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Development of a mobile application for road incident reporting in Kenya

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DEVELOPMENT OF A MOBILE APPLICATION FOR ROAD INCIDENT REPORTING IN KENYA

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Declaration

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

Ngichabe John Kulova

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Signed …….

Date …….

Approval

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Abstract

Road users lack a medium where they can report road incidents and complaints directly to the authorities concerned. The authorities lack concrete evidence to solve road incidents since there is no proper road incident reporting system. Road incidents happen everywhere but the witnesses to these road incidents lack a convenient and efficient method to report them. The frequency of road incidents that go unnoticed in Kenya is on the rise especially the hit and run incidents. Since there is no medium to report them, they go unaccounted for and hence the parties responsible are never held responsible. The witnesses to road incidents would rather leave the incident to chance rather than walking to the authorities responsible to report it because they have no convenience of reporting these incidents at the touch of a button. With the increase of smart phones in Kenya, an opportunity exists because of the untapped gap of incident reporting.

The proposed solution was to develop a mobile application that can be used to report road incidents. The mobile application was developed on the Android platform. It was developed concurrently with a web application developed in PHP and JavaScript languages to supplement its functionality. The testing of the application was successful and it was strongly agreed by the respondents that the system would be effective in reporting road incidents. Thus the mobile application comes in handy to provide a solution to the way users report road incidents. The recommendations made by users were used to improve the application. The application will allow users to report incidents that happen on the roads. Based on the overall statistics of user testing and evaluation, it is safe to say that the application fulfills its simplicity and usability requirement. Based on the questionnaire responses, the application is generally considered easy to understand and use. The implication of the results of application testing is that the application will come in handy in reporting road incidents thus improving road safety.

Keywords: Report, mobile, road incidents, Web application

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Acronyms/Abbreviations

DIP	-	Document Image Processing
ERD	-	Entity Relationship Diagram
FIR	-	First Information Report
GIS	-	Geographic Information System
GPRS	-	General Packet Radio Service
GPS	-	Global Positioning System
GSM	-	Global System for Mobile
IDE	-	Integrated Development Environment
IT	-	Information Technology
MARS	-	Mobile Accident Reporting System
OCR	-	Optical Character Recognition
OS	-	Operating System
PHP	-	Hypertext Preprocessor
RADaR	-	Road Accident Data Recorder
RTA	-	Road Traffic Accident
SMS	-	Short Message Service
SQL	-	Structured Query Language
TRRL	-	Transport Research Laboratory
WHO	-	World Health Organization

Definition of Terms

Android -A Linux-based operating system designed primarily for touch-screen mobile devices such as smart phones and tablet computers (InfoBridge , 2013).

Infrared light -Light is electromagnetic radiation with longer wavelengths than those of visible light, extending from the nominal red edge of the visible spectrum (Boundless, 2015).

Radar -An object detection system that uses radio waves to determine the range, altitude, direction, or speed of objects (Arlo Maritime, 2013).

Road incidents -In this study, road incidents refer to road accidents, over speeding, carjacking and reckless driving (Lebowitz & Mzhen, 2014).

Server -A physical computer dedicated to run one or more services, to serve the needs of the users of other computers on a network (Integrated Device Technology, 2014).

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Chapter 1 - Introduction

1.1. Background

Kenya has seen the increase in the use of the Internet and mobile phones. According to the statistics, the number of mobile subscribers in Kenya has seen the increase in the use of the Internet and mobile phones. According to the statistics, the number of mobile subscribers in Kenya has grown by 1.7% between March 30 and June 30 in the year 2012 with an estimated 13.5 million Internet users (Xinhua, 2012). Due to this, a large number of the population travels with their mobile phones and are in constant communication. Previous researches have shown that road safety has been put to trial as far as road incidents are concerned. Road incidents refer to road accidents, carjacking, over speeding and reckless driving (Raper, 2009).

The World Health Organization predicts global road safety fatalities to rise to 2.4 million per year by 2030 (World Health Organization, 2009). According to WHO, the current trend, if there is failure to act, will translate to almost 8000 deaths per year on our roads by 2030 (Gachuru, 2010).Out of 100,000 vehicles, about 510 are involved in fatal accidents in Kenya compared to 260 in South Africa and 20 in the UK. 65% of deaths involve pedestrians and 35% of pedestrian deaths are children (Manoa, 2009).

Road crashes cost approximately 1 to 3 percent of a country's annual Gross National Product (GNP). These are resources that no country can afford to lose, especially those with developing economies. It is estimated that developing countries currently lose in the region of $100 billion every year. This is almost twice as much as the total development assistance received worldwide by the developing countries. These losses undoubtedly inhibit the economic and social development of developing countries. An estimate of the total national cost of road accidents will help governments to realise the heavy economic losses being incurred annually. Governments must try to reduce these losses by providing road safety improvements and should see expenditure on road safety as an investment and not as a cost.

Every year more than 1.17 million people die in road crashes around the world. The majority of these deaths, about 70 percent occur in developing countries. Sixty-five percent of deaths involve pedestrians and 35 percent of pedestrian deaths are children. Over 10 million are crippled or injured each year. It has been estimated that at least 6 million more will die and 60

million will be injured during the next 10 years in developing countries unless urgent action is taken. The majority of road crash victims (injuries and fatalities) in developing countries are not the motorised vehicle occupants, but pedestrians, motorcyclists, bicyclists and non-motorised vehicles (NMV) occupants (World Health Organization, 2009).

The Global Burden of Disease study undertaken by the World Health Organisation (WHO), Harvard University and the World Bank showed that in 1990, traffic crashes were assessed to be the world's ninth most important health problem. The study forecast that by the year 2020 road crashes would move up to third place in the table of leading causes of death and disability facing the world community. A national medium or long term road safety plan is a prerequisite for achieving sustainable improvements in road safety. The plan should set measurable long term and mid-term road safety targets, build capacity of local institutions, and provide alternative sources of financing for road safety measures.

Safety intervention programmes on a pilot or demonstration basis are quite effective as learning curves and lessons can be quickly realised. Kenya currently has one of the world's highest rates of deaths related to road accidents. Motorbike accidents account for a large proportion of these deaths and as the popularity of motorbikes increases, this number is only getting higher (Borgen Magazine, 2013).

1.2. Problem Statement

Road incidents happen everywhere, but the witnesses to these road incidents lack a convenient and efficient method to report them. The frequency of road incidents that go unnoticed in Kenya is on the rise especially the hit and run incidents. Since there is no medium to report them, they go unaccounted for and hence the parties responsible are never held responsible.

Road users lack a medium where they can report road incidences directly to the authorities concerned. The authorities lack concrete evidence to solve road incidents since there is no proper road incident reporting system. Currently, the total number of mobile subscribers in Kenya stands at 32.8 million, increasing the penetration of mobile telephony services to 80.5% (Communication Authority of Kenya, 2014). Previous research has been done on how to improve on the efficiency of the traffic agencies to enforce safety on Kenyan roads. Many policies have been enacted to curb road carnage but still many incidents still happen and do not

reach the appropriate agencies in time. These indications show that incident reporting is problem thus there is a great potential for a mobile application to report the incidents as they occur.

There are several incidents, which happen and go unrecorded or even not reported because a mobile application lacks for recording and reporting the road incidences to the appropriate authorities.

1.3. Research Objectives

i. To assess the current technological methods used in road incident reporting.
ii. To review related designs, architectures and models of incident reporting.
iii. To develop a mobile application for reporting road incidences in Kenya.
iv. To test the application with the road users.

1.4. Research Questions

i. What are the current methods used for road incident reporting?
ii. How are the related designs, architectures and models of the incident reporting implemented?
iii. How can the mobile application be used to report road incidences?
iv. How can the feedback of the developed solution be used to improve the application?

1.5. Justification of the study

The significance of this study was to establish the how a mobile application can be used to report road incidents. With a proper road incident reporting system, road users can report any road incidents that pose a threat to road safety on our Kenyan roads. This will consequently assist the authorities to track and resolve reported road incidents.

1.6. Scope

This research was limited to developing a mobile and web application that enables users to report any road incident in real time. The target market for the application includes all the road users, onlookers and the authorities. The application was developed on Android platform. This study was conducted within Nairobi's urban population which was easy to reach and which was envisaged to be the primary target market for the application.

1.7. Limitations

The following were the limitations as far as this research was concerned:

i. The developed application was limited to the Android platform only and the target users are assumed to have android devices.

ii. The audience was also limited to Nairobi area.

Chapter 2: Literature Review

2.1Introduction

This chapter explores the literature review on similar systems used to report road incidents. It also focused on their structure and architecture as well as their implementation. Other systems that are not necessarily meant for road incidents are also discussed in this chapter.

Some of the systems which are discussed here include the road accident reporting computerized system which is used to assess accident situation in Thailand. In Kenya, Nduru which is a mobile application was developed with intention to end road carnage in East Africa. Also discussed in this chapter is a vehicle speed reporting system.

Safety intervention programmes on a pilot or demonstration basis are quite effective as learning curves and lessons can be quickly realised. Kenya currently has one of the world's highest rates of deaths related to road accidents. Motorbike accidents account for a large proportion of these deaths and as the popularity of motorbikes increases, this number is only getting higher (Borgen Magazine, 2013). In Kenya, Nduru which is a mobile application was developed with intention to end this road carnage and extend to East Africa.

Stationary red light cameras collect all of the evidence authorities needed to prosecute light-runners at intersections since they record the violation of traffic laws. RADaR is a mobile application developed for Android tablet, for paper-less accident data collection digitally, from the accident site/scene. The system will operate with a central web-based server for data storage. A Mobile Accident Reporting System (MARS) is a GIS solution that has mobile and web components. It is used to record roads accidents both visually and spatially, and provide web clients with a map showing the locations of the latest car accidents as points on that map (Al-Nasser, 2010).

Also discussed is the National Incident Based Reporting System (NIBRS) which is an incident-based reporting system for crimes known to the police (Federal Bureau of Investigation, 2010). In Ohio, an Incident-Based Reporting System (OIBRS) is a voluntary crime reporting program in which Ohio law enforcement agencies can submit crime statistics directly to the state and federal government in an automated format. In Tennessee, an Incident Based Reporting System (TIBRS) has been adopted an incident based reporting system designed to collect data on

every single crime occurrence and on each incident and arrest within the occurrence (Tennessee Bureau of Investigation Crime Statistics Unit, 2011).

2.2 Trends in Road Traffic Accidents (RTA)

Kenya Police reports indicate that on average one in ten people involved in a RTA die instantly. Equally significant is the fact that every other person who dies is a pedestrian according to Table 2.1. As of 2013 the average number of deaths on Kenya roads was about 3000 a year.

Table 2.1 Deaths on Roads: Jan-July 2013 (Manyara, 2013)

Category	Number	Percentage
Pedestrians	835	46.7%
Passenger (4-wheeled vehicles)	452	25.3%
Drivers (4-wheeled vehicles)	166	9.3%
Motor Cycle Riders	175	9.8%
Bike Passengers	81	4.5%
Pedal Cyclists	79	4.4%
TOTAL	1788	100.0%

Since independence (1963) road transport in Kenya continue to be the predominant mode of transport carrying about 93% of all cargo and passenger traffic. Available data show that the government has greatly improved the major road networks especially in the 1990s. As of 2012 the road network was estimated at 160,886 km of which 61,936 km is classified roads. Studies show that the causes, frequency and severity of road traffic injuries attributed to a poor driving culture, badly designed and neglected roads, and inadequate enforcement of existing traffic laws (Manyara, 2013).

Based on the Accident Cause Code Classification, Kenya Police reports reveal that 85.5% of crashes are caused by poor driver behavior, of which driver error represents 44.4%, pedestrians and passengers 33.9% and pedal cyclists 7.2%. Other proximal factors include

vehicle defects 5.1%, road environment 2.9%, and other factors 6.4% (Odero, Khayesi, & Heda, 2003). Table 2.2 shows the causes and percentages of traffic crashes in Kenya.

Table 2.2 Causes and Percentages of Traffic Crashes in Kenya (Odero, Khayesi, & Heda, 2003)

Causes(specific factors)	**Particulars**	**1990**	**1985-90**
Human -(speed, misjudgement, improper overtaking, alcohol, traffic violation)	Drivers and motor cyclists	44.4	44.3
	Pedestrians	27. 1	27.4
	Passengers	6.8	6.7
	Pedal cyclists	7.2	5.9
Subtotal		85.5	84.3
Vehicle - (overload, defective breaks, tires, steering system, headlights, tire burst)	Tires or wheels	2.5	2.2
	Other defects	2.6	3.9
Subtotal		5.1	6.1
Traffic Environment - (potholed, sharp/steep bends, slippery road)	Road defects	1.3	1 .4
	Animals	0.7	0.9
	Obstruction	0.5	0.8
	Weather	0.4	1 .4
Subtotal		2.9	4.5
Other Causes		6.4	6.2

In its 2012 report the World Health Organization (WHO) identified five key road safety risk factors: speeding, drunk–driving, non-use of helmets, non-use of seat-belts and the absence of child restraints. According to the report only 7% of the world's population is covered by comprehensive legislation for all five risk factors. Although the Kenya law addresses all the aforementioned factors, the challenge is in implementation.

2.3 Road Incident Reporting Systems

Several incident reporting systems are presented and analyzed focusing on the architecture and highlighting the similarities and differences. The limitations of these systems are also noted.

2.3.1 Road Accident Reporting Computerized System in Thailand

The computerized system was developed as a supplementary tool for assessing the accident situation in Thailand. The accident under-reporting, accident reported matching and accidents during holiday festivals were performed to present more precisely about the accident situation in Thailand. The sectors that have taken care of accident data normally provide the valuable information to decision maker in order to support them establish the strategies, safety campaigns, safety programs, the action plans, or any countermeasures for road safety. The accident reporting system was developed to understand more about the natures of data, tasks, issues, and the output of the system. There are three parts including accident under reporting, accident rate, and accident during festival. The main purpose of the accident reporting system is to support the road safety program in order to evaluate and summarize the accident data from concerning organizations (Ponboon, 2005). The system architecture is illustrated by figure 2.1 below.

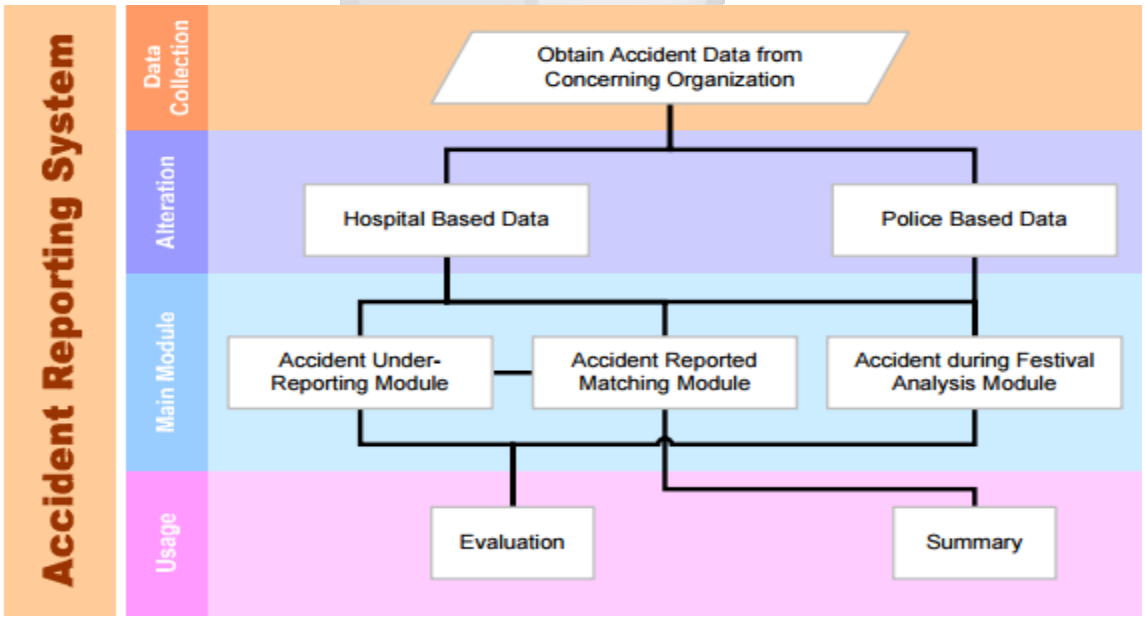

Figure 2.1Thailand reporting system architecture (Ponboon, 2005)

2.3.2 Kenya's Nduru Road Safety App

Nduru, a mobile app intended to end road carnage in East Africa, is now available for Android devices. Nduru promises to manage almost all incidences related to road safety. It gives road users the ability to take charge of their safety through the mobile phone, allowing them to flag situations that could potentially lead to an accident before they do. The app also has a "speedometer" that helps passengers detect the speed of the vehicle. If the vehicle exceeds the 80 kilometres per hour speed limit, users can report the vehicle to the police. It also has audio and text tutorials that help users administer first aid to victims (Wakoba, 2012). Figure 2.2 shows some of the functionalities that Nduru app offers

Figure 2.2: Nduru Mobile Application (Wakoba, 2012)

2.3.3 Vehicle Speed Reporting System

Speed enforcement techniques include mobile and stationary radar, laser speed measurement devices, aerial enforcement and mobile patrols. In general, common manual and stationary speed enforcement involves a configuration that includes an observation unit, typically an unmarked police car more or less hidden at the roadside, and an apprehension unit comprising of one or more clearly visible marked police cars. The observation unit is equipped with a measurement device such as radar or a laser device and possibly a documentation device such as a still or video camera. Radar units use high frequencies to measure the speed of target vehicles approaching or receding from a stationary or moving patrol vehicle while laser instruments use pulses of infrared light to measure the speed. Speeding vehicles are detected at the first station, their description is relayed to the apprehension unit downstream, which flags them to stop and issues citations to drivers (U.S. Department of Transportation, 2008). Figure 2.3 shows the vehicle speed reporting system.

Figure 2.3: Speed Reporting System (U.S. Department of Transportation, 2008)

2.3.4 Red Light Camera Systems

Stationary red light cameras collect all of the evidence authorities needed to prosecute light-runners at intersections. A picture of the number plate of the offending vehicle and a picture of the driver's face are taken. The system is immobile; a second camera is needed for the picture of the driver's face. In a typical red-light system, cameras are positioned on poles at the corners of an intersection, pointing inward to photograph cars driving through the intersection. Generally, a red-light system has cameras at all four corners of an intersection, to photograph cars going in different directions and to get pictures from different angles. Red-light systems use film or digital cameras. The traffic signals and the triggers of the system are constantly monitored. If a car sets off a trigger when the light is red, two pictures at the edge and in the middle of the intersection are taken to record the violation (Thematic Network, 2006).

2.3.5 A Mobile Accident Reporting System (MARS)

MARS is a GIS solution that has mobile and web components. It is used to record roads accidents both visually and spatially, and provide web clients with a map showing the locations of the latest car accidents as points on that map. Also, users of the web client have the ability to show the photos taken by reporters for the selected accident in addition to other information such

as the vehicles involved or if there are any injuries (Al-Nasser, 2010). The structure of MARS is as shown in Figure 2.4.

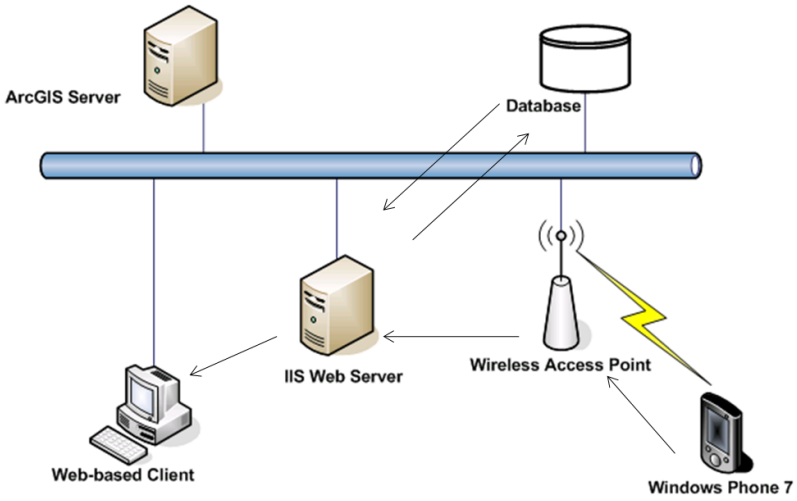

Figure 2.4: MARS System Architecture (Al-Nasser, 2010)

The MARS Mobile Component is used by the accident reporter on the site to record the information related to the accidents, such as, location, vehicles involved and photos. The application has been developed using the recently released Windows Phone 7 platform that supports high-resolution cameras. Users, can add or compose a new report, and save or edit the created reports. They also can browse both saved and sent reports. This approach leads to a more intuitive application and reduces learning time (Al-Nasser, 2010). The accident image uploading page is shown by Figure 2.5.

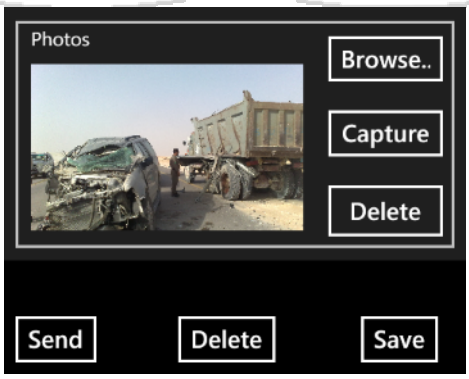

Figure 2.5: MARS Accident Image Uploading Page (Al-Nasser, 2010)

The website is the front end that is accessed by the web users. Its main objective is to provide users with querying capabilities that facilitate the generation of accident locations. Figure 2.6 shows the MARS web interface.

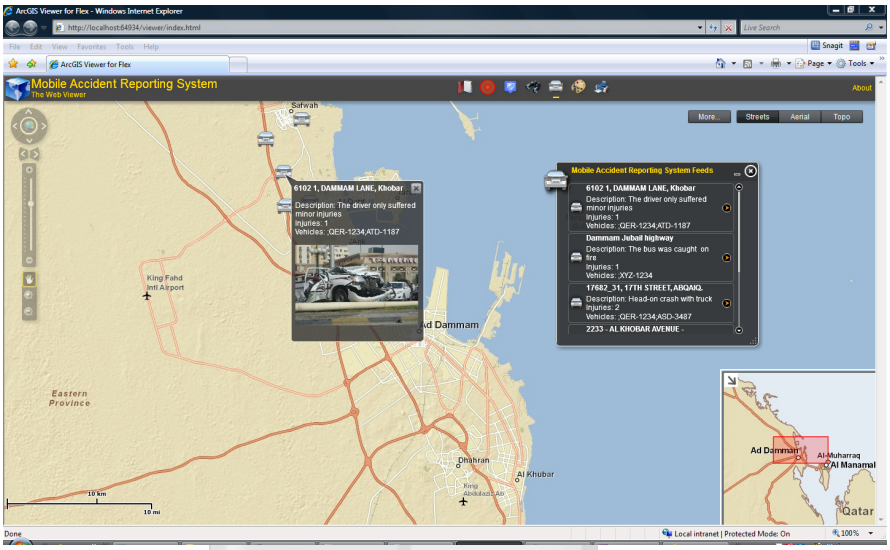

Figure 2.6: MARS Web Interface (Al-Nasser, 2010)

2.3.6 The RADaR Application (An Innovative Tool for Scientific Accident Data Recording)

The Road Accident Data Recorder (RADaR) is an innovative application developed for the purpose of accident data (crash data) recording, which is otherwise carried out manually by concerned police personnel. RADaR is a mobile application developed for Android tablet, for paper-less accident data collection digitally, from the accident site/scene. The system will operate with a central web-based server for data storage (International Road Federation, 2008). The structure of RADaR is shown by Figure 2.7 below.

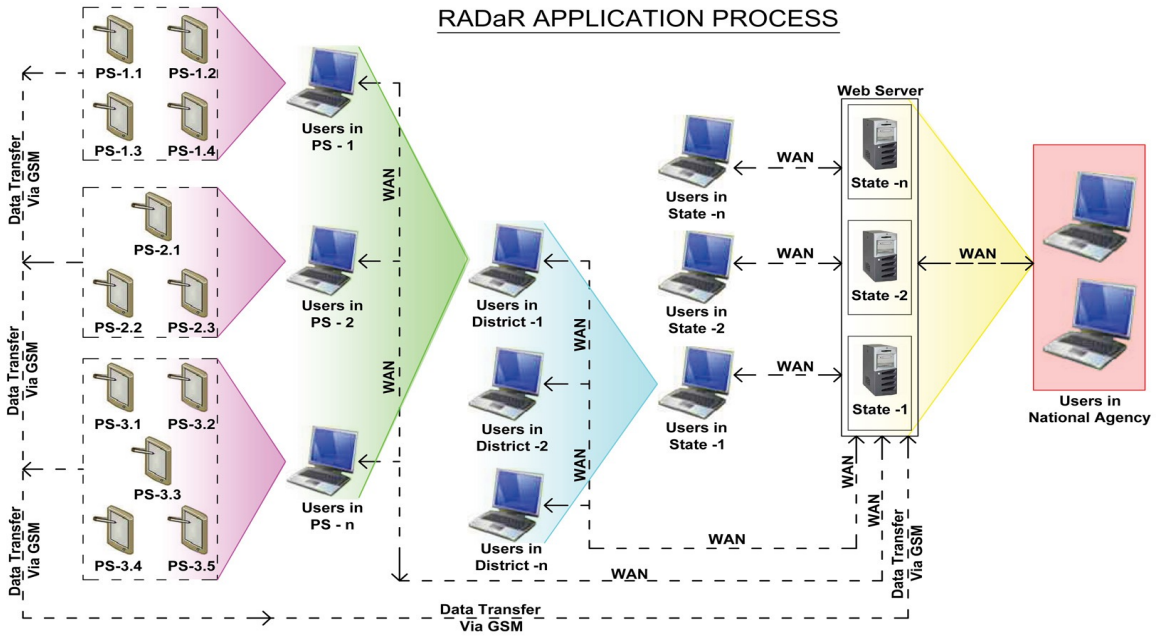

Figure 2.7: Structure of RADaR (International Road Federation, 2008)

2.3.7 A Road Traffic Accident Reporting System Using Business Process Simulation Case Study

The new system aims to provide timely statistical analysis of traffic behavior to government bodies and to enable more effective utilization of traffic police personnel. The case study investigates the computerization of an RTA system at a Police Force level. The drivers behind the change are to both reduce the cost of the process and increase process execution speed. These objectives are to be met using digital technology to collect and transmit data to a central database, where in combination with information from a geographical information system (GIS) it can quickly provide internal and external agencies with relevant RTA information. Cost savings are to be made from the reduction in RTA officer hours in returning to base to collate and disseminate information and from the centralization of administrative services leading to more efficient processes (Greasley, 2004).

The information is transmitted by a mobile link to a geographical information system (GIS) which provides accurate location analysis of both injury and non-injury incidents using the geocode system. The geocode system is a network of grids covering the UK that allow a location

to be assigned within a $10m^2$ area. The GIS system will combine the accident location analysis with data relating to the location of pelican crossings, traffic lights, street parking and anything else that might contribute to accidents or affect schemes being proposed. Along with data on details on road conditions at the time of the accident this information will help determine a prioritized list of road safety improvement measures (Greasley, 2004).

2.3.8 National Incident-Based Reporting System (NIBRS)

The National Incident Based Reporting System (NIBRS) is an incident-based reporting system for crimes known to the police. For each crime incident coming to the attention of law enforcement, a variety of data are collected about the incident. These data include the nature and types of specific offenses in the incident, characteristics of the victim(s) and offender(s), types and value of property stolen and recovered, and characteristics of persons arrested in connection with a crime incident. Incident-based data provide an extremely large amount of information about crime. The information is also organized in complex ways, reflecting the many different aspects of a crime incident (Federal Bureau of Investigation, 2010).

2.4 Ohio Incident-Based Reporting System

The Ohio Incident-Based Reporting System (OIBRS) is Ohio's version of the FBI's National Incident Based Reporting System (NIBRS). OIBRS is a voluntary crime reporting program in which Ohio law enforcement agencies can submit crime statistics directly to the state and federal government in an automated format. This process has replaced the UCR/Summary reporting process in many areas of the state. Our most important goal is not only to report crime statistics to the FBI, but to provide benefits for law enforcement agencies participating in OIBRS. OCJS has upgraded the repository and crime mapping solutions to provide better usage of the data. The upgraded repository provides advanced queries and reports for improved analysis. Crime mapping is also providing to be an excellent tool for analysis of crime (Ohio Department of Public Safety, 2011).

2.5 Tennessee Incident Based Reporting System (TIBRS)

TIBRS is an incident based reporting system designed to collect data on every single crime occurrence and on each incident and arrest within the occurrence. The most significant difference between TIBRS and the traditional UCR system is the degree of detail in reporting.

Unlike the summary system that collects only eight crimes, TIBRS collects 22 crime categories made up of 47 specific crimes called Group A offenses. Additionally, arrests are reported for 11 Group B offense categories. In TIBRS up to 10 offenses can be reported in an incident, providing a more accurate picture of crime. The goals of TIBRS are to enhance the quantity, quality and timeliness of crime data collection by law enforcement and to improve the methodology used for compiling, analyzing, auditing and publishing crime data. A major advantage of TIBRS is the capability to break down and combine crime offense data into specific information. All law enforcement agencies as well as colleges and universities report their monthly crime statistics to the TBI. The TBI then reports those law enforcement statistics to the FBI (Tennessee Bureau of Investigation Crime Statistics Unit, 2011).

2.6 An Android Application for Disaster Response Management in India

The application which is used to support flash flood disaster management possesses the following functionalities:

i. Reporting system in which the application allows rescue workers to report incidents and other information when needed. Such reports can be about people rescued, resources required, information about disaster and an assessment of its impact.
ii. Two reports used for this functionality are the first incident report and summary report.
iii. Emergency/distress call from which the application allows an immediate call be made to an emergency response office. Request can be about an airlift (evacuation or medical aid) or a need for more resources (rescue workers or materials).
iv. Disaster alert in which weather-related information is prepared for any further chances of disaster. The importance of the application is that it allows visualization of current weather and weather forecast updates.
v. Geo-visualization System from which the map viewer visualizes the current user's location, nearby amenities, weather information and spatial extent of the disaster.

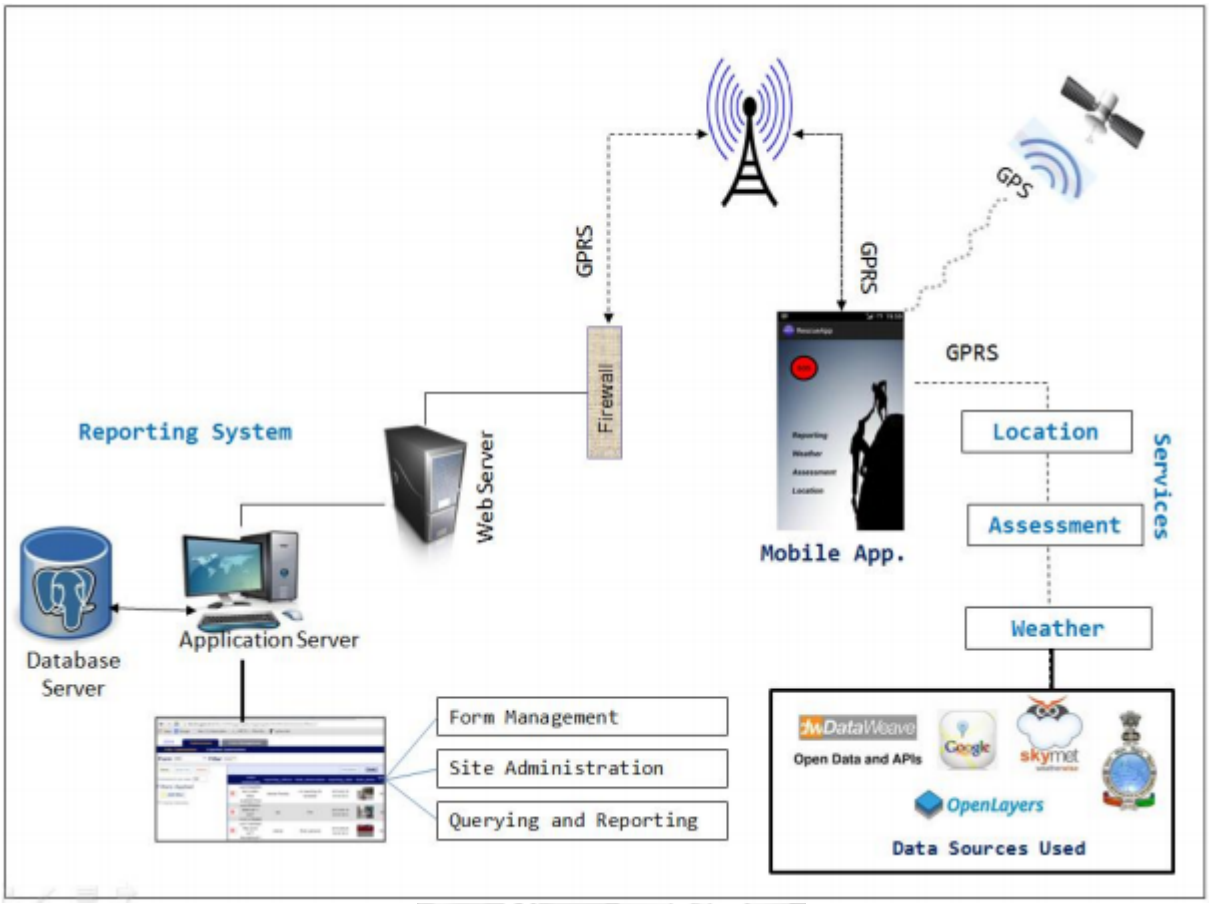

Figure 2.8 Information Flow in the Application (Tanya, 2014)

Figure 2.8 shows the communication flow between the client (mobile application) and server application. The reporting system uses GPRS to connect to web server. The other functions of emergency/distress call, disaster alerts and geo-visualization are achievable through SOS (commonly used description for distress signal), weather, and location and assessment services. The data sources used are displayed in the information flow diagram. For these services too, the mobile application uses GPS to retrieve and display location and GPRS to connect to the various data sources used. Once data is received at the server from the mobile application, it is updated into the integrated database. Querying and reporting access allows user to apply SQL queries on the database and generate specific reports for planning and decision- making (Tanya, 2014).

2.7 A mobile solution for Road Accident Data collection and Presentation

A number of accident databases have been built in other countries and others have been proposed by scholars. However, their data is not shared by non-member states and are not applicable to a Kenyan or African scenario. It is also noted that an accident database cannot be deployed as a standalone system. Data must be obtained from other subsystems such the driving license, driver penalty point and motor vehicle registration (Derdus, 2014).

2.8 Conclusions

The literature review outlined in this chapter has fed into the design of the mobile incident reporting system in the following areas:

a) Geo-mapping of incidents reported onto Google maps.
b) The mobile phone as a reporting tool.
c) The system will operate with a central web-based server for data storage.
d) Gathering of data is done via crowdsourcing techniques.

Chapter 3: Research Methodology

3.1 Introduction

This chapter is concerned with the methodology of the software in development process of the application. The chapter focuses on the Business Study, Feasibility Study, System Analysis and Design Methods, Implementation Methods, Testing and Evaluation Methods employed.

3.2 Software methodology

The System Design method implemented was the Waterfall software development methodology. The advantage of waterfall development is that it allows for departmentalization and control. A schedule can be set with deadlines for each stage of development and a product can proceed through the development process model phases one by one. Development moves from concept, through design, implementation, testing, installation, troubleshooting, and ends up at operation and maintenance. Each phase of development proceeds in strict order.

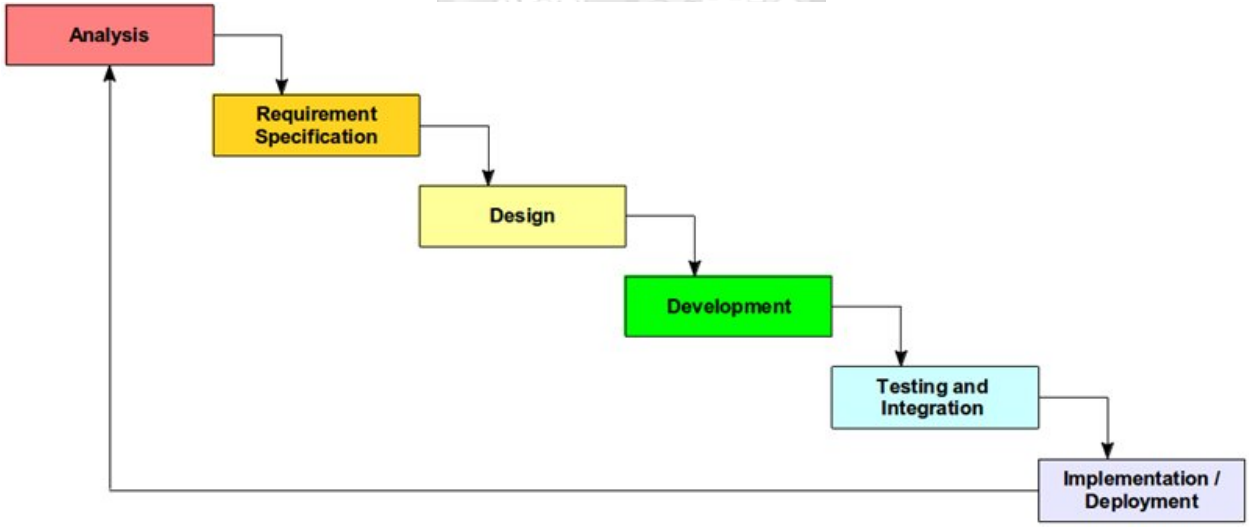

Figure 3.1: Waterfall methodology illustration

3.2.1 Feasibility study

A feasibility study is an assessment of the practicality of a proposed plan, method or solution. A feasibility study was done through reviews of relevant literature on existing systems related to incident reporting systems. The study was performed to analyze and evaluate the impending solution of the proposed system.

3.2.2 Business Study

Research Design

To capture the full perspective of the research study a Descriptive research and Qualitative Research was done.

i) *Descriptive Research;* this research type helped the researcher define the characteristics of the population in study. This provided a deeper understanding of interactions between the populace, road incidents and the ability of the populace to report road incidents. The information acquired greatly influenced the decision on the technology to be adopted.

ii) *Qualitative Research;* this research type was used to gain an understanding on views of the populace of the study in context to the area of study. The results from this research aided in guaranteeing user satisfaction of functional and non-functional requirements of the application.

Location of Study

The study was done at a University for data collection within the County of Nairobi. The name of the University was Strathmore University located in Madaraka area. Random individuals were selected for the study. The area was selected for study due to easy access by the researcher and also due to its strong presence within the area of research.

Target Population

The target population was drawn from students from the University who were willing to answer the researcher's interview questions. Respondents were picked randomly as earlier stated.

Sampling Strategy

The sampling used was purposive kind of sampling to enable collection of data for the research and answer the research questions of the study. Purposive sampling is a type of sampling design in which the informant is deliberately chosen due the qualities they possess (Tongco, 2007). To determine the sample size the following formula was used according to (Kothari, 2004):

$$n = \frac{Z^2 p(1-p)}{c^2}$$

Where:

n = sample size.

Z = z score (e.g. 1.96 for 95% confidence level).

p = sample proportion of successes, expressed as decimal.

c = confidence interval, expressed as decimal.

The required sample size calculated from the formula is 384 for a confidence level of 95% and confidence interval of 5. This sample size also comprised of mixed gender, age, educational level. To be able to gather data for this research, the target population was identified as Nairobi County residents with most of them being roads users and onlookers that live in Nairobi. The population was chosen because the road users including the motorists and pedestrians within Nairobi were considered in the research model to be the probable adopters of the mobile application (Kennedy Kangethe, 2014).

Data Collection

Two methods of data collection were employed in this research; interviews and questionnaires. The data collection procedure for the interview involved a visit to the major roads and streets selected to have one-on-one interview with the selected users. Random visits were done to conduct the interviews. The other method of data collection is the use of questionnaire that was prepared and distributed in form of a Google document (Google docs) and a few printed copies distributed. The online form was shared through emails and Facebook to reach the target sample population of users. The data collected from this form was automatically collected by Google documents and aggregated in an excel format spread sheet with the responses. It is from the spread sheet that the data analysis was done. Below is a list of data collection methods that the researcher used to get feedback from the population of study.

i) Interviews;

Interviews were used to gather information from the road users about the feasibility of the application. Interviews result in more interactive conversations that yield more data about the challenges faced by users in reporting incidents and mobile application usage. The interviews

help in getting to understand the user's perspective on the challenges and hence develop an application that satisfies their needs.

ii) Questionnaires;

Questionnaires were used to collect data from the respondents regarding challenges faced in reporting road incidents in the country as well as to test whether the mobile application developed meets the desired functionalities by the users in reporting road incidents.

3.3 System Design

The system design was achieved by developing the system architecture after gathering the requirements, the three tier architecture, the context diagram, the entity relationship diagram, the use case diagram, and the sequence diagrams. The road incident reporting system was designed based on the requirements gathered and presented using the design procedures of Unified Modeling Language (UML).

3.3.1 Entity Relationship Diagram

Entity relationship diagram (ERD) was used as a data modeling type to show the relationship of the various entities stored in the database. The ERD shows the structure of the database of the application defining the relationships between the tables.

3.3.2 Context Diagram

Context diagram shows the mobile application in high-level design showing the relationship it has with other external entities and data stores with the information flow. The context diagram is thus very crucial in the design of the mobile application system.

3.3.3 Use-Case Diagram

Use-case diagrams were drawn to describe the interaction of various actors of the mobile application system. This helps in understanding the requirements of the system thus effectively design the mobile application system that captures all the users and the respective use-cases.

3.3.4 Sequence Diagram

Sequence diagrams are very important diagrams to illustrate the interaction of processes showing the messages sequence sent from one process to another. The diagrams are very useful

in design because they help clarify in detail the roles played thus realise the various use-cases of the system. The sequence diagram of the various processes of the road incident reporting system was drawn to visualise the sequences of the messages in the system.

3.3.5 System Architecture

The system architecture is a presentation of the various components of the system and their relationship in building the system. The system architecture of the road incident reporting application was designed based on the requirement gathered to help developing the mobile application.

3.4 Application Implementation

The application comprised of development of a mobile and web application connected to a central database. Below are approaches employed in the development of the applications:

i) *Mobile Application;* the Operating System for the mobile application implementation was Android. The source code was written in Java, utilizing android classes. The application was compiled and tested using the android Software Development Kit (SDK) emulator and an android device. The application is optimized for android version 4.4.4 compatible with android devices on minimum version 3.0 and maximum version 4.4.4. JSON was used as the web service that provides the interface between the android application and the database. Reasons for choosing android as the client application include: flexible SDK, availability of Android Development Tools (ADT) and availability of abundant support from online developer communities.

ii) *Web Application;* the web based application was developed using Hypertext Preprocessor (PHP) and NodeJS JavaScript technology. The website was hosted on an online Apache HTTP server. Reasons for using PHP were; it is an Open Source platform, it is platform independent; it supports all major webservers and databases; it has multiple layers of security to prevent threats and malicious attacks.

iii) *Database;* the database was developed using the MySQL(NoSQL) database. The reasons for using MySQL were; it is an open source platform; it is fully compatible with PHP and other platforms; it is secure in that all passwords are encrypted before storage restricting unauthorized access to the database.

3.5 Application Evaluation

The prototype underwent the following tests:

i) *Functional Tests*; functional and non-functional tests were performed on the prototype.

ii) *Compatibility Tests;* compatibility test were performed on different mobile and web-based applications on different Android based platforms and browsers respectively.

iii) *Unit tests;* to test the efficiency of the code behind

iv) *User Acceptance Tests;* this test was done on the developed application to measure user satisfaction and collect feedback for refining the prototype.

Chapter 4: System Design and Architecture

4.1 Introduction

This chapter discusses the system architecture of both the front-end and back-end sides of the application outlining the various requirements needed for the implementation of the application. This involves the presentation of the context diagrams, sequence diagrams, use case diagrams and, the entity relationship diagrams (ERD).

4.2 System Architecture

The front-end user is the road user in possession of a mobile phone with the road incident reporting application installed. The front end user files a report from within the application. The filed report contains the details of the road incident being reported. The report is stored in the backend server that resides at a police station. Front-end users also have the option to view road incidents have been posted by other users. This acts as important information to them especially if there is an incident that may concern them while on the road such as a road accident.

The backend user has a more refined view of the reported files. The user can track reported incidents like over speeding public service vehicles, carjacking incidents and road accidents. These are all monitored on a map in the backend user's personal computer since the font user and backend user share the same source of data. Figure 4.1 shows an overview of the components of the system.

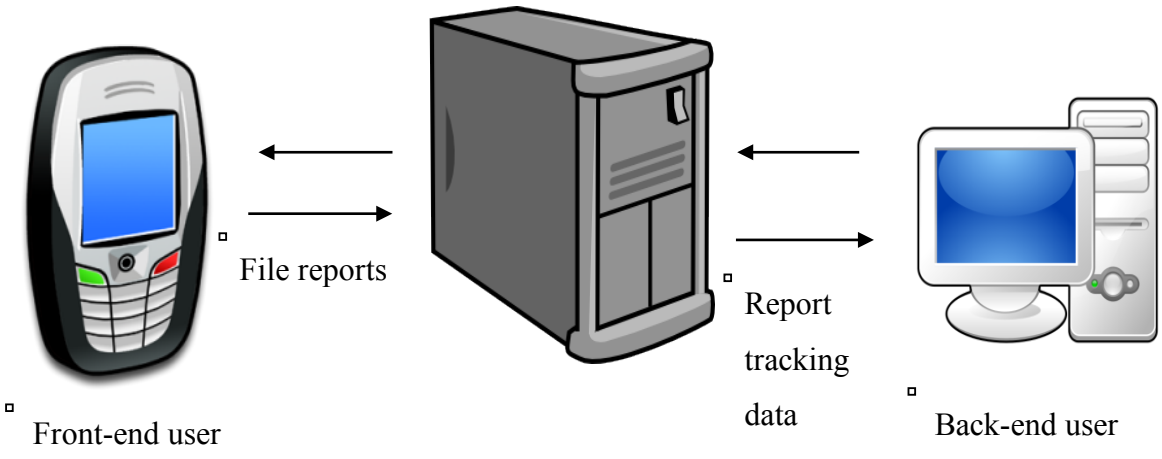

Figure 4.1: System Architecture

4.3 The Three-Tier Architecture

The system was built around the 3-tier architecture. 3-Tier architecture is that unique system of developing web database application which works around the 3 tier model, comprising of database tier at the bottom, the application tier in the middle and the client tier at the top. This 3-tier architecture module is the framework for most Web Applications on the Internet. This system helps to separate the Business Logic from the Application, Data Storage and database.

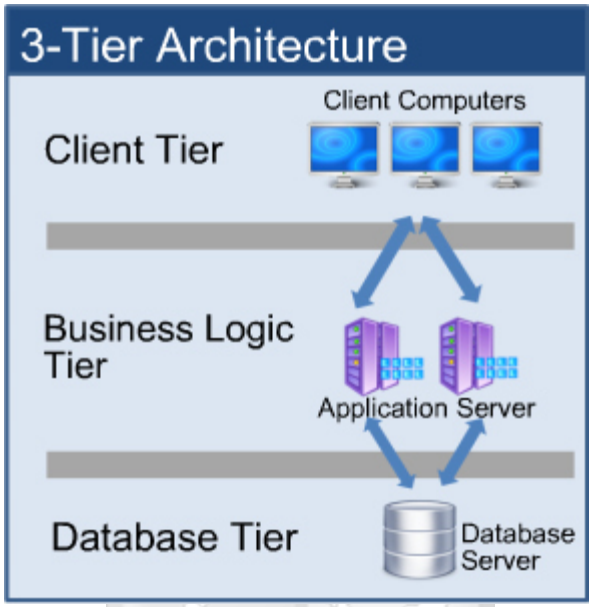

Figure 4.2: Three-Tier Architecture

The client tier represents the front-end and back-end section of the whole system as shown by Figure 4.2. The front-end user interacts with the system using his/her mobile phone while the backend user interacts with the system through a backend web interface. The business logic tier represents the code behind the system that runs on an application server. Finally, the database tier holds the database of the system. The business logic tier interacts directly with the database whenever there is data required but the client tier.

4.4 Context Diagram

Figure 4-3 presents a context level diagram of the back-end and front-end user application. It shows how the parties involved interact with the system as well as what data is exchange between the two. The normal user (Front end user), registers into the system. The user gets a registration confirmation that allows him/her to be able to report road incidents. The

backend user on the other hand, also has to be a registered user. He/she is registered as an administrator in the backend of the system. Figure 4-3 gives the context level diagram.

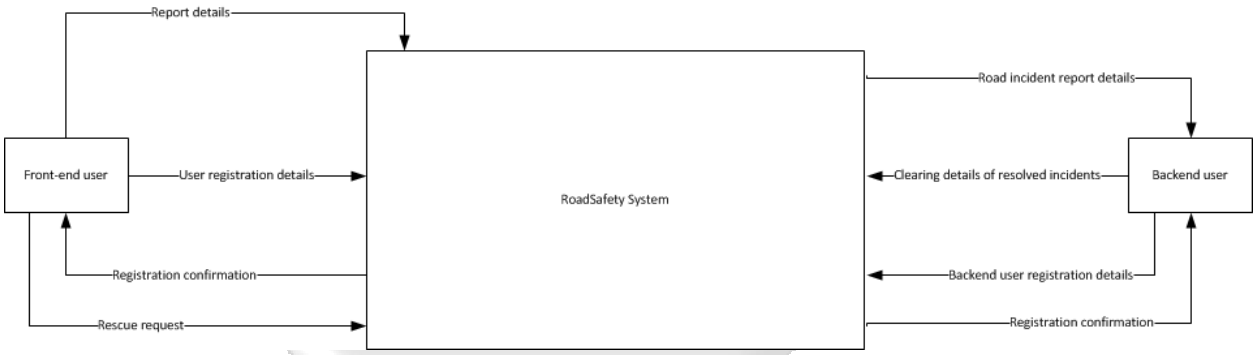

Figure 4.3: The Context Level Diagram

4.5 Entity Relationship diagram (ERD)

Figure 4.4 is an Entity Relationship Diagram (ERD) showing the structure of the database of the road incident reporting application and the relationships between the tables.

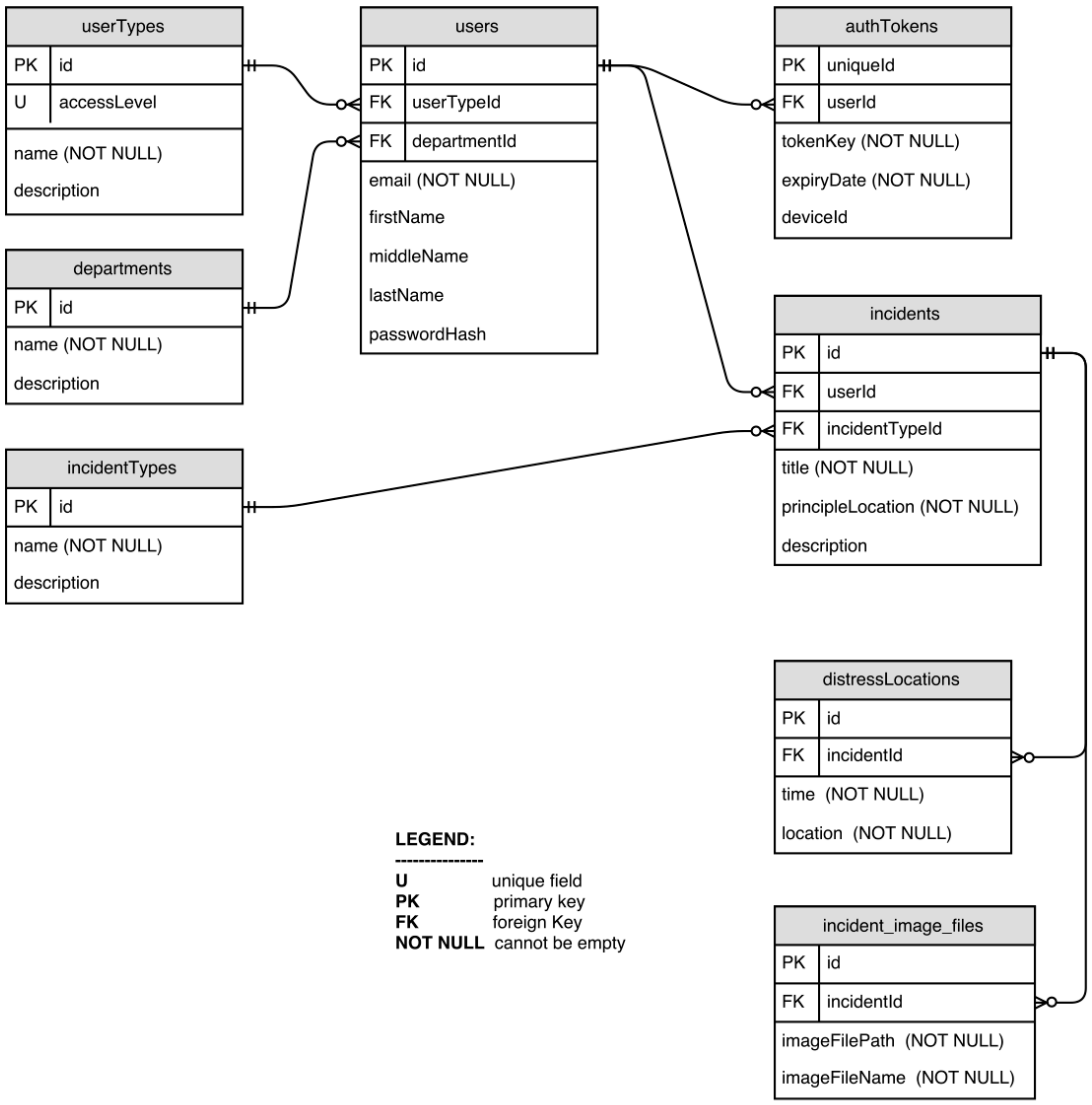

Figure 4.4: Entity Relation Diagram

4.6 Use Case Diagram for the System

A use case diagram at its simplest is a representation of a user's interaction with the system. A use case diagram can portray the different types of users of a system and the various ways that they interact with the system. The use case diagram is described by Figure 4.5 below:

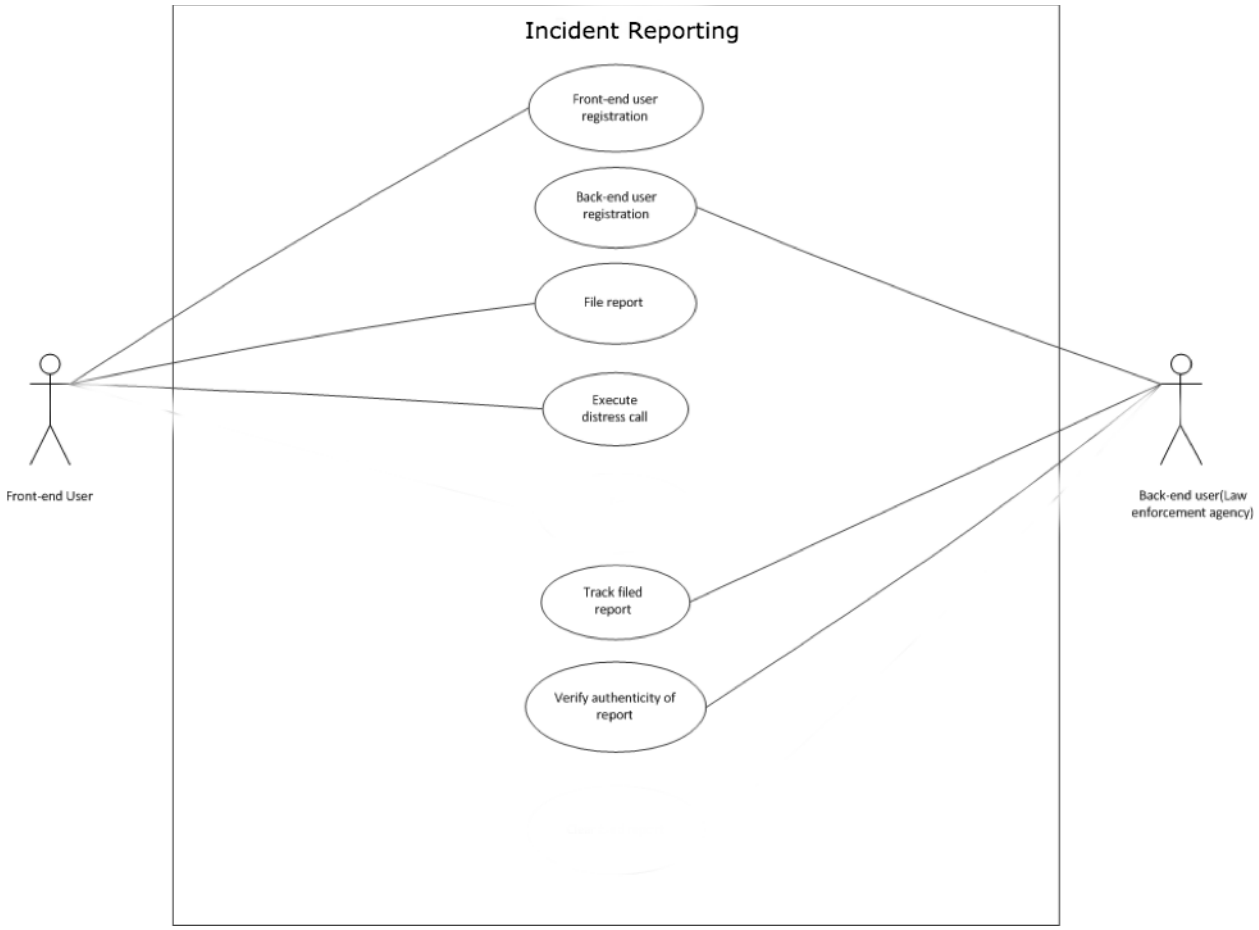

Figure 4.5: Use Case Diagram

4.7 Sequence Diagrams

Figure 4.6 shows a sequence diagram detailing the processes that occur in the front end user side.

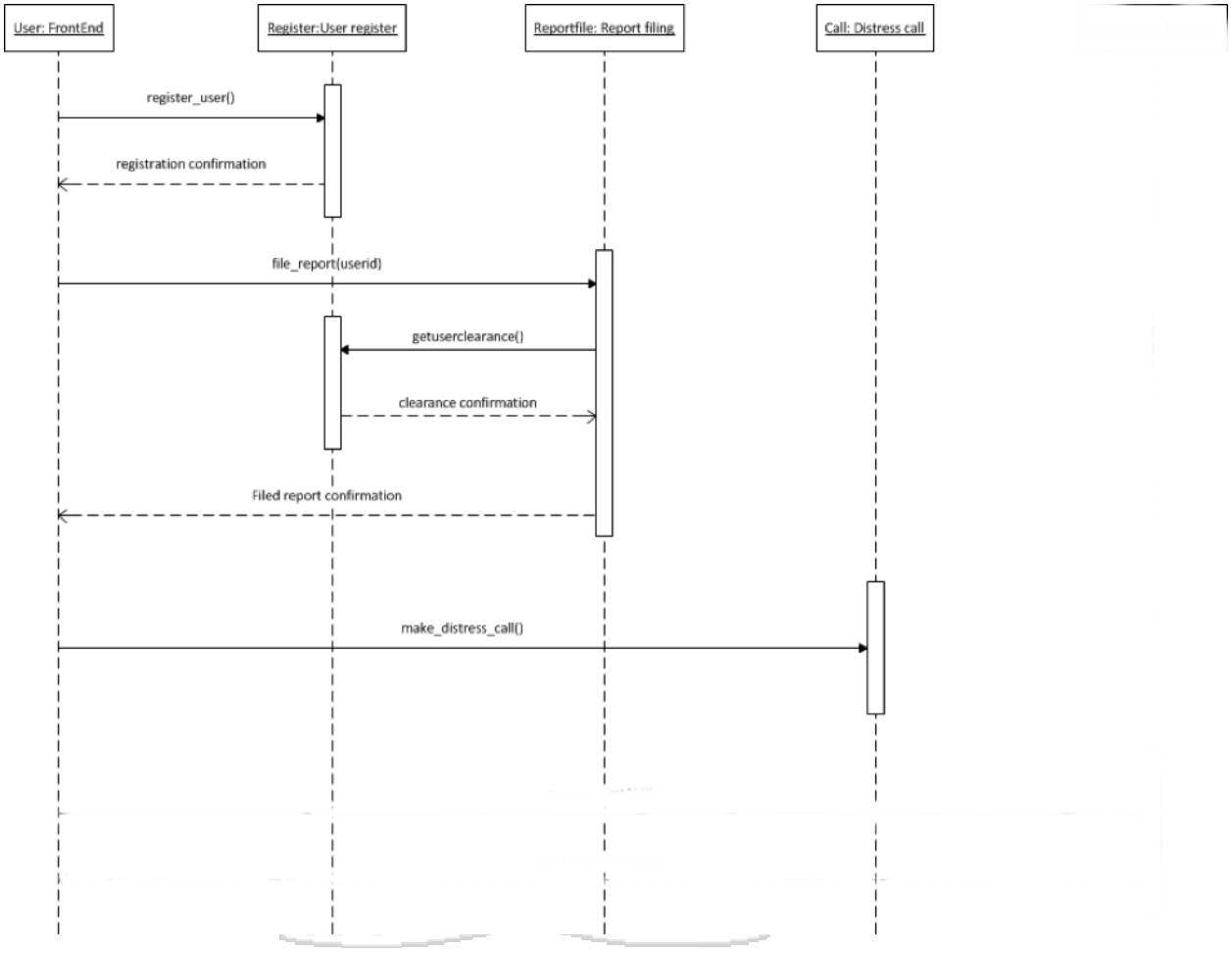

Figure 4.6: Sequence Diagram

4.8 Functional Requirements

The functional requirements describe the core functionality of the application. This section includes the front-end and back-end functional process requirements.

4.8.1 Front-End Functional Requirements

a) Registration

A user after accessing the application and having successfully installed it submits details that will be used to create their user account. A user simply submits registration information and

the profile is immediately created upon submission of required information. There exists a repository of registered users thus when a user registers, this is confirmed using the repository data and verification of the registration done. Successfully registered users will be able to access functionalities such as reporting road incidents and viewing road incidents posted.

b)Login

The user should be able to login to the application at different instances and should be provided with an option of whether to stay signed in to the application or login only when they need to access the application or data required.

c)File Road Incident Report

After the user is logged in the system, he is now able to post road incidents via the file road incident page of the front-end application on the mobile phone. This functionality allows the user to add a GPS location to the posted report so as to track the location of the incident. The user is also free to take pictures of the incident i.e. if it is a road accident and finally post the report.

d)View Road Incident Report

The user is not required to be logged in order for him/her to view the road incidents that have been posted by other users. The feature shows the user a list of all the incidents that have been posted by other users. Some may be accompanied by images e.g. if it is an incident involving a road accident. If available, the location of the incident is also added as part of the list of road incidents.

e) Distress Call

This functionality allows the user to send bulk SMSs to all his contacts in his phonebook at the touch of a button. It is applicable when there is a carjacking incident and there is not enough time to make a call. This functionality also captures your GPS location so that it can help track you in case of a carjacking incident.

f)Update Road Incident Report

This functionality allows a user to update a road incident that he posted earlier. He can either update the report to add more information about the incident or correct the information due to typo errors. It also allows the user to delete the incident altogether.

4.8.2 Back-End Functional Requirements

a)User Registration

The backend user is the administrator who has more privileges than the front-end user. When a backend user registers; he is given a higher user level clearance as compared to the frontend user. This means he can access more functionality aside from the frontend user functionalities.

b)View and Track Reported Road Incidents

This module, allows the user to view reported road incidents on the fly. The data is represented on a map (Google Maps), showing where all the incidents have been reported. If it is a carjacking incident, the map tracks down the location of the vehicle since the mobile phone of the frontend user will be relaying the coordinates to the server in the backend.

c)Clear Reports

Once the reported incident has been resolved, the backend user (administrator) clears the incident from the backend. This means that it will no longer appear as an incident in the backend or to other users.

4.9 Non –Functional Requirements

Non-functional requirements refer to the general behaviour of the system and how it is expected to function.

4.9.1 Security

Key security issues will be to ensure that information pertaining to road incidents is not misused or altered. The system shall allow for elaborate user authentication for both the frontend and the backend users accessing the road incident information.

4.9.2 Non- Repudiation

Non – repudiation is the inability of a person (to whom a public key has been bound by a recognized certification authority through issuance of a public key certificate) to deny having made a digital signature. This is especially imperative to ensure that when road incident information is sent; participating users do not deny that information was sent.

4.9.3 System Availability

The system has an availability of 80% to allow users to send and access the road incident information upon request. The 80% availability takes into consideration network interruptions and service delays experienced across mobile operators.

4.9.4 Data Retention

Data retention refers to the storage of a system's information for a specified period of time. Since information is fetched from the server constantly; the mobile application caches the information to reduce trips back and forth to the server.

4.9.5 General Performance

The response time for data requests especially for information resident in external repositories is acceptable to the user and the waiting time is also negligible.

Chapter 5: System Implementation and Testing

5.1 Introduction

This chapter focuses on the development of the mobile application for incident reporting where the all the functionalities of the application are implemented. The screen shots of the application are presented in this chapter for both the front-end and the back-end sides.

5.2 Road Incident Reporting Application

5.2.1 File Road Incident Report

After the user is logged in the system, he is now able to post road incidents via the file road incident page of the front-end application on the mobile phone. This functionality allows the user to add a GPS location to the posted report so as to track the location of the incident. The user is also free to take pictures of the incident i.e. if it is a road accident and finally post the report. Figure 5.1 shows the screen that is used to report road incidents.

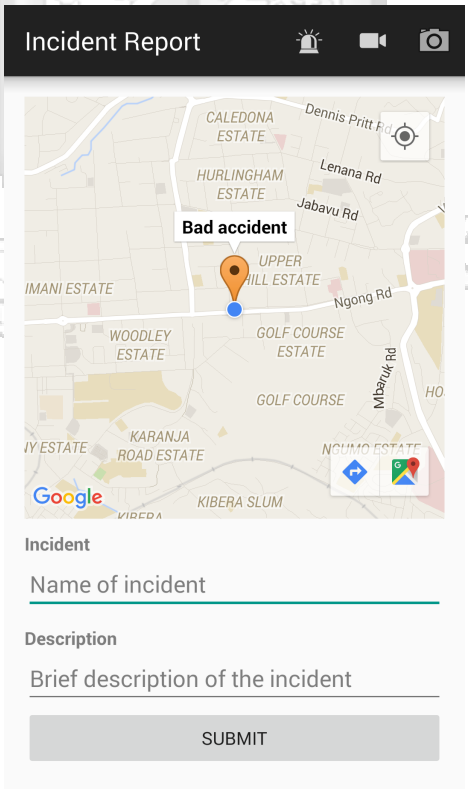

Figure 5.1: Report Road Incident Screen

5.2.2 Distress Call

This functionality allows the user to send an alert by the touch of a button. It is applicable when there is a carjacking incident and there is not enough time to make a call. This functionality also captures your GPS location so that it can help track you in case of a carjacking incident.

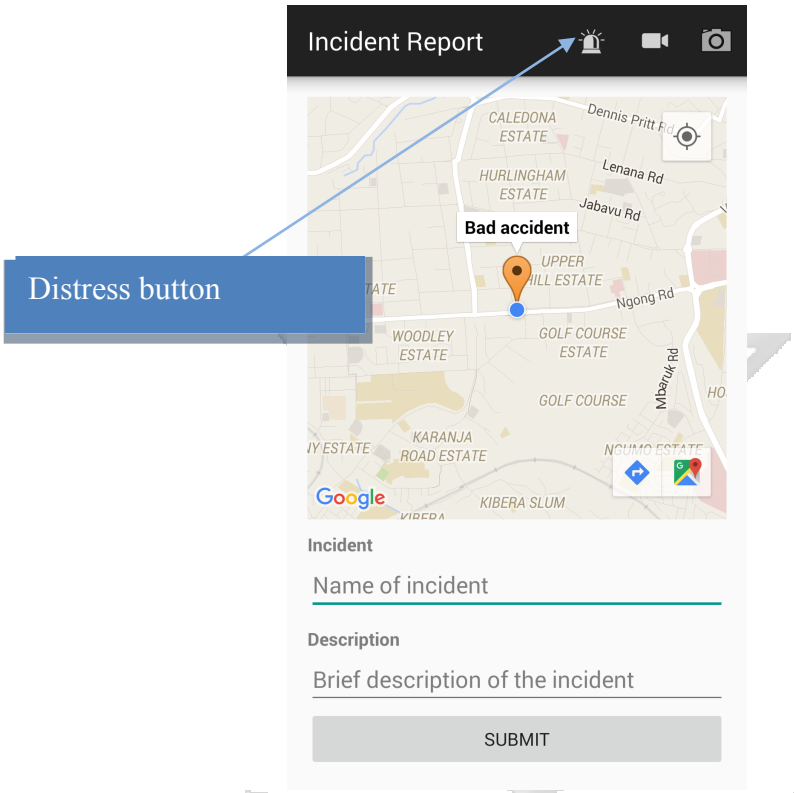

Figure 5.2: Distress Call Screen

5.3 Back-End

5.3.1 View and Track Reported Road Incidents

This module, allows the user to view reported road incidents on the fly. The data is represented on a map (Google Maps), showing where all the incidents have been reported. If it is a carjacking incident, the map tracks down the location of the vehicle since the mobile phone of the frontend user will be relaying the coordinates to the server in the backend. Figure 5.3 is a snapshot of how to view and track reported incidents.

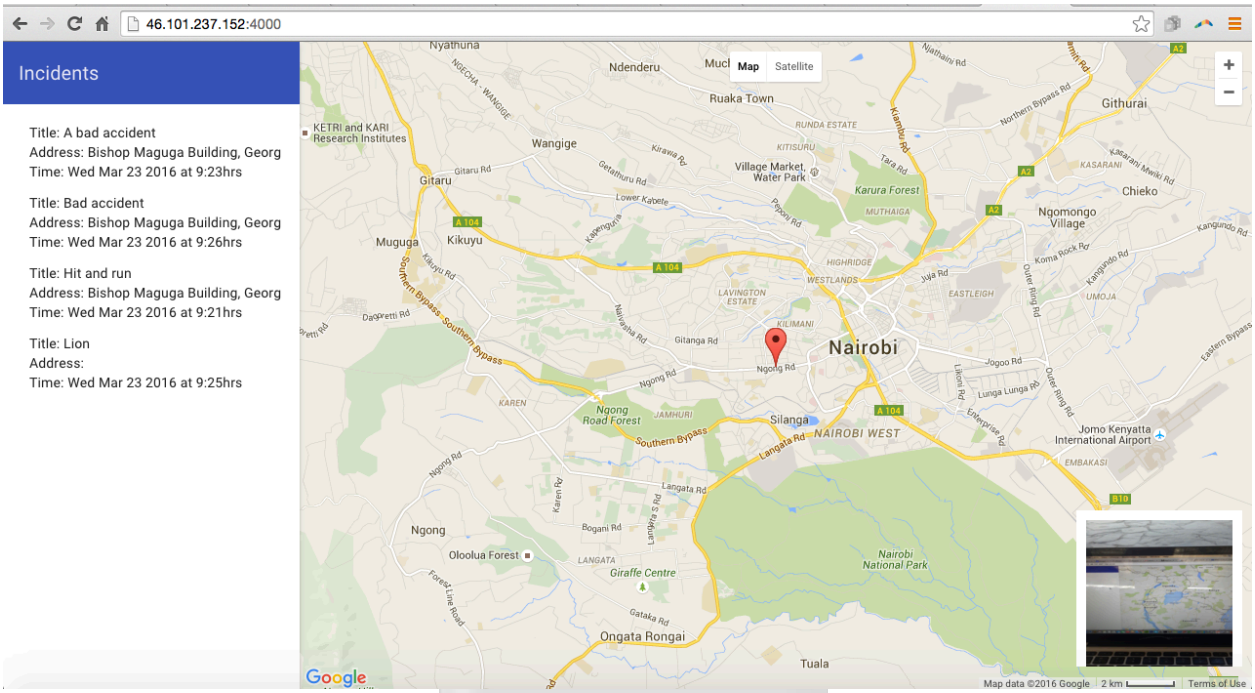

Figure 5.3: View and Tracking of Reported Incidents

5.4 Testing

The sample used for testing the application was Strathmore University. The respondents included students across the faculties in the university including faculty of IT, faculty of commerce. The university students were chosen because they represent the target population who will make use of the application. The university students also mainly use android phones and thus represent the target users of the application developed. The responses from the user acceptance testing formed the basis of the summative evaluation of the application. A sample of users with varying skills in using mobile applications were approached and asked for their participation in testing and appraising the application. These samples were selected because they are representative of the target users of the application.

In order to obtain a proper evaluation mechanism for the application, the developer designed a two-fold approach. Firstly, after a brief explanation of the purpose and functions of the application, the users were given a task sheet containing a list of tasks for them to perform with the application. These tasks were chosen in order to exercise key capabilities of the application. The second part was the evaluation, which asked both open and closed questions about the tasks performed by the users. The evaluation was to address both the functionality and

non-functional capabilities of the application. An evaluation of the results of the participants' assessment was then discussed and issues that arose were responded to.

5.5 Evaluation of Results

A total of 15 questionnaires were handed out to potential users of the application. Out of the 15 questionnaires, 13 were filled and returned by the users. This section discusses the results from the field work.

5.5.1 Impact of the Application may have to the Authorities Concerned

Figure 5.4 shows a chart detailing the respondents' perception on the impact of the road incident reporting application regarding the road incidents as far as the response of the users is concerned.

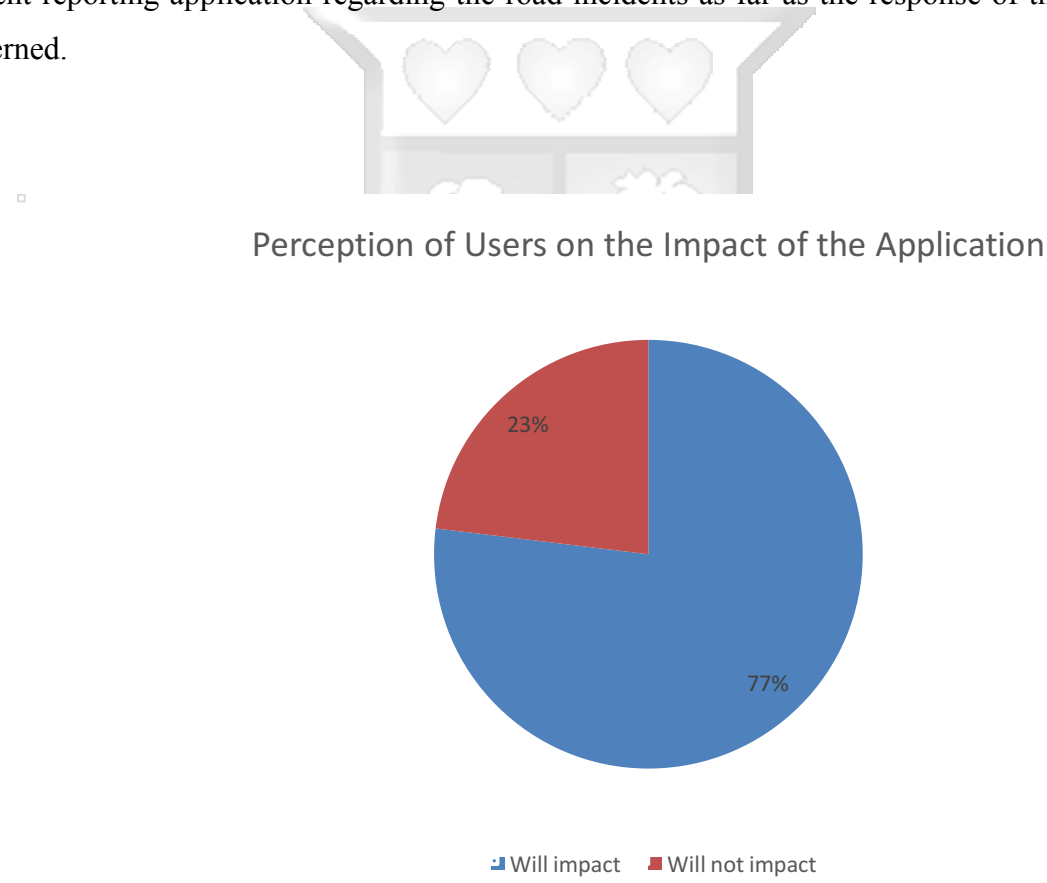

Figure 5.4 Perception of Users on the Impact of the Application

23% of the respondents think that the application will not have any impact as far as the road incident reporting is concerned. They had the following reasons:

i. There are other applications that may serve as better mediums to report such incidents. They said Twitter and Facebook would be better mediums.
ii. The application will have to get enough traffic in terms of users to be able to pull the attention of potential viewers.
iii. User acceptance as far as the police are concerned would be an obstacle.

77% of the respondents thought it would have an impact due to the following reasons:

i. The application is specific i.e. targets information only on road incidents.
ii. Carjacking incidents will be easier to track down once the system is taken up.
iii. Data mining and road incident reports can be easily mined from the central database.
iv. The application is simple and easy to use.
v. There is no registration and sign in process needed hence this will not discourage users from using the application hence more reports.
vi. Image and video capture features will help serve as proof of the reports.
vii. The reports will be of high importance to agencies such as KWS e.g. Tracking down lions and other wild animals that have strayed.

5.5.2 The Impact of the Application on Road Safety

Figure 5.5 shows a chart detailing the impact of the application on road safety.

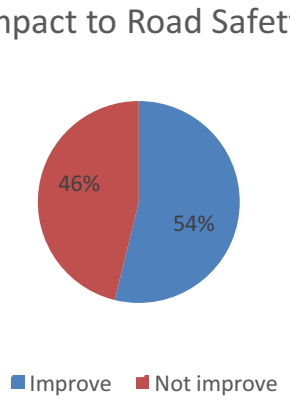

Figure 5.5 Impact of the Application on Road Safety

54% of the respondents thought that the application will improve on the road safety. They had the following reasons:

i. It will help improve it but not necessarily prevent harmful road incidents.
ii. They added that it will only help the authorities act faster since they will be getting first-hand information in real-time especially with the real-time tracking feature
iii. The data mined will help future harmful occurrences once mined and analyzed.

46% thought it will not improve road safety. The following were their reasons:

i. The application runs on high end phones hence not everyone has such devices with such features.
ii. The application may fail to submit data to the servers for one reason or the other.
iii. In cases of extreme road incidents such as car-jacking, the time to activate the real-time tracking may be a challenge.
iv. Users may not use the application because it does not have anything else to provide other than reporting as compared to Facebook and Twitter. This will render the application database empty.

5.5.3 Percentage of Respondents Willing to Use the Application

Figure 5.6 is chart showing the percentage of respondents who would actually use the application verses those who wouldn't.

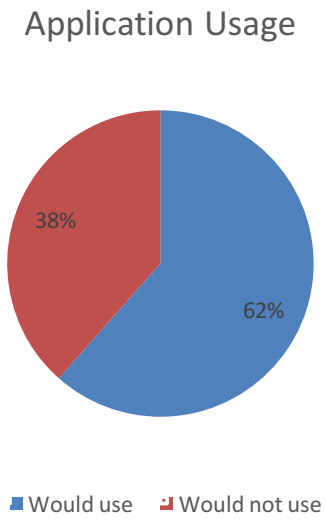

Figure 5.6 Percentage of Respondents Willing to Use the Application

62% of the respondents responded said that they would use the application but under the following conditions:

i. That, their privacy is respected and considered at all times i.e. the magnitude of their filed reports does not pose a threat to their lives and privacy as well as location of users.
ii. They will have the motivation to use it if it gathers user traffic.
iii. If it proves to be effective in solving reported road incidents.
iv. More features should be added to the application other than just reporting. E.g. advertising features.

38% of the respondents said that they would not use the application due to the following reasons:

i. There are better reporting avenues such as Facebook and Twitter and WhatsApp.
ii. The application does not have other incentives other than just reporting.
iii. Some of the features are not practical in special scenarios such as car-jacking.

5.5.4 The Respondents' Recommendations to the Application

The following were the main additions to the road incident reporting application, the respondents put forward:

i. Reporting road incidents- The respondents pointed out that it would be appropriate if the reports would also be channeled to Twitter and Facebook platforms to get a larger audience.
ii. Look and feel-The appearance and look and feel of the application should be upgraded. They added that the current one needed improvements to look more appealing.
iii. The application should have more features as incentive to the users other than just incident reporting.
iv. The alert feature should be done in a different way to enhance practicality of the feature.
v. The web interface should have a report extraction feature.
vi. The Web interface should have an icon of the application at the top.

5.5.5 Front-End Usability

a)Ease of Use in Terms of Navigation

Figure 5.7 is a chart showing how the respondents rated the ease of use of the road incident reporting application in terms of the navigation.

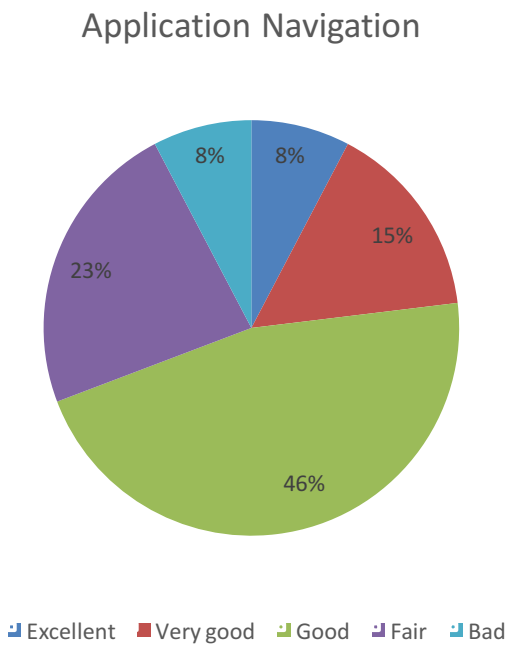

Figure 5.7 Ease of Use of the Application

8% of the respondents thought the navigation of the application was excellent, 15% thought it was very good, 46% thought it was good, 23% thought it was fair and 8% thought it was bad. The following were the responses from the respondents:

i. 46% of the respondents said it was good because of the design of the user interface.
ii. 8% thought it was bad primarily because of the color used in the design.

b)User-Interface Ratings

Figure 5.8 is a chart showing the ratings of the user interface as per the respondents.

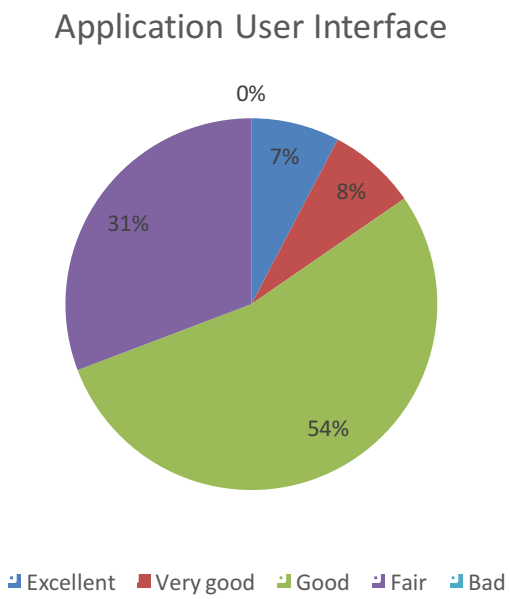

Figure 5.8 User-Interface Ratings of the Application

0% of the respondents thought the front-end mobile interface was bad, 8% thought it was very good, 7% thought it was excellent, 31% thought it was fair, 54% thought it was good. The following were the views from the respondents:

i. The application colors should be a bit brighter.
ii. The application icons should be well placed and proportional especially on the backend application.

5.5.6 Back-End Usability

a) Data Representation Ratings

Figure 5.9 shows a chart showing the ratings based on data representation in the backend of the application.

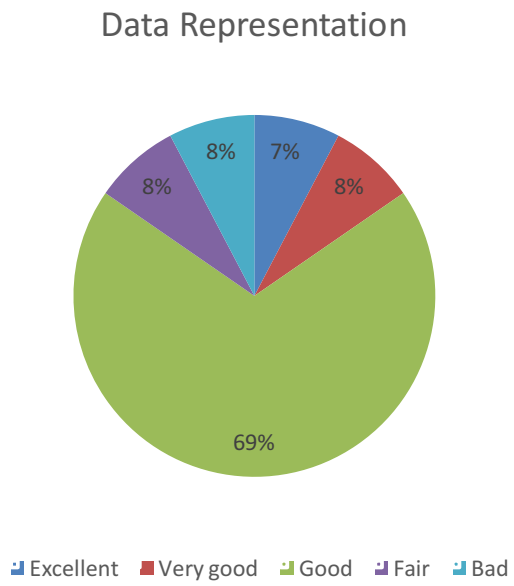

Figure 5.9 Data Representation in the Backend

8% of the respondents thought it was bad, 7% thought it was excellent, 8% thought it was very good, 8% thought it was fair, 69% thought it was good.

5.5.7 Back-End Navigation

Figure 5.10 shows the results from the users based on the navigation of the backend of the application.

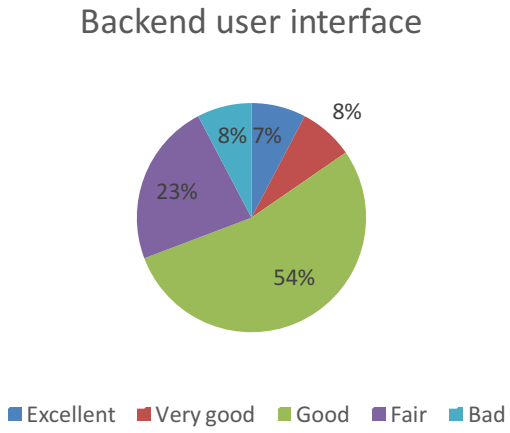

Figure 5.10 Backend Navigation

7% of the respondents thought the navigation was excellent, 8% thought it was very good, 54% thought it was good, 23% thought it was fair and 8% thought it was bad.

5.5.8 Back-End Look and Feel/Appearance

Figure 5.11 is a chart showing the feedback from the users based on the appearance of the back-end of the application.

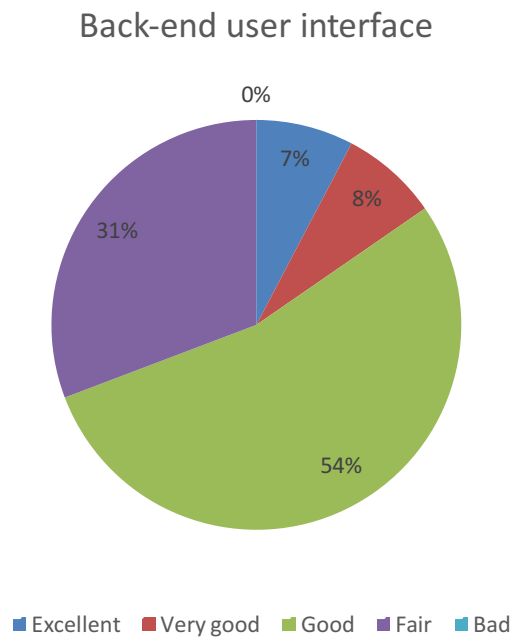

Figure 5.11 Back-End Look and Feel/Appearance

7% of the respondents thought the appearance was excellent, 8% thought it was very good, 54% thought it was good, 31% thought it was fair and 0% thought it was bad.

Chapter 6: Discussions

6.1 Introduction

The results of user evaluation of the developed application were analyzed and used as a basis to determine if application is usable. The results show that the target users are ready to use the application because it matches the unique needs and requirements by road users. The results also show that the application is easy to use and overall the application is good. Some recommendations were noted during the user testing exercise and used for further enhancement of the application.

6.2 Discussion in relation to Research Objectives

The implemented application was tested according to several test metrics such as completeness of tasks, ease of use, and the overall appearance of the application. The testing of the application also sought to identify areas of improvement and functionalities that might be added to enhance the usability of the application. It is clear from the testing statistics that the application is helpful, that the users found it useful, and that they were willing and ready to use it. Based on the questionnaire responses, the application is generally considered easy to understand and use. The research objectives can thus be said to be achieved because the application had good reception among the target users that participated in the testing process.

The systems discussed in chapter two are directed toward capturing one road incident i.e. only road accidents. The application aims at enhancing road safety by capturing other road incidents, not only road accidents. The systems discussed in chapter two were built for in-house organizational use. They are governed by authorities i.e. the incidents are reported by the authorities that govern the system. The reporting factor is not open to the public. There are exceptions though such as Nduru application and the MARS application. The backend reporting structure of Nduru application and MARS is open to the public and not to any government authority. The research objectives can be said to have been achieved because the all the research questions have been answered.

6.3 User Perception on the Application

From the application testing, the following were the perceptions of the users towards the road incident reporting application. The perceptions are categorized as follows:

In support of the application

i. The application is specific i.e. targets information only on road incidents.
ii. Carjacking incidents will be easier to track down once the system is taken up.
iii. It will help improve road safety but not necessarily prevent harmful road incidents.

They added that it will only help the authorities act faster since they will be getting first-hand information in real-time.

Not in support of the application

i. There are other applications that may serve as better mediums to report such incidents. They said Twitter and Facebook would be better mediums.
ii. The application will have to get enough traffic in terms of users to be able to pull the attention of potential viewers.
iii. User acceptance as far as the police are concerned would be an obstacle.
iv. That, their privacy is respected and considered at all times i.e. the magnitude of their filed reports does not pose a threat to their lives and privacy.

6.4 Challenges in Implementing the Application

6.4.1 GPS Inaccuracy and Power Consumption

The Android GPS precision while reporting a road incident was not very accurate, especially when using the network provider. This is because the network provider location provider uses the cell towers as the location markers for every mobile phone under that network provider. The inaccuracy of the location provider this application used in terms of distance is as far as the user is from the network provider cell tower.

6.4.2 GPS Battery Power Consumption

The GPS module for the Android platform consumes the phone's battery at a high rate. The main challenge in this application as regards to this is in implementing tracking of carjacked users. This module required the user to have his mobile phone GPS module on.

6.4.3 Proving the Credibility of a Reported Road Incident

The credibility of the reported road incidents was hard to prove. Since the application is open to the public, any malicious user can decide to post an inaccurate road incident report. A way to sieve the accurate from inaccurate reports was a challenge while implementing this system.

Chapter 7: Conclusions and Recommendations

7.1 Conclusions

The main goal of the dissertation was to develop a mobile application that can be used to report road incidents and hence address the need of users with difficulty in reporting incidents. The opportunity that exists in Kenya concerning road incident reporting is not well tapped especially with the increase in the number of smart phones with android OS. Thus the mobile application comes in handy to provide a solution to the way users report road incidents. Literature of various incident reporting systems was studied and previous research done on the reporting systems. Most of the reporting systems were web based and based on social media to report incidents.

The challenges of incident reporting on Kenyan roads was investigated successfully and it was noted that road users and onlookers lack a proper means of reporting cases on the roads. The assessment done showed that most road users notify the authorities concerned and fellow motorists using social media platform such as Twitter, Facebook and other online blogs. the related designs, architectures and models of incident reporting was studied and the gaps in reporting identified since most of these designs and models did not give instantaneous reports thus not very effective as a mobile application that comes in handy.

The proposed solution is an android based mobile application was designed, developed and tested for use by road users in Kenya. The solution was designed based on the users need for a platform to report incidents. The requirements were gathered and mapped using various diagrams such as use-case diagrams, sequence diagrams, context diagrams and entity relationship diagrams of the database. The application will allow users to report incidents that happen on the roads. Based on the overall statistics of user testing and evaluation, it is safe to say that the application fulfills its simplicity and usability requirement. Based on the questionnaire responses, the application is generally considered easy to understand and use. The research objectives can thus be said to be achieved because the application had good reception among the target users that participated in the testing process.

7.2 Recommendations

The recommendations that can be drawn from the research are that the authorities and government should recognize and embrace the efforts of mobile applications in trying to improve the status of the roads in Kenya when it comes to road incidents. It should also support such efforts through funding and integration of the various road systems with the relevant departments and authorities for improved road safety. The registration and login process were considered time-consuming for users reporting incidents. As a result, it was proposed to use the mobile device's email address for the login purposes and eliminate the registration process. The navigation of the application was recommended for improvements to make it very easy to navigate. The application can be extended to run on other operating systems such as the iOS based on the user base and mobile device penetration so as to get access to huge audiences. The application will be free to download on Google Play Store but further research needs to be done on how the mobile application can be incorporated in to the relevant authorities such as the traffic police.

7.3 Suggestions for Future Research

Based on user feedback, the application will continuously be improved to cater for users changing needs. Further research should be done in future to enhance functionalities of the application and thus ensure user retention. There needs to be more research on how to verify authenticity of the reported road incidents because the incidents are just reported by anyone with the application installed on their mobile phone.

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Appendix A

Questionnaire

This is a questionnaire designed to collect user perception data based on a road incident reporting application. Any information given will not be used against you.

1. Do you think the road incident reporting application will impact on road incidences and the response of the authorities in dealing with reported road incidents?
   a) Yes
   b) No

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1a) If yes, please state how and why you think so

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1b) If no, please state how and why you think so

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2. In your opinion do you think this mobile application will help improve road safety?
   a) Yes
   b) No

2 a) If yes, please state your reasons below

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2 b) If no, please state your reasons below

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3. Would you use this application to report road incidents?

a) Yes
b) No

3a) If Yes, please specify why

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3b) If no, please specify why

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Front-End Usability of the Application

1. How would you rate the application's ease of use in terms of navigation?
   1) Excellent ▫
   2) Very good ▫
   3) Good ▫
   4) Fair ▫
   5) Bad ▫

   In the navigation, what would you like changed or improved i.e. if any?

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2. How would you rate the application's user interface in terms of looks?
   1) Excellent ▫
   2) Very good ▫
   3) Good ▫
   4) Fair ▫
   5) Bad ▫

   In the interface, what would you like changed or improved i.e. if any?

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Back-end usability of application

1. Please rate how the information is represented on the map.
   1) Excellent ▫
   2) Very good ▫
   3) Good ▫
   4) Fair ▫
   5) Bad ▫

2. Provide any suggestions on changes you think should be made.

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3. How would you rate the navigation?

   1) Excellent ▫
   2) Very good ▫
   3) Good ▫
   4) Fair ▫
   5) Bad ▫

4. In the navigation, what would you like changed or improved i.e. if any?

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5. How would you rate the look and feel i.e. the appearance?
   1) Excellent ▫
   2) Very good ▫
   3) Good ▫
   4) Fair ▫

5) Bad ▫

6. In the navigation, what would you like changed or improved i.e. if any?

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Appendix B

System Requirements

Hardware Requirements

At the development end the following were the requirements needed:

i. Processor: Pentium IV or higher
ii. RAM: 256 MB
iii. Space on disk: 250MB or higher to store the application and backup.

The following are the requirements at the application end to ensure effective development and testing:

i. Device: Android phone with version 2.2 or higher for running the application. Samsung Galaxy S3 Mini was used for running and testing the application.
ii. Space to execute: 3 MB as the space to be occupied by the application.

Software Requirements

The following software requirements have been considered for the development of the application: for the development end the following requirements were used to develop and run the application:

i. Operating System: Windows 7
ii. Language: Android SDK, Java
iii. Database: MySQL
iv. Tools: Eclipse Helios IDE
v. Technologies: Java, Android, XML
vi. Debugger: Android DDMS (Dalvik Debug Monitor Service), Android mobile device.
vii. Editor: Notepad++ for editing code.
viii. Server: Xampp Server v 3.1.0

At the application end the following were the requirements needed:

i. Framework: Android SDK Version 2.2.1
ii. Network: Mobile network and Internet (cellular or Wi-Fi) to provide network connectivity for testing the developed application.

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