A CRIME REPORTING APPLICATION USING GEOGRAPHICAL INFORMATION SYSTEM

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A PROJECT SUBMITTED TO THE DEPARTMENT OF COMPUTER SCIENCE AND MATHEMATICS, COLLEGE OF BASIC AND APPLIED SCIENCES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE

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DECLARATION

I hereby declare that this project has been written by me and is a record of my own research work. It has not been presented in any previous application for a higher degree of this or any other University. All citations and sources of information are clearly acknowledged by means of reference.

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CERTIFICATION

This is to certify that the content of this project entitled '**A Crime Reporting Application using Geographical Information System'** was prepared and submitted by **OBE ISRAEL ONIYIMIDE** in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN COMPUTER SCIENCE.** The original research work was carried out by him under by supervision and is hereby accepted.

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DEDICATION

This project is dedicated to God, Almighty.

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ABSTRACT

This project is based on Development of A Geographical Information System For a Real Time Crime Reporting Application. It evolved from manual reporting keeping file of crime reported. With the help of the internet, computer and other mobile devices crime reporting applications will be of great help in efficiency and effectiveness of the police force. This project aims to create an efficient and reliable crime reporting application that can do all the manual work with ease. In order to achieve its aim and objectives, a database was created, and design steps were taken using extreme programming.

This project work was built on flutter framework with other frontend and backend technologies using Visual Studio Community 2017 as the Integrated Development Environment.The Crime Reporting Application created is useful in helping users, police officers and administrators monitor and manage their respective operations properly. The Crime Reporting Application is a faster and more efficient way of keeping crime records and monitoring them.

The application was able to perform the targeted goals that where aligned from the beginning of the project work.

The application built is able to report crimes and show the distance of the reporter by using Global Positioning System (GPS) from the police men who see the report feeds and the closest police officer will have to attend to the crime reported.

Keywords: Geographical information system, Crime reporting system, Crime record management systems, Geographical positioning system.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Crime refers to an act performed against the legislation of a country. Crimes can lead to different sort of damages such as loss of life, property or disaster to community. Crime involves robbery, carjacking, kidnapping, murder, drug trafficking, human trafficking, domestic violence, Child sexual abuse, corruption etc. Crimes places a great weight on the country's reputation and the economy. Most reasons of crime are due to lack of training, weak laws and legislations. Nigeria's level of crime is assessed to be at 68.36 percent, furthermore the rate of corruption and bribery 85.11 percent, Safety while travelling alone at night is predicted to be 29.86 percent which is quite low.

Victims of crime typically lack simple medium where they can report crime and complaints directly to the authorities concerned. According to Numbeo. (2021), crime is on the rise, and crimes are occurring more frequently. Because there is no convenient means to report log crimes, they go unreported, and the persons guilty are never held accountable. Crime recording analysis is an important aspect of the approach for lowering crime rates. If a good data gathering and analysis system is in place, this is true. A typical system normally consists of a database in the form of a summary spreadsheet with codes and mileposts to identify the location, sort, and severity of criminal actions.

Location is referenced in a geo-referenced incident database. It features a graphical interface that displays incident data and enables for query searches on various incident attributes. By adopting GIS, a geo-referenced incident database may

be accessed, displayed, visualized, queried, analyzed, and merged with data from other databases, while also enabling configurable and visual report functions. This project attempts to demonstrate how GIS and certain of its related disciplines may assist in recording, processing and analysis of crime incident information and thereby boosting awareness and action using crime data. It also provides some insight into the creation of an internet-based GIS reporting system. It solves the gaps through efficiently, effectively and reliably collecting and disseminating data from crime incidences in Nigeria by building a smartphone-based app for reporting and sharing data related crime episodes. The collected crime information benefits the public as well as other stakeholders such as the police personnel, hospital services, fire service, the insurance business and higher education institution.

With the rising use of the internet and cellphones, the quick advancement of technology has made life easier for everyone. There are approximately 198,961,361 active lines in Nigeria, according to statistics from the Nigerian Communications Commission as of July 2020. (Government, 2021).

1.2 Statement of the Problem

Today, crimes such as: robbery, kidnapping, for instance are frequently unaccounted for, and as a result, the parties involved are not held accountable. Witnesses and victims of crime frequently lack an easy way to report wrongdoing. As a result, numerous incidences continue to occur and are not reported to the right authorities in a timely manner. The widespread use of mobile phones in Nigeria has created new opportunities for crime reporting. There are numerous events that go unrecorded or even unreported since there is no convenient method for registering and reporting crimes to the right authorities. Implementing a Geographical Information

System (GIS)-based crime incidents recording and sharing application provides an opportunity for improved dissemination of information as well as improved visualization and analysis techniques. Use of geographical information system comes in handy in identifying the location of the incident reporter, mapping the incident to the location as well as maintaining an accurate database.

1.3 Aim and Objectives of the Study

The main objective of this study was to develop a crime reporting system of reporting crimes from any location as they occur thus improving response to crime.
The specific objectives are to

i. Identify the user and system requirements;
ii. specify the design of the system;
iii. implement the system and
iv. test the system.

1.4 Methodology of Study

In order to meet up with the afore mentioned objectives of the study, the following methods were adopted

a. A review of literature was done in order to identify and understand existing.
b. The user and system requirement of the system was identified from system users via informal interview.
c. The system design was specified using unified modelling language (UML) diagram such as: use case, sequence diagram, class diagram.
d. The database was implemented using Firebase and the frontend will be implemented using .NET framework.

1.5 Scope and Limitation

This project was limited to developing a mobile application. The target users are all users including other interested parties. The test case audience of this study is limited to the students. The application was developed on Google's Android platform

Financial Constraints: because of the exorbitant nature of things nowadays in traveling for the collection of data needed for the project, it was difficult to make both ends meet, especially given the country's economic state.

1.6 Significance of Study

Much progress has been made in Nigeria over the years in the different aspects of crime protection by introducing new protection and safety policies. These initiatives include improved education and training standards, improving safety regulations and enforcements and introducing new technology such as smoke detectors, movement sensors in night lights. The primary objective of these crime safety initiatives is to reduce the rate of crimes committed by mitigating their occurrences. However, many of these have failed to keep pace. By improving the following standards, crime occurrence can be prevented by Surveillance, rule setting, etc. (Westyorkshire, 2021). Reducing crime requires efficient management of all the information related to such kind of incidents.

The aim of this project is to develop a mobile application that can be used to report crime incidents. With a proper crime reporting system, civilians can report any crime that pose a threat to environment/economies safety on and thus also improve incident resolution by the authorities by assisting the authorities to respond, track and resolve reported incidents. It also provides a publicly accessible platform through which data can be shared and disseminated.

1.7 Terms and Acronyms Definition

GIS: A geographic information system (***GIS***) is a framework for gathering, managing, and analyzing data. Rooted in the science of geography, ***GIS*** integrates many types of data. It analyzes spatial location and organizes layers of information into visualizations using maps and 3D scenes

NCC – Nigerian Communication Commission

GPS: Global Positioning System, is a global navigation satellite system that provides location, velocity and time synchronization

Police – A civil organization whose members are given special legal powers by the government and whose task is to maintain public order and to solve and prevent crimes

Crime – An action prohibited by law or a failure to act as required by law

NPF: Nigeria Police Force

CRMS: Crime record management systems

CRS: Crime reporting system

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

When a group or society is formed, some rules and laws are established to be followed. The goal of these rules and laws is to provide a peaceful life for everyone who lives in that society. When a law is broken by anyone, we call it a crime, and the person who breaks the law is referred to as a criminal. A well-organized law enforcement system is required for a peaceful life. In Nigeria, we don't have very good facilities in the law enforcement sector, and with fewer resources, some tasks cannot be completed effectively. Crime is an act that brings about offences and it is punishable under the law. Major crimes in Nigeria include rape, kidnapping, murder, burglary, fraud, terrorism, robbery, cyber-crimes, bribery and corruption, money laundering and so on. According to the statistics released by the Nigerian National Bureau of Statistics in 2016, Lagos, Abuja, Delta, Kano, Plateau, Ondo, Oyo, Bauchi, Adamawa and Gombe States made the top ten list of states with high number of crimes. Crime is an important topic and it is of interest to us because of the consequences and penalties it attracts (which ranges from fine to death). Analyzing this data set can provide insight on crime activities within Nigeria.

2.2 Crime Agencies in Nigeria

Nigeria Police Force (NPF): Serious crime reached epidemic proportions in the 1980s, particularly in Lagos and other urbanized areas marked by rapid growth and change, stark economic inequality and deprivation, social disorganization, and insufficient government service and law enforcement capabilities. Because most of

the country was virtually unpoliced—the police were concentrated in urban areas where only about 25% of the population lived—and public distrust of the police contributed to underreporting of crimes, published crime statistics were most likely grossly understated. The crime wave was exacerbated in the late 1980s by worsening economic conditions as well as the ineffectiveness, inefficiency, and corruption of police, military, and customs personnel who colluded and conspired with criminals or actually engaged in criminal conduct (Pike, 1998).

Violent crime against foreigners is a major issue, particularly in Lagos and the country's southern half. Visitors and residents alike report a high rate of armed muggings, assaults, burglaries, car jackings, and extortion, often involving violence. Car jackings, roadblock robberies, and armed break-ins are common, with victims occasionally being shot for no apparent reason. Reports of armed robberies in broad daylight on rural roads in the country's northern half appear to be on the rise. Typically, law enforcement responds to crimes slowly, if at all, and provides little or no investigative assistance to victims. Section 194 of the 1979 constitution designates the Nigeria Police Force (NPF) as the national police with exclusive jurisdiction throughout the country. However, there is a constitutional provision for the establishment of separate NPF branches "forming part of the Federation's armed forces or for their protection of harbors, waterways, railways, and airfields." The Port Security Police, for example, was reported to have a strength of between 1,500 and 12,000 in 1990, according to various sources.

Nigeria's police force began in 1861 with the formation of a thirty-member consular guard in Lagos Colony. A 1,200-member armed paramilitary Hausa Constabulary was formed in 1879. The Lagos Police Department was established in 1896. The Niger Coast Constabulary, a similar force, was formed in Calabar in 1894

under the newly established Niger Coast Protectorate. Similarly, in the north, in 1888, the Royal Niger Company established the Royal Niger Company Constabulary, with headquarters in Lokoja. When Northern and Southern Nigeria protectorates were established in the early 1900s, a portion of the Royal Niger Company Constabulary became the Northern Nigeria Police, and a portion of the Niger Coast Constabulary became the Southern Nigeria Police. Northern and Southern Nigeria were merged in 1914, but their police forces were not merged until 1930, when they formed the Nigeria Police Force (NPF), which is headquartered in Lagos. During the colonial era, the majority of police were affiliated with local governments (native authorities). During the First Republic, these forces were first regionalized and then nationalized in the 1960s.

National Drug Law Enforcement Agency (NDLEA): (ndlea, 1989)The National Drug Law Enforcement Agency (NDLEA) is a Federal agency in Nigeria tasked with eradicating hard drug cultivation, processing, manufacturing, selling, exporting, and trafficking. Decree No. 48 of 1989 established the agency. The NDLEA can be found at international airports, seaports, and border crossings. It attempts to eradicate cannabis by destroying plantations. The NDLEA also targets leaders of drug trafficking and money-laundering organizations.

Economic and Financial Crimes Commission (EFCC): The Economic and Financial Crimes Commission (EFCC) is a Nigerian law enforcement agency that investigates financial crimes such as advance fee fraud (419 fraud) and money laundering. The EFCC was established in 2003, partially in response to pressure from the Financial Action Task Force on Money Laundering (FATF), which named Nigeria as one of 23 countries non-cooperative in the international community's efforts to fight money laundering. The agency has its head office in Abuja, Nigeria (efcc, 2007).

National Agency for Food and Drug Administration and Control (NAFDAC): is a federal agency under the Federal Ministry of Health that is responsible for regulating and controlling the manufacture, importation, exportation, advertisement, distribution, sale and use of food, drugs, cosmetics, medical devices, chemicals and packaged water in Nigeria.

In 1993, the organization was formed to combat illegal and counterfeit products in Nigeria under the country's health and safety law. In Nigeria, adulterated and counterfeit drugs are a problem. Over 150 children died as a result of paracetamol syrup containing diethylene glycol in one incident in 1989. The problem of counterfeit drugs was so severe that neighboring countries such as Ghana and Sierra Leone officially prohibited the sale of Nigerian drugs, foods, and beverages (nafdac, 2017).

2.3 Information System (IS)

(Zwass, 2016) defined Information system as a formal, sociotechnical, organizational system designed to collect, process, store, and distribute information is known as an information system (IS). Information systems are made up of four components from a sociotechnical standpoint: task, people, structure (or roles), and technology. Information systems are defined as a set of components that work together to gather, store, and process data, with the data being utilized to give information, contribute to knowledge, and create digital products that help people make better decisions.

A computer information system is a system that processes or interprets data and is made up of people and computers. In certain cases, the phrase is simply used to

refer to a computer system with software installed. Information Systems is the academic study of systems with a focus on information and the related hardware and software networks that people and organizations use to gather, filter, analyze, produce, and distribute data. The importance of an information system with a defined boundaries, users, processors, storage, inputs, outputs, and the previously mentioned communication networks is emphasized.

Any information system is designed to assist with operations, management, and decision-making. An information system is an organization's use of information and communication technology (ICT) as well as how people interact with this technology to support business activities.

2.3.1 History of Information System

According to (adataanalyst, 2017) The evolution of Information System function can be summarized as follows:

a. 1950 – 1960: Electronic Data Processing, Transaction Processing System

During this time, the primary function of IS was to handle transaction processing, recordkeeping, and accounting. IS was primarily used to process electronic data (EDP).

Computer-assisted data processing (EDP) is defined as the use of computers to record, classify, manipulate, and summarize data. The Transaction Processing System (TPS) was the first computerized system built to process corporate data. It is also known as information processing or automatic data processing. TPS was primarily designed for an organization's clerical personnel. The early TPS relied on batch processing data that was amassed over time and then processed all transactions. TPS collects, saves, alters, and retrieves an organization's day-to-day transactions.

TPS typically computerizes or automates an existing manual process to enable for faster processing, better customer service, and lower administrative expenses. Cash deposits, automatic teller machines (ATMs), payment orders, and accounting systems are examples of TPS outputs. Transaction processing or real-time processing are other terms for TPS.

b. 1960 to 1970: Management Information Systems

The role of IS shifted from TPS to Management Information Systems during this time period (MIS). MIS converts data into meaningful, informative reports and gives managers the tools they need to organize, evaluate, and manage departments within a company. To aid business decision-making, MIS provides information in the form of displays and pre-defined reports. Cost trend, sales analysis, and production performance reporting systems are examples of MIS output. Usually, MIS generates three basic types of information which are:

i. Detailed information reports typically confirm transaction-processing activities. A detailed Order Report is an example of a detailed report.

ii. Summary information establishes data into a format that an individual can review quickly and easily.

iii. Exception information report information by filtering data that is an exception inventory report. Exception reports help managers save time because they do not have to search through a detailed report for exceptions.

During this time, enterprises gradually switched their focus from simply automating core business procedures to consolidating control within the data processing function.

c. 1970 to 1980: Decision Support Systems

The emergence of personal computers (PC) was a key advancement during this time period. There was a dispersion of computing or processing power across the company with the arrival of PCs. In an organization, the IS function is strongly associated with management rather than a technical approach. The role centred on developing a "interactive computer-based system" to assist decision-makers in problem-solving.

Decision Support Systems (DSS) refers to the emerging role of information systems in providing interactive ad-hoc support for managers and other business professionals during the decision-making process. The planning, management, and operations levels of an organization, typically senior management, are served by DSS.

Data is gathered from both internal and external sources by DSS. Inventory, sales, production, and financial data from an organization's database are examples of internal data sources. Pricing, interest rates, population, and trends are examples of external factors. Managers use DSS to alter data and aid in decision-making. Projected income projections based on new product sales assumptions, product pricing, and risk analysis systems are examples of DSS.

d. 1980 to 1990: Executive Information Systems

Many organizations bought their own gear and software to suit their departmental needs around this time, which gave rise to departmental computing. Employees could use their own resources to meet their job requirements rather than relying on indirect support from a centralized corporate service department. As a result of this tendency, new difficulties of data incompatibility, integrity, and connectivity between departments have emerged. Executive information systems (EIS) and executive support systems (ESS) were created because senior executives were not using DSS or MIS.

Executives may make better decisions with the help of EIS, which provides both internal and external information that is relevant to the organization's strategic goals. These are sometimes thought of as a subset of DSS. Systems allowing simple access to all rivals' actions, economic developments to support strategic planning, and corporate performance analysis are examples of EIS.

e. 1990 to 2000: Knowledge Management Systems:

The rapid rise of intranets, extranets, the internet, and other interconnected worldwide networks greatly impacted the capabilities of information systems in business during this period. It became possible to send information to different parts of the world regardless of time or distance.

During this time, enterprise resource planning (ERP) systems began to appear. ERP stands for enterprise resource planning, and it is a type of strategic information system that integrates all aspects of a company, including production, sales, resource management, human resource planning, and marketing.

Furthermore, artificial intelligence (AI) techniques were developed and used to commercial information systems for the first time. Knowledge management systems (KMS) and expert systems (ES) are interrelated.

Expert systems (ES) are computer programs that simulate the abilities of human experts to make decisions. Systems that provide financial estimates, diagnose human ailments, and schedule delivery routes, for example. Knowledge management system (KMS) is an information technology system that saves and retrieves information to aid in the generation, organization, and dissemination of business knowledge inside a company. Feedback databases and helpdesk systems are examples of KMS.

Data from Knowledge Management Systems is used by ES to generate desired information system output, such as a loan application approval system.

f. 2000 – present: E-Business:

The Internet, as well as related technology and apps, has altered the way organizations and individuals operate. In this period, information systems functions are still the same as they were 50 years ago, including record keeping, reporting management, transaction processing, support management, and process management. It's utilized to help with corporate processes, decision-making, and gaining a competitive edge.

2.3.2 Types of Information System

a. Transaction Processing System (TPS)

The term "transaction processing system" refers to an information system that processes data originating from business transactions. Their goals are to offer transactions so that data may be updated and reports can be generated, that is to do storekeeping. Batch processing and online transaction processing are the two methods used to complete the transaction, for instance, a billing system, a payroll system, and a stock control system.

b. Management information System (MIS)

The purpose of a Management Information System is to turn relatively raw data available through a Transaction Processing System into a summarized and aggregated form for the manager, usually in the form of a report. Middle management and operational supervisors are likely to use the reports. MIS generates a wide variety

of report kinds. A summary report, on-demand report, ad-hoc report, and exception report are some of the reports available.

Sales management systems, for example, and human resource management systems are both examples of such systems.

c. Experts System

Experts systems include knowledge to assist management in detecting and fixing problems. These systems are based on artificial intelligence research principles. Experts Systems is an information system that is founded on knowledge. It acts as an expert consultant to users by utilizing its knowledge of a specific area. An expert system's components include a knowledge base and software modules. These modules make inferences based on knowledge and provide answers to a user's query.

2.4 Geographic Information System (GIS)

According to (Geographic, 2017) a geographic information system (GIS) is a tool for capturing, storing, manipulating, analysing, managing, and presenting various forms of geographic data. This technology's core phrase is geography, which signifies that some of the data is spatial. To put it another way, data that is linked to geographic areas.

The White House defines spatial data infrastructure as "the technology, regulations, standards, human resources, and related activities essential to gather, process, distribute, use, maintain, and preserve spatial data." GIS technology is an important aspect of this infrastructure.

GIS allows you to compare and contrast many different sorts of data. Data on people, such as population, income, and education level, can be included in the

system. It may contain information on the landscape, such as the location of streams, various types of vegetation, and various types of soil. It could include information regarding factory, agricultural, and school locations, as well as storm drains, highways, and electric power lines.

Any information that involves a location can be used by GIS. The location can be specified in a variety of ways, including latitude and longitude, address, and ZIP code. People can use GIS technology to compare the positions of various objects to see how they relate to one another. A single map may, for example, include places that cause pollution, such as factories, as well as areas that are sensitive to pollution, such as wetlands and rivers, using GIS. A map like this would aid in determining where water resources are most vulnerable.

Typically, this data is accompanied by tabular data known as attribute data. Additional information about each of the spatial features is referred to as attribute data. Schools are an illustration of this. The spatial data represents the real location of the schools.

2.4.1 Uses of GIS

As described by (Geographic, 2017) GIS can be utilized in problem-solving and decision-making processes, as well as for data visualization in a spatial setting. Geospatial data can be used to figure out:

1. the location of features and relationships to other features.
2. where the most and/or least of some feature exists.
3. the density of features in a given space.
4. what is happening inside an area of interest (AOI).
5. what is happening nearby some feature or phenomenon.

6. how a specific area has changed over time (and in what way).

2.4.2 Data Formats

(Geographic, 2017) Hardware and software systems are included in GIS applications. Cartographic data, photographic data, digital data, and spreadsheet data are all examples of these types of applications. The position of rivers, highways, hills, and valleys may be included in cartographic data, which is already in map form. Survey data and mapping data that may be readily entered into a GIS are examples of cartographic data.GIS includes a lot of photographic interpretation. Analysing aerial images and evaluating the features that emerge is what photo interpretation entails.
GIS can also be used to store digital data. Computer data gathered by satellites that depict land use—the position of farms, towns, and forests—is an example of this type of data.

Another technique that can be linked into a GIS is remote sensing. Imagery and other data from satellites, balloons, and drones are used in remote sensing.
Finally, data in table or spreadsheet format, such as population demographics, can be included in GIS. Age, income, and ethnicity are only a few examples of demographics, as are recent purchases and internet browsing tendencies.

GIS technology allows all of these distinct types of data to be superimposed on top of one another on a single map, regardless of their source or original format. To connect these seemingly unconnected variables, GIS uses location as the key index variable. Maps, however, must first be scanned, or converted to digital format.

GIS consist of the following:

a. Spatial Relationships

Spatial linkages and linear networks can be seen using GIS technology. Topography, such as agricultural fields and waterways, can be displayed through spatial relationships. They may also show land-use patterns, such as where parks and housing complexes are located.

Putting information into GIS is called data capture. Data that are already in digital form, such as most tables and images collected by satellites, can simply be transferred into GIS.

In a GIS, highways, rivers, and public utility grids are examples of linear networks, sometimes known as geometric networks. A road or highway may be indicated by a line on a map. However, using GIS layers, the road may represent the border of a school district, a public park, or another demographic or land-use sector. The linear network of a river can be represented on a GIS to show the stream flow of different tributaries using various data collecting methods.

GIS must align the data from all of the many maps and sources so that they all fit together on the same scale. The link between the distance on a map and the actual distance on Earth is known as a scale because various maps have different projections, GIS frequently has to alter data. A projection is a technique for transmitting data from the Earth's curving surface to a flat sheet of paper or a computer screen. Different projections achieve this goal in different ways, but they all result in some distortion. Stretching some portions and squeezing others is unavoidable when transferring a curved, three-dimensional structure to a flat surface.

A globe map can depict either the right size or shape of countries, but not both at the same time.

b. GIS Maps

After all of the needed data has been entered into a GIS system, it can be merged to create a range of different individual maps, depending on which data layers are included. Comparing natural features with human activities is one of the most common applications of GIS technology.

GIS maps, for example, can show what man-made features are near natural features, such as whether residences and businesses are in flood-prone areas.

GIS technology also enables users to "go deep" into a given location and access a variety of data. Information like average income, book sales, and voting habits can be linked to maps of a single city or area. The same map can have any GIS data layer added or removed.

Information about numbers and density can be displayed on GIS maps. GIS can, for example, display the number of doctors in a given neighbourhood in relation to the population.

Researchers can also look at change over time using GIS technology. They can investigate subjects like the advance and retreat of ice cover in polar regions, as well as how that coverage has evolved over time, using satellite data. A police precinct might look at changes in crime data to see where officers should be assigned creating time-lapse imagery, which displays processes occurring over wide areas and over lengthy periods of time, is one key application of time-based GIS technology.

Data on the movement of fluid in ocean or air currents, for example, aids scientists in better understanding how moisture and heat energy travel throughout the world.

Users can utilize GIS technology to gain more information about certain locations on a map on occasion. By pointing to a specific spot on a digital map, a person can access additional information stored in the GIS. For example, a user might click on a school to find out how many students are enrolled, how many students per instructor there are, or what sports facilities the school has.

GIS systems are widely used to make three-dimensional pictures. This will be beneficial to geologists analysing earthquake faults, for example.

2.5 Location Based Service (LBS)

(Goodrich, 2020) defined location-based service as any technology that functions by using real-time location tracking. This means that the technology tracks the user's physical and geographic position over time. This data is utilized to carry out services and functions. Although the technology is most commonly utilized with mobile devices, it may be used with any device that can provide a location, including desktop computers. LBS is a broad word that also refers to software services that employ spatial data and information to give services or information to users. It can be utilized in a range of settings, including health, indoor object search, entertainment, work, and personal life. Navigation software, social networking services, location-based advertising, and tracking systems are all examples of location-based services. Mobile commerce can be included in LBS when it comes in the form of coupons or advertising targeted at customers based on their present location. Personalized weather services and even location-based games are among them.

Many businesses and government entities rely on LBS to gain meaningful insight from data related to a specific location where actions occur. One of the most powerful and helpful characteristics of location-related data and services is the spatial patterns that they may provide, where location is a common denominator in all of these activities and can be used to better understand patterns and relationships. LBS is used in banking, surveillance, online commerce, and numerous weapon systems.

Location data and/or time-of-day limits, or a combination of both, regulate access policies. As such, an LBS is an information service that has a variety of applications in social networking today, such as information, entertainment, or security, and is available with mobile devices over the mobile network and uses information about the mobile device's geographic location.

As highlighted in ISO/IEC 19762-5[10] and ISO/IEC 24730-1, this idea of location-based systems is incompatible with the defined concept of real-time locating systems (RTLS) and related local services. While networked computing devices are often excellent at informing users of days-old data, they may also be tracked, even in real-time.

Many computer systems and applications in the twenty-first century use location-based services (LBS). Technological advancements such as the World Wide Web, Global Positioning Systems, and the widespread usage of mobile phones have enabled modern location-based services.

Location-based services were created by combining data from satellite navigation systems, cellular networks, and mobile computing in order to give services based on users' geographic positions.

The capacity to open and close specific data objects using location and/or time as (controls and triggers) or as part of complex cryptographic key or hashing systems

and the data they give access to is referred to as LBS. Location-based services are one of the most extensively utilized application-layer decision frameworks in computing.

2.5.1 How Location Based Services Works

According to (Goodrich, 2020) a typical mobile device has numerous systems that can offer location information. GPS, RFID, Wi-Fi, and cellular are the most common. The next part will go through these in greater detail, but they all work on the same principles. To function, a mobile device must communicate with other devices and hubs. Satellites, routers, towers, and other devices can all be used to communicate. The precise location of the mobile device can be triangulated because it pings various connection hubs.

An LBS can direct a user to the nearest eatery. An LBS may, for example, send an SMS message announcing a sale at a nearby shopping centre. One way for determining the position of a mobile user is to use the mobile phone network. The current cell ID, for example, can be used to identify the base transceiver station (BTS) with which the phone is communicating. After that, the only thing left to do is figure out where the BTS is located. GPS satellites are used by other systems. This method is far more accurate than the previous one, and some smartphones now have built-in GPS sensors, making it even easier. The employment of short-range locating beacons is another popular option. These gadgets, which commonly use WiFi or Bluetooth, are suited for indoor LBS applications.

Push and Pull services are the two sorts of services available. In a Push service, the user receives information from the service provider without having to request it at that moment, even if the user had previously subscribed to the service. A Push service is similar to the LBS advertisement stated above. The user must actively request information in a Pull kind. This is the type of query used in the restaurant example. LBS is supported through specialized APIs in software development platforms, notably those used to create mobile applications, such as J2ME and Android.

Information, entertainment, and security are all provided through location-based services, which employ real-time geodata from a smartphone. Consumers can "check in" at restaurants, coffee shops, businesses, concerts, and other locations or activities using some services. People that check in are frequently rewarded with rewards, coupons, or discounts. Among the most popular services are Google Maps, Foursquare, GetGlue, Yelp, and Facebook Places.

If a person has opted in to accept it, location-based services employ a smartphone's GPS technology to track their whereabouts. Without the need for human data entry, the service can determine a smartphone user's position down to a street address when they opt in.

2.5.2 Technologies Used to Track Location

As explained by (Goodrich, 2020) these are technologies that are used to track location

a. GPS

The Global Positioning System is a constellation of satellites that exists purely to aid in the location of objects all over the world. Any device having a GPS receiver

(which most smartphones have) can use it to ping the satellites. It will connect with at least four satellites as a result, and the satellites will be able to compare signal delays to determine where the signal originated. This allows your phone to track your location and deliver turn-by-turn directions.

b. Wi-Fi

Wi-Fi location monitoring differs from previous methods in a few ways. A device will typically connect to just one Wi-Fi network at a time. The potential of triangulation is thus eliminated. For this type of location tracking, IP addresses are used instead. Every network has a physical IP address that tells the rest of the internet where it is located. `This is required in order to deliver data accurately through the internet infrastructure. When your phone joins to a Wi-Fi network, it identifies the network's physical IP address. This enables location services to determine your present position.

c. Cellular

Cellular tracking functions similarly to GPS. Your gadget, however, is connecting to cellular towers rather than satellites. In most cases, you'll be within range of at least two towers, which is enough for the system to utilize triangulation to locate you.

d. QR codes

In theory, QR tracking is similar to Wi-Fi. A dynamic QR code logs information about the scan when it is scanned. The physical position of the QR code can be documented once it has been confirmed. Any time the code is scanned, that site can be labelled.

e. Radio-frequency identification (RFID)

RFID tracking is essentially a hybrid of these various techniques. The RFID scanner is usually placed in a fixed location. The location of the scanner can be tracked by pinging other networks. When the RFID scanner is turned on, it can record the access and tag its location. This can be used to determine the device that is accessing the scanner.

2.5.3 Uses of Location-based Services

According to (Goodrich, 2020) companies have found several ways to use a device's location

a. Store locators: Retail shoppers can rapidly locate the nearest store location using location-based intelligence.

b. Proximity-based marketing: Local businesses can only target adverts to people in their immediate vicinity. Mobile marketing that is based on location targets ads to potential clients in that city who are more likely to act on the information.

c. Travel Information: An LBS can send real-time information to a smartphone, such as traffic updates or weather forecasts, allowing the user to plan accordingly.

d. Roadside assistance: Many roadside help businesses offer an app that allows them to track your exact location without you having to give directions in the event of a flat tire or an accident.

e. Mobile Workforce Management: An LBS allows employees to check in at a location using their mobile device for logistics-dependent organizations that employ individuals out in the field or at several locations.

f. Fraud Prevention: An LBS adds another layer of security by tying a customer's location to a credit card transaction via their smartphone. You can flag transactions done across multiple geographic places in a short period of time by tying the smartphone's location to a credit card.

2.6 System Development Life cycle (SDLC)

In systems engineering, information systems, and software engineering, the Systems Development Life Cycle (SDLC) is the process of developing or updating systems, as well as the models and processes that individuals use to construct these systems. The term refers to computer or information systems in general. The SDLC principle underpins a variety of software development approaches in software engineering. These approaches provide a framework for planning and regulating the software development process as it pertains to the establishment of an information system.

Different development techniques have traditionally governed the process of creating computer software and information systems. A software development methodology is a framework for planning, managing, and controlling the development of an information system. SDLC, or Software Development Life Cycle, is the formal name for a software development approach. Requirement Analysis, Design, Coding, Testing, Installation, and Maintenance are some of the aspects of this approach or process.

2.6.1 System Development Life Cycle Phase

The first phase of the Software Development Life Cycle is requirement analysis. The major goal of this phase is to determine what the client's genuine needs

are and to appropriately document them. The focus of requirement analysis is on determining what the system requires. It is an important phase in the Software Development Life Cycle. Software Requirement Specification (SRS) is the result of requirement analysis; it is a detailed and comprehensive description of the behavior of the software to be built.

The steps of a typical Software Development life cycle are as follows

Stage 1: **Planning and Requirement Analysis Requirement Analysis.** In SDLC, this is the most significant and crucial stage. It is carried out by the team's top members, with input from the customer, the sales department, market surveys, and industry domain specialists. This data is then utilized to establish the main project approach and conduct product feasibility studies in the areas of economics, operations, and technology. The planning step also includes determining the project's quality assurance requirements and identifying the project's risks. The technical feasibility study's goal is to identify the many technical techniques that can be used to successfully implement the project with the least amount of risk.

Stage 2: **Defining Requirements** Following the requirement analysis, the product needs must be properly defined and documented, and they must be approved by the client or market analysts. This is accomplished through the use of a Software Requirement Specification (SRS) document, which contains all of the product requirements that must be defined and developed throughout the project life cycle.

Stage 3: **Designing the product architecture**. SRS is the go-to resource for product architects looking to create the greatest architecture for a new product. Typically, many design approaches for the product architecture are presented and documented in

a Design Document Specification based on the requirements given in the SRS (DDS),the optimum design strategy for the product is chosen based on numerous characteristics such as risk assessment, product robustness, design modularity, budget, and time restrictions. A design approach outlines all of the product's architectural modules, as well as the product's communication and data flow representation with external and third-party modules, if any are used. All of the modules of the proposed architecture's internal design should be thoroughly documented in DDS, down to the tiniest of details.

Stage 4**: Building or Developing the Product**. The actual development of the product begins at this stage of the SDLC. During this stage, the programming code is generated according to DDS. Code generation can be done quickly and easily if the design is done in a precise and organized manner. Developers must adhere to their organization's coding rules, and programming tools such as compilers, interpreters, and debuggers are used to develop code. Code is written in a variety of high-level programming languages, including C, C++, Pascal, Java, and PHP. The programming language is chosen based on the type of software that is being created.

Stage 5: **Testing the Product**. Because testing is frequently incorporated in all phases of the SDLC in modern SDLC models, this stage is usually a subset of all stages. This stage, however, simply relates to the product's testing phase, during which problems are reported, monitored, fixed, and retested until the product fulfills the SRS's quality requirements.

Stage 6**: Deployment in the Market and Maintenance.** The product is formally released in the right market once it has been tested and is ready to deploy. Product deployment is sometimes done in stages based on the commercial strategy of the

company. User acceptance testing may be performed on the product before it is published to a limited audience and tested in a real-world setting (UAT). The product may then be released as is or with proposed enhancements in the intended market niche, depending on the feedback received. After a product is launched, it is maintained for existing customers.

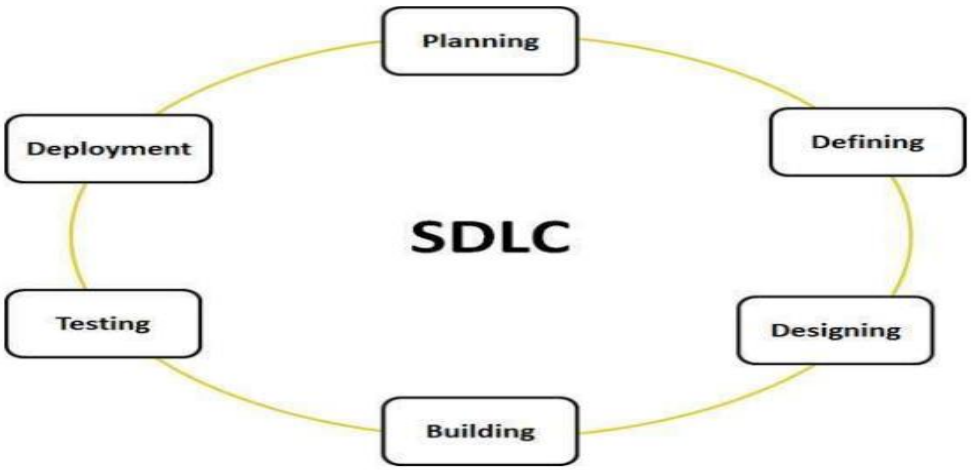

Figure 2.1 SDLC Phases

2.6.2 SDLC Models

During the software development process, numerous software development life cycle models have been established and designed. "Software Development Process Models" is another name for these models. In order to assure success in the software development process, each process model follows a set of stages specific to its type. Following are the most important and popular SDLC models followed in the industry

a. Waterfall Model

The Waterfall model is a traditional software engineering model that is sometimes referred to as a waterfall model. Model of a linear-sequential life cycle. It

specifies a number of fundamental duties that must be completed in order for the business to functional requirements definition, architecture design, detailed design, implementation, component verification, integration verification, and requirements validation are the steps that should be followed in order. In the presence of a waterfall before moving on to the next phase, each phase must be completed completely. A review is conducted at the end of each phase to determine if the project is on track whether the project should be continued or abandoned. The waterfall model serves as a starting point for other models.

There are also different lifespan models. The waterfall model is the most basic model of software development. It specifies that all phases of the SDLC will run in a sequential order. That is, after the first phase has been completed, the second phase will begin, and so on.

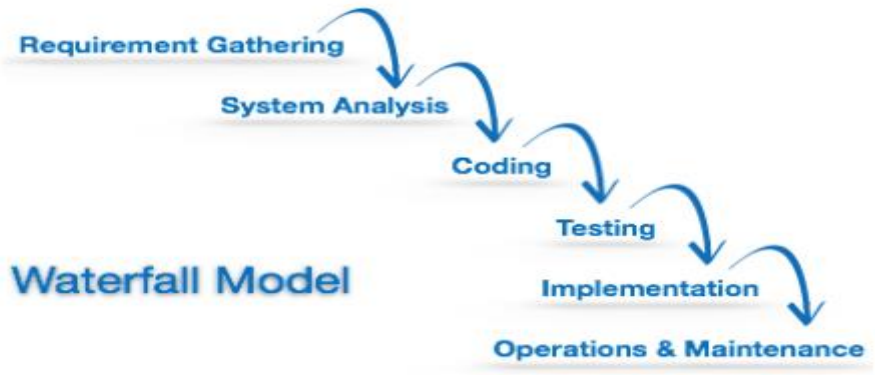

Figure 2.2 Waterfall Model

This approach assumes that everything went well as intended in the prior stage, so there's no need to worry about previous issues that might crop up in the next. If there are any errors from the previous phase, this model will not work properly.

The model's sequential nature prevents us from undoing or redoing our activities. This technique works best when developers have previously planned and produced similar software and are familiar with all of its domains.

b. Iterative Model

The iterative approach is a new way of designing systems that could deliver faster outcomes, need less upfront knowledge, and offer more flexibility. The project is broken into small segments using iterative development. This allows the development team to show results earlier in the process and receive valuable feedback from users. Each iteration is frequently a mini-Waterfall process, with input from one step providing critical knowledge for the following phase's design. In iterative model we are building and improving the product step by step, we can track the defects at early stages. This avoids the downward flow of the defects. This paradigm iterates through the software development process. It simulates the development process in a cyclic fashion, repeating each step after each cycle of the SDLC process.

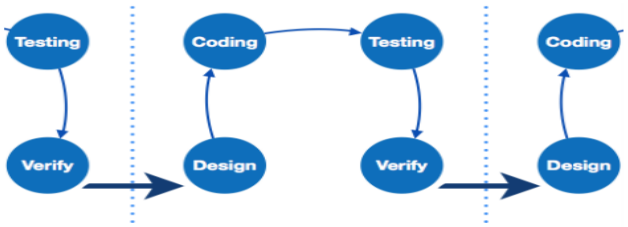

Figure 2.3 Iterative Model

The software is first constructed on a modest scale, with all of the necessary stages taken into account. After that, more features and modules are planned, programmed, tested, and added to the software with each iteration. Every cycle results

in software that is complete in and of itself, with more features and capabilities than the one before it. The management team can concentrate on risk management and plan for the next iteration after each iteration. It is easier to oversee the development process because a cycle only comprises a small piece of the entire software process, but it uses more resources.

c. Model V-Model

The main disadvantage of the waterfall model is that we can only move on to the next stage after the previous one has been completed, and there is no way to go back if something goes wrong later on. The V-Model allows software to be tested in reverse at each stage.

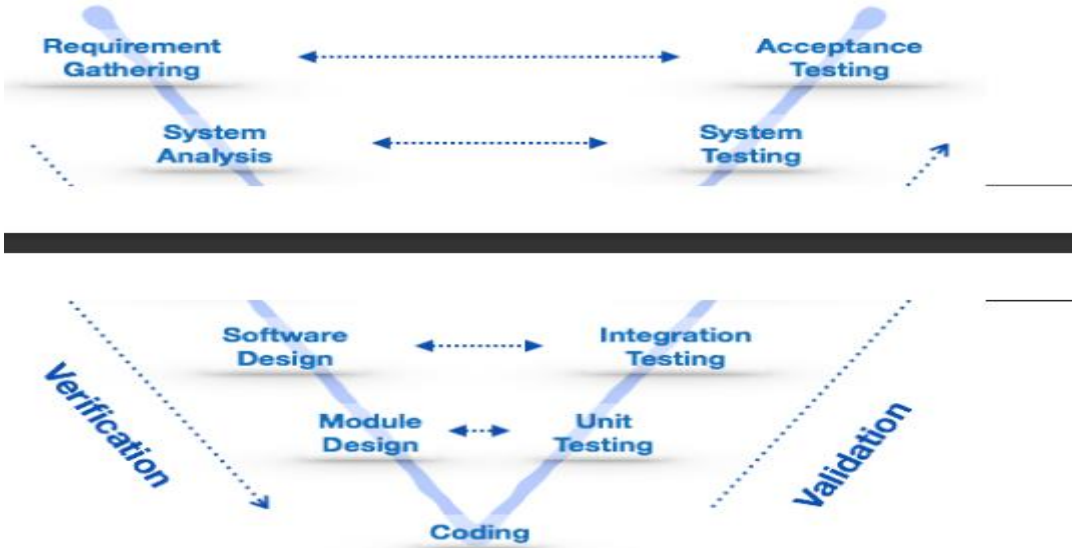

Figure 2.4 V-Model

Test plans and test cases are developed at each stage to verify and validate the product against the stage's requirements. The test team, for example, prepares all of

the test cases in accordance with the requirements during the requirement collection stage. Later, when the product has been produced and is ready for testing, the test cases from this stage verify the software's compliance with the stage's requirements. As a result, both verification and validation can happen at the same time. The verification and validation model is another name for it.

d. Big Bang Model:

In its current form, this model is the most basic. It necessitates little planning, a great deal of programming, and a lot of money. This model is based on the Big Bang theory of the universe. According to scientists, many galaxies, planets, and stars evolved as a result of the big bang. Similarly, if we pool our programming and financial resources, we may be able to produce the best software product.

Figure 2.5 Big bang Model

Only a little bit of planning is necessary for this approach. It doesn't follow any method, and the customer isn't always sure what they want or need in the future. As a result, the input specifications are arbitrary. This architecture is not appropriate for major software projects, but it is excellent for learning and experimenting.

e. Spiral Model

The spiral approach is similar to the incremental model, except it places a greater emphasis on risk assessment. Planning, Risk Analysis, Engineering, and Evaluation are the four phases of the spiral model. In iterations, a software project goes through these phases again and again. Starting in the planning phase, the baseline spiral gathers requirements and assesses risk. Each subsequent spiral builds on the baseline spiral. Requirements are gathered during the planning phase. In the risk analysis phase, a process is undertaken to identify risk and alternate solutions. The spiral model combines elements of both iterative and SDLC models. It's as if you pick one SDLC model and merge it with the iterative cyclic process model.

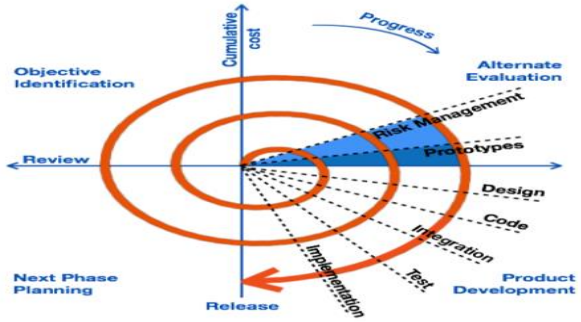

Figure 2.6 Spiral model

This model takes into account risk, which is typically overlooked by other models. At the outset of each iteration, the model begins by identifying the software's goals and restrictions. Prototyping the software is the next step. This involves a risk assessment. At the conclusion of the risk analysis phase, a prototype is created. The engineering phase produces software, which is then tested at the end of the phase. Before moving on to the next spiral, the client can evaluate the project's output to data in the evaluation phase.

The software is then built using a conventional SDLC methodology. The plan for the next iteration is prepared in the fourth phase.

2.6.3 Model Adopted

(Yasvi, 2019)Extreme Programming (xtreme Programming) is a software development methodology. Which is largely concerned with improving software quality and adapting to changing client needs. It's a form of agile software development. It promotes rapid development cycles and frequent releases. These updates are meant to improve the user experience.

By implementing certain measures that focus on establishing particular checkpoints at which client requirements can be adopted and met, productivity and software quality can be improved. A process of development that tries to achieve better results quality software and aids in the provision of the best possible solution. Extreme Programming is distinct from other types of software. Adaptability is emphasized more in development approaches as well as adaptability to changing consumer needs

XP is a more radical agile technique that focuses on the software development process and the quality of the software. Using unique techniques to handle the analytical, development, and test phases in order to make a significant change in the final product's quality

Extreme Programming focuses on light-weight methods. The primary steps included in the cycle of XP are- Planning, Design, Coding, Testing. The system is built using an iterative strategy that divides the total project into individual functions. For one function, the development cycle is completed from design through testing.

The developers go on to the next function after performing and troubleshooting the previous one.

Kent Beck invented XP while working on the Chrysler Comprehensive Compensation System (C3) payroll project. Kent Beck took over as C3 project leader in March 1996, fine-tuning the project's development style and publishing an Extreme Programming book in 1999. The XP paradigm is thought to be superior to the classic waterfall methodology. Companies all across the world are increasingly using it for software development. Because the waterfall approach requires the development process to be completed on a single project and the requirements to be known in advance, there is no way to change the requirements once the project is underway.

2.7 Unified Modeling Language (UML)

The Unified Modeling Language (UML) is a visual modeling language that is widely used in the creation of object-oriented software. The Object Management Group (OMG) selected this language as its standard modeling language in 1997. Class diagram, Object diagram, Component diagram, Deployment diagram, Use Case diagram, State-chart diagram, Activity diagram, Sequence diagram, and Collaboration diagram are the nine diagramming techniques defined by UML 1.x. Class Diagram, Object Diagram, Component Diagram, Composite Structure Diagram, Package Diagram, Deployment Diagram, Use Case Diagram, Sequence Diagram, Communication Diagram, State Diagram, Activity Diagram, Timing Diagram, and Interaction Overview Diagram are the thirteen diagramming techniques defined by UML 2.x. These diagrams are linked together and show various facets of the problem domain.

UML relies largely on graphical components as a visual modeling language. The many UML diagrams are built on the foundation of these graphical components. For example, in a Class Diagram, UML employs a rectangle to represent classes, an ellipse to define use cases in a Use Case Diagram, and an arrow to show message direction in a Sequence Diagram.

Diagrams are beneficial in a variety of situations. For starters, diagrams can organize related data together, reducing the amount of effort spent looking for essential pieces. Second, diagrams can be used to organize information about a single piece, eliminating the need to match labels. Third, diagrams provide a huge number of visual inference cues that are simple to apply by humans. In a nutshell, diagrammatic representations improve three aspects of human information processing: search, recognition, and inference.

Nonetheless, the same information can be represented in a variety of ways, but not all of these representations are equally convenient to use. In other words, diagrams that are similar in terms of information structure but not in terms of computing because different diagrammatic representations may help search, recognition, and inference to varying degrees.

2.7.1 UML graphical constructs

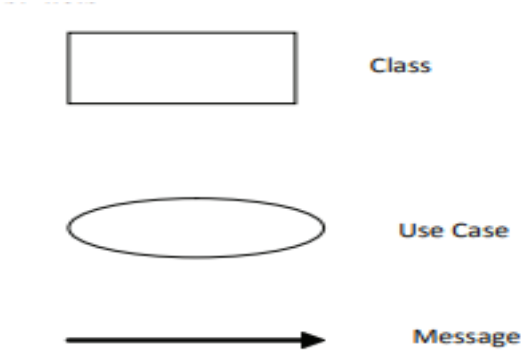

Figure 2.7 UML graphical constructs

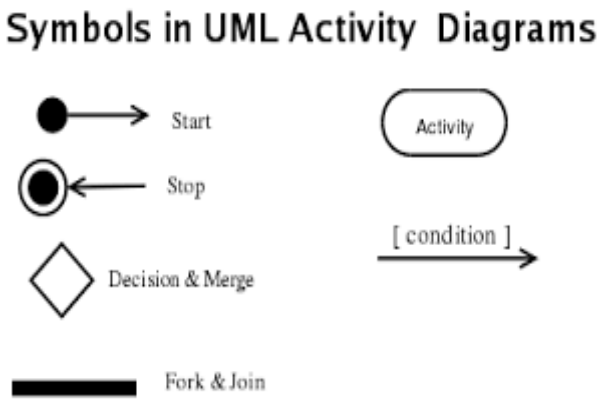

Figure 2.8 UML Activity Symbols

Figure 2.9 UML Symbols

2.7.2 Types of UML Diagrams

Class, activity, object, use case, sequence, package, state, component, communication, composite structure, interaction overview, timing, and deployment are all included in the current UML standards.

There are two types of diagrams in this collection: structural diagrams and behavioural or interaction diagrams.

a. Structural UML diagrams

i. Class diagram:

The class diagram is the most extensively used UML diagram. It serves as the foundation for all object-oriented software systems. Class diagrams are used to describe the static structure of a system by displaying the classes, methods, and properties of the system. Class diagrams also aid in the identification of relationships between various classes or items. Almost every object-oriented method, including UML, relies on class diagrams. They describe a system's static structure.

The essential component of every object-oriented solution is the class diagram. It depicts the classes in a system, their attributes and activities, as well as the relationships between them.

A class in most modelling software is made up of three pieces. The top of the page has the name, the middle has the attributes, and the bottom has the operations or methods. Classes are put together to build class diagrams in a complex system with numerous related classes. Different types of arrows represent different types of links between classes. The diagram is shown in *figure 2.10.*

ii. Package diagram:

Package Diagrams are used to show how packages and their components have been structured. A package diagram only depicts the interdependencies between distinct packages as well as the internal structure of packages. Packages aid in the organization of UML diagrams into meaningful groups and the comprehension of the

diagram. They're mostly utilized to organize classes and make use of case diagrams. The diagram is shown in *figure 2.11*.

iii. Object diagram:

An Object Diagram is a snapshot of the instances in a system and their relationships. We may investigate the behaviour of the system at a specific point since object diagrams describe behaviour when objects have been instantiated. An object diagram is similar to a class diagram, with the exception that it displays the instances of classes in the system. We utilize class diagrams to illustrate actual classifiers and their relationships. An Object Diagram, on the other hand, depicts unique instances of classes and their relationships at a given point in time. . The diagram is shown in *figure 2.12.*

iv. Component diagram:

Component diagrams show how a system's physical components are connected. We use them to simulate implementation details in our models. Component Diagrams depict the structural relationship between software system elements and help us in understanding if functional requirements have been covered

by planned development. Component Diagrams become essential to use when we design and build complex systems. Interfaces are used by components of the system to communicate with each other. The diagram is shown in *figure 2.13.*

v. Composite structure diagram:

Composite structure diagrams are used to show the internal structure of a class. Composite structure diagrams are used to show a class's internal structure as well as its points of interaction with other components of the system. The link between pieces and their configuration determines how the classifier (class, component, or deployment node) behaves. Parts, ports, and connections are used to illustrate the internal structure of a structured classifier. We can also use composite structure diagrams to model cooperation. They're similar to class diagrams, but instead of representing the entire class, they display particular elements in greater detail. The diagram is shown in *figure 2.14.*

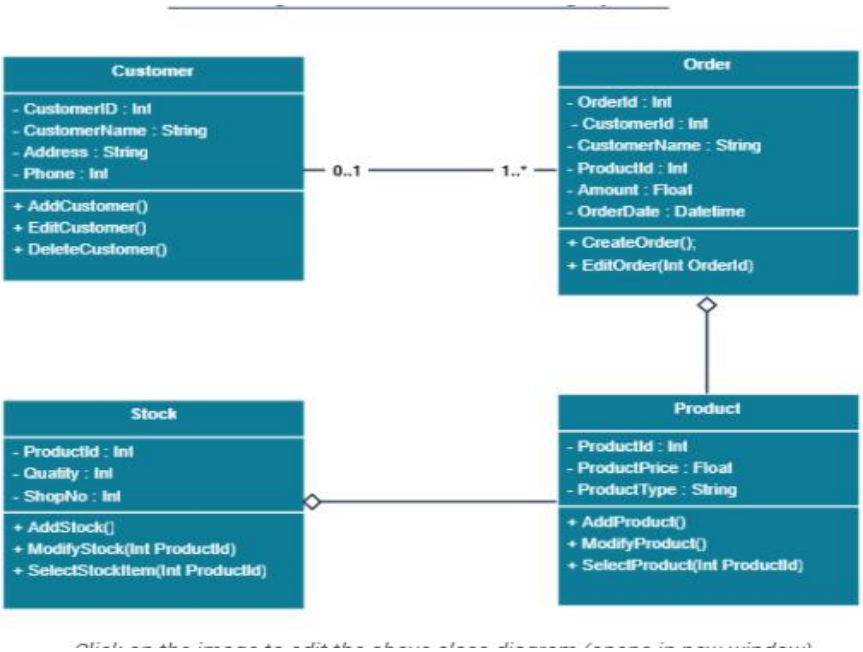

Figure 2.10 Class diagram

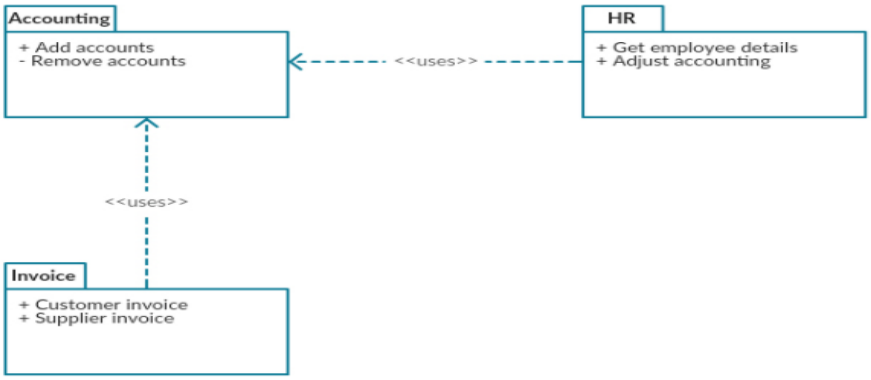

Figure 2.11 Package diagram

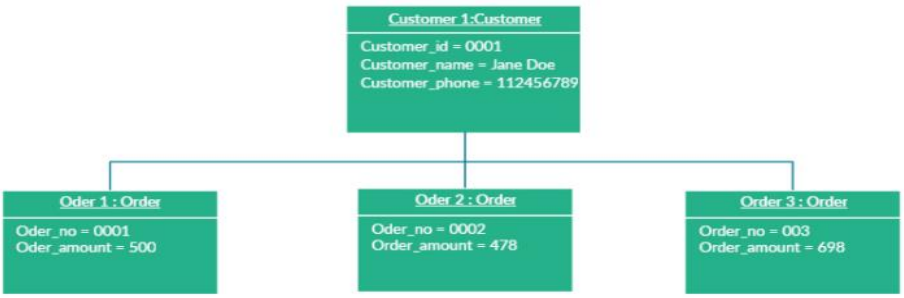

Figure 2.12 Object diagram

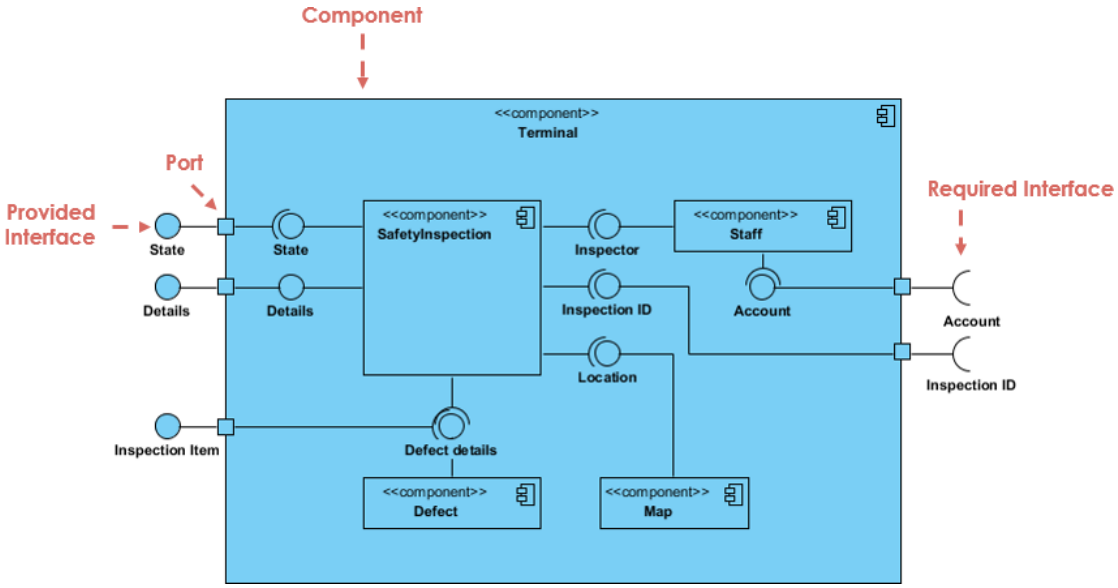

Figure 2.13 Component diagram

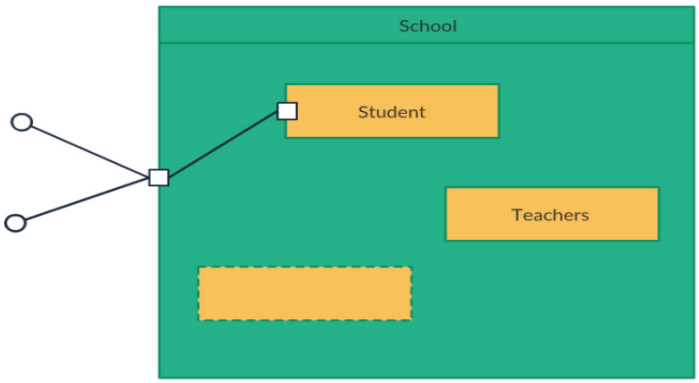

Figure 2.14 Composite structure diagram

b. Behavioural UML diagrams

i. Activity diagram

Activity diagrams are graphical representations of workflows. They can be used to describe the business and operational workflows of any system component. Activity diagrams are sometimes used instead of state machine diagrams. Activity Diagrams are used to depict the flow of control in a system. An activity diagram can also be used to represent the stages involved in executing a use case. Using activity diagrams, we model sequential and concurrent activities. As a result, we use an activity diagram to clearly depict workflows. An activity diagram concentrates on the state of flow and the order in which it occurs. The diagram is shown in *figure 2.15.*

ii. Sequence diagram:

A sequence diagram simply displays the order in which things interact, or the order in which these interactions occur. A sequence diagram can also be referred to as an event diagram or an event scenario. Sequence diagrams show how and in what order the components of a system work together. Businesspeople and software engineers frequently use these diagrams to document and understand requirements for new and current systems. In UML, sequence diagrams depict how items interact with one another and in what order they interact. It's worth noting that they only reveal interactions for a specific scenario. The processes are depicted vertically, with arrows indicating interactions. The diagram is shown in *figure 2.16.*

iii. Use case diagram:

Use Case Diagrams are used to show how a system or an element of a system works. They're frequently utilized to depict the system's functional requirements and

interactions with external agents (actors). A use case is a diagram that depicts several scenarios in which the technology could be used. A use case diagram provides a high-level overview of what a system or element of a system performs without getting into technical details. Use case diagrams are the most well-known of the behavioural UML types, providing a graphic representation of the players involved in a system, the many functions required by those actors, and how these functions interact. It's an excellent beginning place for any project conversation because it's simple to identify the key players and system operations. The diagram is shown in *figure 2.17.*

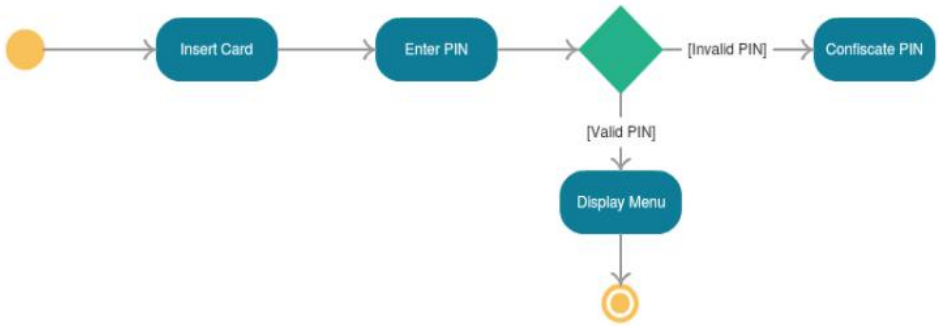

Figure 2.15 Activity diagram

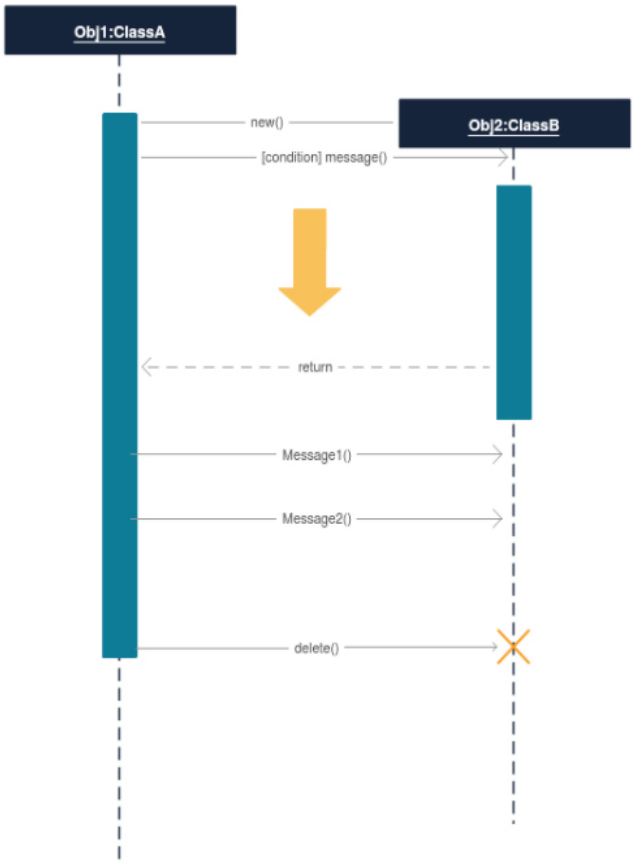

Figure 2.16 Sequence diagram

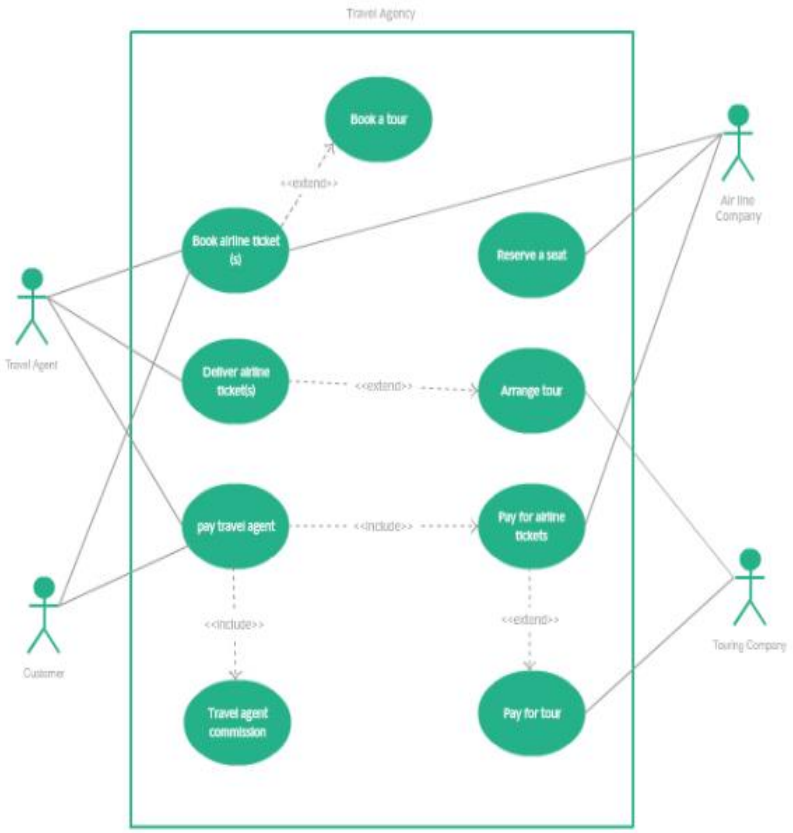

Figure 2.17 Use case diagram

2.8 System development tools

We use a Flute software framework for the front end and firebase for the backend and the database and android studio as an emulator in order to comprehend the system to be built.

2.8.1 Flutter

Google's Flutter is a free and open-source UI software development kit. It allows developers to create native mobile applications from a single codebase, allowing them to create cross-platform apps for Android, iOS, Linux, Mac, Windows, Google Fuchsia, and the web.

Flutter is made up of two primary components:

a. SDK (Software Development Kit): SDK stands for "Software Development Kit" and refers to a set of tools It's a collection of software tools and packages that allow developers to construct apps for a variety of platforms. It tools will include libraries, documentation, code examples, workflows, and instructions, among other features that developers can use and incorporate into their own projects.

Software development kits (SDKs) are tools for creating software for certain platforms or languages.

b. A frame (a widget-based UI library): A set of reusable pieces and a range of UIs that you can customize for your own purposes (buttons, texts, slider etc.).

Flutter makes use of the DART programming language. Dart is a computer language created by Google in October 2011. At the front end, it focuses more on mobile and web application development. Dart is an object-oriented programming language with a syntax similar to JavaScript.

2.8.2 Framework Architecture

The primary components of the flutter framework are as follows

a. Dart's platform: Flutter applications are written in the Dart programming language and utilize the complex features of the language extensively. Flutter is operated on a Dart virtual, timely, Windows, macOS and Linux system. Flutter uses a just-in-time compilation to build and deploy apps to allow "hot reloading" builds to deliver updates to the source files to a running application. Flutter now supports static hot reload, meaning that changes in source code are reflected in the running app without rebooting or losing.

b. Flood motor: Flutter's engine, mainly developed in C++, uses Google's Skia graphics library for low levels rendering. It works also with platform-specific SDKs like Android and iOS. The Flutter Engine is a portable operating time for Flutter apps. It includes animations and graphics, I/O files and networks, accessibility support, architecture of plug-ins, a compiler toolchain and a runtime and build toolchain for Darts. Dart workflow and compilation. Most developers utilise Flutter via the Flutter Framework which has a reactive framework and a platform, layout and base widget collection.

c. Library of the Foundation: The Dart-based Foundation library provides basic classes and methods for building Flutter applications, such as motor connection APIs.

d. Specific Design Widget: The Flutter frame has two different widgets, each with its own design language. In Cupertino widgets Apple's iOS Principles of Human Interface are employed while Google's standards on Material Design are applied in Material Design widgets.

2.7.3 Firebase

A cloud-hosted NoSQL database, Firebase Realtime Database enables you to store and synchronize data across your users in real-time. Firebase is the backend-as-a-service (BaaS) service, which originated as a YC11 startup and has become a Google Cloud Platform for next-generation app development. Firebase helps developers focus on the development of exceptional user experiences. Users do not have to manage their servers, build APIs, because the firebase is your server, your API and your datastore, all written to fit the most requirements.

2.7.4 Android Studio

Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and intended exclusively for Android development. It is a substitute for the Eclipse Android Development Tools (E-ADT) as the primary IDE for native Android application development.

The following features are included in the current stable version:

i. Gradle-based build support
ii. Android-specific refactoring and fast fixes
iii. Lint tools to catch performance, usability, version compatibility and other concerns
iv. ProGuard integration and app-signing capabilities
v. Template-based wizards to develop standard Android designs and components
vi. A comprehensive layout editor that allows users to drag-and-drop UI components, possibility to examine layouts on numerous screen configurations
vii. Support for building Android Wear apps.

viii. Built-in support for Google Cloud Platform, enabling integration with Firebase Cloud Messaging (Earlier 'Google Cloud Messaging') and Google App Engine.

ix. Android Virtual Device (Emulator) to launch and debug apps in the Android studio.

2.9 Review of Related Works

(Oludele Awodele, Onuiri Ernest E., Olaore Olufunmike A., Sowunmi Oluwawunmi O., 2015) the goal of their research is to design and implement a computerized real time Crime Reporting Management System (CRMS) for the (NPF). The waterfall model of system development was used in the development of this CRMS, from requirement elicitation from CRMS stakeholders to system design and analysis using tools such as entity relationship diagrams for the database and use case diagrams that describe user requirements. The system was built with Hypertext Mark-up Language (HTML) for a highly interactive graphical user interface, as well as PHP and MySQL for a robust database.

The CRMS improves efficiency in correcting the previously mentioned problems, and it is an effective tool for easy data analysis, which will improve the NPF's law enforcement operations. It also allows for criminal records checks by Background Check Companies (BCC). The implementation of the CRMS will result in a lower level of threat to Nigerian citizens, improving national buoyancy.

The proposed CRMS improves the NPF's crime recording operations. The CRMS data is stored in a centralized database that contains information about criminals, crime, and system users. The database serves as the foundation for all system actions and can

be easily updated and used to aid in all system processes; that is, all required information is stored in one central location and is thus easily accessible. Furthermore, the accuracy of the centralized database will enable functions such as crime report generation and statistical crime data analysis.

This is a more efficient method of storage than a paper-based file system. Aside from the functions mentioned above, the system performs the fundamental functions of storing, retrieving, and manipulating crime and criminal data and information. The benefits of the proposed system according to (Oludele Awodele, Onuiri Ernest E., Olaore Olufunmike A., Sowunmi Oluwawunmi O. , 2015) are as follows:

1. Interstation communication in real time.
2. Centralized data handling.
3. Reduced time consumption.
4. Computerized record keeping with manpower.
5. Cost reduction.
6. Operational efficiency.

The limitation of this research is that it is web based and also, it’s time efficient it takes time to input details on the software also inadequate information from officers were not forthcoming thereby making it complex to specify requirements of the system.

Another research work done by (Aderonke Busayo Sakpere, Anne V.D.M. Kayem, and Thabo Ndlovu, 2015) focuses on Unreported crime due to fear of privacy violations is a persistent concern in technologically limited environments. According to a recent South African Institute of Race Relations (SAIRR) report, roughly half of

all crimes are never reported to the police. This high rate of unreported crimes may have an impact on society's decision-making and law enforcement agencies' resource allocation. As a result, a crime reporting platform that ensures anonymity and security is required. As researched in, crime reporting and the likelihood of an individual making a report are not as simple as filling out a form.It has been discovered that digitizing the reporting process not only increases the likelihood of individuals reporting crimes, but it can also result in more comprehensive and meaningful reports.

Also The proliferation in the use of mobile devices is perceived to provide a good security platform for crime reporting. As a result, a mobile application that can facilitate crime reporting in a secure and covert manner is required. In this regard, an interface must be designed that provides the full functionality of the paper-based service while adhering to good design principles and being compatible with the mobile platform. The architecture of their software called CryHelp, the user (reporter) uses an Android-powered mobile device to report crime incidents to law enforcement authorities. Their framework is made up of three major components: the "User Interface," "Secure Data Transfer," and "Data Storage." The user interface component allows users to create and fill out crime reports that are similar to the existing paper-based crime reports.

The secure data transfer allows for the successful transfer of data from the mobile device to storage. The data storage component manages the information gathered from all user reports sent to authorities. It also manages data access control within the authority organization.Throughout the development stage of the Mobile Crime Application System, the user-centered design methodology was used in an iterative fashion to develop the user interface component of the Cry Help App.

The design's goal is to first determine whether a mobile device can be used effectively to generate a crime report based on existing crime reports used by law enforcement authorities. Second, investigate to what extent it is possible to generate instant crime reports that can be used as panic buttons in emergency situations. Their application doesn’t support video and audio or even perhaps more than a single image, as often times a scene could be taking place, that could be better documented by audio or a series of images.

(Dr Kahkashan Tabassum, Dr Hadil Shaiba Saada Shamrani Sheikha Otaibi, 2018) worked on an online crime reporting system for Riyadh city. This paper proposes an application that individuals in Riyadh can use to effectively report and manage their complaints. Furthermore, the system allows people to register complaints and assists the police department in identifying criminals.

The application's main goal is to improve the effectiveness and efficiency of interactions between police officers and the general public. It would be an excellent tool for monitoring and tracking criminals across the country, as well as keeping a complete online record of crime-related information.

(Pedro Taveras, Maurice Dawson, 2019) worked on an assessment Of National Crime Reporting System: Detailed Analysis of The Mobile Application. This project's goal is to find programming faults in a national crime reporting system. Various tools were used to examine the source code in order to determine the code's trustworthiness and quality, as well as to identify any existing or future security

flaws.These flaws are categorized and processed in order of priority. It is not about dynamic analysis or any other method of flaw detection; the goal is to perform static analysis. Furthermore, the goal of this research is not to exploit the vulnerabilities discovered, but rather to make the most thorough detection possible by precisely analyzing the threat posed by each detected vulnerability.

The application is divided into three sections. First and foremost, there is a mobile application for Android smartphones. This first software allows users to alert authorities to any suspicious activity or problem they encounter. Then there's a desktop application that allows cops to look at all of the reports that users have submitted. This implies they can prioritize distinct situations and take appropriate action as a result. Finally, the project configures the web service backend, which is utilized to communicate between the mobile app and the desktop software. The mobile application is the focus of this research.

They had a lot of errors during the conclusion of the application and it was difficult to establish a final assessment because they had no tool available to analyze the TypeScript language. There are numerous mistakes to fix, but they don't belong in the application's primary code instead, they belong in the libraries. As a result, finding a tool that can evaluate this language is critical in order to conduct a thorough investigation and ensure that software developers can effectively improve the application's quality, stability, and security.

(Jr., 2019) worked on an online crime management & reporting system. This study aims to provide an overview of the investigative process and, in doing so, identify effective and efficient approaches to the investigation and detection of the volume of crimes. The review is particularly aimed to highlight the research evidence

those investigative practices and actions that are likely to lead to a positive outcome. The development of software includes the process of brainstorming and planning, requirements analysis, system analysis and designs, implementation and testing, deployment, and maintenance. The criteria of evaluation of software quality were adapted in ISO/IEC 25010:20011.

This also shows that distance is also a factor that influences greatly how crimes are being handled with many crimes going unreported as a result. Crime Management and Reporting System would really help the complainant and the authority to communicate privately and easily with regards to the reported issue. In addition, it would be easier for the complainant to report a witnessed crime without the fear of getting involved in the problems because of the security that the only authorized user can see the report. Based on the findings, the researchers recommend the following for further study: widening the limit of the system by considering other cities; a generic platform for keeping human records from birth till death, deploying this sort of platform will serve as a source of information on persons from various states within the country and even those outside.

Verification using Biometric is highly recommended to enhance the security of data stored in the system. This increases the restriction on access to the system, thus unauthorized users have no access to the system. Face recognition technology can be added. The researchers made use of waterfall model to develop the wayfinding system application software because it gave the researchers an easy overview of the software based on the required specifications, and to present the general flow on the development of the software application.

The result of the shows that the system provides users with the most reliable and complaint process. The simplicity and the friendliness are the advantages of this application. The application was made user-friendly so that anyone could access the system via login and enter their password and initially, users have all details without any risk. The software is built with options such as the complaint registration, the area of the incident where it happens and the type of crime. In the modern world nowadays, the use of computer and mobile phones are becoming rampant that is why the researchers presented a simple but efficient, and convenient crime reporting and the requirements provided better perspective and very user-friendly and flexible for all the times.

Based on the findings of the study, the researchers recommend the following for further study: widening the limit of the system by considering other cities; upgrade the system by detecting double reported crimes or incidents and examine the success of citizens' self-reporting crimes online from the perspective of the law enforcement agencies receiving the online reports. Examining the validity of reports using the crowd is worth attention. This is a good source of information, but validation is a challenge that needs to be studied. They can add an email verification and an auto-reply SMS in an off-line reporting, which is texting using mobiles phones or tablets.

2.9.1 Summary of the Literatures Reviewed

S/No.	Author(s)	Title of Paper	Problem Statement	Method used	Results	Contribution	Limitation
1.	Oludele Awodele, Onuiri Ernest E., Olaore Olufunmike A., Sowunmi Oluwawunmi O.	A Real-Time Crime Records Management System for National Security Agencies	Creating a more effective storage method than a paper-based file system.	Waterfall Model	The system was measured in terms of authentication, real-time access and centralized storage, and it proved efficient.	Providing counter measures for security concerns in crime reporting.	Over the course of this research work, the major limitation encountered was; inadequate information as officers were not forthcoming with information thereby making it complex to specify requirements of the system. (b) The system was webbed based which does not make it time efficient

2.	Aderonke Busayo Sakpere, Anne V.D.M. Kayem, Thabo Ndlovu	A Usable and Secure Crime Reporting System for Technology Resource Constrained Contexts	Designing an Application to reduce the high rate of unreported crimes	Iterative design Model	The system was time efficient also it could allow Users send a crime report covertly with little more than a gesture	The system allows the uploads of images for better description of the crime being reported	The application could not support video recording or upload and also audio notes
3.	Dr Kahkashan Tabassum Dr Hadil Shaiba Saada Shamrani	An Online Crime Reporting and Management System for Riyadh City	This application provides an E-cops reporting and management system that guarantees effective and easy	Waterfall Model	This web-based application provides an E-cops reporting and management	The e-cops reporting and management system is an online application that can allow both the parties either the police or the	The application is web-based and also it not time efficient in terms of reporting

	Sheikha Otaibi		solutions to crimes within a short duration of time by connecting all people (citizens/public), police officials and others who would want to directly or indirectly participate in solving the cases.		system that guarantees effective and easy solutions to crimes within a short duration of time by connecting all people (citizens/public), police officials and others who would want to directly or indirectly	individuals within Riyadh city to report and manage their complains. (b) It also provides the management of crimes at any time from any place of the world.	

					participate in solving the cases. (b) Also the application had other languages like Arabic and French		
4	Pedro Taveras, Maurice Dawson, (2019)	National Crime Reporting System: Detailed Analysis of The	Finding programming faults in a national crime reporting system		The mobile application was functional and information on the application		The system has error that needs to be looked into and the application was incomplete.

		Mobile Application			became more sure.		
5	Jr., Tomas Ucol Ganiron (2019)	Development of an Online Crime Management & Reporting System	the inconvenience of going to the police station and personal belief of the weak investigative capabilities of the authorities to resolve petty crimes and limited spreading of crime information to the community.	Waterfall model	The application has a live chat and also criminal list can be viewed by all. The application helps the residents to be aware and to be concerned about what is	a) The system shows criminal list b) live chat c) The system allows a short video clip	The system does not have any means in which authentication of user is done

					happening in their surroundings.		

CHAPTER THREE

METHODOLOGY

3.1 Method of Identification of User and System Requirements

There are several methods of identification of user and system requirement. The method used to identify the User and System Requirements are informal surveys, observation of current crime reporting processes, review of other relate works.

Informal survey is one of the methods used in the collection of user and system requirement. Informal survey involves observation of already existing system or ways in which legacy systems are being operated on. Observation on how crimes being reported are handled also gave an insight on how the target system should be.

3.1.1 Identification of system requirement

System requirements are more extensive definitions of the functions, services, and operational limitations of the software system. The functional specification, often known as a system requirements document, should specify exactly what is to be implemented.

The computer system is made up of various components that collaborate to achieve a common purpose. The following are the system's requirements for implementation

a. **Functional Requirement of the System**

These are assertions about the services that the system should deliver, how the system should react to specific inputs, and how the system should behave in specific scenarios, among other things.

The functional requirement of the system is

i. New users should be able to register an account using their email.
ii. A user should be able to report crimes happening in their current location.
iii. Users should be able to access a list of all the crimes they have reported.
iv. Users should be able to call police emergency hotlines.
v. Police officers should be able contact users via their phone numbers.
vi. Police officers should have access to all the reported crimes submitted.
vii. Police officers should be able to filter out crimes based on those closest to their GPS location.

b. Non-Functional Requirement of the system

These are limitations on the services or functions that the system is able to provide. Among these include time limitations, limitations on the development process, and limitations imposed by standards. Rather of referring to specific system features or services, non-functional requirements are frequently applied to the system as a whole.

Non-functional requirements of the system include the following:

i. Both users and police officers should be authenticated via their email and password before having access to the crime reporting platform.
ii. The system ought to be responsive despite poor internet connectivity.

c. Software Requirement

The following software was installed and utilized in order to ensure the successful and efficient deployment of the system:

i. Android version: 4.4 or greater

d. Hardware Requirement

The following hardware requirements are necessary for the proper implementation of the system on android device:

i. RAM: 500MB or greater

ii. Storage: space 250MB or greater

iii. Processor: single or multicore processor

3.1.2 Identification of user requirement

a. System admin

The Firebase Admin is responsible for creating police accounts and registering their details on the database. They have access to all user generated content and can delete and edit data objects on the database.

b. Basic users

i. Users (individuals reporting crimes): these users are the once reporting the crimes that the police attend to.

ii. Police users: this class of user have access to all the reported crimes from the users who submitted reports. They can view the distance between themselves and the crime location in kilometers and can place a call to the user who submitted the report.

3.2 System Design Methods

This shows the process of the defining elements of the system.

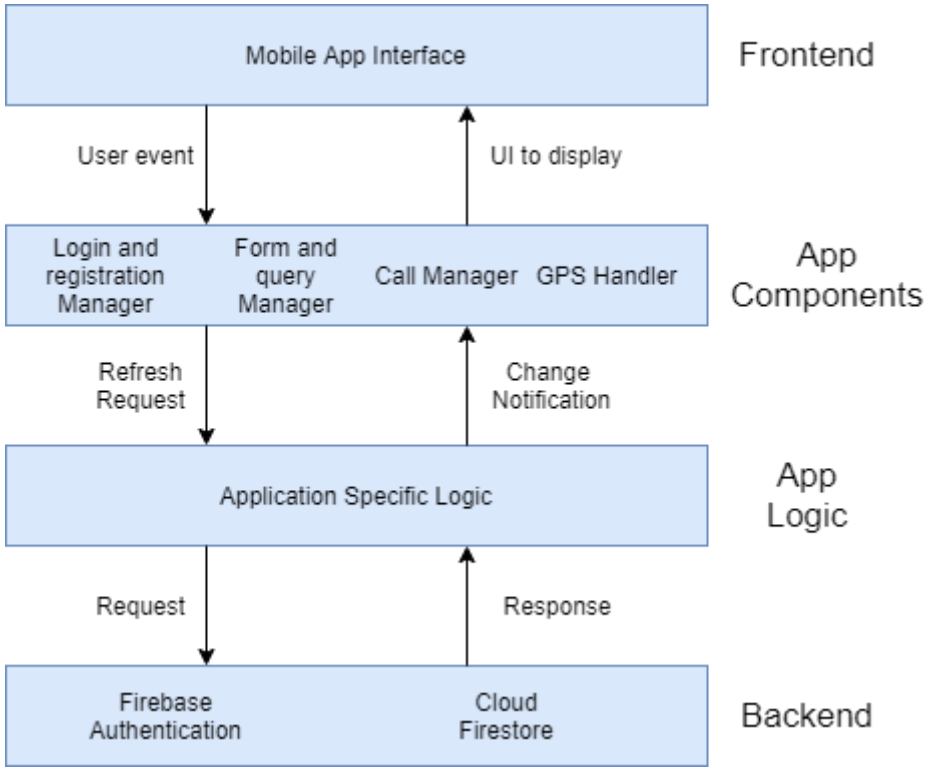

Figure 3.1 System Design Methods

3.2.1 User Use case diagrams

The user shall be able to register new account, then login to the system, interact with the reporting crime page, call the police hotline if the user wants to, the user will be able to access reported crime history and edit incase of errors also, the user will be able to view account details and edit them like change of name or password.

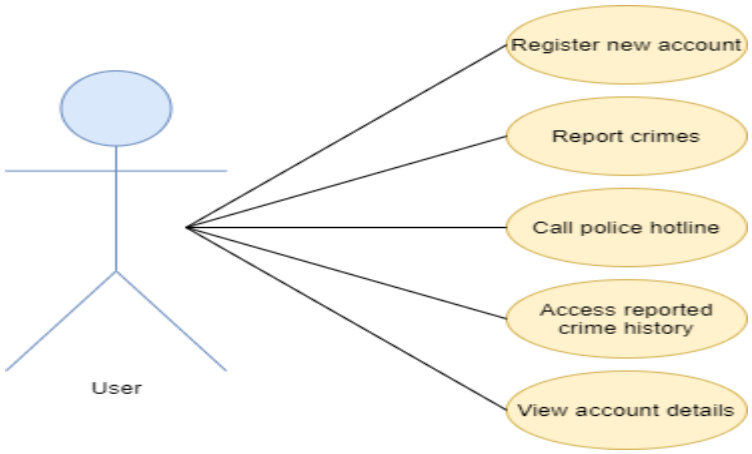

Figure 3.2 User use case diagram

3.2.2 Police use case diagrams

The police officer shall be able to view reported crimes, also call users who reported the crime also, the police can view account details and edit them like change of name or password.

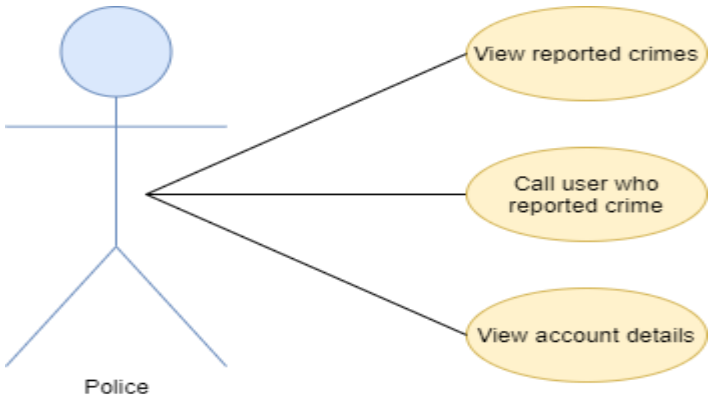

Figure 3.3 Police use case diagram

3.2.3 Admin use case diagram

The admin shall be able to create the police account for authentication purpose also he will be able to edit users information and also delete accounts.

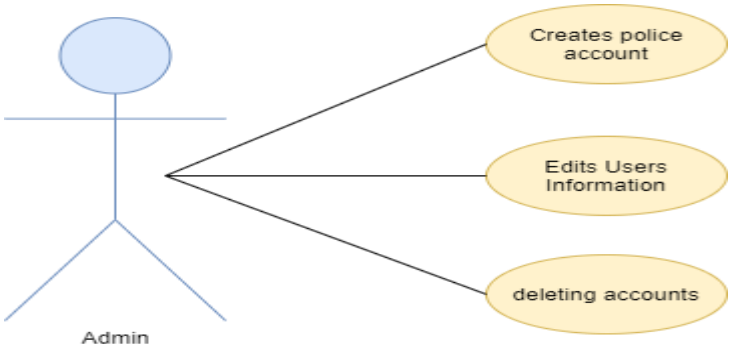

Figure 3.4 Admin use case diagram

3.3 Sequence diagrams

This is a diagram that shows the interaction between all the actors on the application.

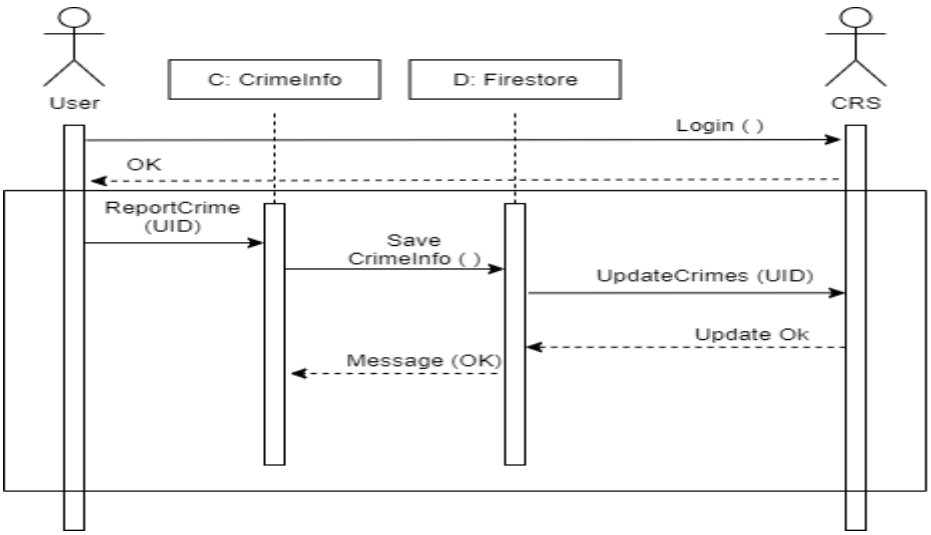

Figure 3.5 Sequence diagram

3.4 Activity diagram

The activity diagram shows how the application works step by step from the start said which you two option which is either to login or register a new account and it will be classified into either user or police, if it’s a user it takes them straight to the crime report menu then the crime report form comes up after that page that the report is confirmed and then sent to, the police on the crime feeds. If the account being logged into is that of police it goes straight to the crime feeds, then crime information can be seen by typing on the crime.

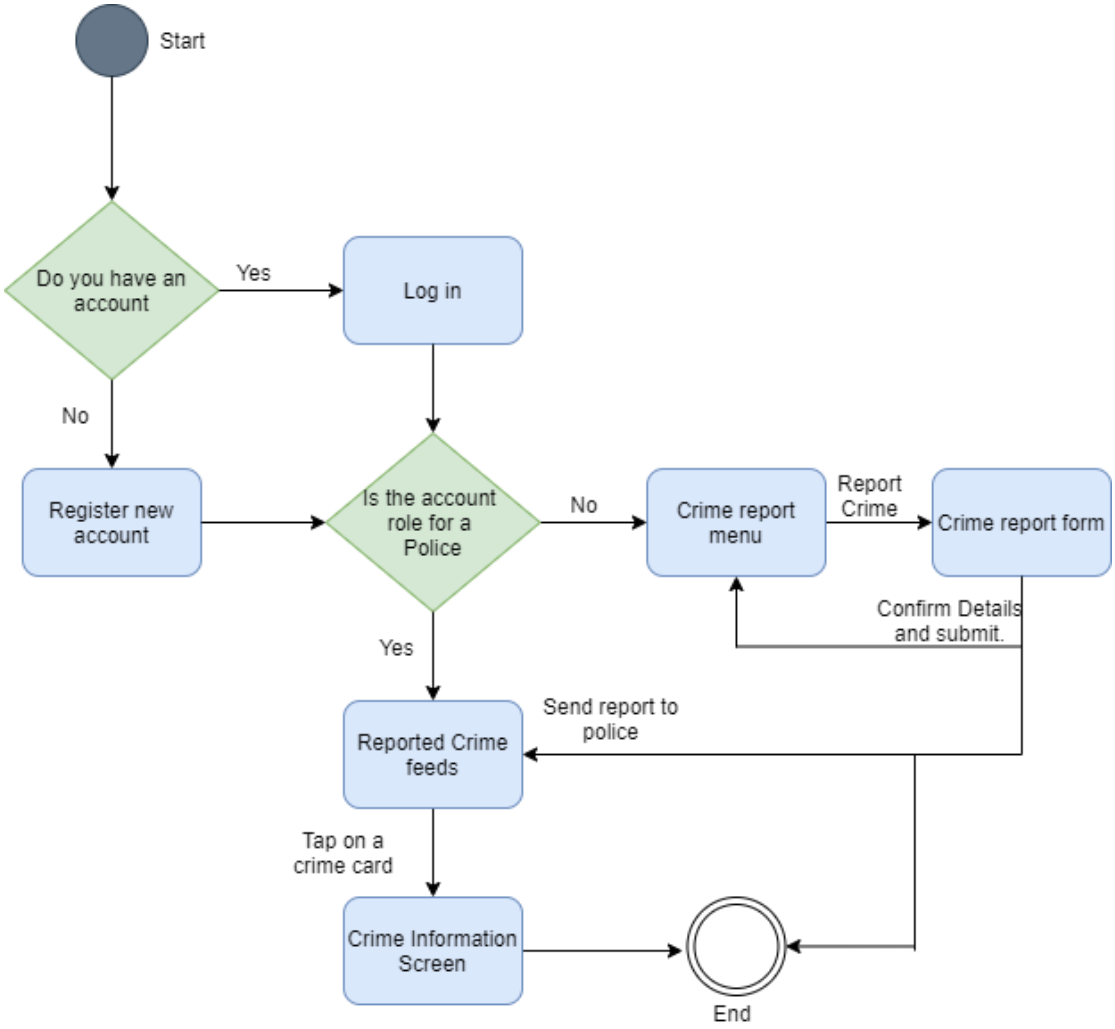

Figure 3.6 Activity diagram

3.5 Class diagrams

The class diagrams show what information is gotten and how it is gotten from the actor or user.

Figure 3.7 Crime class diagram

Figure 3.8 User class diagram

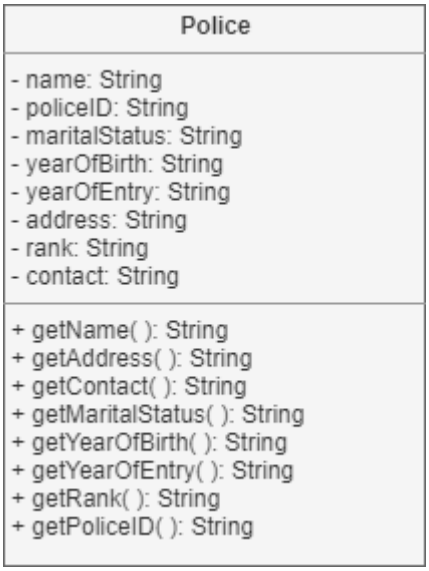

Figure 3.9 Police class diagram

3.5 System Implementation#

The system was built using Flutter framework. The implementation was divided into three main parts which are the frontend, the backend and the database. The frontend was built using Flutter.

3.5.1 Database implementation

Firebase was used for the implementation of the system in which the database codes were stored in the model folder of the framework. The offline version was used so it could track changes in the code.

3.5.2 Front-end implementation

The frontend was built using Flutter. Flutter enables a smooth and easy cross-platform mobile app development**.** You don't need to develop an iOS and Android app separately. All you need is one codebase for both platforms.

CHAPTER FOUR

IMPLEMENTATION AND RESULT

4.1 Introduction

This chapter shows the implementation of the crime reporting application using geographic information system. The tools used in system design and development of the system's primary idea and functionality to accomplish its defined mission.

It describes a variety of functionalities step beneath every module with their outputs. The entire notion is a system, which are set of things working together as components of a mechanism or an interconnecting system, which are set of matters working collectively as parts of mechanisms or an interconnecting system, it is a set of interacting or interdependent issue forming a set of elements to other elements.

4.2 Database Implementation

The image below shows the offline cloud firestore which was used to model the database. The crimes data tables/collections present in the database are users, police, and crimes. All corresponding data entries sent to the database are stored in their corresponding collection.

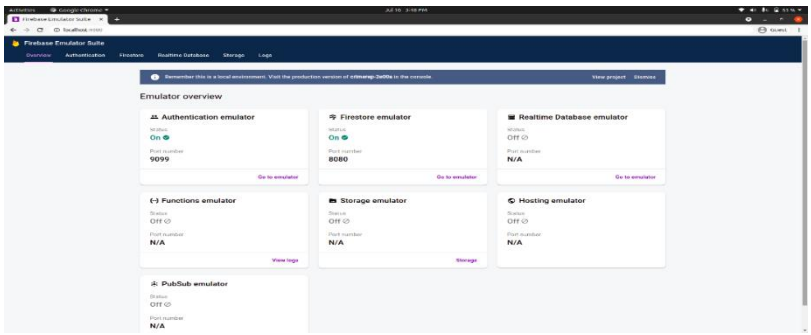

Figure 4.1 Firebase Database

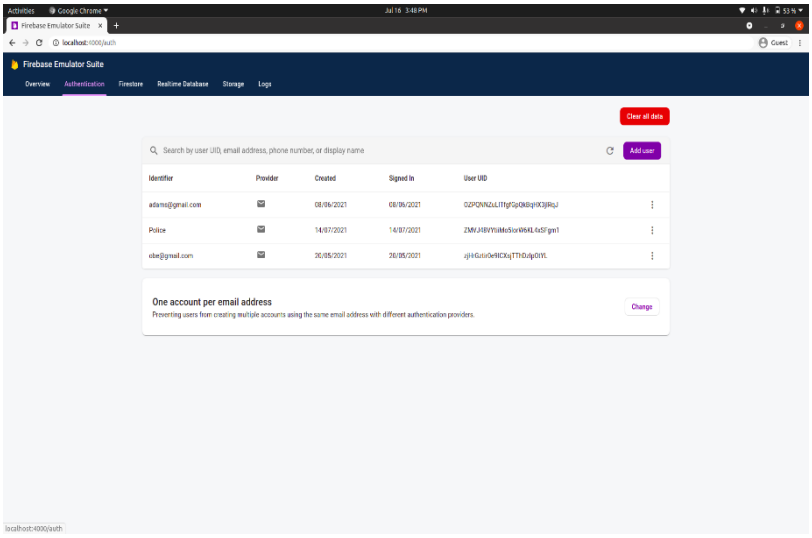

Figure 4.2 Firebase Database

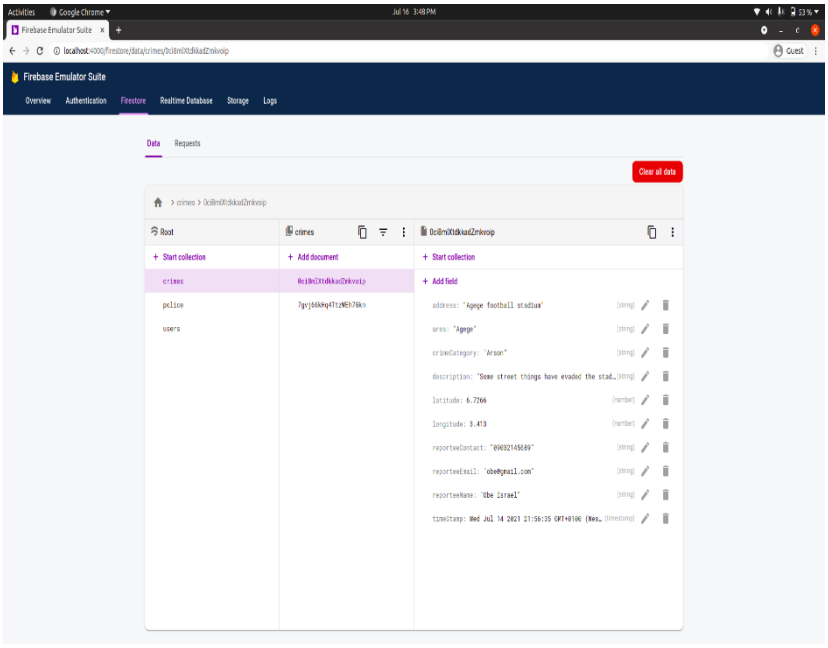

Figure 4.3 Firebase Database

4.3 Result of implantation Front end

The application shows the icon image on the splash screen, then it moves to the login or register page for the user to proceed to the home page to report the crime. After it brings out the crime form so the user can fill the crime being reported also, before the user is able to submit the crime reported must be verified by the user by clicking on the check box.

On the other hand the police after they login they can view all the crimes reported and the distance of the crime reported will be shown then the police officer closer to the location will be alerted and will move there and the police officer can also call the reporter. The user and police officers can edit their login details and change their passwords.

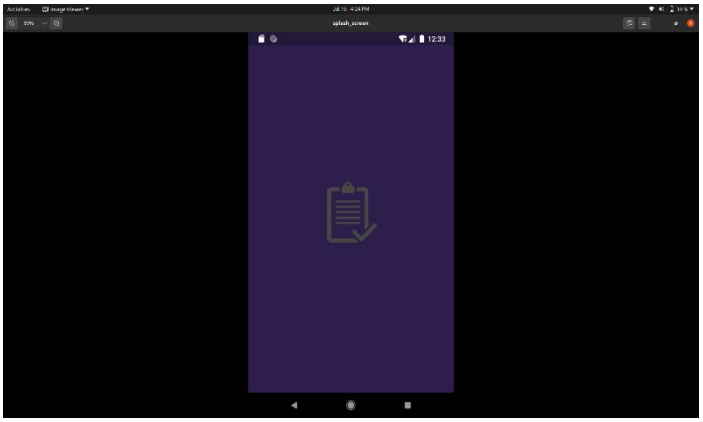

Figure 4.4 Splash screen

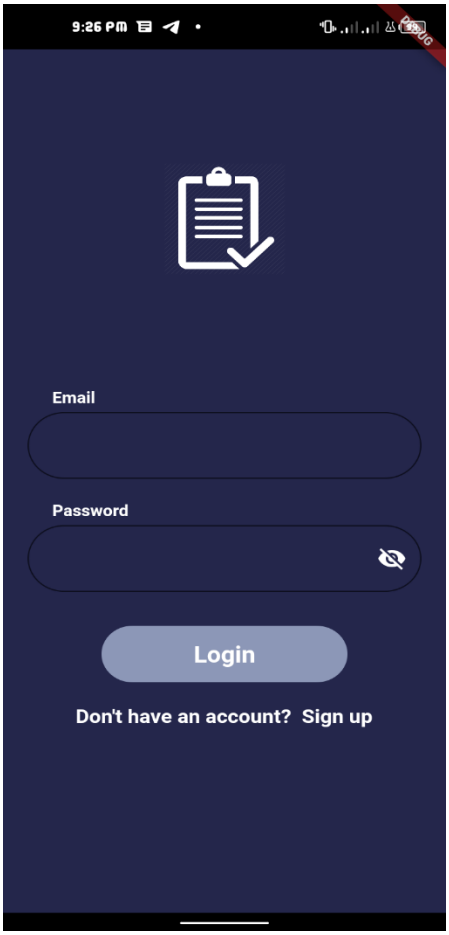

Figure 4.5 Login screen

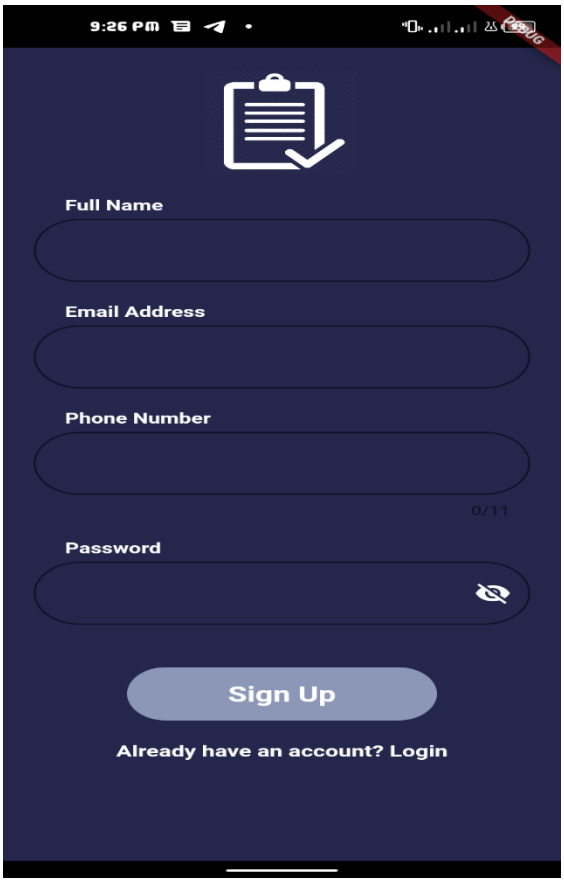

Figure 4.6 Registration screen

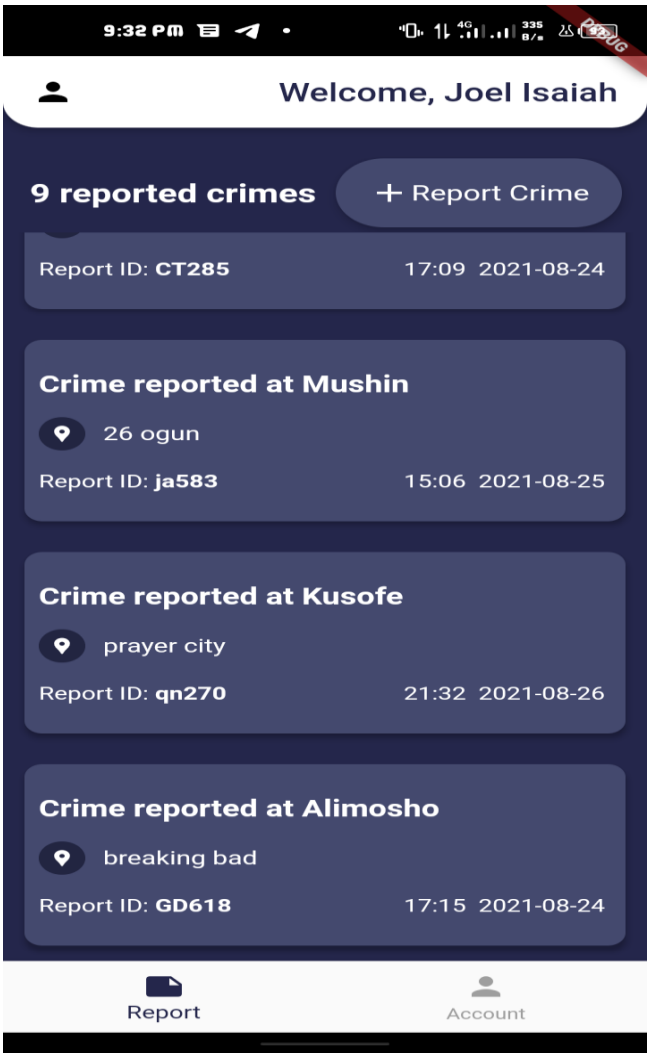

Figure 4.7 Home screen

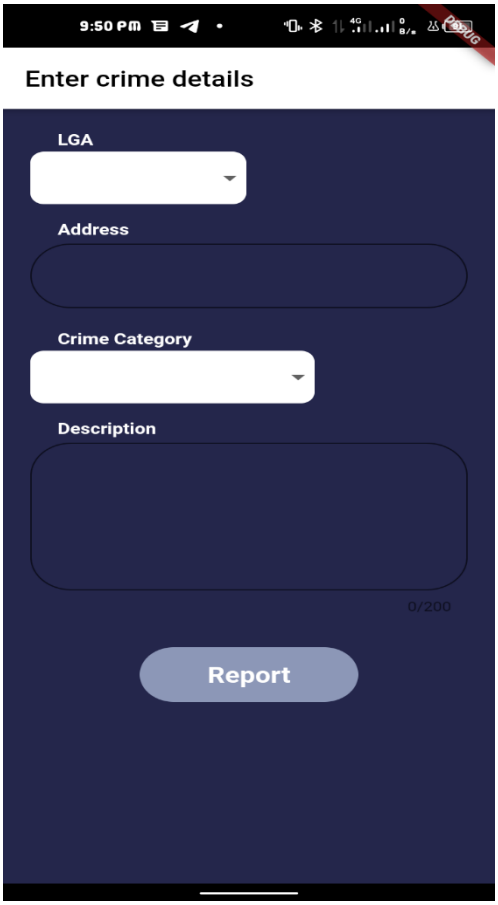

Figure 4.8 Reporting screen

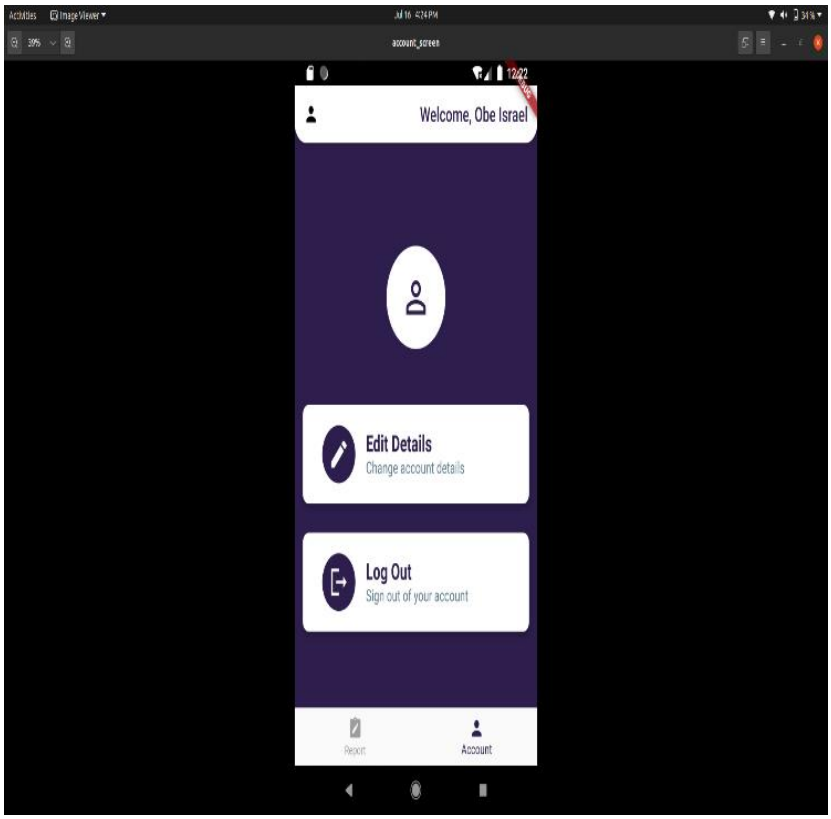

Figure 4.9 User edit screen

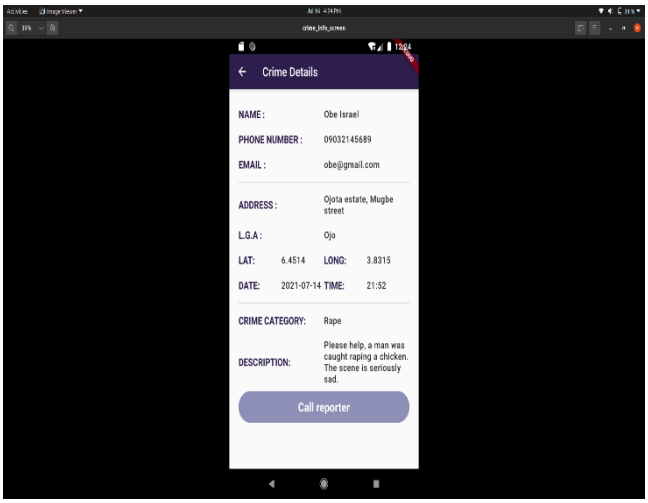

Figure 4.10 Crime Detail screen

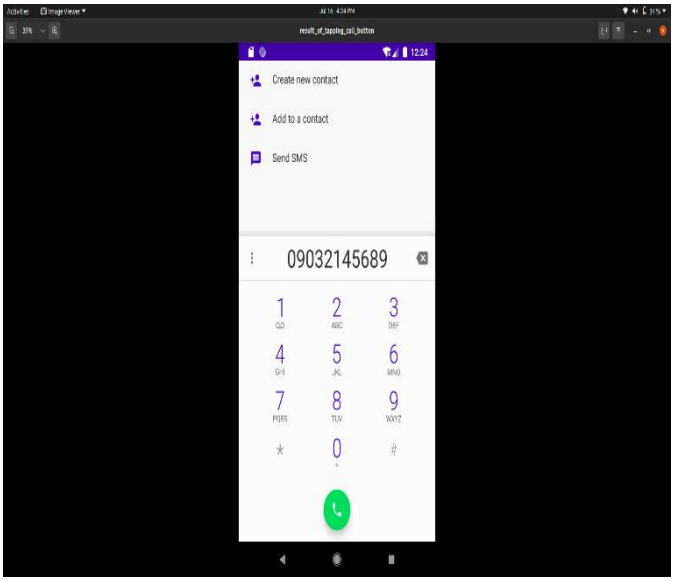

Figure 4.11 The call reporter page

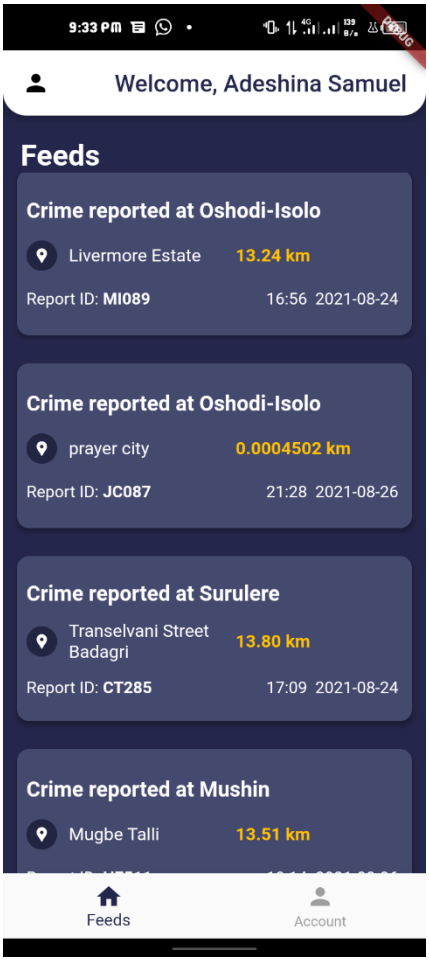

Figure 4.12 Police Home page

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

Having reviewed the challenges encountered through the manual report of crimes being reported, this proposed system is believed to help eradicate the problems associated with the manual method of reporting by the introduction a crime reporting

application using geographic information system which will make documentation more efficient and effective for serving the users better and to have a more developed way of reporting crimes.

The crime reporting application has amazing features like a distance calculator that notifies the police on how far the crime reported is from their location also, a voice recording feature will be added to the application for those who can't type in English they can easily speak their language.

5.2 Recommendation for Further Study

It is recommended that police officers and users should start using the real time crime reporting system because it is more efficient and effective to use.

Also, since the use of computers is growing fast globally, introducing the electronic system will enable police officers and users fit into the current global trend. The following are also recommended.

i. Other types of authentication methods (Single-factor, Two-factor, Multi-factor authentication) can be used for securing hospital management systems.

ii. Other types of frameworks (AngularJS, Symfony, ASP.NET) can be used in building online crime reporting systems.

iii. Other types of database management systems can be used for crime reporting systems

5.3 Conclusion

The application built is able to report crimes and show the distance of the reporter by using Global Positioning System (GPS) from the police men who see the report feeds and the closest police officer will have to attend to the crime reported.

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Appendix I

Title of Appendix