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**Mobile Phone Application for Reporting and Tracking Missing Persons
in Kenya**

Mutisya Wayua Elizabeth

**Submitted in partial fulfilment of the requirements for the Degree of
Master of Science in Mobile Telecommunication and Innovation**

Faculty of Information Technology

Strathmore University

Nairobi, Kenya

June, 2017

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Elizabeth Wayua Mutisya

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14th June 2017

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Abstract

In Kenya, the first step to finding a missing person involves making a report to the Kenya Police who are significantly understaffed and irregularly spread. Most of the police officers are not invested in finding missing persons and will brush off such cases. The use of traditional media such as newspapers to share detail of a missing person is limited to few persons who have the resources to contact the media. On the other hand, the use of social media which is free, often results in confusion and mixed reports because of lack of control in how the reports are disseminated. This negatively affects the success rate of finding a missing person. It is important to find a centralised solution of managing reports of missing persons to increase the success rate of reuniting these persons with their families.

This study analysed the current models of reporting missing persons in Kenya and internationally as a way of identifying the challenges facing these models. A comparison was thereafter drawn between the currently centralised National Missing and Unidentified Persons System (NamUs) database and the fragmented reporting systems available in Kenya.

Following on the findings of the literature review, a mobile application was designed, developed and tested to solve the lack of a centralised, widely accepted model for reporting missing persons in Kenya. This mobile application borrowed key features of the Federal Bureau of Investigation's Child ID mobile application. The mobile application was developed using Agile methodology.

The mobile application was designed to be interactive and implement GPS functionality to ensure that any reports made on the application could be tracked. Thorough testing was done to ensure correctness, completeness, reliability, and usability of both applications.

Keywords: Missing person, Reporting, Mobile application

Contents

Abstract	ii
Contents	iii
List of Figures	vii
List of Tables.....	ix
Abbreviations/Acronyms	x
Acknowledgements	xi
Dedication	xii
Chapter 1 : Introduction	1
1.1 Background of Study	1
1.2 Problem Statement	3
1.3 Research Objectives	4
1.4 Research Questions	4
1.5 Assumptions.....	4
1.6 Scope and Limitations.....	5
1.7 Relevance	5
Chapter 2 : Literature Review	7
2.1 Introduction.....	7
2.2 History of Reporting Missing Persons	7
2.3 Analysis of Major Reporting Systems Globally	9
2.3.1 National Missing and Unidentified Persons System (NamUs).....	9
2.3.2 United Kingdom Missing Persons Bureau.....	10
2.4 Reporting Missing Persons in Kenya.....	11
2.4.1 The Child Welfare Society of Kenya (CWSK).....	11
2.4.2 Kenya Missing and Unidentified Persons (KMUPS)	12
2.4.3 Missing Child Kenya (MCK).....	12
2.5 Review of Existing Mobile Technology Solutions	13

2.5.1 FBI Child ID Application.....	13
2.5.2 Missing Person Application	14
2.6 Review of Mobile Application Development Technologies.....	14
2.7 Challenges Identified in Existing Systems.....	15
2.8 Summary	15
Chapter 3 : Research Design and Methodology.....	17
3.1 Introduction	17
3.2 Review of Current Reporting Systems in Kenya and Globally	17
3.3 Mobile and Web Application Design, Development and Testing	17
3.3.1 Planning and Requirement Analysis	19
3.3.2 Designing Phase	19
3.3.3 Building Phase	20
3.3.4 Testing Phase	21
3.4 Mobile and Web Application Validation	21
3.5 Summary	22
Chapter 4 : Planning and Requirement Analysis	23
4.1 Introduction	23
4.2 Planning	23
4.2.1 Google Survey Feedback Discussion.....	23
4.3 Requirement Analysis	28
4.3.1 Client Expectation.....	28
4.3.2 Functional Requirements	29
4.3.3 Non-Functional Requirements	29
4.4 Summary	30
Chapter 5 : System Designing.....	31
5.1 Introduction	31
5.2 System Design.....	31

5.2.1 Use Case Diagram.....	31
5.2.2 Use Case Descriptions	32
5.2.3 Operation Contract	34
5.2.4 Sequence Diagram	35
5.2.5 Database Schema	36
5.2.6 Database Dictionary	37
5.2.7 Mobile Application Wireframes	40
5.2.8 Web Application Wireframes	43
5.3 Summary	45
Chapter 6 : System Building and Testing	46
6.1 Introduction	46
6.2 Android Mobile Solution	46
6.2.1 Sign Up	46
6.2.2 Create a Missing Person Record	46
6.2.3 Share Location and Details of Missing Person	48
6.2.4 Close a Missing Person’s Record.....	49
6.2.5 Store Details of Close Family Members and Friends	49
6.2.6 Store Contact Details of Police Stations in Kenya.....	49
6.3 Web Backend Solution.....	50
6.4 System Testing	51
6.4.1 Mobile Application Testing Results.....	51
6.4.2 Web Application Testing Results.....	56
6.5 System Validation	58
6.6 Summary	62
Chapter 7 : Conclusions, Recommendations and Future Work	63
7.1 Introduction	63
7.2 Conclusions	63

7.3 Recommendations	64
7.4 Future Work	64
References	i
Appendix A: Google Survey Form	i
Appendix B: Turnitin Report	iv
Appendix C: Sample Test Cases	vi
Appendix D: Mobile and Web Application Wireframes	xii
Appendix E: Reviewed Systems' Screens	xiv

List of Figures

Figure 1.1: Estimated Number of Internet Users in Kenya.....	2
Figure 1.2: Trends of Kenyan Smartphone Users	3
Figure 2.1: AMBER Alert Statistics	8
Figure 3.1: Iterative Model Phases.....	18
Figure 4.1: Respondents Who Are Familiar with the Reporting Procedure	24
Figure 4.2: Respondents Who's Reported Missing Person Was Found	24
Figure 4.3: Respondents Who Feel Their Loved One was Found As A Result Of Reporting to the Police Station	25
Figure 4.4: Respondents Who Believe the Application Will Increase Effectiveness of Finding Missing Persons	25
Figure 4.5: Respondents Who Would Download and Use A Free Reporting Mobile Application.....	26
Figure 4.6: How Much the Respondents Would Pay for the Mobile App.....	26
Figure 4.7: Respondents Who Own a Smartphone	27
Figure 4.8: Respondents whose Smartphones Run on Android.....	27
Figure 4.9: Language That Respondents Prefer the App to be In	28
Figure 5.1: Use Case Diagram	32
Figure 5.2: Sequence Diagram	35
Figure 5.3: Database Schema	36
Figure 5.4: Home Screen Wireframe	40
Figure 5.5: Missing Persons' List Wireframe.....	41
Figure 5.6: Missing Person's Details Wireframe	41
Figure 5.7: Add Missing Person Wireframe	42
Figure 5.8: Report Missing Person Wireframe	42
Figure 5.9: Web Application Site Map	43
Figure 5.10: Web Application Admin Home Screen	44
Figure 5.11: Web Application Manage Users Wireframe	44
Figure 5.12: Web Application Manage Reports Wireframe	45
Figure 6.1: Mobile Application Home Screen	47
Figure 6.2: Mobile Application Missing Person Record Screen	48
Figure 6.3: Mobile Application Report Sighting	49
Figure 6.4: Web Application Home Screen	50

Figure 6.5: Web App Manage User Accounts	51
Figure 6.6: Effectiveness of Add New Missing Person Module.....	58
Figure 6.7: Effectiveness of Report Sighting Module	59
Figure 6.8: Effectiveness of Social Media Sharing Module	59
Figure 6.9: Effectiveness of Developed Application as a Whole	60
Figure 6.10: User-friendliness of the Application	60
Figure 6.11: Effectiveness of Family Profile Module.....	61
Figure 6.12: Administrators who would Recommend the Application	61
Figure A.1: Part One - Google Survey.....	i
Figure A.2: Part Two - Google Survey	ii
Figure A.3: Part Three - Google Survey	iii
Figure B.1: Turnitin Receipt	iv
Figure B.2: Turnitin Results Screenshot	v
Figure D.1: Mobile Application Sign in Screen.....	xii
Figure D.2: Mobile Application Sign Up Screen.....	xiii
Figure D.3: Web Application Sign in Screen.....	xiii
Figure E.1: Milk Carton with Photos of Missing Children.....	xiv
Figure E.2: Missing Persons Bureau Case Search Tool.....	xv
Figure E.3: CWSK Upload Interface	xvi

List of Tables

Table 2.1: Latest NamUs Statistics	10
Table 4.1: Client Expectations	28
Table 5.1: Entities' Key	36
Table 5.2: Admin Table	37
Table 5.3: User Table.....	37
Table 5.4: Case Table.....	38
Table 5.5: Sighting Table.....	38
Table 5.6: Family Members' Table.....	39
Table 5.7: Key to Fields in Database Tables.....	39
Table 6.1: Mobile Application Functional Test Case Results	54
Table 6.2: Mobile Application Performance Test Case Results	55
Table 6.3: Mobile Application Usability Test Case Results	56
Table 6.4: Web Application Test Case Results.....	57
Table 6.5: CRUD Matrix for Web Application	57
Table C.1: Mobile Application Test Case.....	ix
Table C.2: Web Application Test Case.....	x

Abbreviations/Acronyms

AMBER	America's Missing: Broadcast Emergency Response
App(s)	Application(s)
CAK	Communications Authority of Kenya
CID	Criminal Investigations Department
CMCK	Centre for Missing Children in Kenya
CWSK	Child Welfare Society of Kenya
MP	Missing Person
MCK	Missing Child Kenya
OB	Occurrence Book

Acknowledgements

My biggest appreciation is to God who, without his grace, I would not have found the strength to complete the work expected from me. He is merciful!

I would like to express my utmost gratitude to the Strathmore University through Safaricom Academy, who gave me a chance to gain in-depth insight into mobile applications and their value as solutions to existing problems in society. Awarding me a scholarship to join this Masters' program is a gift that I will cherish for my entire life.

I am highly indebted to Dr. Joseph Sevilla, my supervisor, who guided me through this period and gave me useful knowledge that was vital in the completion of the dissertation. He is an exceptional and extremely inspiring mentor who constantly encouraged me to focus on completing this dissertation.

Lastly, I would like to thank all my colleagues and friends who gave me support through different ways. From taking the time to honestly fill my questionnaire to trading thoughts on the subject matter, you all played a key role in seeing this project to completion.

To all, I am genuinely appreciative of all that you have done!

Dedication

I dedicate this dissertation to families who have lost their loved ones and are working tirelessly to be reunited with them.

Chapter 1 : Introduction

1.1 Background of Study

Involuntary separation of a person from their family and friends is a situation that causes untold grief and anguish to the persons involved. This separation could be accidental in instances where a child strays away from their minder as they happily explore their surroundings. It could even be as a result of a mental condition suffered by the missing person. Most times however, there is a more sinister underlying reason behind this separation. This could include abduction for ransom or child trafficking. In Kenya, about 20,000 people go missing every year. Only 40% of these people are found after long time. Even more saddening is the fact that only 30% of these are found within the first three months of reporting (Omweri, 2015).

When a person goes missing, the first few hours are critical to the success of tracing them and reuniting them with their family. It is important to exhaust all resources available to ensure that as many people as possible are on the lookout for the missing person. Without including technology, especially mobile applications, to help capture and share comprehensive updates about the missing people, effective tracing is greatly reduced.

Not all police stations in the country are equipped to deal with missing person reports. One can make a report at any police station but this information will be forwarded to a station with a Criminal Investigation Department (CID) officer (Chacha, 2015). Once this is done, then the agonising wait begins for the CID police to take action. This is extremely frustrating to the family members because the CID officers do not communicate adequately with them often keeping them in the dark about the progress of the case.

Many people resort to the media to appeal to members of the public to help them search for their loved ones. This often leads to confusion due to there being many varied channels of communication. Some organisations such as Child Welfare Society of Kenya (CWSK) have set up reporting websites as a way of streamlining the dissemination of information to the public. Another organisation, Missing Child Kenya (MCK) uses their Facebook, Twitter and Instagram handles to share reports of missing children. Their niche is children under the age of 18 meaning the organisation will not handle any case of a missing adult.

Reporting on a website alone or social media alone reduces the strength of the alerts shared. All these aspects of filing a police report and reporting on social media ought to be combined on a centralised, easy to access platform that has greater functionality than simply sharing.

The number of registered mobile phone subscribers in Kenya in 2016 was found to be about 38.5 million (Communications Authority Kenya, 2016). 3.1 million Devices were sold in 2015 out of which 1.8 million were smart phones (Zab, 2015). In other words, over 50% of the sales were smart phones. Internet penetration in Kenya was at 85.3% as at September 2016 as shown in Figure 1.1 (Communications Authority Kenya, 2016). These figures combined show that it would be prudent to design a mobile phone application that Kenyans can use to share alerts of missing persons and update family on any sightings of the missing person.

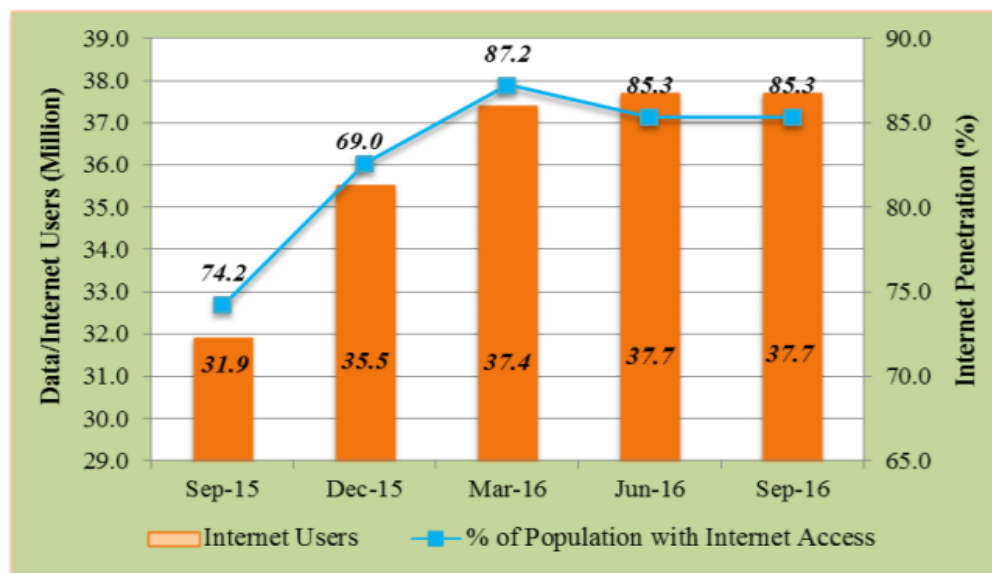


Figure 1.1: Estimated Number of Internet Users in Kenya

Source: Communications Authority Kenya, 2016

The latest study released in 2016 by Jumia titled *2nd White Paper on African Mobile Trends* in Kenya revealed that smart phones make up 58% of mobile devices sold in 2015 (Murage, 2016). It is estimated that 3,600,000 smartphones were sold in 2015 in Kenya

(Murage, 2016). The study also revealed that majority of Kenyans use smartphones majorly to browse the Internet at 78% as shown in Figure 1.3 (Murage, 2016).



Figure 1.2: Trends of Kenyan Smartphone Users

Source: Murage, 2016

The availability of mobile distribution platforms such as Google Play and Apple Store has led to the efficient distribution of the mobile application to consumers. Consumers are able to access any application from the mobile distribution platforms, download and install it to their phones.

1.2 Problem Statement

The success of finding a person who has gone missing largely depends on how far and fast the missing person alert is spread. Unless the public is aware that one is indeed missing, they cannot act even if they come into contact with the missing person. Currently reporting a missing person begins with the Kenya Police who do not have a centralised system that the public can access to search for missing persons. The organisations in Kenya that provide social media support for missing persons are largely fragmented resulting in many varied voices on social media spreading this information. This results in confusion, as there is lack of a focal reporting point.

1.3 Research Objectives

The purpose of this study was to examine the state of the current systems of reporting missing persons in Kenya. The result of this process would aid in developing a mobile phone application that can be used centrally to send out alerts of missing persons and share any location-based updates of the whereabouts of the missing person.

The specific objectives of the study are:

- i. To identify challenges faced by the current systems of reporting missing persons in Kenya.
- ii. To review the existing systems of reporting missing persons and draw comparison with systems employed in Kenya.
- iii. To design, develop and test a mobile application that will improve the efficiency of reporting and tracing a missing person in Kenya.
- iv. To validate and prove that the developed mobile application is effective in reporting and tracing a missing person in Kenya.

1.4 Research Questions

The following research questions were formulated to ensure the stated objectives of the study are achieved:

- i. What challenges are faced by the current systems of reporting missing persons in Kenya?
- ii. How effective are the existing popular systems of reporting missing persons compared to the systems employed in Kenya?
- iii. How can a mobile application that will improve the efficiency of reporting and tracing a missing person in Kenya be designed and tested?
- iv. Is the developed mobile application effective in reporting and tracing a missing person in Kenya?

1.5 Assumptions

The study makes the following assumptions:

- i. There are no documented proper, effective mechanisms put in place to track missing persons in Kenya.
- ii. Personnel in charge of the current system lack appropriate training to effectively employ the existing system.
- iii. Research done in Nairobi only is adequate to support the need for a mobile application for tracking missing persons in the country.

1.6 Scope and Limitations

The scope of the study will focus on missing persons only and not bodies that cannot be identified. This study will be limited to Nairobi County because of time and travel constraints.

The following are limitations that the researcher will encounter during the research process:

- i. The police stations may not be willing to provide any assistance towards getting current data about the filed missing person reports.
- ii. There will be no interactive session with the general public to educate them on how to use the mobile application.

1.7 Relevance

An effective reporting system should provide timely, correct and complete information. Developing an interactive mobile application for reporting missing persons will achieve these three characteristics. The lives of many Kenyans can be saved through implementation of this mobile application on a large scale. CA puts mobile phone usage at over 80% (Communications Authority of Kenya, 2016) making a mobile Android application an effective tool to solve this problem. This solution will combine the powerful ability of an interactive mobile phone application and the sheer number of Kenyans using such applications making it an efficient application.

Mobile devices' lower costs and ease of use are removing barriers and empowering citizens to quickly and efficiently connect to applications developed for health, education, employment, public safety, financial, transportation, legal and other services. Karadimas et al. points out that mobile telephony can reach areas where there are infrastructure constraints for traditional media or where wired phone service is not a feasible option

(Karadimas et al., 2008). CA estimates that for every 100 inhabitants in Kenya, 85.3 access the Internet using their mobile phones (Communications Authority of Kenya, 2016).

Chapter 2 : Literature Review

2.1 Introduction

According to the California Missing Persons website, a person is considered to be missing when their whereabouts is unknown to the reporting party (California Missing Persons, n.d). Any information regarding the possible location of the missing person is crucial to the success of finding them (California Missing Persons, n.d). Putting this information in a central location would go a long way to increasing the number of missing persons found alive and unharmed.

This section critically reviews existing technology used to report and trace missing persons. Reviewing already existing applications with operations similar to the proposed solution will help guide the research in a direction that will help produce the optimal application for the challenges raised in the first section of the paper.

2.2 History of Reporting Missing Persons

From as early as 1913 (McMahan, 2015), the police authorities have been receiving reports about missing persons and doing their best to solve these cases. One key project was the milk carton system (Palmer, n.d) which was initiated by the National Child Safety Council (NCSC) in December, 1984. NCSC would prepare artwork containing photos of missing children and send to milk carton manufacturers for printing. A sample of the carton artwork can be found in Appendix E. As the project gained momentum, over 700 independent dairies joined the program increasing its' publicity (Palmer, n.d). The program grew to include other forms of packaging such as shopping bags, pizza boxes and junk mail envelopes (Palmer, n.d).

In 1996, America's Missing: Broadcast Emergency Response (AMBER) Plan was launched after a nine-year-old girl was kidnapped as she was riding her bicycle around their neighbourhood in Texas (Friedman, 2010). She was found murdered four days later in a creek within a five-mile radius of her home. Local residents contacted their local radio stations suggesting that special alerts be broadcast through the radio to prevent similar incidents from occurring in the future (Barber, 2016).

Later that year, Dallas Fort-Worth Broadcaster's established a coordinated system with local law enforcement whereby they could warn the public when a child was kidnapped and in danger (Barber, 2016). The alerts were manually sent to radio stations but this later grew to include televisions, surrounding law enforcement agencies, newspapers and local support organisations. This program was eventually taken to the National Centre for Missing & Exploited Children, known as NCMEC, with a request for a national initiative. Since inception, there have been 495 successful recoveries thanks to the issuance of these alerts (National Centre for Missing & Exploited Children, 2014). Figure 2.1 shows a month-by-month breakdown of the number of AMBER alerts reported in 2014 (National Centre for Missing and Exploited Children, 2014).

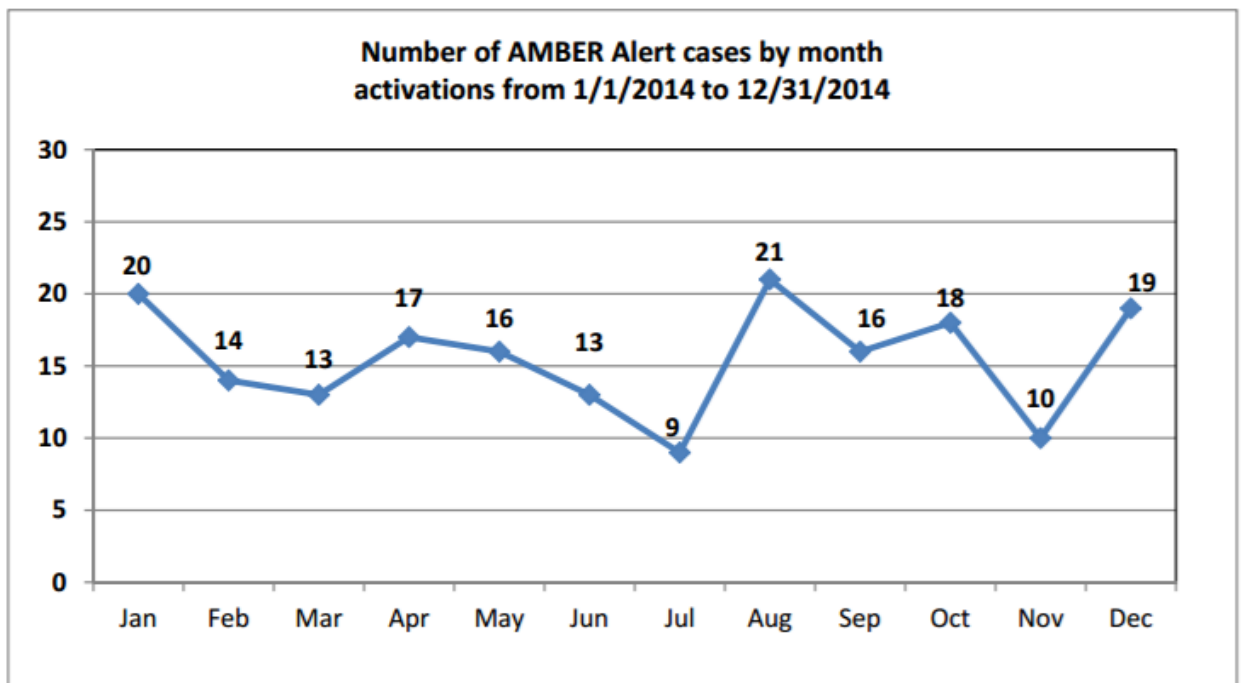


Figure 2.1: AMBER Alert Statistics

Source: National Centre for Missing and Exploited Children, 2014

Several countries have adopted the AMBER Alert system including Canada, Mexico, Australia and eighteen countries in Europe. Google and Facebook have also implemented AMBER alerts to be pushed on their platforms (Goel, 2015).

2.3 Analysis of Major Reporting Systems Globally

This section discusses the biggest resources available to people in the United States of America (USA) and United Kingdom (UK) who are searching for their missing loved ones:

2.3.1 National Missing and Unidentified Persons System (NamUs)

About 750,000 cases (McMahan, 2015) of missing persons are reported in the United States of America (USA) each year. This roughly translates to approximately 2,300 cases reported every day (McMahan, 2015). As of December 2012, the Federal Bureau of Investigation (FBI) had 87,217 active missing person records (McMahan, 2015).

The National Institute of Justice's National Missing and Unidentified Persons System (NamUs) is a national centralised database in USA for missing persons and unidentified decedent records. It is made up of two similarly-structured databases that hold records of missing persons (MP) and unidentified persons (UP). NamUs is a free online system that can be searched by medical examiners, coroners, law enforcement officials and the general public from all over the country in hopes of resolving these cases (Vivian, 2011).

This repository was launched in January, 2009 as a tool for storing, managing and comparing missing persons' cases (Vivian, 2011). NamUs is built on technology that has the ability to automatically search MP records against UP records to find any matches. Any records containing a match are forwarded to the investigator in charge of the case. This narrows down the amount of time that would be spent by agencies in solving cases (Vivian, 2011). The NamUs advanced search page allows one to filter cases by specific criteria (NamUs, 2017).

Through NamUs, one can share details of the MP record through printing a poster or sharing through email. Different law-enforcement agencies and the public can collaborate on NamUs to solve missing persons' cases. Law-enforcement agents and the general public can search the system, create new cases or update any new information regarding a case. However, any information entered by a member of the public has to be verified before being updated (NamUs, n.d). Authorized users have access to free forensic services such as fingerprint and DNA analysis making the database a powerful tool.

NamUs has a feature that provides instant and secure sharing of case information between any of the law-enforcement agencies in the event that a case match is found. These details are shared to the agents, through timely email alerts. The inbuilt security protocols prevent the general public from viewing sensitive case information (NamUs, n.d).

Since NamUs was launched in 2009, there have been over 24,000 cases of missing persons reported in the MP database (NamUs, 2017). NamUs has been key in solving at least 12% of these cases as shown in Table 2.1 (NamUs, 2017).

MISSING PERSON CASE BREAKDOWN

TOTAL CASES	24902	
OPEN CASES	12828	51.51%
CLOSED CASES	12074	48.48%
NAMUS AIDED	1535	12.71%

Table 2.1: Latest NamUs Statistics

Source: NamUs, 2017

2.3.2 United Kingdom Missing Persons Bureau

An average of 838 cases of missing persons is recorded daily by the police in England, Wales and Scotland (National Crime Agency, 2014). This translates to a rough estimate of slightly over 300,000 cases in a year. If a missing person is not found within 72 hours of being reported, the police share the information with the Missing Persons Bureau. This is the national and international point of contact for all missing people and unidentified body cases in UK (Coletta, 2012).

The Missing Persons Bureau receive about 1000 cases in a month and assist in profiling each case using data from the previously filed cases (Coletta, 2012). Through analysing previous cases, they are able to derive patterns and give the police tips on how to handle current cases (Coletta, 2012).

Their cases are open to the general public who can make use of their advanced search tool. A sample of the search tool can be seen in Appendix E (Missing Persons Bureau, 2017)

to find their missing loved ones. The public is encouraged to review the cases and offer any details that will maximise the chances of identification.

This website provides a centralised point for the public to review missing persons' cases and contribute to the success of finding them quickly and unharmed. The search tool allows for one to perform refined searches that will reduce duplicity of the results.

2.4 Reporting Missing Persons in Kenya

Just like the rest of the international world, the first thing to do when a loved one goes missing in Kenya is to file a report at the nearest police station. The complaint is filed and booked in the Occurrence Book (OB) and given an OB number as a reference number. However, this is where the similarities end. There is no centralised database through which the police authorities and public can work together to solve cases of missing persons. There are also no defined laws that outline how MP cases are to be handled by the police (Sum, 2014). The MP case files are forwarded to the CID who are legally tasked to handle such cases. Most police officers in the local stations are reluctant to assist with MP cases forcing the public to take matters into their own hands.

There are a number of organisations in Kenya that provide free social media services to spread the word about MPs. Interestingly, they all focus on children under the age of 18. They include:

2.4.1 The Child Welfare Society of Kenya (CWSK)

This is a state corporation that was established through a Gazette notice in 1955. Its mandate includes the care, protection, welfare and adoption of children. It's also the National Emergency Response for children in Kenya. In 2014, President Uhuru Kenyatta signed a legal notice turning CWSK into a Government agency (PSCU, 2014). The organisation runs an online database holding details of children who are lost and found and currently residing in their shelters (PSCU, 2014). They also post photos and information of children reported as missing.

Their database has minimal functionality and interactivity. One can click on the children's photos to enlarge them and read more information such as their age and where they were found.

The public can also put up a photo of a missing child if they are not already in the database. One is expected to upload the child's name, description, recent photo and a phone number through which they can be contacted to clarify the information. The uploading interface on the website can be seen in Appendix E.

2.4.2 Kenya Missing and Unidentified Persons (KMUPS)

KMUPS was a community-based organisation launched in May 2012 that assisted families to locate their missing or unidentified persons including runaways who may be facing abuse (Techmoran, 2013). This was a service that they offered free of charge without discrimination (Techmoran, 2013).

They made use of the huge numbers of Kenyans using social media, over 5 million according to the latest statistics published by Internet World Statistics, to push their agenda of sharing details of MPs on Facebook and Twitter. The organisation depended on volunteers to report any MP sighted so that they could upload the details onto their Facebook Page (Techmoran, 2013). They have at least 9,000 likes on their Facebook page and over 13,000 followers on Twitter. The organisation relied on donations from well-wishers to keep it running (Techmoran, 2013). They accepted all kinds of donations from money to manpower to distribute flyers.

KMUPS closed shop at the end of 2016 when the CEO relocated to USA.

2.4.3 Missing Child Kenya (MCK)

MCK was born in early 2016 when a group of six women became overly concerned at the increase in cases of missing children being reported (Simbasafe Kenya, n.d). It is best described as a central place through which the Kenyan public can communicate about their missing children thanks to time, money and resources from amazing selfless digital citizens and organisations who want to create safe communities for children in Kenya (Simbasafe Kenya, n.d). Their main tool of communication is a standardised poster that can be customised to display a missing child's photo and core details such as name, nicknames and area they were last seen at.

The team creates personalised posters for each child reported as missing at no cost. They then share across their social media accounts including Facebook, Twitter, WhatsApp and Telegram.

In case of a lost and found child taken to a police station, the caseworkers liaise with the police officers to reconnect the child with their family.

The organisation recently got funds from a well-wisher to put up a noticeboard outside the Children's' Court at Milimani Law Courts in Nairobi. This is another platform through which they share posters of unsolved MPs.

2.5 Review of Existing Mobile Technology Solutions

There are a number of mobile applications that are freely available on the Google Play Store and/or Apple App Store. This study sought to examine the most popular applications developed by law enforcement authorities for tracking MPs.

2.5.1 FBI Child ID Application

The FBI developed a free application in 2011 that can store photos and vital information about a user's children so that it is easily accessible in case it is required (Federal Bureau of Investigation, n.d). The application is available on both Google and Apple online stores.

The application stores physical identifiers of the children like weight, height, and date of birth (Federal Bureau of Investigation, n.d). The application also has the ability to store photos of your child's birthmarks or scars (Federal Bureau of Investigation, n.d). Your child's profile on the application can be updated as often as possible to ensure that the information is up-to-date. This information can be quickly shared through e-mail to the police at the click of a button. This information is not stored by the FBI giving the parents some control in how their children's information is accessed (Federal Bureau of Investigation, n.d). However, the FBI will store the information sent to them when a parent reports their child as missing.

The application also has tips on keeping children safe and what steps to take in case your child goes missing.

2.5.2 Missing Person Application

The Missing Person application focuses on reporting missing people in the UK and Europe (Google Play Store, 2017). Anyone who has the application installed on their mobile device can view each individual missing person reported on the application. The application has three main tabs: home, news and sightings. The home page shows a list of reported missing persons that is scrollable. Each case contains contact details through which a person can communicate with whoever created the record as shown in Figure 2.14 (Google Play Store, 2017). The application allows one to take a photo of the missing person who has been sighted for uploading. Any sightings reported are mapped to show the location of the sighting (Google Play Store, 2017).

2.6 Review of Mobile Application Development Technologies

This section will review advantages of mobile application over mobile websites. A comparison will be drawn between the two concepts to clearly bring out the benefits of using a mobile application.

- Mobile (responsive) Website

A mobile (responsive) website is one that has been designed to fit all types of screens from desktop, tablet to smartphone. A mobile website is accessed from the mobile device's browser using the website's URL (Eldar, 2015). This works across all devices and doesn't require prior submission to any application store.

- Mobile Application

A mobile application is designed specifically for mobile devices only (smartphones and tablets only). A mobile application has to be downloaded from an application store and installed for the user to access it (Eldar, 2015). Mobile application can get access to the mobile device's camera, photo library and contacts. They can also have push notifications and GPS enabled. They can be accessed offline.

Based on the requirements for an effective missing persons' application, a mobile application would be a better solution since it has more functionality that can be made available to the application users.

2.7 Challenges Identified in Existing Systems

NamUs and Missing Persons' Bureau are powerful tools that implement technology to centralise reporting of missing persons in USA and UK. Combined with the FBI Child ID and Missing Person applications, USA and UK have a centralised, well-structured reporting system starting from the police stations. These tools are however limited to their respective countries.

This chapter makes it clear that there is lack of centralised reporting system that handles missing persons' records in Kenya. Police records in Kenya's police stations are collected in the traditional, manual format resulting in fragmented information that is not shared easily to the other police stations. This makes it difficult to track any progress made in reported cases of missing persons. Missing Child Kenya and Child Welfare Society of Kenya work independently and focus on children under the age of 18. In the unfortunate event that a person older than 18 goes missing, the police stations and traditional media are the only available channels that can be used to report the incident.

A reporting system that can replicate the powerful nature of NamUs and introduce a mobile application to access and share missing persons' records is needed to fill in this gap created by the existing solutions.

2.8 Summary

Globally the law enforcement authorities have made great strides in implementing web and mobile technologies to consolidate MP reports. Having a centralised, publicly accessible database for reporting missing persons is significant in increasing the success rate of finding missing persons. It is also commendable that the FBI have developed a simple yet robust application that allows parents to store and continuously update their children's information.

Unfortunately, this research has revealed that in Kenya, the reporting system is not centralised and only a few concerned organisations are attempting to make use of social media to improve the efficiency of tracking a MP in the country.

Despite the well-placed efforts, there is still need for a more centralised platform that gives the public more control in putting up reports of their missing loved ones. There is also

need for more accurate statistics to be collected as a way of effectively informing future actions by the involved stakeholders.

A mobile phone application that can store a person's details and provide functionality for generating a missing person's alert would be beneficial in the Kenyan scene. Such an application should also be able to collect GPS data of any sightings reported to increase the effectiveness. The application should also allow users to view profiles of reported cases and share the details on their social media accounts. Recording statistics of the cases and sharing them publicly will encourage public participation. Such a solution would provide much needed centralisation and transparency as seen in the reviewed global systems.

Chapter 3 : Research Design and Methodology

3.1 Introduction

Proper research and design methodology must be undertaken to describe how each research objective for this study will be fulfilled. The results from this analysis guided the mobile development and testing phases to ensure that an application that effectively reports and tracks missing persons was developed.

This chapter sought to clarify how to identify the challenges faced by the current systems of reporting missing persons in Kenya. It also sought to identify the most appropriate methodology to be used to undertake comprehensive system analysis and design.

3.2 Review of Current Reporting Systems in Kenya and Globally

It was imperative to study in depth the existing systems used to report and trace missing persons in Kenya. The results of this study determined the necessity of the proposed solution. This research objective was fulfilled in depth in the Literature Review (Chapter 2).

3.3 Mobile and Web Application Design, Development and Testing

This objective of mobile application development was achieved using the iterative model of Software Development Lifecycle (SDLC). A mobile application with a robust web backend was identified as a solution to the existing gaps in the literature review.

The SDLC is a series of well-defined, structured stages in software engineering used to develop a software product (TutorialsPoint, 2017). It provides a series of steps that should be followed to design and develop a software product efficiently (TutorialsPoint, 2017). There are different types of SDLC frameworks designed to suit certain scenarios. This study made use of the iterative model of software development.

The iterative model implements incremental development cycles scheduled to last two weeks per cycle (AgileMethodology, 2017). The study preferred this SDLC because it provided opportunities to assess the direction of a project throughout the entire lifecycle (AgileMethodology, 2017).

The mobile application was initially developed on very small scale incorporating very general and basic functionality. At the end of this iteration, the developer met with the

supervisor to assess progress and determine what to implement next. Incrementally, all new iterations incorporated more features and modules designed, coded, tested and added to the software. Every cycle produced an improved version of the software, which was complete in itself and had more features and capabilities than that of the previous one as shown in Figure 3.1.

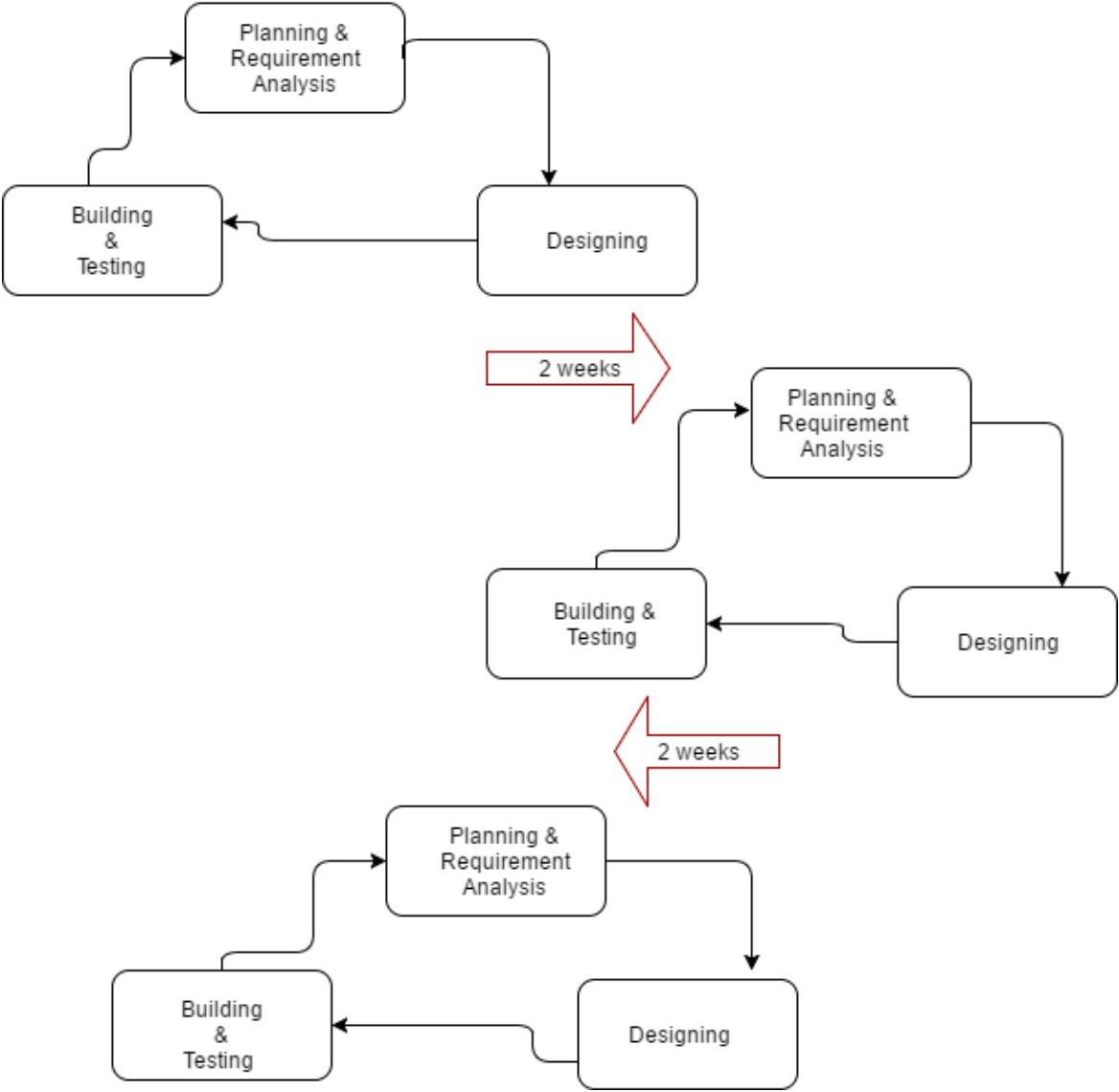


Figure 3.1: Iterative Model Phases

3.3.1 Planning and Requirement Analysis

It was important for the study to capture user opinions of the shortcomings of the current system of reporting missing persons in Kenya. To collect this feedback, a survey was developed at the planning phase using Google Forms and sent out to a list of 50 people in the researcher's mailing list. A copy of this survey can be found on Appendix A. These people were chosen because they are Internet-savvy and familiar with Google Surveys. The researcher opted to use a Google Survey because it is a free tool that directs results into a shareable spread sheet (Randall, 2015). It is easier to prepare and disseminate compared to traditional surveys prepared using Microsoft Office Word. The results of the survey are also easy to collect and analyse through a Google Sheet,

The results informed the requirement analysis as the respondents clarified what kind of mobile application would satisfy the shortcomings of the existing systems of handling missing persons' reports. During iteration, reference was made to the results of the data collected to correctly inform the SDLC.

At the requirements analysis phase, client expectations were clearly brought out in a simple table. The functional and non-functional requirements of the proposed solution were also tabled down.

3.3.2 Designing Phase

In this phase, physical and logical design of the mobile application was constantly refined using Use Case Diagrams and descriptions, Sequence Diagrams and Entity Relationship Diagrams. These diagrams were modelled using Unified Modelling Language (UML) notation.

A Use Case Diagram is used to describe a set of actions that the system should perform in collaboration with one or more external actors (Bell, 2004). A Use Case Diagram was drawn to depict the major actions that would be performed by the mobile and web applications. A Use Case description was used to expound on the major use cases depicted in the whole use case diagram.

A Sequence Diagram is used to show the interactions between objects in the sequential order that those interactions occur (Bell, 2004). A Sequence Diagram was drawn to depict the interaction of mobile application with the database.

A database schema lays down the conceptual view of the database to be used (TutorialsPoint, 2017). The database schema was drawn to depict how information would be stored in the database.

Wireframes were used to conceptualise and design the graphical layout of the mobile and web applications. The wireframes were developed using a tool called Justin Mind (justinmind.com).

All these diagrams were created by an online tool found at creately.com.

3.3.3 Building Phase

The logical diagrams were used a basis for actual coding of the application. The mobile application was developed using Android (android.com), which is an open-source coding platform. Android is well-structured and easy to set-up, implement and integrate (Siby, 2011). It was first unveiled in 2007 (Rishabh Software, 2014). The Software Developer Kit (SDK) is provided freely on its' website and the community is very active and robust (Rishabh Software, 2014). Such an application is interactive and can hold and display an image, which is a core requirement of the proposed solution. Location-based functionality was also implemented to improve the functionality of the mobile application.

Since Android is scripted in Java with the help of a rich set of libraries, anyone who understands Java can easily develop Android based mobile applications (Soffar, 2015).

The back-end of the proposed solution was developed as a web application using:

- Bootstrap (getbootstrap.com), which is an open-source framework for creating mobile responsive websites. It combines HTML, CSS and JavaScript in one platform. It was used to design the look of the web pages.
- Xampp (apachefriends.org), which is a cross-platform web server solution stack package. It was used to store data on the backend.

- MySQL (mysql.com), which is an open-source relational database management system. It was used to communicate with the back-end's database.

The software used was entirely open source because the researcher had limited funds available.

3.3.4 Testing Phase

To comprehensively test the developed mobile application, the code written was subjected to the following types of tests after each building phase:

- Performance testing to ensure that the application was battery efficient and made use of storage efficiently. The mobile application was installed in 5 different devices and run for one week on each device to monitor storage and battery usage.
- Functional testing to confirm that the application worked as required when started and that data validation was implemented. This was tested by 10 administrators from Missing Child Kenya using test cases prepared by the researcher.
- Usability testing to confirm that the Graphical User Interface (GUI) was user friendly and easy to navigate. This was tested by 10 administrators from Missing Child Kenya, which is one of the Kenyan social media groups reviewed in the Literature Review (Chapter Two), using test cases prepared by the researcher.

The main objective of testing was to identify and correct the following areas:

- Application installation failure.
- Application crash during execution.
- Layout issues.
- Application hanging due to some resource being unavailable.

3.4 Mobile and Web Application Validation

Once the mobile application was developed and tested, it was sent to 10 administrators at Missing Child Kenya and 2 administrators from MumsVillage Kenya. They were given a system validation questionnaire to complete as they explored the developed mobile

application. The researcher designed this questionnaire and a copy can be found in Appendix C.

The feedback from the administrators was analysed to determine the usability and performance of the mobile application in a real-life situation. The feedback was also used to determine whether the application fulfilled the research objective of being an effective tool for reporting and tracing of missing persons in Kenya.

3.5 Summary

Research methodology is core to the success of the study. This process ensured that the data collected from the literature review and online survey would be interpreted accurately to generate the user requirements. Implementation of the iterative method of development ensured that no user requirement was overlooked in the final version of the mobile application. The end result of this process was a well-supported mobile application that would effectively improve the current system of reporting missing persons in Kenya.

Chapter 4 : Planning and Requirement Analysis

4.1 Introduction

As a way of comprehensively understanding the end users' requirements, a Google Survey was prepared and sent out to a mailing list of 50 people. The researcher based on user's familiarity with Google Apps curated this mailing list. The users include people involved with Missing Child Kenya and mothers who are highly invested in their children's safety. The researcher chose these people as they are likely to make use of any tool available to trace a person who is missing. The Google Survey linked the results into a spreadsheet for further analysis.

Following on the feedback collected, the researcher broke down both user and system requirements to fully capture what should be included in the mobile phone application. This was a key pre-requisite to the system design covered in Chapter 5.

4.2 Planning

Planning is the act of deciding how to do something (Cambridge Dictionary, 2017). The researcher executed the planning phase by designing a Google Survey to collect feedback from end users. The feedback would be used to inform what kind of features would be incorporated in the mobile phone application. This was the starting point of developing the proposed mobile phone application.

4.2.1 Google Survey Feedback Discussion

These are the analysed findings based on the 34 responses from the survey that the researcher received:

a) Respondents who are familiar with the reporting procedure.

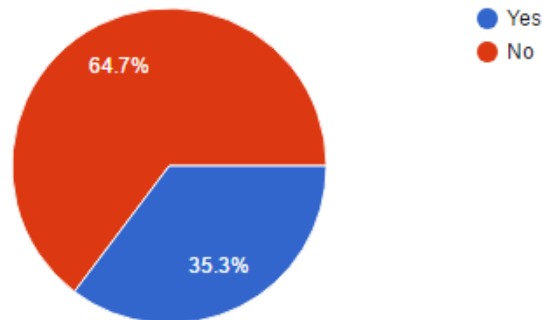


Figure 4.1: Respondents Who Are Familiar with the Reporting Procedure

Only 12 respondents (35.3%) were familiar with the reporting procedure as shown in Figure 4.1. This proved that including information of the reporting procedure as well as contacts to all police stations in Kenya would add great value to the proposed solution.

b) Respondents whose reported missing person was found

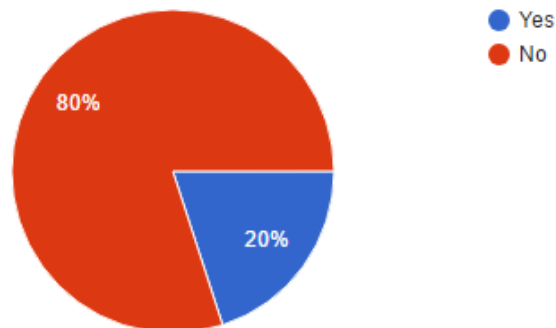


Figure 4.2: Respondents Who's Reported Missing Person Was Found

Only 20% of respondents found the missing person after reporting to the police station as shown in Figure 4.2. The high failure rate of finding the missing persons shows the need for an alternative solution to the current reporting system.

c) Respondents who feel their loved one was found as a result of reporting to the police station

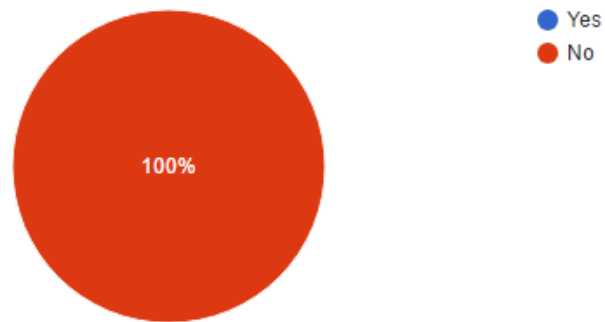


Figure 4.3: Respondents Who Feel Their Loved One was Found As A Result Of Reporting to the Police Station

Out of the four respondents who found their missing person, none attributed this success to the current reporting system at the police station. This is shown in the results in Figure 4.3. This further proves that the current system has a huge gap that can be filled using the proposed mobile solution.

d) Respondents who believe the application will increase effectiveness of finding missing persons

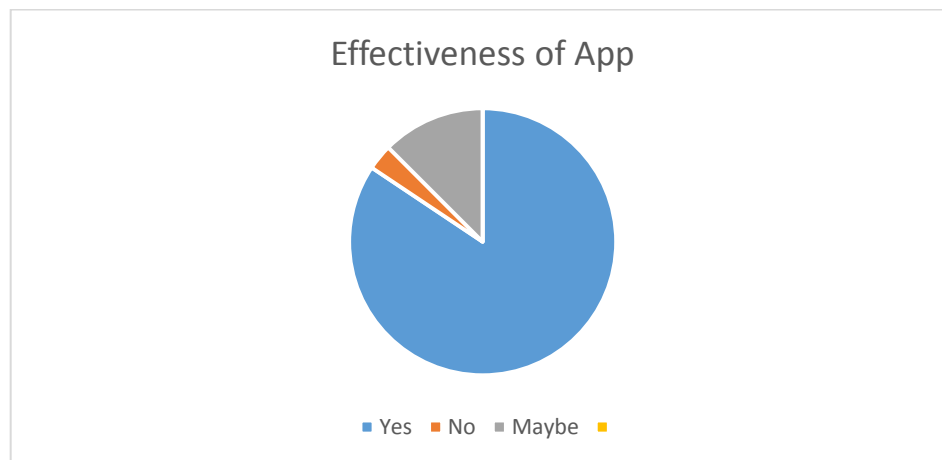


Figure 4.4: Respondents Who Believe the Application Will Increase Effectiveness of Finding Missing Persons

Figure 4.4 shows that 17 respondents agreed that the proposed solution when implemented properly would be increase effectiveness of the current system. 4

respondents were not certain of the effectiveness of the proposed solution. This proved that the proposed solution would increase the effectiveness of the current system.

e) Respondents who would download and use a free reporting mobile application

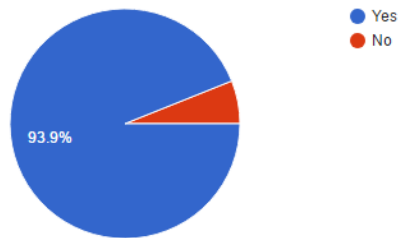


Figure 4.5: Respondents Who Would Download and Use A Free Reporting Mobile Application

96.2% of the respondents would evidently download and make use of a mobile application for reporting and tracing missing persons if made available as shown in Figure 4.5. This data provided further support to the proposed solution if deployed as a freely downloadable mobile application.

f) How much the respondents would pay for the mobile app

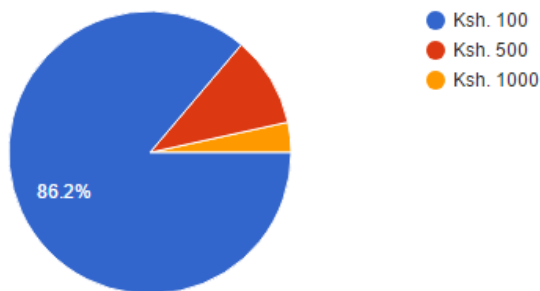


Figure 4.6: How Much the Respondents Would Pay for the Mobile App

86.2% of respondents would pay Ksh. 100 for this mobile application as shown in Figure 4.6. This gave the researcher an idea of how much to price the application if it was to generate revenue.

g) Respondents who own a smartphone

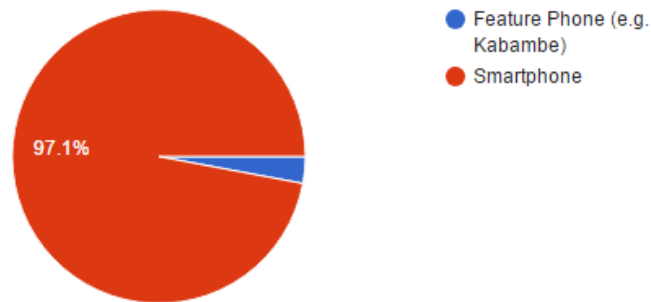


Figure 4.7: Respondents Who Own a Smartphone

97.1% of the respondents own smart phones as shown in Figure 4.7. This provided justification for employing a smart phone-based mobile application for reporting and tracing missing persons.

h) Respondents whose smart phones run on Android

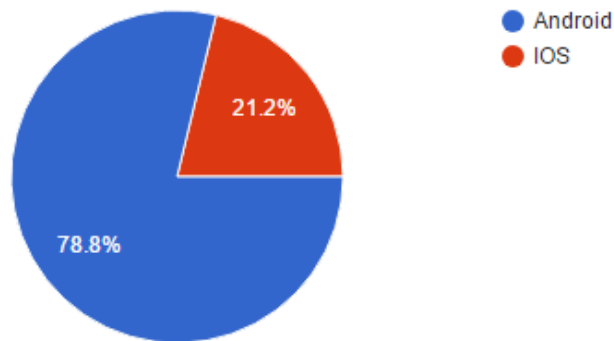


Figure 4.8: Respondents whose Smartphones Run on Android

78.8% of the respondents own a smartphone running on Android as shown in Figure 4.8. This provided justification for choosing Android OS to develop a mobile application for reporting and tracing missing persons.

i) Language that respondents prefer the application to be in

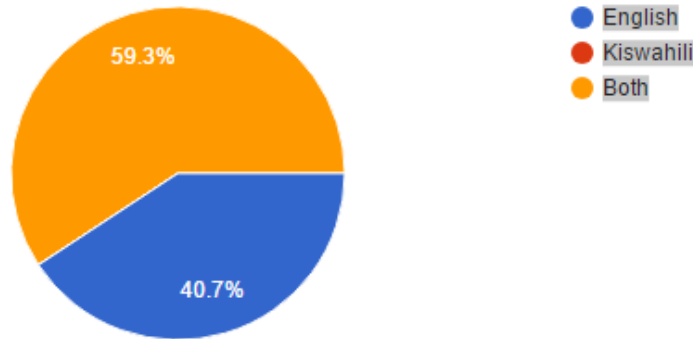


Figure 4.9: Language That Respondents Prefer the App to be In

The results in Figure 4.9 show that 59.3% of the respondents would be comfortable with an application that is in English and Kiswahili. 40.7% of the respondents would prefer an English-only application. This proved that the initial version of the mobile application should be in English and later improved to include Kiswahili.

4.3 Requirement Analysis

4.3.1 Client Expectation

Figure 4.1 shows a simple breakdown of the user needs of each category of clients expected to interact with the proposed mobile application:

User	Information Need from System	Input to system
Loved one	Generate poster of missing person for sharing.	Upload details of missing loved one.
Common mwananchi	Search through list of Missing Person reports.	Upload details of sighting of missing person.
Interested institution(s)	Search through list of Missing Person reports.	Bulk upload of missing persons' records.
Administrator	View statistics of application usage and report analysis.	Manage users of the application.

Table 4.1: Client Expectations

4.3.2 Functional Requirements

The system should accomplish the following functional requirements:

- **Advanced search:** Anyone who downloads the application can browse through the list of reported MPs and make an advanced search based on date or location.
- **Registration:** A user has to register using Facebook or Google authentication to create a new MP record, report a sighting, leave a comment or generate a poster for sharing.
- **Poster generation:** A registered user can download a poster of a MP to share on their social networks.
- **Location and time based sightings:** The application has the ability to record an accurate location based sighting of a recorded MP.
- **Notifications:** The application sends out a notification to all users when a new MP is reported as missing or as found. The application also sends a specific notification to the owner of a MP record if a sighting relating to that record is posted.

4.3.3 Non-Functional Requirements

The non-functional requirements addressed by the proposed mobile and web applications should include the following:

- **Reliability:** The application should exhibit consistent, predictable behaviour that leaves users reassured of its' functionality.
- **Responsiveness:** The application should have minimal latency of under one second to satisfy users (Au, 2014).
- **Uptime:** The percentage of application load cycles that don't crash should be greater than 99% (Au, 2014).
- **Security:** The application's databases should be able to withstand any malicious attacks directed at them.

- **Robustness:** The application should complete its transactions to safe states so that the database can maintain its consistency and not save incomplete values.
- **Ease of use:** The mobile application and web backend should be simple to use without requiring a high learning curve as they will be accessed by people of all ages who might not be necessarily tech-savvy.

4.4 Summary

The findings from the Google Survey employed by the researcher showed that 97.1% of respondents owned a smartphone, out of which 78.8% owned a smartphone running on Android OS. This data provided a good basis for developing a mobile phone application running on Android as it would be easily accessible by majority of Kenyans.

None of the respondents attributed finding the missing persons to the effectiveness of the current reporting system at the police stations. This proved that there was a gap in the current system that could be filled by development and deployment of a mobile phone reporting application.

The responses from the survey illuminated the challenges faced by the current system and provided a viable solution to the existing problem; an Android mobile phone application for reporting and tracing missing persons in Kenya.

The researcher used the findings from the survey to conduct an analysis of the user requirements. The researcher further analysed the functional and non-functional requirements of the proposed mobile application for reporting missing persons. This was a key activity that informed the system design phase.

Chapter 5 : System Designing

5.1 Introduction

The design phase is an important prerequisite to actual coding of the proposed mobile application. The proposed system's functional components will be illustrated through the use of a use case diagram, sequence diagram, entity relationship diagram and database dictionary. This will enable the researcher to design and develop a system with complete and correct functional operations as captured in the results of the user survey. It will also increase user acceptability of the system if done properly.

5.2 System Design

The analysis and design of the proposed solution assisted in allocating functions to the system components. The deliverable was the following analysis and design components. Object Oriented Analysis and Design methodology was employed.

5.2.1 Use Case Diagram

A use case diagram was drawn using creately.com to identify the following aspects of the proposed system:

- The functional requirements of the proposed system.
- The actors that will interact with the system.
- Any internal or external factors that may influence the system.

The final use case can be seen in Figure 5.1:

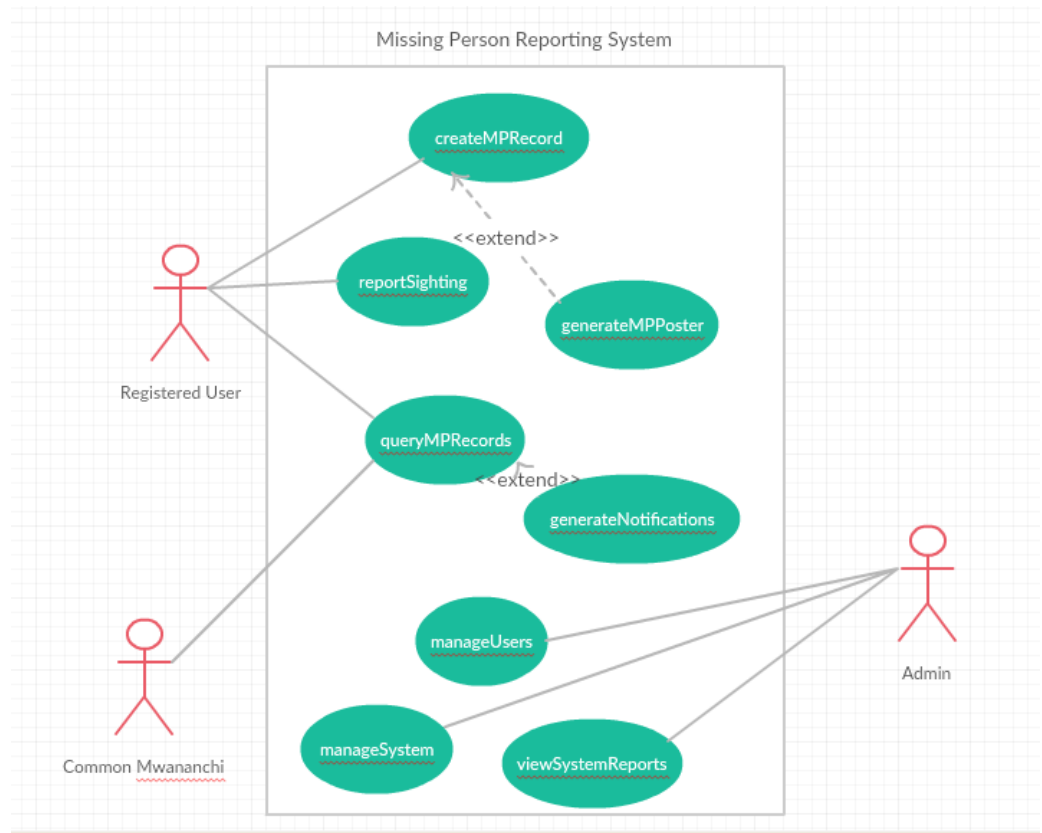


Figure 5.1: Use Case Diagram

5.2.2 Use Case Descriptions

This use case depicts the functionality of the Missing Persons system using the actors expected to interact with the system.

Use case: createMPRecord()

In expanded, essential, conversational style:

Typical course of events

Actor Intentions

1. Use case begins when application user selects “Create MP record”.
3. User enters login details.

System Responsibility

2. Request for login details
4. Validate login details
5. Display form to be filled.

- | | |
|--|---|
| <ol style="list-style-type: none"> 6. Enter MP details as requested in the form | <ol style="list-style-type: none"> 7. Verify that submitted name and DOB do not match existing records. 8. Record to database 9. Display “MP record saved” |
| <ol style="list-style-type: none"> 10. Selects “Download MP Poster”. | <ol style="list-style-type: none"> 11. Generate MP Poster with saved details. |

Alternatives:

Step 2: If user was already logged in, system should move to step 5.

Step 3: User can login with Facebook or Google authentication.

Step 4: If submitted details are wrong, prompt user to login in again.

Step 7: If submitted MP details match existing records, display these records to user.

Step 1-11: If system experiences delay, application will crash and restart.

Use case: reportSighting()

In expanded, essential, conversational style:

Typical course of events

Actor Intentions	System Responsibility
<ol style="list-style-type: none"> 1. Use case begins when app user selects “Report Sighting”. 3. User enters login details. 	<ol style="list-style-type: none"> 2. Request for login details 4. Validate login details 5. Display form to be filled.
<ol style="list-style-type: none"> 6. Enter location details of the MP sighted as requested in the form 	<ol style="list-style-type: none"> 7. Record to database 8. Send notification to owner of MP record. 9. Display “Sighting details saved”

Alternatives:

Step 2: If user was already logged in, system should move to step 5.

Step 3: User can login with Facebook or Google authentication.

Step 4: If submitted details are wrong, prompt user to login in again.

Step 1-11: If system experiences delay, application will crash and restart.

5.2.3 Operation Contract

Contract – sendSightingNotification

1. Operation:

sendSightingNotification()

2. Cross reference:

Use case: Report Sighting

3. Preconditions:

Sighting was saved on app database.

4. Post conditions:

Notification of a sighting sent to user's application instance.

Contract – closeCase

1. Operation:

closeCase()

2. Cross reference:

Use case: Close Case

3. Preconditions:

Close case instance was started.

4. Post conditions:

Record status changed to “closed” on database.

5.2.4 Sequence Diagram

This sequence diagram in Figure 5.2 models how the system behaves when an application user is creating a new MP case record.

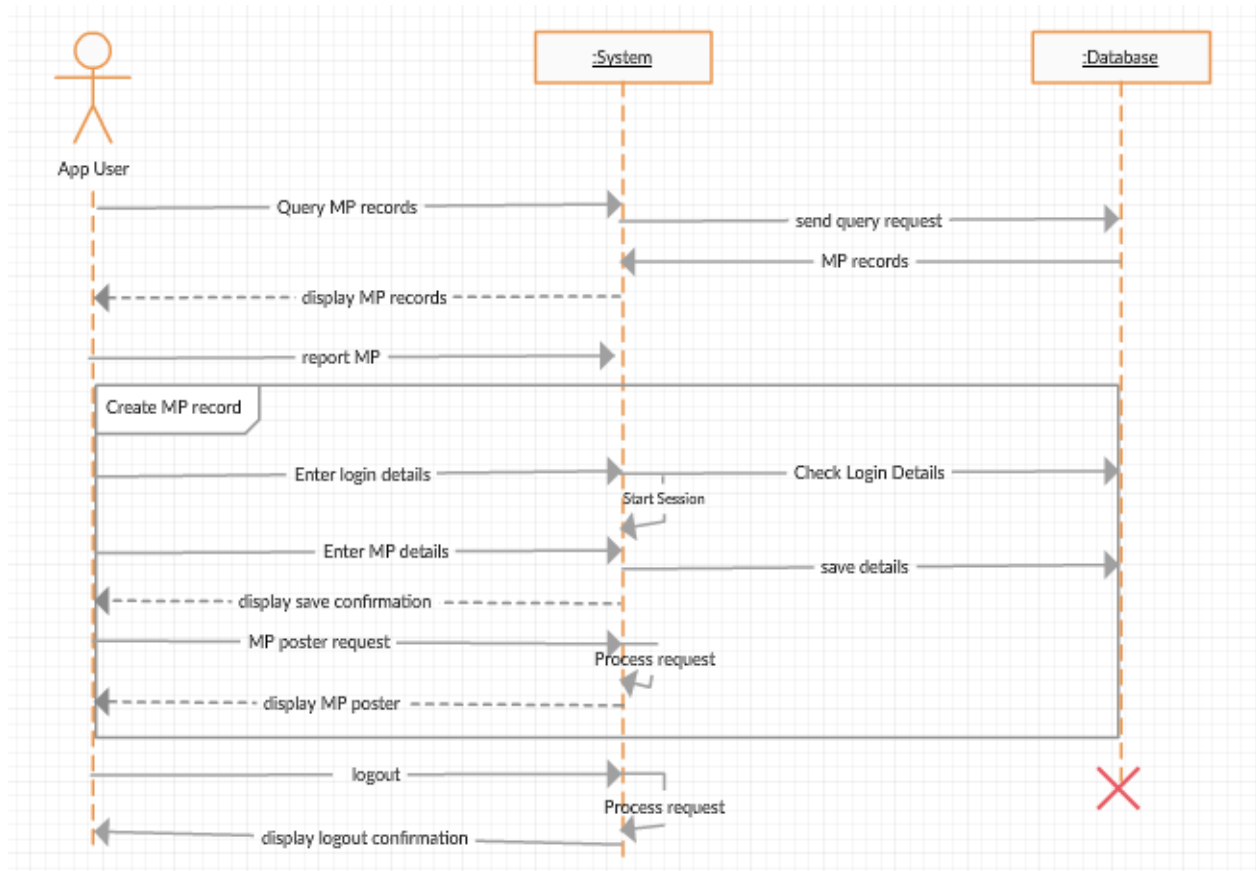


Figure 5.2: Sequence Diagram

5.2.5 Database Schema

This database schema in Figure 5.3 shows how the information generated by the application system will be stored in the database.

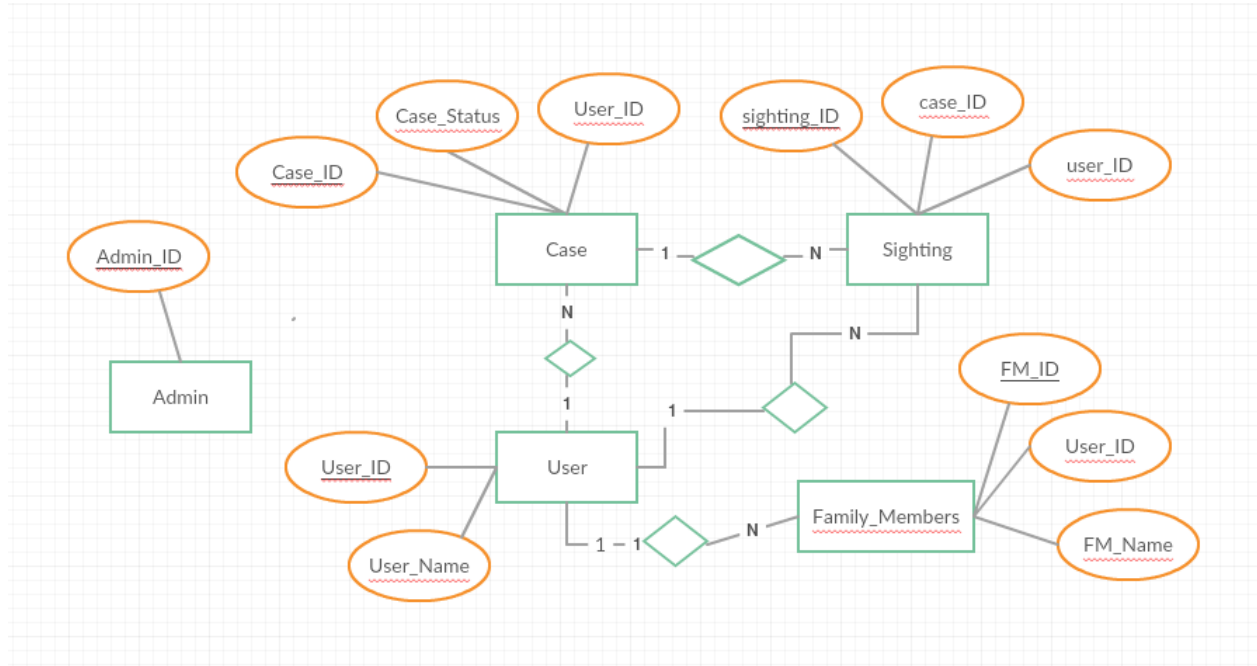


Figure 5.3: Database Schema

The entities listed in the database schema are described in the Table 5.1 below:

Case	This is a record of a missing person created by a user.
Sighting	This is a report of a missing person’s location as reported by a user.
User	This is an entity whose details are registered in the application’s database and can access the application.
Family Member	This is a record of a person’s details saved by a registered user to make it easier to share in case they go missing.
Admin	This is an entity that has CRUD rights and can generate system reports.

Table 5.1: Entities’ Key

5.2.6 Database Dictionary

The fields in the database schema were expounded further in Table 5.2, Table 5.3, Table 5.4, Table 5.5, and Table 5.6.

Admin Table

FIELD NAME	DATA	TYPE DESCRIPTION
Admin_Id	Int (25)	Primary Key (NOT NULL)
Admin_Name	Varchar (50)	NOT NULL
Admin_Pwd	Varchar (50)	NOT NULL

Table 5.2: Admin Table

User Table

FIELD NAME	DATA	TYPE DESCRIPTION
User_Id	Int (25)	Primary Key (NOT NULL)
User_Name	Varchar (50)	NOT NULL
User_Email	Varchar (50)	NOT NULL
User_Pwd	Varchar (50)	NOT NULL

Table 5.3: User Table

Case Table

FIELD NAME	DATA	TYPE DESCRIPTION
Case_Id	Int (25)	Primary Key (NOT NULL)
Case_PName	Varchar (50)	NOT NULL
Case_Nickname	Varchar (50)	NOT NULL
Case_DOB	Varchar (50)	NOT NULL
Case_Birthmarks	Text (250)	NOT NULL

FIELD NAME	DATA	TYPE DESCRIPTION
Case_Home	Varchar (50)	NOT NULL
Case_Last_Seen	Varchar (50)	NOT NULL
Case_Last_Wearing	Text (250)	NOT NULL
Case_Photo	Varchar (50)	NOT NULL
Case_OB*	Varchar (50)	NOT NULL
Case_ContactOne	Varchar (50)	NOT NULL
Case_ContactTwo	Varchar (50)	NOT NULL
Case_Status**	Varchar (50)	NOT NULL
User_ID	Int (25)	Foreign Key

Table 5.4: Case Table

Sighting Table

FIELD NAME	DATA	TYPE DESCRIPTION
Sighting_Id	Int (25)	Primary Key (NOT NULL)
Sighting_URL ***	Varchar (50)	NOT NULL
Case_ID	Int (25)	Foreign Key
User_ID	Int (25)	Foreign Key

Table 5.5: Sighting Table

Family Members Table

FIELD NAME	DATA	TYPE DESCRIPTION
FM_Id	Int (25)	Primary Key (NOT NULL)
FM_Name	Varchar (50)	NOT NULL
FM_Nickname	Varchar (50)	NOT NULL

FIELD NAME	DATA	TYPE DESCRIPTION
FM_DOB	Varchar (50)	NOT NULL
FM_Birthmarks	Text (250)	NOT NULL
FM_Home****	Varchar (50)	NOT NULL
FM_ContactOne*****	Varchar (50)	NOT NULL
FM_ContactTwo	Varchar (50)	NOT NULL
FM_Photo	Varchar (50)	NOT NULL
User_ID	Int (25)	Foreign Key

Table 5.6: Family Members' Table

Table 5.7 provides a key to some fields in the above database tables.

Case_OB*	The OB (Observation Book) number assigned by the Police Station where the case is officially reported. It is mandatory to have it according to Kenyan law.
Case_Status**	The case can be open/closed. Cases whose status is closed will not appear on the mobile application.
Sighting_URL ***	The Google Maps URL of the place where the MP was reportedly seen.
FM_Home****	The home address of the family member listed in the user's profile.
FM_ContactOne*****	A contact address of the family member listed in the user's profile.

Table 5.7: Key to Fields in Database Tables

5.2.7 Mobile Application Wireframes

The mobile application screens (wireframes) were simulated using *Creately*, an online collaboration tool.

The flow of the mobile application screens begins with the Sign In/Sign Up screen which can be found in Appendix D:

Once the user signs in, they will access the home screen shown in Figure 5.4:

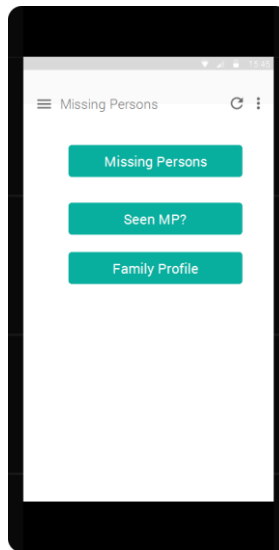


Figure 5.4: Home Screen Wireframe

The user can view the list of missing persons recorded in the mobile application. A user that is not registered can still view the list of people reported as missing but will have to register to report a sighting or contact the owner of the missing person record in the screen shown in Figure 5.5:

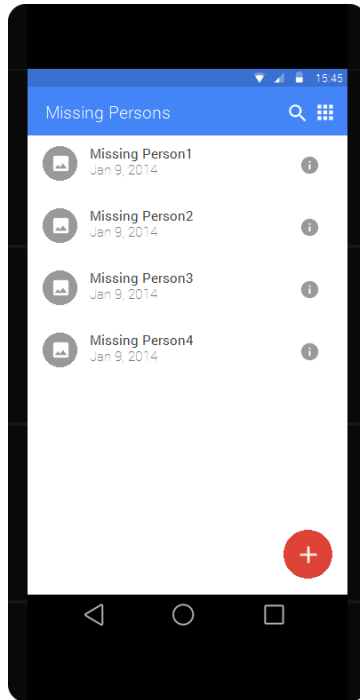


Figure 5.5: Missing Persons' List Wireframe

The missing person's record can be expanded when selected to display more details as shown in Figure 5.6:

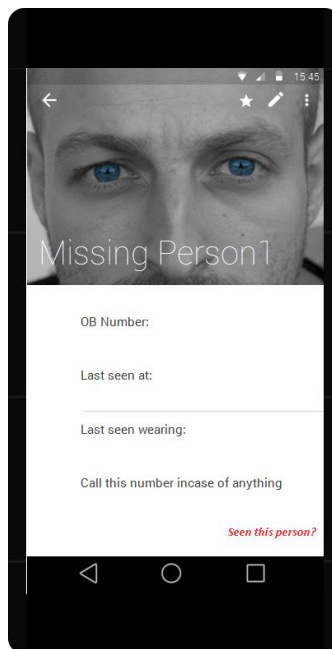


Figure 5.6: Missing Person's Details Wireframe

The registered user can add a new record of a missing person as shown in Figure 5.7:

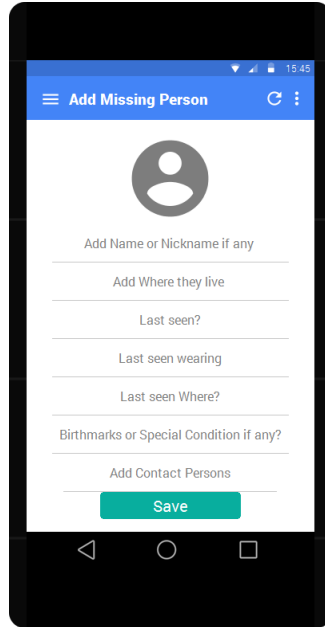


Figure 5.7: Add Missing Person Wireframe

A registered user can also report if they have seen someone listed on the missing person's record by selecting the "Seen this person?" button which will redirect them to this reporting screen shown in Figure 5.8:

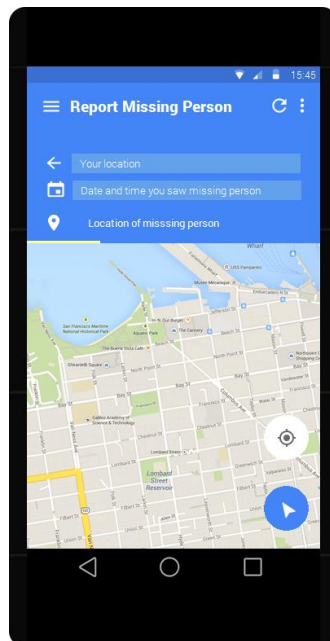


Figure 5.8: Report Missing Person Wireframe

A registered user will be able to sign in successfully but if not registered, the user attempting to sign in will be requested to a Signup screen, which can be seen in Appendix D.

5.2.8 Web Application Wireframes

The system administrators will use the web application to manage access to the applications and generate reports of usage statistics.

A general site map of the web application will look like Figure 5.9:

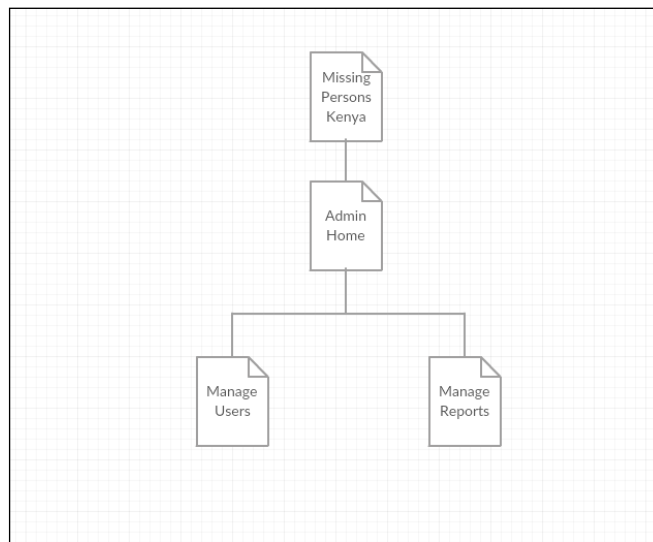


Figure 5.9: Web Application Site Map

The administrator will have to login in order to access the web application's homepage. The login wireframe can be seen in Appendix D.

The homepage will have two tabs that lead to the main functionalities as seen in Figure 5.10.

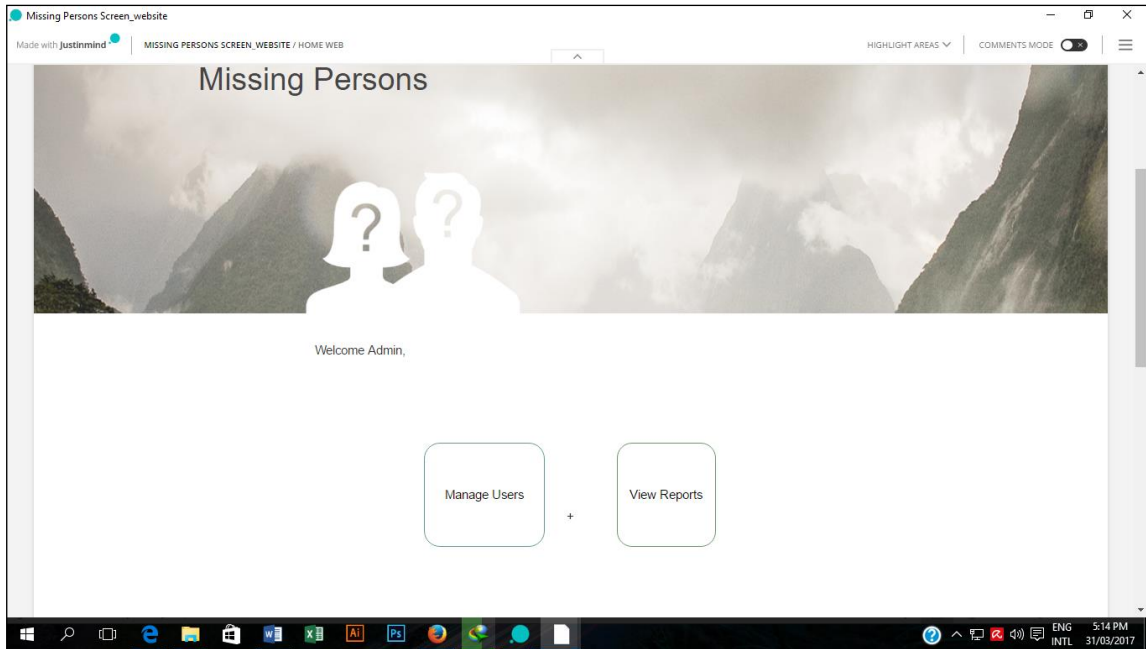


Figure 5.10: Web Application Admin Home Screen

In the Manage Users section shown in Figure 5.11, the admin will view all registered users. The admin will be able to add a new user, flag an existing user or delete a user.

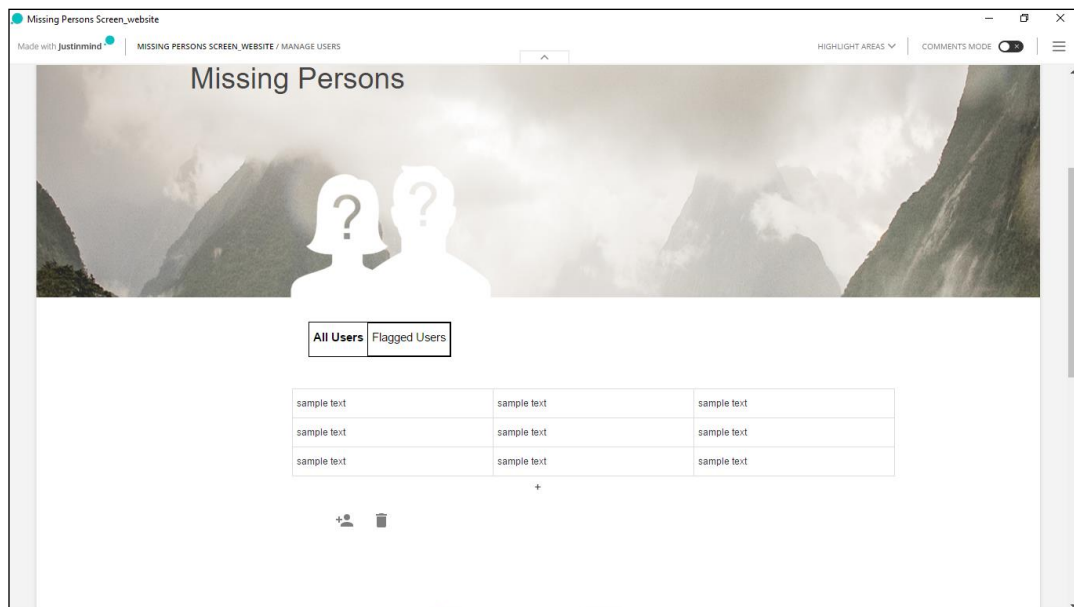


Figure 5.11: Web Application Manage Users Wireframe

In the Manage Reports section shown in Figure 5.12, the admin will view the core numbers of the application. The admin will be able to view how many users have registered in a particular day, the number of uploaded cases in a given day and number of closed cases. All these are reports that will be downloadable.

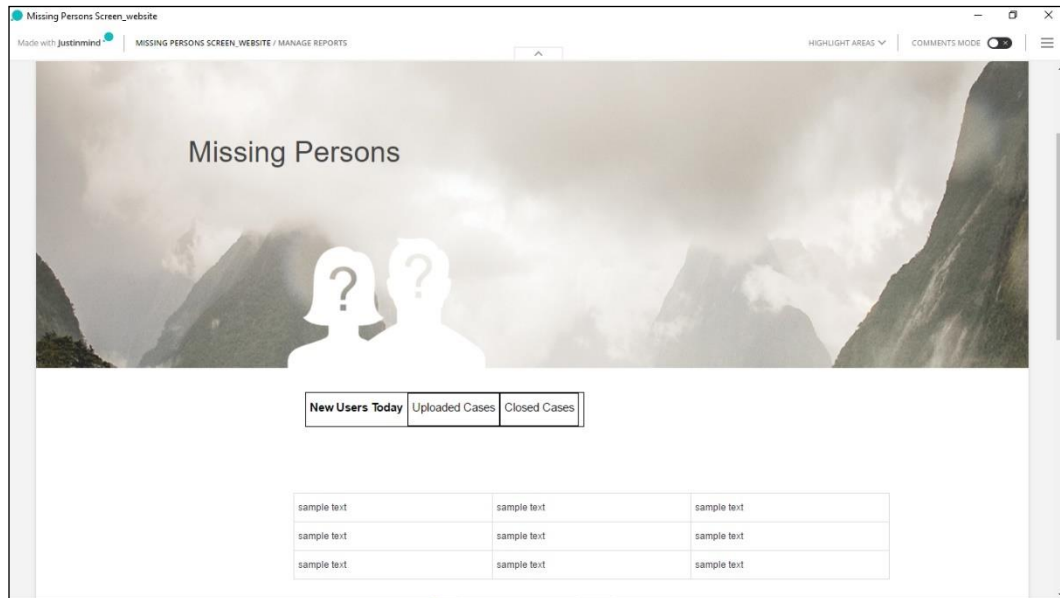


Figure 5.12: Web Application Manage Reports Wireframe

5.3 Summary

The system design process equipped the researcher with a proper understanding of the system architecture. Using a use case diagram, key actors who will interact with the system were identified. The sequence diagram helped analyse flow of messages in the proposed system. The entity relationship diagram identified the main entities and what details would be stored about them in the database tables. All these led to modelling of mobile application wireframes for the mobile and web applications. These steps were key in forming a proper base for the actual mobile and web applications' programming.

Chapter 6 : System Building and Testing

6.1 Introduction

This section provides an in-depth look into the implementation of the web and mobile application solutions designed in the previous chapter. These applications were developed in line with the research objective of developing a mobile application that will improve the efficiency of reporting and tracing a missing person in Kenya.

The mobile application was developed using Android Studio, incorporating location-based reporting of a missing person. The web application provides a backend through which the administrator can generate reports on usage of the mobile application as well as manage the mobile application users. Both applications were subjected to a rigorous testing and validation process to ensure that the objectives of this dissertation were fully met.

6.2 Android Mobile Solution

The Android application was developed using Android Studio. It provides a simple, easy to use but powerful interface through which a user can browse through a dynamic list of persons reported as missing. The mobile application is made up of the following core components discussed below:

6.2.1 Sign Up

For a user to download and share the details of a missing person listed on the mobile application, they have to sign in. This is a deliberate step by the researcher to reduce spammers misusing the data stored in the application.

The registration process requires the user to key in their name, email address and password. After completing the CAPTCHA, the user will receive a confirmation email as the final step in the registration process. After confirmation of their email address, the user can now sign in and access further functions of the mobile application.

6.2.2 Create a Missing Person Record

A user who has signed in can create a new record of a missing person. To avoid duplication of records, the name and birthdays of all records are compared and any matches displayed

to the user for further confirmation. If none of the pre-existing records match the user's record, then they can proceed to save the record.

A registered user can also download the details of the missing person into a graphic poster and share on their Facebook or Twitter accounts. Figure 6.1 depicts the application's home screen. Figure 6.2 depicts the list of missing persons displayed on the application and an expanded record.

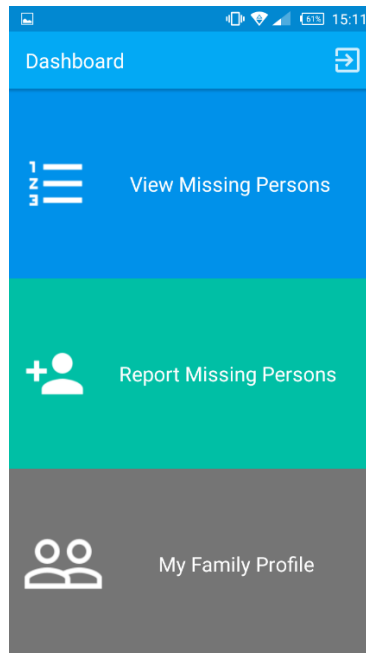


Figure 6.1: Mobile Application Home Screen

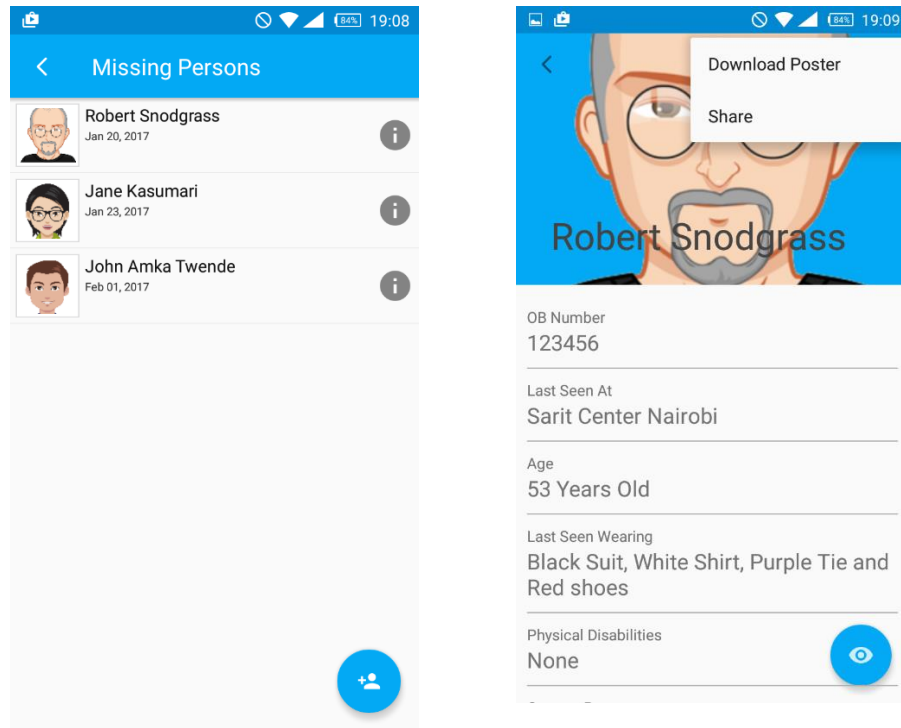


Figure 6.2: Mobile Application Missing Person Record Screen

6.2.3 Share Location and Details of Missing Person

A missing person's record can be expanded to view an enlarged photo and all of their details including their nickname and where they were last seen. If anyone reported seeing the missing person, this information will be displayed too. A registered user can report seeing the missing person by selecting the location on the provided map as shown in Figure 6.3. This location is saved as a URL on the database and updated on the application's map.

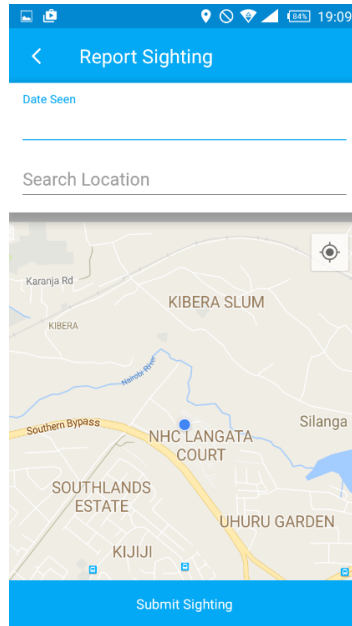


Figure 6.3: Mobile Application Report Sighting

6.2.4 Close a Missing Person's Record

Once a Missing Person reported on the application is found, the owner of the record should close the record to remove it from view. This is designed to keep the list of missing persons up-to-date and relevant. However, the closed record is not deleted to maintain data integrity and the owner can reopen the case in case of any future changes.

6.2.5 Store Details of Close Family Members and Friends

A registered user can save details of close family members including recent photos as a precaution. This information is private and accessible by the user only. If the family member goes missing, the user can publish this information on the application publicly as a missing person.

6.2.6 Store Contact Details of Police Stations in Kenya

Based on the feedback from the questionnaires, the researcher opted to add this functionality as a value addition of the mobile application.

6.3 Web Backend Solution

The web backend was designed to give the system administrator access to the usage activities of the mobile application. The administrator can view statistics of reported cases and registered users. The home page of the web back end is shown in Figure 6.4



Figure 6.4: Web Application Home Screen

The administrator can flag users with suspicious activities and update contacts of the police stations as shown in Figure 6.5. Having a backend provides a centralised data management system for the mobile application.

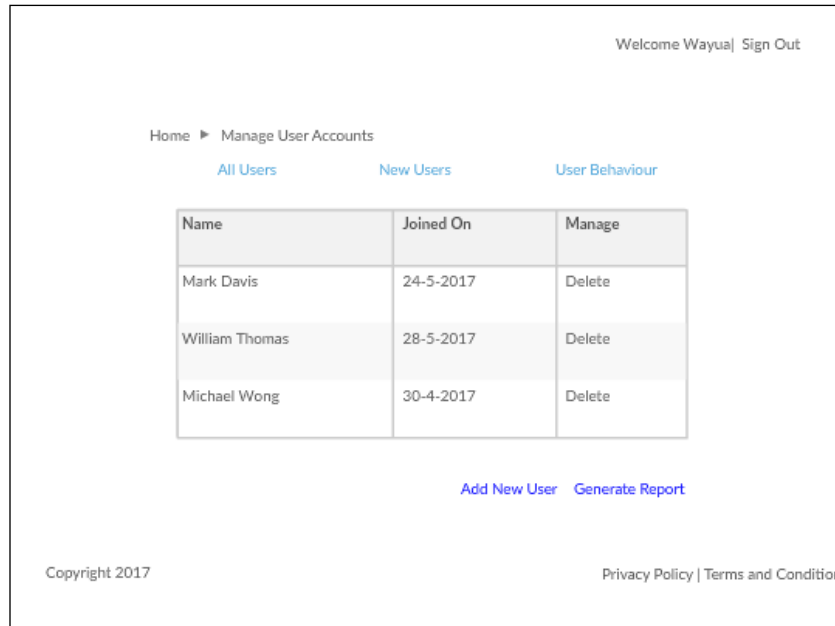


Figure 6.5: Web App Manage User Accounts

The web backend was developed using HTML 5, PHP, JavaScript and WampServer.

6.4 System Testing

The mobile and web applications were subjected to thorough, detailed testing to ensure that both functional and non-functional requirements were met. Ten (10) administrators at Missing Child Kenya executed testing the mobile application. They were sent the APK of the mobile application to install and run on their Android Devices while filling in a test case prepared by the researcher. A sample of the full test case can be found in Appendix C. Their feedback was analysed and discussed in section 6.4.1 of this chapter.

The web back end was additionally subjected to a CRUD testing process to ensure that data integrity was upheld.

6.4.1 Mobile Application Testing Results

The 10 administrators tested the following aspects and their results displayed in Table 6.1, Table 6.2 and Table 6.3:

1. Functional Testing

Test Case ID	Summary	Expected Result	Actual Result
Mob_2017_1	Verify that application should be installed successfully.	The application should be installed successfully.	100% agreed that the installation process was simple and easy.
Mob_2017_2	Verify that application should be uninstalled successfully.	The application should be uninstalled successfully.	100% of the testers agreed that the uninstallation process was simple and easy.
Mob_2017_3	Validate whether the application works as expected whenever the application starts/stops.	The application should start immediately its' icon is clicked on in the device menu.	100% of testers agreed that the application started immediately its' icon was clicked on in the device menu.
Mob_2017_4	Verify whether navigation between screens is smooth and easy to understand.	The navigation between screens should be clear and not generate errors	100% of the testers agreed that the flow between the screens made sense and did not have dead ends.
Mob_2017_5	Verify whether data validation is correct in the input fields	Only correct data formats should be accepted in the input fields	100% of the testers agreed that the correct data formats were being accepted in the input fields
Mob_2017_6	Verify whether a new case created is correctly saved and displayed	A new case's details should be correctly saved and displayed	100% of testers agreed that a new case's details were correctly saved and displayed

Test Case ID	Summary	Expected Result	Actual Result
Mob_2017_7	Verify whether a new sighting is correctly saved and displayed	A new sighting's details should be correctly saved and displayed	100% of testers agreed that a new sighting's details were correctly saved and displayed
Mob_2017_8	Verify whether a new member added to the family profile is correctly saved and displayed	A new member added to the family profile should be correctly saved and displayed	100% of testers agreed that a new member added to the family profile was correctly saved and displayed
Mob_2017_9	Verify whether the login module is secure.	False/incorrect login details should not be accepted by the application.	100% of the testers confirmed that false/incorrect login details were not accepted by the application.
Mob_2017_10	Verify whether session state was implemented.	A user is not signed in should not create a new case, sighting or family profile.	100% of the testers confirmed that they could not create a new case, sighting or family profile while signed out.
Mob_2017_11	Verify whether the social sharing buttons work	A user who is signed in should be able to share a poster of a missing person on their social accounts.	100% of the testers confirmed that they were able to share a poster of a missing person on their social

Test Case ID	Summary	Expected Result	Actual Result
			accounts while signed in.
Mob_2017_12	Verify that a poster of a missing person can be downloaded and saved in the device's Photo Library.	A user who is signed in should be able to download a poster of a missing person that will be saved in their Photo Library.	100% of the testers confirmed that they were able to download a poster of a missing person and access it from their Photo Library while signed in.

Table 6.1: Mobile Application Functional Test Case Results

2. Performance Testing

Test Case ID	Summary	Expected Result	Actual Result
Mob_2017_13	To validate that the device is able to perform required multitasking requirements whenever it is necessary to do so.	A user should switch between different applications while running the Missing Persons application.	100% of the testers confirmed that they could switch between different applications while running the Missing Persons application.
Mob_2017_14	To validate that the installed application enables other applications to perform satisfactorily and it does not eat into the memory of the other applications.	The Missing Persons application should not eat into the memory of the other applications on the device.	100% of the testers agreed that the Missing Persons application did not eat into the memory of the other

Test Case ID	Summary	Expected Result	Actual Result
			applications on the device.
Mob_2017_15	To validate whether the application performs according to the requirement in all versions of network connectivity that is 2g, 3g and 4g.	The application should connect to all networks that is 2g, 3g and 4g.	100% of the testers confirmed that the application connected to all networks that is 2g, 3g and 4g.
Mob_2017_16	To validate whether the Missing Persons application runs on devices running Android 5.1 and above only.	The Missing Persons application should run on devices running Android 5.1 and above only.	100% of testers agreed that the Missing Persons application ran on devices running Android 5.1 and above only.
Mob_2017_17	To validate that the application does not suffer from insufficient session expiration.	The application should not timeout or close unexpectedly.	100% of testers confirmed that the application did not close unexpectedly.

Table 6.2: Mobile Application Performance Test Case Results

3. Usability Testing

Test Case ID	Summary	Expected Result	Actual Result
Mob_2017_18	To validate that all buttons should have the required size and be suitable to big fingers.	The user should comfortably press on any button	91% of the testers responded that the button size was user friendly and easy to press.

Test Case ID	Summary	Expected Result	Actual Result
Mob_2017_19	To validate that the icons feel natural and consistent with the application.	The user should instantly understand the icons used.	94% of the testers could easily recognise the icons used.
Mob_2017_20	To verify that the font size is big enough to be readable and not too big or too small.	The user should comfortably read the words displayed on the device's screen.	98% of the testers could easily read text displayed on the screen.
Mob_2017_22	To verify that the layout of the application is consistent to avoid confusion to the end users.	The layout of the application should be consistent across all app screens.	93% of the testers confirmed that the layout of the application was consistent.
Mob_2017_26	To verify that the application's text is visible on the device's screen in all types of weather.	The application's text should be visible in bright and dull weather.	94% of the testers responded that the text was visible in different kinds of weather.

Table 6.3: Mobile Application Usability Test Case Results

6.4.2 Web Application Testing Results

The web back end was tested by the 10 administrators from Missing Child Kenya using the following test case:

Test Case ID	Summary	Expected Result	Actual Result
Web_2017_1	To validate that the login module is secure.	The admin should not login using incorrect details.	100% of the testers could not login using invalid details.

Test Case ID	Summary	Expected Result	Actual Result
Web_2017_2	To validate that an admin has to be logged in to view reports.	Reports should not be accessible if the admin is not logged in.	100% of the testers could not access a report without prior login.
Web_2017_3	To verify that a report could be exported to PDF and printed.	The admin should be able to print a report.	100% of the testers were able to download and print a report.
Web_2017_4	To verify that the admin could not delete any reports.	No report should be deleted.	100% of the testers could not delete any record.
Web_2017_5	To verify that the admin could block a user from accessing the app.	A user could be blocked from accessing the mobile application.	100% of the testers could block a user from accessing the app.

Table 6.4: Web Application Test Case Results

The CRUD matrix was developed to test the web application's Create/Read/Update/Delete Functions:

CRUD	Create	Read	Update	Delete
User Type				
System Administrator	YES	YES	YES	NO

Table 6.5: CRUD Matrix for Web Application

6.5 System Validation

This section sought to validate and prove that the developed mobile application is effective in reporting and tracing a missing person in Kenya. 10 administrators from Missing Child Kenya and 2 from *MumsVillage Kenya* were sent a questionnaire to complete regarding the effectiveness of the mobile application. A copy of this questionnaire can be found in Appendix C. Their results have been analysed below to prove the effectiveness of the developed solution.

Figure 6.6 shows that 95% of the respondents agreed that the information collected about a missing person was sufficient to generate a report that would guide the public in finding the missing person.

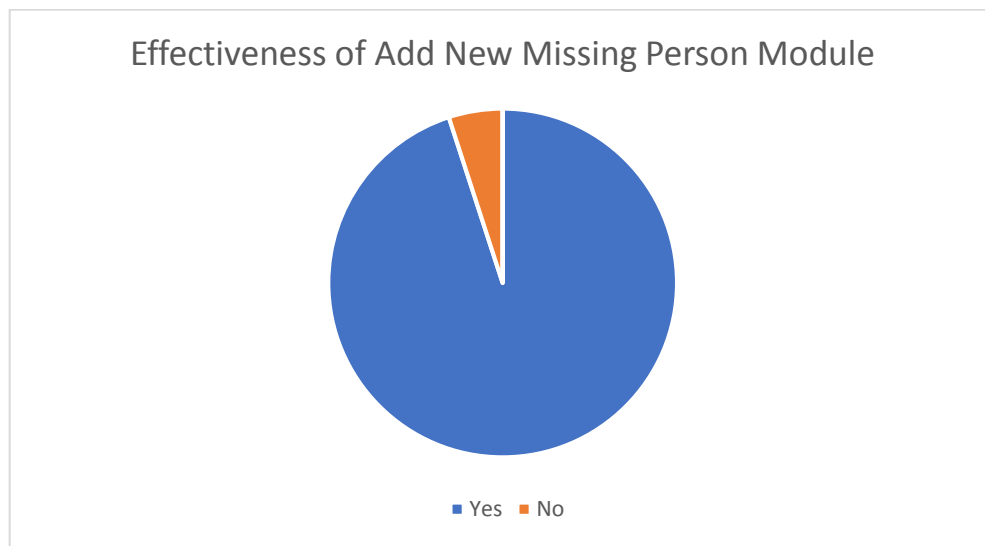


Figure 6.6: Effectiveness of Add New Missing Person Module

Figure 6.7 shows that 97% of the administrators agreed that the Report Sighting module does indeed collect the necessary information of where the missing person was seen to enable them to be located.

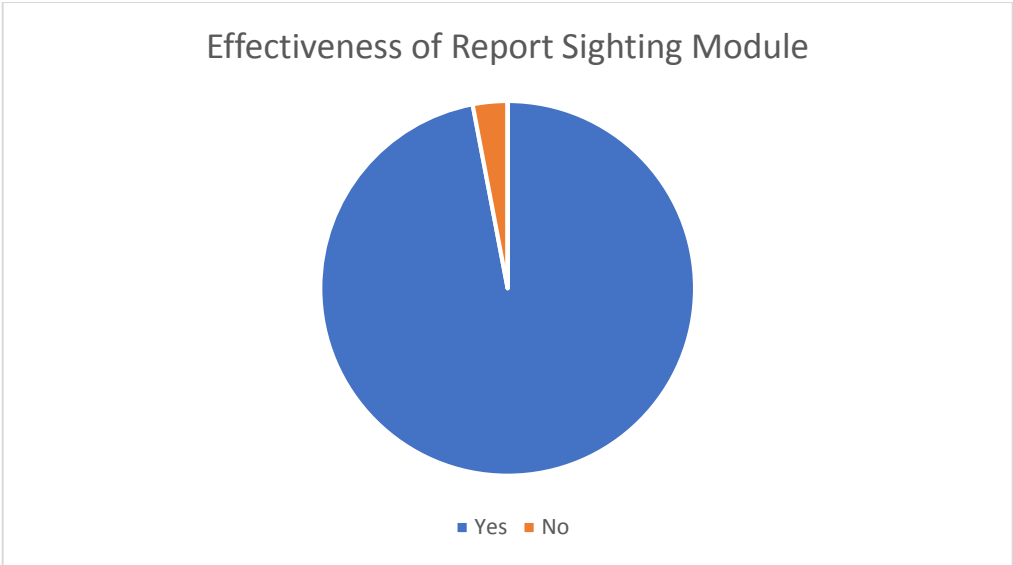


Figure 6.7: Effectiveness of Report Sighting Module

94% of the administrators felt that the social media sharing functionality incorporated on each missing person’s record was effective in sharing the downloaded missing person’s poster as shown in Figure 6.8.

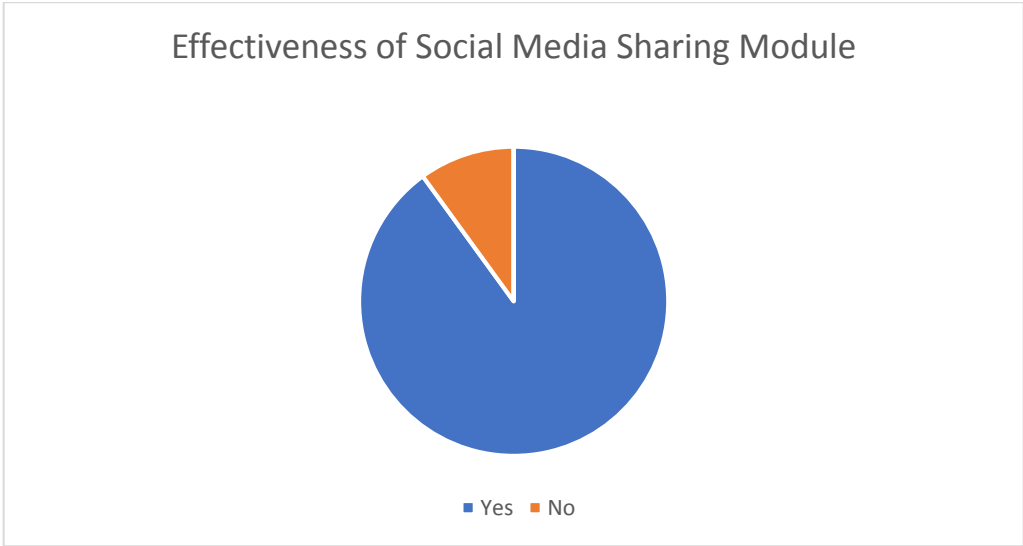


Figure 6.8: Effectiveness of Social Media Sharing Module

98% of the administrators felt that the application provides a centralised platform for reporting missing persons as shown in Figure 6.9.

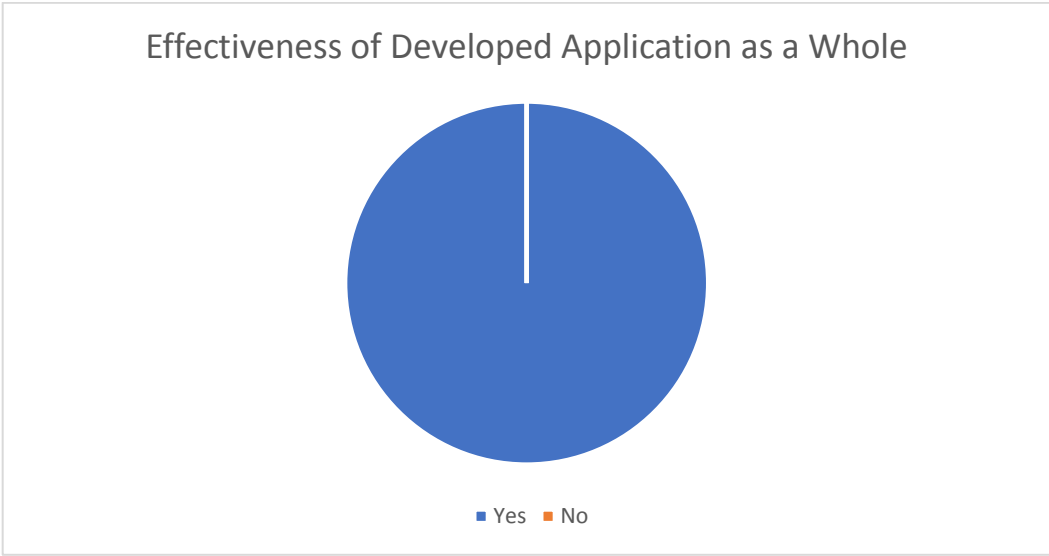


Figure 6.9: Effectiveness of Developed Application as a Whole

98% of the administrators felt that the application was user-friendly as shown in Figure 6.10.

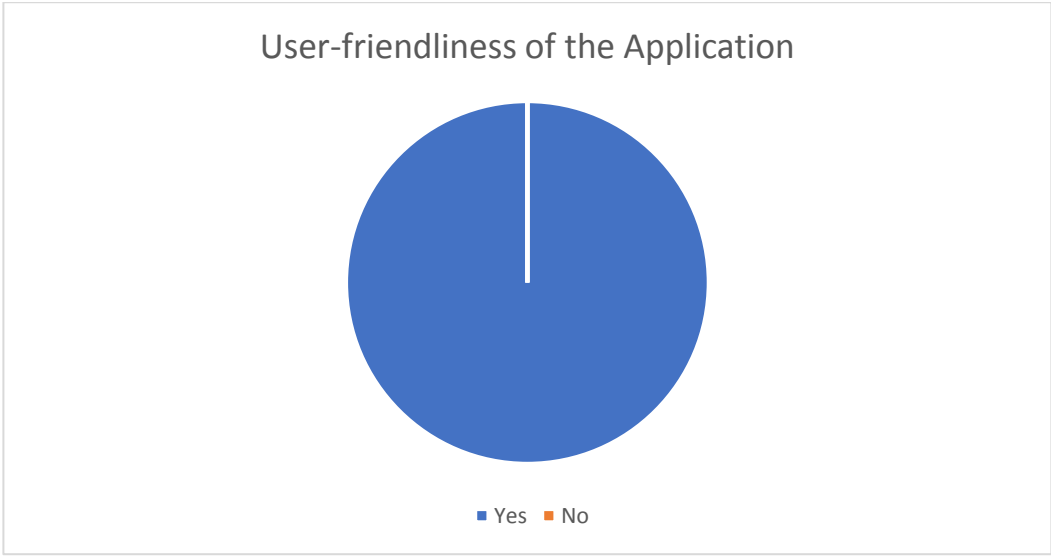


Figure 6.10: User-friendliness of the Application

Figure 6.11 shows that 94% of the administrators felt that the application’s Family Profile module was useful and would use it to save details of their loved ones as a precautionary measure.

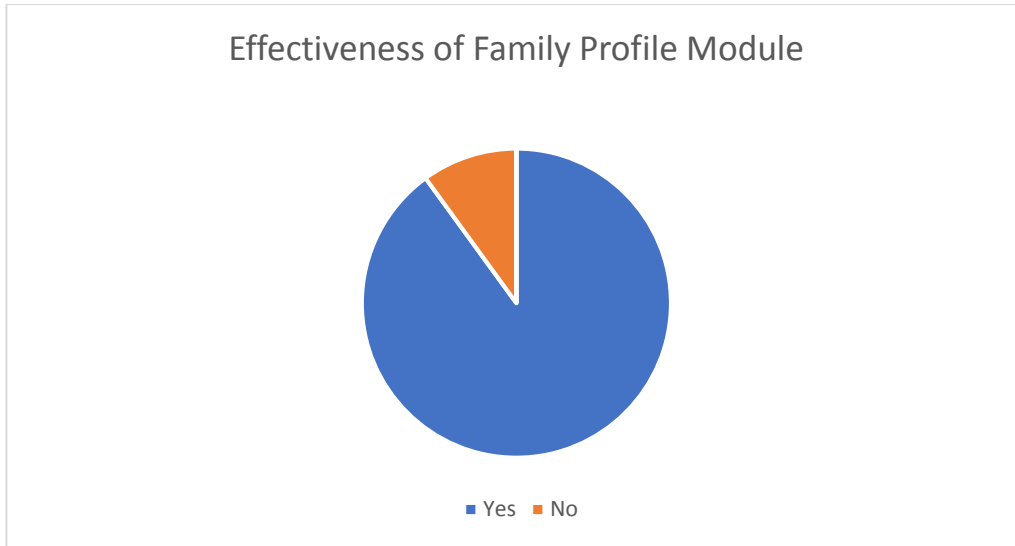


Figure 6.11: Effectiveness of Family Profile Module

Figure 6.12 shows that 98% of the administrators would recommend the application to other users.

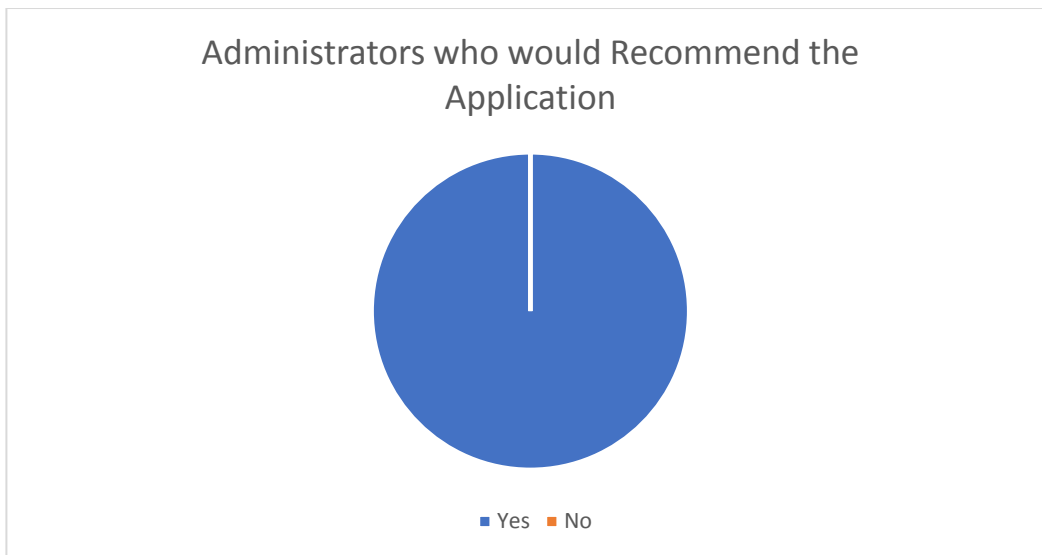


Figure 6.12: Administrators who would Recommend the Application

These results show that majority of the administrators felt that the mobile application had fulfilled the objective of being effective in reporting and tracing a missing person in Kenya. The Add Missing Person and Report Sighting modules implemented a centralised

system of reporting details of a missing person. The social media sharing functionality increased the effectiveness of disseminating details of a missing person.

6.6 Summary

One of the research objectives was to design and develop a valid mobile application for reporting and tracking missing person. This objective was accomplished in this chapter which clearly showcased the core features of the developed mobile application and web backend. Through the mobile application, registered users can report a missing person or report seeing anyone listed on the missing persons' list. The web backend gives the system administrator rights to manage users and generate reports on app usage and data statistics.

The researcher developed test cases to test the usability, functionality and performance of the mobile and web applications. The test cases together with the applications were sent to 12 administrators at Missing Child Kenya. 2 administrators from MumsVillage Kenya were also requested to go through the system and thereafter complete the system validation questionnaire. Their feedback showed that the applications were user friendly, easy to navigate and provided an effective reporting tool for missing persons.

Chapter 7 : Conclusions, Recommendations and Future Work

7.1 Introduction

This section seeks to provide adequate summary of the entire research study dissertation. This research focused on the plight of families looking for their loved ones and had access to limited resources. The research brought]to light the limited number of resources that Kenyans who are looking for missing people have access to. A solution to this limitation was proposed and developed in line with the research objectives. Any recommendations to the implementation process and any future work to be done will be discussed in depth in this section.

7.2 Conclusions

This study solely focused on the current system of reporting missing persons in Kenya that is available to the ordinary citizens and its efficacy. It further sought to propose, develop and validate a mobile application that would improve the current state of affairs.

Literature review was conducted to analyse any works done locally and globally to solve this existing problem. The findings from this review process showed that there are no local solutions implemented to improve the current system of reporting missing persons. Globally, institutions like the FBI have implemented applications that make it easy for people to sift through records of missing persons and share any information that they feel will help find the missing persons. This was further backed by feedback collected from a sample of citizens using a Google Survey (see *Appendix A*) that showed a 20% success rate of finding missing persons reported to the police stations.

The findings further showed that 78.8% of respondents owned a smartphone running on Android. This gave backing to the proposed mobile and web applications. The mobile application was developed using Android Studio and provided registered users with a platform to upload details of a missing person or browse through existing records. The web application gave the system administrator access to usage statistics of the mobile application.

7.3 Recommendations

This is an important and sensitive solution that can save the lives of many persons in Kenya who are reported missing but rarely found alive. Proper implementation of the mobile application can increase the success stories of people who go missing. In Kenya, the first place many people turn to when a person goes missing is the police stations. As such, the police authorities should be involved in the implementation of such a solution. They hold data of most missing persons and can crosscheck this against records in the mobile application for any matches.

Children's homes should also be involved in the implementation process because they receive children who have not been claimed on a weekly basis.

As a way of generating revenue to further develop this mobile application, the application can be priced at Ksh. 100 per download. This recommendation is backed by findings from the Google Survey that revealed that 86.2% of respondents would be comfortable paying such an amount for the mobile application.

7.4 Future Work

It is important to come up with a similar solution for persons who do not have smartphones as a way of increasing the audience. As a way of further increasing the scope of this study, an alternative solution running on iOS and Windows can be developed so as not to lockout persons who prefer these operating systems over Android.

Involving as many people as possible in the tracing process will increase the effectiveness of this process.

Developing a release of this solution that uses Kiswahili as the main language will also improve the user experience.

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Appendix A: Google Survey Form

4/10/2017

QUESTIONNAIRE ON REPORTING AND TRACING SYSTEM FOR MISSING PERSONS IN KENYA

QUESTIONNAIRE ON REPORTING AND TRACING SYSTEM FOR MISSING PERSONS IN KENYA

Dear Respondent,

The following questionnaire seeks to address issues regarding the efficiency, effectiveness and reliability of the current system for reporting and tracing missing persons in Kenya. The data provided will help the researcher in completing this research study. Your information shall be handled with the utmost privacy and shall not be breached under any circumstance. To reinforce confidentiality, do not put your name anywhere in the questionnaire but kindly give truthful information. The information will only be for the purpose of the study.
(Please fill in the following questions or use a tick where appropriate)

*Required

1. **1. Do you know the procedure for reporting a person as missing in Kenya? ***

Mark only one oval.

- Yes
 No

2. **If no, what would you do in case a loved one goes missing? ***

3. **2. a). Have you ever reported a person as missing in Kenya? ***

Mark only one oval.

- Yes
 No

4. **If yes, please describe your experience.**

5. **3. a). Was the person reported as missing found?**

Mark only one oval.

- Yes
 No

6. **If yes, do you believe that it was a result of reporting this person as missing at the police station?**

Mark only one oval.

- Yes
- No

7. **4. Do you think making use of a mobile application would increase the effectiveness of the reporting and tracing system? Please explain your answer. ***

8. **If yes, what kind of features do you think this mobile application for reporting and tracing missing persons should have?**

9. **5. Do you own a mobile phone? ***

Mark only one oval.

- Yes
- No

10. **If yes, what kind is it?**

Mark only one oval.

- Feature Phone (e.g. Kabambe)
- Smartphone

11. **If it's a Smartphone, what operating system does it run on?**

Mark only one oval.

- Android
- IOS

12. **6. Would you download a mobile application for tracing missing persons if it was a free app? ***

Mark only one oval.

- Yes
- No

Figure A.2: Part Two - Google Survey

4/10/2017

QUESTIONNAIRE ON REPORTING AND TRACING SYSTEM FOR MISSING PERSONS IN KENYA

13. If the application was NOT free, how much would you pay for it?

Mark only one oval.

- Ksh. 100
- Ksh. 500
- Ksh. 1000

14. 7. What language would you prefer such an application to be in? *

Mark only one oval.

- English
- Kiswahili
- Both


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Figure A.3: Part Three - Google Survey

Appendix B: Turnitin Report



Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

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Assignment Title	Masters Theses - 2017
Submission Date	13/04/17, 11:15

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Figure B.1: Turnitin Receipt

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Figure B.2: Turnitin Results Screenshot

Appendix C: Sample Test Cases

Mobile Application Test Case

Test Case ID	Summary	Expected Result	Actual Result
Mob_2017_1	Verify that application should be installed successfully.	The application should be installed successfully.	
Mob_2017_2	Verify that application should be uninstalled successfully.	The application should be uninstalled successfully.	
Mob_2017_3	Validate whether the application works as expected whenever the application starts/stops.	The application should start immediately its' icon is clicked on in the device menu.	
Mob_2017_4	Verify whether navigation between screens is smooth and easy to understand.	The navigation between screens should be clear and not generate errors	
Mob_2017_5	Verify whether data validation is correct in the input fields	Only correct data formats should be accepted in the input fields	
Mob_2017_6	Verify whether a new case created is correctly saved and displayed	A new case's details should be correctly saved and displayed	

Test Case ID	Summary	Expected Result	Actual Result
Mob_2017_7	Verify whether a new sighting is correctly saved and displayed	A new sighting's details should be correctly saved and displayed	
Mob_2017_8	Verify whether a new member added to the family profile is correctly saved and displayed	A new member added to the family profile should be correctly saved and displayed	
Mob_2017_9	Verify whether the login module is secure.	False/incorrect login details should not be accepted by the application.	
Mob_2017_10	Verify whether session state was implemented.	A user is not signed in should not create a new case, sighting or family profile.	
Mob_2017_11	Verify whether the social sharing buttons work	A user who is signed in should be able to share a poster of a missing person on their social accounts.	
Mob_2017_12	Verify that a poster of a missing person can be downloaded and saved in the device's Photo Library.	A user who is signed in should be able to download a poster of a missing person that will be saved in their Photo Library.	
Mob_2017_13	To validate that the device is able to perform required	A user should switch between different	.

Test Case ID	Summary	Expected Result	Actual Result
	multitasking requirements whenever it is necessary to do so.	applications while running the Missing Persons application.	
Mob_2017_14	To validate that the installed application enables other applications to perform satisfactorily and it does not eat into the memory of the other applications.	The Missing Persons application should not eat into the memory of the other applications on the device.	
Mob_2017_15	To validate whether the application performs according to the requirement in all versions of network connectivity that is 2g, 3g and 4g.	The application should connect to all networks that is 2g, 3g and 4g.	
Mob_2017_16	To validate whether the Missing Persons application runs on devices running Android 5.1 and above only.	The Missing Persons application should run on devices running Android 5.1 and above only.	
Mob_2017_17	To validate that the application does not suffer from insufficient session expiration.	The application should not timeout or close unexpectedly.	
Mob_2017_18	To validate that all buttons should have the required size and be suitable to big fingers.	The user should comfortably press on any button	
Mob_2017_19	To validate that the icons feel natural and consistent with the application.	The user should instantly understand the icons used.	

Test Case ID	Summary	Expected Result	Actual Result
Mob_2017_20	To verify that the font size is big enough to be readable and not too big or too small.	The user should comfortably read the words displayed on the device's screen.	
Mob_2017_22	To verify that the layout of the application is consistent to avoid confusion to the end users.	The layout of the application should be consistent across all app screens.	
Mob_2017_26	To verify that the application's text is visible on the device's screen in all types of weather.	The application's text should be visible in bright and dull weather without straining the user.	

Table C.1: Mobile Application Test Case

Web Application Test Case

Test Case ID	Summary	Expected Result	Actual Result
Web_2017_1	To validate that the login module is secure.	The admin should not login using incorrect details.	
Web_2017_2	To validate that an admin has to be logged in to view reports.	Reports should not be accessible if the admin is not logged in.	
Web_2017_3	To verify that a report could be exported to PDF and printed.	The admin should be able to print a report.	

Test Case ID	Summary	Expected Result	Actual Result
Web_2017_4	To verify that the admin could not delete any reports.	No report should be deleted.	
Web_2017_5	To verify that the admin could block a user from accessing the app.	A user could be blocked from accessing the mobile application.	

Table C.2: Web Application Test Case

System Validation Questionnaire

1. Does the application's Add New Missing Person module collect adequate information about the missing person being reported?
 - Yes
 - No

2. Does the application's Report Sighting module collect accurate adequate information about the missing person who was spotted/found?
 - Yes
 - No

3. Is the social media sharing functionality incorporated on each missing person's record effective?
 - Yes
 - No

4. Does the application provide a centralised platform for reporting missing persons?
 - Yes
 - No

5. Is the application's Family Profile module useful in your opinion?
 - Yes
 - No

6. Rate the user-friendliness of the mobile application on a scale of 1-5 (1 being Very difficult to use and 5 being Very user-friendly). Explain why.

7. Would you recommend this application to other people?

- Yes
- No

Appendix D: Mobile and Web Application Wireframes

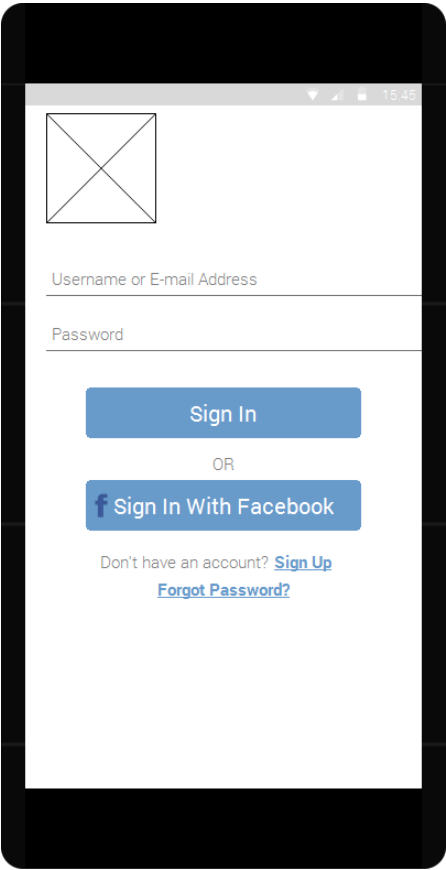


Figure D.1: Mobile Application Sign in Screen

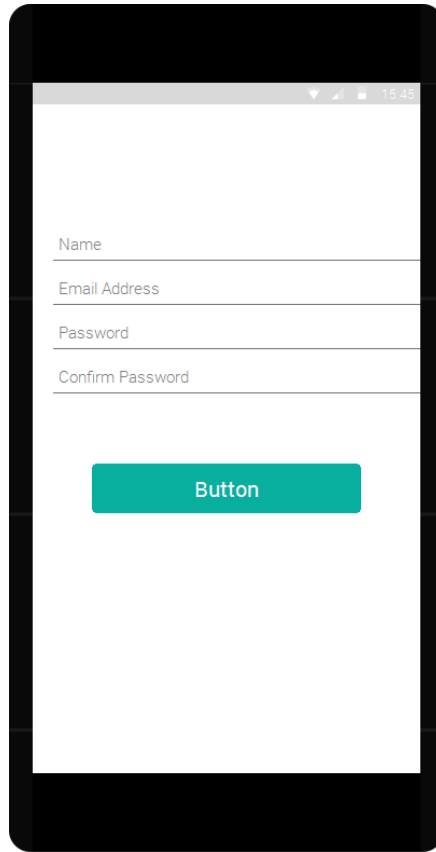


Figure D.2: Mobile Application Sign Up Screen

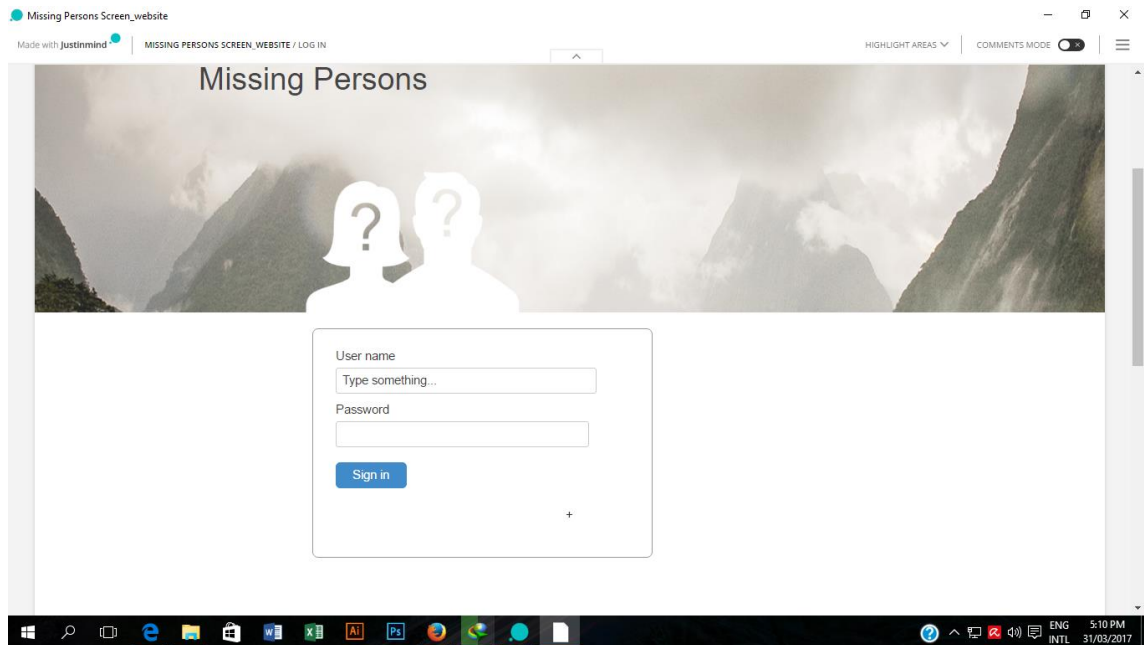


Figure D.3: Web Application Sign in Screen

Appendix E: Reviewed Systems' Screens

A sample of the Milk Carton System (The Star, 2014) shown in Figure E.1:



Figure E.1: Milk Carton with Photos of Missing Children

Source: The Star, 2014

The Missing Persons Bureau search tool (Missing Persons Bureau, 2017) shown in Figure E.2:

The image shows a search tool interface for the Missing Persons Bureau. At the top, it says "Unidentified case search" and "Results: 550". The interface is divided into several sections for filtering search results:

- Gender:** A dropdown menu with "Any" selected.
- Ethnicity:** A dropdown menu with "Any" selected.
- When they were last seen:** A section containing "The age" and "The Date dd-mm-yyyy", both with empty input fields.
- Investigating force:** A dropdown menu with "Any" selected.
- Bureau reference:** An empty input field.
- Location:** A scrollable list of locations including "Any", "Channel Islands", "England - All", "England - East", "England - East Midlands", "England - London Area", "England - North East", "England - North West", "England - South East", and "England - South West".
- Distinguishing Feature:** A dropdown menu with "N/A" selected.
- Feature Detail:** A dropdown menu with "N/A" selected.
- Body Position:** A dropdown menu with "N/A" selected, followed by a "+" button.
- Clothing:** A dropdown menu with "N/A" selected.
- Clothing Colour:** A dropdown menu with "N/A" selected, followed by a "+" button.
- Jewellery:** A dropdown menu with "N/A" selected, followed by a "+" button.
- Cases with Images:** A checkbox that is currently unchecked.

At the bottom right of the form is a "Search" button.

Figure E.2: Missing Persons Bureau Case Search Tool

Source: Missing Persons Bureau, 2017

The Child Welfare Society Kenya web interface for uploading details of a missing person shown in Figure E.3:

UPLOAD A PHOTO OF A MISSING CHILD

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Please report to us any missing or lost children. You may upload photo of the missing child/ren

Submit a new post

Title

Post content or file description










B *I* U **“** ABC         

Figure E.3: CWSK Upload Interface

Source: CWSK, 2017