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# Investigation and knowledge base application: case of Kenya Police

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Investigation and Knowledge Base Application: Case of Kenya Police

Ernest Esiabia Onguko

Submitted in partial fulfilment of the requirements of the Degree of Masters of Science in  
Mobile Telecommunication and Innovation.

Faculty of Information Technology

Strathmore University

June, 2017

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Ernest Esiabia Onguko

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**Approval**

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## **Abstract**

The police mainly depend on the information they get from various sources to aid investigations, usually, there is delayed investigation process if no information about a suspect or a scene of injustice is in place. To add on that even if there is information the police collect this information by use of paper and notebooks, usually it is hard to maintain and correlate the data from the field by the police officers because they are on paper. Therefore, the police need to develop a better model for collecting information on criminals. This study sought to find out how to integrate technology into the Kenya police service to improve their service delivery in terms of intelligence and information gathering and data analysis. The study has used both qualitative and quantitative methods to collect data because there will be need to get a deeper understanding into how the Kenya Police work in order to understand their data gathering process and how well the application would fit into their operations and improve them. It also sought to help build knowledge base for the police for easy manipulation of data to assist in predicting and even giving heads up on where to begin investigations. The end results was a mobile application that helps the police gather intelligence and be able to fasten their investigations easily by analysis, criminal mapping, triangulation of data, fast retrieval of criminal suspects.

*Keywords Data-Gathering, Police, Analysis, Notebooks, knowledge management*

### **Dedication**

I dedicate this dissertation to God, my family for their encouragement that I could make it, to all my classmates for the support granted throughout the masters period, the lecturers for their guidance and finally, to my supervisor Prof. Ismail Ateya Lukandu, for his advice throughout the research period.

### **Acknowledgments**

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## **List of Abbreviations/Acronyms**

<b>BBC</b>	—	British Broadcasting Cooperation
<b>BBM</b>	—	Blackberry Messenger
<b>CID</b>	—	Criminal Investigation Department
<b>HCI</b>	—	Host Controller Interface
<b>HQ</b>	—	Head Quarters
<b>ILP</b>	—	Intelligence Led Policing
<b>IPOA</b>	—	Independent Policing Oversight Authority
<b>IR</b>	—	Infra-Red
<b>JSON</b>	—	JavaScript Object Notation
<b>KNBS</b>	—	Kenya National Bureau of Statistics
<b>NIM</b>	—	National Intelligence Model
<b>OB</b>	—	Occurrence Book
<b>PDA<sub>s</sub></b>	—	Personal Digital Assistant
<b>RF</b>	—	Radio Frequency
<b>SPI</b>	—	Serial Peripheral Interface
<b>UART</b>	—	Universal Asynchronous Receiver Transceiver
<b>UK</b>	—	United Kingdom
<b>UML</b>	—	Unified Modelling Language
<b>UN</b>	—	United Nations
<b>USB</b>	—	Universal Serial Bus

## Chapter 1 Introduction

### 1.1 Background of Study

There is a general belief that technology contributes and makes our life easier, the technologies have changed the way we think, react, perceive things, our attitudes and even the way we engage as a community (Nunn & Quinnet, 2002). Technology, in particular has changed the whole world into a small village thanks to communication channels all around the globe (Chan, 2001). Unlike traditional way of communication and sharing of information, many companies and organisations have adopted information technologies for faster information transfer and have flexible data management. In this case, there is an increasing and vast widespread investment by organisations and even individuals in use of information technology, which has shown that it has become an important aspect in our lifestyle.

From all the big organisations that use information technology systems, the police can be mentioned as among this group because they have high usage rate of information systems (Nunn & Quinnet, 2002). According to Gottschalk and Holgersson (2006) most police departments in the world and agencies offer information technology as a support for their police officers, this makes their work easier. The matter of fact is that “information is the bloodline of the police”, (Colvin & Goh, 2005).

According to Gottschalk (2006), information that is received by the police when they are enforcing law is immense. Information technology system tools are used by police while they patrol, tracking of crime in an ongoing investigation, solving crimes and even in the traffic pursuit. Information technology has high effect on police practices (Colvin & Goh, 2005). In fact, if we have increased usage and support of use of information technology by police it definitely improves the performance and quality of law enforcement departments (Gottschalk & Holgersson, 2006).

In the past few years the development and adoption of information technologies has enabled many companies to grasp and improve on information gathering and dissemination. The development of powerful databases with easy access improves speed of retrieval and have searching adjustability, to add on this we have the internet which act as a means for sharing information across cooperating entities and companies (Chen & Hauck, 2002). Police collect and analyse data for informed decision-making, the data they collect sometimes is called intelligence.

The terms knowledge and intelligence can be conversely be used (Hughes & Jackson, 2004). It is rather now important for one to know how the information the police gather from the field is important and can be stored for future references and triangulation of data for future staff and easy solving of crime and even having clues or leads to crime even if it is a source of information that would aid an investigation.

This paper focuses on the concept of use of mobile application for collection of intelligence and crime related matters by the police to make a knowledge base for the police. It will give more insight on the methods used to collect information by the Kenya police. The paper will also review the development of a mobile application and a back-end system for analysis based on collected information.

## **1.2 Problem Statement**

The police are using notebooks famously called field interview cards to collect information with, this information can easily be lost or misplaced, and it is hard to be maintained and tracked (Ratchliffe J. H., 2003). A criminal may have records in different towns but the police will not know until it is late, this is because of the lack of a common knowledge base of information on criminals or gangs. In summary, the police do not have a common reference database for search, information entry, and storage for criminals and crime-related events for easy references when in need.

## **1.3 Research Objectives**

- i. To do a research on challenges faced by the police during their investigations and gathering of intelligence.
- ii. To review the models and architectures used for information gathering.
- iii. To design develop and test an application that best suits the field interview process.
- iv. To validate the solution and test functionalities of the application.

## **1.4 Research Questions**

- i. What are the challenges that the police face while gathering information during patrols or investigations?
- ii. What are some of the models that currently exist for information gathering?
- iii. How can a mobile-based application be designed, developed, and tested?

- iv. Does the solution solve the problem of storing and gathering criminal information for the police?

### **1.5 Justification of the Research**

One may recognise the police as knowledge workers, as they are involved in the process of investigation, which involves the assembling of knowledge. Investigation is a process of construction (Maguire, 2003). Therefore with the implementation of the application, the police would have crime knowledge gathered which will essentially help them to come to conclusions through analysis as to what crimes have been or may be committed, by whom, how and why and if not. From the information they may establish a starting point of an investigation about a specific incident or crime. This will save the money spent on papers, note books, travelling expenses and it will also enrich the digital data on criminals and suspects which can be used in future during investigations moreover the police will have a criminal knowledge base.

### **1.6 Scope of the Research**

This study was carried out in Nairobi Kenya; focus was on the police investigators, and patrol officers, traffic police and private investigators. The data used was sample data used by the police. The application is integrated by the main database of criminal records of the police, this at the end allow the users of the application be able to view their accounts and other services.

### **1.7 Limitations of the Research**

For effective and efficient information collection about criminals, and easy management of data, the Kenya police needed the development of an application which came with some limitations. All the investigators, patrol and traffic police officers will need to have an Android phone so that they can be able to get and access the details of the suspects, also due to limited time constraints the research only covered the Nairobi area.

## **Chapter 2 Literature Review**

### **2.1 Introduction**

This section discusses research that has already been done on collection of intelligence and management of data. The chapter also touches the different proposed models for data collection and management of data. Within the literature, we had several sections that will outline some important work that has been done previously and what is expected of the police by the public. The study also sought to show not only the failings of the police in the republic of Kenya, but kept in mind the international context of intelligence or information gathering, the various models and architectures used, mobile technologies that can be used to improve the information gathering process and then finally, how to go about testing and evaluating the built application.

### **2.2 State of Security and Intelligence in Kenya**

Human security has deteriorated since 1990; petty crime had been reported often in local and international press mentioning the rise of crime and insecurity in the country (Confidential, 2002). Kenya has a high level of unemployment, with the small arms and light weapons entering the country through the unguarded borders, the unemployed youth being majority get their hands on them thus the armed robberies, conflicts between clans, fighting for resources and cattle rustling. This is also brought about by the drought in various parts of the country (Aronson, 2013).

The living conditions and overcrowding of the non-formal settlements which are characterised by very high population density and unstructured semi-permanent houses with inaccessible roads and bad drainage sewage and water systems have made the residents to turn in to crime which makes security hard to tackle.

#### **2.2.1 Current Responses to Crime**

According to Omondi (2013) the government of Kenya launched community-policing initiative in order to bring the community and police together, this was to help solve crime. This initiative was to show the shared interdependencies between the police and the community for safer neighborhoods and create a mutual understanding about the role of each citizen. The initiative did not work well due to problems related to corruption and citizen police ratio. The government then introduced the Nyumba Kumi initiative in the year 2014 as a way of Kenyans knowing who stays next to them as neighbors and also as a way of the government alerting and making the citizens know their constitutional mandate (Kariuki, 2014). However, it was discovered that over

time Nairobi, residents were less concerned on whom was their neighbor because they highly concentrate in making money; this is according to (Adika, 2014).

### **2.3 The Public Expectancy of the Police**

Police work has always had a close relationship with Technology. Technology helps to improve the practical way of doing things and efficiency of police work in crime control and it enhances their expertise status and validity (Ericson & Haggerty, 1997). Police are investing in information technology to raise their holding power to store and process big data, to improve their intelligence and investigative effectiveness and to provide ready access to criminal files and other crime-related information. The need for technology that is compatible with other agencies is also an important driving force for new technology (Ericson & Haggerty, 1997).

Police departments are different from big or small institutions in that their use of information technology to improve performance and management is not driven by market debate or with any competition of gaining profits involved, but it is mainly for public demand, which is a result of extraneous imposition that requires procedural regularity, probity, and performance. From the 1980s, a new ideal concept of public accountability has emerged in a number of Western countries such as Australia and Britain (Davids & Hancock, 1998). Police routinely were governed by department laws and rules that were brought about by the courts and police.

The mode of regulation was mainly through legislation and rule making, investigations and also enforcement, criminal sanctions and organisational discipline. However, in the new policing, new managerialism is transforming the traditional police to look like organisations that have plans, strategies, and even mission and vision statements. They also have emphasis on crime administration, customer service, and measures in performance (Leishman, Loveday, & Savage, 1996). Call it the 'entrepreneurial revolution' in policing (Ackroyd, Harper, A, Shapiro, & Soothil, 1992). Police are being inspected too, for example in Kenya we have the IPOA (Independent policing oversight authority) which is a watch dog it makes sure that everything the police do is up to the books by having internal audits and investigations of how crimes were solved, some budgetary process, receiving complaints from the public about police and so on.

Thus as the police are upgrading to using information technology they also have in mind the new management and accountability systems, where by many other external factors and

agencies be it local, international or non-governmental may use the information they have, in private sector people sale this kind of information.

Apart from meeting the demands of external watchdog agencies, like IPOA for information on police actions for accountability purposes. The police also provide and disseminate accident and crime data to external organisations or agencies like the traffic, insurance, private security, neighboring countries, and any other relevant body depending on the information they have, it can be even individuals (Davids & Hancock, 1998).

Progressively, information from the police is commoditised and sold to other institutions that are external and even individuals, partly to recover costs and partly to discourage jokey requests (Davids & Hancock, 1998). Thus, the external requests for police information are also partly why we really need to improve information technology capabilities within police organisations.

## **2.4 Intelligence Led Policing**

Intelligence led policing is very common name currently known by most of the law enforcement personals in the world. ILP originated as result of an audit commission report done in the UK in 1993 (Ratchliffe, 2008). Getting information from informants and other sources could lead to crime prevention and better way of managing resources, this was one of the conclusions of the report. The report encouraged the Kent police to adopt and develop the concept so that they could use it to fight and decrease property related crimes (Klerks, 2008). The Kent police believed that a small number of people controlled and were responsible for many incidences of crime that occurred in their jurisdiction; this led to the first use of the ILP concept, which was successful. The success made ILP concept enter into the National Intelligence Model (NIM), used widely in the UK police.

This concept was later adopted by the United States with another name, Comparison Statistics (CompStart). They incorporated statistical system, which is used to compare policing results (Ratchliffe, 2008). Other countries namely Australia, Canada and the Netherlands adopted the concept but added some more functionalities. The concept is still evolving and one of its children is known as the community policing, which is bringing police closer to the community. Figure 2.1 shows an intelligence led policing and crime reduction process.

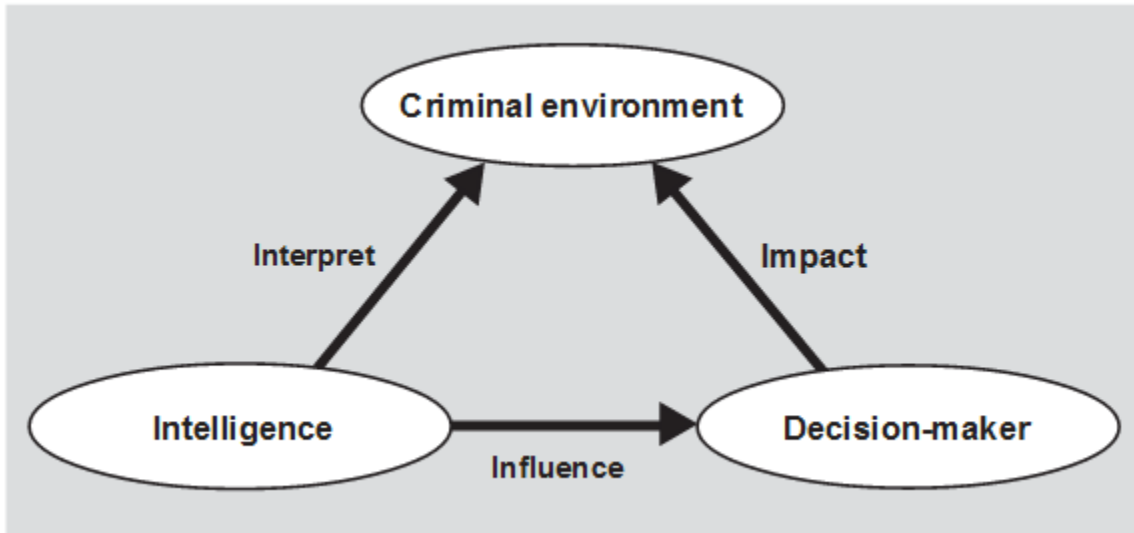


Figure 2.1 Model of Intelligence-Led Policing (Ratchliffe J. H., 2003)

ILP is both a philosophy of management and a business model that involves data analysis and crime intelligence, which are very important to the police, it is a framework for decision making in relation to crime reduction, some disruptions and prevention of crime through management and enforcements that are effective strategies that are targeted to prolific offenders (Ratchliffe, 2008).

Intelligence also has some purpose, first and first intelligence is used after being gathered using various tools to develop and perform implementations through pro-active strategies to get to identify criminal gangs and other community members involved in criminal activities and apprehend them. Therefore, the main role of intelligence is to decide on action to take for better security and safety of the community and risk expectation (Ratchliffe, 2008). The other role of intelligence is to help in making suggestions by giving clues on priority strategies; it helps to assess the threats available, development of policies and lastly helps in management and planning of resources. In other words, intelligence is used based on objectives to help in the decisions, which have priority (Ratchliffe, 2008).

The other concept goes to the decision makers; one may ask who should be the one to use the intelligence to make impact on the criminal surroundings. It goes back to the police who have no option but to have knowledge of the community, the activities of criminals and be able to make decisions based on the intelligence they have so that we can have reduced offences in the

community. According to Tamerus (2005) the strategy that is chose by the police may take the following directions

- i. Prevention Surveillance maybe directed to certain areas when the police have the knowledge about the criminal environment
- ii. Hot spots Influence on market of criminals for some commodities like drugs
- iii. Patterns of crime This may include targeting of home burglaries, a crime series, violence and robberies and street crime
- iv. Hot shots this involves identification the crime leaders, offenders that are persistent and getting some insights of the lifestyle and networks of offenders.

ILP handles two things at a time, it is thus called unique, it is used for prevention and for action taking and on other hand it is a tool used for planning and resource allocation thus promoting effectiveness in logistics and decision making (Ratchliffe, 2008). Figure 2.2 depicts an e-police logical operational architecture used in Nigeria for solving crime. The ILP method can be adopted in Kenya dues to its advantages as mentioned above.

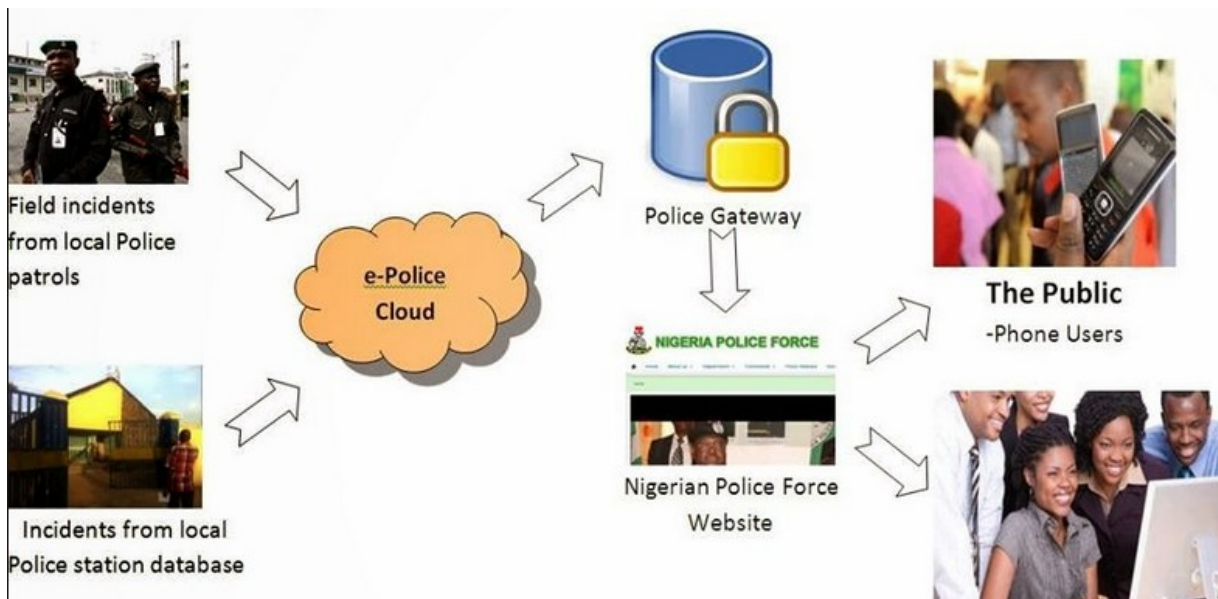


Figure 2.2 Police Architecture (Ratchliffe, 2008)

## **2.5 Information Collection and Management**

There is limited specialisation within the force in Tanzania, which is a third world country like Kenya for performing investigations (Simon, 2009). The CID is responsible for the investigations of all cases; the police of Tanzania lack a record keeping strategy regardless of the seriousness of the type. They have a slower process of criminal trials and extreme investigation delays. Also according to the public prosecution in Zambia the lack of credible evidence in most cases has led to lack of prosecution, the main reason why we have this is due to lack of sufficient investigation techniques (Simon, 2009). These same cases have been witnessed in Kenya.

The Nigerian police have moved from the comprehensive way of getting original information, analysing, and interpreting evidence, to vigorously obtaining confessional statements from the suspects through torture. Other than that, the other problem that comes with the police after their investigations is missing case files. Case files contains statements of the witnesses and that of the implicated suspects together with reports made by the police and other important documents required which are attached for any legal pursuit. As at 2006, we had 25,000 case files that were unaccountable, that is about 3.7%, thus the prosecutions were held off (Oluwafemi, 2013).

Oluwafemi (2013) continues to insist that the current way of record keeping is that the detectives take guard ship of their investigation documents, keep them in their homes or lockers that are private. This leads to loss, theft and inaccessibility if the officer is transferred to another department, retires or dies. Due to poor public record keeping, it is hard for the police to piece together unconnected facts when we have poor record keeping; even though some information might not be connected, they may still be key to unravel some criminal mastery cases. With all this problem of having a grave deficiency in public records it leads the Nigerian police investigators to be in the realm of guessing and speculations, which have no place in their courts (Oluwafemi, 2013).

From a UN report, David James and Moharmoud (2015) talk about the Occurrence Book (OB). The OB book is one of the most important police incident record in use in Somaliland and is used in all police stations across Kenya. All legal protests to the police are recorded in this book, the book records the specifics of the suspects, informants, and victims that are in place, and sometimes it even records the results of finished investigations. The document is a source of

pointing out leads for investigations and used by the police managers whose obligations is to provide overlook, control and direction to investigations of criminals. The book is also used to provide the annual crime statistics of the country, thus it is the main document for recording and is given due by specialised units like the National CID (David & Moharmoud , 2015).

### 2.5.1 Personal Health Management

Patient data is being put in digital format for easy storage and exchange between authorised users; this is called electronic health record (EHR). The main aim is to support quality in health care services (Bougrain, 2002). EHR has grown from the much known traditional paper based information collection from the patients where their information is taken by the health facilitator like the nurses. Currently, many organisations have adopted the HER to make their service delivery easier. Another type of record tool is called the PHR (personal record management) which helps individual to manage and share their health information, this helps with illness when even another doctors accesses, they can be able to know the history of a patient easily thus avoid mistakes and save time (Tang, Ash , Bates, & Overhage, 2006). This kind of architecture can be adopted and imitated to the police sector for easy storage and access to criminal information. Figure 2.3 shows an information management architecture for health services.

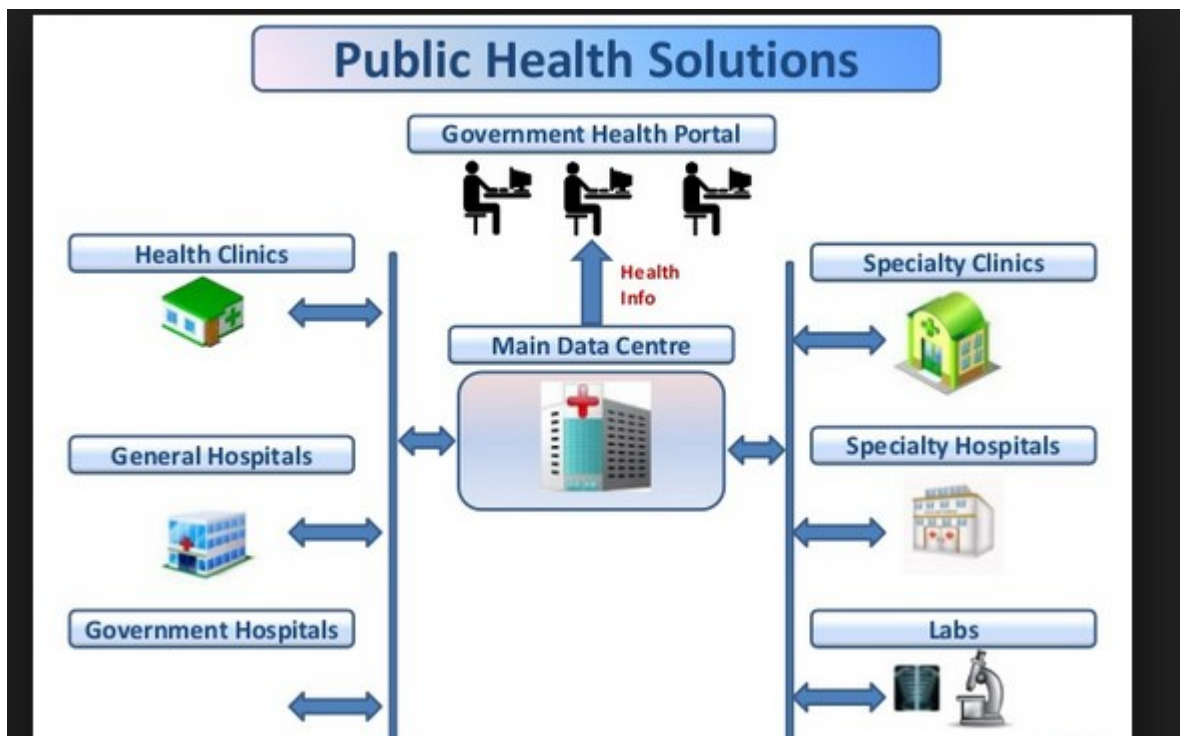


Figure 2.3 Health Information Management Architecture (Bougrain 2002)

### 2.5.2 Education Management Information System

Data collection, processing, managing analysis, and reporting makes it very easy for educational institutions to achieve automated procedures and routines. Reviews and evaluation can be made by EMIS information, planning after evaluations can be done too and this make performance higher because of monitoring from indicators and being able to make decisions easily. Departments in universities are using university management information systems (UMIS); it gives the capabilities to do evaluations. UMIS consists of majorly data that is managed by people using computer software and hardware, making information accessible from anywhere within a campus (Haitham & El-Ghareeb, 2009). A UMIS may contain information about the student including age, contact, date, gender, birth, department and so forth. It may also contain information about the library, the task involving the borrowers of books and return date. Finally, it may contain the finance and faculties in the institution (DeLone & McLean, 1992). With all this information for example the library about the books issuing and return one can easily retrieve information and know the status of a book, also one can easily control the inventory of the library and to add on other UMIS components helps in decision making and resource allocation easily. This kind of method can also be adopted and imitated to the police sector for easy storage and access to criminal information from any part of the country. Figure 2.4 shows an EMIS information process

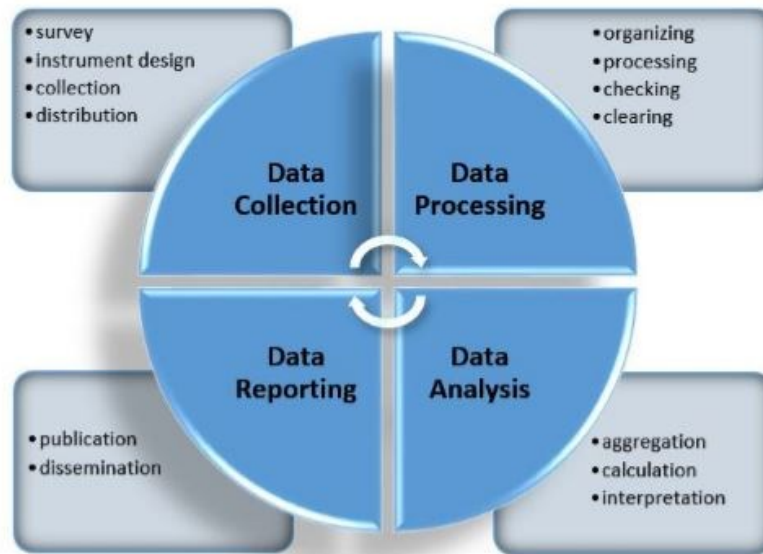


Figure 2.4 Typical Life Cycle of EMIS Information (Haitham, 2009)

## **2.6 Technology Engagement with the Kenya Police**

The lifeblood of modern policing is based on information, in other words the management and collection of information is fundamental and very critical in any police organisation. Organisations are able to collect and record a profusion of data thanks to the current technological infrastructures. According to Dunworth and Julie (2000) this kind of information has the potential to “revolutionise” policing in unseen ways. The only problem which goes down to the directors and the analysts is what they will do with the information, computing out how to make the data helps the police in achieving their goals.

The National Police Service has limited incorporation and engagements with ICT, Interviews from police officers in Langata police station revealed (Likaka, 2014). Police patrolling in the streets do not have airtime for work; a number of them are issued the VHF radio, which are rarely used. A good number of officers, however, have smartphones and access the social media for entertainment and socialising. Some of them use the smart phones to access routes but majority use them for personal work (Likaka, 2014). However, Some security individual are using other platforms, like for instance Chief Francis Kariuki in Kenya uses twitter to communicate with the people of his village on security matters (Sitole, 2012). The research looked on to his twitter account and he is still using twitter as at February 2017.

Likaka (2014) carried out a survey which concluded that the police needed new technologies for enhancement of communication while patrolling, also on the conclusions, the introduction of digital records would be handy when compared to the current way of “pen and paper”, this would enable easy reporting of incidences and convenient storage and retrieval of crime related data thus fast triangulation and short period of investigations.

## **2.7 Current Technologies for Tackling Crime in Kenya**

### **2.7.1 Tackling Crime Challenges Using ICT**

The use of ICT is highly gaining momentum and emerging as the best way to tackle, predict, and conduct crime investigations (Habibat, 2014). *Sisi ni Amani Kenya* is an ICT initiative example used to aid security of the public through the use of SMS on mobile technology. However, the police are not using this technology in a systematic way, they only use it when we have prolonged outcry from the public. They use it also around the general elections, even though potentially such a tool may help the police in keeping law and order in terms of gathering the data

that have been given to them. They need to perform analysis and take appropriate actions such as deploying of patrols and conducting investigations (Likaka, 2014).

Another good example is Ushahidi, which allows collection of data in offline including video and photos, which can then be forwarded to the police. Ushahidi helps in getting information from victims through SMS, email, web application, and twitter too, it then organizes reports for rapid response across agencies. Ushahidi helped Kenyan citizens to tell stories through SMS and social media and relating the stories to the exact geographical location of where the incident occurred. In 2013 general elections, it was used for a short time as a crisis-mapping platform for early warning and appropriate response from the police (Likaka, 2014). Just like *Sisi ni Amani Kenya* it is not being utilized by the police consistently.

## 2.8 Crime Gathering Existing Solutions

A number of solutions exist for gathering information from the public. This section will provide some of the existing solutions and how they work. A Kenyan based system called *Najua* allows users to make submissions on crime in their surroundings; the users can report confidential information on corruption, terrorism and other crime forms to relevant authorities. The message is usually copied to the relevant security organs including the Inspector General of Police and Cabinet secretary of Interior and Coordination of National Government thus the police will be accountable for lack of prompt action. The system, however, does not provide any analysis part or filtering of spam data that comes in meaning the police can easily get false and misleading information and reports. Figure 2.5 shows the *Najua* application.



Figure 2.5 Najua Application

(Adapted From <https://play.google.com/store/apps/details?id=com.najua.optimax.najua&hl=en>)

*TipSubmit* is an application that allows users who are called tipsters to make submissions to law enforcement agencies. The application exists in phone, web, and SMS. The tipster can easily include videos, images, and a little description of the tip at hand. The application allows for real-time chat between the tipsters and enforcement agencies (Agingaba & Akotam, 2013). This application is being run by civilians, the tips sources remain anonymous and unaccounted for, the application is not used for investigations or prosecution either, however it allows for cash rewards to tipsters on reports related to sex offenders. Figure 2.5 and 2.6 shows the tipSubmit application.

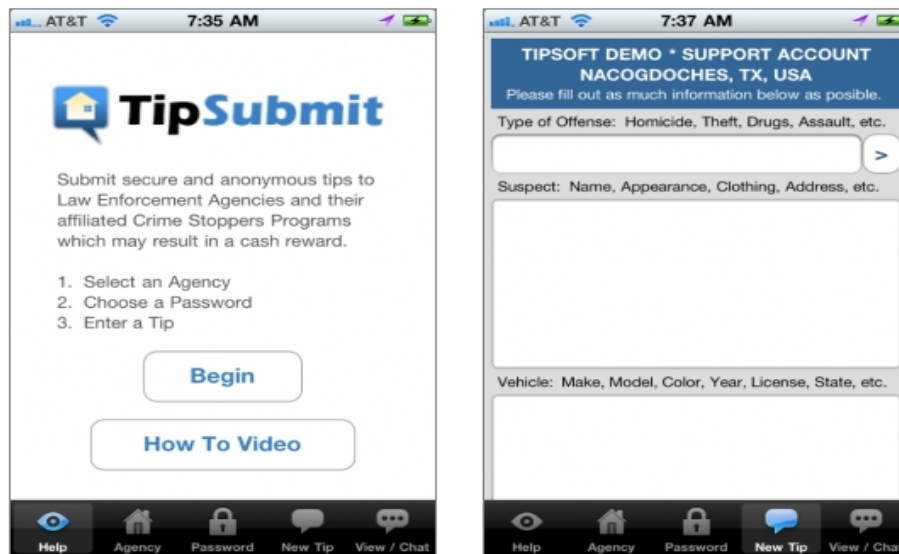


Figure 2.6 TipSubmit Screen Shot (Agingaba & Akotam, 2013)

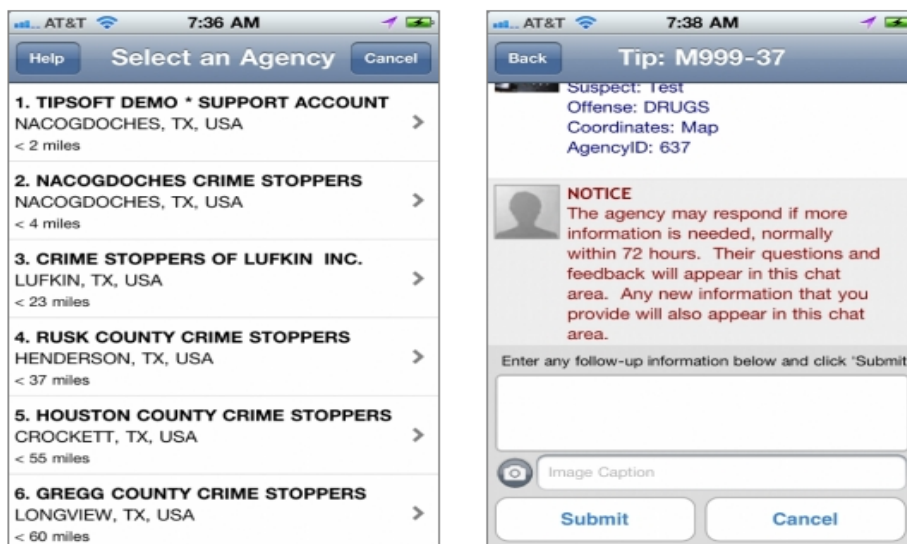


Figure 2.7 TipSubmit Screen Shot (Agingaba & Akotam, 2013)

*Accurint* application developed by LexisNexis is a mobile application that connects the law enforcement agencies and the government to records and tools for investigations and verification when in the field. The application allows for search ability of the local criminal records from various databases instantly. The application allows for easy organisation of data that aids easy decision-making (Jennifer, 2013).

*Web-cast* is a system that shows crime data trends, it shows the types of common crimes that occur and the respective places. Graphs are produced when one types the type of crime, location and even weapons used (Agingaba & Akotam, 2013).

*Pronto* a digital notebook launched out through Great Britain enables the capture, use, storage and sharing of information from field contacts, witnesses and offenders. It allows the police to work in dynamic ways in that it reduces the time which is usually wasted on travel, it saves on costs for example the savings predicted due to Pronto was about 18 million pounds each year. The application gives the user's ability to use backend systems in the frontline too. The Dyfed-police also prioritised a range of activities which would move them from using the paper forms which include, direct crime, reports, traffic processes and domestic abuse too (Airwave, 2013).

Samsung Galaxy note 3 designed a special application, which was rolled out to four thousand police officers of the Yorkshire to replace their notebooks. The application allows officers record a crime without returning to the police station. The application allows police to take electronic witness statements on the spot and fill forms too. The UK police have embraced technology to an extent of the west midlands having invested close to 25 million euros, this support was on technology to help police solve and prevent offences. The introduction of the mobile devices enabled the officers to spend more time with the communities and work effectively (Gilbert, 2014).

According to Jane (2013) a technology reporter with BBC electronic notebooks are being used by many police forces, Lothian and Borders police in the UK was the first to introduce it back in the year 2004. PDAs were originally being used, the introduction of the electronic notebook led to reduction on authority, which allowed the force to cut those operating the crime bureau from 34 to 13. The application has led to an estimated savings of about £700,000 in only crime reporting. The system led to creation of more data, which by the year 2013 it had 97,000 interviews, three million names, and more than 445,000 witness statements.

## **2.9 Gaps and Limitations**

The process of intelligence relies upon the ability to obtain and use data. The major problem that lies ahead is the collection and storage of the data, which may come in different forms, electronic, and hard copy. Thus, care must be taken in this early stage, as it is the determinant of the results to be found in the other phases. A collection plan in which the information is needed should be identified, the means of acquiring it also laid down, this is imperative so that we have assurity of the order and clear precise collection of relevant information. The collection plan will include all the relevant information categories that are relevant to the analysis, the data items needed to do the analysis, contacted sources, and when it was taken (UN, 2006).

The methods used by police of notebooks has been replaced by an e-notebook where they can be able to take notes from an informant in a crime scene, take details of suspects, pictures, voice statements and save them. This information is organised and thus easy to reference and make reports easily. Retrieval of information and searching and collection of information is easy as it can be accessed by another officer once it is put in the database also its easy to access all the cases including contacts of informants and suspects whenever one is in the field.

Law enforcement use of e-notebook to aid in criminal investigations will continue to be an important tool in collection of data, sharing, preventing crime, and identifying evidence and individuals associated with criminal activity. The adoption of formal policies and processes within agencies will lead to a unified, consistent approach to modern technology usage. As the police will become even more familiar and comfortable using it, they will continue to find robust and comprehensive ways to incorporate emerging needs to be included in the platform, thus yielding additional success in having more data thus analysis will help in and interrupting criminal activity, closing cases and ultimately solving crimes easily (UN, 2006).

Crime prevention and intervention also can happen when we have analysis of data, the analysis report may have arrest data, criminal history, field interviews, and this may lead to prediction and easy intervention through investigations. Analysis has largely grown to a specialisation and needs skills that are specific and understanding of police business (Hickman, Hickman, & Reaves, 2003) concluded that knowledge is the linchpin of control and prevention of crime. These conclusions were based on both Kenya and all over the world.

## **2.10 Conclusions**

This chapter has discussed the background of the research highlighting the growing need and demand of a criminal knowledge base system. The problem under discussion was how to save the precious time wasted by police while collecting information and sharing. Various models were also discussed from the health and education sectors, which showed how information is managed. Various applications both local and international were also highlighted. The next chapter will discuss the research methodologies that were used.

## **Chapter 3 Research Methodology**

### **3.1 Introduction**

The literature review has shown how information is being collected, stored and the importance of the data. It has also shown us how the use of information technology can be adopted for effective collection, retrieval, and storage of data. In this chapter, we had a description of the software research methodologies that were used to answer the research questions from chapter 1, which gave a description of the design and the various methodologies to be used to implement an investigation and knowledge base application. The chapter will also give an outline of the development, testing, and validation methodologies that will be used.

### **3.2 Software Methodology**

Agile Development Methodology was used in the development of the proposed application. This methodology combines both iterative and incremental processes with focus on quick adaptability of the process for the satisfaction of the customer by rapidly delivering a working software. The methodology is divided into period's tasks, to come up with specific features for release. The iterations are aimed on delivering working software build at each subsequent iteration (High smith, 2011). Petersen and Wohlin (2009) suggested that Agile Development Methodology is good to use because it helps team compete and is perfect for long projects. Agile accepts changes to an application without long impact, it allows users to participate, and lastly they insist on its ability to allow late changes in the application.

Agile development methodology has got five main phases as shown in Figure 3.1, they include Planning Phase and Requirement Analysis Phase, Design Phase, Building Phase, Testing Phase and lastly Evaluation Phase(Vijayasathy & Turk, 2008).

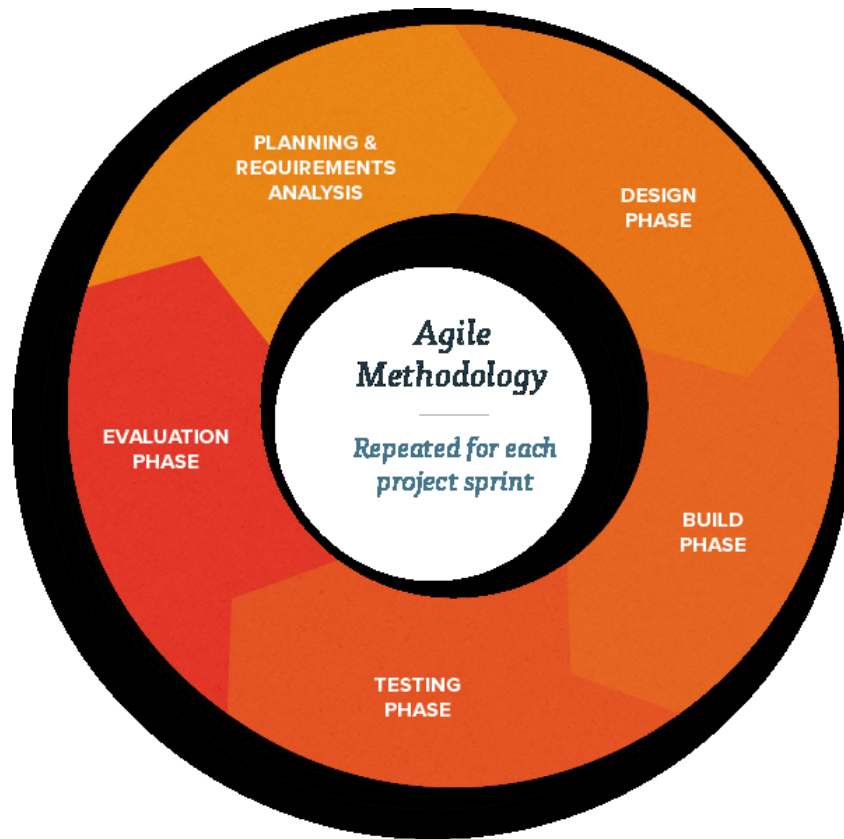


Figure 3.1 Agile Development Diagram (Adapted from Agile Methodology, 2016)

### 3.2.1 Planning Phase

This is the initial phase of the methodology whose main function is to facilitate in planning how the whole process will be done. This phase helps to identify the resources that will be needed to achieve or to build the system and to provide a blueprint of how the system development process will be achieved. A Gantt chart was used for planning and enabled the study process have a plan of starting and ending the project in terms of scheduling and time management (Pekka et al., 2002). This Gantt is found in Appendix E.

### 3.2.2 Requirement Analysis Phase

This is the second phase; it involved analysis of the requirements of the system. The Analysis helped to reveal important information like the environment that will be needed to develop and test the application, the parameters needed to be in place for the successful development and reveal what the client wants. To start with, a review of the ways and techniques of how the police and other sectors like health and schools collect and manage data and intelligence

was done, also from the literature review, books, journals, articles and electronic accepted website sources was used to understand how the police operate and the problems they encounter.

Secondly, the requirements information of the solution was also collected from respondents who included police investigators living within the confines of Nairobi and other parties like private investigators. The information was collected with questionnaires and interviews. This questionnaire is found in Appendix B. As for the feedback about the use of the system, another set of questionnaires in Appendix C was used. These methods were chosen because of their high chance in providing accurate information that is first hand which will be helpful in understanding the scenario on the ground, as well as provide information which will be useful in coming up with requirements and evaluation of the application.

**i. Location of Study**

The location of study for the research was in Nairobi Kenya, Police experts in investigations and intelligence gathering persons private or public who were located in Nairobi were involved. Nairobi was chosen because it has high crime rate in the whole country compared to other counties and most investigative officers are in Nairobi because of the high population.

**ii. Target Population**

The target population comprised of police officers and private investigators. The respondents from the police are investigators who have done the job for a long time, this was the group used by the researcher to make inference and getting requirements.

**iii. Sample Size**

Non-probability sample technique was utilized, where the sample population was divided into stratum to represent the different police stations selected and respondents invited to fill the quota required for each of the stratum.

$$n = \frac{z^2 pq}{d^2}$$

n=the desired sample size

z=the standard normal deviate set at 1.96 which is 95% confidence level

P=the proportion in the specific population to have a specific characteristic

$$q=p-1$$

d=absolute precision set at 0.05

Equation 3-1 Sample Size Calculation (Moazzam, 2014)

Equation 3-1 shows the formulae that were used to derive the population, this means that everyone had an equal chance of being in the sample population. The respondents were 30 in number, calculated with a confidence level of 95%.

#### iv. Sampling Strategies

The sampling strategy selected for this study was Quota sampling. The subjects were divided into groups and were selected simply because they are easiest to recruit for the study (Mugenda and Mugenda, 2003). This strategy was selected because it involved direct user participation in the gathering of information about career guidance through answering online questionnaires sent via email.

### 3.3 Data Analysis Functional Modelling

Pre-formulated questionnaires were done by use of Google forms for data collection, analysis of the data was done using Google analytics tools that provided charts and graphs. For comprehensive analysis and modelling of the user, requirements object oriented analysis was used. Their after concepts of objects was used to make a good understanding of the system design. For the database, modelling the **relational database schema and ERD** diagrams was used which will also describe the tables, relationships and the attributes. DFD diagrams were appropriate for the implementation the general view of how data will flow, finally the wire frames showed the process flows of the mobile application. Edraw was the tool that was used to come up with all the design diagrams (Lori , 2016).

### 3.4 Design Phase

Unified Modelling Language (UML) notion was used for modelling and designing diagrams to offer a clear picture of the system to be developed (Object Management Group, 2015). The study employed four different UML diagrams for its design. These diagrams include a use case diagram, relational database schema, ERD, DFD level 0 and 1.

### **i. Use Case Diagram**

Use cases were used to identify and separate system functionalities in terms of who is responsible for it, thus coming up with actors and uses cases. The actors of this system are police officers, system administrators and data manager. The use case is in text for describing the action performed by the actors on the system (Object Management Group, 2015).

### **ii. DFD (Data Flow Diagram)**

This was used to show the overall look of the system and the flow of data (Object Management Group, 2015).

### **iii. Database Design**

A database design was generated out of the entity relationship diagram (ERD) that shows various entities and their attributes and how they are related to one another (Object Management Group, 2015).

### **iv. Wireframes**

Fluid UI was used to design the wire frames, Fluid is an online tool used for designing of mobile applications (Bona, 2014). Through this the developer had a clear view of how the interfaces were to look like and also in terms of the total user experience.

## **3.5 Building Phase**

In this phase, the actual development of the designed system took place. During this phase, the relational database was developed, designed wireframes were transformed to the actual system with interfaces corresponding to the wireframes and functionality added.

### **a) Prototype Development**

This involved coming up with a mobile application and web application for admins. Both the mobile and web application were connected to the central database. The application development environments that will be employed include

- i. *Mobile Application.* A mobile application that run on Android Operating System was developed. Java programming language was used to develop the mobile client. Data will be passed between the mobile application and the database in JavaScript Object Notation (JSON) format (Douglas , 2013). The application was ran and tested on Android device. Android devices were chosen due to high number of

target users using devices running on Android, it is open source, a large online community exist hence freely available support.

- ii. *Web Application.* Phalcon development framework was used to develop the web application for the back end (Aidan, 2015). Php is supported in many web servers and databases and can allow security features to be implemented such as cross-site scripting and SQL injections, thus convenient for this research.
- iii. *Database.* MySQL database management system was used to store application data. MySQL was selected because of its high performance, it is open source and there is a lot of support from its open community (Nick, 2017).

### 3.6 System Testing

Testing was done on each module that was developed. This ensured that the application was according to and meets the stakeholders needs. A number of tests was done on the system including

- i. *Functional Testing.* Functional testing was carried out to ensure the system met the user and stakeholder needs. To achieve this, there was testing after the development of each module. End users who are the police, data managers and system administrator ensured the system matched all the requirements that were outlined during the analysis and design phase. Both functional and non functional tests were done by engaging with the system and later feeling in questionnaires.
- ii. *Usability Testing.* Usability testing was carried out on the system to ensure that the system could be used by end users with a lot of ease. To carry out this testing a sample of end users who were previously selected through non probability sample technique to get the requirements were used again and given the prototype of the system to use it. They recorded all the difficulties they met while using the system on a questionnaire that was provided. Duration of using the system as well was recorded and then analysed. Also users were observed as they interact with the system, all this showed how usable the system was.
- iii. *Compatibility Testing.* Compatibility testing was carried out to ensure the system was compatible with all modern browsers and Android operating system versions. Some of the browsers included Mozilla firefox, Chrome and internet explorer.

- iv. *Integration Testing.* Since system features were developed as modules, there was integration testing that was done to ensure that once the overall process of integrating the different modules was done, the system behaviour would not change.
- v. *Load and Stress Testing.* Load testing was also carried out on the system to determine the amount of time the system took to respond to a given number of users. Stress testing also was done and it determined the maximum number of users the system was able to support. When carrying out this test, we assumed the other factors like network performance were constant.

### **3.7 Validation**

Police investigators who participated in the gathering of requirements through questionnaires were involved again to validate the system through questionnaires. The process informed the researcher that the system indeed behaved the way it was expected. The research was able to find out that indeed, it solved the problem of police gathering intelligence data and having a common knowledge base, this was only validated by the users who are the police. With all the test cases done, it proved that the system in place was valid and beneficial to the entire policing process. This was also supported by 28 potential users.

### **3.8 Ethical Considerations**

Consent and confidentiality were considered during the data collection process to avoid any issues that would affect the research and the respondents. Therefore, their names and other details were excluded from the interview and questionnaire forms that were used. The correspondents were also be assured of the confidentiality of their responses and told their role in the research.

## **Chapter 4 System Design and Architecture**

### **4.1 Introduction**

This chapter discusses the system design and architecture of both the front-end and back-end of the application and the design tools required for implementation of the application. The research questions and objectives were used to guide the discussions in this research. In order to design and develop a mobile application to allow the police document criminal activities occurring and recording of suspects in their daily activities and investigations, system analysis was performed and various diagrams such as use cases and others were drawn and detailed information for each design was illustrated.

### **4.2 Requirements Analysis**

The requirements were elicited from different people that included police investigators, sponsors, data managers, and private investigators. Data was collected through different data collection tools and analyzed to come up with the requirements for the proposed scheme to meet their requirements. From the analysis, the following requirements were identified and divided into functional and non-functional requirements.

#### **4.2.1 Functional Requirements**

This explains the function the system developed as a proof of concept will perform and they include

- i. Search suspect, the user can search for a suspect and check their data.
- ii. Search case, the user can search for a case and check data.
- iii. View profile, the user view a suspects or informants Bio profile.
- iv. Upload suspects, witnesses and informants, the user can upload suspects, witnesses, and informants on specific crimes.

#### **4.2.2 Non-functional Requirements**

These requirements explain the conditions that the system should perform the functions it is meant to do and they include

- i. Usability, the system should be easy to use and interact with.
- ii. Performance, the response time should be acceptable.
- iii. Reliability and availability, the system should be reliable and available anytime to perform user tasks.

### 4.3 System Architecture

The system architecture comprises of the mobile application which communicates with the MS SQL database that interfaces with the back end web system where the system reads data from the database. The front-end users of the application possess a smartphone where he/she captures the details of the criminal, suspect, or informant. Personal information or bio-data of the interviewee will be captured by the police themselves. The back-end user will have access to the criminal's data from where he or she can view the details of the criminals. Data analytics is also done on the back-end giving insights on the criminals in terms of cities, towns and gangs and crime type. Figure 4.1 shows the architecture of the system.

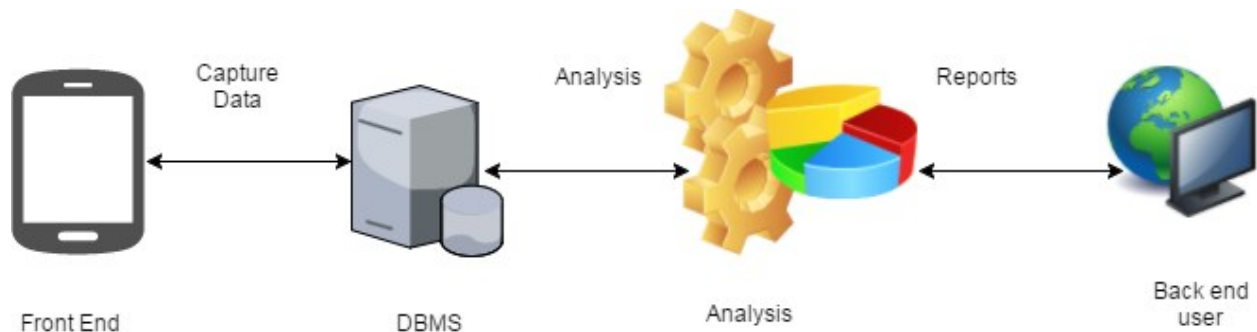


Figure 4.1 System Architecture

#### 4.3.1 Client Side

Police investigators should have smart phones to be able to submit reports on any suspicious or intelligence information from criminals or informants during their patrols and investigations on cases. Automated forms on the application will enhance the capturing of the data; this includes bio-data, crime type, workplace, and residence and so on. The captured data is then saved on the database that runs on MySQL that stores all the data captured by the police.

#### 4.3.2 Server Side

The server side is a web-based portal for admin that shall have access to the logs of the various type of data submitted by the police from their mobile applications. The server side has a provision to send requests to the client side as they request for more information. Data analytics is performed on the data details that are stored in the database. JavaScript libraries will be used to generate the charts and graphs for presentation on the web-based application and Android libraries such as Android Charts will be used for generation of the charts and graphs on the mobile interface.

## 4.4 Data and Process Modelling

### 4.4.1 DFD Models

The data flow diagrams will be used to show how the data moves through the system.

Figure 4.2 shows a Level zero DFD of the system

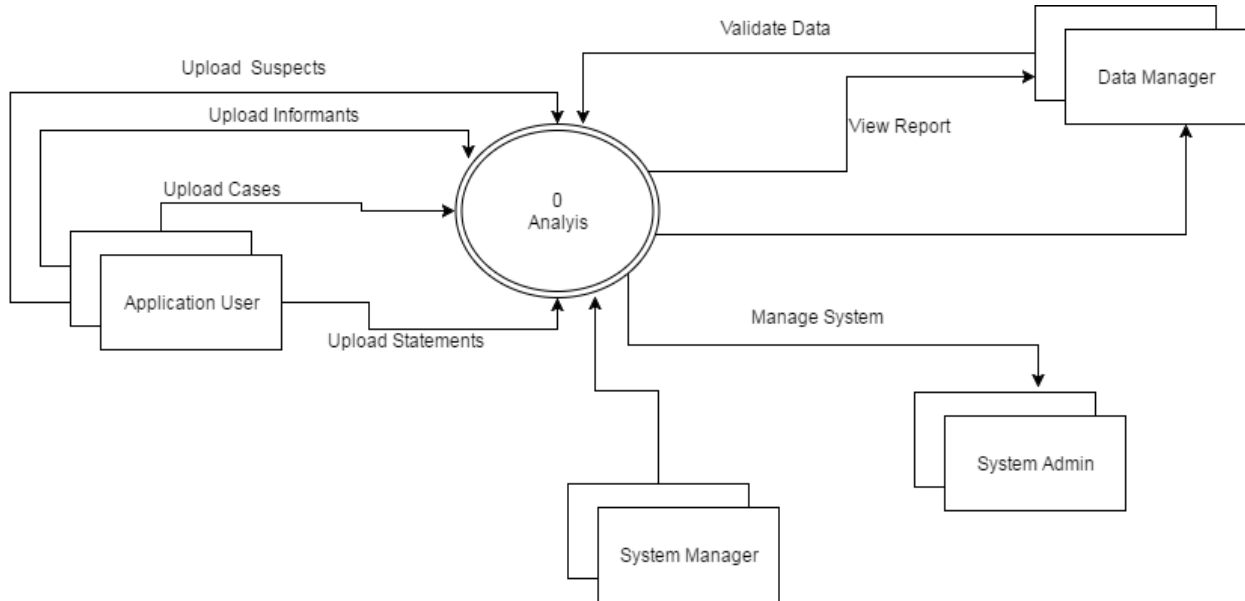


Figure 4.2 Level zero DFD of the System.

Figure 4.3 shows a DFD Level 1 for the system. It shows the various sub processes that make up the entire system information flow among entities is shown.

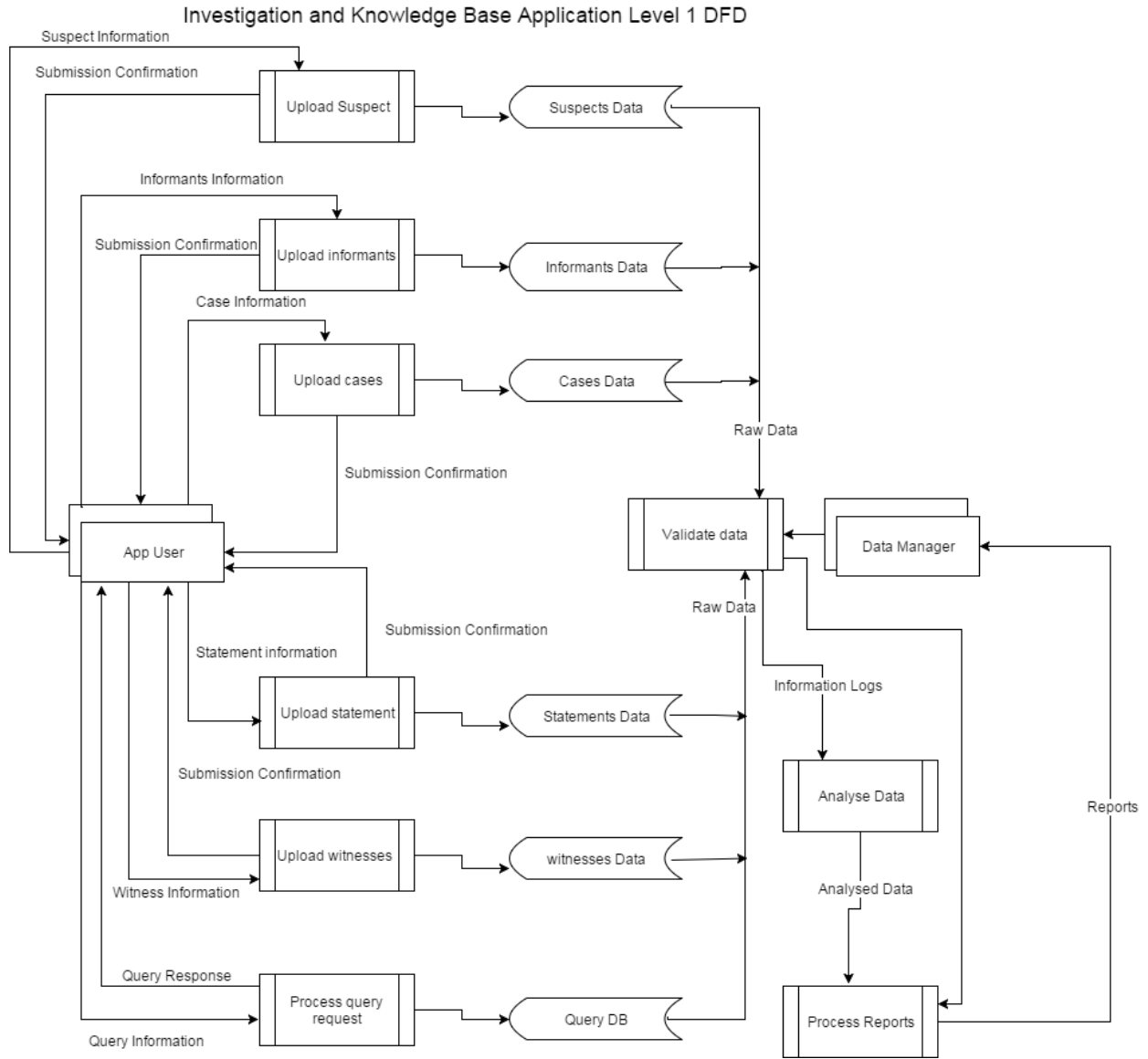


Figure 4.3 Level 1 DFD

#### 4.4.2 Use Case Modelling

The use-case diagram shows the different actors who interact with the system and their roles in the system. The mobile application will require registration in order to upload or query any information. Figure 4.4 illustrates the use case diagram



Figure 4.4 The Use Case Diagram

The police will be the main user of the application who will first need to be registered upon which they can do their work. They can upload informants, suspects, witnesses with all the statements. The data manager will be viewing reports and validation of data. On the other hand, the system administrator will be responsible for maintaining the system.

## 4.5 Database Design`

The database design of the system will be presented in two ways. The relational database schema and ERD.

### 4.5.1 Entity Relationship Diagram

The Figure 4.6 is an Entity Relationship Diagram (ERD) that shows the database design of the Investigation and Knowledge Base System. It shows the primary keys and the foreign keys of the tables and the kind of relationships between the tables.

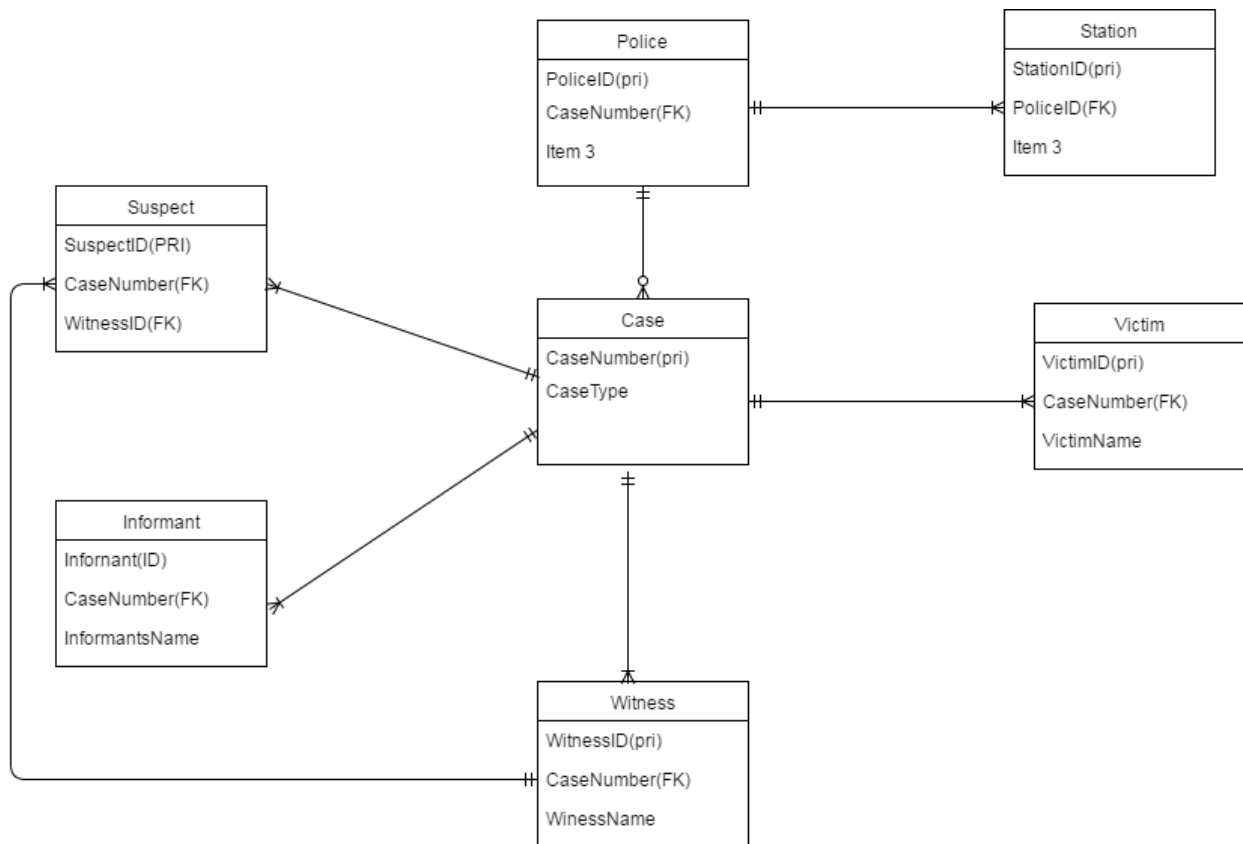


Figure 4.5 Entity Relationship Diagram

For explanation of the major tables in the database, see Figure F.5, appendix F.

## 4.6 Network Design

The police information management data will be anchored on the existing police servers thus no physical network configuration will be required from the side of the client except internet

availability. The existing platform is preferred due to its accessibility from anywhere and anytime and being cost effective since the client does not have to worry about the network setup.

#### 4.7 Security Design

Criminal related data needs to be kept confidential and private and therefore the system will have measures that protect all this data from unauthorized access. A PHP web framework Phalcon is implemented for the backend, it ensures that there is no any unauthorized access by elimination of SQL injections, it also ensures security by using of encryption algorithms to be used on passwords and use of time outs.

#### 4.8 Wireframes

On the mobile application, a user is required to register and then sign in. The mobile user, who is mostly the frontend user, can add the data but only the data manager using the web application can view the analytics. Figure A.1 in appendix A, shows the log in page. After logging in, we have the home page, in the home page depending on who the informant is, the user will select the required button. Among the buttons, we have witness, informant, victims, witness, and suspects and lastly search. Their wires frames are A.2, A.3, A.4, and A.5 respectively. Upon selection, any of the buttons an interface to take the bio data, pictures, and statements in recording will appear, filled, and then saved. The user can the later search some of the interviews he/she has done.

### POLICE FIELD INTERVIEW

Log in

**UserName**

**PassWord**

No account?

**Register**

Figure 4.6 Login Page

Login

login

Password

\*\*\*\*\*

Remember me

Register Login

Figure 4.7 Login on Web Page

Only the administrator will be able to log into the back end system and be able to edit and add data and download analysis depending on what is needed at the time.

## Chapter 5 Prototype Building and Testing

### 5.1 Introduction

This chapter focuses on the development of the police knowledge base for investigations and explains the implementation of the system functionality and the requirements needed the application to function. Screenshots were provided to show the different modules and how the user interacts with the application.

### 5.2 Functionality of the System

The functionality of the system can be categorised into the front-end and back-end functionalities.

#### 5.2.1 Front-End Functionality

##### *a) Registration and Login*

Once a user has accessed the application for the first time, the first step is to create an account and upon being successfully registered, a profile is created for them. The user can then be able to access the services after login.

##### *b) Crime Data*

Once the user is signed in, he/she can submit the crime related data to the system's back-end.

#### Back-end Functionality

##### *a) User Registration*

The user registers and is granted administrator's rights meaning he/she has higher access privileges compared to the front-end user. The user can therefore access more functionalities compared to the front-end user.

##### *b) Crime Data*

The backend user can access a suspect's data, which include their crime related history, bio data, description of looks, gangs, family friends and any triangulated information that is linked to him or her.

##### *c) Data Analytics*

All crime data is subjected to analytics, which are meant to reveal the various aspects such as, most crimes committed, trends of crimes, gangs and relationships between the suspects and most importantly for investigations.

### **5.3 Hardware Environment**

The application runs on an Android device version 5.0.2 (lollipop) quad-core processor of 1.3 Gigahertz of processor speed, 1 Gigabytes RAM capacity, and a 16 Gigabytes hard drive capacity with a 5.5-inch screen size. Desktop computer specifications include a 4 Gigabytes RAM capacity, core i3 processor of speed 1.9 Gigahertz and a 750 Gigabytes hard drive capacity.

### **5.4 Software Environment**

The mobile application runs on an Android Operating System with the source code written in java. The application was compiled and tested using the Software Development Kit, (SDK) and an Android device. The application is compatible with the latest Android version 6 down to Android devices on a minimum of version 2.0. SQL is used as the database query language and JSON used as the web service language for communication between the database and the Android front-end. Android is preferred due to its large online development community, availability, and ease of use of Android Development Tools (ADT).

The web application is developed on a PHP framework, which is Phalcon 3.0.1 and hosted on an online apache HTTP server. PHP; Phalcon was picked since it is open source and has a large community of online developers, implements the HTTPS protocol that prevents online attacks. PHP is also platform independent and compatible with all major web servers and databases.

The database runs on MySQL since it is compatible with PHP and it is open source. It ensures encryption of passwords before storage and therefore eliminates unauthorized access into the system.

### **5.5 System Modules**

Users interact with the system via the various modules on the application. The major module of the system is shown in the screenshot below.

#### **5.5.1 Systems Home Page**

Users gain access to the application through logging into the system. Login requires a user to supply their police email address and password. A user gets the login credentials through registering or creating an account in the system. The Figure 5.1 shows the home page of the application. The user will select any button to fill in details of the informant who may be a suspect, victim or witness and save. Later they can search and edit.

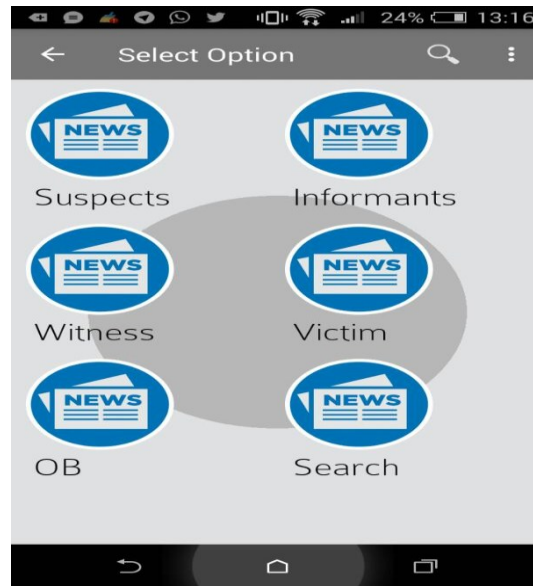


Figure 5.1 Home Page

Once the users logged into the system they will be redirected to the main profile screen, the login is shown in Figure D.1 of appendix D. The main profile page contains links, which include; witness, victim, informant and suspect. The screen is shown in Figure D.2, D.4, D.5, and D.6 respectively of Appendix D. The data back end is shown in Figures D.5, D.6, D.7, D.8 and D.9 of appendix F. Figure 5.2 shows the home page of the systems web back end. From the back end we have users, location, color, counties, crime types, race, station and city, upon clicking on any of them the administrator is able to add more information like for example the administrator can add more cities, more counties and location. All this will be added in the mobile application.

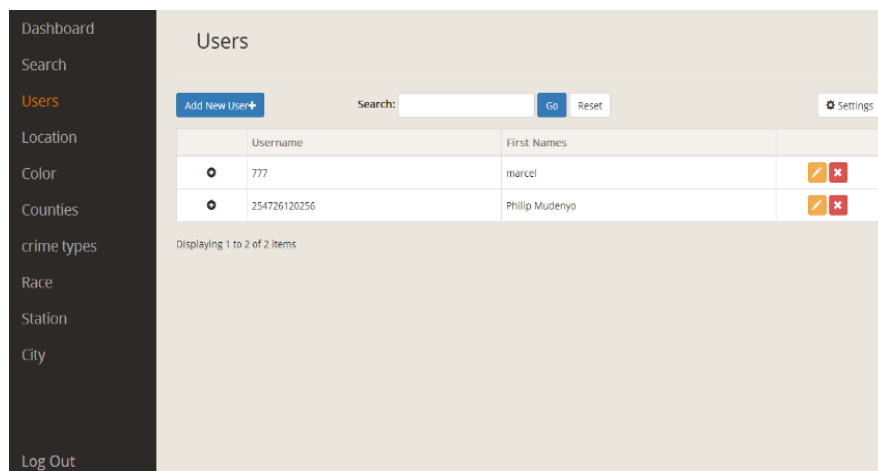


Figure 5.2 Home Page

## 5.6 Testing

This section describes tests that were performed on both the mobile and web application. Testing was done on four main areas; functionality tests, usability tests, compatibility tests and security tests.

### 5.6.1 Functional Testing

Functional tests were carried to determine whether the system design and its implementation was a success or a failure. Different use cases of the system were tested with results being flagged off as a success or fail. Figure 5.3 shows the results where 79% agreed on the idea that the systems design and implementation was successful.

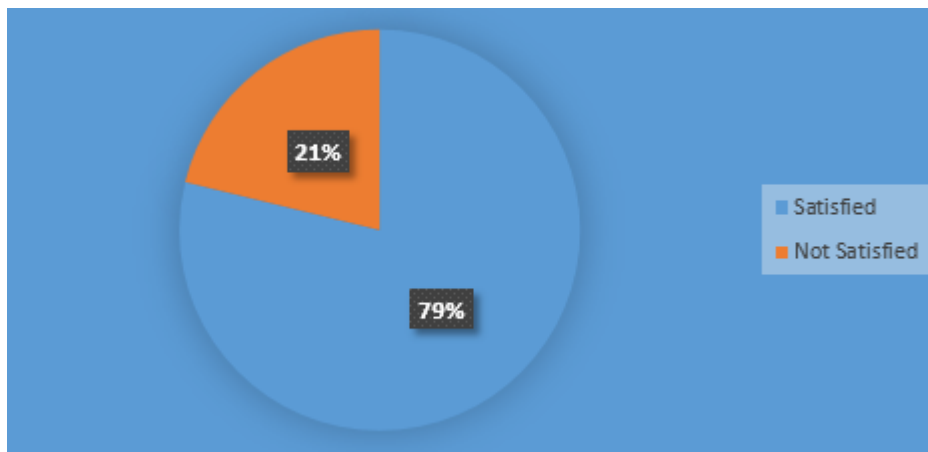


Figure 5.3 Users' Functional Testing Response.

#### 5.6.1.1 User Account Creation

The use cases of the system were tested with results being flagged off as a success or fail. The login and log out test case were done; see Figure F.1 on appendix F. Other functional tests done were Add informant, Add case, and search, see Figure F.2, F.3, and F.4 simultaneously on appendix F. Table 5.1 shows the description of user account creation.

Table 5.1 User Account Creation Test Case

Test Case Name Creating User Account		Test Case 1	
Brief Description Users create their accounts by filling all the registration fields then they are required to press the submit button and upon successful submission a user account is created.			
Pre-condition The user should have downloaded the application from the Google Play Store to be able to use the application.			
Step	Action	Expected results	Pass/Fail
1.	User runs the application.	The application loads the login page.	Pass
2.	User taps on the register link to create an account in the system.	The application loads the registration screen.	Pass
3	The user fills all the required registration fields and taps on the submit button.	The application returns a success message and redirects the user to the login page.	Pass
Post condition User can now have access to the system by logging in.			

## 5.7 Analytics

Table 5.2 Analytics Test Case

Test Case Name Analytics		Test Case 6	
Brief Description Once the user is logged in he/she can process analytics on the data or other crime factors.			
Pre-condition The user should be logged in to the system.			
Step	Action	Expected results	Pass/Fail
1.	User logs into the application.	The application loads the service menu.	Pass
2.	User taps on the analytics data within the menu.	The application loads the analysis form with an option of displaying the analytics.	Pass
3	The user keys in the analysis details on the form and can generate the analytics.	The system displays a visualization of the data analytics.	Pass
Post condition The analysis can be used for decision making			

### 5.7.1 Usability Test

Usability testing was carried out to ascertain the user friendliness of the system and how a new user interacts with the system; whether they experience ease of use or not. The responses were shown in the Figure 5.4 where 82% agreed on the system being user friendly.

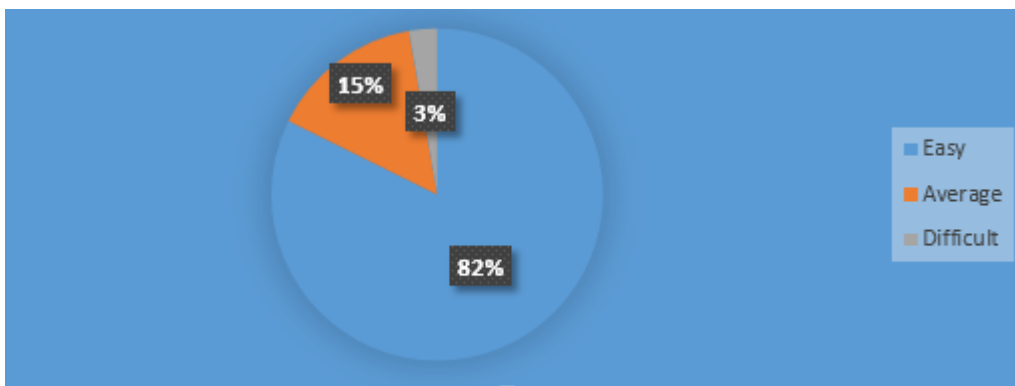


Figure 5.4 Usability Testing Response.

Table 5.7 shows the usability Tests Performed

Table 5.3 Usability of the Application Test Case

Test Case Name Usability of the Application.			
Test Description Test for Usability Application.			
Pre-Condition Application launch must have been successful.			
Post- Condition Ease of use of the application by the system.			
Step	Actions	Expected Response	Result
a)	Users can access the menu items and interact with them seamlessly.	Menu items should be visible, clickable, and functional.	Pass
b)	Users can navigate on the application with ease.	An appealing user interface with the components well in place.	Pass

### 5.7.2 Compatibility Testing

Compatibility testing was done to ensure that the system; both the mobile and web application are compatible with the existing platforms. Mobile application was tested on the existing Android versions while the web application was tested on the all the major web browsers.

### 5.7.2.1 Android Platform Testing

Table 5.4 Android Platform Testing

Android Platform	Compatible
Android 10 – 2.3.3	Yes
Android 11 – 3.0	Yes
Android 12 – 3.1	Yes
Android 13 – 3.2	Yes
Android 14 – 3.0	Yes
Android 15 – 4.0	Yes
Android 16 – 4.0.3	Yes
Android 17 – 4.1	Yes
Android 18 – 4.2	Yes
Android 19 – 4.3	Yes
Android 20 – 4.4	Yes
Android 21 – 4.4W	Yes
Android 22 – 5.0	Yes
Android 23 – 5.1	Yes
Android 24 – 6.0	Yes
Android 25 – 7.0	Yes
Android 26 – 7.1	Yes

### 5.7.2.2 Web Browser Testing

Table 5.5 Web Browser Testing

Web Browser	Compatibility
Internet Explorer – Version 4 and above	Yes
Mozilla Firefox – Version 4 and above	Yes
Chrome – all versions	Yes

### 5.7.3 Security Testing

Security testing was carried out to ensure there is authentication and authorization into the system and to ensure that input validation is properly implemented into the system. The table below shows the test case carried out.

Table 5.6 Security of the Application Test Case.

Test Case Name Security of the Application			
Test Description Test for Security of the Application			
Step	Action	Expected Response	Result
a)	User Authentication	Login credentials are checked against what is in the database to find a match between the two. The password is then encrypted before it is stored in the database.	Pass
b)	Input Validation	User's input is checked to see if it is of the correct format and whether it meets the requirements.	Pass

#### 5.7.4 Validation Testing

The validation process was done to ascertain whether the information and knowledge base system contained mistakes when the user used it. This was solved by the police themselves engaging with the system and later was provided with a questionnaire to fill in their responses. Validation response questionnaire are shown in Appendix C .For the back end, validation was done using the W3 validation service tool, which can validate HTML for ensuring it conforms to HTML 5 standards. Below Figure 5.5 shows the table of results for HTML 5 validation.

PAGE	PASS/FAIL	COMMENTS
Register	PASS	No Problems
Home	PASS	No Problems
Crime Type	PASS	No Problems
Users	PASS	No Problems
Color	PASS	No Problems
County	PASS	No Problems
Race	PASS	No Problems
Station	PASS	No Problems
City	PASS	No Problems
Search	PASS	No Problems
Location	PASS	No Problems
Dashboard	PASS	No Problems

Figure 5.5 The Results of HTML 5 Validation

## **Chapter 6 Discussions**

### **6.1 Introduction**

The purpose of this research was to identify the challenges facing the police while performing their daily routines of patrols and investigations. The other aim was to investigate the current techniques used for taking field interviews, conducting investigations, intelligence gathering, design, developing, testing of a mobile application and to validate the mobile application for identifying and uploading crime related data in terms of informants and suspects in Kenya. This was done in order to identify and develop a suitable technique that will be adopted to address the current challenges faced while collecting information and conducting investigations.

The mobile application was developed for the police who had access to a data enabled phone running an Android operating system. The web application was developed and could be accessed using a standalone computer, laptop, or mobile device. This chapter describes the research findings and achievements of how the research objectives were achieved and it provides a review of the application developed citing the advantages and limitations of the developed application.

### **6.2 Findings and Achievements**

A review of the literature indicated the techniques and the tools used by the police in getting information from the public. The manual process of performing investigations and taking of statements by the police is time consuming, tiresome and expensive. The mobile application platform is the most appropriate technique for collection of information and conducting investigations since it is fast, affordable, and very reliable. However, at the present, there is no unified system tool used for gathering intelligence and conducting field interviews during investigations in Kenya. This research will therefore improve on the online techniques for gathering intelligence and conducting field interviews in Kenya. Using a mobile application will maximise on the advantages of online and real time data an information sharing and bridge its gaps and limitations by providing a unified system for the police connected to easily known shared databases for gathering intelligence and conducting field interviews.

### **6.3 Discussion in Relation to Research Objectives**

This dissertation identifies the challenges faced by the police in collection of information or intelligence and conducting interviews based on journals, websites, books, and user feedback. A mobile and web application was designed and developed with a selected technique from the literature review and results from system analysis. The research objectives acted as a guideline to develop the mobile application.

The first objective was achieved through the functional testing that was done on the system. Users of the system were able to interact with the system by creating accounts and even inserting required data be it of suspect, informant, cases, or statements. The data sets provided on both the mobile and web application confirmed that indeed they were the required data attributes and types needed for the application.

The data sets captured by the system were also influential in enabling the ability of data analysis. However, the users gave useful feedback on areas that require improvement and some functionalities that need to be reviewed to enhance usability of the system. However, from the questionnaires issued out, the majority of users were comfortable with the system functionalities and the usability of the system, which they rated to be very high.

The second objective was to review existing algorithms, systems architecture and application used currently in investigations and data or intelligence gathering. This information was useful as it enabled the researcher to gain an understanding of the techniques used and identify the strengths and limitations of each technique hence choosing the best technique to be adopted. This objective was achieved by the review of literature based on the current techniques used for gathering of data and conducting investigations. Available techniques include use of notebooks and web based applications like Facebook to do data mining. Based on the literature review of previous systems the mobile platform emerged to be the best technique for gathering intelligence and conducting interviews.

The third objective was achieved through the development of the product which is both a mobile and web application. This is shown by the mockups of the system, the database schemas, and the entity relationship diagrams as shown in chapter four. Users interacted with the developed product before it was rolled out to find out if it indeed met the security requirements and a security, testing was done which had a good reception among the targeted users who participated in it. The

Phalcon framework and the system timeouts implemented helped enforce the security of the application.

The fourth objective was about validating the effectiveness of the solution and was done by users interacting with the system, managing the crime data information to find out how efficient the system was as compared to the previous way of managing crime data. The compatibility test done on the system also found out that the system could function well on different existing platforms. The system met the needs of the users as one of its main goal was to make it easier to collect information from the public and be able to use the information for investigations and the use of the analytics feature implemented in the system. This objective was therefore met with satisfaction from the users as it had addressed the main concerns the users had in managing data related to crime.

#### **6.4 Advantages of the Proposed Mobile Application**

- i. The application is very easy to use and straightforward.
- ii. The application can easily be adopted by users of all levels of education and technological backgrounds.
- iii. The application also incorporates a web application that makes it easier for the administrator and the professionals to store and manipulate data seen in the mobile application.

#### **6.5 Limitations of the Proposed Mobile Application**

- i. The mobile application is only usable by smartphone owners with Android operating system.
- ii. Some information on mobile application and the entire web application need Internet for one to access them.

## **Chapter 7 Conclusions, Recommendations and Future Work**

### **7.1 Conclusions**

The challenges encountered by the security personal, investigators, and crime solvers were determined in this research. The challenges include the storage of data related to crimes that is the informants and the perpetrators with all their links and affiliations. Another challenge is a proper record of analysis that could help track crime data, which help in investigations and being able to track a crime offender from different counties.

The main goal of the dissertation was to develop a mobile and web application that helped minimise the loss of data by police when they use notebooks and mainly have a criminal knowledge base. Thus, the mobile application comes into play by providing a solution that enables the police to collect data from criminals and informants directly when they are in the field. The mobile application developed will help and enhance the entire cycle of crime solving process right from investigations to prosecution or action taking.

### **7.2 Recommendations**

The developed system is very important for the police, as it will minimise the durations for investigations with time and aid digital recording of statements. However, the police should consider conducting of training the investigators on how to use the application. Workshops on the use of the application on both the front and back end would be very important. In addition, the deployment of the application could be specified for a specific android device across all the police force. The police should also consider taking of oath upon starting on the use of application for assurance of all information loaded is legal and truth otherwise on which there might be repercussions. The administrator should not be allowed to delete any information from the back end unless instructed by a court or higher authority through proper channels of the law; this could also have some sort of punishment.

### **7.3 Future Improvements**

There can still be improvement on the solutions from this research, research never ends and technology changes and improves overtime, thus, there is room for more discoveries. In addition, a mobile application can be built for other platforms available, formats that can be integrated with pads for better view, also better features like face, and figure print recognition can be integrated.

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## APPENDIX A Wireframes

Figure A.1 and A.2 shows the login, registration, and Home page to the application that has various links to the application.

**POLICE FIELD INTERVIEW**

Log in

**UserName**

**PassWord**

No account?

**Register**

Figure A.1 Login Page

**Choose category**

<b>New FI</b>	<b>+</b>
<b>Suspects</b>	<b>+</b>
<b>Informants</b>	<b>+</b>
<b>Witness</b>	<b>+</b>
<b>Victim</b>	<b>+</b>
<b>Shift</b>	<b>+</b>
<b>Search</b>	

Figure A.2 Form Categories

Figure A.3 and A.4 shows the witness and suspect pages, Bio Data and statement is recorded

**Witness**

Personal details

first name                      second name

nick name

**sex**                      Suspect name

**race**                      Suspect Details

**skin**                      notes about suspect and offence

**Build**

Case number

Record statement

**Next**

Figure A.3 Witness Bio Data

**Suspect**

**Subject Info**

**Identifiers**

**ID.Information**

**School Information**

**Parent Information**

**Employer information**

Additional notes

Record and take photo

**Back**                      **Next**

Figure A.4 Suspect Bio Data

Figure A.5 shows the wireframe screen of the victim while Figure A.6 shows search results



Figure A.5 Victims Bio Data

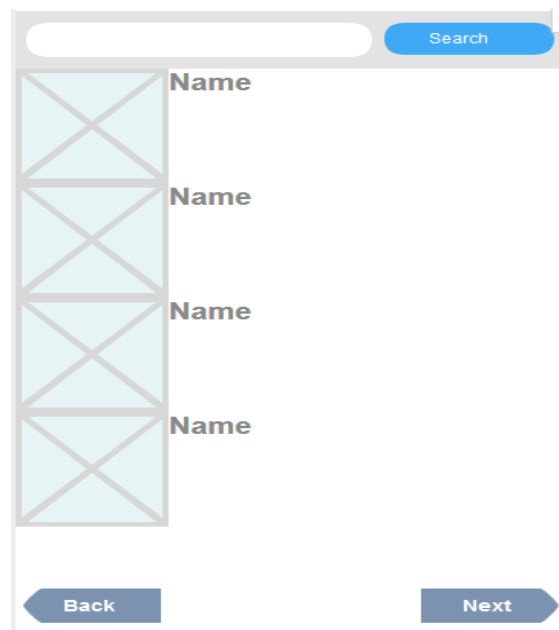


Figure A.6 Search Case

## APPENDIX B Requirements Questionnaire

Below is the questionnaire that was used to gather requirements.

### Requirements Questionnaire

#### Police Investigation and Knowledge Base Application

I am conducting a survey to help me gather requirements for a system I intent to develop for the police. I humbly request you to give me the problems you face during investigations and how you store and access data of criminals.

Respondents Name	
Occupation	

Section 1		
1	What do you use to collect information or conduct interviews with? Tick.	a. Notebook[], b. mobile application[], c. none[] d. other.....

2	What way above do you think is appropriate for you?	.....
3	How do you record statements?	a. Notebook[], b. mobile application[], c. none[], d. Tape[], e. other.....
4	How do you track cases? Tick and explain	a. Manually [], b. electronically .....
5	Tick your problems when conducting interviews? Alternatively, performing investigations?	a. storage[], b. access to data[], c. triangulating data[], d. getting suspects bio data[], e. other[].....
6	Would you use a mobile application to conduct investigations? Why?	a. yes[], b. no[], .....
7	Suggest the features you would like on the application	

Thank you we will be conducting you to review the system.

### **APPENDIX C Evaluation Questionnaire**

Below is the questionnaire that was used to evaluate the system.

#### Evaluation Questionnaire

#### Police Investigation and Knowledge Base Application

I am following up from our previous conversation; I have come up with a system, please try out the application, and help me improve on the system.

Section 1		
1	What do you think about the application?	
2	What changes would you recommend	.....
3	Do you think it will save time?	a. yes [], b. no

4	Would it help in the track and retrial of cases?	b. yes [], b. no
5	What features did you suggest that does not appear?	.....
6	Would you use a mobile application to conduct investigations?	c. yes[], b. no[],
7	Suggest the features you would like to be added in the application	.....

**Appendix C Verification and Validation Questionnaire**  
Investigation and Knowledgebase system

Section A: Usability Testing

A1. Were you able to log in? (Choose ONE)\*

- Yes
- No

A2. Were you able to upload suspect's data? (Choose ONE)\*

- Yes
- No

A3. Were you able to upload informant's data? (Choose ONE)\*

- Yes
- No

A4. Were you able to upload victim's data? (Choose ONE)\*

- Yes
- No

A5. Were you able to search any data you previously uploaded? (Choose ONE)\*

- Yes
- No

A6. Were you able to take photo and audio? (Choose ONE)\*

- Yes
- No

A7. Were you able to upload overall data? (Choose ONE)\*

- Yes
- No

A4. If any of your answer above is 'No' please list the problems you encountered?

.....  
.....  
.....

A5. How would you rate the whole application? (Choose only ONE per row)\*

	Poor	Fair	Good	Very Good	Excellent
<b>Navigability</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Easy to learn and use</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Easy to find the core functionality</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Responsiveness</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Useful and satisfying</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

A6. What feature interested you most? \*

.....

A7. Any comments, suggestions or recommendations about this application? \*

.....  
.....

**Section B:**

B1. Do the functionalities provided by the application solve the problems faced during investigations and general working of police? (Choose ONE)\*

- Yes
- No

B2. Are you satisfied with solution provided by the application as far as crime is concerned? (Choose ONE)\*

- Yes
- No

B3. Would you recommend or use this application? Why?

- Yes
- No

.....  
.....

## APPENDIX D Screen Shots

The screenshot shows a mobile application interface with a green header bar containing a back arrow and the word "Register". The screen is divided into two main sections. The left section is a registration form with the following fields: "First Name", "Other Names", "Date of Birth" (with a "YYYY-MM-DD" placeholder), "Email", "Password", and "Gender" (with radio buttons for "Male" and "Female"). Below these fields are a "Show Password" checkbox and a "REGISTER" button. The right section is a login area with "Email Address" and "Password" input fields, a "Show Password" checkbox, a "LOGIN" button, and two links: "Register Here" and "Forgot Password".

Figure D.1 Login Register

Figure D.2 shows shows the witness page upon selection, the bio data is taken and photos including the audio statement. This page represents how the other pages in home page look like. Figure D.3 shows the continuation of filling the details and taking statement.

The screenshot shows a mobile application interface with a dark header bar containing a back arrow and the text "Step One". The screen displays a form with the following fields: "Date", "Case Number", "Location", "City", "Station", "First Number", "Last Number", and "Middle Number". A "NEXT" button is located at the bottom of the form. The Android navigation bar is visible at the very bottom.

Figure D.2 Witness

The screenshot shows a mobile application interface with a dark header bar containing a back arrow and the text "Step Two". The screen displays a form with the following fields: "race", "Color", "County", "ID Number", "DOB", "Crime Type", "Incidence", and "Location". A "NEXT" button is located at the bottom of the form. The Android navigation bar is visible at the very bottom.

Figure D.3 Witness Continued

Figure D.4 represents the part of application where the user is required to collect the picture and statement from the witness, victim or suspects and later loading all of the details and sends.

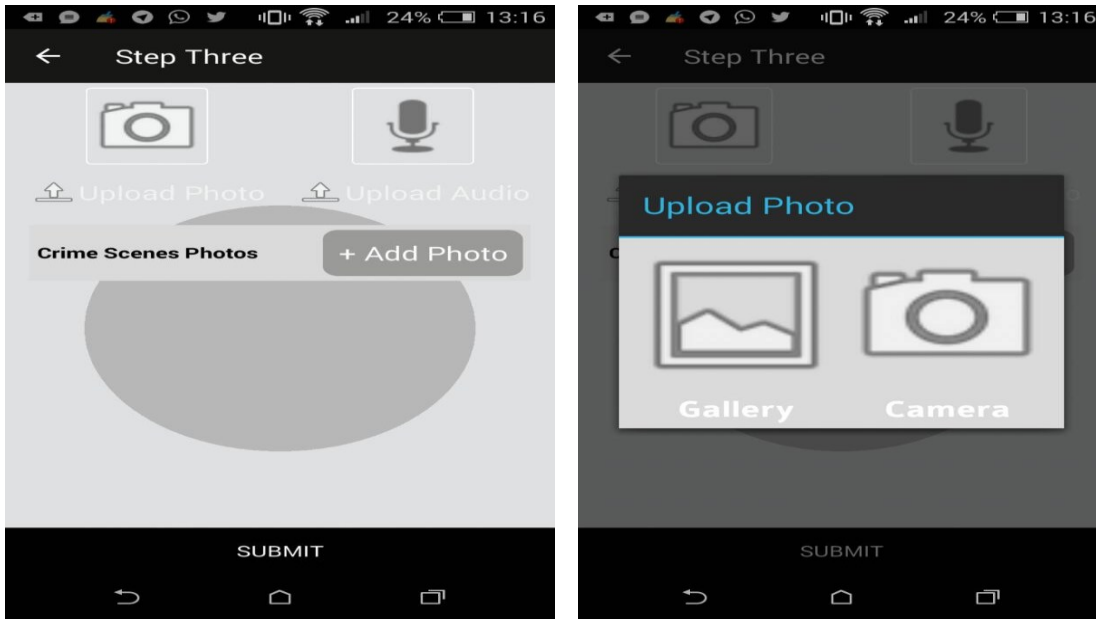


Figure D.4 Photo and Audio

## Back End Screens

Figure D.5 shows the login page to the back end web system

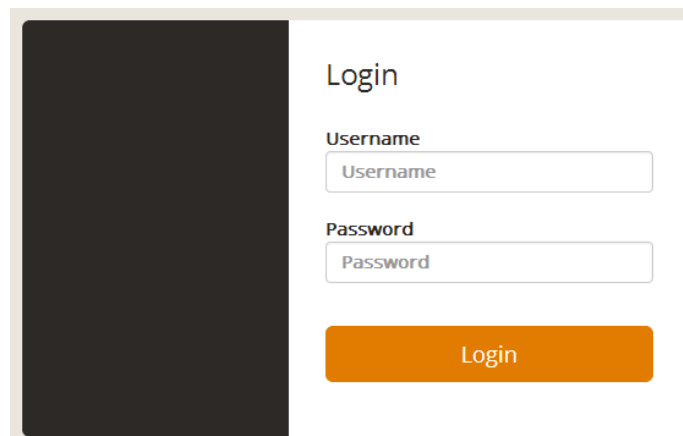


Figure D.5 Login

Figure D.6 shows the home page of the back end system. It contains all the data collected by the police including location, color, county, crime types, race, station and city as shown in D.6, D.7, D.8, D.9

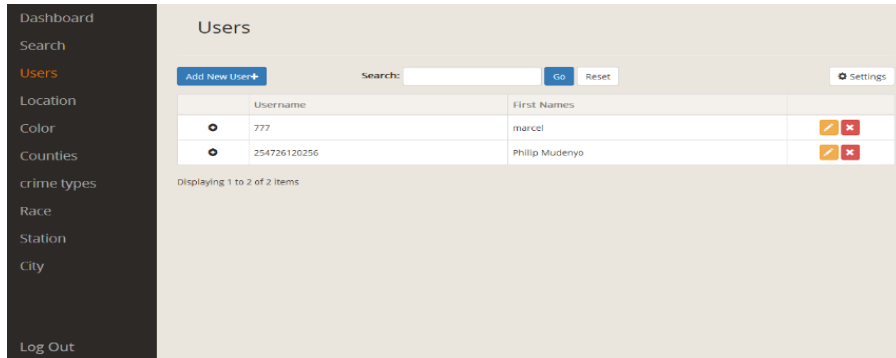


Figure D.6 Home Page

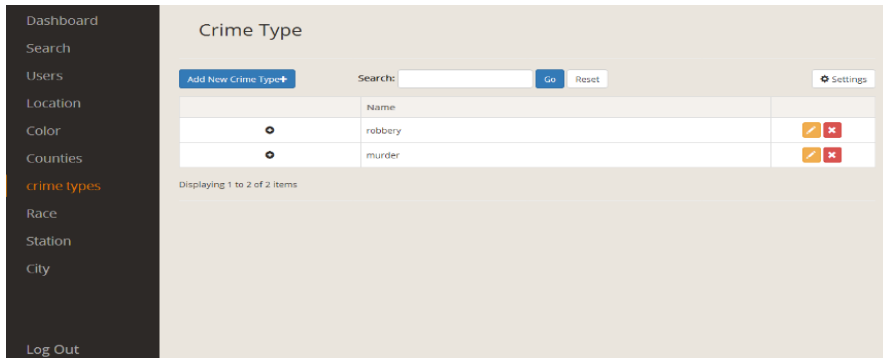


Figure D.7 Crime Type

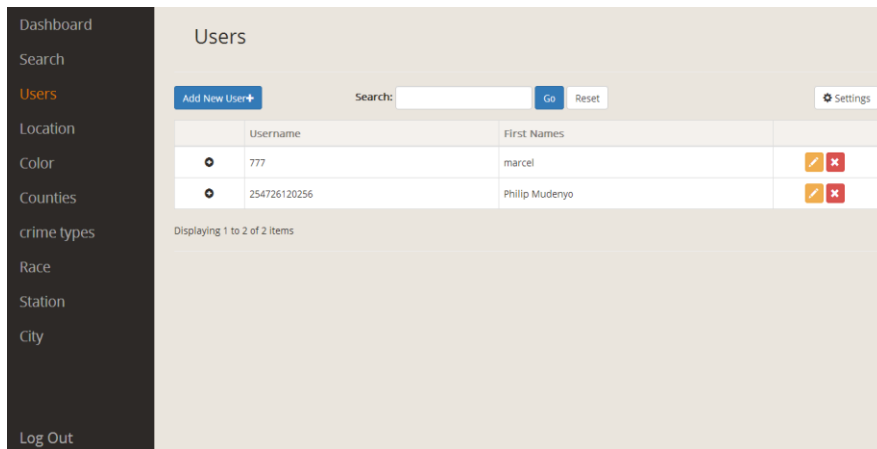


Figure D.8 Users

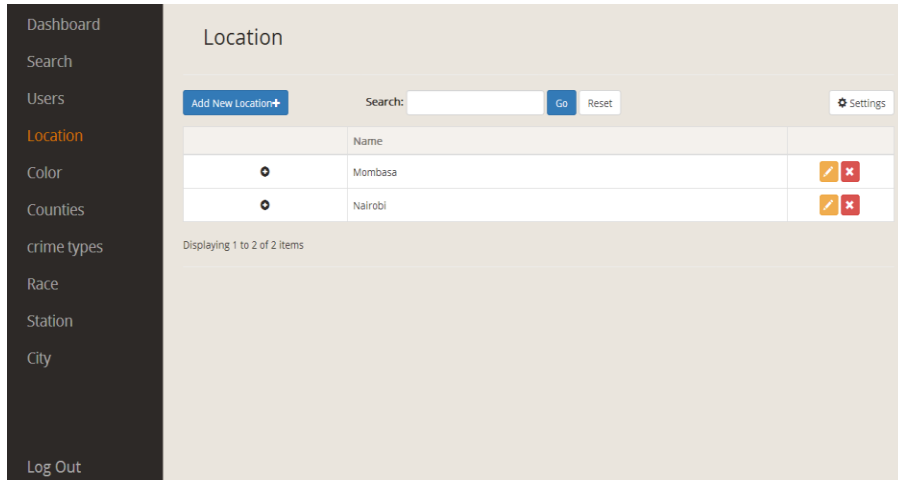
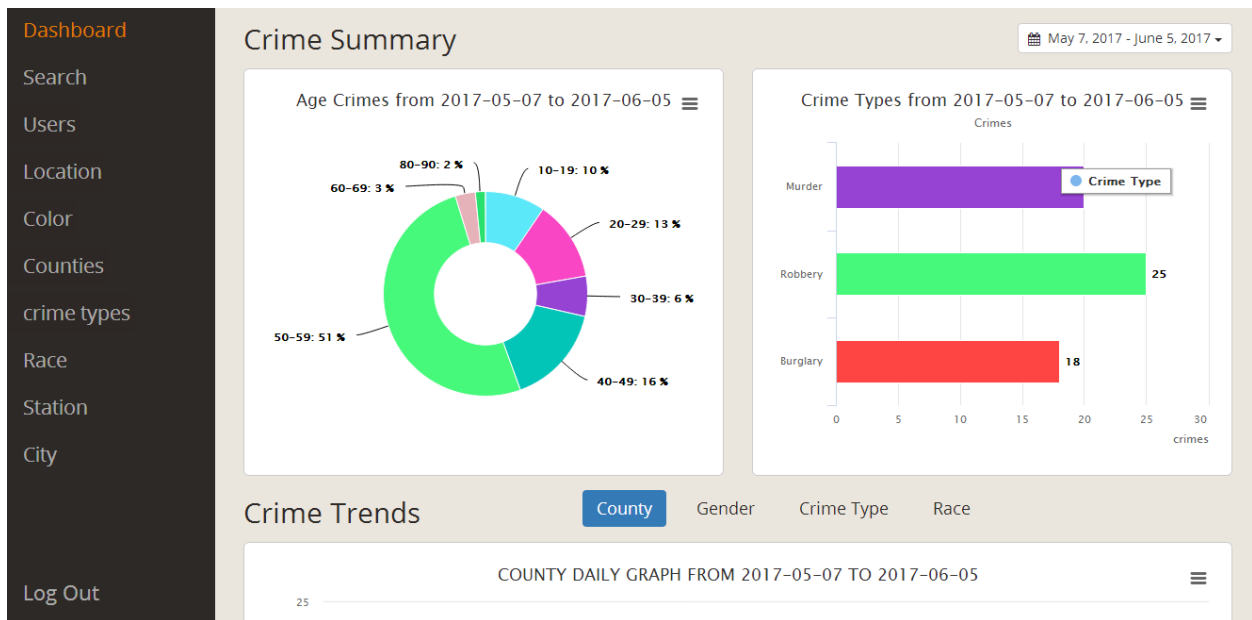


Figure D.9 County Page



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## APPENDIX F Testing

Figure F.1 Login and Logout Test Case

Test Case Name Login and Logout of the System		Test Case 2	
Brief Description Users login to the system using their police number, passwords, and logout once they want to exit the system.			
Pre-condition The user should have downloaded the application from the Google Play Store to be able to use the application.			
Step	Action	Expected results	Pass/Fail
1.	User runs the application.	The application loads the login page.	Pass
2.	User fills in the login credentials to access the system.	The application logs in the user and the home screen is displayed.	Pass
3	The user logout of the system once they are done using it.	The application redirects the user back to the login screen.	Pass
Post condition User can now utilize the system's services.			

Figure F.2 Add Suspects Data and Search Test Case

Test Case Name Add Suspects Data and Search		Test Case 3	
Brief Description Users login to the system using their police number and passwords and once logged in they can add suspect's data as well as search.			
Pre-condition The user should be logged in to the system.			
Step	Action	Expected results	Pass/Fail

1.	User logs into the application.	The application loads the service menu.	Pass
2.	User taps on the suspects data within the system	The application loads suspects form.	Pass
3	The user searches for the suspects cases using their identification number.	The application displays a form with the suspect's details.	Pass
Post condition User can saves the crime record.			

Figure F.3 Add informants Data Test Case

Test Case Name Add informants Data and Search		Test Case 4	
Brief Description Users login to the system using their police number and passwords and once logged in they can add informant's data as well as search.			
Pre-condition The user should be logged in to the system.			
Step	Action	Expected results	Pass/Fail
1.	User logs into the application.	The application loads the service menu.	Pass
2.	User taps on the informants data within the system	The application loads informants form.	Pass
3	The user searches for the informants cases using their identification number.	The application displays a form with the informant's details.	Pass
Post condition User can saves the informant's record.			

Figure F.4 Add Case Data and Search Test Case

Test Case Name Add Case Data and Search		Test Case 5	
Brief Description Users login to the system using their police number and passwords and once logged in they can add Case data as well as search.			
Pre-condition The user should be logged in to the system.			
Step	Action	Expected results	Pass/Fail
1.	User logs into the application.	The application loads the service menu.	Pass
2.	User taps on the case data within the system	The application loads case form.	Pass
3	The user searches for the cases using their case number.	The application displays a form with the case details.	Pass
Post condition User can saves the case details.			

Figure F.5 Data Base Table Explanation

Table	Explanation
User	This table stores all individual user details and will help determine user roles.
User_groups	This table stores all users' details and will help determine user roles.
Groups	All the user groups information is stored here
User_control	Stores all the functions of each user.
Cases	Stored all related information for a particular case.

Suspects	Stored bio data and crime related data of the suspect.
Informants	Stores bio data of informants and crime related information and the suspect details.
Statements	Stores statements from the informants, suspects and witnesses.

## Turnitin Report

The screenshot shows a Turnitin report for a document titled "Investigation and Knowledge Base Application: Case of Kenya Police" by Ernest Onguko Esiabia (ID: 091344). The document is displayed in a central pane. To the right, a "Match Overview" sidebar shows a total similarity score of 13%. Below the total score, a list of seven matches is provided, including a student paper and several internet sources.

Match Number	Source	Similarity Percentage
1	Submitted to Strathmo... Student Paper	6%
2	www.cmc.qld.gov.au Internet Source	1%
3	www.lexisnexis.com Internet Source	1%
4	ljarece.org Internet Source	<1%
5	digital.library.unt.edu Internet Source	<1%
6	eprints.usm.my Internet Source	<1%
7	digitalcommons.kenne... Internet Source	<1%

Figure D. 10 Turnitin Results