The Nelson Mandela AFrican Institution of Science and Technology

NM-AIST Repository **https://dspace.mm-aist.ac.tz**

Computational and Communication Science Engineering Masters Theses and Dissertations [CoCSE]

2020-06

Development of a mobile application system for road accidents reporting and driver's over-speeding behavior awareness in Tanzania

Mrema, Ikunda Jackson

NM-AIST

https://doi.org/10.58694/20.500.12479/907

Provided with love from The Nelson Mandela African Institution of Science and Technology

DEVELOPMENT OF A MOBILE APPLICATION SYSTEM FOR ROAD ACCIDENTS REPORTING AND DRIVER'S OVER-SPEEDING BEHAVIOR AWARENESS IN TANZANIA

Ikunda Jackson Mrema

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master's in Information and Communication Science and Engineering of the Nelson Mandela African Institution of Science and Technology

Arusha, Tanzania

June, 2020

ABSTRACT

Road traffic accidents account as one of the major causes of injuries and loss of human lives. Various studies have shown that the implementation of road accident reporting systems can reduce road accidents injuries and deaths through time minimization in assisting the victims and also in the mapping of road accident-prone areas. This study reviewed several in-vehicle and smartphone sensor-based systems for road accident reporting and driver's behavior awareness. Questionnaires, interviews, observations, document reviews were used to collect data from road users and traffic police officers. The study developed a mobile application system using the evolutionary prototyping method, where users tested the system and their feedbacks were incorporated iteratively. Findings from the survey revealed that road traffic accidents are mostly reported through police emergency numbers which are sometimes unreliable and unavailable giving traffic police officers challenges in knowing the precise accident location. Since traffic police officers are the recognized first responders in Tanzania, road accident information delays may increase the time taken to help road accident victims. The developed mobile application system has the potential to provide an alternative tool for the reporting of road accidents and over-speeding drivers in addition to the existing methods. The system would serve as a source of road accidents data from road users. The mobile application also collects users' smartphone sensors logs for the future development of automatic road accident reporting systems. The developed mobile application system was validated and accepted by the users who agreed on its usefulness in improving road safety.

DECLARATION

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

..... 24/06/2020

Ikunda Jackson Mrema Date

Name and Signature of the candidate

The above declaration is confirmed by:

..... 24th June 2020

Dr. Mussa A. Dida Date

Name and Signature of the supervisor

COPYRIGHT

This dissertation is a copyright material protected under the Berne Convention, the Copyright Act of 1999 and other International and National enactments, in that behalf, an intellectual property. It may not be reproduced by any means, in full or in part, except for short extracts in fair dealing, for research or private study, critical scholarly review or discourse with an acknowledgment, without a written permission of the Deputy Vice Chancellor for Academic, Research and Innovation, on behalf of both the author and the Nelson Mandela African Institution of Science and Technology.

CERTIFICATION

I, the undersigned certify that I have read and hereby recommends for acceptance by The Nelson Mandela African Institution of Science and Technology, a dissertation entitled, "Development of Mobile Application System for Road Accident Reporting and Driver's Over-speeding Behavior Awareness in Tanzania" in partial fulfillment of the requirements for award of the degree of Master's in Information and Communication Science and Engineering.

..... 24th June 2020

Dr. Mussa A. Dida Date

Name and Signature of supervisor

ACKNOWLEDGMENT

First and foremost, I thank the Almighty God for the strength and endurance he has given me during the whole research period.

I would like to express my gratitude to my supervisor Dr. Mussa A. Dida, for his willingness to supervise this research, his continuous support, concern, and guidance throughout this study. I thank my colleagues for their invaluable research advice, and encouragement during the entire research period.

I would also like to thank the Traffic Police Headquarters in Dar es Salaam (Tanzania) and everyone who participated in this study for their cooperation especially during the field surveys. The information they provided gave me insights into the research I was conducting.

I am extending my very deep gratitude to the African Development Bank (AfDB) scholarship program for funding this research, and the NM-AIST for making a conducive environment for me in achieving my study and career goals.

Last but not least, I would also like to thank my parents, Mr. and Mrs. Jackson Yesusa Mrema for their constant encouragement, prayers, support, and love.

DEDICATION

To my dear parents Mr. and Mrs. Jackson Yesusa Mrema.

TABLE OF CONTENTS

ABSTRACT i

DECLARATION ii

COPYRIGHT iii

CERTIFICATION iv

ACKNOWLEDGMENT v

DEDICATION vi

TABLE OF CONTENTS vii

LIST OF TABLES x

LIST FIGURES xi

LIST OF APPENDICES xiii

LIST OF ABBREVIATIONS AND SYMBOLS xiv

CHAPTER ONE 1

INTRODUCTION 1

1.1 Background of the Problem 1
1.2 Statement of the Problem 2
1.3 Rationale of the Study 3
1.4 Objectives of the Study 3
1.4.1 Main Objective 3
1.4.2 Specific Objectives 4
1.5 Research Questions 4
1.6 Significance of the Study 4
1.7 Delineation of the Study 4

CHAPTER TWO 6

LITERATURE REVIEW 6

2.1 Road Traffic Accidents in Tanzania 6
2.2 Speed Limits for Road Safety 7
2.3 Road Traffic Accident Reporting 7
2.4 Existing Road Accidents Data Systems in Tanzania 7
2.5 Mobile Technology Penetration in Tanzania 8

2.6 Related Works 9
2.6.1 In-Vehicle Sensors-Based Systems for Driver's Behavior Awareness and Road Accident Reporting 9
2.6.2 Smartphone Sensor-Based Systems for Driver's Behavior Awareness and Road Accident Reporting 11
2.6.3 Characteristics of Road Accident Reporting Systems and Applications .. 13
CHAPTER THREE 15
MATERIALS AND METHODS 15
3.1 Field Survey 15
3.2 Study Area 15
3.3 Sampling Technique 15
3.4 Data Collection Methods 16
3.4.1 Questionnaires 16
3.4.2 Interviews 17
3.4.3 Observation 17
3.5 Data Analysis Method 17
3.6 Methodology for System Development 17
3.7 Requirement Identification 18
3.8 System Design 18
3.8.1 Driver's Over-speeding Behaviour Awareness Module 19
3.8.2 Road Accident Reporting Module 19
3.9 System Implementation 20
3.10 Mobile Application System 20
3.11 Web Application System 21
3.12 Data storage 22
3.13 System Testing and Validation 23
3.13.1 System Testing 23
3.13.2 System Validation 23
CHAPTER FOUR 24
RESULTS AND DISCUSSION 24
4.1 Questionnaire Results from the Traffic Police Officers Respondents 24
4.1.1 Demographic Characteristics of the Traffic Police Officers Respondents 24
4.1.2 Means Used to Receive Road Accident Reports 24
4.1.3 Challenges Faced in Responding to Road Accidents 25

4.1.4 Information Collected During Road Accident Reporting 26
4.2 Questionnaire Results from the Road Users Respondents 27
4.2.1 Demographic Characteristics of the Respondents 27
4.2.2 Sources of Help That is Provided at the Accident Scene 28
4.2.3 Awareness of Existing Mobile Applications for Road Accident Reporting 29
4.2.4 Attitude Towards a Mobile Application System for Road Accidents Reporting and Over-Speeding Awareness 29
4.3 Interview Results 30
4.3.1 Structured Interviews 30
4.3.2 Semi-Structured Interviews 31
4.4 Requirement Identification 33
4.4.1 Functional and Non-Functional Requirements 33
4.5 System Design 35
4.5.1 System Architecture 35
4.5.2 Use Case Diagram 36
4.5.3 Data Flow Diagram 39
4.6 System Implementation Results 40
4.6.1 Mobile Application System Implementation 41
4.6.2 Web Application System Implementation 46
4.6.3 Database Implementation 50
4.7 System Validation 52
4.7.1 System Testing 52
4.7.2 User Acceptance Test 53
4.8 Discussion 57
CHAPTER FIVE 59
CONCLUSION AND RECOMMENDATIONS 59
5.1 Conclusion 59
5.2 Recommendations 60
REFERENCES 62
APPENDICES 67
RESEARCH OUTPUT 99

LIST OF TABLES

Table 1: Road traffic accidents statistics between year 2009 – 2013 and 2014 – 2018.. 6

Table 2: Road traffic accidents statistics between Jan – Feb 2018 and Jan – Feb 2019 . 6

Table 3: Speed limits in Tanzania for different vehicle types 7

Table 4: Demographic characteristics of the traffic police officers respondents..... 24

Table 5: Demographic characteristics of road users respondents 28

Table 6: Functional requirements..... 34

Table 7: Non-functional requirements..... 35

Table 8: Description of the use cases 38

Table 9: System testing results..... 53

Table 10: Road users validation survey responses..... 55

Table 11: Traffic police officers validation survey responses..... 56

LIST FIGURES

Figure 1: Mobile and fixed lines penetration in Tanzania (Source: TCRA, 2019)..... 9

Figure 2: Internet penetration in Tanzania (Source: TCRA, 2019)..... 9

Figure 3: Evolutionary prototyping model 18

Figure 4: Flowchart of over-speeding detection using data from GPS receivers 19

Figure 5: Means used to receive road accident reports. 25

Figure 6: Challenges faced in responding to road accident reports. 26

Figure 7: Information collected during road accident reporting 27

Figure 8: Source of help provided at the accident scene. 28

Figure 9: Awareness of the existing mobile applications for road accident reporting.. 29

Figure 10: Attitudes of the respondents towards mobile application reporting..... 30

Figure 11: System architecture 36

Figure 12: Use case diagram..... 37

Figure 13: Level-0 DFD (context diagram)..... 39

Figure 14: Level-1 DFD 40

Figure 15: (a) User log-in screen (b) User registration screen (c) Home screen 42

Figure 16: (d) Set speed limit screen (e) Speed notifications screen (f) Over-speeding notifications 42

Figure 17: Over-speeding reporting screen 43

Figure 18: (g) Choose accident type screen (h) create a report screen..... 44

Figure 19: (h) Menu screen (i) View sent reports screen 45

Figure 20: Sample GPS and accelerometer sensor logs 46

Figure 21: Log-in page 47

Figure 22: System dashboard..... 47

Figure 23: User profile page 48

Figure 24: System admin user management page..... 48

Figure 25: Viewing sent road accidents and over speeding reports..... 49

Figure 26: Mapping of reported road accidents and over speeding incidents 50

Figure 27: Firebase authentication page..... 50

Figure 28: MYSQL database tables. 51

Figure 29: Database schema 52

Figure 30: Technology acceptance model 54

LIST OF APPENDICES

Appendix I: Yamane Sample Size Calculation Formula 67

Appendix II: Field Survey Data Collection Questionnaires for Traffic Police Officers 68

Appendix III: Field Survey Data Collection Questionnaires for the Citizens 71

Appendix IV: Field Survey Semi-Structured Interview 75

Appendix V: Field Survey Validation Questionnaire for the Citizens 76

Appendix VI: Field Survey Validation Questionnaire for the Traffic Police Officers ... 77

Appendix VII: The Sample Codes for Mobile Application Development 78

Appendix VIII: The Sample PHP Codes Used in Web Application Development 96

LIST OF ABBREVIATIONS AND SYMBOLS

API	Application Programming Interface
CDS	Context-based Insurance
CSS	Cascading Style Sheets
DFD	Data Flow Diagram
ERD	Entity Relationship Diagrams
GIS	Geographic Information System
GM	General Motors
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HTML	Hypertext Markup Language
ICT	Information and Communication Technology
IDE	Integrated Development Environment
iOS	iPhone Operating System
IoT	Internet of Things
JSON	JavaScript Object Notation
MSD	Minimum Set of Data
NAOT	National Audit Office
OBD	On-Board Diagnostic
OBPS	On-Board Processing System
OBU	On-Board Unit
OECD	Organization for Economic Co-operation and Development
PHP	Hypertext Preprocessor
RAC	Royal Automobile Club

RAIS	Road Accident Information System
RTA	Road Traffic Accident
SDK	Software Development Kit
SMS	Short Message
SUMATRA	Surface and Marine Transport Regulatory Authority
TAM	Technology Acceptance Model
TCRA	Tanzania Communications Regulatory Authority
TPF	Tanzania Police Force
UBI	Usage-Based Insurance
UML	Unified Modeling Language
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VRU	Vulnerable Road Users
VS	Visual Studio
VTS	Vehicle Tracking System
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem

Road traffic accidents are one of the major causes of morbidity and mortality in Tanzania and even worldwide (Boniface, Museru, Kiloloma, & Munthali, 2016). According to the World Health Organization (WHO) global status report on road safety of 2018, road traffic accidents are the 8th world-leading cause of death for people of all ages with the number of deaths being 1.35 million in 2016 and up to 50 million injuries (World Health Organization, 2018).

The Organization for Economic Co-operation and Development (OECD) health statistics report of 2019 referred to a road traffic accident as an accident that happens on a road that is open to public traffic. It results in one or more person to be injured or killed and involves one or more moving vehicles. In addition, it may include collision between vehicles, between vehicles and pedestrians or between vehicles and animals or fixed obstacles (OECD, 2019). Road traffic accidents are also referred to as road traffic crashes by most international organizations including WHO.

There are various measures that have been identified by the WHO in reducing the occurrence of road traffic accidents. These include strong enforcement of road safety laws, public awareness campaigns, smart road design, a few to mention. Despite these measures, the number of road traffic accidents in low and middle-income countries is still higher compared to that of the developed countries. Factors causing road traffic accidents deaths and injuries in Tanzania are categorized into the human, mechanical and road conditions/infrastructure factors. Human causes are further categorized into reckless driving, over-speeding, drunk-driving, overtaking and overloading (National Audit Office, 2012). A study by Eliakunda, Mashoke and Gurisha 2018 also showed over-speeding to be one of major causes of road traffic accidents.

Among other challenges facing road safety is the under-reporting of road traffic accidents which leads to untrustworthy road accidents data (Detho, Samo, Mukwana, Samo, & Siyal, 2018). Under-reporting of road traffic accidents is common in many parts of the world resulting in a lower priority being given to road safety as compared to other public health challenges. Under-reporting of road accidents to the traffic police officers is caused by various challenges facing current reporting methods for instance the use of telephone calls through

emergency numbers which are not very reliable and sometimes unavailable. It has been noticed that there are no dedicated reporting systems during road accidents apart from the emergency numbers which mostly are not reliable and sometimes unavailable (Trek Medics, 2018). The lack of alternative dedicated platforms for reporting purposes has contributed to low reporting rates from road accident witnesses.

Different methods and technologies have been used for road accident and drivers' over-speeding reporting however the recent technological advancements have decreased the cost of hardware and made the currently available smartphones to have a number of in-built sensors such as cameras with high resolution, accelerometer, gyroscope and GPS receiver. This has consequently made them a good candidate as an alternative tool for collecting, processing, and analyzing driving data in order to detect and identify dangerous driving behaviors thus alerting and reporting drivers when they are violating road safety regulations (Chaovalit, Saiprasert, & Pholprasit, 2014; Saiprasert & Pattara-atikom, 2013)

This study aimed to evaluate road accidents reporting systems and driver's over-speeding behavior awareness in Tanzania. As a result, the study developed a mobile application system for road accidents and driver's over-speeding reporting by road users acting as witnesses. The developed mobile application system is expected to provide an effective reporting tool in addition to the traditional methods.

1.2 Statement of the Problem

When road traffic accidents (RTAs) occur, road users who witness the accident (either as bystanders or victims) play a great role in reporting the situation to the responsible emergency authorities (Romano, Onorati, Aedo, & Diaz, 2016). In Tanzania, the traffic police officers are the recognized emergency first responders in cases of RTAs. Currently, the way that road accidents witnesses share and report these incidents is through the police emergency numbers one hundred and twelve (112), nine hundred and ninty nine (999) and social media platforms such as WhatsApp, Instagram and Twitter. The challenge with these platforms, for instance, one hundred and twelve (112) police emergency numbers is their availability and reliability. This contributes to low and slow response from the responsible authorities. In addition, the use of police emergency numbers results to lack of centralized RTA data collected from road users as witnesses.

Challenges facing the use of social media for road accident reporting is that they were never intended for reporting of these kinds of incidents. Social media such as Instagram and WhatsApp can get chaotic with many members and incidents leading to difficult management and/or follow up of the message threads (Trek Medics, 2019). These challenges lead to the under-reporting of RTA which subsequently results to lack of accurate accident data that would otherwise be used in minimizing the response time and mapping accident-prone areas. On the other hand, lack of adherence to road safety regulations is one of the contributing force for the human factors that account for the cause of road accidents. Over-speeding specifically has been the cause of many RTAs (Saiprasert & Pattara-atikom, 2013). Studies have also indicated that drivers' behavior awareness on the road can help improve road safety.

This study aimed to develop a mobile application system that would use smartphones in-built sensors such as Gobal Positioning System (GPS) receivers and cameras to enable road users to report road accidents and over-speeding drivers to the traffic police officers. This would provide accurate and timely reporting of road accidents to miniminize rescue time. The reported road accidents will also serve as another source of road accident data from road users and aid in mapping of accident-prone areas.

1.3 Rationale of the Study

This study will provide road users with an alternative tool for reporting road accidents and drivers' over-speeding behavior to the responsible authorities. The mobile application tool developed will also serve as a source of road accidents data from road users as witnesses for future references. In addition, the sensor logs data collected from smarthphones with time will provide enough large datasets for the development of robust algorithms for automatic road accident detection and reporting.

1.4 Objectives of the Study

1.4.1 Main Objective

The main objective of this study is to evaluate the existing methods and systems used for reporting road accident and driver's over-speeding behavior awareness.

1.4.2 Specific Objectives

(i) To identify the requirements for the development of a mobile application system for reporting road accident and driver's over-speeding behavior awareness.

(ii) To develop a mobile application system for reporting road accident and driver's over-speeding behavior awareness.

(iii) To validate the developed mobile application system.

1.5 Research Questions

(i) What are the requirements for the development of a mobile application system for reporting road accident and driver's over-speeding behavior awareness?

(ii) What mobile application system can be designed and developed for reporting road accident and driver's over-speeding behavior awareness?

(iii) Does the developed system meet user requirements for reporting road accident and driver's over-speeding behavior awareness?

1.6 Significance of the Study

This study will be a step towards increasing the awareness of how mobile phones can be used to minimize the time for reporting road accidents and provide driver's over-speeding behavior awareness for the improvement of road safety. The study will also serve to provide literature for further research besides improving on the already existing literature. The developed mobile application has high potential in the timely reporting of RTA and driver's over-speeding behavior to ensure road safety. The system will also collect smartphones' accelerometer, gyroscope and GPS sensor data logs for the future development of automatic road accident detection algorithms.

1.7 Delineation of the Study

The study assumed that RTAs are being reported by road users - that is passengers, drivers or/and pedestrians - when they witness them. The developed mobile application is only paving way for the further development of automatic road accident reporting. There are studies which show that sensor data logs collected from the smartphones can be used to develop automatic

accident detection algorithms that would determine whether an accident has occurred or not from the readings of anomaly sensor logs. Future research studies will be able to develop automatic road accident detection and reporting algorithms using a large amount of dataset from smartphone sensor logs collected by the developed application - which is the long-term motivation of this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Road Traffic Accidents in Tanzania

According to the World Health Organization (WHO) road safety report of 2018, Tanzania is one of the countries with high rates of road accidents with a fatality rate of 29.2/100 000 population. Table 1 shows the road traffic accidents statistics for the years 2009 – 2013 and 2014 – 2018 while table 2 shows the statistics for Jan – Feb for the years 2018 and 2019. It has been noted that regardless of the decrease in the number of accidents between the years, the rate of decrease in the number of deaths and casualties is still low. This shows that despite the efforts taken to reduce road traffic accidents, the small rate of decrease in the number of deaths and causalities indicates that there is a need for the development of an ICT research tool for road accidents reporting in order to minimize rescue time and save victims life.

Table 1: Road traffic accidents statistics between year 2009 – 2013 and 2014 – 2018

Year	2009 - 2013	2014 - 2018	Difference	Percentage
Number of Accidents	118,810	41,595	-77,215	-64.99
Deaths	18,757	14,853	-3,904	-20.81
Casualties	101,521	42,106	-59,415	-58.52

Traffic Headquarters, DSM

Table 2: Road traffic accidents statistics between Jan – Feb 2018 and Jan – Feb 2019

Year	Jan– Feb 2018	Jan– Feb 2019	Difference	Percentage
Number of Accidents	783	502	-281	-35.9
Deaths	343	222	-121	-35.3
Casualties	715	470	-245	-34.3

Traffic Headquarters, DSM

Human factors are the main contributor to all road traffic accidents with 74% of all accidents that happened in the year 2010 (National Audit Office, 2012). Other factors include vehicle/mechanical and road conditions (Detho *et al.* 2018). The sub-category of the human factors include misjudgment; excessive speed; overtaking errors; negligent pedestrians, passengers, cyclists, and cart pushers; alcohol and drugs consumption; reckless driving;

overloading of passengers and goods; parking errors and driver fatigue (Eliakunda *et al.* 2018). Among these factors reckless driving, over speeding and driving errors have been known as the main causes of road accidents in Tanzania.

2.2 Speed Limits for Road Safety

The methods for enforcing over-speed monitoring include the use speed radar guns, speed bumps, physical traffic police and the Vehicle Tracking System (VTS) that is installed in public transport buses limiting driving speeds to adhere to the regulated speed limit of 80 km per hour outside the urban areas and 50 km per hour in the urban areas (Government of Tanzania, 1973; Ramju, Kaijage, & Sinde, 2016). Table 3 shows the different road speeds for different vehicle types.

Table 3: Speed limits in Tanzania for different vehicle types

Vehicle type	All Cars	Buses and Coaches(less than 12 m in length), Goods Vehicle(less than 3.5 tones in weight)
Built-up area	50km/h	50km/h
Urban area	50km/h	60km/h
Single carriageways	Not stated	80km/h
Dual carriageways	Not stated	80km/h

Road traffic act, Sections 51 & 52

2.3 Road Traffic Accident Reporting

Road traffic accident reporting in a post-crash is mainly done by bystanders/witnesses. The responsible authorities for post-crash response include Traffic Police, Insurance Companies, Ministry of Health and Social Welfare and Fire and Rescue Services (National Audit Office, 2012). The police emergency numbers in Tanzania are one hundred and twelve (112), nine hundred and ninty nine (999). The current approach to road accidents reporting is through traditional ways including emergency telephone calls, physical reporting to the traffic polices or sharing of information through social media such as Instagram and WhatsApp.

2.4 Existing Road Accidents Data Systems in Tanzania

Currently, police road accident data in Tanzania is captured through completing an accident form for those accidents reported to traffic offices and eventually this data is being fed into the

Road Accident Information System (RAIS). The system was used for collecting, processing, examining and regulate reporting crash information to be better equipped in the planning and execution of the road safety measures in Tanzania. It was initiated in 2015 as a pilot study carried out through the ten regions of Tanzania with the main component of capturing road accident location through the use of GPS coordinates (SUMATRA, 2017).

Several benefits have been achieved from the implementation of RAIS. Some of them include automatic generation of statistical reports, customized analysis, and maps generation of the accident data. The system can also be accessed by different mobile devices such as smartphones, laptops, and notepads. Road accident data entry and editing have been made an easy and time-saving process.

Despite the benefits that have been seen from RAIS, it still faces some challenges such as the limited analysis of accident location data due to the lack of applicable and powerful Geographic Information System (GIS) software. The developed system aims to address this challenge through the use of GPS location sensors embedded in smartphones. While the RAIS system is used by the traffic police officers in recording road accidents data, the developed system will be used by road users in reporting road accidents, these two systems can be combined to obtain more accurate information.

2.5 Mobile Technology Penetration in Tanzania

Mobile phones have become pervasive in everyday life. According to the Tanzania Communications Regulatory Authority (TCRA) estimates, three out of four people have access to a mobile phone. Tanzania Communications Regulatory Authority statistics also show that the number of mobile phone users has raised from 27.4 million in 2013 to 43.5 million in 2018 (Fig. 1). On the other hand, the number of internet users in Tanzania rose from 9.3 million in 2013 to 23.1 million in 2018, with the majority of those using their handsets to go online as shown in Fig. 2 (TCRA, 2019). In comparison to the estimated total country population which is 54 million, mobile applications provide a promising opportunity to be used for the improvement of road safety.

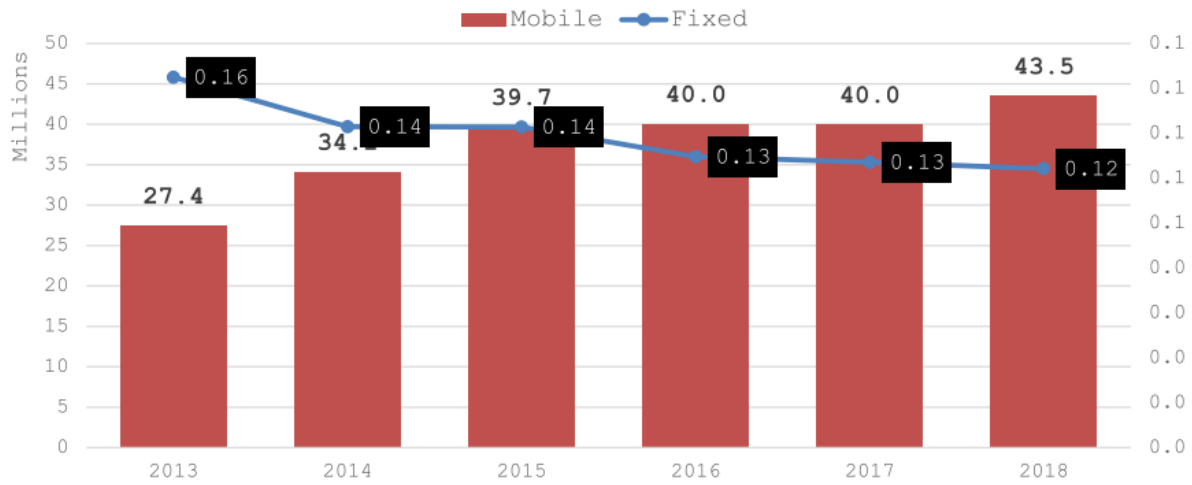


Figure 1: Mobile and fixed lines penetration in Tanzania (TCRA, 2019)

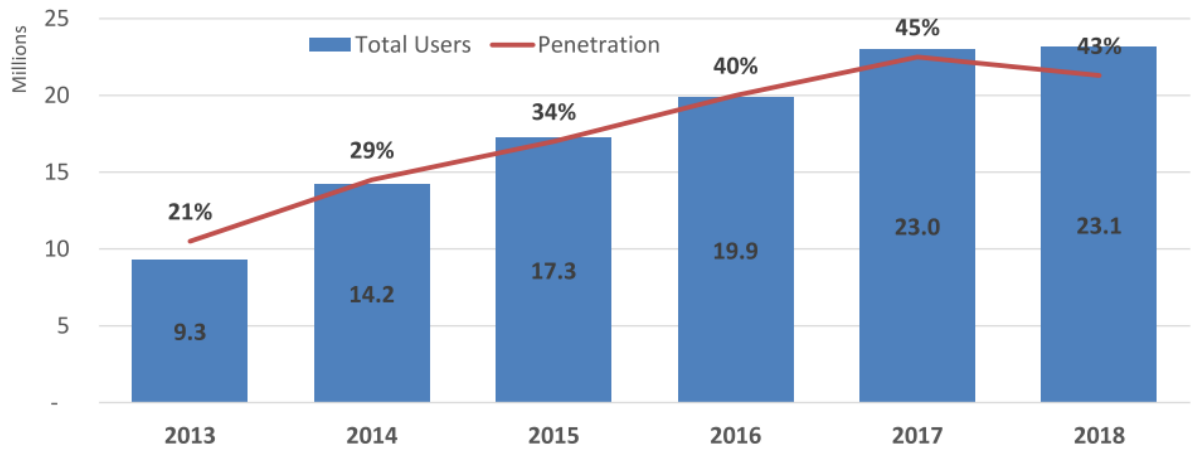


Figure 2: Internet penetration in Tanzania (TCRA, 2019)

2.6 Related Works

A literature review of relevant related studies on systems and applications, for driver's behavior awareness and reporting of road traffic accidents, was conducted. The review showed that the related systems are categorized as in-vehicle sensor-based systems (hardware-based) and smartphone sensor-based systems for road accidents reporting and drivers' behavior awareness.

2.6.1 In-Vehicle Sensors-Based Systems for Driver's Behavior Awareness and Road Accident Reporting

Several vehicle built-in systems that have been implemented to increase road safety and reduce road accident occurrence. Since 2018, each new car sold in the European Union started to

implement the in-vehicle eCall system for the detection and reporting of accidents to the emergency services (European Union, 2018). The main challenge of eCall implementation is that its installation in older cars is difficult hence it can be only be installed in new cars and its implementation is only for European Union nations.

e-NOTIFY is also one of the proposed systems -similar to the eCall- that was developed by Fogue *et al.* (2012) using On-Board Unit (OBU) that utilized in-vehicle sensors to automatically detect and report accident situations to the nearest Control Unit and nearby vehicles. On-Board Unit device was used to obtain information from in-vehicle sensors for accident detection and communicating the accident information. The system utilized Vehicle-to-Vehicle (V2V) and Vehicle to Infrastructure (V2I) communications for the notification of the accident. The limitation of this system is the use of OBU which is expensive and must be installed in the car for the system to function.

Zaldivar, Calafate, Cano and Manzoni (2011) also proposed an android-based mobile application system that detects and reports vehicle accidents through an On-Board Diagnostic (OBD II) which collects vehicle information such as GPS, accelerometer, airbag triggers and vehicle speed. On-Board Diagnostic II is the second generation of On-Board Diagnostic device that diagnoses the vehicle electrical system to detect vehicle problems. The mobile application was able to detect an accident by calculating G-force estimates or detecting airbag triggers through the smartphone which was connected to an OBD II using Bluetooth connections to receive data from the vehicle internal bus. After an accident is detected, it is reported to the emergency services destinations through email or Short Message (SMS). This system is limited by the expensive installation of the OBD II device.

A study that was done by Meseguer, Calafate, Cano and Manzoni (2013) implemented a Driving Styles Platform basing on neural networks to characterize the driving style of each user as well as the type of road on which the vehicle was traveling. The developed android application didn't use smartphone sensors instead utilized the OBD-II Bluetooth connection to collect vehicle information such as speed, acceleration, engine revolution per minute, throttle position and the vehicle's geographical location. Costs associated with the installation of the OBD II device was also the limitation of this study.

A study by Lameck, Machuve and Kisangiri (2013) proposed a system for automatic vehicle over speed, accident alert, and locator system for public transport (buses) in Tanzania. The

proposed system used an On-Board Processing System (OBPS) that was installed in the public vehicles to sense road accidents and over-speeding events and send the information using GSM networks to the control database server which reported the events to the responsible authorities. As with the other in-vehicle sensor systems, this system was expensive to install.

A similar study by Nyamawe and Mbosso (2014) proposed a system for tracking over-speeding bus vehicles using GPS in determing the speed at which the bus is moving and GSM modem in relaying those data (speed and bus location) as SMS to the central database that could analyze the data and provide over-speeding reports. Again, this sytem was costly to install as it required buying of additional hardwares and was not user-friendly.

OnStar is the vehicle built-in system that has been implemented by the General Motors (GM) vehicles. It implements in-vehicle sensors to detect road accidents and informing emergency services (General Motors, 2019). This system is proprietary and it can only be installed on General Motor vehicles.

2.6.2 Smartphone Sensor-Based Systems for Driver's Behavior Awareness and Road Accident Reporting

A study by Omondi, Osebe, Bryant and Bent (2016) presented a Context-based Driver Score (CDS) model that was used to score a driver behavior based on context which included road quality, weather and time of the day. The study aimed to improve Usage-Based Insurance (UBI) products by including the context of the driver, which was mostly not considered by the insurance companies. Data was collected from the smartphone sensors to model vehicle maneuvers and its interaction with the road.

Smolka and Skublewska-Paszkowska (2016) presented a system similar to the eCall but using a mobile device, for instance, a smartphone. The system detects accidents and sends a notification about the collision to the emergency services or emergency contacts.

WreckWatch is the client-server system proposed by Thompson, White, Dougherty, Albright and Schmidt (2010) that implemented the use of smartphones in road accident detection to reduce traffic congestion and the time to notify the emergency responders. The research study discussed some major challenges that involve accident detection using the smartphone's sensors and how the proposed system intended to address them.

A study by Goncalves, Goncalves, Rossetti and Olaverri-Monreal (2014) developed a traffic management system using crowd-sourced smartphone GPS sensor data, and other parameters such as traveling time and distance for the recommendation of alternative route paths for shorter traveling time or fuel consumption saving. The system implemented only the GPS sensor, and only drivers were involved in collecting driving data.

Another study was done by Sandsjö, Sjöqvist and Candefjord (2003) to develop a smartphone-based platform for the collection of low-cost and long-term naturalistic data that aimed at Vulnerable Road Users (VRU). The LogYard smartphone application was developed for recording high-quality data from a large number of users for off-line analysis. The study addressed the privacy and integrity issues of the participants and aimed to provide data for the development of an automatic crash notification system for vulnerable road users.

A study by Fazeen, Gozick, Dantu, Bhukhiya and González (2012) proposed a system that used the internal accelerometer and GPS of a smartphone to assist the driver and add on the existing safety for drivers on the road, to increase drivers' awareness. The mobile system was used to classify road condition types and drivers' driving patterns.

Another study by Engelbrecht, Booysen, Bruwer and Van-Rooyen (2015) provided a review of smartphone-based sensing in vehicles for Intelligent Transport System Applications. The study identified certain advantages of using smartphone-based sensing as opposed to in-vehicle sensing. Among the advantages is that the smartphone-based sensing links driving behavior to a person, rather than a vehicle of which the driver may be unknown. It also provides connectivity without any additional equipment, hence low installation costs.

Candefjord *et al*. (2014) proposed using smartphones to automatically detect road accidents in order to increase road safety and reduce the time to call for help specifically for cyclists - being among vulnerable road users. The study used an accelerometer, gyroscope and GPS sensors logged data to develop an algorithm for accident detection. Unfortunately, the algorithm and data were kept proprietary.

A study by Bhatti, Shah, Maple and Ul-Islam (2019), presented an accident detection and reporting system basing on the Internet of Things (IoT). An android application was developed to collect smartphone sensor data and process them on the cloud to detect an accident. The study focused on how to reduce the significant false positives rates for automatic accident detection that were found in the previous studies.

Waze is a crowd-sourcing mobile application that provides real-time traffic information for road users. In addition to that, it provides other services such as reporting of various road incidents - including road accidents – and it also collects anonymous users' speed and their GPS locations for its service improvements (Waze, 2019). The limitation with this mobile application is that it doesn't send these road incidents reports to the responsible authorities instead the information is used mainly for communications among the drivers with the application. Royal Automobile Club (RAC) mobile app is another mobile traffic application based in the United Kingdom that enables users to share and view various road incidents, route planner, and shortest route and traffic news services (RAC, 2019). The application is based only in the United Kingdom and Europe in general.

A study by Romano *et al*. (2016) developed a mobile application as a crowd-sourcing software for emergency reporting of incidents such as road accidents, terrorism, -a few to mention - through citizen journalism. The study suggested using a dedicated application rather than social media and traditional reporting methods due to the small scale of these emergency incidents compared to large content that is found on the social media platforms.

This study is different from the discussed previous related studies in that, the study addresses both road accident reporting and driver's over-speeding behavior awareness. The approach used by this study is to develop a mobile application system that would report road accidents and over-speeding drivers without any other additional hardware. Road accidents and over-speeding behavior were reported by road users who were the witnesses of these events. The mobile application system developed would ensure road safety both passively and actively. Passively, through enabling drivers to observe speed limits by enhancing their driving over-speeding behavior awareness and, actively, by enabling timely reporting of road accidents to help minimize rescue time hence saving victims' lives.

2.6.3 Characteristics of Road Accident Reporting Systems and Applications

From the literature review that has been conducted it has been observed that the systems and applications for road accident reporting have the following main characteristics:

(i) Accident Report Content

The content of the report includes automatic user location retrieval through mobile embedded GPS. It also includes simple forms that collect road accident data in text, photos, videos or

audio but the text format has been seen to be given more emphasis. The accident reports contain the Minimum Set of Data (MSD) of the accident information in most accident reporting systems (Sontakke & Gawande, 2012).

(ii) Usability

The mobile applications and systems for road accident reporting need to be attractive and simple in design in order for them to be easy to use.

(iii) Interaction

Given the road accident situation, the user interaction with mobile application systems for reporting road accidents need to be quick and intuitive (Romano *et al*. 2016).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Field Survey

A field survey was conducted in the region of Dar es Salaam, Tanzania, to determine the overall situation regarding the reporting of road accidents and over-speeding drivers to the traffic police authorities. This was also done in order to gather system development requirements. The conducted survey involved two groups: the traffic police officers and the road users who included all the citizens who were willing to complete the survey.

3.2 Study Area

The study was carried out in Dar es Salaam region which is Tanzania's largest city with five districts which are Kinondoni, Ilala, Temeke, Ubungo, and Kigamboni. The region's 2016 projected population was 5 465 420 based on the 2012 census which had a population of 4 364 541 (National Bureau of Statistics, 2017). Dar es Salaam was chosen as a study area because of its high number of people who influence the high use of roads for land transportation. According to the crime and traffic incidents statistics report of 2016, Dar es Salaam region also has the highest number of road traffic accidents (Tanzania Police Force, 2016).

3.3 Sampling Technique

Yamane's simplified formula was used to obtain the sample sizes (Joskow & Yamane, 1965). This formula was used because it is widely applied in statistics for sample size calculations. The formula is expressed as:

$$n = \frac{N}{1 + N(e^2)}$$

Where n is the sample size, N is the population size and e is the acceptance sample error (margin of error). For this study, the acceptance sample error was 0.1 and the population size of Dar es Salaam used was 4, 364, 541 resulting in a sample of one hundred (100) road users. On the other hand, the population size for traffic police officers in Dar es Salaam was estimated to be 1300 (Lukumay *et al.* 2018). Hence, the resulting sample size for the traffic police officers was ninty-three (93). The sample size calculations using Yamane formula are attached in appendix I.

The simple random technique was used for data collection from the respondents who were willing to participate in the study from the all the discrits of Dar es Salaam - Kinondoni, Ilala, Temeke, Ubungo, and Kigamboni . The survey was conducted in three traffic police stations: Traffic Police Headquarters, Oysterbay Station, and Urafiki station in Ilala, Kinondoni and Ubungo districts respectively. The survey aimed to determine the means used to receive road accident reports, the challenges faced in getting road accident reports and the information collected during road accident reporting.

3.4 Data Collection Methods

The study collected both quantitative and qualitative data using questionnaires, structured and semi-structure interviews, observation as data collection methods.

3.4.1 Questionnaires

Two different structured questionnaires were administered to both traffic police officers and road users as follows.

(i) Questionnaires for Traffic Police Officers

One hundred questionnaires (100) were administered to the traffic police officers to compensate response uncertainties and questionnaires loss. The questionnaires for the traffic police officers consisted of demographic questions about age and gender. Other questions included the means used to receive road accident reports, challenges faced in responding to road accidents and the kind of information that is collected during road accident reporting (see appendix II).

(ii) Questionnaires for the Road Users

One hundred and ten (110) questionnaires were administered to the road users – drivers, passengers, and pedestrian - in the Dar es Salaam region. Extra questionnaires were used to compensate for response uncertainties. The questionnaires consisted of demographic information about age, gender, and level of education. Additional questions included questions on the source of help that was provided at the accident scene, awareness of existing mobile applications for road accident reporting and the attitude towards the use of mobile application system for road accident reporting and over-speeding awareness (see appendix III).

3.4.2 Interviews

Structured and semi-structured interviews were conducted to the road users and traffic police officers to determine their opinions regarding the use of mobile application system for reporting road accidents and driver's over-speeding behavior awareness.

(i) Interview for Traffic Police Officers

Structured interviews were conducted to traffic police officers with senior positions who were not able to complete the questionnaires because of their tight responsibilities schedules. Semi-structured interviews were conducted to obtain opinions on the over-speeding drivers' reporting using the mobile application system.

(ii) Interview for the Road Users

Some road users were also interviewed (structured and semi-structured interviews) to determine their attitude on road traffic accident reporting and the feasibility of the use of a mobile application system for driver's over-speeding behavior awareness and reporting.

3.4.3 Observation

The survey also involved observation of road traffic accidents along Dar es Salaam roads. One of the observed incidents was a motorcycle and car accident. The accident was not reported for various reasons, 1), the victims of the accident were only slightly injured hence did not need help to visit the hospital facilities, 2) there was no alternative method for accident reporting to traffic police officers – other than the police emergency numbers. This road accident incident observation happened only by chance.

3.5 Data Analysis Method

Data collected from the survey were analyzed using both Python programming language and Excel software because of their simplicity and availability of various data analysis libraries. The results of data analysis are described in chapter 4.

3.6 Methodology for System Development

The evolutionary prototyping model was used as a system development method. The first version of the system prototype was developed, and then more functions and features were

customized and added in collaboration with few users who were used for the testing of the developed application. This model was best suited for this study because it enabled the adoption of the software system while improving on the early working versions (Budde & Kautz, 1992). At every stage, the implemented features were unit tested. After enough features were done, the prototype was validated by the end-users. In this model, the following stages were involved as depicted in Fig. 3.

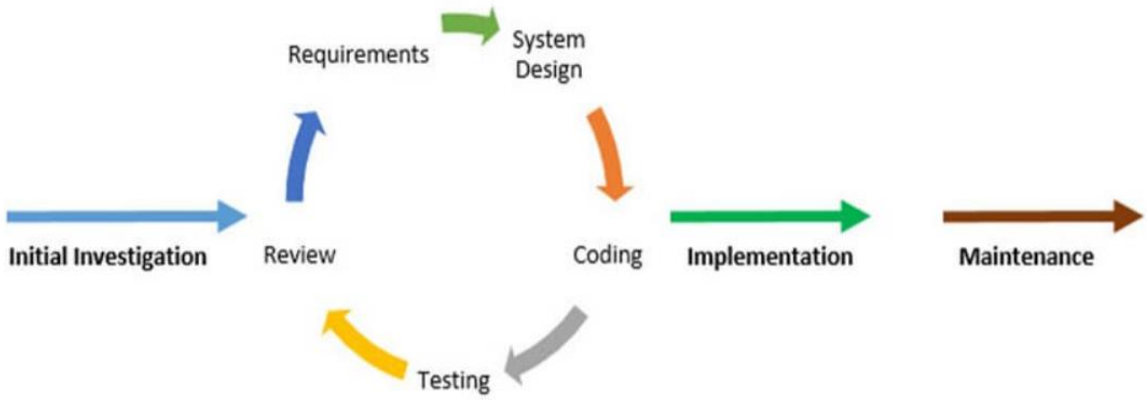


Figure 3: Evolutionary prototyping model

3.7 Requirement Identification

The user requirement definition is the specification in which the users can interact with the system. In this stage, system requirements were gathered – through field data collection - from the involved stakeholders who included traffic police officers and road users. Existing related systems were also studied to understand their strengths and weaknesses. The identified system functional and non-functional requirements are discussed in chapter 4.

3.8 System Design

This involves the process of defining the system architecture, modules, interfaces, and data to meet specified requirements. The system design process involves system modeling using tools such as Data Flow Diagram (DFD), Unified Modeling Diagrams (UML) diagrams such as use case diagrams and Entity Relationship Diagrams (ERD) (Sommerville, 2011). The developed system had two main modules: driver's over-speed behavior awareness and road accident reporting modules as described in the following subsections.

3.8.1 Driver's Over-speeding Behaviour Awareness Module

The over-speeding awareness module relied on the smartphone GPS sensor receiver to determine the vehicle speed together with the location coordinates (longitude and latitude). With this system module, road users -passengers and drivers- could get speed limit violation alerts whenever the preset speeds were being violated. Figure 4 shows the flow chart that was used to develop this module.

For road safety speed adherence purposes, passengers were also able to share this speeding behavior -for the case of over-speeding drivers- by sending notifications to the near-by traffic police station for further actions. This module would also be useful in determining the speeds that the vehicle was traveling at, in case an accident occurs.

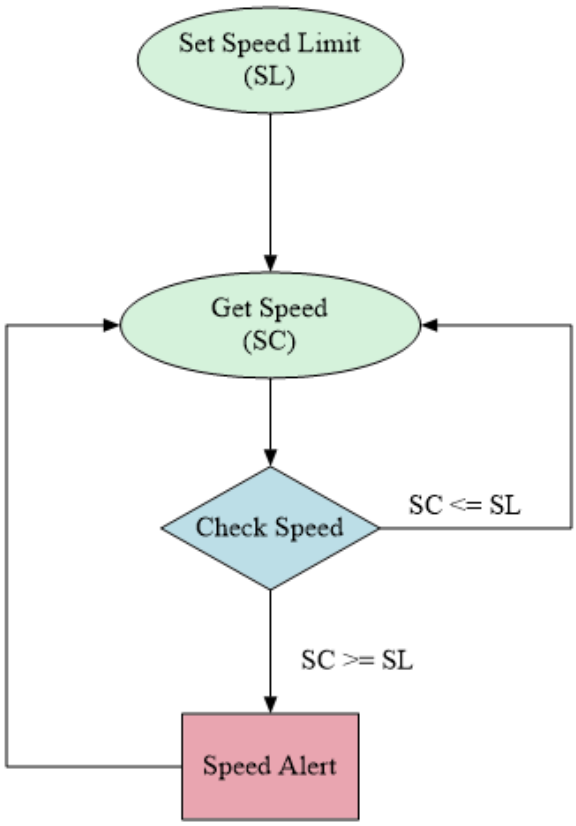


Figure 4: Flowchart of over-speeding detection using data from GPS receivers

3.8.2 Road Accident Reporting Module

This module involved road accident reporting by the road users – acting as witnesses - who could be the driver, passenger or pedestrian. Road accident reporting was done through the mobile app and the user could attach the report with the accident photos. Global Positioning S

sensors were used to automatically get the accident location. Reporting could also be done using the police emergency number for emergency calls and messages.

3.9 System Implementation

This stage involved the development of the system by generating the actual system code. The initial system prototype was developed in this stage, where the very basic requirements were showcased, and user interfaces provided. The system was comprised of the mobile application for road accidents reporting and the web application for receiving reports sent from the users.

3.10 Mobile Application System

The mobile application enabled road users to report road accidents and become aware of the obtain driver's over-speeding behavior. The following tools and technology were used in the development of the mobile application.

(i) Flutter

Flutter is a Google framework that enables a programmer to write a single code base for both Android and iOS with native performance and capabilities (Google, 2018). Without using flutter, the mobile applications for Android and iOS have to be developed separately with android development based on Java language and iOS based on Objective-C or Swift programming language (Zammetti, 2019). Flutter is fundamentally based on the dart programming language that was also developed by Google. The study employed the Flutter framework to develop a mobile application that would run on both the Android and iOS platforms - without developing two separate application. This aimed to increase the number of potential end-users by reaching a wider range of mobile devices platforms.

(ii) Dart Programming Language

Dart is an object-oriented programming language created by Google in 2011 and is also a general-purpose programming language - just like Python - used to develop web application, mobile application, Internet of Things application a few to mention. Flutter platform uses this programming language to develop cross-platform mobile applications (Zammetti, 2019).

(iii) Android Studio

Android Studio is an Integrated Development Environment (IDE) created by Google for android application development. The mobile application was implemented using the Android Studio development environment. Android studio comes together with an Android Software Development Kit (SDK) and an editing environment. To use Android Studio for Flutter-based applications some plugins (for dart and flutter) were installed.

3.11 Web Application System

The implementation of this system involved the employment of various tools for software development. The following software development tools were employed during web application system implementation.

(i) Laravel PHP Framework

The web-based application was developed using the Laravel PHP framework. Laravel is a set of PHP files that facilitates programming with PHP servers (Laravel, 2019). It serves as an intermediate system that intercepts user requests with the PHP servers hence providing high-security features. Laravel framework was chosen because of its vast availability of tools for developing applications using the use of modern coding principles, which offers rapid application development (Stauffer, 2019).

(ii) XAMPP Web Server

It is a free and open-source, cross-platform PHP development environment (Apache Friends, 2017). This was chosen for web servers implementation because it is easy to use compared to other web servers such as WAMP server.

(iii) Bootstrap Framework

Bootstrap is an open-source front-end (HTML, CSS, and JavaScript) development framework created by Twitter especially for the development of responsive web apps (Otto & Thornton, 2017). Bootstrap was used in order to reduce development time since it offers ready-made blocks of code and thus, no coding from scratch was needed.

(iv) Visual Studio Code

Visual Studio Code (VS Code) is a code editor that was used to edit and write the web application files. This editor was chosen because it is easy to use, free and open-source (Kahlert & Giza, 2016).

3.12 Data storage

The system was developed with MYSQL as the database for data storage. Firebase authentication services were used to authenticate mobile app users.

(i) Firebase Authentication

Firebase is a Google platform that provides an easy developing environment for mobile and web applications. Firebase authentication services were used for users registration and login through the use of Firebase Authentication APIs (Moroney, 2017). This made the developed application easy to use since many users don't prefer giving their information during mobile app registration. Firebase authentication enabled user registration and login using credential previously provided by third-party accounts such as Facebook and Google accounts. The third-party accounts were used to authenticate mobile application users that they were who they said they were, without the need to provide their credentials again.

(ii) MYSQL Database

Road accidents, over-speeding reports, and the smartphone's sensor logged data sent by road users using the mobile application were stored in the MYSQL database. Sensor-logged data was transmitted to the MYSQL database server in real-time using mobile data/Wi-Fi network services. When network services were not available sensor-logging data were being locally stored on the mobile device and were automatically synchronized to the database server when network services became available.

(iii) Data Structure

JavaScript Object Notation (JSON) data format was used for data exchange between the mobile and the web application. This data structure allowed the transmission of information sent by the mobile application users to be received by the traffic police officers through the web application. JSON was used because it is a simple data exchange format that is easy for human read/write and easy for machines to understand (Smith, 2015).

3.13 System Testing and Validation

This stage aimed to check that the system meets its specifications and fulfills its intended purpose. It involved testing for system defects and errors and fixing them until the system's original requirements were met. A full working system was then validated by the users.

3.13.1 System Testing

System testing comprised a series of different tests whose purpose were to exercise the full working system. It was done through unit testing, integration testing, and full system testing. Unit testing involved testing that each individual unit (module) was working as anticipated while integration testing involved testing the interaction between different units ensuring that they talk to each other in the right way. Finally, systems testing for all different modules was conducted to test if they worked together correctly. The results of system testing are discussed in chapter 4.

3.13.2 System Validation

System validation answers if the right system was developed. User acceptance testing was used to validate the developed system. The Technology Acceptance Model (TAM) was adopted during the validation process. A sample of each users' category, including traffic police officers and road users, were randomly chosen to test the system for 2 - 4 days. Thereafter, a survey evaluation was conducted to find out about the system's perceived usefulness, ease-of-use and attitude towards use. The evaluation data were collected using the questionnaire method. The results of system validation are also being discussed in chapter 4.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Questionnaire Results from the Traffic Police Officers Respondents

The field survey was conducted using qualitative methods for data collection consisting of questionnaires, observation, and interviews. The survey aimed to determine the demographic characteristics of the respondents, means used to receive road accidents reports, challenges faced in timely response to road accidents and kind of information collected during road accident reporting.

4.1.1 Demographic Characteristics of the Traffic Police Officers Respondents

The demographic characteristics of the respondents considered were age and gender. The age of the respondents was used to estimate their work experience. With the total number of ninty-three (93) respondents, 79% were male and 21% female. The high number of male respondents was due to the fact that most of the traffic police officers are male. The age interval for most of the respondents was 31- 40 years with 63% of all the respondents as shown in table 4. The respondents of this age group were adults with average work experience. Respondents with an age interval between 41 -50 years had 29% respondents' proportion and they represented those with enough work experience. Respondents with 21 – 30 years were only 8% of all the respondents.

Table 4: Demographic characteristics of the traffic police officers respondents

Demographic Characteristics	Respondents	Percentage (%)
Gender		
Male	73	79
Female	20	21
Age groups (years)		
21-30	7	8
31-40	59	63
41-50	27	29

4.1.2 Means Used to Receive Road Accident Reports

The study aimed to identify the currently available means used by the traffic police officers in receiving road accident reports from the road users.

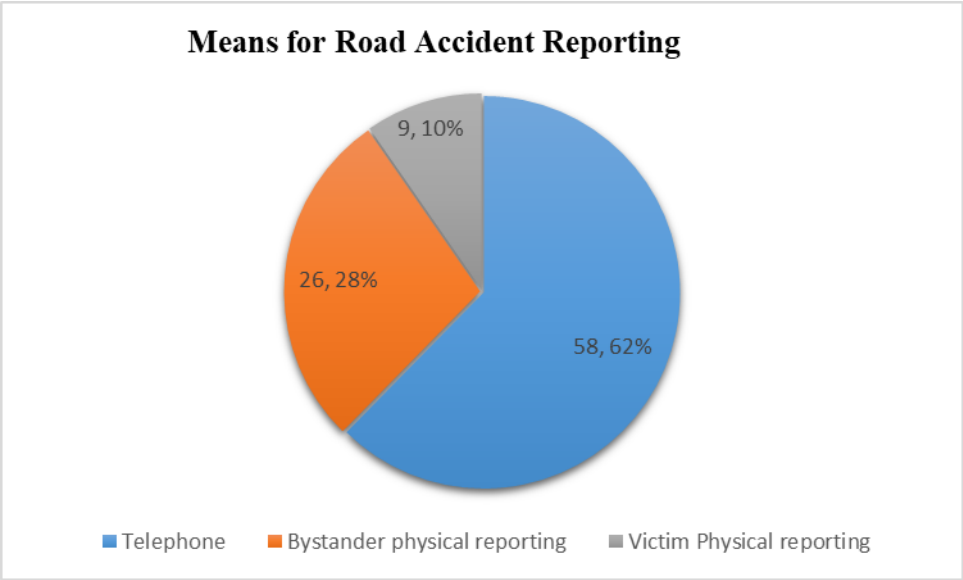


Figure 5: Means used to receive road accident reports

It has been noted from Fig. 5 that, most road accidents reports are received by the traffic police officers through telephones calls with a response of 62%. Bystanders physical reporting for road accidents was found to be 28% of all the responses. Victim physical reporting had a response of 10%. This shows that there are still some challenges in the reporting of accidents to the responsible authorities which may lead to increase in response time and underreporting of road accidents hence there is a need for an alternative road accident reporting tool that will aid effective and immediate reporting

4.1.3 Challenges Faced in Responding to Road Accidents

Several challenges face traffic police officers in providing a timely response to road accidents. These challenges hinder timely assistance to road accident victims. Figure 6 shows that information delay was noted to be the most contributing challenge in responding to road accidents with a response frequency of 43%, followed by accident location accuracy with 38% of all responses. Other challenges included false information (13%) and lack of transport (6%). These findings signify that road users may fail to report road accidents on time due to the limitations of the existing methods. An alternative mobile application tool will enable road accident witnesses to easily report the accident with its accurate co-ordinate location using the smartphone's GPS sensor.

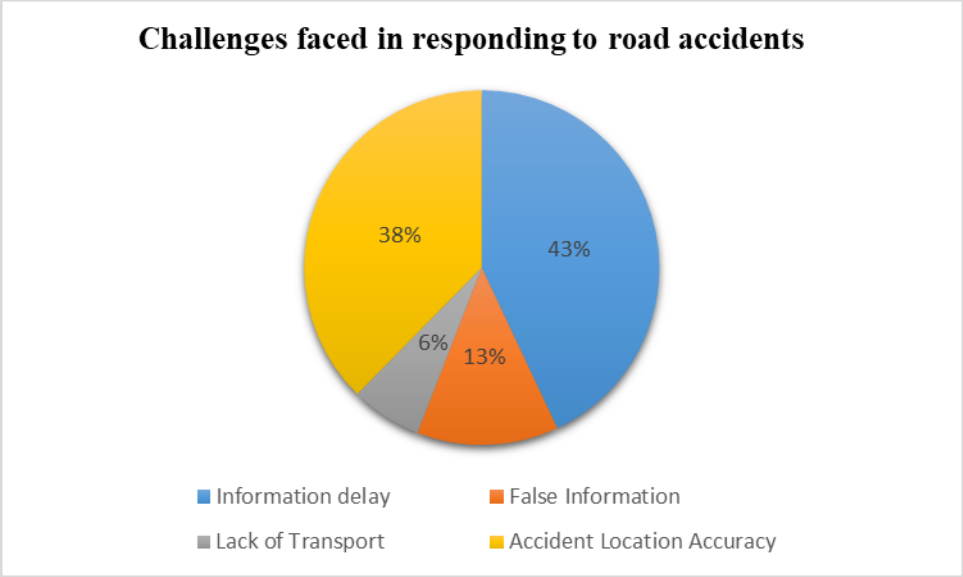


Figure 6: Challenges faced in responding to road accident reports

4.1.4 Information Collected During Road Accident Reporting

The traffic police respondents were asked about the necessary information collected during road accident reporting. The question aimed to determine the road accident details that will be reported using the mobile application. Figure 7 shows the obtained results from the respondents. 32% of the respondents responded 'victims' details' as the most frequently collected information collected. 25% of the responses were on vehicle types involved, 19% on the location of the accident, 18% on road accident diagrams and 6% on accident causes.

The responses were used in identifying the requirements for the mobile application system. The mobile application system needed to have reporting features addressing the necessary required information when reporting road accidents. Images were considered as a way to determine the type of vehicles involved and provide some insight into the accident causes. The location of the accident was to be captured by the GPS smartphone sensor.

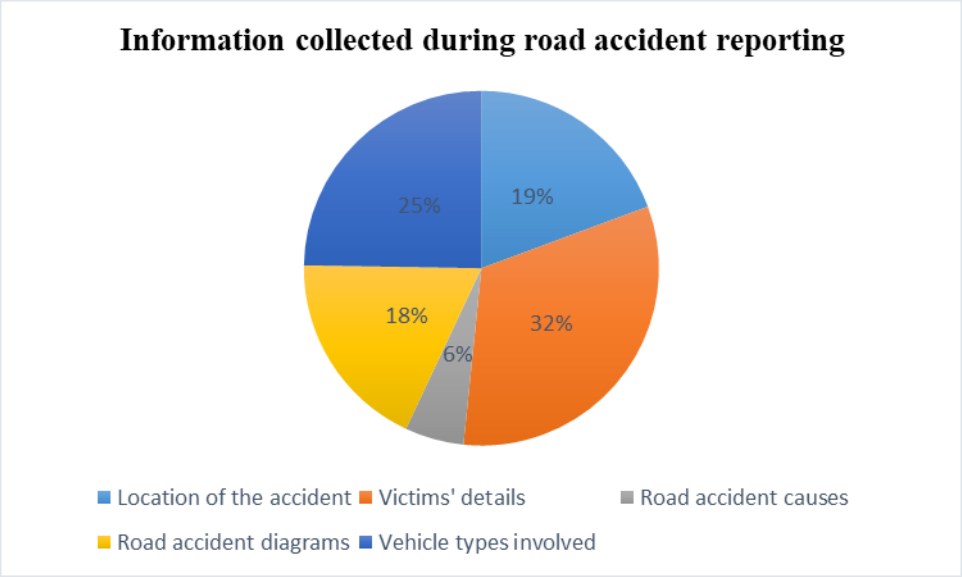


Figure 7: Information collected during road accident reporting

4.2 Questionnaire Results from the Road Users Respondents

The questionnaires administered to road users consisted of questions on the demographic characteristics of the respondents, sources of help provided at the accident scene, awareness of existing mobile applications for road accident reporting and their attitude toward a mobile application system for road accident reporting.

4.2.1 Demographic Characteristics of the Respondents

The demographic characteristics of the respondents considered were gender, age, and level of education. It has been noted from table 5 that 64% of all the respondents were male and 36% were females. 43% of the respondents had an age interval of 21-30 years, 32% had 31-40 years age interval, 12% had from 41-50 age interval and 8% with the age interval of 51 years or older. Only 5% of the respondents had an age interval of 20 years or younger. The survey covered all the age groups in order to obtain responses from a wide range of road users. Respondents' characteristics on the level of education were as follows. 68% completed more than secondary school, 17% completed secondary school only and the remaining 15% did not complete secondary school.

Table 5: Demographic characteristics of road users respondents

Demographic Characteristics	Respondents	Percentage (%)
Gender		
Male	64	64
Female	36	36
Age groups (years)		
20 or younger	5	5
21-30	43	43
31-40	32	32
41-50	12	12
51 or older	8	8
Education level		
Completed sec school only	17	17
Completed more than sec school	68	68
Didn't complete sec school	15	15

4.2.2 Sources of Help That is Provided at the Accident Scene

75% of the respondents indicated that the source of help provided at the accident scene is from the accident witnesses (bystanders) as shown in Fig. 8. This indicates that if the bystanders are given alternatives means to request help, it may increase the different sources of help that can be provided at the road accident scene. Traffic police sources of help had 23% of all the responses and only 2% of the responses on the hospital as the source of help.

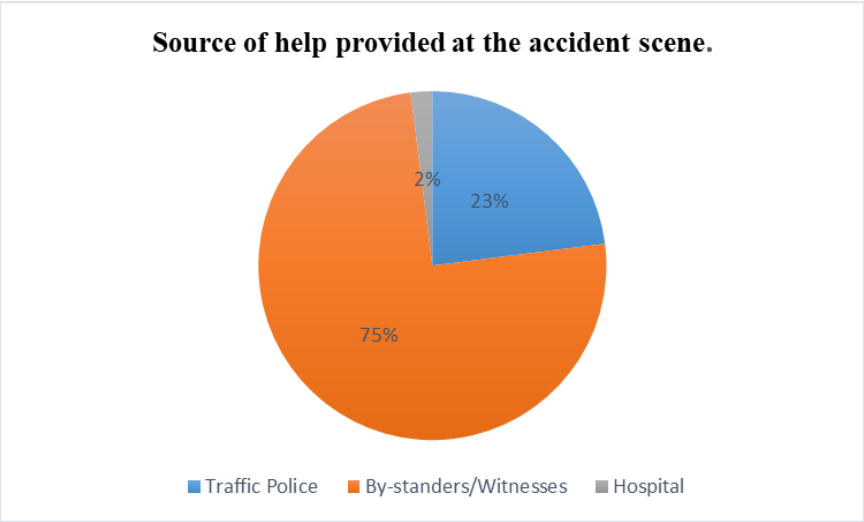


Figure 8: Source of help provided at the accident scene

4.2.3 Awareness of Existing Mobile Applications for Road Accident Reporting

It was noted from Fig. 9 that 99% of the respondents were not aware of any existing mobile application specifically for road accidents reporting. Only 1 respondent was aware of such a mobile application. However, the mobile application mentioned by the respondent was for road traffic monitoring and was the application was no longer available. The lack of any other alternative means for road accident reporting signifies the need for the development of a mobile application reporting tool.

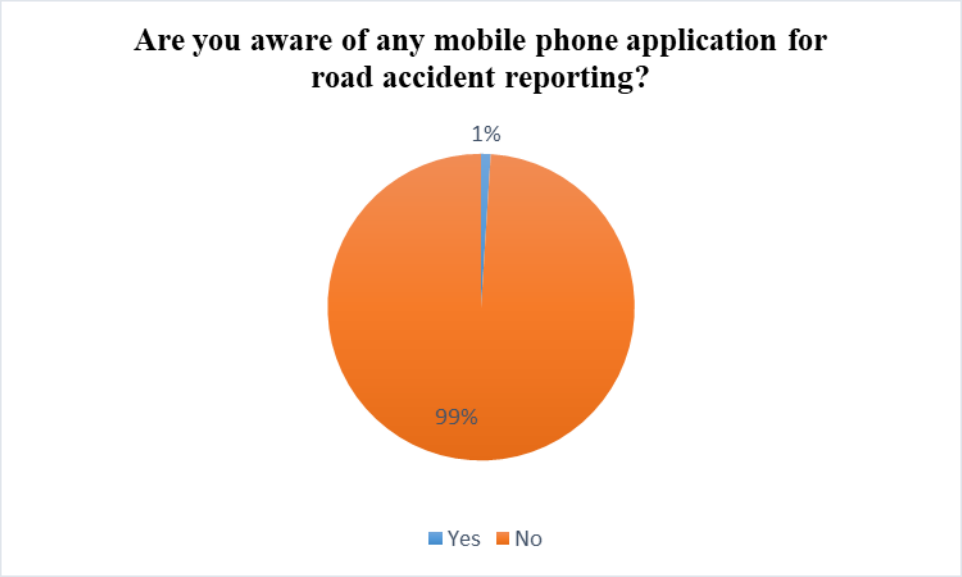


Figure 9: Awareness of the existing mobile applications for road accident reporting

4.2.4 Attitude Towards a Mobile Application System for Road Accidents Reporting and Over-Speeding Awareness

From the survey conducted, 84% of the respondents agreed with a positive attitude on the benefits of the mobile application system for road accident reporting and driver's over-speeding awareness, 11% were not sure and 3% didn't know if the mobile application was going to be useful or not. Only 2% of the respondents didn't think that having a mobile application for road accident and drivers' over-speeding reporting will help in notifying the responsible authorities on time as shown in Fig. 10. The high number of respondents with a positive attitude on the use of mobile application confirmed the need to develop this system.

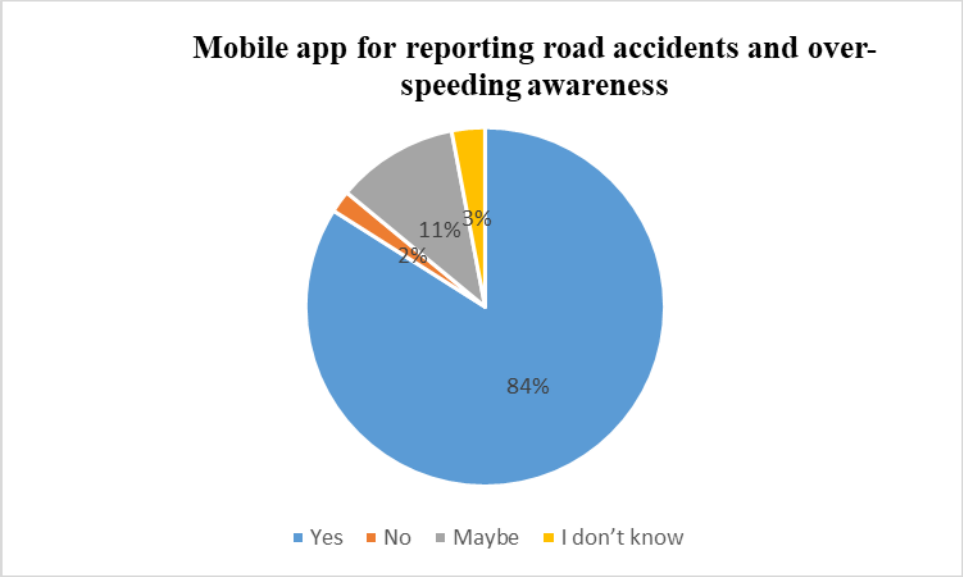


Figure 10: Attitudes of the respondents towards mobile application reporting

4.3 Interview Results

Structured and semi-structured interviews were conducted to both the traffic police officers and road users in gathering their opinions and views regarding the mobile application system for road accidents reporting and driver's over-speeding behavior awareness.

4.3.1 Structured Interviews

The head of traffic police officers at the Oyster-bay police station was interviewed about his opinion regarding the use of a mobile application for reporting road accidents and he said: "*The application will aid in knowing the exact location where the road accident occurred – which is one of the main challenges that we face*" He also added that *"Education should be provided to the society so as to keep the good spirit in reporting and helping road accident victims"* Another traffic police officer responded that *"The police emergency numbers should be provided to the community and application of ICT should be considered in educating road users and drivers"*

Interview with some randomly picked road users realized that the majority of the people don't know the traffic police emergency numbers and were suggesting that they should be publicly known as stated by one of the respondents: "*There should be a reliable communication system for reporting road accident to the responsible authorities and emergency numbers should be known and they should be free* " Another respondent added: "*Having an application will ease*

the reporting process as I am always not comfortable to call and speak with the traffic polices. I think the use of a mobile application will enable me to overcome this challenge"

4.3.2 Semi-Structured Interviews

Semi-structured interviews were also conducted to the road users to determine their opinions regarding the use of a mobile application system in reporting over-speeding drivers. Semi-structured interviews were used because of their flexibility which allows asking questions differently inorder to obtain most details form the respondents. Some of the responses were as follows:

(i) Interview With One of the Passengers Respondent

Qn: How do you feel about reporting over-speeding drivers using a mobile application system?
Ans: "*I would feel good to report over-speeding drivers since this will make them reduce their driving speeds"*
Qn: Do you think a mobile application system for driver's over-speeding reporting would help to increase road safety and reduce road accidents?
Ans: *Yes, I think it would improve driver's discipline in adhering to the given speed limits if we as passengers, could be given an easy way to report over-speeding drivers. It could improve our voice and maybe even reduce road accidents which could have been avoided.*

Qn: Do you think a mobile application system would be suitable for reporting over-speeding drivers? What are the limitations of the current methods for reporting
Ans: "Yes, I thik it will be a good solution to many passengers who wish to report over-speeding drivers but they cant use the emergency numbers given. There are numbers for reporting over-speeding drivers but I have never really used them"

Qn: If there was an application for reporting over-speeding drivers, how would you react?
Ans: "*I think if I am given a platform to report drivers who use excessive speeds for the public transport, I would definitely use it"*

Qn: What features additional features do you think a mobile application for driver's over-speeding reporting need to have?
Ans: *With the features that you have presented, I think there should be an option where one*

can also send texts to the police when reporting. Being able to see what speed the driver is driving is really something useful for me.

(ii) Interview With One of the Driver Respondent

Qn. Do you think a mobile application system for driver's over-speeding reporting would help to increase road safety?
Ans: "Being a driver, a mobile application for driver's over-speeding reporting would help and remind me to be more cautious on the road and avoid high speed"

Qn. Do you think a mobile application system would be suitable for reporting over-speeding driver? How
Ans: "*Yes but I think it will depend on how the application is designed"*

Qn: If there was an application for reporting over-speeding drivers, how would you react?
Ans*: "I would react positively since this would help me to reduce the driving speeding and avoid accidents"*

Qn: What features additional features do you think a mobile application for driver's over-speeding reporting need to have?
Ans: "*The driver has to be given a way to be stopped after being reported. Or there should be a way to communicate to the drivers"*

(iii) Interview With One of the Traffic Police Officer Respondent

Qn: Do you think a mobile application system for driver's over-speeding reporting would help to increase road safety?
Ans*: "Yes, if passengers can report over-speeding drivers that would be really useful since sometimes accidents happens because people tend to be scared to report the aggressive drivers through the available emergency numbers"*

Qn: Do you think a mobile application system would be suitable for reporting over-speeding driver?
Ans: "*It may have its challenges from what I can see on how it operates but it will still be suitable and useful in some scenarios"*

Qn: What features additional features do you think a mobile application system for driver's over-speeding reporting need to have?

Ans: "*Receiving driving speed as an evidence for over-speeding is really good, I just think more details have to be added when someone is reporting"*

4.4 Requirement Identification

The user requirement definition is the specification in which the users can interact with the system. System requirements were gathered from the involved stakeholders who included traffic police officers and road users. Existing systems were also studied to understand their strengths and weaknesses.

4.4.1 Functional and Non-Functional Requirements

The identified requirements from this study were categorized into functional requirements - which deal with the functionality of the system and the non-functional requirements -which deal with the system qualities/properties. Table 6 and Table 7 show the identified functional and non-functional requirements respectively.

Table 6: Functional requirements

Requirement category	Requirement description	System actor
Users registration	All users should register their accounts with a username and password	Road user
	All the traffic police officers should be registered to the system prior to their login	System admin
Users account management	Each user should be able to set their account profile information	Road user, traffic police officer
	The system should allow users to edit or delete user accounts	System admin
Send road accidents and over speeding reports	The system should allow users to send the created reports to the web application server	Road user
	Users should be able to view/delete his/her sent report	Road user
View speed violation notifications	Users should be able to set the allowed speed limit	Road user
	Users should be able to view speed limits violation notifications	Road user
Receive road accidents and over speeding reports	The system should allow users to receive all sent road accident and over-speeding reports	System admin, traffic police officers
Map location of received road accidents and over speeding reports	The system should allow users to view a location map of all the received reports	System admin, traffic police officer
View near-by police stations	Users should be able to view all the nearby police stations	Road user
	The system should allow users to add/edit or delete police stations details	System admin

Table 7: Non-functional requirements

Requirement category	Requirement description
Security	The system should authenticate all users prior their interaction with the systems' functionalities.
Reliability	The system should be available to users all the time with the minimal system downtime
Usability	The system should be simple, easy and self-intuitive to use.
Scalability	The system should be able to accommodate new features and functions with fewer re-design issues.
Response time	The system should have a short response time to users' requests.
Robustness	The system should be ready to restart successfully and no data should be lost after a system failure.
Operating System	The system should run independently of the device platform.

4.5 System Design

After obtaining the initial system requirements, the system to be implemented was designed. This involved defining system data and architecture to achieve the specifications of the system. The system modeling tools used included Data Flow Diagram (DFD), use case diagrams and Entity Relationship Diagrams (ERD).

4.5.1 System Architecture

The developed system consisted of a mobile application, database server and a web interface for the road users and traffic police officers. The road users used the mobile application to report road accidents and driver’s over-speeding behavior. The system also collects sensor driving data and provides driver’s speeding alerts (feedback) when certain speed limits are violated.

The road accidents, over-speeding reports sent by the road users are stored on the web server and accessed by the traffic police officers using the web application. The driving sensor data logs are also sent to the web server but to only be accessed with limited permission in order to address the privacy of the users. Figure 11 illustrates the architecture of the developed system.

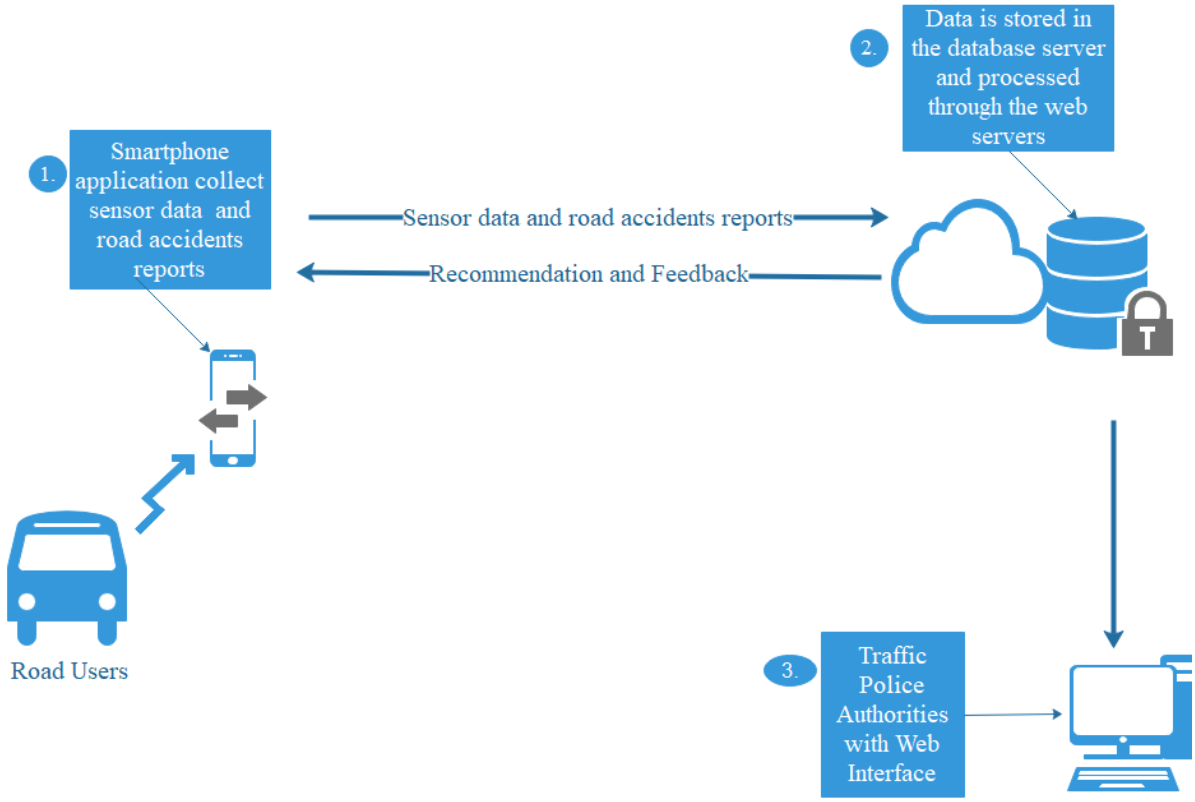


Figure 11: System architecture

4.5.2 Use Case Diagram

Use case diagrams are used to show the interaction between the system functionalities and actors. Systems may represent a website, mobile app, software component, or a business process while actors include individuals, organizations or other systems that interact with the particular system and, the use cases show all the basic interaction of the identified system requirements (Sommerville, 2011). The main actors of the mobile application system were traffic police officers, road users (drivers, passengers, and pedestrians) and system administrators. Figure 12 represents a high-level mapping of system use cases and the external actors showing each actor is involved in the system.

(i) Description of the Use Cases

Each of the use cases shown in the previous Fig. 12 has been described in table 8.

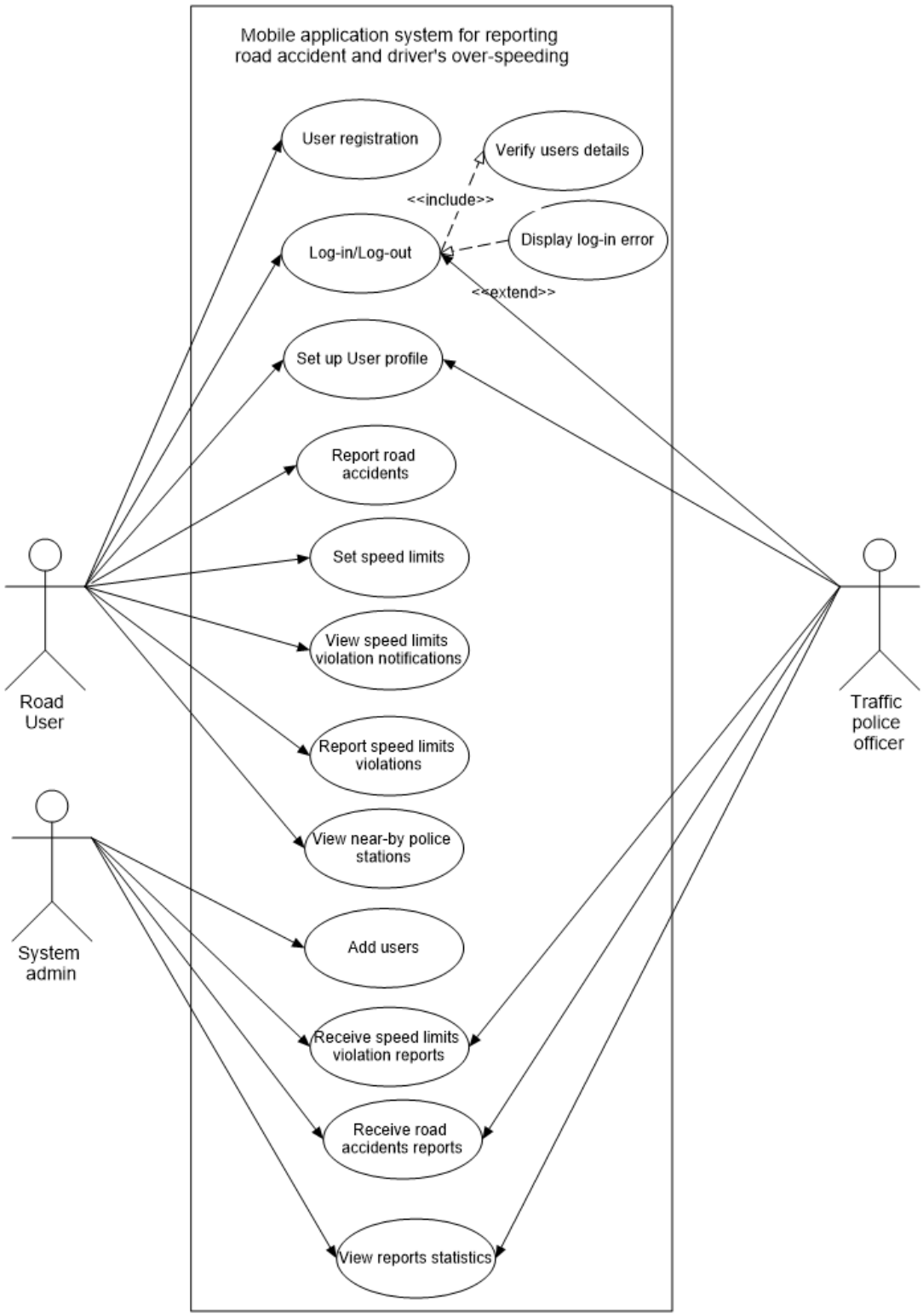


Figure 12: Use case diagram

Table 8: Description of the use cases

Use Case	Description	Actor
User registration	Users register their accounts by using usernames and passwords	Road user
Add users	Users register traffic police officers to the system	System admin
Log-in/log-out	Users can log in to the system by entering their credentials	Road user, traffic police officer
Set-up user profile	User may edit their account details	Road user, traffic police officer
Set speed limit	Users can set the allowed speed limits	Road user (passenger, driver)
Report road accident	Users can report road accidents and driver's over-speeding behavior.	Road user
View near-by police station	User can view the near-by police stations	Road user
View speed limit violation notification	Users can view speed limit violation notifications	Road user (passenger)
Report speed limit violations	Users can report the speed violation to the traffic police authorities	Road user (passenger)
Receive road accident reports	Users may receive road accident reports with their exact map locations.	System admin, traffic police officer
Receive speed limit violation reports	Users can view speed limit violation reports with their exact map locations.	System admin, traffic police officer
Generate reports	Users can view the statistics of the received reports	System admin, traffic police officer

4.5.3 Data Flow Diagram

(i) Level 0 DFD

The context diagram in Fig. 13 provides a general overview of data flow in the system. The diagram comprises three main actors who were the road user, system admin, and the traffic police officers.

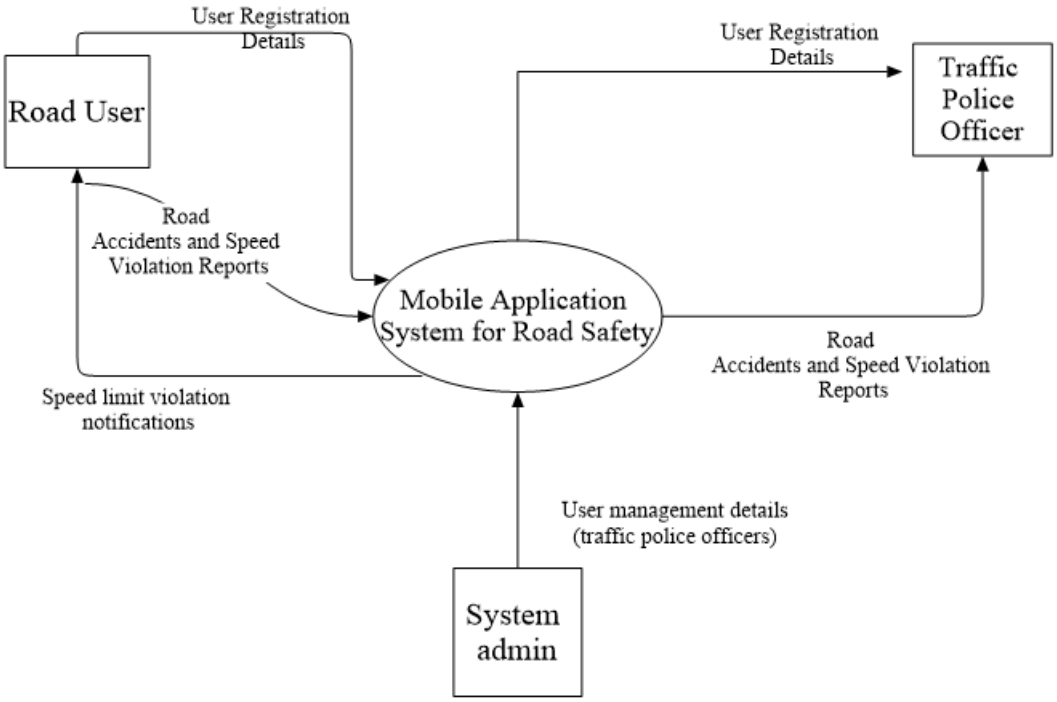


Figure 13: Level-0 DFD (context diagram)

(ii) Level 1 DFD

The level-1 DFD breaks down the system into the various sub-process. Figure 14 illustrates how data flow among various system processes, actors and data stores.

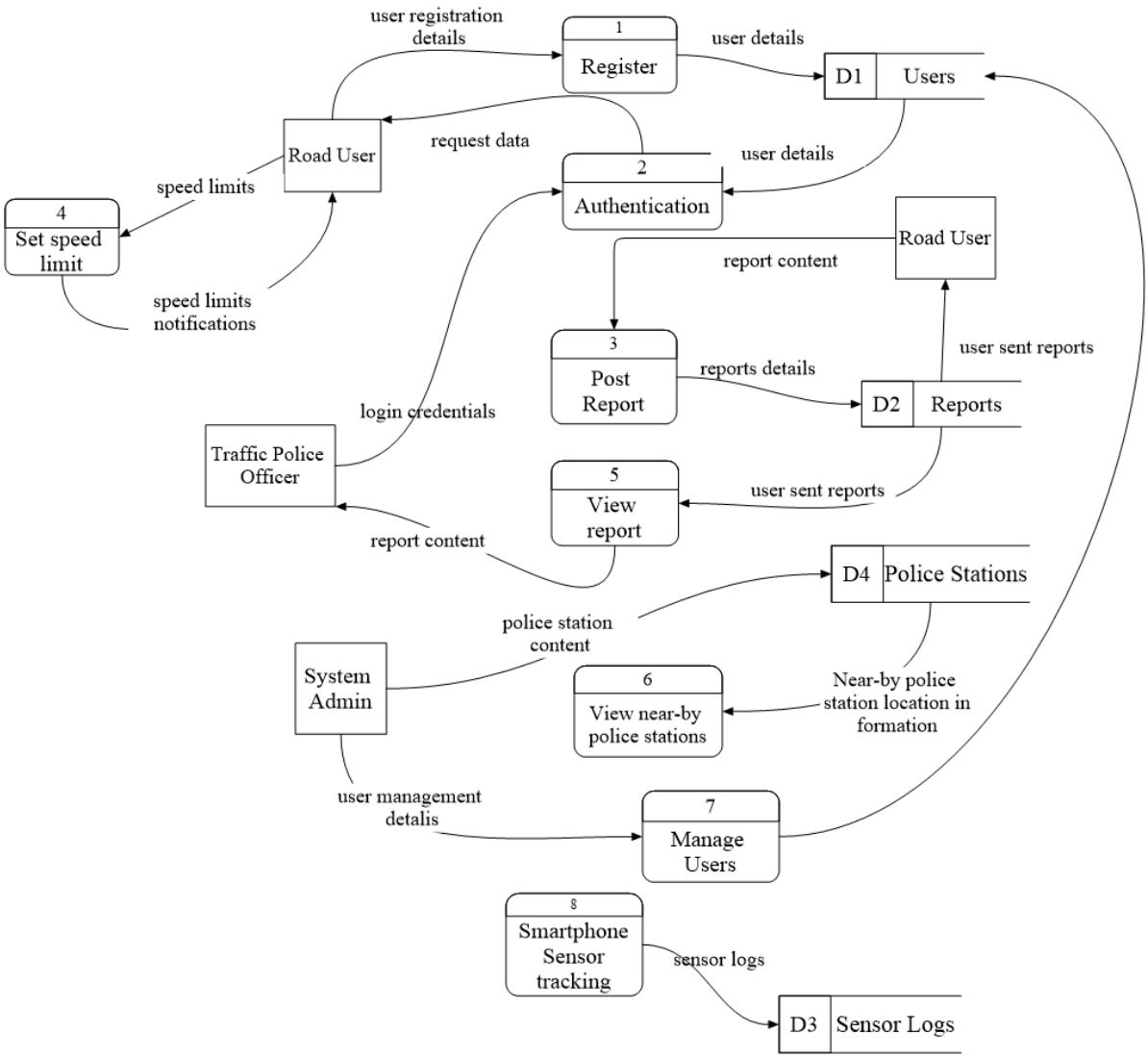


Figure 14: Level-1 DFD

4.6 System Implementation Results

The implemented system consisted of mobile and web applications. The system had simple and attractive user interfaces and enable road users to report road accidents and over-speeding to the traffic police officers who used the developed web application to receive the sent reports and take necessary actions. The mobile app also notified road users when speed limits were violated. The developed system was named "*SafeRoads*" because of its main goal of improving road safety.

4.6.1 Mobile Application System Implementation

The mobile application could be installed on both the iOS and Android platforms and had the following main functionalities as described in the sub-sections.

(i) User Login

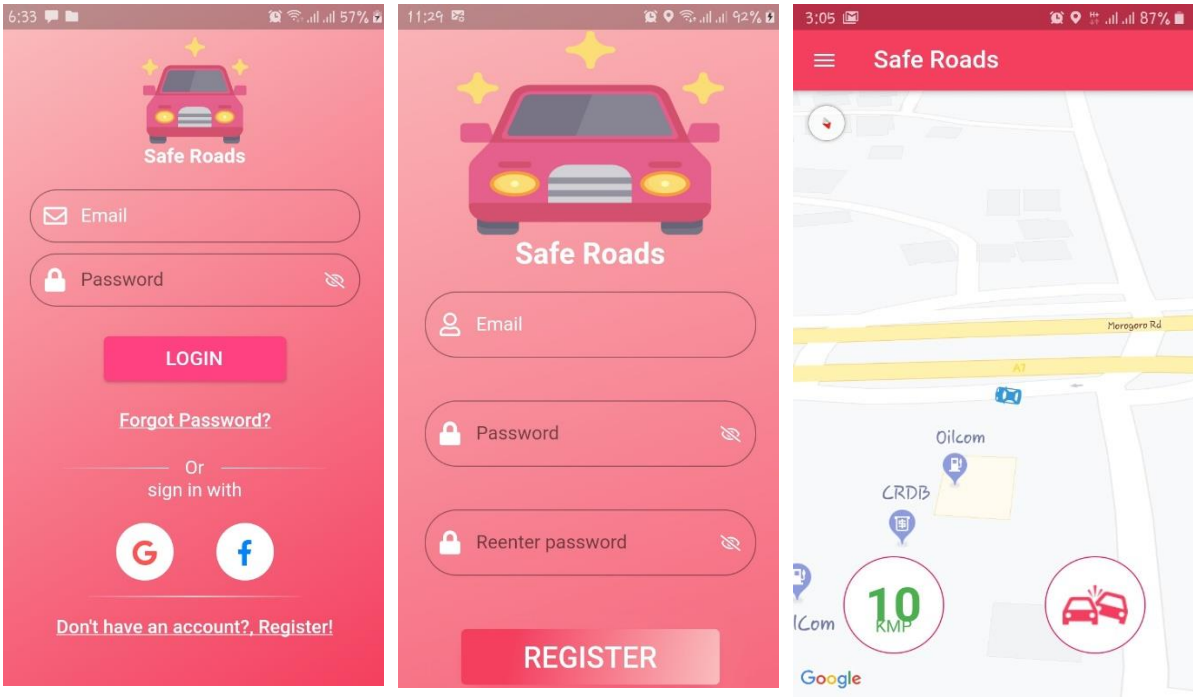
Users needed to have a registered account prior to the mobile application login. To register an account, users submitted their email addresses (as usernames) and passwords, which were to be used during login (Fig. 15 b). On the other hand, users could also log in to the system using their Google or Facebook accounts authentication. This feature implemented Firebase authentication to connect Google/Facebook users' accounts to our system for login details. After successful registration and login, users were presented with the application home screen containing the application menu, GPS driver's speed readings and a button for road accident reporting. Figure 15 (a) shows the mobile app log-in screen and Fig. 15(c) shows the application home screen after a successful user login.

(ii) Speed Limit Violation Notifications

Road users (drivers and passengers) could set a speed limit for a particular journey and be able to get warning notification when the driving speeds exceeded the set speed limits (Fig. 16 (d)). The warning notifications were indicated by speed widget color changes. If the user was within the allowed speed limits the color of the widget would become green and if this limit was exceeded, the color would change to red as shown in Fig. 16 (e) and (f).

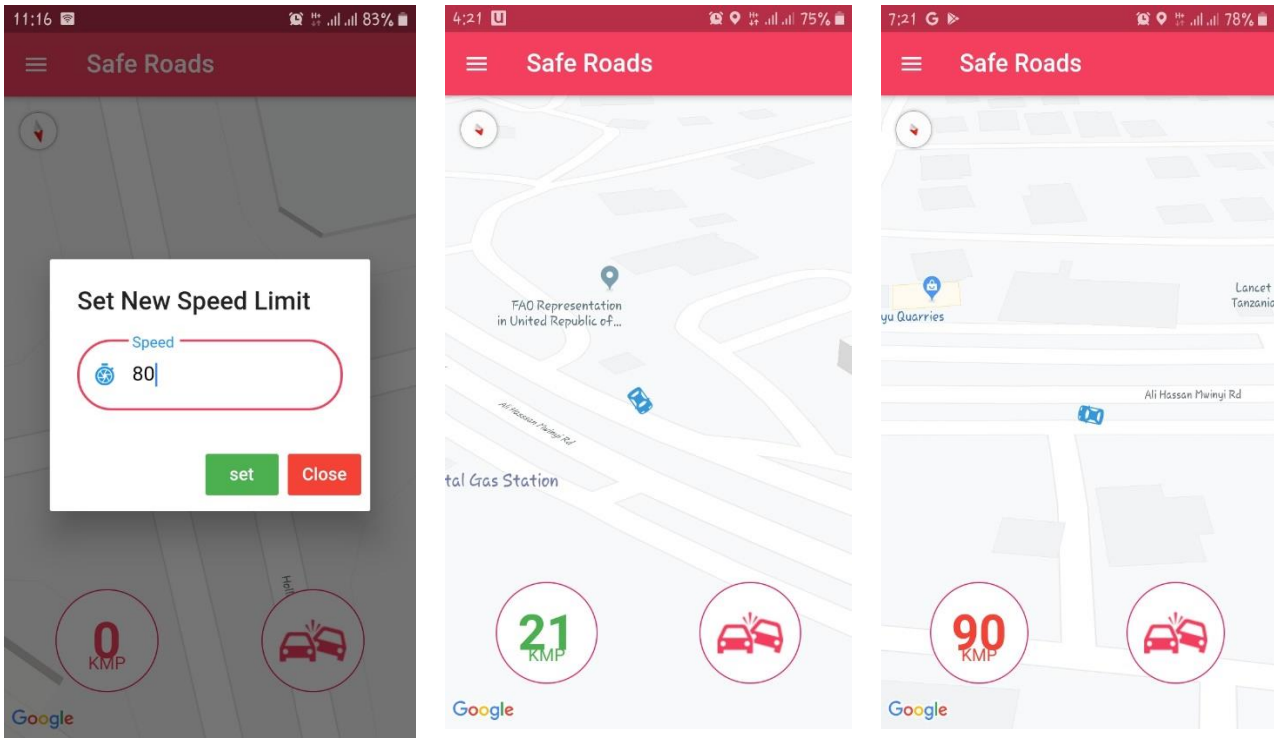
(iii) Report Over-Speeding Drivers

Road users (specifically the passengers) could also report the driver's over-speeding behavior to the traffic police officers. Users needed to long-press the speed reading button to access this reporting feature. This option will enable users to send the actual GPS speed readings to the traffic police officers that will be used as evidence when making an over-speeding report. Figure 17 shows the screen for reporting over-speeding drivers.



(a) (b) (c)

Figure 15: (a) User log-in screen (b) User registration screen (c) Home screen



(d) (e) (f)

Figure 16: (d) Set speed limit screen (e) Speed notifications screen (f) Over-speeding notifications

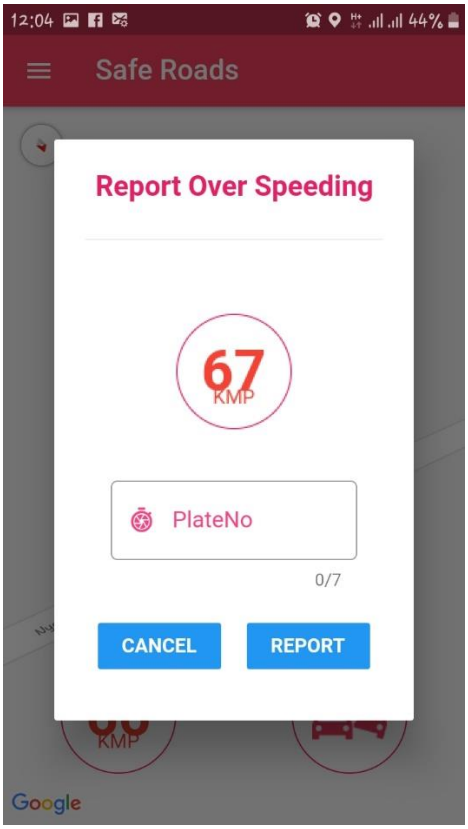
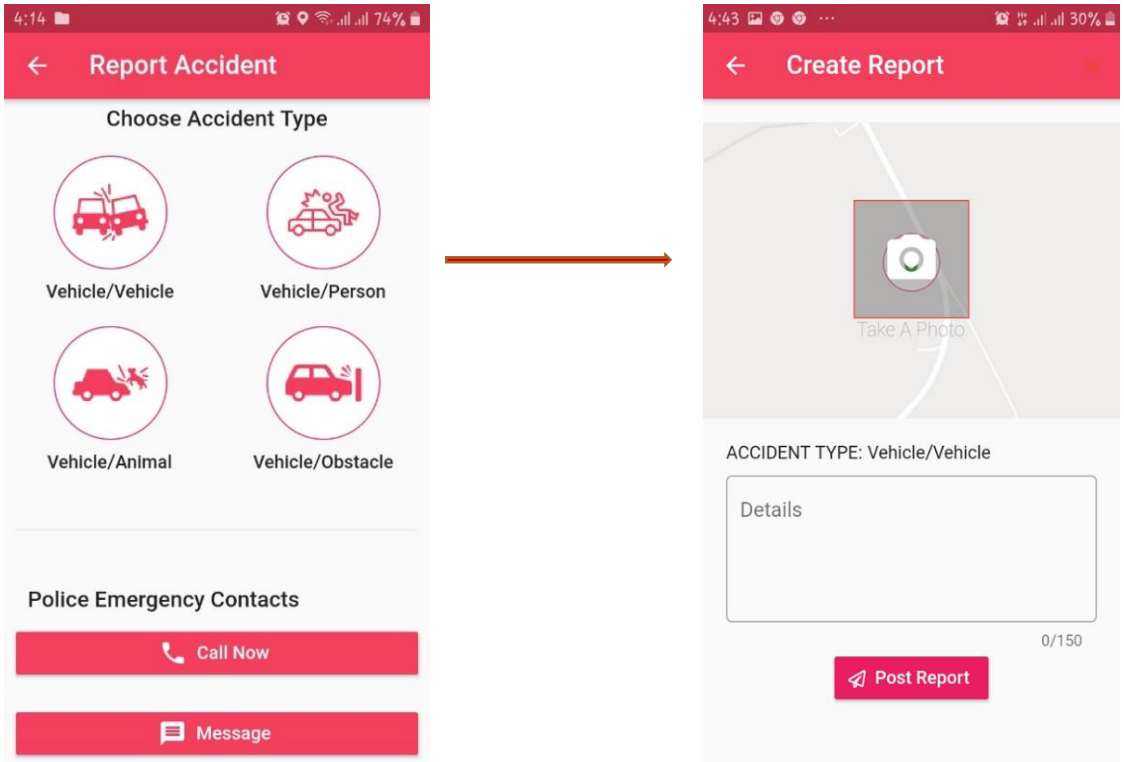


Figure 17: Over-speeding reporting screen

(iv) Road Accident Reporting

All road users, that is the drivers, passengers or pedestrians could report a road accident as witnesses/bystanders. Users could report a road accident in two steps: first, by choosing an accident type from the different kinds of accidents (vehicle/vehicle, vehicle/person, vehicle/animal or vehicle/obstacle) as shown in Fig. 18 (g) and secondly, by attaching accident photos and details (Fig. 18 (h)). The accident location is automatically retrieved by the GPS location co-ordinates when users post the report. Users could also report a road accident by calling or sending a message to the police emergency contacts. The reported road accidents and over-speeding reports are sent using Internet and in the case of rural/remote areas where the network is often not available and unstable, the reports are stored locally on the mobile app, and are automatically uploaded to the web-servers when a network becomes available.

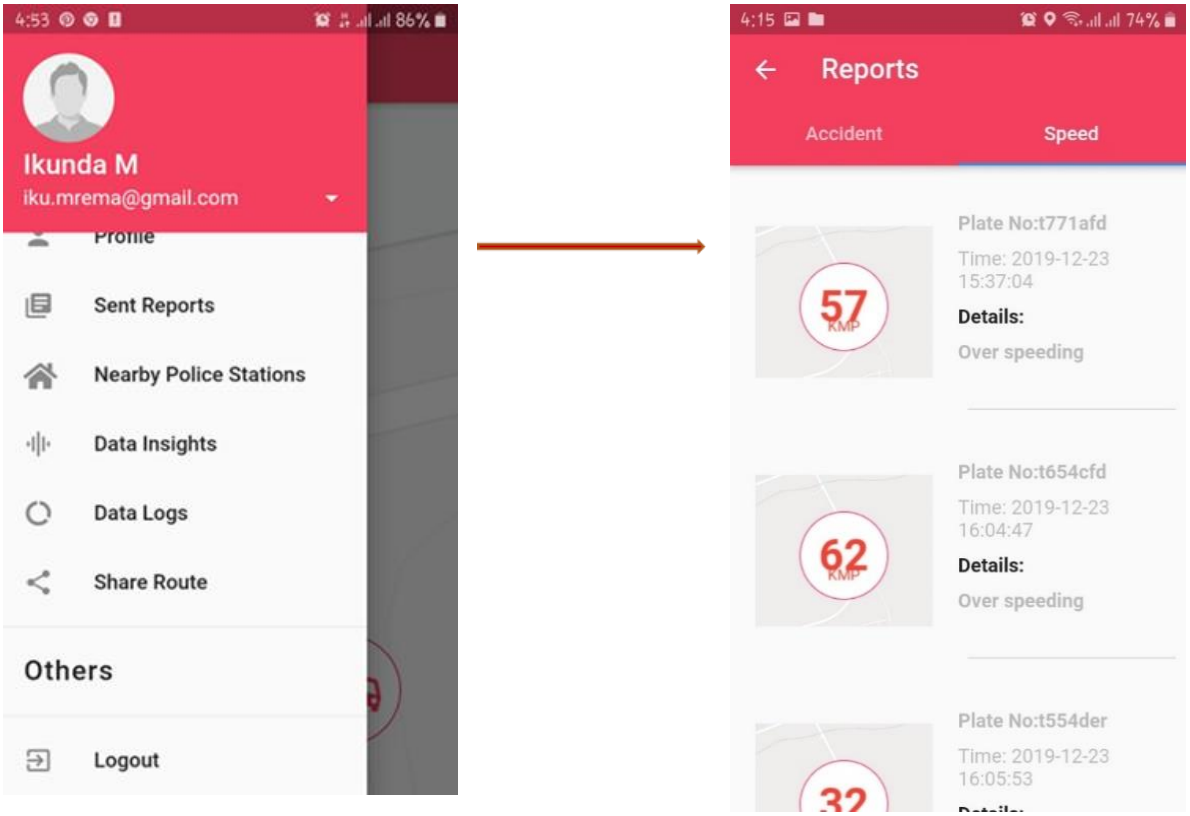


(g) (h)

Figure 18: (g) Choose accident type screen (h) Create a report screen

(v) View Sent Reports

After users have sent a report using the mobile application, they could view the sent reports from the application menu as shown in Fig. 19 (h). The sent reports are categorized as either accidents or over-speeding reports (Fig. 19 (i)). Users also had an option to delete these reports from the application.



(h) (i)

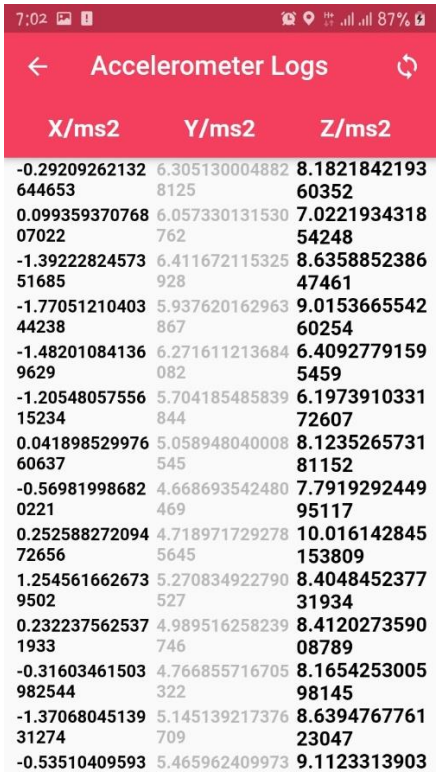
Figure 19: (h) Menu screen (i) View sent reports screen

(vi) Sensor Logs

The mobile application also collected smartphone's sensor logs which were to be used in future researches for the development of automatic road accident detection and reporting algorithms. Data was collected from the accelerometer, gyroscope and GPS sensors and were to be stored securely in the database server. Only users with the required privileges were to be allowed to access this data, only for research purposes. Figure 20 show a sample of collected sensor logs from the GPS and accelerometer sensor. The data is stored locally on the smartphone when there is no internet and automatically synchronized and sent to the database when the network become available.

GPS Logs

Latitude	Longitud	Altitude	Speed
-3.4013895	36.7961089	1192.2999267578125	0.0
-3.4013895	36.7961089	1192.2999267578125	0.0
-3.3988486	36.7996158	1192.2999267578125	0.0
-3.3987194	36.799625	1193.5999755859375	0.0695261299610138
-3.3987872	36.7996025	1184.5	2.41882381439209
-3.3988973	36.7995723	1187.2	2.6800645351409913
-3.3989253	36.7995574	1189.8	0.2476796865463257
-3.398948	36.7995652	1175.2	1.433232057094574
-3.3990576	36.7996053	1175.1	0.0
-3.3990576	36.7996053	1175.1	0.0
-3.3990576	36.7996053	1175.1	0.0
-3.400878	36.7964653	1175.1	0.0
-3.4013893	36.796109	1175.1	0.04538172259926796
-3.398524	36.7998532	1175.1	0.0
-3.4013895	36.7961089	1175.1	0.0
-3.3988668	36.7995593	1175.1	0.0
			0.0381406



Accelerometer Logs

X/ms2	Y/ms2	Z/ms2
-0.29209262132644653	6.3051300048828125	8.182184219360352
0.09935937076807022	6.057330131530762	7.022193431854248
-1.3922282457351685	6.411672115325928	8.635885238647461
-1.7705121040344238	5.937620162963867	9.015366554260254
-1.482010841369629	6.271611213684082	6.40927791595459
-1.2054805755615234	5.704185485839844	6.197391033172607
0.04189852997660637	5.058948040008545	8.123526573181152
-0.569819986820221	4.668693542480469	7.791929244995117
0.25258827209472656	4.7189717292785645	10.016142845153809
1.2545616626739502	5.270834922790527	8.404845237731934
0.2322375625371933	4.989516258239746	8.412027359008789
-0.31603461503982544	4.766855716705322	8.165425300598145
-1.3706804513931274	5.145139217376709	8.639476776123047
-0.53510409593	5.465962409973	9.1123313903

Figure 20: Sample GPS and accelerometer sensor logs

4.6.2 Web Application System Implementation

The web application was developed to provide the near-by traffic police officers with timely road accidents and over-speeding reports from the road users using mobile applications. The reports were stored in the MYSQL database server. The link for the web interface is found at http://qlicue.com/saferoads/login with the following are the web application functionalities.

(i) System Login

The system administrator had a role to register traffic police officers as system users. After they have been registered to the system, they could login to the system using their login credentials (email address/username and password) as shown in Fig. 21.

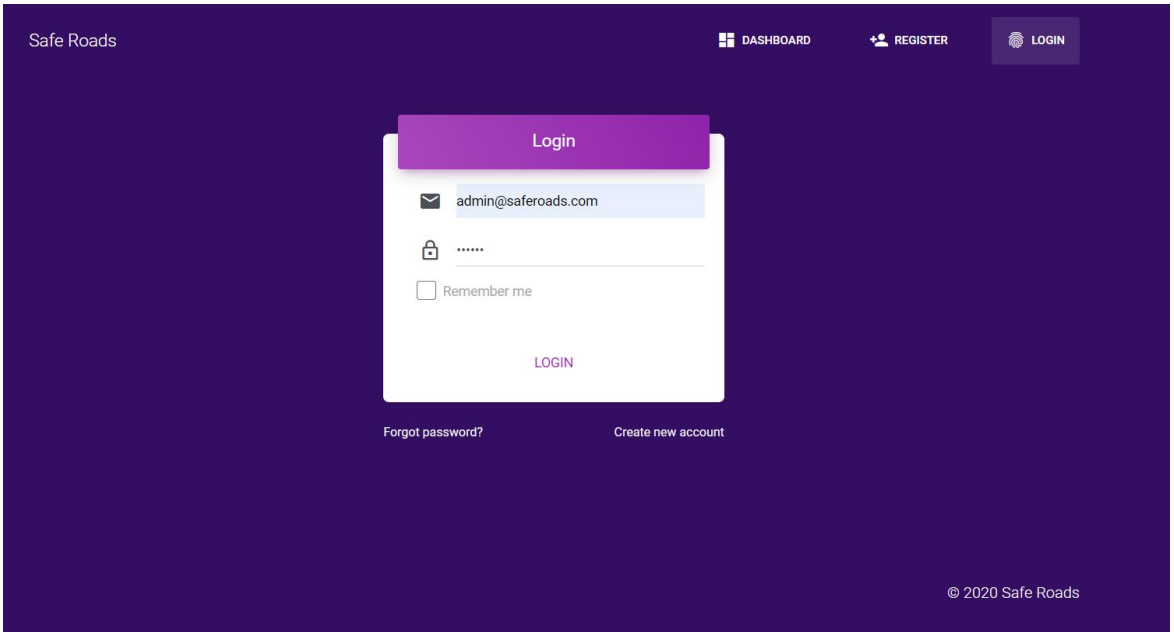


Figure 21: Log-in page

(ii) System Dashboard

The system dashboard provides users with a summary of all the received reports from the road users. From the system dashboard, users can view both the received road accidents and over-speeding reports statistics as shown in Fig. 22.

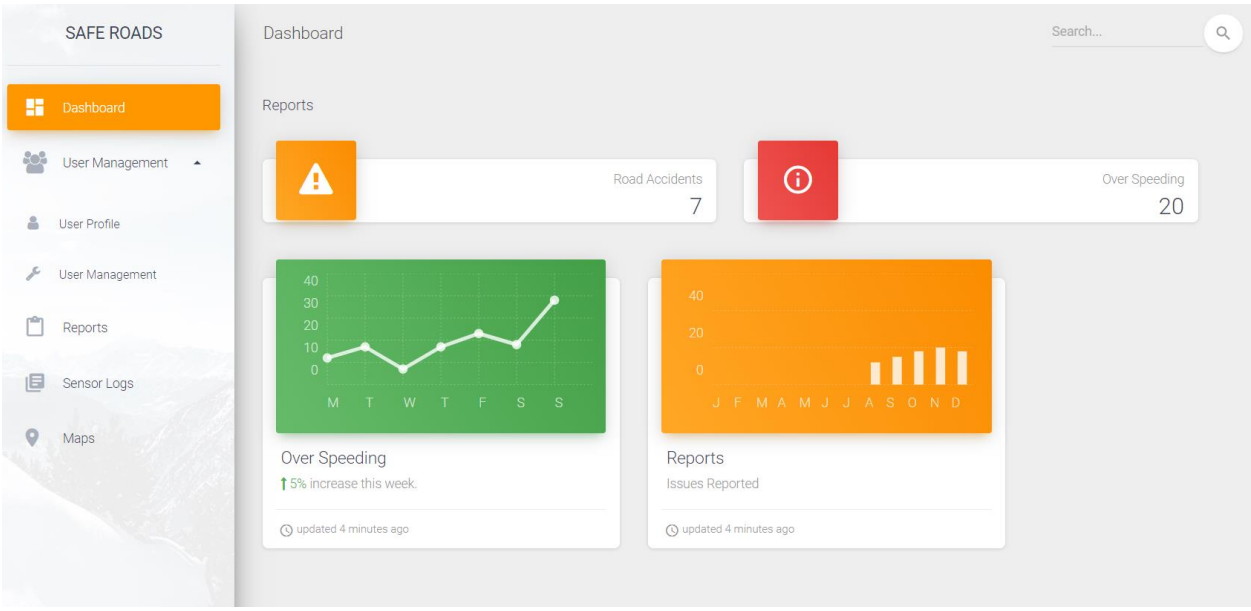


Figure 22: System dashboard

(iii) User Management

Users could edit their profile details through the user profile tab. They could also change the password from the initial one provided by the system admin as shown in Fig. 23. The system admin could also add or delete users as shown in Fig. 24.

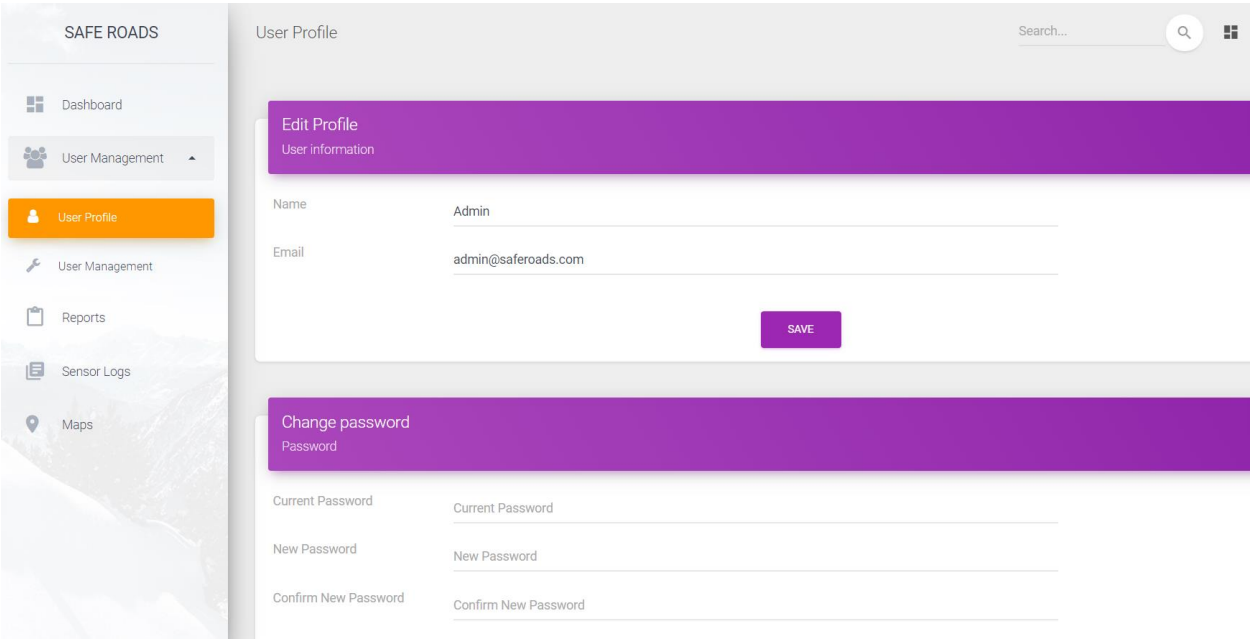


Figure 23: User profile page

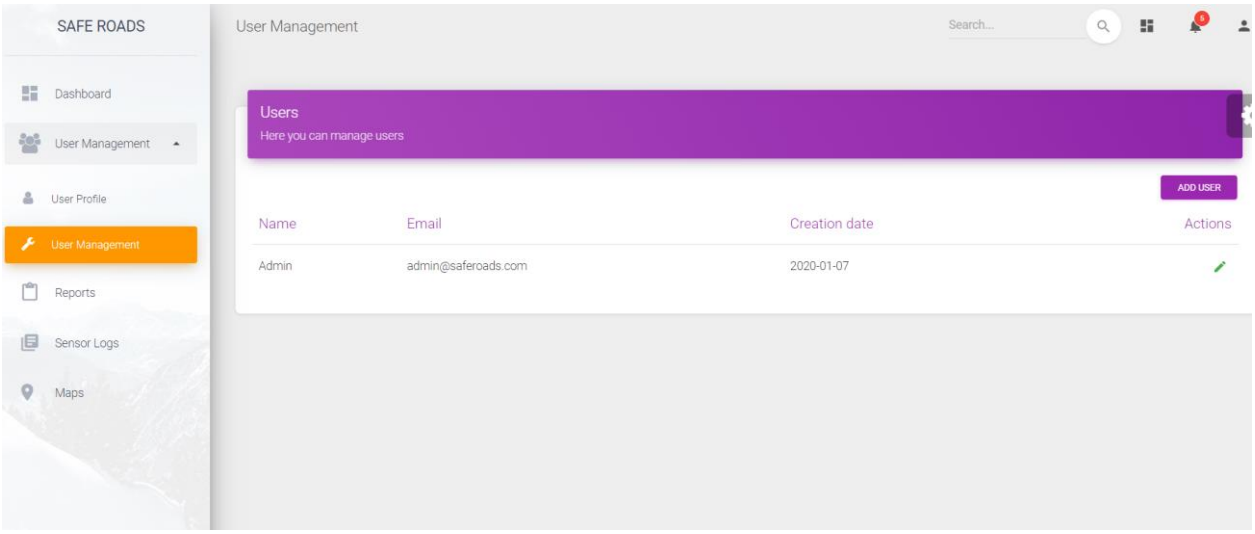


Figure 24: System admin user management page

(iv) System Reports

The web application allows traffic police officers to view received road accidents and over-speeding reports from mobile application users. Figure 25 shows the report page with over-speeding reports. The reports also indicate the near-by police station where they were sent. Global Positioning System (GPS) locations for the road accidents and over-speeding reports were used for map generation of each report.

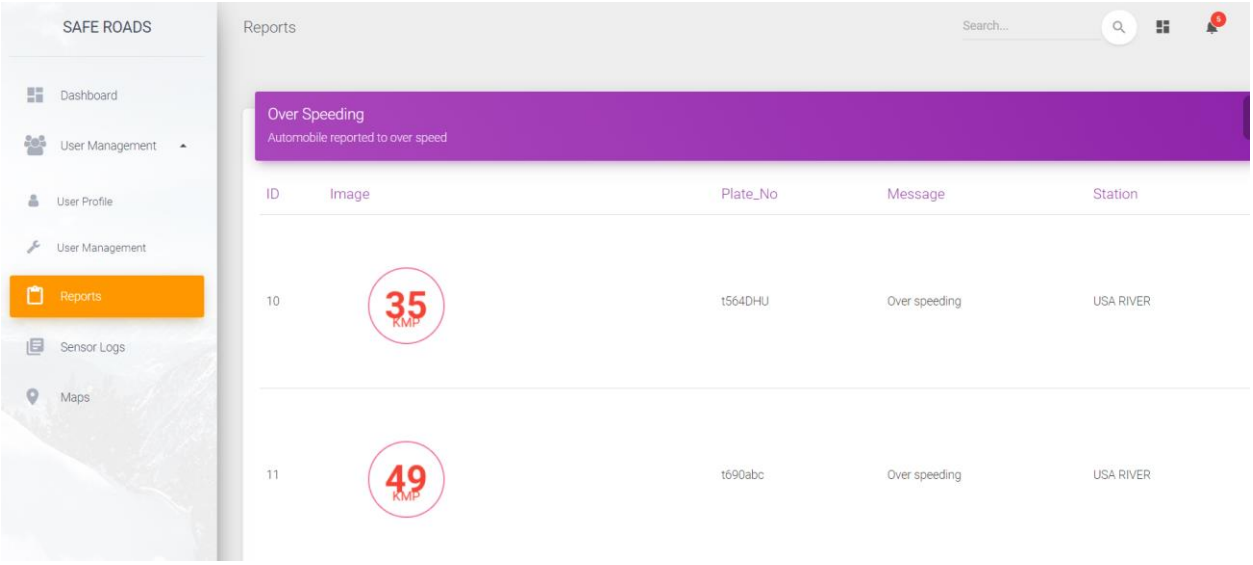


Figure 25: Viewing sent road accidents and over speeding reports

(v) Mapping of Received Reports

In order for users to determine which areas have the most received reports from the mobile application users, the system generates a map of all the received report as shown in Fig. 26. The mapping of received road accidents and over-speeding reports will help to determine the areas that are more prone to accidents and over-speeding drivers.

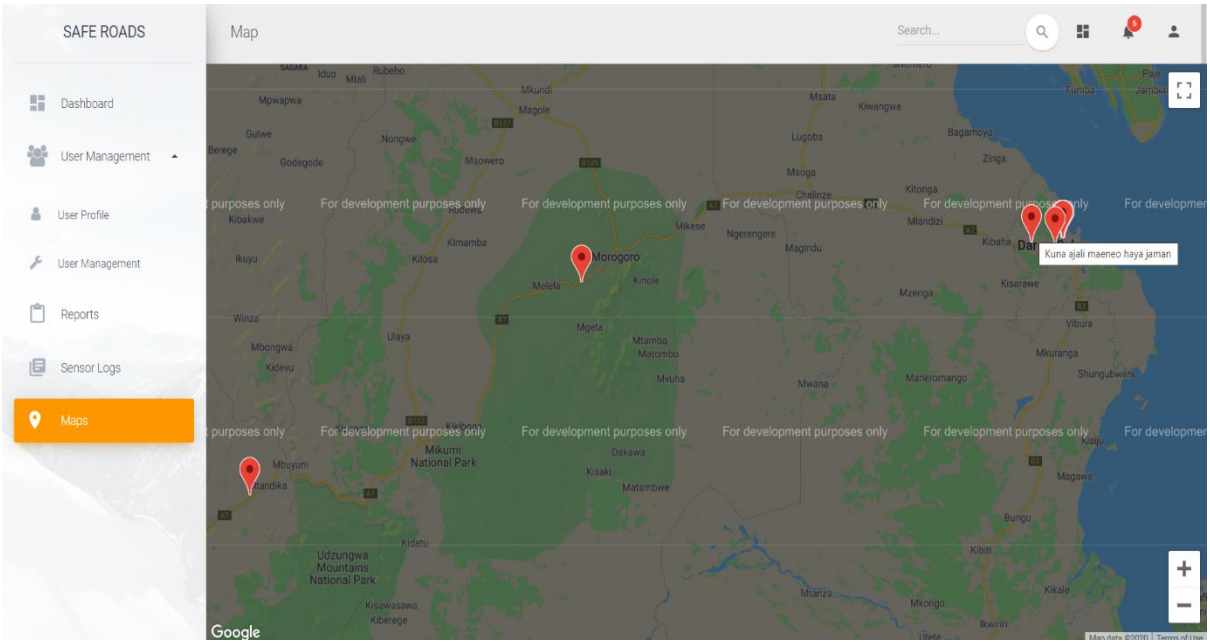


Figure 26: Mapping of reported road accidents and over speeding incidents

4.6.3 Database Implementation

(i) Firebase Authentication

Firebase authentication was used to authenticate users who logged in to the mobile application using either their Google/Facebook accounts. Figure 27 shows some of the users who logged in to the mobile application using their Google accounts.

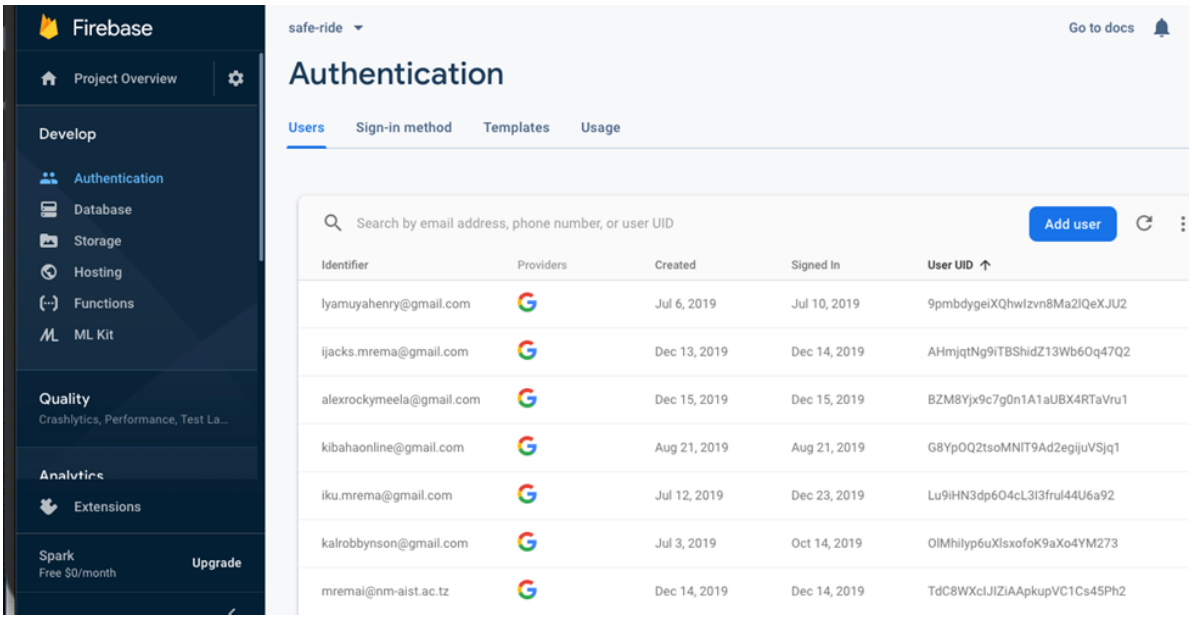


Figure 27: Firebase authentication page

(ii) MYSQL Database

MYSQL database was used for the mobile and web applications implemented in the system. The database had eight tables as shown in Fig. 28. The reports table used the report_id to categorize the two types of received reports that is, road accident or over-speeding report. The police stations' table stored the locations of police stations that were used in determining the nearest station that users should report to. Acceleration, gyroscope and GPS tables contained sensor data logs from the users' using the mobile application.

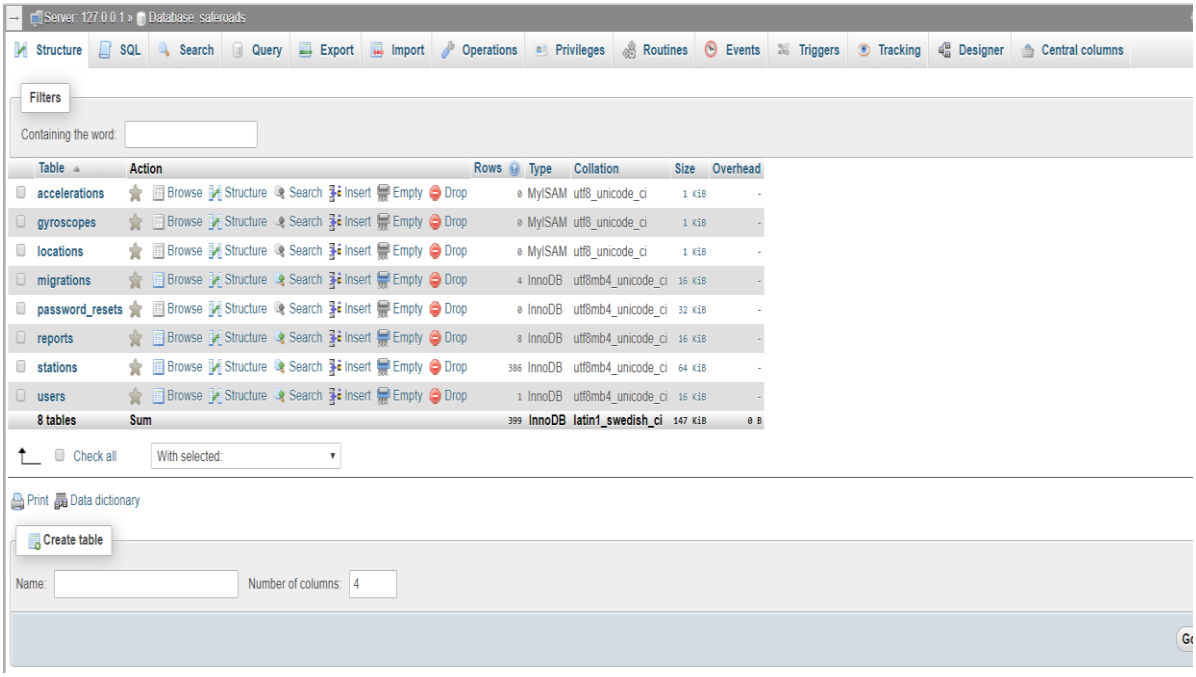


Figure 28: MYSQL database tables.

(iii) Database Schema

The database schema was used to show the relationships among the tables that were created in the database. All of the relationships involved among tables were many -to- many relationships as shown in Fig. 29.

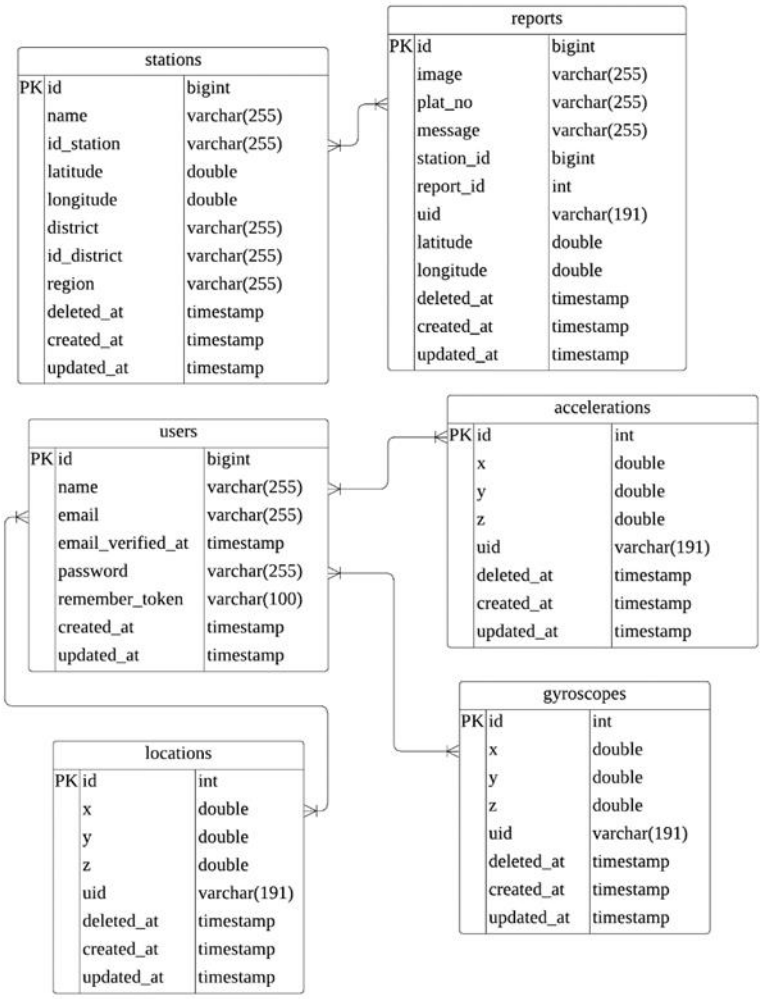


Figure 29: Database schema

4.7 System Validation

System validation involved both system testing and user acceptance testing.

4.7.1 System Testing

To obtain a complete working system, each system module was tested to confirm that functional and non-functional requirements were satisfied. System testing was also conducted with different users from Arusha and Moshi regions to enable the adoption of the developed system to other areas in Tanzania. Table 9 shows testing results for different system functionalities.

Table 9: System testing results

System Requirement	Test Result
The system should allow users to register with the system using a username and password	PASS
The system must allow a registered user to login and logout	PASS
The system should allow users to manage their user profile	PASS
The mobile application should allow users to report road accidents	PASS
The mobile application should allow users to set their driving speed limits	PASS
The mobile applications should allow users (drivers and passengers) to view their speeding behavior	PASS
The mobile application must allow users to report over speeding	PASS
The mobile application must allow users to view and delete sent reports	PASS
The mobile application must allow users to view near-by police stations	PASS
The web application should be compatible with all browsers and the mobile application should work on the both Android and iOS platforms	PASS
The web application system should allow the system administrator to manage users (register, suspend or remove a user account from the system)	PASS
The web application system should allow users (traffic police officers) to receive road accidents and over speeding reports	PASS
The web application should allow users to map received reports from the mobile application	PASS
The web application system should produce reports statistics for the users	PASS

4.7.2 User Acceptance Test

The user acceptance test was used to determine the level of acceptance of the developed system by the potential end-users. The validation model adopted for the developed system was the Technology Acceptance Model (TAM) shown in Fig. 30. The model was created by Fred Davis and Richard Bagozzi in 1986 to predict the use and acceptance of the information system and technology (Davis, Bagozzi, & Warshaw, 1989).

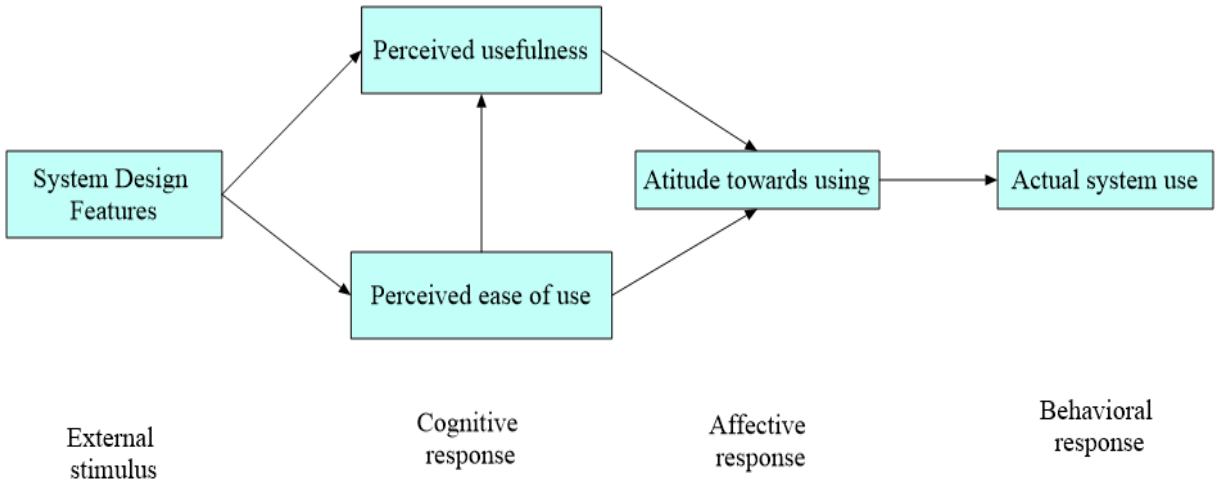


Figure 30: Technology acceptance model

The TAM involves two fundamental beliefs, the perceived usefulness, and the perceived ease-of-use. The two beliefs contribute to the users' attitude towards using an information system (attitude towards using) which is the main determinant of whether users will actually use the developed system. In addition, these two elements (perceived usefulness and the perceived ease-of-use) are influenced by the system design features (the external stimulus). In general, the model shows that system design features influence the attitude toward using and actual system use (behavioral Intention to use) indirectly (Davis, 1993).

The user acceptance test for road accident reporting was conducted in a simulated environment that involved some participants who tested the developed system. Overall, a sample of 15 people (5 traffic police officers and 10 road users) was used to test the developed system for 4 days and thereafter a validation survey was conducted.

Two types of survey questionnaires were given to both the traffic police officers and road users (see appendix IV and V). Table 10 and Table 11 show the validation survey results of road users and traffic police officers respectively.

Table 10: Road users validation survey responses

Model elements	Question	Number of respondents					Mean Score
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree	
Perceived Usefulness	The use of '*SafeRoads'* mobile application could help me to report accidents and over speeding more rapidly	5	3	1	1	0	4.20
	I think the use of '*SafeRoads'* mobile application system could improve road safety.	6	2	0	1	1	4.10
Perceived Ease of Use	I think I could easily learn how to use '*SafeRoads'* mobile application	6	2	0	2	0	4.20
	I think the '*Saferoads*' mobile application interface is simple and attractive	6	1	1	2	0	4.10
Attitude Toward Using	I think it is a good idea to use *SafeRoads* mobile application to report road accidents and driver's over-speeding	4	4	1	1	0	4.10
Behavioral Intention to Use / Willingness to use the application	I have the intention to use *SafeRoads* mobile application when it becomes available on Google Play	5	4	1	0	0	4.40

Table 11: Traffic police officers validation survey responses

Model elements	Question	Number of respondents					Mean Score
		Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	
Perceived Usefulness (U)	The use of '*SafeRoads'* web interface could help to receive road accidents reports and over-speeding more rapidly and quickly	2	2	1	0	0	4.20
	I think the use of '*SafeRoads'* application system could improve road safety.	3	1	0	1	0	4.20
	The '*Saferoads'* web application will assist to get accurate statistics of road accidents and over speeding reports	3	1	1	0	0	4.40
Perceived Ease of Use (E)	I think I could easily learn how to use '*SafeRoads'* web application on any browser	3	1	1	0	0	4.40
	I think the web application interface is simple and attractive	2	1	1	1	0	3.80
Attitude Toward Using (A)	I think it is a good idea to use *'SafeRoads'* web application to receive road accidents and over-speeding reports.	2	2	0	1	0	4.00
Behavioral Intention to Use (BI)	I have the intention to use '*SafeRoads'* web application in receiving road accidents and over speeding reports when it becomes implemented online	1	3	1	0	0	4.00

From the survey results obtained in table 11 and table 12, most of the participants agreed with a mean score of 4.00 and above that the developed mobile application is useful in reporting road accidents and over-speeding for the improvement of road safety. Also, both the traffic police officer and road users confirmed the developed system to be attractive in design and easy to use. It has also been noted that most of the users have the intention to use the developed mobile application system when it becomes publicly available.

Some of the road users who took the validation survey recommended that more features should be added to the mobile application to make it more useful. Among the suggested features to be added was the provision of road safety education to road users since it was noted that most road users lack the knowledge on how to be safe on the roads. Provision of first aid education to road users was suggested as another feature that could educate road accidents witnesses on how to assist the accident victims.

Traffic police officers survey participants suggested that the web application should also be accessible using mobile devices such as tablets and smartphones as this will make the report to be received by a wider traffic police officers audience.

4.8 Discussion

According to the obtained results, this study developed a complete mobile application system as a tool for road accidents reporting and driver's over-speeding behavior awareness. The potential system users tested and confirmed that the system could be used to improve road safety and one could easily learn how to use it. The benefits presented by the system in effective reporting of road accidents and driver's over-speeding behavior have shown to increase users' intentions of using the system.

Road accidents and over-speeding reports are saved in the MYSQL database server. Road accident reports are comprised of accident images captured by the user during road accident reporting using the mobile application. The current location of the road accident is tracked by the GPS sensor and sent automatically to the web application when users send a report. On the other hand, over-speeding reports are sent as images of the speed readings serving as proof that the allowed speed limit was violated. Over-speeding notifications were given to road users after a speed limit was set. Notifications in the form of color-changing from green for safe speeds to red for over-speeding made road users aware of their speeding behavior hence assisting them to make the necessary speed adjustments in order to avoid road accidents. The sent road accidents and over-speeding reports were received by the traffic police officers using the web application interface.

Findings from a study by Saiprasert and Pattara-atikom, (2013), revealed that GPS speed readings using a smartphone are as precise as of the ones from the vehicle's speedometer with an offset of 4km/hr. In addition to this, the system testing conducted for over-speeding notifications had a good number of readings with the exact speed values as the vehicle's

speedometer. With rapid technology advancement, this study believes that GPS satellite technology will improve significantly in the near future, hence reducing the speed offset. In addition, the GPS locations retrieved automatically when reporting of road accidents and driver's over-speeding had a satisfactory level of accuracy as most users preferred this than providing location description by themselves.

The use of photos (multimedia) when road users send road accidents reports would also enable the traffic police officers to obtain significant additional information regarding the accident reported compared to when it is reported through telephone calls. For instance, through the accident photos sent by witnesses, the condition of the victims and information on the vehicles involved in the accident could also be determined. Lastly, most road users recommended that the mobile application should provide some feedback response when they have reported road accidents or/and driver's over-speeding behavior as it would assure them that some form of action and decision has been taken for what they have reported.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study aimed to evaluate the existing methods and systems used for road accident reporting and driver's behavior awareness and thus developing a mobile application system as an alternative tool for over-speeding and road and accident reporting to the responsible authorities in addition to the existing methods. The study had three research questions as follows:

(i) What are the requirements for the development of a mobile application system for reporting road accidents and driver's over-speeding behavior awareness?

(ii) What mobile application system can be designed and developed for reporting road accidents and driver's over-speeding behavior awareness?

(iii) Does the developed system meet user requirements for reporting road accidents and driver's over-speeding behavior awareness?

In the first research question, a literature review and field survey was conducted to evaluate the existing systems and methods used in road accidents reporting and driver's over-speeding behavior awareness by utilizing the smartphone's in-built sensors. User and system requirements were identified after the field survey for the development of the mobile application system.

The second research question was answered by successfully developing a mobile application system using evolutionary prototyping methodology. Various system modeling techniques, tools, and technologies such as DFD, UML diagrams and use cases were used for system implementation. The study developed a mobile application system that utilizes smartphone's in-built sensors for reporting road accidents to the nearest traffic police stations with the assumption that road users (drivers, passengers, and pedestrians) are the available witnesses. The system also notifies drivers on their speeding behavior – through the utilization of the GPS sensor - and enable passengers to report over-speeding drivers to the traffic police officers.

The system will help the continuous collection of smartphone sensor data - accelerometer, gyroscope, and GPS - for the future development of more robust automatic road accident

detection and reporting using machine learning algorithms. The mobile application may also provide a platform reporting of other types of road incidents such as fire outbreaks, road hazards, road closure, criminal attacks, and natural disasters

Finally, the potential users tested and validated the system to determine if it met all requirements identified in the first research question. The potential users showed a satisfactory level of acceptance towards the system and agreed on its use in contributing to the improvement of road safety. Generally, this study aimed to improve road safety by enabling drivers to observe safe driving speeds through receiving over-speeding notification and/or passengers reporting over-speeding drivers to the responsible authorities hence contributing to the reduction of road accidents. Immediate road accidents reporting using the developed mobile application could also minimize victims' rescue time hence saving people's lives.

There were some challenges that were faced when undertaking this study. Some of these challenges included:

(i) The validation of road traffic accidents reporting through the mobile application was only done through simulation due to the nature of the problem. It was very difficult to test and validate road accident reporting using the mobile application system since road accidents usually occur without anticipation or warnings.

(ii) GPS sensor data logging was consuming smartphone battery power hence making the application less favorable for the users. Future researches may consider using the accelerometer smartphone sensor for speed detection and over-speeding notifications.

(iii) The continuous transfer of smartphone sensor logs led to system overloading. This was due to insufficient infrastructure resulting from the high maintenance costs of a real-time database for sensor data logging.

5.2 Recommendations

The study recommends that the developed system to be piloted and adopted by the stakeholders. The road users should be encouraged to use the system when reporting road accidents and over-speeding drivers to the traffic police officers in addition to the existing ways. On the other hand, the traffic police officers should also be made aware of the benefits of using the developed web application in receiving road accidents and over-speeding reports.

In addition to receiving these reports, they should be given the necessary means for taking the right action once they receive these reports from the road users. As it has always been the case with new software technology, it is never easy to get the software totally right during the first time. Hence, future studies may involve further improvement and addition of features to the developed system as follows:

(i) The developed system could be combined with the existing Road Accident Information System (RAIS) for road accident data integration.

(ii) The developed mobile application system could also be used as a platform for providing road safety educational information to road users including drivers, passengers and pedestrians. This information may also include ways that will guide a passerby in assisting victims in case of road accidents.

REFERENCES

Apache Friends. (2017). *XAMPP installers and downloads for Apache Friends*. Retrieved June 14, 2020, from https://www.apachefriends.org/index.html

Bhatti, F., Shah, M. A., Maple, C., & Ul-Islam,S. (2019). A novel internet of things-enabled accident detection and reporting system for smart city environments. *Sensors*, 19(9), 1–29. https://doi.org/10.3390/s19092071

Boniface, R., Museru, L., Kiloloma, O., & Munthali, V. (2016). Factors associated with road traffic injuries in Tanzania. *Pan African Medical Journal*, 23(2), 1–8.

Budde, R., & Kautz, K. (1992). *Prototyping: An approach to evolutionary system development*. Berlin: Springer-Verlag.

Candefjord, S., Sandsjö, L., Andersson, R., Carlborg, N., Szakal, A., Westlund, J., & Sjöqvist, B. A. (2014). Using smartphones to monitor cycling and automatically detect accidents-towards ecall functionality for cyclists. *Proceedings of International Cycling Safety Conference, Göteborg, Sweden*, 11(2), 18-19.

Chaovalit, P., Saiprasert, C., & Pholprasit, T. (2014). A method for driving event detection using symbolic aggregate approximation with resource usage exploration on smartphone platform. *Eurasip Journal on Wireless Communications and Networking*, 2014(1), 1–11. https://doi.org/10.1186/1687-1499-2014-135

Davis, F. (1993). User acceptance of information technology: System characteristics user perceptions and behavioral impacts. *International Journal of Man-Machine Studies*, 38(2), 475–487.

Davis, F., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Journal of Management Science*, 35(8), 982–1003. https://doi.org/10.1287/mnsc.35.8.982

Detho, A., Samo, S. R., Mukwana, K. C., Samo, K. A., & Siyal, A. A. (2018). Evaluation of road traffic accidents on hyderabad Karachi motorway section. *Journal of Engineering, Technology and Applied Science Research*, 8(3), 2875–2878.

Eliakunda, W., Mashoke, M., & Gurisha, Z. (2018). Vehicles accident in Tanzania : Causes and control challenges. *International Journal of Business Management and Economic Research*, 9(6), 1491–1500.

Engelbrecht, J., Booysen, M. J., Bruwer, F. J., & Van-Rooyen, G. J. (2015). Survey of smartphone-based sensing in vehicles for intelligent transportation system applications. *IET Journal of Intelligent Transport Systems*, 9(10), 924–935.

European Union. (2018). *Digital agenda for European Commission*. Retrieved August 5, 2019 from https:// ec. europa. eu/digital-single-market/en/ecall-time-saved-lives-saved

Fazeen, M., Gozick, B., Dantu, R., Bhukhiya, M., & González, M. C. (2012). Safe driving using mobile phones. *IEEE Transactions on Intelligent Transportation Systems*, 13(3), 1462–1468. https://doi.org/10.1109/tits.2012.2187640

Fogue, M., Garrido, P., Martinez, F. J., Cano, J. C., Calafate, C. T., & Manzoni, P. (2012). Automatic accident detection: Assistance through communication technologies and vehicles. *IEEE Vehicular Technology Magazine*, 7(3), 90–100.

General Motors. (2019). *OnStar in vehicle safety and security*. Retrieved from https:// www. onstar.com/us/en/home/

Goncalves, J., Goncalves, J. S. V., Rossetti, R. J. F., & Olaverri, M. C. (2014). Smartphone sensor platform to study traffic conditions and assess driving performance. *The 17th IEEE International Conference on Intelligent Transportation Systems*, 2014(10), *8-11*.

Google. (2018). *Beautiful native apps in record time*. Retrieved January 13, 2020, from https://flutter.dev/

Government of Tanzania. (1973). *The road traffic act cap*. Retrieved from https://moj.gov. jm/ sites/default/files/laws/Road%20Traffic%20Act_1.pdf

Joskow, J., & Yamane, T. (1965). *Statistics: An introductory analysis*. *Journal of the American Statistical Association*, 60(2), 2307-2703. https://doi.org/10.2307/2282703

Kahlert, T., & Giza, K. (2016). *Visual studio code: Code editing redefined.* Retrieved from https://code.visualstudio.com/?wt.mc_id=DX_841432

Lameck, S., Machuve, D., & Kisangiri, M. (2013). Automatic vehicle over speed, accident alert and locator system for public transport (Buses) in Tanzania. *International Journal of Engineering and Computer Science*, 2(8), 2327–2331.

Lukumay, G., Ndile, M. L., Outwater, A. H., Mkoka, D. A., Padyab, M., Saveman, B. I., & Backteman, E. S. (2018). Provision of post-crash first aid by traffic police in Dar es Salaam, Tanzania: A cross-sectional survey. *BMC Journal of Emergency Medicine*, 18(1), 1–9. https://doi.org/10.1186/s12873-018-0199-9

Trek Medics. (2019). *Trek Medics International annual report of 2018*. Retrieved from https://www.trekmedics.org/wp-content/uploads/2020/02/annual-report_2019.pdf

Meseguer, J. E., Calafate, C. T., Cano, J. C., & Manzoni, P. (2013). Drivingstyles: A smartphone application to assess driver behavior. *Proceedings of International Symposium on Computers and Communications*, 13(4), 535-540.

Moroney, L. (2017). *The definitive guide to firebase: Build android apps on Google's mobile platform.* Apress Publishing Journal, 13(1), 842-942. https://doi.org/10.1007/978-1-4842-2943-9

National Audit Office. (2012). *Performance audit report on the management of traffic inspections and speed limits. Dar es Salaam.* Retrieved from https:// www. tanzania.go.tz / egov_uploads/documents/555_sw.pdf

National Bureau of Statistics. (2017). *Tanzania in Figures 2016*. Retrieved from https:// doi.org/10.1192/bjp.111.479.1009-a

Nyamawe, A. S., & Mbosso, E. C. (2014). Road safety : Adoption of ICT for tracking vehicles' over-speeding in Tanzania. *International Journal of Computer Applications*, 96(16), 12–15.

Organization for Economic Co-operation and Development. (2019). *OECD Health statistics 2019: Definitions, sources and methods*. Retrieved from http:// stats. oecd. org/ fileview2. aspx?IDFile=2057d8ba-4e8b-4adf-b65b-7f4be 8fac 837

Otto, M., & Thornton, J. (2017). *Bootstrap: The most popular HTML, CSS, and JS library in the world.* Retrieved January 15, 2020 from https://getbootstrap.com/

Laravel. (2019). *Laravel: The PHP framework for web artisans*. Retrieved January 15, 2020 from https://laravel.com/

Royal Automobile Club. (2019). *RAC Mobile Traffic Apps*. Retrieved August 30, 2019, from https: //www. rac.co.uk/drive/travel/driving-in-the-uk/mobile-apps/

Ramju, F., Kaijage, S., & Sinde, R. (2016). Implementation and impact of information and communication technology on vehicle over-speed and drinking driving monitoring in Tanzania. *Journal of Computer Engineering and Intelligent Systems*, 7(7), 10–17.

Romano, M., Onorati, T., Aedo, I., & Diaz, P. (2016). Designing mobile applications for emergency response: Citizens acting as human sensors. *Sensors*, 16(3), 87-100. https://doi.org/10.3390/s16030406

Saiprasert, C., & Pattara-atikom, W. (2013). Smartphone enabled dangerous driving report system. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 10(4), 1231-1237. https://doi.org/10.1109/HICSS.2013.484

Sandsjö, L., Sjöqvist, B. A., & Candefjord, S. (2015). A concept for naturalistic data collection for vulnerable road users using a smartphone-based platform. *International Technical Journal on the Enhanced Safety of Vehicles (ESV)*. 15(4), 1-4.

Smith, B. (2015). *Beginning JSON*. NewYork: Springer Science.

Smolka, J., & Skublewska-Paszkowska, M. (2016). A method for collision detection using mobile devices. *Proceedings International Conference on Human System Interactions*, 9(4), 126–132. https://doi.org/10.1109/HSI.2016.7529620

Sommerville, I. (2011). *Software Engineering (*9th ed*)*. Boston: Addison-Wesley.

Sontakke, S. R., & Gawande, A. D. (2012). Crash notification system for portable devices. *International Journal of Advance Computer Technology*, 2(3), 33–38.

Stauffer, M. (2019). *Laravel up & running: A framework for building modern php apps* (2nd ed). Calfornia: O'Reilly Media.

Surface and Marine Transport Regulatory Authority. (2017). *Improvement of road safety in Tanzania mainland*. Retrieved from https:// www .sumatra. go. tz / index. php / component /docman/doc_details/262-improvement-of-road-safety-in-tanzania-mainland?Itemid=234

Tanzania Police Force. (2016). *Crime and traffic incidents statistics report: January - December 2015*. Dar es Salaam. Retrieved from https://www. nbs.go.tz/ nbs/ takwimu /trade/CrimeStats_Jan-Des2016English.pdf

Tanzania Communications Regulatory Authority. (2019). *Quarterly communications statistics :July-September 2019 operators' submissions*. Retrieved from https://www. tcra.go.tz /images/ headlines/ TelCom_ Statistics_March_2019.pdf

Thompson, C., White, J., Dougherty, B., Albright, A., & Schmidt, D. C. (2010). Using smartphones to detect car accidents and provide situational awareness to emergency responders. *Journal of Computer Sciences, Social-Informatics and Telecommunications Engineering*, 48 (3), 29–42. https://doi.org/10.1007/978-3-642-17758-3_3

Trek Medics. (2018). *Tanzania: Ambulance and emergency medical services.* Retrieved from https://www.trekmedics.org/database/tanzania/

Walcott-Bryant, A., Tatsubori, M., Bryant, R. E., Oduor, E., Omondi, S., Osebe, S., Bent, O. (2016). Harsh brakes at potholes in Nairobi: Context-based driver behavior in developing cities. *IEEE 19th International Conference on Intelligent Transportation Systems*, 11(9), 675-681 https://doi.org/10.1109/ITSC.2016.7795626

Waze. (2019). *Get the best route in real time with help from fellow drivers*. Retrieved from https://www.waze.com

World Health Organization (2018). *Global status report on road safety 2018.* Geneva.

Zaldivar, J., Calafate, C. T., Cano, J. C., & Manzoni, P. (2011). Providing accident detection in vehicular networks through OBD-II devices and android-based smartphones. *5th IEEE Workshop On User Mobility and Vehicular Networks*, 11(7), 817–823.

Zammetti, F. (2019). *Practical Flutter: Improve your mobile development with Google's latest open-source SDK*. California: Apress Media.

APPENDICES

Appendix I: Yamane Sample Size Calculation Formula

$$n = \frac{N}{1 + N(e^2)}$$

Whereby:

n is the calculated sample size

N is the population size

e is the acceptance sample error (margin of error)

i. Sample size for the road users:

Population size, N = 4,364,541

e = 10%

$$n = \frac{4{,}364{,}541}{1 + 4{,}364{,}541(0.1^2)}$$

$$Sample\ size = 100$$

ii. Sample size for the traffic police officers:

Population size, N = 1300

e = 10%

$$n = \frac{1300}{1 + 1300(0.1^2)}$$

$$Sample\ size = 93$$

Appendix II: Field Survey Data Collection Questionnaires for Traffic Police Officers

DODOSO KWA AJILI YA POLISI WA BARABARANI

Jina langu ni **Ikunda J. Mrema**, ni mwanafunzi wa shahada ya uzamili katika chuo cha The **Nelson Mandela Institution of Science and Technology (NM-AIST)**. Ninafanya utafiti unaohusu kutengeneza mfumo wa kuripoti na kupata msaada kwa njia ya aplikesheni ya simu pindi ajali za barabarani zitokeapo. Ili kuweza kutengeneza mfumo huu nimeandaa dodoso ili kupata mahitaji muhimu yatakayohitajika. Majibu yako ni muhimu na yatatumika kwa ajili ya utafiti bila kuhusishwa mojamoja na anayejibu.

Nashukuru kwa muda na ushirikiano wako.

Tafadhali weka alama ya vema (√) panapohusika

1. Jinsia yako ni ipi?

   Mwanaume ☐

   Mwanamke ☐

1. Je una umri gani?

   Miaka 20 na kushuka ☐

   Kutoka 21 hadi 30 years ☐

   Kutoka 31 up to 40 years ☐

   From 41 hadi 50 years ☐

   Miaka 51 na Zaidi ☐

2. Mkoa/ wilaya ya kituo cha kazi:
   ……
   ……
   ……

3. Wadhifa
   ……
   ……

4. Ni kwa njia gani huwa mnapata taarifa pale ajali ya barabarani inapotokea?
   Kwa njia ya kupiga simu ☐
   Mesaji fupi ☐
   Mitandao ya kijamii ☐
   Nyinginezo, elezea ☐
   ……
   ……
   ……

5. Je ni kwa kiwango gani unaridhishwa na hiyo njia?

Nimeridhika sana ☐

Nimeridhika ☐

Sijaridhika ☐

Sijaridhika kabisa ☐

6. Inachukua muda gani kwa taarifa kuhusu ajali za barabarani kufika kwenye kituo cha polisi?

Chini ya dakika 30 ☐

Dakika 30 mpaka saa 1 ☐

Saa1 mpaka saa 2 ☐

Zaidi ya saa 2 ☐

7. Ni changamoto zipi huwa mnazipata kwenye kupata taarifa pindi ajali inapotokea?

Taarifa kuchelewa kufika ☐

Kujua eneo husika la ajali ☐

Nyinginezo, elezea tafadhali ☐

……
…….

8. Pale ajali inapotokea ni taarifa gani ambazo huwa mnazikusanya kuhusu ajali hiyo?

Taarifa za majeruhi ☐

Eneo ambalo ajali imetokea ☐

Nyinginezo, elezea ☐

……
……
……

9. Ni kwa jinsi gani huwa mnawasaidia majeruhi?

Kutuma usafiri eneo la ajali ☐

Kuomba msaada hospitali ☐

Kuomba msaada wa usafiri binafsi ☐

Nyingine, elezea tafadhali ☐

……
……

10. Unaona kwamba matumizi ya teknologia ya aplikesheni ya simu yataweza kusaidia kurahisha kupata taarifa na kutoa msaada kwenye ajali za barabarani

Ndio ☐

Hapana ☐

11. Ni vitu gani huwa mnafuatilia mpaka mgonjwa apelekwe na kukabidhiwa hospitali

……
……

12. Maoni:

Unadhani nini kifanyike ili kuboresha jinsi ya kuripoti na uombaji wa msaada pindi ajali za barabarani zitokeapo?

……
……
……

Appendix III: Field Survey Data Collection Questionnaires for the Citizens

DODOSO KWA AJILI YA WAHANGA NA MASHUHUDA WA AJALI ZA BARABARANI

Jina langu ni **Ikunda J. Mrema**, ni mwanafunzi wa shahada ya uzamili katika chuo cha The **Nelson Mandela Institution of Science and Technology (NM-AIST)**. Ninafanya utafiti unaohusu kutengeneza mfumo wa kuripoti na kupata msaada kwa njia ya aplikesheni ya simu pindi ajali za barabarani zitokeapo. Ili kuweza kutengeneza mfumo huu nimeandaa dodoso ili kupata mahitaji muhimu yatakayohitajika. Majibu yako ni muhimu na yatatumika kwa ajili ya utafiti bila kuhusishwa mojamoja na anayejibu.

Nashukuru kwa muda na ushirikiano wako.

Tafadhali weka alama ya vema (√) panapohusika

1. Jinsia yako ni ipi?

   Mwanaume ☐

   Mwanamke ☐

2. Je una umri gani?

   Miaka 20 na kushuka ☐

   Kutoka 21 hadi 30 years ☐

   Kutoka 31 up to 40 years ☐

   From 41 hadi 50 years ☐

   Miaka 51 na Zaidi ☐

3. Aina ya makazi

   Ninaishi na familia ☐

   Ninaishi binafsi/mwenyewe ☐

4. Kiwango cha elimu

   Elimu ya msingi ☐

   Elimu ya secondari ☐

   Zaidi ya elimu ya sekondari ☐

5. Wadhifa/Aina ya kazi

   …….

6. Je umewahi kupata (kuwa majeruhi) au kushuhudia ajali ya barabarani?

   Ndio ☐

   Hapana ☐

7. Je ulihusikaje kwenye hiyo ajali ya barabarani?

Kama majeruhi ☐

Kama shuhuda wa ajali ☐

8. Ni aina gani ya ajali ya barabarani ilihusika?

Ajali ya pikipiki ☐

Ajali ya gari ☐

Ajali ya basi ☐

Nyingine, elelzea ☐

……
……
……

9. Ni muda gani ulitumika mpaka kupata msaada?

Chini ya nusu saa ☐

Kuanzia nusu saa mpaka saa moja ☐

Kuanzia saa moja mpaka saa 2 ☐

Zaidi ya saa 2 ☐

10. Ni njia gani ya mawasiliano ulitumia/ilitumika kuripoti ajali ya barabarani ili kuomba msaada wa hospital? (Weka tiki kwenye njia zote ulizotumia)

Njia ya mawasiliano ya simu ☐

Meseji fupi ya simu ☐

Mitandao ya kijamii, mfano Whatsapp ☐

Nyinginezo, elezea ☐

……
……
……
……

11. Je ni kwa kiwango gani unaridhishwa na hiyo njia?

Nimeridhika sana ☐

Nimeridhika ☐

Sijaridhika ☐

Sijaridhika kabisa ☐

12. Je ulipata/ulipatikana msaada wowote kutoka vituo vya afya (hospitali) za karibu?

Ndio, tafadhali elezea ☐

……
……
……
……

Hapana ☐

13. Ni njia ipi ilitumika kwa ajili ya usafiri kwenda hospital kitengo cha emeginsi?

Usafiri wa jamii (Kujitolea) ☐

Ambulansi ya hospitali ☐

Usafiri wa polisi ☐

Usafiri binafsi ☐

Nyingine, elezea ☐

……
……
……
…….....

14. Ni kwa njia gani taarifa za ajali ya barabarani ziliwafikia kituo cha polisi?

……
….
……
……
……..

15. Je unafahamu kuhusu aplikesheni ya simu yoyote ya kuripoti ajali za barabarani?

Ndio ☐

Tafadhali,elezea……...…
…….....
.....

Hapana ☐

16. Je unadhani matumizi ya aplikesheni ya simu kwenye kuripoti ajali za barabarani yatasaidia kuokoa maisha ya watu kwa kupunguza muda wa kupata msaada wa huduma za hospitali?

Ndio ☐

Hapana ☐

17. Je ungependelea kutumia aplikesheni ya simu kwa ajili ya kuripoti ajali za barabarani na mwendokasi wa dereva?

Ndio ☐

Hapana ☐

18. Maoni:
Unadhani nini kifanyike ili kuboresha jinsi ya kuripoti na uombaji wa msaada pindi ajali za barabarani zitokeapo?

……
……
……
……

Appendix IV: Field Survey Semi-Structured Interview

SEMI-STRUCTURED INTERVIEW

Jina langu ni **Ikunda J. Mrema**, ni mwanafunzi wa shahada ya uzamili katika chuo cha The **Nelson Mandela Institution of Science and Technology (NM-AIST)**. Ninafanya utafiti unaohusu kutengeneza mfumo wa kuripoti madereva wanoendesha kwa mwendo was kasi ili kuweza kuepuka ajali za barabarani. Ili kuweza kutengeneza mfumo huu nimeandaa dodoso ili kupata mahitaji muhimu yatakayohitajika. Majibu yako ni muhimu na yatatumika kwa ajili ya utafiti bila kuhusishwa mojamoja na anayejibu.

Nashukuru kwa muda na ushirikiano wako.

Maswali:

1. Je unadhani ni kwa jinsi gani mfumo wa aplikesheni ya simu kwa ajili ya kuripoti madereva wanaoenda kasi barabarani unaweza kusaidia kuepuka ajali za barabarani?

2. Je unadhani mfumo wa aplikesheni ya simu unataka kutengenezwa unaweza kufaa kuripoti madereva wanaoenda kwa kasi barabarani?

3. Ungekuwa na muamko gani iwapo ungepewa mfumo wa aplikesheni ya simu kwa ajili ya kuripoti madereva wanaoenda kwa kasi barabarani

4. Unadhani ni vipengele gani vya ziada vinaweza kuwepo kwenye huu mfumo wa aplikesheni ya simu utakaotumika kuripoti madereva wanaoenda kwa kasi barabarani?

5. Je una maoni mengine yoyote ya ziada?

Appendix V: Field Survey Validation Questionnaire for the Citizens

DODOSO KWA AJILI YA KUTHIBITISHA MFUMO WA KURIPOTI AJALI ZA BARABARANI

Jina langu ni Ikunda J. Mrema, ni mwanafunzi wa shahada ya uzamili katika chuo cha The Nelson Mandela Institution of Science and Technology (NM-AIST). Ninafanya utafiti unaohusu kutengeneza mfumo wa kuripoti ajali na mwendokasi wa vyombo vya moto kwa njia ya aplikesheni ya simu kwa ajili ya wa usalama barabarani. Lengo la dodoso hili ni kuhakiki na kuthibitisha mfumo wa TEHAMA niliotengeneza ili kuwezesha kuripoti ajali za barabarani na mwendokasi kwa njia ya aplikesheni ya simu. Nashukuru kwa muda na ushirikiano wakoNashukuru kwa muda na ushirikiano wako.

Tiki kwenye chumba kinachoonesha uhalisia wa hisia zako juu ya huu mfumo wa kuripoti ajali za barabarani.

Swali	***1=Nimekubali Kabisa, 2=Nimekubali, 3=Sina uhakika, 4=Ninakataa, 5=Ninakataa Kabisa***				
	1	**2**	**3**	**4**	**5**
Matumizi ya mfumo wa aplikesheni ya simu yanaweza kunisaidia kuripoti ajali za barabarani na mwendokasi wa vyombo vya moto kwa urahisi zaidi					
Nafikiri matumizi ya mfumo wa aplikesheni ya simu kwenye kuripoti ajali na mwendokasi yanaweza kuboresha usalama barabarani.					
Nafikiri naweza kujifunza kutumia mfumo wa aplikesheni ya simu uliotengenezwa kwa urahisi.					
Nafikiri violesura vya mfumo huu vinavutia na rahisi kutumia					
Nafikiri ni wazo zuri kutumia mfumo huu wa aplikesheni ya simu kuriporti ajali za barabarani na mwendokasi wa vyombo vya moto.					
Nina lengo la kutumia mfumo wa aplikesheni ya simu uliotengenezwa pindi utakapopatikana kwenye Google Play					

Appendix VI: Field Survey Validation Questionnaire for the Traffic Police Officers

DODOSO KWA AJILI YA KUTHIBITISHA MFUMO WA KURIPOTI AJALI ZA BARABARANI

Jina langu ni **Ikunda J. Mrema**, ni mwanafunzi wa shahada ya uzamili katika chuo cha **The Nelson Mandela Institution of Science and Technology (NM-AIST)**. Ninafanya utafiti unaohusu kutengeneza mfumo wa kuripoti ajali na mwendokasi wa vyombo vya moto kwa njia ya aplikesheni ya simu kwa ajili ya wa usalama barabarani. Lengo la dodoso hili ni kuhakiki na kuthibitisha mfumo wa TEHAMA niliotengeneza ili kuwezesha kuripoti ajali za barabarani na mwendokasi kwa njia ya aplikesheni ya simu. Nashukuru kwa muda na ushirikiano wako.

Tiki kwenye chumba kinachoonesha uhalisia wa hisia zako juu ya huu mfumo wa kuripoti ajali za barabarani na mwendokasi wa vyombo vya moto.

Swali	***1=Nimekubali Kabisa, 2=Nimekubali, 3=Sina uhakika, 4=Ninakataa, 5=Ninakataa Kabisa***				
	1	**2**	**3**	**4**	**5**
Matumizi ya mfumo wa tovuti yanaweza kusaidia kupokea na kufuatilia ajali za barabarani kwa urahisi na uharaka zaidi					
Nafikiri matumizi ya mfumo wa tovuti na aplikesheni ya simu kwenye kuripoti ajali na mwendokasi yanaweza kuboresha usalama barabarani.					
Mfumo wa tovuti utasaidia kupata takwimu za ajali zilizoripitiwa na ripoti za mwendokasi wa vyombo vya moto					
Nafikiri naweza kujifunza kutumia mfumo wa tovuti uliotengenezwa kupokea ripoti za ajali za barabarani na mwendokasi wa vyombo vya moto kwa urahisi.					
Nafikiri violesura vya mfumo huu vinavutia na rahisi kutumia					
Nafikiri ni wazo zuri kutumia mfumo huu wa tovuti uliotengenezwa kupokea ajali za barabarani na mwendokasi wa vyombo vya moto.					
Nina lengo la kutumia mfumo wa tovuti uliotengenezwa kupokea ripoti za ajali za barabarani na mwendokasi wa vyombo vya moto pindi utakapopatikana kwenye intaneti.					

Appendix VII: The Sample Codes for Mobile Application Development

home_page.dart

```
import 'dart:async';
import 'dart:io';
import 'package:audioplayers/audioplayers.dart';
import 'package:flutter/material.dart';
import 'package:safe_ride/models/accelerometer.dart';
import 'package:safe_ride/models/gps_logs.dart';
import 'package:safe_ride/models/gyroscope_logs.dart';

import 'package:safe_ride/views/pages/reports/report_page.dart';
import 'package:scoped_model/scoped_model.dart';
import 'package:screenshot/screenshot.dart';
import 'package:sensors/sensors.dart';
import 'package:google_maps_flutter/google_maps_flutter.dart';
import 'package:rxdart/rxdart.dart';
import 'package:safe_ride/data/main.dart';
import 'drawer_page.dart';
import 'package:safe_ride/styles/style.dart' as ThemeColor;
import 'package:location/location.dart';

class HomePage extends StatefulWidget {
  final MainModel model;

  const HomePage({Key key, @required this.model}) : super(key: key);
  @override
  _HomePageState createState() => _HomePageState();
}

class _HomePageState extends State<HomePage> {
  final GlobalKey<ScaffoldState> _scaffoldKey = GlobalKey<ScaffoldState>();
  final _formKey = GlobalKey<FormState>();

  final _formKeys = GlobalKey<FormState>();

  int intialSpeed = 0;
  int _currentSpeed = 0;

  Color speedColor = ThemeColor.Colors.saferidePrimaryColor;
  Color speedColorBackground = Colors.white;
  PublishSubject<double> eventObservable = new PublishSubject();

  Completer<GoogleMapController> _controller = Completer();
  Marker marker;
  Map<MarkerId, Marker> markers = <MarkerId, Marker>{};

  CameraPosition kGooglePlex;
  final MarkerId markerId = MarkerId('0098');
  BitmapDescriptor myIcon;

  FocusNode _speedFocusNode = FocusNode();
 TextEditingController _speedTextEditingController = TextEditingController();
```

```
var isDeviceConnected = false;

var location = new Location();

ScreenshotController screenshotController = ScreenshotController();

final FocusNode _plateNoFocusNode = FocusNode();

TextEditingController _platNoTextEditingController = TextEditingController();

AudioPlayer audioPlayer = AudioPlayer();

//Accelerations...

double ax = 0.0;
double ay = 0.0;
double az = 0.0;
double _latitude = 0.0;
double _longitude = 0.0;
@override
void initState() {
  widget.model.fetchStations();
  location.getLocation().then((onValue) {
    setState(() {
      _latitude = onValue.latitude;
      _longitude = onValue.longitude;
    });
  });
  super.initState();

  BitmapDescriptor.fromAssetImage(
        ImageConfiguration(size: Size(48, 48)), 'assets/icons/car.png')
      .then((onValue) {
    myIcon = onValue;
  });

  _getLocation();
}

@override
void dispose() {
  // positionStream.cancel();
  super.dispose();
}

@override
Widget build(BuildContext context) {
  // creating a new MARKER
  markers[markerId] = marker;

  return ScopedModelDescendant(
    builder: (BuildContext context, Widget child, MainModel model) {
      return Scaffold(
        key: _scaffoldKey,
```

```
appBar: AppBar(
  title: Text('Safe Roads'),
),
body: Stack(
  children: <Widget>[
    // Max Size

    Container(
      child: GoogleMap(
        mapType: MapType.normal,
        initialCameraPosition: kGooglePlex,
        onMapCreated: (GoogleMapController controller) {
          _controller.complete(controller);
        },
        markers: Set<Marker>.of(markers.values),
      ),
    ),

    Align(
        alignment: Alignment.bottomLeft,
        child: Screenshot(
          controller: screenshotController,
          child: Container(
            padding: EdgeInsets.all(40),
            child: Padding(
              padding: EdgeInsets.only(top: 10.0),
              child: InkWell(
                onLongPress: () {
                  screenshotController.capture().then((File image) {
                    setState(() {
                      model.capturedImage = image;

                      _reportSpeed(model);
                    });
                  }).catchError((onError) {});
                },
                onTap: () => _showDialog(),
                child: Container(
                  padding: const EdgeInsets.all(15.0),
                  decoration: new BoxDecoration(
                    shape: BoxShape.circle,
                    border: Border.all(color: Colors.pink),
                    color: Colors.white,
                  ),
                  child: Center(
                      child: Stack(
                    children: <Widget>[
                      Align(
                        alignment: Alignment.center,
                        child: Text(_currentSpeed.toString(),
                            style: TextStyle(
                                fontWeight: FontWeight.bold,
                                fontSize: 40,
                                color: speedColor)),
                      ),
```

```
                    Align(
                      alignment: Alignment.bottomCenter,
                      child: Text("KMP",
                        style: TextStyle(color: speedColor),
                        overflow: TextOverflow.fade))
                  ],
                )),
              ),
            ),
          ),
          height: MediaQuery.of(context).size.width / 2,
          width: MediaQuery.of(context).size.width / 2,
        ),
      )),
    Align(
      alignment: Alignment.bottomRight,
      child: Container(
        padding: EdgeInsets.all(40),
        child: Padding(
          padding: EdgeInsets.only(top: 10.0),
          child: InkWell(
            onTap: () {
              Navigator.push(context,
                  MaterialPageRoute(builder: (_) => ReportPage()));
            },
            child: Container(
              padding: const EdgeInsets.all(15.0),
              decoration: new BoxDecoration(
                shape: BoxShape.circle,
                border: Border.all(color: Colors.pink),
                color: Colors.white,
              ),
              child: Image.asset('assets/icons/accident.png'),
            ),
          ),
        ),
        height: MediaQuery.of(context).size.width / 2,
        width: MediaQuery.of(context).size.width / 2,
      ),
    )
  ],
),
drawer: SizedBox(
  width: MediaQuery.of(context).size.width * 0.80,
  child: DrawerPage(),
),
);
},
);
}

Future<void> _getLocation() async {
  marker = Marker(
    markerId: markerId,
    icon: myIcon,
```

```
  position: LatLng(37.33754513, -122.04146632),
  infoWindow: InfoWindow(title: 'Car', snippet: '*'),
  onTap: () {
    //_onMarkerTapped(markerId);
  },
);

kGooglePlex = CameraPosition(
  target: LatLng(37.33754513, -122.04146632),
  bearing: 192.8334901395799,
  zoom: 19.4746,
);

final GoogleMapController controller = await _controller.future;

var location = new Location();

location.onLocationChanged().listen((LocationData currentLocation) {
  GPSLogs _log = GPSLogs(
      altitude: currentLocation.altitude,
      latitude: currentLocation.latitude,
      longitude: currentLocation.longitude,
      speed: currentLocation.speed * 3.6);

  widget.model.addNewGPSLog(log: _log);

  // widget.model.postLocation(
  //     x: currentLocation.latitude,
  //     y: currentLocation.longitude,
  //     z: currentLocation.speed * 3.6,
  //     userId: 1);

  setState(() {
    marker = Marker(
      markerId: markerId,
      icon: myIcon,
      rotation: currentLocation.heading,
      position: LatLng(currentLocation.latitude, currentLocation.longitude),
      infoWindow: InfoWindow(title: 'Car', snippet: '*'),
      onTap: () {
        //_onMarkerTapped(markerId);
      },
    );

    kGooglePlex = CameraPosition(
        target: LatLng(currentLocation.latitude, currentLocation.longitude),
        bearing: 192.8334901395799,
        tilt: 59.440717697143555,
        zoom: 19.4746);

    controller.animateCamera(CameraUpdate.newCameraPosition(kGooglePlex));

    eventObservable.add(currentLocation.speed * 3.6);

    //speed color...
```

```
      if (intialSpeed > 0) {
        _currentSpeed = (currentLocation.speed * 3.6).round();
        if (currentLocation.speed * 3.6 > intialSpeed) {
          playBeep();
          speedColor = Colors.red;
          speedColorBackground = Colors.red;
        } else if (currentLocation.speed * 3.6 - 10 > intialSpeed) {
          stopBeep();
          speedColor = Colors.green;
          speedColorBackground = Colors.white;
        } else {
          speedColor = Colors.green;
          speedColorBackground = Colors.white;
          stopBeep();
        }
      } else {
        _currentSpeed = 0;
        stopBeep();
      }
    });
  });

  //accelerometer

  accelerometerEvents.listen((AccelerometerEvent event) {
    AccelerometerLogs _log =
        AccelerometerLogs(x: event.x, y: event.y, z: event.z);

    widget.model.addNewAccelerometerLog(log: _log);
  });

//gyroscope
  gyroscopeEvents.listen((GyroscopeEvent event) {
    GyroscopeLogs _log = GyroscopeLogs(x: event.x, y: event.y, z: event.z);

    widget.model.addNewGyroscopeLog(log: _log);

    // widget.model.postGyroscope(x: event.x, y: event.y, z: event.z, userId: 1);
  });
 }

 void _showInSnackBar(String value, Color color) {
  FocusScope.of(context).requestFocus(new FocusNode());
  _scaffoldKey.currentState?.removeCurrentSnackBar();
  _scaffoldKey.currentState.showSnackBar(new SnackBar(
    content: new Text(
      value,
      textAlign: TextAlign.center,
      style: TextStyle(
          color: Colors.white,
          fontSize: 16.0,
          fontFamily: "WorkSansSemiBold"),
    ),
    backgroundColor: color,
    duration: Duration(seconds: 3),
```

```
  ));
}

// user defined function
void _showDialog() {
  // flutter defined function
  showDialog(
    context: context,
    builder: (BuildContext context) {
      // return object of type Dialog
      return AlertDialog(
        title: Text("Set New Speed Limit"),
        content: Form(
          key: _formKey,
          child: TextFormField(
            validator: (value) {
              if (value.isEmpty) {
                return 'Please enter speed limit';
              } else
                return null;
            },
            focusNode: _speedFocusNode,
            controller: _speedTextEditingController,
            keyboardType: TextInputType.number,
            style: TextStyle(
                fontFamily: "WorkSansSemiBold",
                fontSize: 16.0,
                color: Colors.black),
            decoration: InputDecoration(
                //focusColor: Colors.white,
                fillColor: Colors.white,
                border: OutlineInputBorder(
                    borderRadius: BorderRadius.circular(30),
                    borderSide: BorderSide(color: Colors.white)),
                hintText: "Speed",
                labelText: "Speed",
                labelStyle: TextStyle(color: Colors.blue),
                hintStyle: TextStyle(
                    fontFamily: "WorkSansSemiBold",
                    fontSize: 17.0,
                    color: Colors.blue),
                prefixIcon: Icon(
                  Icons.shutter_speed,
                  size: 22.0,
                  color: Colors.blue,
                )),
          ),
        ),
        actions: <Widget>[
          FlatButton(
            color: Colors.green,
            child: new Text("set", style: TextStyle(color: Colors.white)),
            onPressed: () {
              if (_formKey.currentState.validate()) {
                if (_speedTextEditingController.text.isNotEmpty) {
```

```
                setState(() {
                  intialSpeed = int.parse(_speedTextEditingController.text);
                  speedColor = Colors.green;
                  speedColorBackground = Colors.green;
                });

                Navigator.of(context).pop();

                _speedTextEditingController.clear();
              }
            }
          },
        ),
        FlatButton(
          color: Colors.red,
          child: new Text(
            "Close",
            style: TextStyle(color: Colors.white),
          ),
          onPressed: () {
            Navigator.of(context).pop();
          },
        ),
      ],
    );
  },
);
}

void _reportSpeed(MainModel model) {
  showDialog<void>(
    context: context,
    barrierDismissible: false, // user must tap button!
    builder: (BuildContext context) {
      return AlertDialog(
        backgroundColor: Colors.pinkAccent[300],
        title: Center(
            child: Text('Report Over Speeding',
              style: TextStyle(
                fontFamily: 'itikaf',
                color: Colors.pink,
                fontWeight: FontWeight.bold))),
        content: SingleChildScrollView(
            child: Form(
          key: _formKeys,
          child: Column(
            children: <Widget>[
              Divider(),
              Container(
                child: Image.file(model.imageFile),
              ),
              Container(
                margin: EdgeInsets.only(left: 20, right: 20),
                child: TextFormField(
                  validator: (val) {
```

```
      if (val.isEmpty) {
        return 'Enter Car Plate Number';
      }
      return null;
    },
    focusNode: _plateNoFocusNode,
    maxLength: 7,
    keyboardType: TextInputType.text,
    controller: _platNoTextEditingController,
    style: TextStyle(fontSize: 16.0, color: Colors.black),
    decoration: InputDecoration(
      //focusColor: Colors.pinkAccent,
      fillColor: Colors.pinkAccent,
      border: OutlineInputBorder(
        borderRadius: BorderRadius.circular(5),
        borderSide: BorderSide(color: Colors.pinkAccent)),
      hintText: "PlateNo",
      labelText: "PlateNo",
      labelStyle: TextStyle(color: Colors.pinkAccent),
      hintStyle: TextStyle(
        fontFamily: "WorkSansSemiBold",
        fontSize: 17.0,
        color: Colors.pinkAccent),
      prefixIcon: Icon(
        Icons.shutter_speed,
        size: 22.0,
        color: Colors.pinkAccent,
      )),
  ),
),
SizedBox(
  height: 10,
),
Row(
  children: <Widget>[
    Expanded(
      child: Container(
        padding: EdgeInsets.all(10),
        child: FlatButton(
          color: Colors.blue,
          child: Text('CANCEL',
            style: TextStyle(
              color: Colors.white,
              fontWeight: FontWeight.bold)),
          onPressed: () {
            model.resetImage();
            Navigator.of(context).pop();
          },
        ),
      ),
    ),
    Expanded(
      child: Container(
        padding: EdgeInsets.all(10),
        child: FlatButton(
```

```
                    color: Colors.blue,
                    child: Text('REPORT',
                      style: TextStyle(
                        color: Colors.white,
                        fontWeight: FontWeight.bold)),
                    onPressed: () {
                      if (_formKeys.currentState.validate()) {
                        model
                          .postReport(
                            platNo: _platNoTextEditingController.text,
                            file: model.imageFile,
                            message: 'Over speeding',
                            reportId: 2,
                            stationId: 9,
                            uid: model.currentUser.uid,
                            latitude: _latitude,
                            longitude: _longitude)
                          .then((onValue) {
                        if (!onValue) {
                          _platNoTextEditingController.clear();
                          _showInSnackBar(
                            'Report sent successfully', Colors.green);
                          Navigator.of(context).pop();
                        } else {
                          _showInSnackBar(
                            'No internet connect', Colors.red);
                        }
                        });
                      }
                    },
                  ),
                ),
              )
            ],
          )
        ],
      ),
    )),
  );
 },
);
}

playBeep() async {
  int result =
    await audioPlayer.play('assets/audios/beep.mp3', isLocal: true);
  if (result == 1) {
    // success

  }
}

stopBeep() async {
  int result = await audioPlayer.stop();
  if (result == 1) {
```

```
    // success

  }
 }
}
```

report_page.dart

```
import 'package:flutter/material.dart';
import 'package:safe_ride/views/pages/reports/create_report.dart';
import 'package:safe_ride/views/widgets/buttons/custom_button.dart';
import 'package:safe_ride/styles/style.dart' as ThemeColor;
import 'package:url_launcher/url_launcher.dart';

class ReportPage extends StatelessWidget {
 @override
 Widget build(BuildContext context) {
  return Scaffold(
   appBar: AppBar(
    title: Text('Report Accident'),
   ),
   body: SingleChildScrollView(
    child: Column(
     children: <Widget>[
      SizedBox(
       height: 20,
      ),
      Row(
       children: <Widget>[
        Expanded(
         child: Text(
          'Choose Accident Type',
          textAlign: TextAlign.center,
          style: TextStyle(fontSize: 17, fontWeight: FontWeight.w600),
         ),
        )
       ],
      ),
      SizedBox(
       height: 20,
      ),
      Row(
       children: <Widget>[
        Expanded(
          child: CustomButton(
         image: 'assets/icons/accident-one.png',
         title: 'Vehicle/Vehicle',
         onTap: () => Navigator.push(
           context,
           MaterialPageRoute(
             builder: (_) => CreateReportPage(
               title: 'Vehicle/Vehicle',
             )),
        )),
```

```
    Expanded(
      child: CustomButton(
     image: 'assets/icons/accident-two.png',
     title: 'Vehicle/Person',
     onTap: () => Navigator.push(
        context,
        MaterialPageRoute(
          builder: (_) => CreateReportPage(
              title: 'Vehicle/Person',
            )),
    ))
  ],
),
SizedBox(
  height: 20,
),
Row(
  children: <Widget>[
    Expanded(
      child: CustomButton(
     image: 'assets/icons/accident-three.png',
     title: 'Vehicle/Animal',
     onTap: () => Navigator.push(
        context,
        MaterialPageRoute(
          builder: (_) => CreateReportPage(
              title: 'Vehicle/Obstacle',
            )),
    )),
    Expanded(
      child: CustomButton(
     image: 'assets/icons/accident-four.png',
     title: 'Vehicle/Obstacle',
     onTap: () => Navigator.push(
        context,
        MaterialPageRoute(
          builder: (_) => CreateReportPage(
              title: 'Vehicle/Obstacle',
            )),
    ))
  ],
),
SizedBox(
  height: 40,
),
Divider(
  endIndent: 10,
  indent: 10,
),
SizedBox(
  height: 40,
),
Row(
  children: <Widget>[
    Expanded(
```

```
        child: Padding(
          padding: const EdgeInsets.only(left: 20),
          child: Text(
            'Police Emergency Contacts',
            textAlign: TextAlign.start,
            style:
                TextStyle(fontSize: 17, fontWeight: FontWeight.w600),
          ),
        ),
      )
    ],
  ),
  Padding(
    padding: const EdgeInsets.all(10.0),
    child: Row(
      children: <Widget>[
        Expanded(
          child: RaisedButton.icon(
            color: ThemeColor.Colors.saferidePrimaryColor,
            icon: Icon(
              Icons.call,
              color: Colors.white,
            ),
            label: Text(
              'Call Now',
              style: TextStyle(color: Colors.white),
            ),
            onPressed: () => _launchURL(url: 'tel:+255 654 940 138'),
          ),
        )
      ],
    ),
  ),
  Padding(
    padding: const EdgeInsets.all(10.0),
    child: Row(
      children: <Widget>[
        Expanded(
          child: RaisedButton.icon(
            color: ThemeColor.Colors.saferidePrimaryColor,
            icon: Icon(
              Icons.message,
              color: Colors.white,
            ),
            label: Text(
              'Message',
              style: TextStyle(color: Colors.white),
            ),
            onPressed: () => _launchURL(url: 'sms:+255 625 756 752'),
          ),
        )
      ],
    ),
  )
],
```

```
      ),
    ),
  );
}

_launchURL({@required String url}) async {
  if (await canLaunch(url)) {
    await launch(url);
  } else {
    throw 'Could not launch $url';
  }
}
}
```

create_report.dart

```
import 'package:flutter/material.dart';
import 'package:font_awesome_flutter/font_awesome_flutter.dart';
import 'package:location/location.dart';
import 'package:safe_ride/data/main.dart';
import 'package:safe_ride/views/pages/camera/camera_page.dart';
import 'package:safe_ride/views/widgets/alerts/custom_circular_progress_bar.dart';
import 'package:scoped_model/scoped_model.dart';

class CreateReportPage extends StatefulWidget {
  final String title;

  CreateReportPage({Key key, @required this.title}) : super(key: key);

  @override
  _CreateReportPageState createState() => _CreateReportPageState();
}

class _CreateReportPageState extends State<CreateReportPage> {
  final GlobalKey<ScaffoldState> _scaffoldKey = GlobalKey<ScaffoldState>();

  final FocusNode _commentFocusNode = FocusNode();

  final TextEditingController _commentTextEditingController =
      TextEditingController();
  var location = new Location();
  double _latitude = 0.0;
  double _longitude = 0.0;
  @override
  void initState() {
    location.getLocation().then((onValue) {
      setState(() {
        _latitude = onValue.latitude;
        _longitude = onValue.longitude;
      });
    });
    super.initState();
  }
```

```
@override
Widget build(BuildContext context) {
 return ScopedModelDescendant(
     builder: (BuildContext context, Widget child, MainModel model) {
   return Scaffold(
     key: _scaffoldKey,
     appBar: AppBar(
       title: Text('Create Report'),
       actions: <Widget>[
         IconButton(
           icon: Icon(
             Icons.close,
             color: Colors.red,
           ),
           onPressed: () {
             model.setScreenShot(status: false);
             Navigator.pop(context);
           },
         )
       ],
     ),
     body: SingleChildScrollView(
         child: Stack(
       children: <Widget>[
         Column(
           children: <Widget>[
             SizedBox(
               height: 20,
             ),
             Container(
               child: Container(
                 height: 250,
                 decoration: BoxDecoration(
                     image: DecorationImage(
                   image: new AssetImage('assets/img/map.png'),
                   fit: BoxFit.cover,
                 )),
                 child: Center(
                   child: Column(
                     mainAxisAlignment: MainAxisAlignment.center,
                     children: <Widget>[
                       InkWell(
                         onTap: () => Navigator.push(
                             context,
                             MaterialPageRoute(
                                 builder: (_) => CameraPage())),
                         child: Container(
                           width: 100,
                           height: 100,
                           decoration: BoxDecoration(
                               border: Border.all(
                                   color: Theme.of(context).buttonColor)),
                           child: Stack(
                             children: <Widget>[
                               model.imageFile != null
```

```
                ? Image(
                    width: 100,
                    height: 100,
                    image: FileImage(model.imageFile),
                    fit: BoxFit.cover,
                  )
                : Container(),
              Container(
                width: 100,
                height: 100,
                color: Colors.black26,
              ),
              Align(
                alignment: Alignment.center,
                child: Icon(
                  Icons.camera_alt,
                  size: 50,
                  color: Colors.white,
                ),
              )
            ],
          ),
        ),
      ),
      Center(
        child: Text(
          'Take A Photo',
          style: TextStyle(
              color: Colors.grey,
              fontSize: 15,
              fontWeight: FontWeight.w100),
        ),
      )
    ],
  ),
),
),
SizedBox(
  height: 20,
),
Padding(
  padding: EdgeInsets.only(left: 20, right: 20),
  child: Row(
    children: <Widget>[
      Text(
        'ACCIDENT TYPE:\t',
        textAlign: TextAlign.start,
      ),
      Text(
        widget.title,
        maxLines: 1,
      ),
    ],
  ),
```

```
),
SizedBox(
  height: 10,
),
Padding(
  padding: EdgeInsets.only(left: 20, right: 20),
  child: TextFormField(
    maxLength: 150,
    maxLines: 4,
    focusNode: _commentFocusNode,
    controller: _commentTextEditingController,
    keyboardType: TextInputType.emailAddress,
    decoration: InputDecoration(
        hintText: 'Details',
        border: OutlineInputBorder(
            borderRadius: BorderRadius.circular(5))),
  ),
),
Padding(
  padding: EdgeInsets.only(left: 20, right: 20),
  child: RaisedButton.icon(
    color: Colors.pink,
    label: Text(
      'Post Report',
      style: TextStyle(color: Colors.white),
    ),
    icon: Icon(
      FontAwesomeIcons.paperPlane,
      color: Colors.white,
      size: 15,
    ),
    onPressed: () {
      if (_commentTextEditingController.text.isNotEmpty &&
          model.imageFile != null) {
        model
            .postReport(
                message: _commentTextEditingController.text,
                platNo: widget.title,
                stationId: 8,
                file: model.imageFile,
                reportId: 1,
                uid: model.currentUser.uid,
                latitude: _latitude,
                longitude: _longitude)
            .then((onValue) {
          if (!onValue) {
            model.setScreenShot(status: false);
            _commentTextEditingController.clear();
            _showInSnackBar(
                'Report sent successfully', Colors.green);
            Navigator.pop(context);
          } else {
            _showInSnackBar('No internet connect', Colors.red);
          }
        });
```

```
                } else {
                  print('Error');
                }
              },
            ),
          ),
        ],
      ),
      model.isSubmitingReportData
          ? Align(
              alignment: Alignment.center,
              child: CustomCircularProgressBar(
                divider: 1,
              ),
            )
          : Container()
    ],
  )),
 );
});
}

void _showInSnackBar(String value, Color color) {
 FocusScope.of(context).requestFocus(new FocusNode());
 _scaffoldKey.currentState?.removeCurrentSnackBar();
 _scaffoldKey.currentState.showSnackBar(new SnackBar(
  content: new Text(
    value,
    textAlign: TextAlign.center,
    style: TextStyle(
      color: Colors.white,
      fontSize: 16.0,
      fontFamily: "WorkSansSemiBold"),
  ),
  backgroundColor: color,
  duration: Duration(seconds: 3),
 ));
}
}
```

Appendix VIII: The Sample PHP Codes Used in Web Application Development

user.php

```php
<?php

namespace App;

use Illuminate\Notifications\Notifiable;
use Illuminate\Contracts\Auth\MustVerifyEmail;
use Illuminate\Foundation\Auth\User as Authenticatable;

class User extends Authenticatable
{
    use Notifiable;

    /**
     * The attributes that are mass assignable.
     *
     * @var array
     */
    protected $fillable = [
        'name', 'email', 'password',
    ];

    /**
     * The attributes that should be hidden for arrays.
     *
     * @var array
     */
    protected $hidden = [
        'password', 'remember_token',
    ];

    /**
     * The attributes that should be cast to native types.
     *
     * @var array
     */
    protected $casts = [
        'email_verified_at' => 'datetime',
    ];
}
```

report.php

```php
<?php

namespace App;

use Illuminate\Database\Eloquent\Model;
use Illuminate\Database\Eloquent\SoftDeletes;

class Report extends Model
```

```
{
    use SoftDeletes;
    protected $fillable = [
        'image',
        'plat_no',
        'station_id',
        'report_id',
        'uid',
        'message',
    ];

    protected $dates = ['deleted_at'];

    public function station(){
        return $this->belongsTo(Station::class);
    }
}
```

location.php

```
<?php

namespace App;

use Illuminate\Database\Eloquent\Model;
use Illuminate\Database\Eloquent\SoftDeletes;

class Location extends Model
{
    use SoftDeletes;
    protected $fillable = [
        'x',
        'y',
        'z',
        'user_id'
    ];

    protected $dates = ['deleted_at'];

     public function user(){
        return $this->hasOne(User::class);
    }
}
```

station.php

```
<?php

namespace App;

use Illuminate\Database\Eloquent\Model;
use Illuminate\Database\Eloquent\SoftDeletes;
```

```
class Station extends Model
{
   use SoftDeletes;
   protected $fillable = [
      'name',
      'id_station',
      'latitude',
      'longitude',
      'district',
      'id_district',
      'region'
   ];

   protected $dates = ['deleted_at'];

    public function reports(){
      return $this->hasMany(Report::class);
   }
}
```