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Emergency response system based on an intelligent and optimal route finder.

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Emergency Response System Based On an Intelligent and Optimal Route Finder

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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 thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

Kiere, Peter Ngunjiri

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18th June 2019

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ABSTRACT

Road accidents have become a significant cause of injuries and death in developing countries. Every year, the lives of more than 1.25 million people around the world are cut short as a result of this road traffic crash menace. Approximately 20 to 50 million more people suffer non-fatal injuries, with which many incur disability as a result of their injury. Road traffic injuries cause considerable economic losses to individuals, their families, and the nations as a whole. These losses arise from the cost of treatment as well as lost productivity for those killed or disabled by their injuries, and for family members who need to take time off work or school to care for the injured. Road traffic crashes cost most countries 3% of their gross domestic product. Reports show that one of the best ways to reduce this fatalities and disabilities from these crashes is by decreasing the casualty evacuation time; this is the timely and efficient movement including en route care provided by medical personnel to injured patients evacuated from the scene of an accident to receiving medical facilities. This research aims at improving the evacuation process in order to reduce the fatalities as well as the impact of the injuries achieved by helping the public have access to specialized equipment and vehicles in aid of disaster and accident management. The purpose of this research has put more focus on ambulance access for patients in critical condition by designing a web-based program that can be accessed from a mobile phone or computer to inform the closest located ambulance to respond to distress calls. Also, there was need to help the ambulance drivers' get to the nearest hospital using the shortest and fastest route, which would be term as the most convenient route. The framework designed helps the patients who need emergency care attended to and their lives put out of danger as fast as possible for further medical attention. The framework also provides the emergency response unit with a platform to get fully reimbursed after delivery of services. An extensive literature review was carried out to determine the impact of delayed emergency response to patients in critical condition and addressed the problem through the development of a system that eliminates unnecessary delays.

Keywords: Emergency Response Units (ERUs), Road incidents, Casualty Evacuation(CE)

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Acknowledgements

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Dedication

This research work is dedicated to my family who have been a continued source of motivation and encouragement all through the undertaking of the Masters program.

Chapter 1: Introduction

1.1 Background

Emergency care for patients in critical condition in developing countries has been inefficient; this has left most patients uncared for, and inconvenienced. Due to a large number of patients requiring emergency medical attention factored with a scarcity of ambulances, the casualty evacuation process from the spot of road incident to medical facilities left to personal and public service vehicles (Geduld & Wallis, 2010).

The study acknowledges that emergency response needs to be fast, instantaneous, and available at the beck and calls of needy patients. It further states that delayed emergency medical care leads to loss of life. The journal article brings to light that careless intervention by witnesses and onlookers poses a threat of aggravated injuries due to broken bones and fractures that could pierce vital internal organs without the notice of the unskilled first aiders (Elmqvist, Brunt, Fridlund & Ekebergh, 2009).

Emergency response units can utilize innovative technology through improved communication to increase their efficiency in responding to distress calls, transferring patients in critical condition from disaster scenes to medical facilities, and, achieving their baseline target of saving lives. The public in such developing countries with slightly used infrastructure could be beneficiaries if a system were designed to get access to emergency care equipment as fast as possible (Elmqvist, Brunt, Fridlund & Ekebergh, 2009).

Road accidents have become a significant cause of injuries and death in developing countries. Road traffic injuries cause considerable economic losses to individuals, their families, and the nations as a whole. These losses arise from the cost of treatment as well as lost productivity for those killed or disabled by their injuries, and for family members who need to take time off work or school to care for the injured.

Reports show that one of the best ways to reduce this fatalities and disabilities from these crashes is by decreasing the casualty evacuation time; this is the timely and efficient movement including en route care provided by medical personnel to injured patients evacuated from the scene of an accident to receiving medical facilities. This research aims at improving the evacuation process in order to reduce the fatalities as well as the impact of the injuries achieved by helping the public have access to specialized equipment and vehicles in aid of disaster and accident management.

1.2 Problem Statement

Developing countries use old techniques for emergency response units to get informed about distress, leading to delayed response and diminished response rates. In cases of disasters and accidents, many patients in critical condition have lost their lives due to poor handling at the accident scenes and late arrival of emergency care. Delayed relay of information leads to communication breakdown and as a result, loss of lives. The unavailability of modern systems explicitly designed for direct communication between victims and emergency response units (ERU's) personnel. Also, traffic experienced in many parts of the world leads to loss of lives due to delay in accessing specialized treatment. In Kenya, the tools available for providing reliable; real-time and accurate traffic information are limited. The primary sources of this information are reports from radio stations and a few blogs dependent on road users' information which might not be accurate and real time. These offer incomplete and intermittent information, without useful features such as Travel Time Estimation and Optimal Route Selection. This research experimented on the use of mobile probes employing GPS and GSM technologies to collect information that helped in actualizing

1.3 Aim

The purpose of this research was to illustrate the feasibility of GPS positioning techniques to collect and disseminate traffic information in Kenya and develop a framework that bridged the gap in communication between disaster scenes and the emergency response units (ERUs). The system needed to be a mobile application software that would inform victims of the nearest available emergency response unit, informing the ERUs to avail themselves as quickly as possible to a disaster scene.

1.4 Specific Objectives

(i) To evaluate the need for a system in solving the existing emergency care access problems.

(ii) To investigate loopholes and gaps in the existing emergency response communication systems.

(iii) To review detailed designs, architectures, and models of emergency response and incident reporting systems.

(iv) To develop a mobile app for emergency response and reporting road incidences in Kenya.

(v) To test and implement the application

1.5 Research Questions

i. What are the current working emergency response systems in Kenya?

ii. What are the loopholes and gaps in existing emergency response communication systems?

iii. How are the detailed designs, architectures, and models of emergency response and incident reporting implemented?

iv. How can the mobile application be used to alert ERU's as well as report road incidences?

v. How can the feedback of the developed solution be used to improve the application?

1.6 Justification

The research resolved the problem of delayed emergency care by the provision of quick access to ERUs hence more lives to being saved since emergency response units arrive at the location of distress quickly. Also, help them in deciding the optimal route to follow while evacuating the casualties for specialized treatment; this would also help reduce delays on our highways which are caused by accidents through quick response hence fast clearing of any traffic hold-ups; this has direct economic significance since more people would have more hours to work on their projects to build our country.

1.7 Scope and Limitation

The research, design, and development of a mobile application, which used in developing and developed countries to connect victims at disaster scenes in need of emergency help to the ERU's. The most significant limitation is the unavailability of steady, easily accessible internet networks in the rural interior regions in most developing countries.

Chapter 2: Literature Review

2.1 Introduction

Throughout history, disasters have inflicted a substantial cost in human, material, and physical resources as well as damage to the environment. They represent a potentially significant obstacle to economic growth and development. A community can achieve no meaningful event if it is vulnerable to disasters.

According to the Green Paper (2014), there should be adequate procedures to deal with disaster situations and relief measures planned before an event, with robust legislation to empower those responsible for carrying out the tasks. It is not enough to assume that a hospital is well equipped to handle casualties if no plan is in place to cover all aspects of disaster management from the scene of the disaster to the hospital itself.

To gain more knowledge to foster a better understanding of emergency healthcare provision, the previous literature was reviewed, which was necessary to maintain relevance to the field of research. It was also important to avoid redundancy in research and identify the gaps in the literature. Therefore, previewed literature concerning prehospital care, ambulance care, and, the implications of overcrowding at emergency departments in hospitals. In all three cases, the role of our proposed system in solving the identified problems was identified.

This chapter tends to explore the literature review done on some similar systems which are used to report road crashes for the evacuation of these victims to take place. It also emphasizes establishing their structures and architecture, as well as the implementation. The systems discussed here are samples from countries across the globe like Thailand, Kenya, and Poland.

The rapid growth in the use of technology has made life easier with intensified use of the internet and smartphones. According to the Communications Authority of Kenya, statistics show that the amount of mobile subscribers in Kenya has grown by 1 percent to reach to 38.9 million by the top quarter of financial year 2016/2017; this has seen the mobile penetration increase to 88.2%. This advancement in technology has seen an outsized range of the population using their mobile phones (Communications Authority, 2017).

Safety intervention programs that are on a pilot or demonstration basis are so effective in developing learning curves, and lessons quickly realized. Kenya currently stands as one of the countries in the world with the highest rates of deaths attributed to road accidents. Moreover, 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 to end this road carnage and extend to East Africa, as discussed in this chapter.

2.2 Trends in Road Traffic Accidents (RTAs)

A road incident refers to an untoward event that happens on the roads and which can cause loss, damage, disaster, or loss of lives. Such road incidents embody road accidents, speeding, drunk driving, carjacking, and hit-and-run. Road traffic incidents exert an enormous burden on Kenya's economy and health care service. Most causes behind most road incidents in African countries embody lack of proper and certified driving schools, unskilled drivers, poor road conditions, distracted driving, overloading and inadequate laws & legislation (Odero and Heda, 2003).

In line with the 2009 World Health Organization (WHO) international standing report, Kenya recorded 3760 traffic deaths, the highest within the region. WHO, within the global standing report on road safety 2015 report predicts global safety fatalities to rise to 2.4 million each year by 2030. In low and middle-income countries, data gathered counsels that road traffic deaths and injuries are likely to cause economic losses of up to 5% of the GDP. These losses beyond question inhibit the economic and social development of developing countries (WHO, global standing report on road safety, 2015).

Fatalities as a result, road crashes have slightly intensified by 6.4 percent this year compared to last year. In line with the most recent survey results, an estimated total of 1977 individuals had lost their lives as a result of crash as up to 27th of August 2018 compared to 1858 who had died by a similar date in 2017. Pedestrians remain the vulnerable cluster of road users with 752 of them have died as a result of injuries sustained due to the accidents. The intensified grooming and sensitization of drivers on road safety measures by the National Transport and Safety Authority employees have seen the fatalities of drivers drop from 207 in 2017 to 200 in 2018.

Road users usually lack a secure medium wherever they want to report road incidents and complaints on to the authorities involved. As per the National Transport and Safety Authority (2017), the frequency of road incidents that go unnoticed in Kenya has increased notably. Since there's no accessible medium to report them, they go unaccounted for, and therefore the parties responsible are never caught up law. Road incidents recording and analysis plays a significant role in the strategy to scale back road incidents; this is often true if supported by a useful data collection and analysis system. Ancient systems usually comprise a database more often a summarized spreadsheet format with use of codes and mileposts to denote location, type, and severity of incidents.

It addresses the deficiencies through efficient, effective, and dependably reportage and disseminative data from road incidents in Kenya by developing a mobile application for reporting, making distress calls, and sharing knowledge concerning road incidents. The collected roads incident data would also benefit the general public as well as the different stakeholders like the police, the insurance business, and educational institutions.

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According to the Green Paper (2014), there should be adequate procedures to deal with disaster situations and relief measures planned before an event, with robust legislation to empower those responsible for carrying out the tasks. It is not enough to assume that a hospital is well equipped to handle casualties if no plan is in place to cover all aspects of disaster management from the scene of the disaster to the hospital itself.

The development of Volunteer Geographic data (VGI) could be a valuable supply of data within modern society. Using this approach, data sources as provided by communities of volunteers as opposed to the government entities or for-profit businesses; fuelled by the emergence of web 2.0 technologies, miniaturization of Global Positioning Systems (GPS) devices and advancement of broad communication links. This has empowered a lot of internet users to become more and more valuable in the production of geographic data. In

VGI, the Nationals have been pointed out as an essential and quick supply of geographic knowledge. Acknowledging that in the future, the citizens would play a critical role each as a client and a producer of geographic knowledge (Goodchild, 2007).

2.2.1 Road Incidents and Road Safety in Kenya

Road incidents are alarmingly growing the public health concern worldwide and are leading in loss of lives, disabilities, and loss of resources. Globally, road incidents marked as the ninth leading reason behind the total death toll (World Health Organization, 2015). Road traffic injuries place a significant burden on international and national economies and household finances. With over 13 million deaths and 20 to 50 million injuries directly coupled to road traffic incidents around the world, the social and economic burden presents a compromising situation for Kenya as a nation (Bachani, 2012). In line with Manyara (2016), in Kenya alone, over 3000 individuals die through road incidents per annum, most of them in their prime(15-45 years). Most of the road incidents cause them fatalities or severe disabilities that deprive several families. Often, the transport industry stakeholders blame the poor state of Kenyan roads as being the principal reason behind these incidents.

A report by the World Health Organization (2015) indicates that between 3,000 and 13,000 Kenyans lose their lives in road traffic crashes per annum. WHO in its report "The global Status on Road Safety" additionally states that Kenya, Tanzania, and Rwanda with respective 29.1%, 32.9% and 32.1% deaths per 1000 individuals, they have been listed as amongst the worst ten performers, in terms of fatalities in Africa, and among the worst twenty worldwide. Uganda`s rate goes a little lower at 27.4%, and the majority of these people are often vulnerable road users as well as pedestrians, motorcyclists, and cyclists.

2.2.2 Prehospital Emergency Care

In their research, Elmqvist et al. identified the critical nature of prehospital care in the determination of a patients chances of survival once taken to the hospital. They state the importance of a patient's first encounter with prehospital care. They also identified that saving a critically injured patient was not only a matter of maintaining the vitals but even identification of the patient to ensure they retain their identities by means of a communicative contact to be confirmed after survival to help regain a state of equilibrium after a disastrous experience (Elmqvist, Brunt, Fridlund & Ekebergh, 2009).

According to a study by Knight et al., school sports activities also pose a risk of injury. The injuries more often than not lead to transport to a medical facility. The school emergencies unit attends to the injured patients before calling for a dispatch ambulance to take the patient to the hospital if they do not have their ambulances (Knight, Vernon, Fines & Dean, 1999).

In developing countries such as ours, most schools do not possess a private ambulance to attend to such patients. That is a result of inadequate funding. The presence of this obstacle in emergency healthcare provision leads to the identification of a gap that the current study research seeks to fill by providing access to the available ambulances to the general public through a mobile application system.

2.2.3 Ambulance Care

A journal article by Suserud takes us through the transformation from the traditional role of ambulances, which was just a vehicle to deliver patients to the hospital. A modern perspective where the ambulance is seen as an extension of the hospital where complicated decisions and procedures have to be carried out before arriving at the hospital to increase a patient's chances of survival. Such methods include the preparation of patients for surgery if it is deemed necessary; this helps our current research in acknowledging the importance of ambulance care. Modern ERUs must have at least one ambulance nurse who continues to attend to the patient from the scene of disaster to the hospital where they were to get individualized medical attention and care (Suserud, 2005).

The quickest access to such ambulance care cannot be understated (Elmqvist, Brunt, Fridlund & Ekebergh, 2009). Due to inadequate ambulances on our roads in our country and other developing countries, our research intends to interlink the idle, available ambulances at all hospitals through a system where the users are patients and onlookers at distress scenes and the ERUs. Faster and direct communication between the two is vital to reduce the response time by contacting the closest idle ambulance to attend to patients at an accident or disaster scene.

2.2.4 Emergency Healthcare Inaccessibility

The few hospitals that offer emergency care in developing countries tend to get overcrowded due to the reception of many patients in critical conditions from all regions in the country. According to Fatovich in the journal article titled, access block causes emergency department overcrowding and ambulance diversion in Perth, Western Australia, efforts to reduce access block given the highest priority (Fatovich, 2010).; this gap would be addressed by our current research through the creation of a platform where patients can access the closest ambulance services, and the ERUs can locate the closest EDs that are not overcrowded.

The access block leads overcrowding in the emergency department and lots of ambulance diversion, which directly affects the patient's chances of survival by delaying equipped medical attention. The development of an emergency response system would give the ERUs access to the conditions at emergency departments (EDs) at the hospitals to take the patients to the least populated ED where they can receive emergency medical attention before later being referred to a medical facility of the patient's choice.

2.3 Road Incident Reporting Systems

Several incident reporting systems are presented and analyzed, focusing on the architecture and highlighting the similarities and differences through which this limitations of the systems have been noted.

2.3.1 Kenya's Nduru Road Safety App

Nduru, a mobile app developed to end road carnage in East Africa, is now available for Android devices in the play store. Nduru promises to manage almost all incidences related to road safety. It gives road users the ability to take charge of their security 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 kilometers per hour speed limit for the public service vehicles in Kenya, users can report the car to the police. It also has audio and text tutorials that help users administer first aid to victims (Wakoba, 2012). Figure 2.1 shows some of the functionalities that Nduru app offers (Wakoba, 2012).

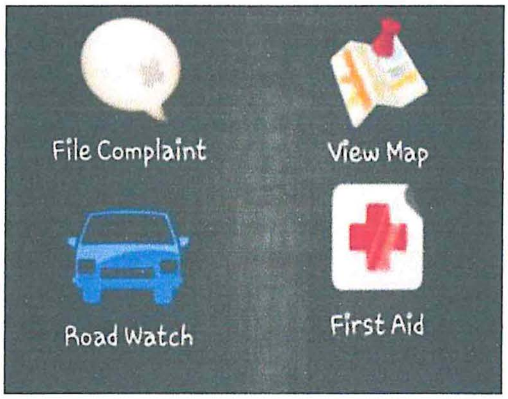

Figure 2.1: Nduru Mobile Application (Nduru, 2017)

2.3.2 Polish Medical Rescue Systems. Pre-hospital and Disaster Medicine

The Polish example is very similar to the Kenyan situation, and a study conducted there brings out glaring comparisons that can help in the analysis of the Kenyan situation. Mortality due to acute, life-threatening conditions is very high in Poland. In a study conducted at Wroclaw

University of medicine, trauma was found to be the leading cause of death for people under the age of 44 years. Per trauma mobility rate from road accidents is 14%. In the older generation, coronary heart disease is a significant cause of death. The average length of life in Poland is 67.5 years for men and 76 years for women. The study found that one of the main reasons for these unfortunate circumstances is the lack of a properly organized emergency medicine system. In Poland, the emergency medical system is monopolized by provincial primary care stations, which are working without structural and administrative co-operation with hospitals. The hospitals do not have regular emergency departments with dedicated and specialized personnel.

The emergency structure for Wroclaw city and province based on one Provincial Primary Care Station with seven local first aid stations, fire rescue ambulances, three pediatric ambulances, and nineteen general ambulances. None of the local hospitals possess an emergency department with specialized emergency nurses and doctors. As a result, the overall mortality in emergency cases is very high in this region. A quick assessment of the medical system in Nairobi revealed that it is ill-prepared to a much greater extent than the Wroclaw situation and that the lack of a local, regional or provincial program of disaster preparedness would quickly overwhelm the city and force people to self-defense and imposition of all types of rescue activities as is seen today.

According to the Daily Nation (March 8, 2001), an analysis by the government, local and international agencies and the medical community have shown that there are limited know-how and capacity for authorities to respond to major disasters in Kenya. This was obvious during the August 7, 1998 bomb blast, where the quality of pre-hospital care provided by the first responders (public and police force) and ambulance services was found to be lacking and inappropriate. This had a serious impact on the general outline of injuries.

A report by the International Medical Corps (IMC), embarked on a major program to provide Kenya with the necessary capacity to effectively deal with disasters, (the success of the program not seen yet). First responders had limited training if any, in basic first aid, Cardio Pulmonary Resuscitation (CPR), extrication and stabilization techniques, incident command system and mass handling casualties. Further, nursing and medical schools in Kenya do not adequately address resuscitation, trauma, or basic first aid. Most civil and medical authorities lack disaster preparedness programs or contingency plans for in-house response to mass casualty incidents.

The study reviewed indicated that the typical Kenyan scenario, how, if any triage is carried out, and whether prioritization of the victims' needs occurs. Lack of triage often leads to wrong decisions made on what to do with the victims, where to take them for further medical attention, and by what mode to take them.

2.3.3 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 can 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 2.2.

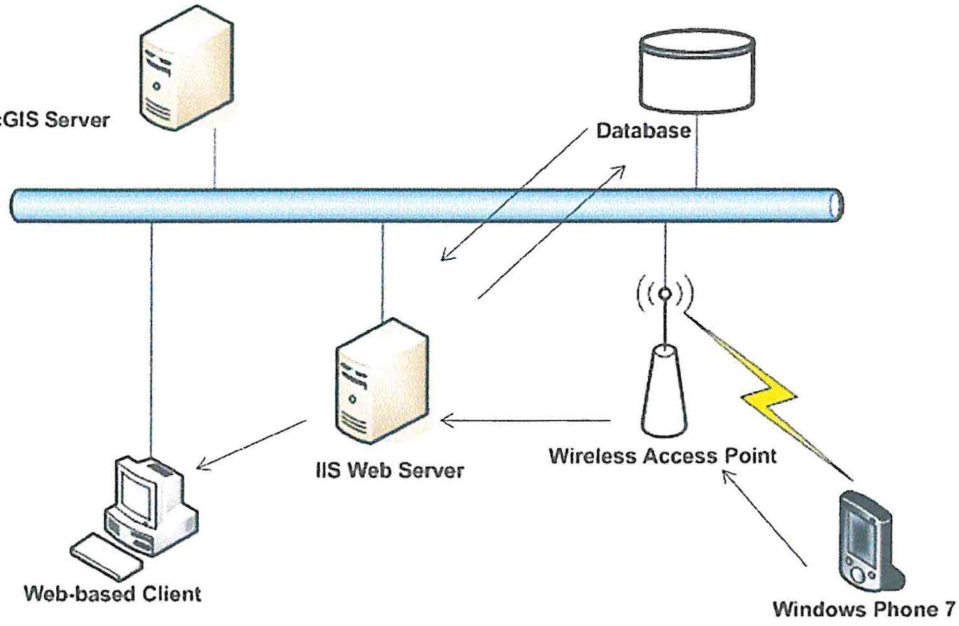

Figure 2.2: MARS System Architecture (Al-Nasser, 2010)

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 statements. This approach leads to a more intuitive application and reduces learning time (Al-Nasser, 2010). The accident image uploading page is shown in Figure 2.3.

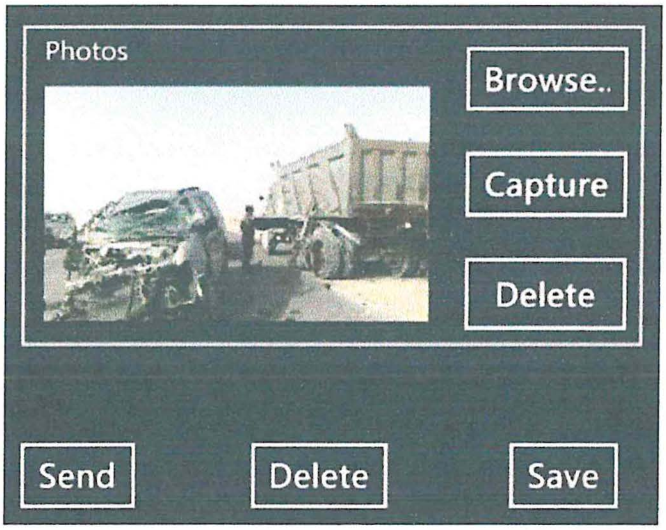

Figure 2.3: MARS Accident Image Uploading Page (Al-Nasser, 2010)

The website is the front end that is accessed by web users. Its main objective is to provide users with querying capabilities that facilitate the generation of accident locations. Figure 2.4 shows the MARS web interface.

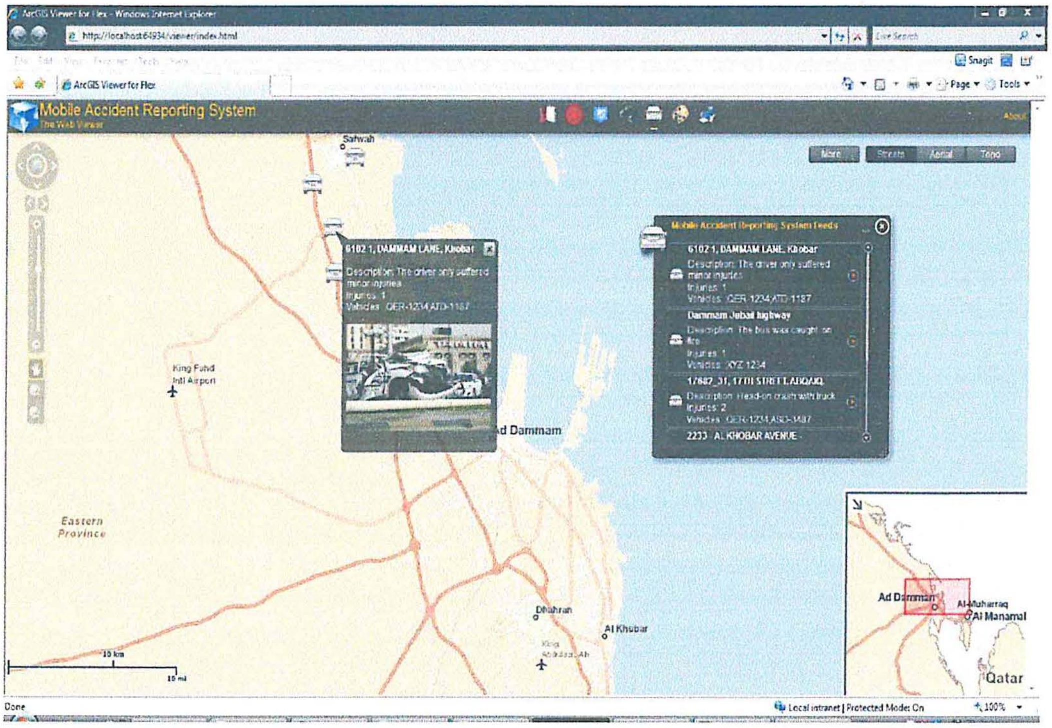

Figure 2.4: MARS Web Interface (Al-Nasser, 2010)

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

The Road Accident Data Recorder (RADaR) is an innovative application developed for 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 operates with a central web-based server for data storage (International Road Federation, 2008). The structure of RADaR is shown in Figure 2.5 overleaf.

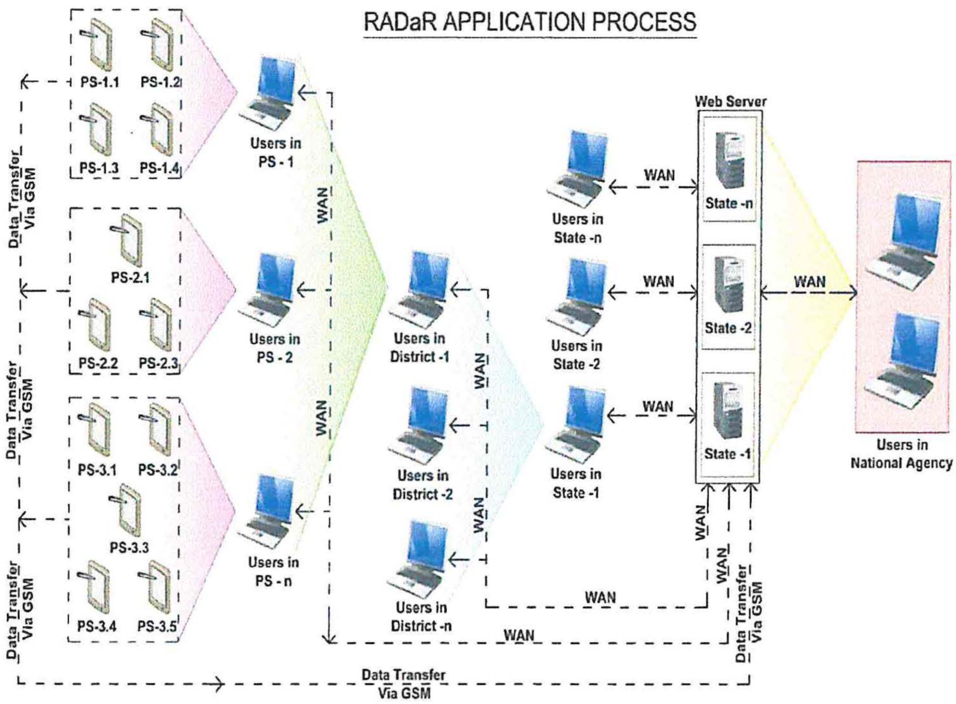

Figure 2.5: Structure of RADaR (International Road Federation, 2008)

analysis results, he/she considers them for his or her which means and implications (De Vos, 2006)

For the aim of this study, information collected victimization interviews, questionnaires, and documentation.

In this chapter, there was emphasizes on the methodology of the software in the 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 for implementation was be the Waterfall software development methodology. The advantage of waterfall development is that it allows for departmentalization and control. A schedule 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 shows the waterfall methodology illustration.

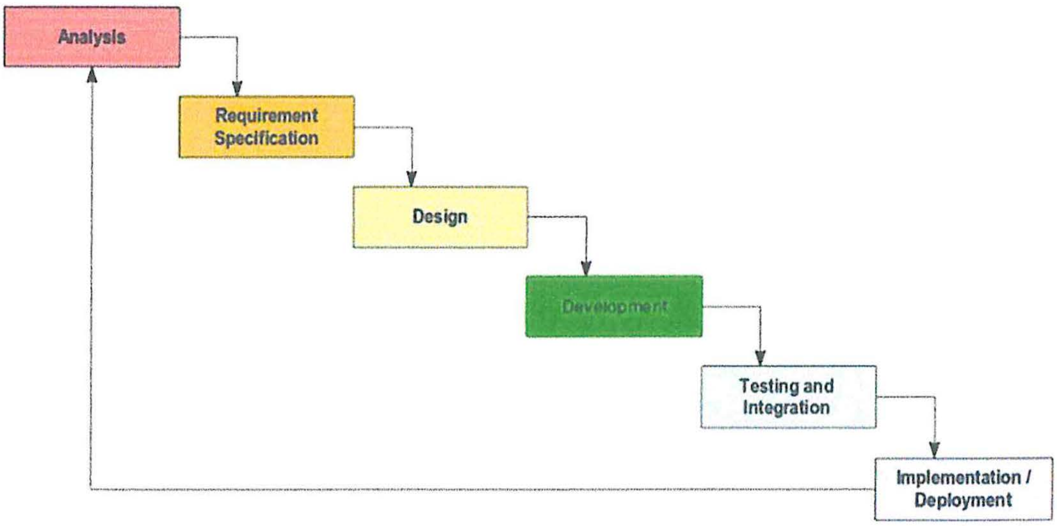

Figure 3.1: Waterfall methodology illustration (Ensmenger, 2010).

3.2.1 Feasibility study

A feasibility study is an assessment of the practicality of a proposed plan, method,

Chapter 3: Research Methodology

3.1 Introduction

This chapter discusses the information analysis and interpretation of the findings on electronic health records and addition, the evaluation methods. According to De Vos (2013), information analysis entails the analyst breaking down information into constituent components to get answers to analysis queries and to check the hypothesis. Information interpretation aims to find out more about the population from that the sample drawn De Vos (2013). Interpretation of data is the most key process in proving or disproving your hypothesis. It's vital to pick out the right technique to form a helpful explanation of your information. If an improper information analysis technique is chosen, the analysis results are also suspected and lack believability.

According to William(2012), interpretation has two significant aspects particularly establishing continuity within the analysis through linking the results of a given study with those of another and also the institution of some relationship with the collected information. Interpretation outlined as the device through which the factors that seek to clarify what has been discovered by the scientist within the course of the study would be highly understood. Interpretation provides a theoretical conception which might function a guide for any analysis work. Interpretation of the data has become a vital and essential process, mainly due to many following reasons:

i. Allow the researcher to possess in-depth know-how regarding the abstract principle behind his findings.

ii. The researcher is in a position to understand his/her findings and also the reasons behind their existence.

iii. Draw a clear understanding and knowledge with the assistance of any analysis.

iv. Provides good steering within the studies regarding the analysis work.

v. Typically might end in the formation of the hypothesis.

The purpose of deciphering information is to scale it back to an intelligible and understandable kind so the relations of analysis issues was studied and tested, and conclusions drawn. On the opposite hand, once the analysis interprets the 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 method.

3.2.2 Business Study

a) Research Design

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

i. Descriptive Research; this type of research helped the researcher define the characteristics of the population in the study. This would provide a deeper understanding of interactions between the populace, road incidents, and the ability of the people to report road incidents. The information acquired significantly influenced the decision on the technology to be adopted.
ii. Qualitative Research; this research type was used to gain an understanding of 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.

b) Location of Study

The study was done in Meridian Equator hospital for data collection within the County of Nairobi. Random individuals were selected for the study. The area was chosen for review due to easy access by the researcher and also due to its strong presence within the field of research.

c) Target Population

The target population is drawn from staff from the hospital, as specified after permission was granted, who were willing to answer the researcher's interview questions. Respondents were picked randomly as earlier stated.

d) Sampling Strategy

Polit and Hungler(1999) discuss with the population as a combination or totality of all the objects, subjects, or members that adjust to a collection of specifications. During this study, the population enclosed hospital skilled such directors, Nurses, and CIO's (Chief info Officer). The people are elite because of their eligibility criteria. Eligibility criteria specify the characteristics that folks within the population should possess to be enclosed within the study (Polit & Hungler 1999).

The eligibility criteria during this study are that participants got to:-

i. Be health professionals

ii. Employed for more than two years

iii. Work with patient health records.

iv. Work in ER and patient evacuation

According to Hooloway and Wheeler (2002), sampling ways of qualitative analysis are radio- controlled by the principle of gaining in-depth info. During this analysis study, a purposive sampling technique wants to choose the participants from the population. Babbie (2011) refers to purposive sampling as wherever the scientist selects the units or parts that are most helpful or representative to the analysis.

e) Data Collection

Two methods of data collection were employed in this research, which are interviews and questionnaires. The data collection procedure for the interview involved a visit to the major roads and streets selected to have a 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 a questionnaire that was prepared and distributed in the 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. Google documents were automatically consolidated the data collected from this form and aggregated in an excel format spreadsheet with the responses. It is from the spreadsheet that the data analysis is done. Below is a list of data collection methods that the researcher used to get feedback from the population of the 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 problems 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 achieved by improving 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 Modelling 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

The context diagram shows the mobile app 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 particular 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 realize the various use-cases of the system. The sequence diagram of the multiple processes of the road incident reporting system was drawn to visualize the sequences of the messages in the order.

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 to develop the mobile app.

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 written in Java, utilizing android classes. The application compiled and tested using the Android Software Development Kit (SDK) emulator and an Android device. The app optimized for Android version 5.0.0 and above which was be compatible with

Android devices on minimum version 5.0 and maximum version 8.0.0. JSON 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 Pre-processor (PHP) and NodeJS JavaScript technology. The website hosted on an online Apache HTTP server. Reasons for using PHP; it is an Open Source platform; it is platform independent; it supports all significant web servers 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 encrypted before storage restricting unauthorized access to the database.

3.5 Application Evaluation

The prototype went through the following tests:

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

ii) Compatibility Tests; compatibility test 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.

3.6 Ethical Considerations

Clough and Nutbrown (2002, 84) comment as follows concerning ethics in research:

"...... to understand, researchers must be more than technically competent. They must enter into chattered intimacies, open themselves to their subjects" feeling worlds, whether these worlds are friendly to them or repulsive. They must confront the duality of represented and experienced selves simultaneously, both conflicted, both real....." In concert with Clough and Nutbrown's view above, it follows that in planning my research, a consideration was taken that would protect the feelings, welfare, and rights of the participants.

The following ethical considerations were taken into account during the research. These considerations applied to both the quantitative and qualitative research sections of this study.

3.6.1 Permission

A written permission was obtained from the **Kenya Medical Practitioners** and Dentists Board to conduct this research, to ensure that it is a proper exercise.

3.6.2 Confidentiality and privacy

Confidentiality refers to handling the information concerning the respondents confidentially. Respondents assured that their names and the names of their hospitals dealt with in the strictest confidence. This aspect includes the principle of trust in which I assured the participants that their trust would not be exploited for personal gain or benefit, by deceiving or betraying them in the research route or it's published outcomes (Lubbe, 2003,41).

3.6.3 Voluntary participation and informed consent

The principle of voluntary participation explained to the respondents, and they were informed that they have the right to withdraw from the study at any time. The principle of informed consent was attached to the questionnaires, and verbally explained to the interviewees. Both principles entail explaining the research process and its purposes to the participants.

3.7 Research Quality

The quality of research was measured through its validity. Validity is the extent to which a concept is accurately measured in a quantitative study. The second element in measuring the research quality is reliability or accuracy. This is the extent to which a research instrument consistently has the same results if used in the same situation on repeated occasions (Heale & Twycross, 2015). The reliability of the sources of information of the data used in the study, the research instruments, and any other concerned research aspect would be guaranteed and accredited.

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 sequence diagrams, use case diagrams, and, the entity relationship diagrams (ERD).

4.2 System Architecture

The front-end user is the road user or a casualty in possession of a mobile phone with the e-Rescue application installed. The front end user makes a request in form of a distress call within the application. The call contains the details of the road incident being reported and with the help of Global Position System (GPS), the system can automatically capture the incidents' location. The calls made can be retrieved inform reports stored in the backend server that resides preferably in a cloud environment. Also, there are the ambulance drivers operating on the same front end interface but under different roles. This would enable them to accept request from the users and attend to the distress calls

The backend user has a more refined view of the reported cases and the response rate. The user can view the nearest emergency response time as well as the nearest accredited facility to attend to emergency cases. 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.

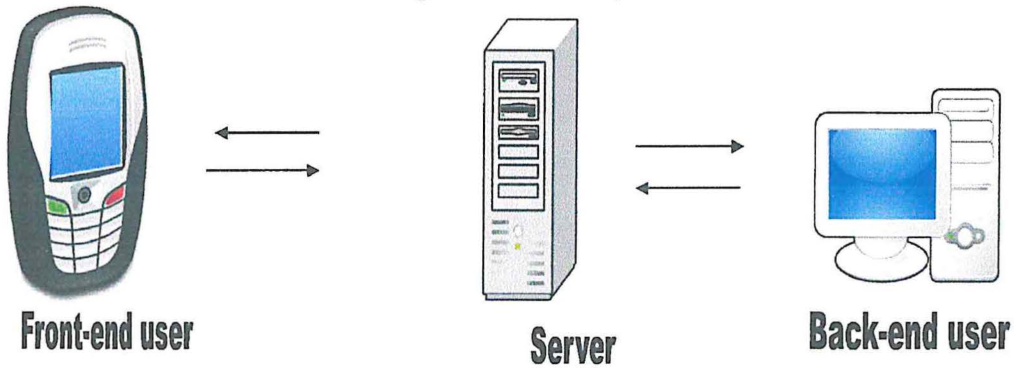

Figure 4.1: System Architecture

4.3 The Three-Tier Architecture

The system is built around the 3-tier architecture. The 3-Tier architecture is a unique system of developing web database application which works around the 3 tier model, comprising of presentation or client tier at the top, the application or the business logic tier in the middle and the database tier at the top. This 3-tier architecture module is the framework for most Web Applications on the Internet.

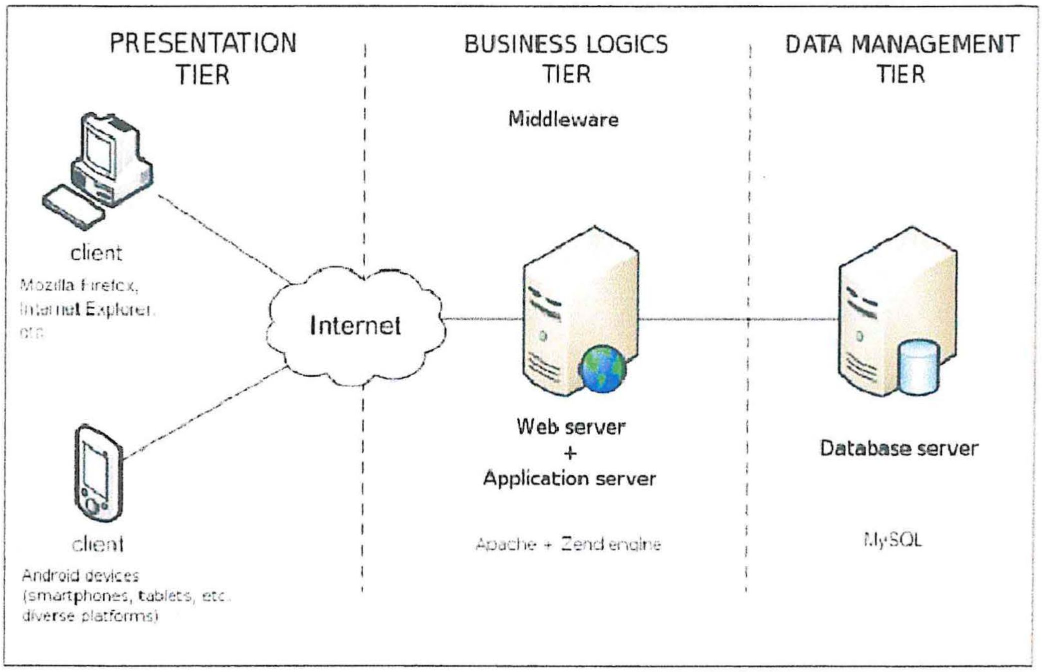

Figure 4.2: Three-Tier Architecture

The client tier represents the front-end and back-end section of the whole system, as shown in 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 Entity Relationship Diagram (ERD)

Figure 4.3 is an Entity Relationship Diagram (ERD) showing the structure of the database of the road incident reporting application and the relationships between the tables.

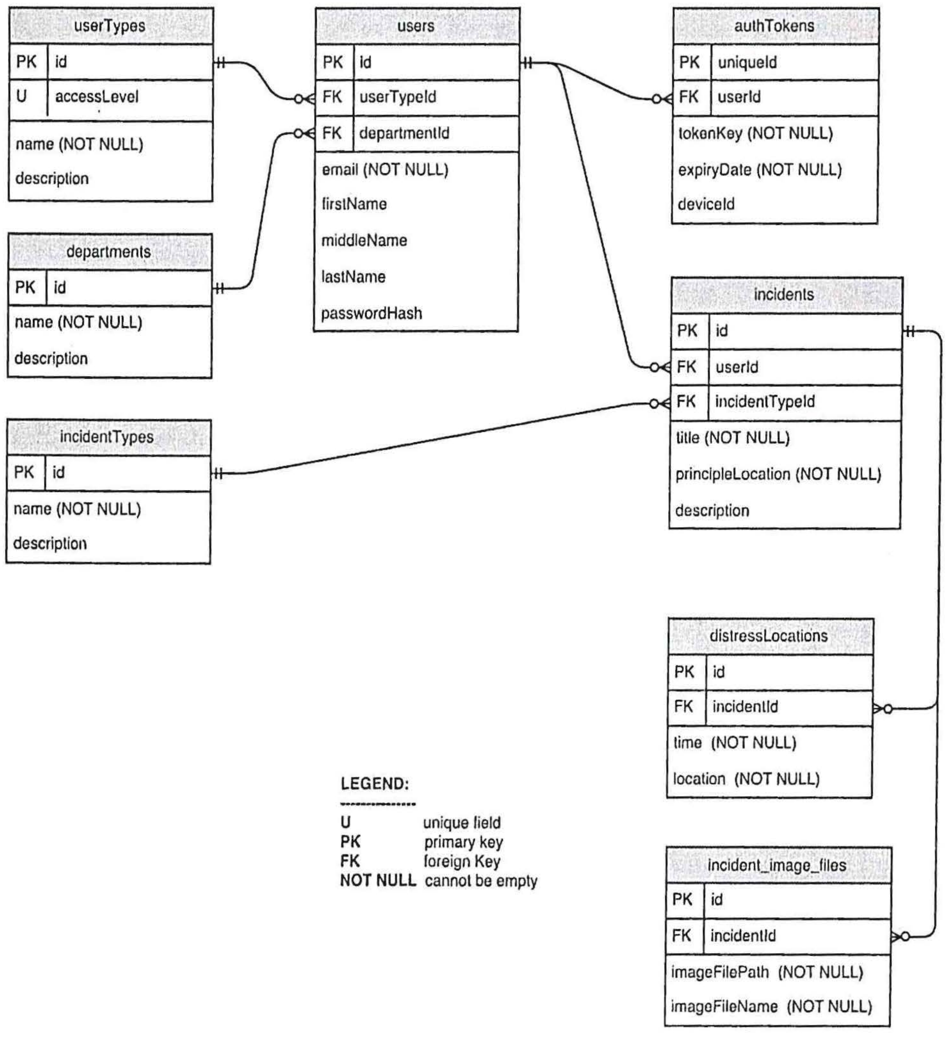

Figure 4.3: Entity Relation Diagram

4.5 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 in Figure 4.4.

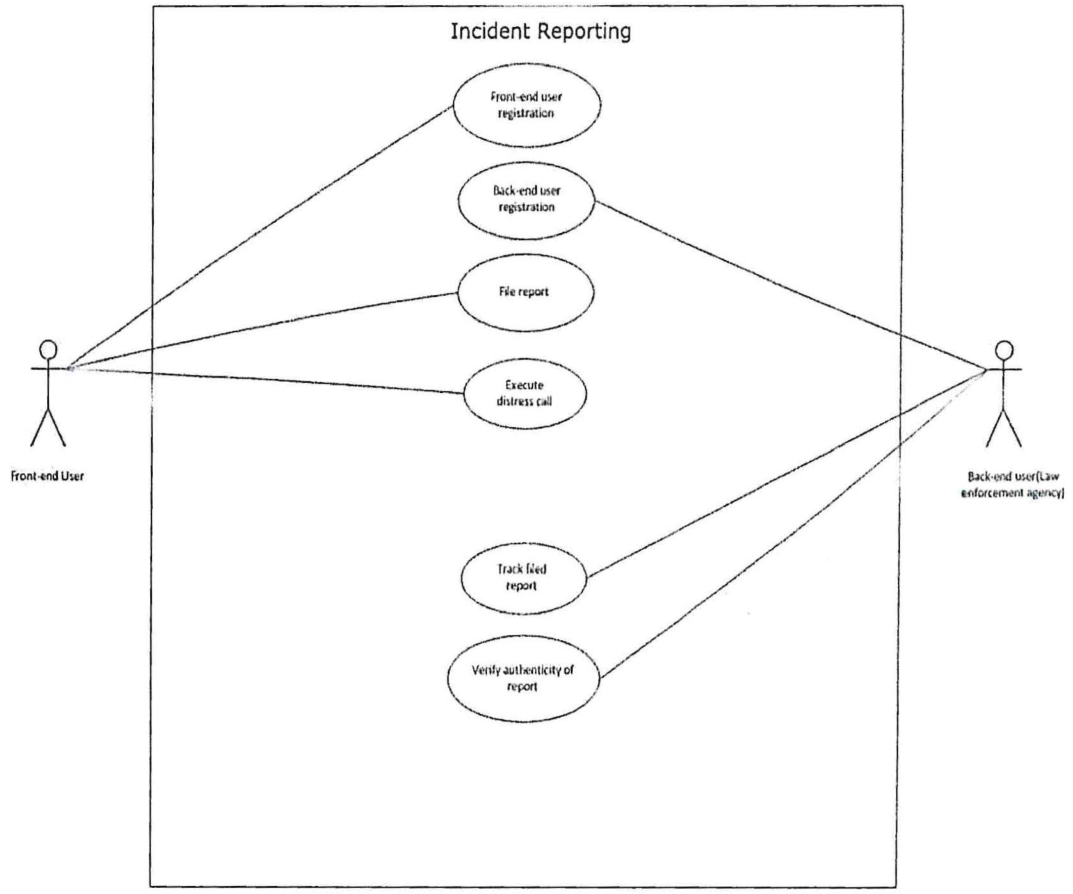

Figure 4.4: Use Case Diagram

4.6 Sequence Diagrams

Figure 4.5 shows a sequence diagram detailing the processes that occur in the front end user side.

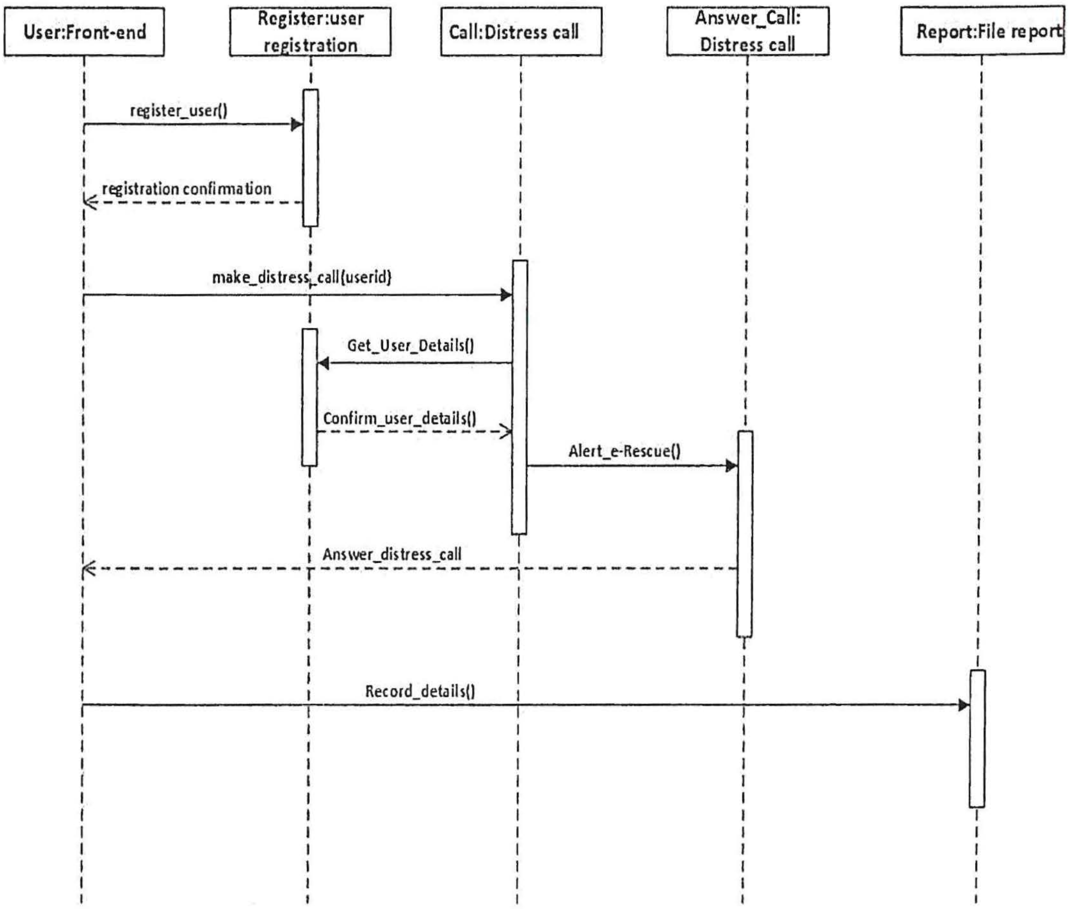

Figure 4.5: Sequence Diagram

4.7 Functional Requirements

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

4.7.1 Front-End Functional Requirements

Registration

A user after accessing the application and having successfully installed it submits details that was used to create their user account. A user provides registration information, and the profile immediately created upon submission of the 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 would be able to access functionalities such as reporting road incidents and viewing road incidents posted.

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 app or login only when they need to access the application or data required.

Make a request

After the user logs into the system, he/she is now able to request the emergency rescue team of the front-end application on the mobile phone. This functionality allows the user to add a GPS location to the posted report 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.

View Road Incident Report

The user is not required to log in 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 also added as part of the list of road incidents.

Distress Call

This functionality allows the user to send bulk SMS 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.

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 data due to typo errors. It also allows the user to delete the incident altogether.

4.7.2 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 would 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, which means that it would no longer appear as an incident in the backend or to other users.

4.8 Non –Functional Requirements

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

4.8.1 Security

Critical security issues were in place to ensure that information about 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.

4.8.2 Non- Repudiation

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

4.8.3 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.

4.8.4 Data Retention

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

4.8.5 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 an emergency response where all the functionalities of the application are implemented. The screenshots of the app presented in this chapter for both the front-end and the back-end sides.

5.2 Road Incident Reporting Application

5.2.1 Make a request

After the user logs in the system, he/she 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 to track the location of the incident. The user is also free to take pictures of the incident and finally post them as an alert, which in turn activates the nearest and available rescue unit. Figure 5.1 shows the screen that is used to make a request on a road incidence.

Figure 5.1: Report Road Incident Screen

5.2.2 Distress Call

This functionality allows the user to send an alert by just one touch of a button. It is applicable when they are in a very critical incidence, and there is not enough time to make a formal request for pick up. This functionality also captures your GPS location so that it can help track your site easily. Figure 5.2 shows the screen that is used to attend to a distress call when a road incidence occurs.

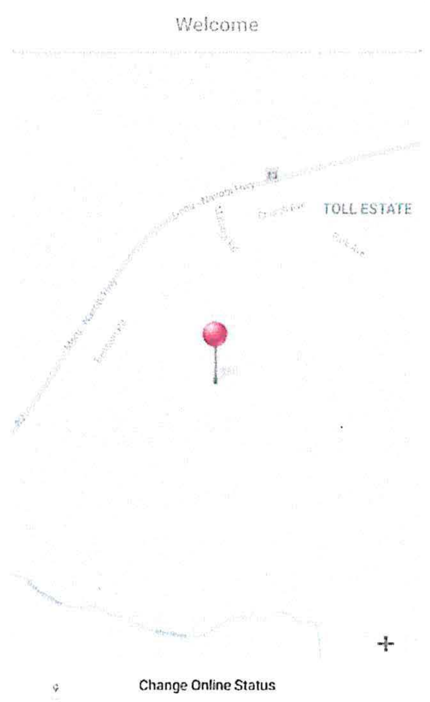

Figure 5.2: Distress Call

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 reported. The map tracks down the location of the incidence since the mobile phone of the frontend user would be relaying the coordinates to the server in the backend.

5.4 Testing

The sample used for testing the application was Nairobi County. The respondents included daily commuters across the county. The passengers were chosen because they represent the target population who were to make use of the application. Also, it was identified that most of them 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 apps was 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.

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 app. These tasks were chosen in order to exercise the critical 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 review 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 of the field work.

5.5.1 Impact of the Application may have to the Authorities Concerned

Figure 5.3 shows a chart detailing the respondents' perception of the impact of the road incident reporting application regarding the road incidents as far as the response of the users is concerned.

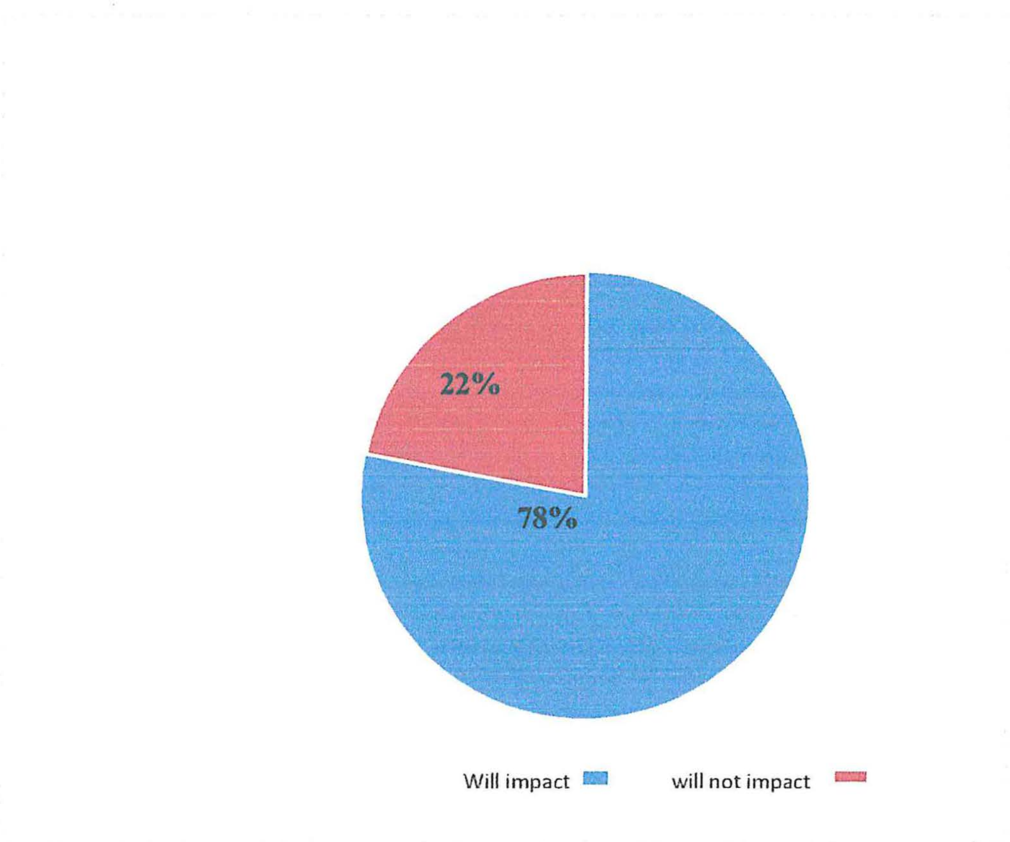

Figure 5.3 Perception of Users on the Impact of the Application

22% of the respondents thought that the application would not have any impact as far as the road incident reporting is concerned. They had the following reasons:

i. Other applications may serve as better mediums to alert and report such incidents. They said forums on Facebook and Twitter would be better mediums.
ii. The application would have to get enough traffic in terms of users to be able to break through in terms of usage and user acceptance.
iii. User acceptance, especially when you are requesting the ambulance for unknown people, would be a challenge.

78% of the respondents thought it would have an impact due to the following reasons:

i. The application is specific, i.e., targets road users only on road accidents that require emergency response units.
ii. It would be easier to utilize the emergency resources in case of an incidence, unlike the current situation where there is no proper channel to communicate.
iii. Road incident reports can be efficiently mined from the central database hence enhancing research.

iv. The application is simple and easy to use.

v. The registration and the sign-in process is quite simple; hence, this would not discourage users from using the application, therefore, making it more effective.

vi. The capability to capture image and record short video would help in increasing the efficiency of the application.

5.5.2 The Impact of the Application on Road Safety

Figure 5.4 shows a chart detailing the impact of the application on road safety.

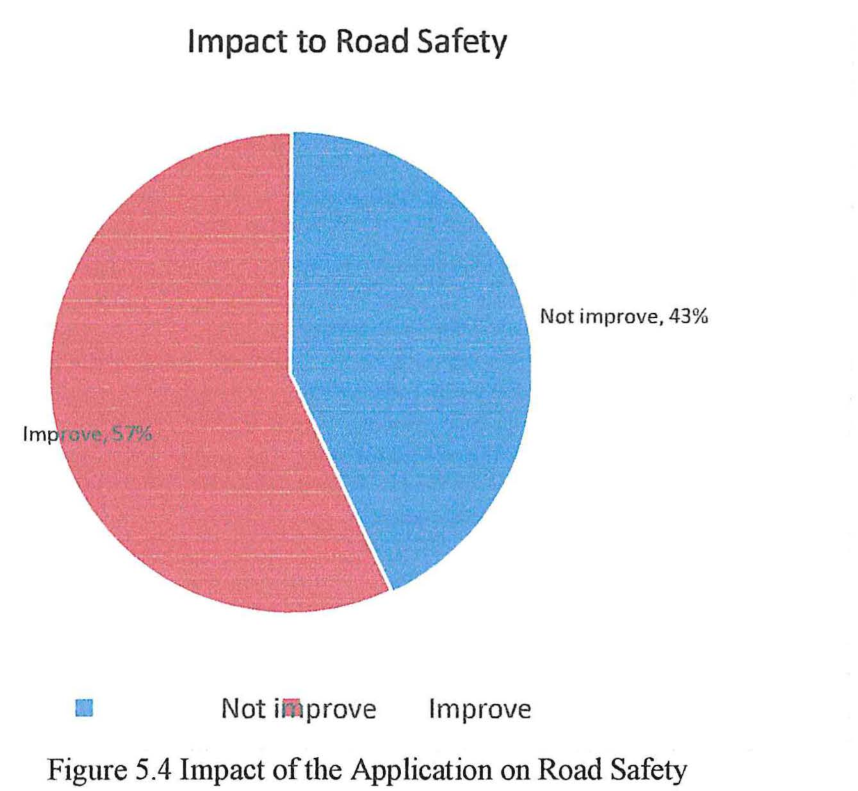

Figure 5.4 Impact of the Application on Road Safety

57% of the respondents thought that the application would improve on road safety. They had the following reasons:

i. It would help enhance casualty evacuation but not necessarily prevent serious road incidents.

ii. They added that it would significantly help the emergency response units' act faster since they would be getting first-hand information in real-time.

iii. The data mined would help future harmful occurrences once extracted and analyzed.

46% thought it would 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. Users may not use the application because it does not have anything else to provide other than alerting and reporting as compared to Facebook and Twitter. This would render the application database empty.

5.5.3 Percentage of Respondents Willing to Use the Application

Figure 5.5 is a chart showing the percentage of respondents who would actually use the application versus those who would not use the application.

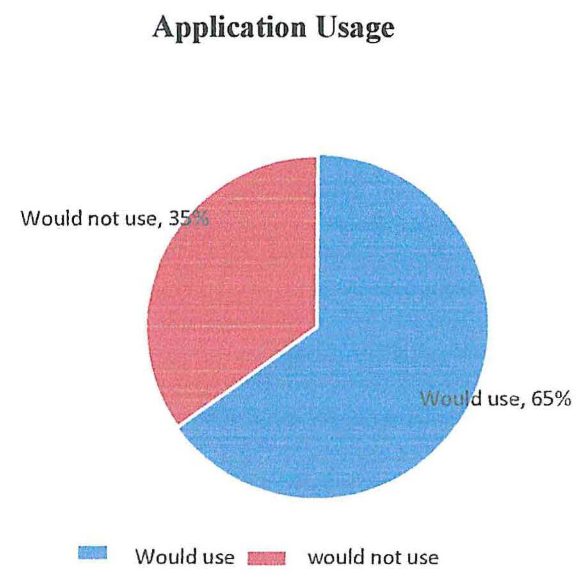

Figure 5.5 Percentages of Respondents Willing to Use the Application

65% 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 filled reports does not pose a threat to their lives and privacy as well as the location of users.
ii. They would have the motivation to use it if it gathers user traffic.
iii. They can use it if it proves to be useful in solving the current evacuation process in road incidents.
iv. More features should be added to the application other than just alerting and reporting.

35% 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 alerting and reporting.

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. Look and feel-The appearance and look and feel of the app should be upgraded. They added that the current one needed improvements to look more appealing.
ii. The application should have more features as an incentive to the users other than just incident alerting and reporting.
iii. The web interface should have a report extraction feature.
iv. 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 5.6 is a chart showing how the respondents rated the ease of use of the road incident reporting application in terms of the navigation.

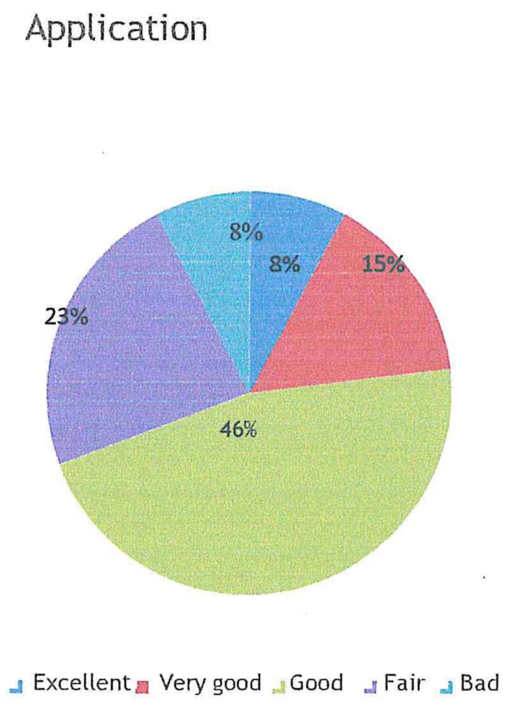

Figure 5.6 Ease of Use of the Application

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

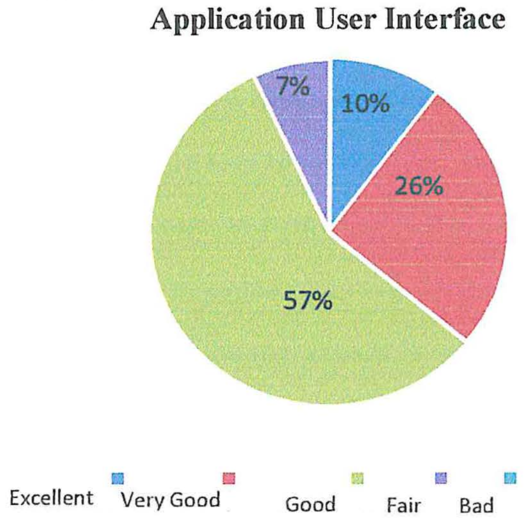

Figure 5.7 User-Interface Ratings of the Application

0% of the respondents thought the front-end mobile interface was bad, 26% thought it was very good, 10% thought it was excellent, 7% thought it was fair, 57% thought it was good. The following were the views of 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.

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 and were built for in-house organizational use. , i.e., the incidents 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 all the research questions have been answered.

6.3 User Perception of the Application

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

In support of the application

i. The application is specific, i.e., targets information only on road incidents.

ii. It would help improve road safety but not necessarily prevent harmful road incidents.

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

Not in support of the application

i. Other applications may serve as better mediums to report such incidents.

   They said Twitter and Facebook would be better mediums.

ii. The application would have to get enough traffic in terms of users to be able to pull the attention of potential viewers.

iii. 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

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 the tracking of carjacked users. This module required the user to have his mobile phone GPS module.

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 alert ERU's and report road incidents and hence address the issue of efficient and effective casualty evacuation in road incidents. The opportunity that exists in Kenya concerning road incident casualty evacuation is not well tapped, especially with the increase in the number of smartphones with Android OS. Thus the mobile application comes in handy to provide a solution to the way users seek help in cases of road incidents. The literature of various incident alerting and reporting systems was studied, and previous research is done on the reporting systems. Most of these systems were web-based and based on social media to inform ERU's and also report incidents to the relevant authorities.

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

The proposed solution is an android based mobile application designed, developed, and tested for use by road users in Nairobi County, Kenya. The solution was designed based on the users need for a platform to make distress calls as well as report road incidents. The requirements were gathered and mapped using various diagrams such as use-case diagrams, sequence diagrams, and entity relationship diagrams of the database. The application would 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 emergency response. 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 was considered time-consuming for users reporting incidents. As a result, it was proposed to use the mobile device's email address for 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 windows phone and iOS based on the user base and mobile device penetration to get access to huge audiences. The application would be free to download on Google Play Store, but further research needs to be done on how the mobile application can be incorporated into the relevant authorities such as the traffic police.

7.3 Suggestions for Future Research

Based on user feedback, the application would continuously be improved to cater for users changing needs. Further research should be done in the future to enhance functionalities of the application and thus ensure user retention. There needs to be more research on how to verify the authenticity of the reported road incidents because the incidents 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 emergency response in cases of road incident. Any information given will not be used against you.

1. Do you think the emergency response application will have an impact on casualty evacuation and the response of the Emergency Response Units' (ERU's) 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 indicate how and why you feel 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: Core i3 or higher
ii. RAM: 4GB
iii. Space on disk: 500GB 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 4.2 or higher for running the application. Samsung J series used for running and testing the application.
ii. Space to execute 250 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 or higher
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: Wamp Server v 3.1.0

At the application end, the following were the requirements needed:

i. Framework: Android SDK Version 4.2.1
ii. Network: Mobile network and Internet (cellular or Wi-Fi) to provide network connectivity for testing the developed application.