.2: Downloading new forms

Whenever a traffic accident occurs, the police officer presses the Get New Forms button. When this button is pressed, a window containing the list of available forms is displayed as shown in the Figure 5.2. Then, the selected forms will be downloaded to the mobile.

Figure 5.3: Start filling form

The police officer starts collecting the details of the accident at scene using the downloaded forms by pressing the Start Fill Form button from the main menu window to display a window that contains the list of forms downloaded as shown in Figure 5.3 above.



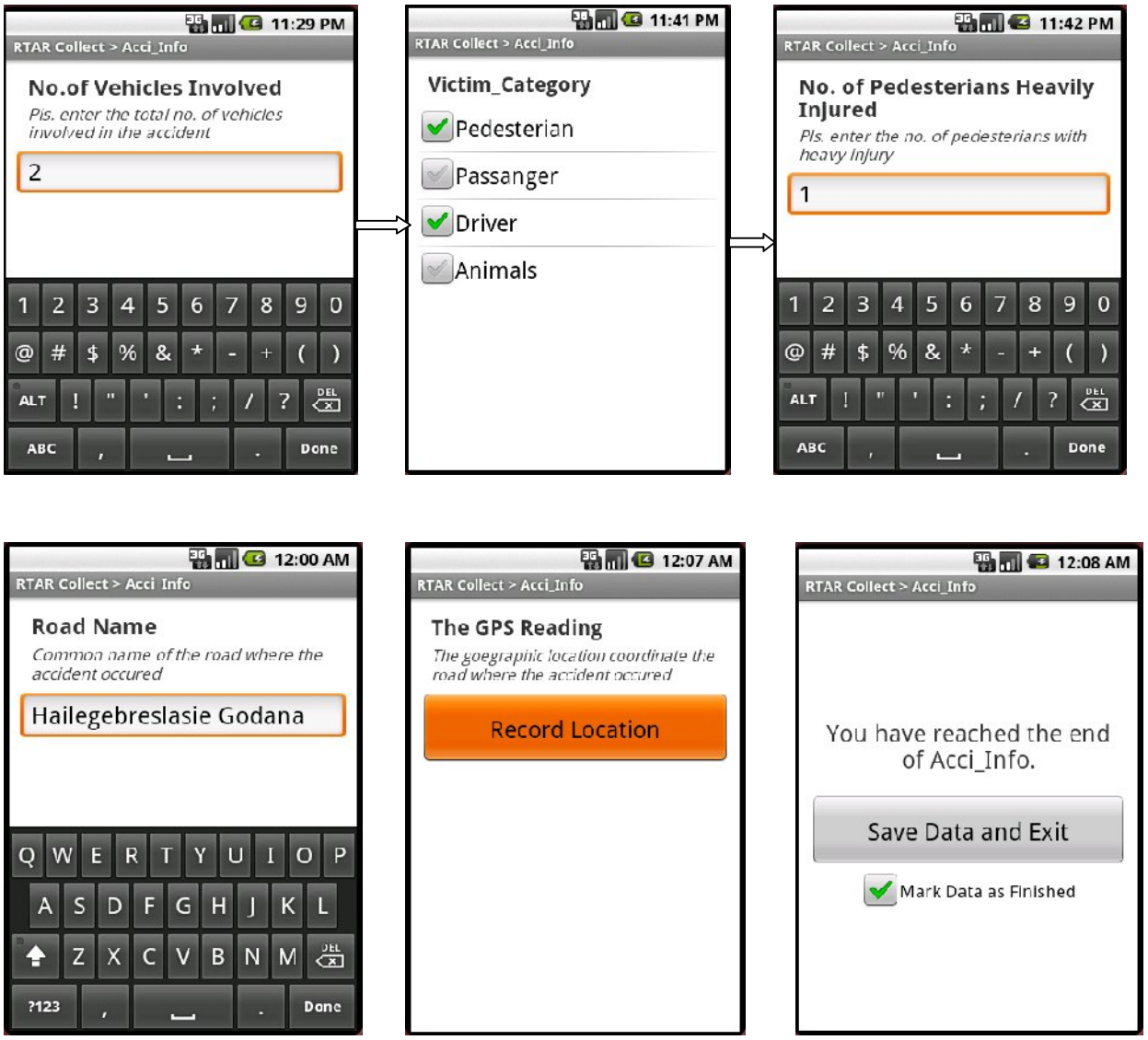


Figure 5.4: Sample windows of form filling activity

The police officer then starts recording the details with the respective form by selecting from the list and proceeds filling the fields as shown in Figure 5.4 above. The application displays a separate window for each fields of the accident detail.

When the police officer finishes recording the last field of the form, gets a window with the options to save and exit as completed data or to save and exit as incomplete data so that it must be reviewed. These are done by checking or uncheck the checkbox as shown in the Figure 5.4 above. If the police officer wants to review form data especially those that are marked as incomplete data, he/she presses the Continue Saved Form button from the main menu window

and gets the window the list of filled forms; both marked as complete and incomplete during recording the details of the accident as shown in Figure 5.5.

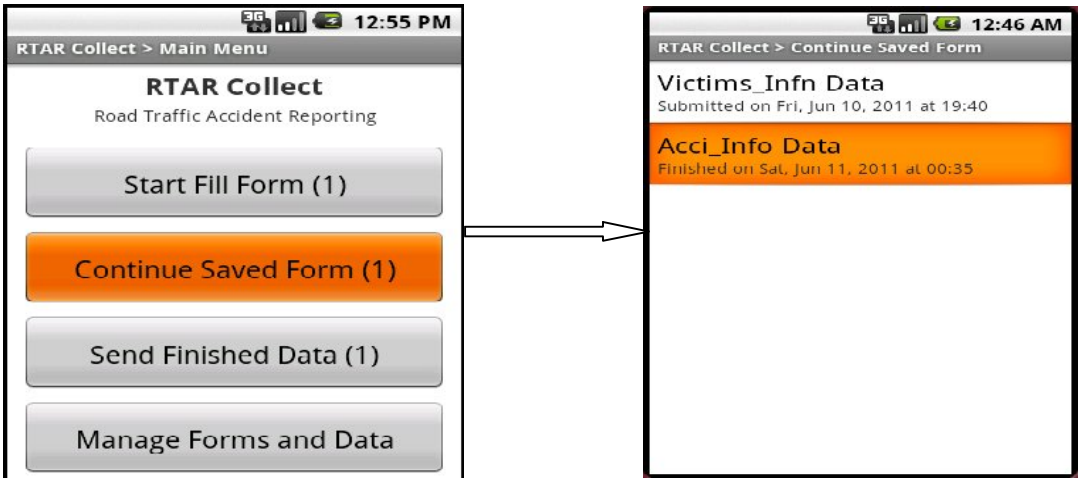


Figure 5.5: Review Filled Forms

When the police officer assures that the details about the accident is complete, he/she can send the data detail recorded using the forms by pressing the Send Finished Data button from the main menu window and selecting the forms to send as shown in Figure 5.6.

Figure 5.6: Sending Finished From Data

5.2.2 The Web Side Application

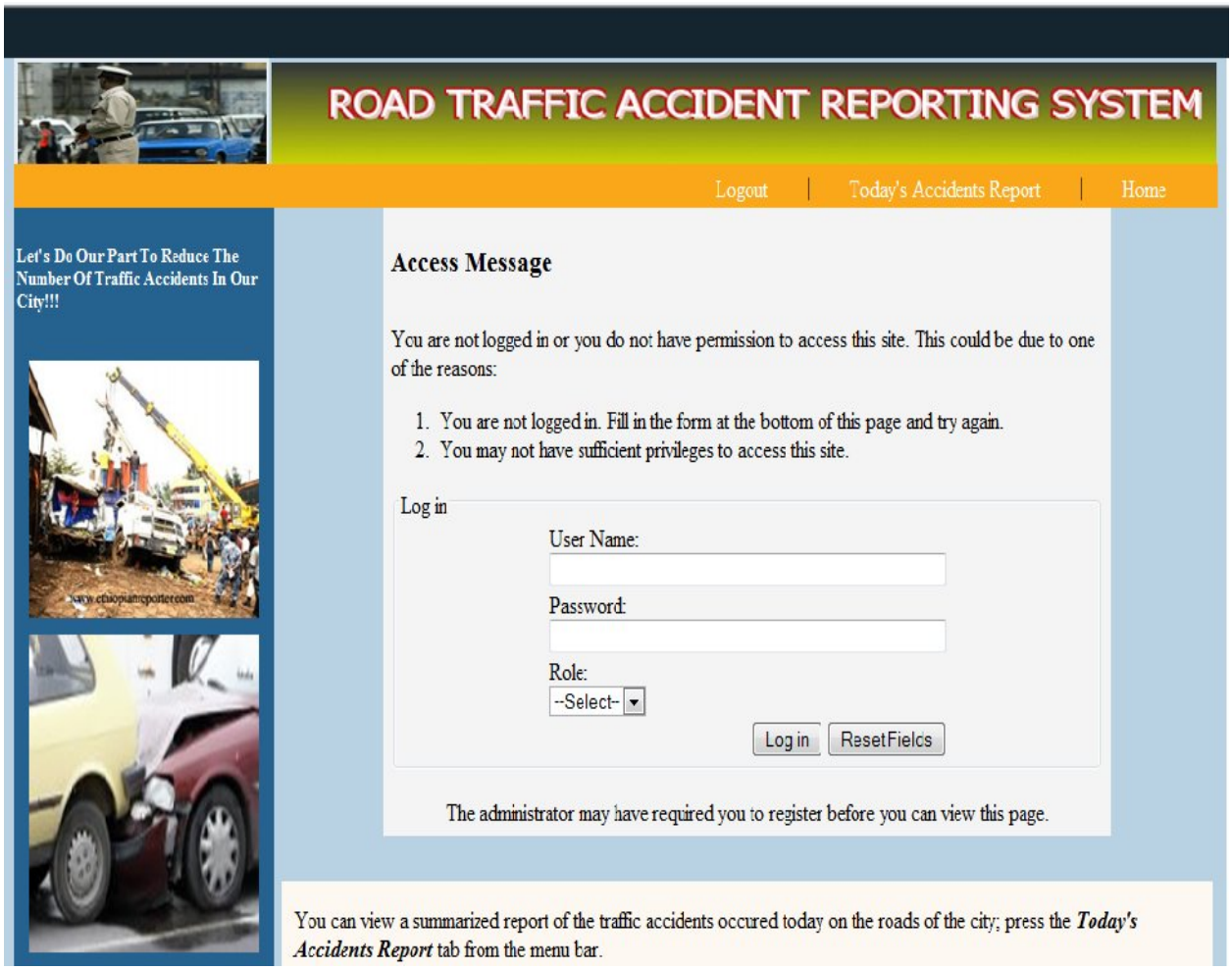


Figure 5.7: Main Page of the Web Application

The main page of the web application contains a form with fields; User Name, Password, and Role so that users can log into the application as a user with an administrator privilege or simple user account. The stakeholders will have account with role of "User" and individuals from the Addis Ababa traffic Police Commission with the responsibility of view submissions and generating different reports will have account with "Admin" role. Depending on the role of the user, different pages are displayed as shown below.

Figure 5.8: Administrator Privileged Users Main Page

For users with "Admin" role, the page shown in Figure 5.8 will be displayed; whereas for users with simple "User" role, the page shown in Figure 5.9 will be displayed.

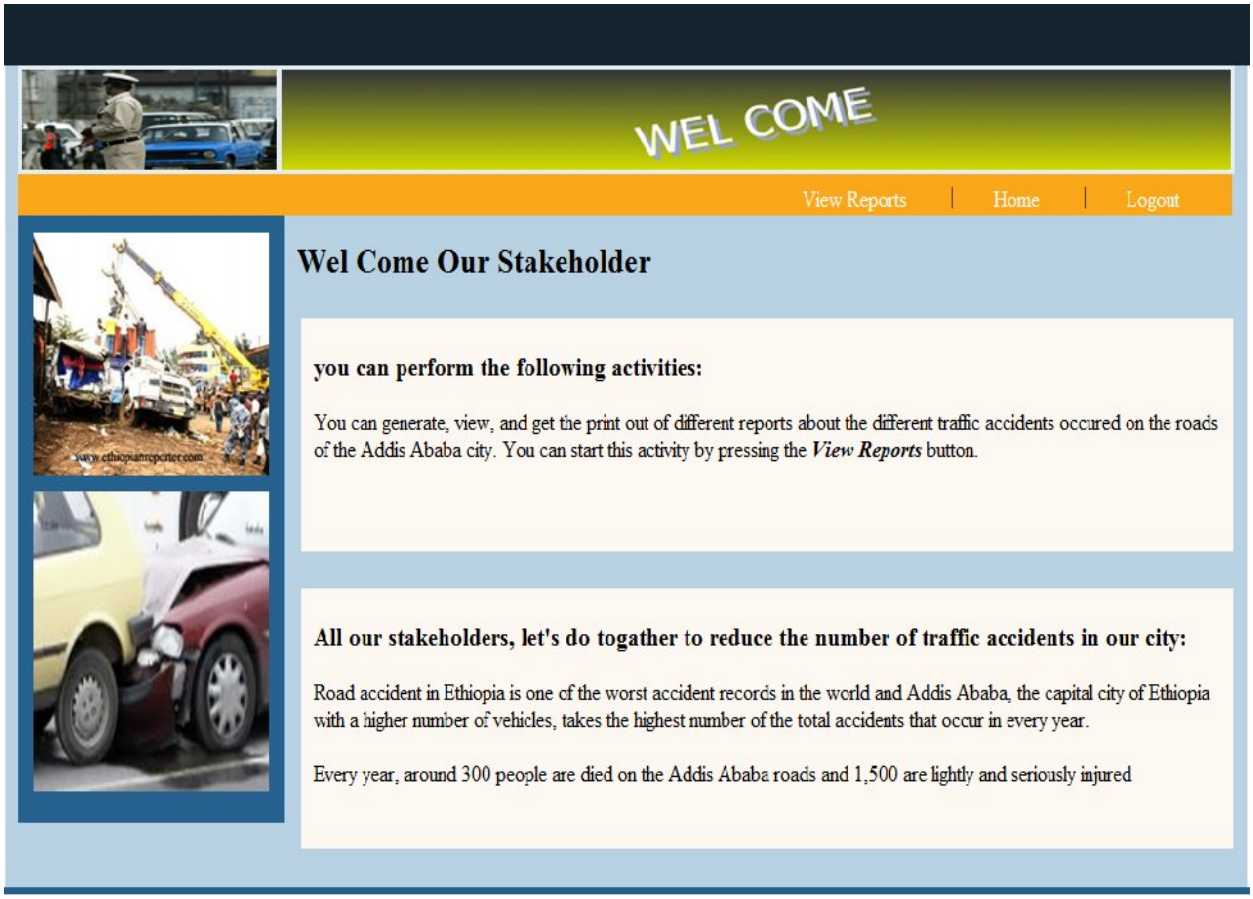


Figure 5.9: Registered User Main Page

User with an administrator account can view submissions and generate different reports by following the respective tab from the menu bar.

When the *View Submissions* tab is pressed, the page shown in the Figure 5.10 will be displayed. Then, by the selecting form, year, and month, the submissions for the selected form in that specific year and month will be displayed as shown in Figure 5.11.

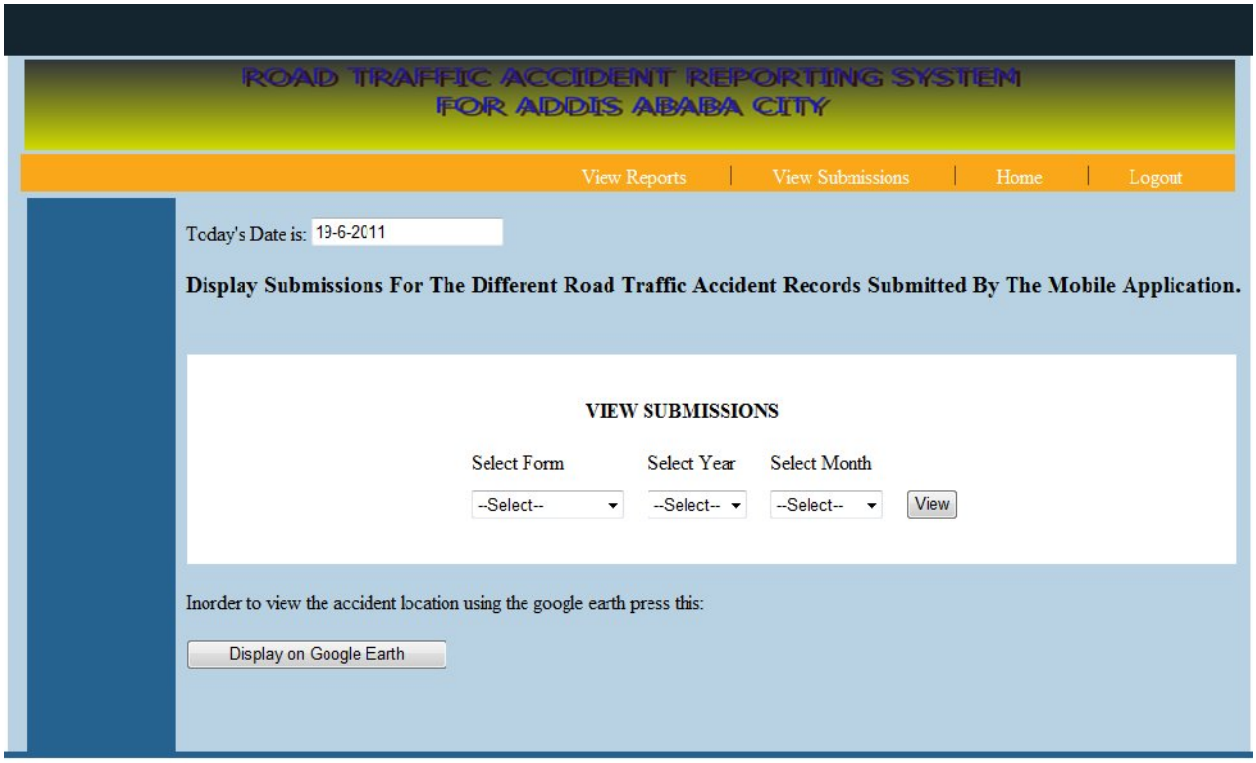


Figure 5.10: Submission view page

Figure 5.11: Sample Submission View for Victims Information Form

Both users with administrator and simple user account can generate and view different reports that are derived from the current different types of reports shown in appendix B, by pressing the *View Reports* tab from the menu bar. When this is done, the page shown in Figure 5.12 will be displayed. This page has a side bar with links that lead to different reports. For instance, if you want to generate and view annual summary report about victims, you click the link with the name *General Victims Report* to display a page that shows the respective summary report for that specific year as shown in Figure 5.13. The same is applied for the other report types. Those users with no account can also see some reports but the number of reports is limited as compared to those users with user account.

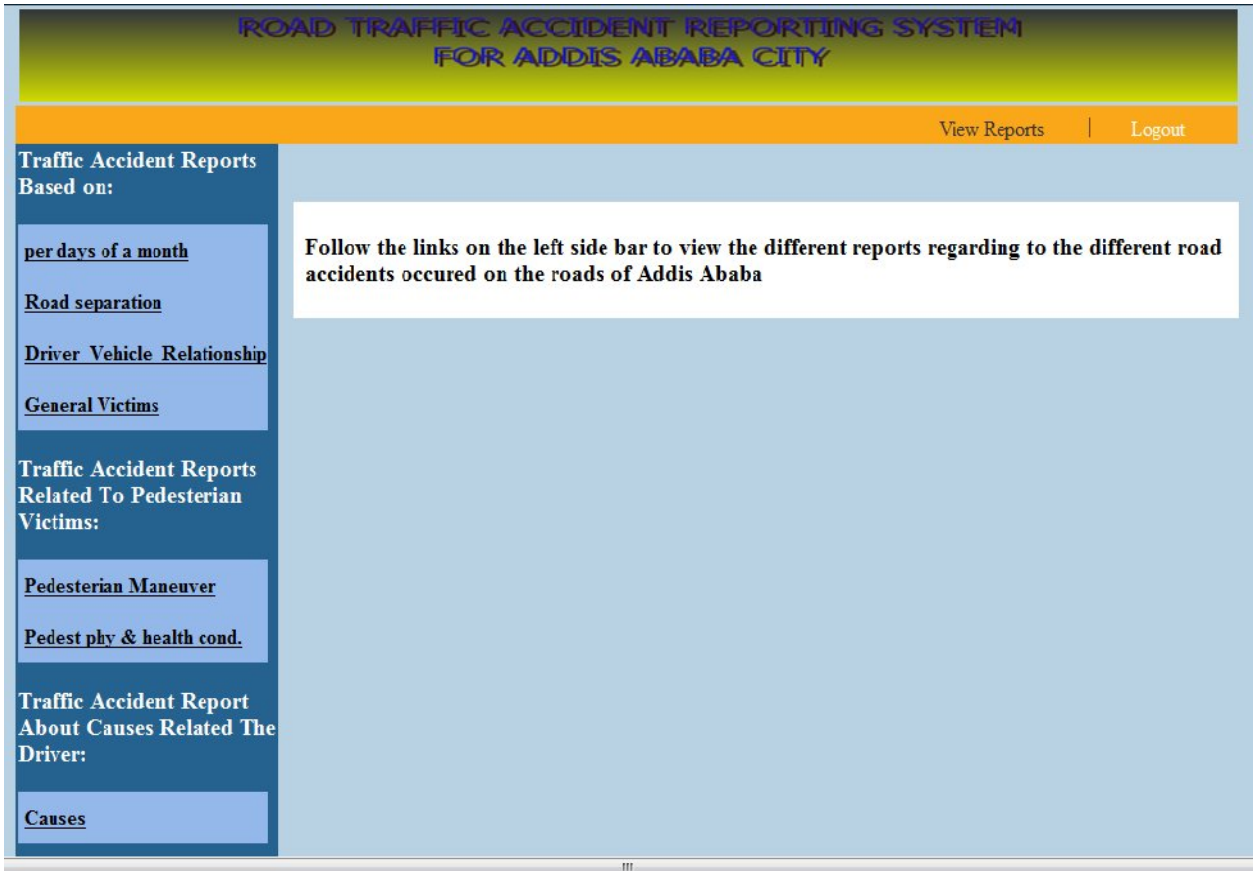


Figure 12: Report View Main Page

The administrator of the system can create/edit/delete accounts for the other users i.e. for those users responsible for managing submissions and generating reports and as well for the different

stakeholders in reduction of road traffic accident in the city. This is done by using the *Mange Users* tab from the menu bar which displays the page shown in Figure 5.14.

The table bellow shows the annual victims report for the year 2011 as a result of traffic accidents that occured on the roads of the Addis Ababa city.

Traffic Accident Summary Report For 2011

Victim_Category	Victim_Age	Death		High_Injuries		Slight_Injuries		Total
		Male	Female	Male	Female	Male	Female	
Driver	< 18 Years	0	0	0	0	0	0	**0**
	18-30 Years	0	0	0	0	0	0	**0**
	31-50 Years	1	0	0	0	0	0	**1**
	> 50 Years	0	0	0	0	0	0	**0**
	Total							**1**
Pedesterian	< 18 Years	0	0	0	0	0	0	**1**
	18-30 Years	0	0	2	0	0	0	**2**
	31-50 Years	1	0	0	0	0	0	**1**
	> 50 Years	0	0	0	0	0	0	**0**
	Total							**4**
Passanger	< 18 Years	1	0	0	0	1	0	**2**
	18-30 Years	0	0	1	0	0	0	**1**
	31-50 Years	0	0	0	0	0	0	**0**

Figure 5.13: Yearly Summary Victims Report

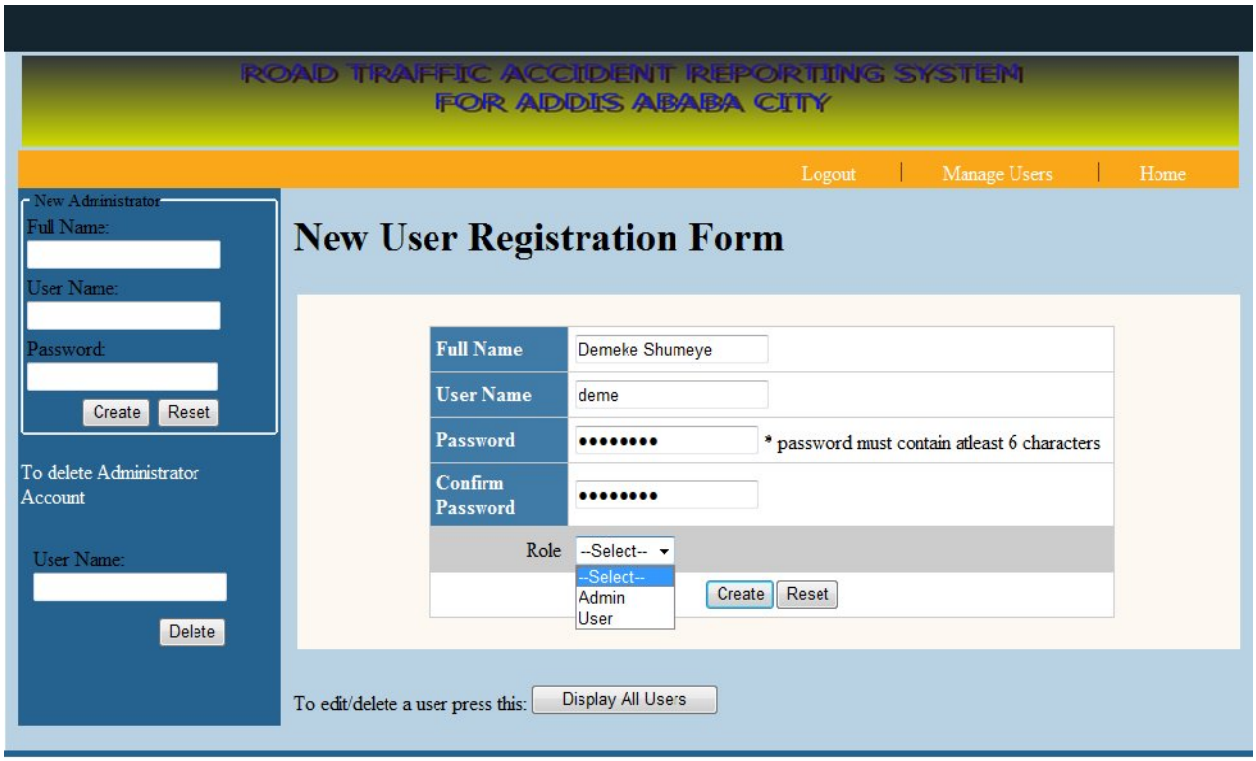


Figure 5.14: Manage Users Main Page

Since the system integrates the ability to include location data as a data item in the collected data detail, users can visualize each accident location using the Google Earth. This can be done by pressing the button *Display on Google Earth* to display the page shown in Figure 5.15. The page contains the field to map i.e. the GPS reading field, and as well the title field where users can select a field that will be used as a title for each accident location, a field to assign the maximum number of submissions to include in the display, and the picture field to assign for each accident location.

Figure 5.14: Displaying Submissions on the Google Earth

CHAPTER SIX: CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

Road accident in Ethiopia is one of the worst accident records in the world; and Addis Ababa, the capital city of Ethiopia with a higher number of vehicles, takes the highest number of the total accidents that occur in every year. Addis Ababa City Police Commission is the organization responsible for collecting the details of each traffic accidents occuring in the city.

To minimize the number of traffic accidents occuring each year in the city, it needs the participation of each stakeholders of road safty. But the current system of traffic accident data collecting, processing, and reporting is fully paper based and manual which makes it difficult to get reliable, accurate, and complete data about each accidents occuring in the roads of the city and for sharing of information among the stakeholders.

In this project, we developed a mobile based road traffic accident reporting system that makes the collection of road traffic accident detail be done by using an application that runs on an android mobile phone so that reliable and complete data be collected and send to the main road traffic accident datastore server that runs on a web server and where different stakeholders can share and access it via the Internet.

6.2 FUTURE WORK

Some of the possible future works that strengthens the system so that it will be more useful and be somewhat complete and as well be capable of supporting the different functionalities needed related to road traffic accident records are listed as follows:

- Since the system integrates the ability to record location data for each traffic accident record, it will be more important if it incorporates a GIS based system so that it will be easy to apply different spatial analysis operations.
- Integrating the road network map of the Addis Ababa city with the system to easily locate and identify the exact location for each traffic accident submission data.
- Making the system to work for every traffic accident occurring on every roads of Ethiopia.

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Declaration

This project work is my original work and has not been submitted as a partial requirement for a degree in any university.

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