A GPS Tracking System for School Transportation Services

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Declaration

I declare that this work has not been previously submitted and approved for the award of a Bachelor's degree by this or any other University. To the best of my knowledge and belief, the proposal contains no material previously published or written by another person except where due reference is made in the proposal itself.

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Approval

The Information System Project 2 proposal was reviewed and approved *(for examination)* by:

Supervisor's signature:

…….…….. [*Signature*]

…….…….. [*Date*]

Abstract

It is important for every school to have a trustworthy and secure transportation service to ensure the safety of the students. It helps the school administration to effectively manage their bus fleet and potentially reduce mishaps. This is where vehicle monitoring takes effect. The system provides real time information about various parameters of the vehicle like the location, the route, the speed, the list of passengers, the adherence of drivers to schedule and much more.

It is a common problem for school management to know at any time who is riding in which school bus, where and at what time he was picked-up and dropped-off. This information becomes especially crucial in cases involving emergencies like school bus accidents. A geographical positioning system based solution for school bus routing and scheduling with time window is and was implemented using the agile methodology that gives room for robustness. The result helps the transport management to design a dynamic shortest and fastest route for the vehicles whilst ensuring all stops are accounted for and it is within the convenient distance for picking the children. The GPS also helps to identify the real-world pickup stops according to the concentration of the children in a particular area as well as to visualize the current optimum route and pickup points as well as a platform used by parents for tracking and children monitoring system which provide a comprehensive and highly reliable integrated services needed for school buses was tracked, monitored and inquired in real time.

The information can be accessed by the parents through a mobile application and this helps them track their wards effectively. The school administration can also access the application to ensure student safety and contact a driver or a parent. The application also allows the administration was informed of emergencies or complaints. In comparison to similar methods, sensitivity analysis of parameters are also conducted to analyse the performance of the approach.

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List of Abbreviations

API	Application Programming Interface
ID	Identification
IDE	Integrated Development Environment
DVR	Digital Video Recorder
GPS	Geographical Positioning System
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HTTP	Hyper Text Transfer Protocol
OOAD	Object Oriented Analysis and Design
OOD	Object Oriented Design
PHP	Hypertext Pre-processor
RFID	Radio Frequency Identification
SQL	Structured Query Language
SMS	Short Message Service
UI	User Interface
WIFI	Wireless Internet

Acknowledgements

In the present world of competition, there is a race of existence in which those having will need to come forward and succeed. A project is like a bridge between the theoretical and practical world. I would like to thank the High Deity for the coming this far. Without His grace, I could not have made this domineering progress of making this dream a reality. I am feeling obliged to thank my parents and my supervisor for supporting me throughout this period, offering guidance and are more than willing to encourage me to proceed further.

Chapter 1: Introduction

1.1 Background

We are extremely lucky to be living in a modern world where technology and science are at high levels of progress. Such scenarios where everything we do has a digital footprint left behind. The education system which is crucial for our growth and future development is intertwined with different sections in order to deliver services to our students. Bearing this in mind, the transportation of children both to and from school is a factor seems was overlooked. Some of our children end up using public transportation means that is matatus, instead of using the availed means of school transportation. This causes adverse effects as they take more time since public transportation has many stops for citizens not forgetting that it can be dangerous for the children as they are exposed to dangers like kidnapping and drug addictions from bad company engagement.

This study has built its arguments on two major variables which are parents' assurance and school transport. This works hand in hand to ensure that the children arrive and depart from school safe and sound and that the parents are aware in case any issues arise in the event of any delays. It also ensures that all children using transportation services are well accounted for and are picked and dropped off at their respective stages. Currently, there are little to no solutions given to this issue and if any, it doesn't accurately tackle the challenge of ensuring that children are picked and dropped off on time from school whilst informing the parents in case of any emergencies that may arise. Due to lack of communication, this can lead to different outcomes others can be more disastrous.

1.2 Problem Statement

The current school transportation systems put in place disregard the safety and security of children. Lack of knowledge of the current actual situation causes unease for the parents when awaiting for the school bus to arrive as it is sometimes time consuming especially when delays occur without them being informed. They are unsure of the exact bus location especially during uncertain weather conditions and do not know if they should seek other alternatives to get their children to and from school.

The administration on the other hand is not able to monitor the bus route taken ensuring all children are picked and dropped off at their respective stages that are safe and in close proximity to where they reside and manage the school transportation effectively.

1.3 Aim

The aim was to develop a GPS tracking system in order to bridge the gap between the school fraternity and the parents. The model contains a comprehensive monitoring system which tracks the bus continuously in real time while using the appropriate routes that are convenient for both the parents and the school drivers to pick and drop the children.

1.4 Specific Objectives

i. To investigate the various means of transport used by children in day schools.
ii. To analyse the current means of school transport systems that are currently implemented.
iii. To develop a GPS tracking system for providing real time data for tracking the bus location.
iv. To test the various techniques developed using various tools to ensure maximum accuracy of the bus location is achieved.

1.5 Justification

It eliminates loopholes that can in one way or another cause delays the departure and arrival time if not handled at its early stages. This is achieved by two major ways; the first being providing an interactive platform that shows the parents the exact location of the driver and by also informs them in the event of any emergencies that can erupt especially in the hustle and bustle during morning hours. It also helps in planning purposes that provide proper time management. The project was undertaken using various means namely; interviewing parents, observations and carrying out surveys to ensure it is suited to meet the needs of parents and the school administration at large. It also involved object oriented design approach at all its development stages.

1.6 Scope

This project throughout all the iterations and stages had one focal point which is the school transportation systems currently used in the country with any correlation identified and accurately documented. The investigations carried out were not in any way discriminative of background, race and religion but included an all rounded survey that was mainly centred on public and private schools who are the ultimate end users of the system.

In addition, the study was chosen and developed to suit those children who use the transportation services offered by the various schools. Taking into account the proximity of school from various homes of the children. Therefore, it excluded those who walk, picking and dropping off by parents or any other alternative means of arriving and departing both to and from school.

Albeit all this, the study was designed to suit the needs of those schools that would adopt the viable idea in their service docket. This narrowed down the search to the schools that are situated exclusively in Kenya's capital city Nairobi and not overseas.

1.7 Limitations

Although the project sought to find the best solution to meet needs of school transportation services, it often included hitches that limited its overall reach to the society. One such example is that the targeted users of this system ought to have android enabled devices this goes for the parents, drivers and the school administration at large. This comes as a result of the system being developed on an android IDE platform thereby limited to those with this type of operating systems on their phones.

A limitation of this research is that the study involved those who reside outside the school environs to facilitate for the transportation services. Thus, is not a best fit for those which learning facilities at the comfort of their household or compound offering any type of formally accepted schooling for example; home-schooling. This can be the case for some orphanages and children homes who more often than not have to find transportation facilities to take their children to schools not forgetting that they are usually in large numbers seeking the basic needs every Kenyan ought to have.

Lastly, the focus is on online methods of communication between the parents and drivers providing updates for the real time tracking of the school bus. Thus, access to the platform and its usage requires one to have internet connection to enable accurate positioning and tracking services.

Chapter 2: Literature Review

2.1 Introduction

This section gives room for an analysis and an in depth look at the similar projects that have been done in the past and the goals that they achieve in being carried out and how they differ from the initial system. It also examines the platforms/technologies employed in school transportation procedures and the challenges that arise with the usage of these platforms. From this, it aims at not only the identification of gaps but also description of the gaps in terms of what has not been done to solve the problem. Lastly, it describes how the system attempted to solve the problem as identified in the previous chapter.

2.2 Presently used tracking Systems

2.2.1 Real time monitoring system

Although somewhat similar to the system as the both contain some characteristics. It is incorporated with a highly automated system that helps provide school bus tracking with a mix of services that help ensure that the school administration renders top notch school bus services. The system comprises of two major parts namely, an on-board tracking unit and a tracking server unit. The on-board tracking unit is mounted in the bus to register the boarding or alighting status of students, which includes boarding and disembarking of time and student locations and the real-time GPS location of the School bus. An on-board RFID reader reads the students RFID card number. The real time location is recorded using GPS tracking device. All the boarding and exiting data is uploaded to the tracking server was stored in the database.

2.2.2 The on-board tracking unit

A microcontroller board retrieves data from the GPS module and the RFID reader and the goes on to forward the data to the server. The board is normally connected to a module that allows the microcontroller connection to the internet to form a voice calls using a GSM library and to send and receive data. The RFID reader scans student RFID tag. This tag is normally combined with GPS coordinates for correct pinpointing of the location. The collected data is then sent to the server via a communication network where it is saved for further processing for building of a track map layer for r and simplified analysis. A buzzer is connected to the system which is activated when an alert is received. Also, an emergency switch is provided to the system to enable

drivers to react instantly in sending an emergency Short Message Services (SMS) notification to alert authority about certain accidents or when the driver needs an emergency help.

The tracking server has two major software components, the database server and the web server. It links the communication between these two components therefore delivering a high end application through the use of a stand- alone platform. The short message system services are provisioned through a third party provider.
The server gets two HTTP requests from the devices the first being the location coordinates and the other being the tag codes with their timestamps. The data is stored in the database whereby analysis is performed from the data received.

2.2.3 Challenges faced with real time monitoring system

The system does not take into consideration scenarios where the students ID tags might be forgotten or misplaced. Foregoing these RFID for biometric identification technology such as fingerprint or eye recognition services was more time consuming as the data needs was matched with the one in the database for confirmation purposes. A case of forgotten identification cards can also restrict the use of these system for children. If the tags are placed on bags this is also not a solution since they change bags every now and then or can even get destroyed due to wear and tear from frequent cleaning of the bags. Not forgetting the different stages that need was achieved for the data was saved and if one of these stages is not adhered to can alter the data stored.

2.3 Related Works

2.3.1 An Intelligent and Secured Tracking System in India

This is a system that transfers information to parents, using text messaging and an android application. The system can identify the location of the bus using GPS as well as to notify the parents when students enter into the bus. It was introduced to monitor kids within the bus in a safe and reasonably reliable manner. It uses a mixture of RFID, GPS and GPRS (General Packet Radio Service) technologies. The RFID tag is embedded onto the children's bags so whenever they enter or leave the bus, the reader records the time, date, and placement and so transfer the information into a secure server. The whole process is automatic, requiring no action from the driver or parents.

Upon completion of the school bus journey, the system sends an SMS to the guardian or authority to indicate a successful start and termination of its journey.

2.4 Gaps in the existing works

All in all, the system even with the solutions and merit that they carry along do need greater effort put in them for utility reasons. Some of these methods only seem to tackle the issue of finding the best route and not the security of the children. Their major focus is to reduce repetitive transportation routes and maximize on the needed ones. This can also be a downfall when analysing the best places to drop off children as they are concerned to reduce distance and not focusing on the primary goal which is that the pickup and drop off location should best suited for the parents too. In addition, taking a picture of the student can in the long run be cumbersome, for example, storage in the database can be recurrent pictures of the same child and also different phones allow different photos was captured therefore, compatibility should be well analyzed. Furthermore, provision of RIID cannot guarantee the presence of the child in the bus. It can be misused for personal gain and tamper with the final results.

2.5 Conceptual Framework

The developed smart school bus tracking system enhances ease of use incorporating utility of application programs. It provides accurate tracking of the child's location. It also provides a platform for the school administration to monitor and accurately manage its transportation systems.

It helps determine the best routes putting into consideration the children's' safety zones and the bus stops. Hence, uses an undying algorithm to compute the best routes to take to avoid delays and promote maximum efficiency at all times. This helps them to admit incoming students and provide the best suited pickup locations for both these parties in a dynamic manner. Furthermore, the system provides various merits namely, scalability, flexibility, security and all at a very affordable cost. All the information ranging from the location at different intervals to the time children are picked from different stops are safely stored and encrypted for security reasons. Not forgetting that it also has user authentication to secure data and prevent it from reaching unauthorized hands.

The system brings together service providers and parents on a common platform using the new improved technologies. Thus, every parent will get access to the application with the school bus that is for picking up their child being accessed by them. This helps in proper planning especially during morning hours to avoid rushed preparations and end up waiting for long hours in rainy conditions or being left by the bus.

The mobile application is incorporated with various features. Parents can record absence of their child due to various reasons like sickness or unforeseen issues; thus no need for the bus to wait for their child at the pick-up point. This saves on time and improves flexibility for both parties as the bus can automatically change the route easily to implement the changes. In addition, it offers parents the transport fee collection (Anon, 2011) platform whereby parents can view their transport payment information. They can also location information of school bus; and they can follow child's bus activity through notifications. These notifications gave information about school bus location including school bus time approaching near the house and cause of any path deviation.

In light of the transport payment services, this is calculated according to the different distances of the stops from the school. Thus, the further away the more the cost as the bus has to start from the longest distance location of the bus stop. Therefore, it can be used by those who also walk to school provided they have paid in advance and indicate the dates of pick-up of their children or in cases whereby parents want to take their children to school personally or drop them at a nearer stop to the school while headed to work. The same applies during leaving school as the parent can easily change the drop-off location and pick the children up. This is all dependent on their preferences provided the pickup and drop off points remain the same. This is the perfect companion for not only payroll processing for drivers but also for fee collection of school bus fees from students and teachers and other users of the bus service in a school. With this feature administration can easily collect the fees in a similar fashion as academic or school fees are collected but with a touch of flexibility. Additions and deductions, like tax increment can also be included within the school bus transport management system. It is also promotes usability since its sends transport alerts to parents for example, when the transport fee is almost depleted.

The system consists of an Internet enabled android application which will interact with a server. Authentication was provided by the implementation RFID tags and fingerprint authentication as a part of dual authentication. Thus, during entrance and

exit of the students, parents may get an accurate notification. Authentication was carried out during boarding and disembarking of children to alert the parents at different stages of the trips.

The driver, faculty members/teachers, parents, and administrators are the end users otherwise referred to as the stakeholders of the application. The application uses wireless technologies like GPS and GPRS. With this android application parents can watch all the movements of the bus and monitor their child's presence making the tracking process become more simplified. The administration on the other hand can perform various monitoring functions like informing parents of various changes like bus capacity for various routes taken. Also informing of the temporary transport changes that can be made due to various reasons like the bus normally on that route is undergoing mechanical changes and exchanging it for another or informing the students that they was picked by different school bus that was in the area. Moreover, the system is capable of recording and updating details like bus and transport insurance, bus identification details, bus school route details such as distance and mapping the route, etc. It also generates comprehensive reports for various stakeholders that are using school bus or transport services offered by an educational institution.

Parents are able to even use this tracking feature on the mobile friendly version, so they are able to keep an eye on their child on the go. In case of any exigencies, parents can receive instant alerts and updates via SMS (short messaging system) on their mobile. This provides them peace of mind knowing that if any emergency or accident takes place, they are immediately informed. It also provides Transport Details and Reports (Fedena, 2019). All this is infinitely more efficient and time and energy saving when compared to the old fashioned way of doing it where a human administrator decides on routes, addition and removal of routes, allocating routes to people.

All the boarding and exiting data is uploaded to the tracking server was stored in the database. The uploaded data is verified for authenticity by checking it with the student and bus information stored in the database. Once verified, the data is stored in the database. The system ensures that the students have boarded the correct buses and ensures all students are returned to their drop-off locations. Also, the system provides a real-time information about the bus location, student’s boarding & disembarking status and sends notifications messages, eliminating the chance of student left sleeping on the bus, loss of items during transit and some other valuable features.

To sum up, a number of school bus tracking systems have been reported in literature, and they address parts of the concern of school bus tracking and monitoring. The GPS provides the position and time information. The GPS system is based on a number of satellites regularly transmit their location in orbit as well as the time. The GPS use this information from at least three satellites and uses this information to calculate its own location (longitude, latitude). In this application, the GPS is used to detect the bus location, the pickup & the drop-off location of students and time. The General Packet Radio Service (GPRS) shield provides away of using GSM network to receive and send data to and from a remote location the data base is used to keep records of the location of the school bus and the boarding and disembarking records of the students. This works hand in hand with the RFID tags and the fingerprint identification for student identification purposes.

Chapter 3: System Development Methodology

3.1 Introduction

A methodology is a process or a series of steps to follow in system development. There are different methodologies that can be implemented but their main components remain similar. This project utilizes agile software development that relies mainly on subsequent iterative approaches. The aim of the methodology ensures that the system is able to improve the school transportation system. The chapter will cover the following areas: development methodology, justification of the methodology, functional, non-functional requirements and tools and techniques.

3.2 System Methodology

The basis of agile software development is that it can adapt over the course of a project. Instead of in-depth planning at the beginning of a project, agile methodologies allow for feedback and change. This gives room for inspection and adaptation in various stages of the system development. Agile development also allows rapid delivery of high quality software that is in line with the niche being solved. The main focus being to produce a well-functioning product. So, in order to get there, there's need for frequent face-to-face communication and accountability.

3.3 System Design

The system used both qualitative and quantitative research methods, qualitative research provided a better understanding through firsthand experience, truthful reporting and quotations from actual conversations. This was used to understand the current platforms and process of transporting school children both to and from school. The quantitative research on the other hand, was used to see the number of people who would like use the new system or thought it was a good idea (California State University, 2012).

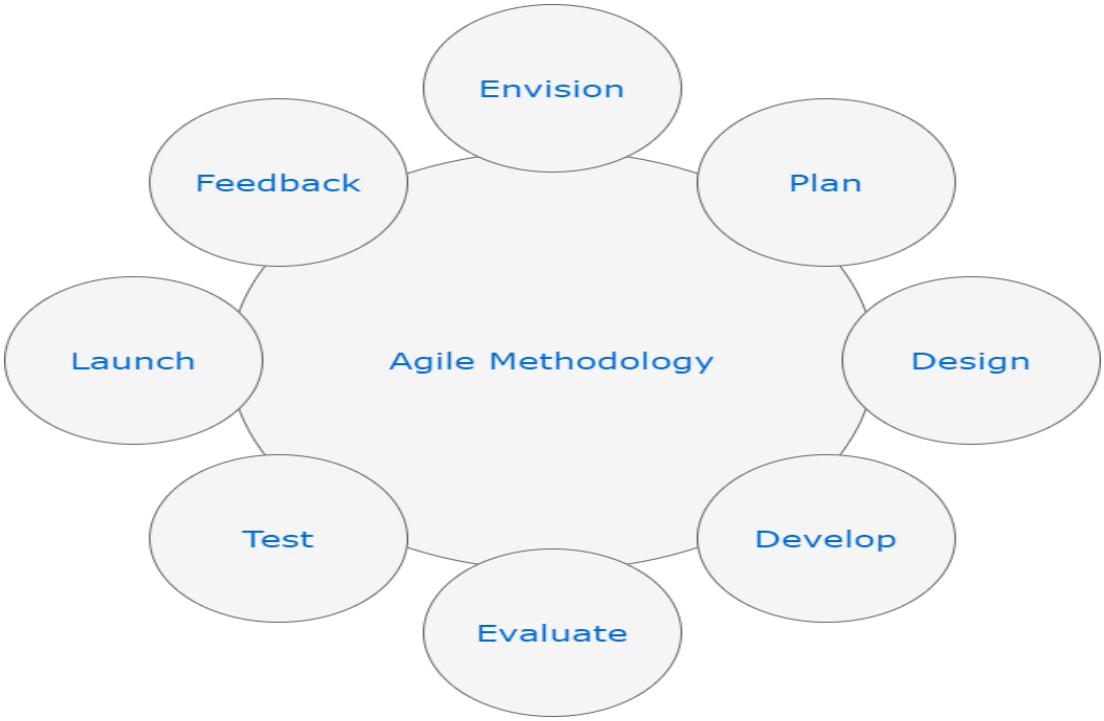


Fig 3.1: Stages of Agile Software Development

3.3.1 System architecture

The project uses GPS tracking mechanism to track the school bus's actual position, show the results predict the arrival time for accurate planning procedures. Here it replaces the hardware parts using an android application. This implements a tracking system using GPS and GPRS. The system allows a user to view the present position recorded of the school bus on Google Map through the internet. Basically, using an android application to develop a bus tracking system which is cost effective. It monitors bus traffic inside spacious bus routes and stops, and can inform administrators and parents whether the bus is arriving on time. Furthermore, it talks about vehicle tracking and various arrival time prediction methods. The system can also be extended to get this information in a cost effective manner.

3.3.2 System Analysis

There are 3 approaches in information system development area; process-oriented, data oriented and object-oriented approaches. Unlike its two predecessors that focus either on process or data, the object-oriented approach combines data and processes

into single entities called objects (University of Missouri, 2001). Object-oriented Analysis and Design (OOAD) concept was used in this study. OOAD increases the understanding of problem domains because OOAD promotes a smooth transition from the analysis phase to the design phase and provides a more natural way of organizing specifications. The project focuses on use-case modeling and class modeling to explore how system analysis are conducted under different methods.

Use-case modeling has been developed in the analysis phase of the object-oriented system development life cycle. A use-case model consists of actors and use cases. An actor is an external entity that interacts with the system and a use case represents a sequence of related actions initiated by an actor to accomplish a specific goal (Hoffer, 2001).

3.3.3 Justification of methodology

The project is set to apply an Object-oriented analysis and design (OOAD) which is a technical approach used in the analysis and design of an application or system through the application of the object-oriented paradigm and concepts including visual modelling. This is applied throughout the development life cycle of the system, fostering better product quality while encouraging stakeholder participation and communication

3.3.4 System Design

Object-oriented design (OOD) techniques was used to refine the object requirements definition identified during system analysis and to define design-specific objects. Design class diagram was used for general conceptual modeling of the systematics of the software, for detailed modeling to translate the models into programming code and for data modeling. The project adopted a design class diagram to hold classes which contain the main objects, methods and interactions of the software. Entity Relationship Diagram (ERD) was also included, which is a graphic that illustrates the relationships between people, objects, places, concepts or events within a system, enabled the system to define business processes and to develop relationships between entities and their attributes in a relational database (TechTarget, 2000).

3.3.5 System Testing

Usability testing was conducted to test the functionality of the system. Usability testing entails testing; validation of interactive elements on each screen (e.g. buttons, text inputs etc.), validation of navigation flow, ease of navigation, responsiveness and user friendliness (Bellatrix, 2015). Target Population. The research was mainly centered in Nairobi County. The target population be parents whose children are in day schools seeking school transport information and they comprise Nairobi residents over 18 years of age.

3.4 Data Collection Procedure

The data collection procedure involved sampling survey procedures employing questionnaires, interviews and observations. Interviews were carried out to gather information about the system and user requirements from the respondents of the research. The research adopted interviews since more information and in greater depth can be obtained through this method (Kothari, 2004). Questionnaires were also used to gather system requirements from the users. Observation protocols be used to understand the operational procedures on the current information dissemination approaches.

3.5 Data Analysis Procedure

Content analysis was used to analyze the research data. Directed content analysis was used to validate study objectives, user and system requirements. Research objectives, system and user needs helped to determine the initial coding scheme. A directed approach analysis that started with a theory or relevant research findings as guidance for initial codes (Hsieh, 2005). Data that cannot be classified are identified and analyzed later to determine if they represent a new category or a subcategory of an existing code. This method was employed since initial classification was not bias while collecting the identification of relevant application objectives and needs. In addition, the methodology helped to focus the interview questions thus simplifying data analysis.

3.6 Functional requirements

According to Rudiger (2012) the functional requirements refer to the functionality and the services that was provided by the system in order for the system to function as intended.

3.6.1 Authentication

According to American Academy of Periodontology (2012) a login page is the first enemy of defence that filters out the trusted and the untrusted parties from interacting with the system. A functioning log in page is necessary to filter out the data.

3.6.2 Administrative functions

This refers to the school staff and parents having the privileges to edit the data in the system.

3.6.3 Audit Trail

The system is able to trail at what place and time a GPS location was generated and on what device to enhance security.

3.7 Non-functional requirements

The definition by Berg (2012) states that the non-functional requirements are the requirements that specifies the criteria that was used to judge the system.

3.7.1 Performance

The performance refers to the action of doing a task or function. The system is able to perform the tasks at a certain speed to ensure tasks are completed efficiently.

3.7.2 Accuracy

This refers to the correctness of data retrieved from latitudes and longitudes interconnection. The data that was collected proved to be accurate thus gave correct results thus promoting efficiency.

3.7.3 Usability

This refers to the ease of use of the system that the user is interacting with. The system should not be complicated such that it contains challenges with its use.

3.8 Tools and Techniques

This refers to the tools that were used to ensure that the system was created in an efficient manner. The IDE for use is Android Studio.

3.8.1 Java

This is the programming language that was used to facilitate the design of the system.

3.8.2 Firebase

Java is a real-time database management system that is used to store data of the organization.

3.8.3 Java Script

This is an interactive object oriented programming language that is used to create interactive effects within web browsers.

3.8.4 React Native

This the package that helps in building of JavaScript systems efficiently.

3.8.5 GPS Location

This is the tool that was used to generate the exact location for each school driver and the route used.

3.9 Milestones and Deliverables

The following modules were covered in this project:

3.9.1 System Security

Security refers to the methods and procedures that ensured that the system is kept safe from intruders. This is done by creating a secure connection that transports the

information to the encrypted database where it is not retrieved easily. The passwords are hashed so to ensure that it cannot be deciphered.

3.9.2 Administrator Module

This is the module ensures the driver knows where children are located and uses the best route for picking and dropping them.

3.9.3 User Module

This module allows parents to see the real time location of the driver and the route taken by the driver.

Chapter 4: System Analysis and Design Description

4.1 Introduction

The aim of this chapter is to provide a list of the identified system requirements and highlight the approaches that were employed in the process of gathering the identified requirements that is, both functional and non-functional requirements. At this stage, one gets diagrammatic representations aiding to visualize the final outlook of the system. This is conducted during the system development stage where the system architecture that includes the mobile application accessed by both the school and the parents has been illustrated.

Requirements Gathering

The system requirements, which are the features and functionality of the location-based tracking system will require to facilitate effective functioning of the system. They are the umbrella of the functional and non- functional requirements of the system. At this stage, they were all accurately identified and examined to confirm that they are tailor made to ensure smoothness in the delivery of the end product.

4.2 System Architecture

The system architecture comprises of four main components; the mobile application, the database and the GPS. On one end, the parents can view the bus location and track it, same goes for the school administration whereas, on the other the driver updates the application to start and end trips, respond to alerts and make necessary changes in the event that there are any changes updated during the trips.

In addition, the devices that are used to access the system, act as GPS tracking devices are able to acquire accurate co-ordinates and positioning of the school bus while in transit. In order to facilitate viewing of this these devices must connected to the internet.

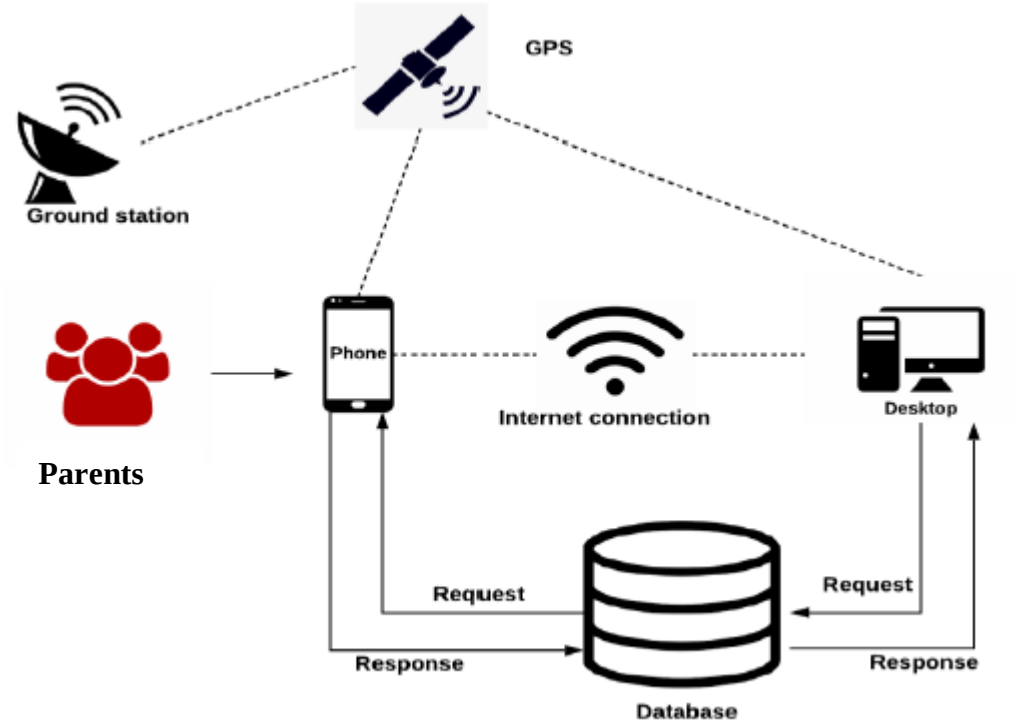


Fig 4.1: System Architecture

4.3 System Design

The diagrams that provide a visual representation of the system fall under this. They help to define the stages of iteration, their components and their interactions (Salustri, 2018). Interactions help to know the flow of logic of information and the modules of the system. Below are the system diagrams that are to illustrate the visual model of the location-based tracking system's components and their interactions. They include: a use-case diagram, a sequence diagram, a class diagram, an entity relationship diagram and a database schema.

4.3.1 Class Diagram

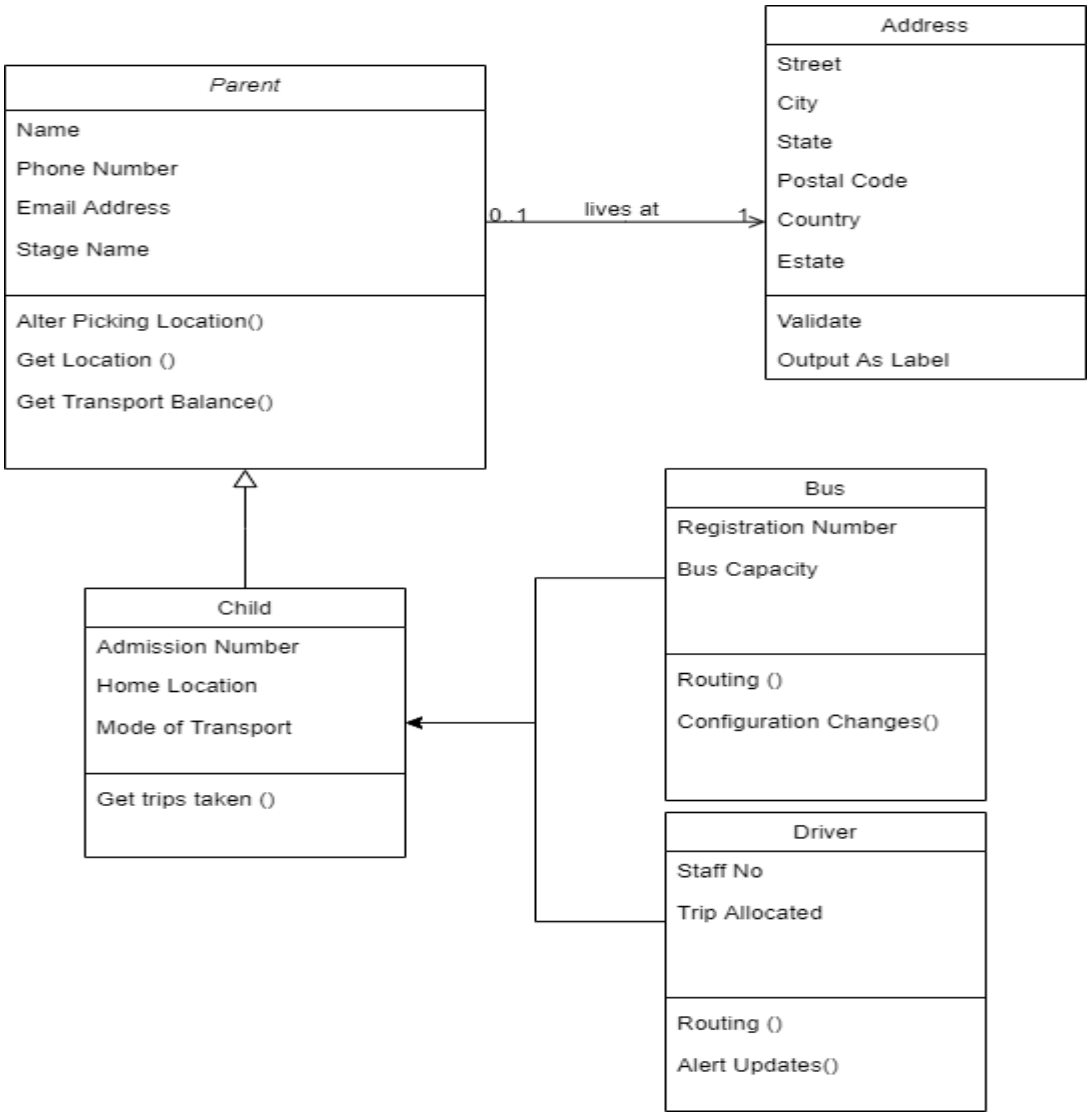


Fig 4.2: Class Diagram

The class diagram above depicts the classes of controllers and models of the mobile application system accessed on both the driver and the parents end.

4.3.2 Use Case Diagram

The diagram below shows the various interactions of the users and the system itself. It also shows some of the background tasks that are performed on the backend in order to relay user information to the various users.

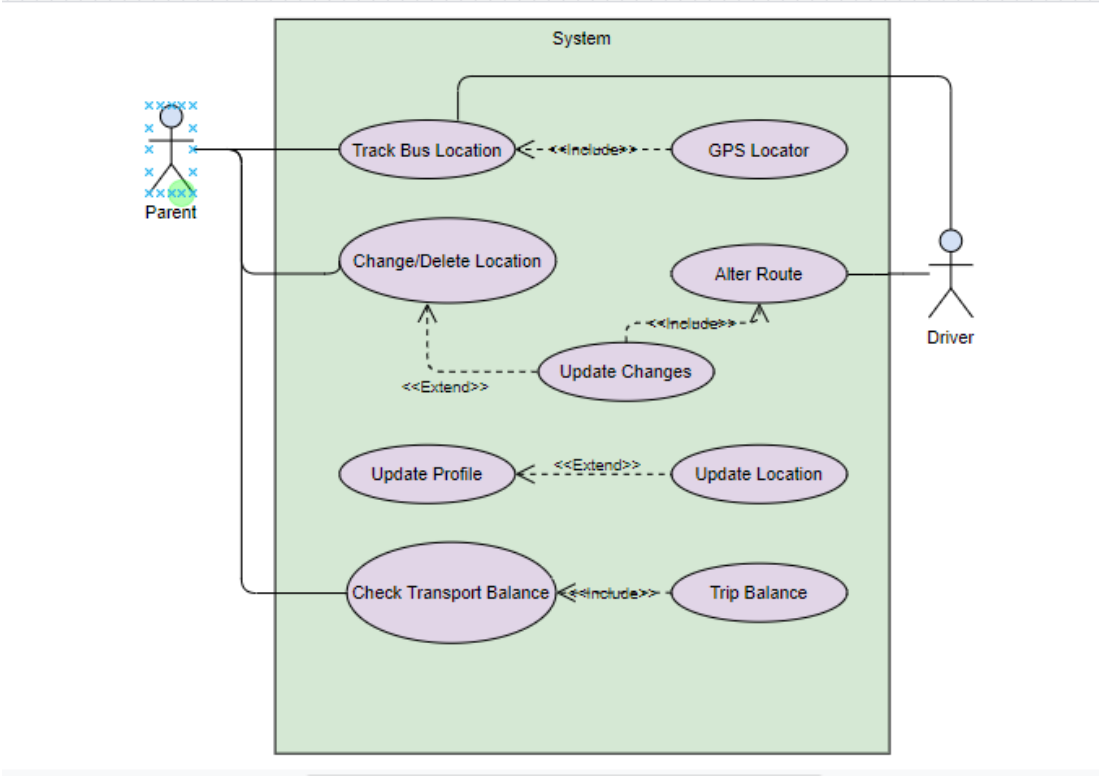


Fig 4.3: Use Case Diagram

4.3.3 Sequence Diagram

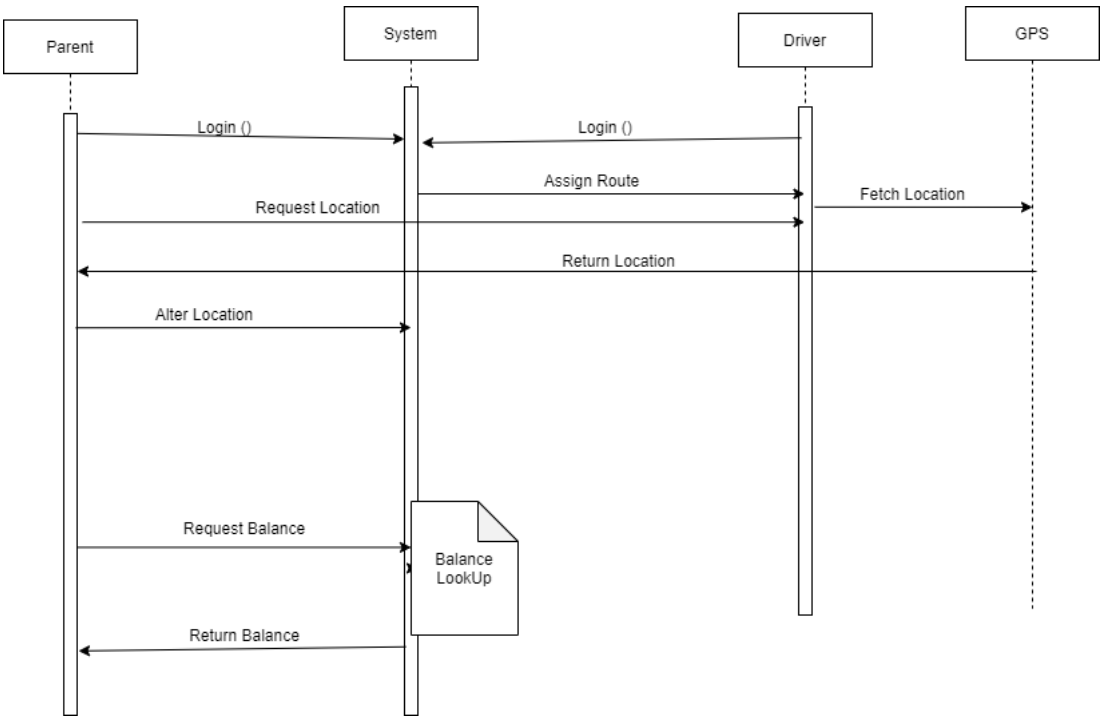


Fig 4.4: Sequence Diagram

The diagram above shows the flow of logic and information from the different objects that interact with one another. It also shows the different stages the processes undergo in other to give the final output to the user.

4.3.4 Database Schema

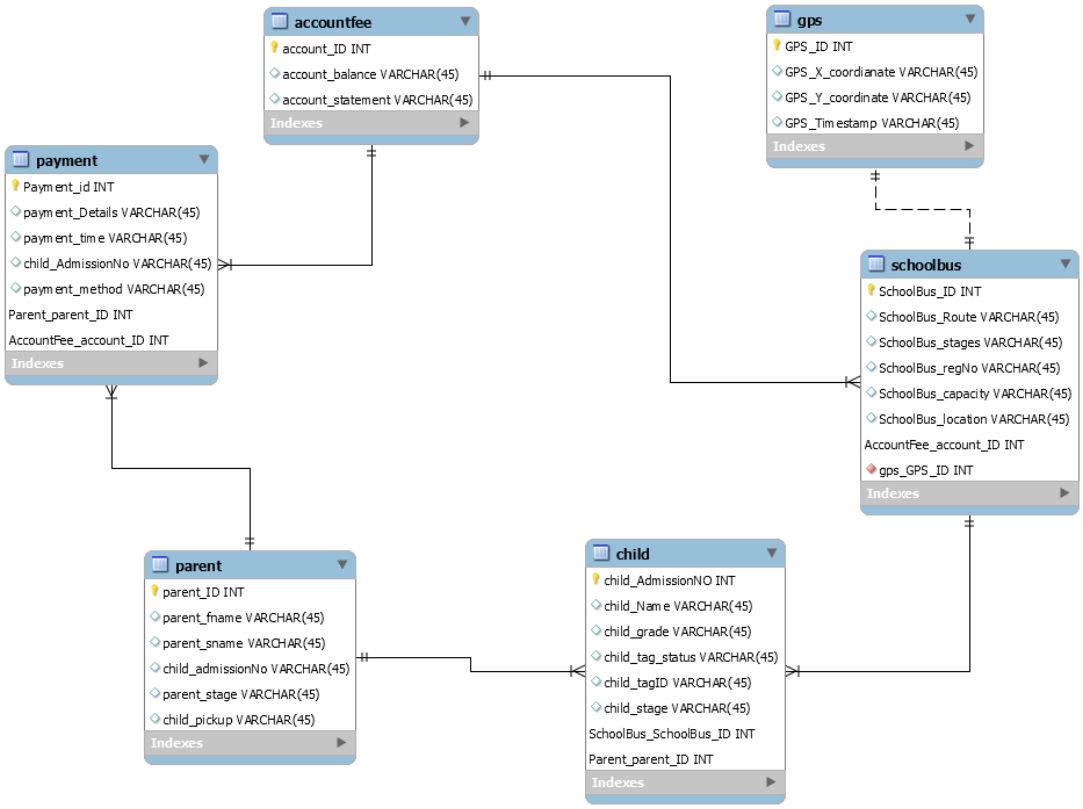


Fig 4.5: Database Schema

The above diagram is a depiction of the design of the location-based tracking system's database in terms of entities and their interrelationships and iss also inclusive of the constraints of data stored in the database.

4.3.5 Entity Relationship Diagram

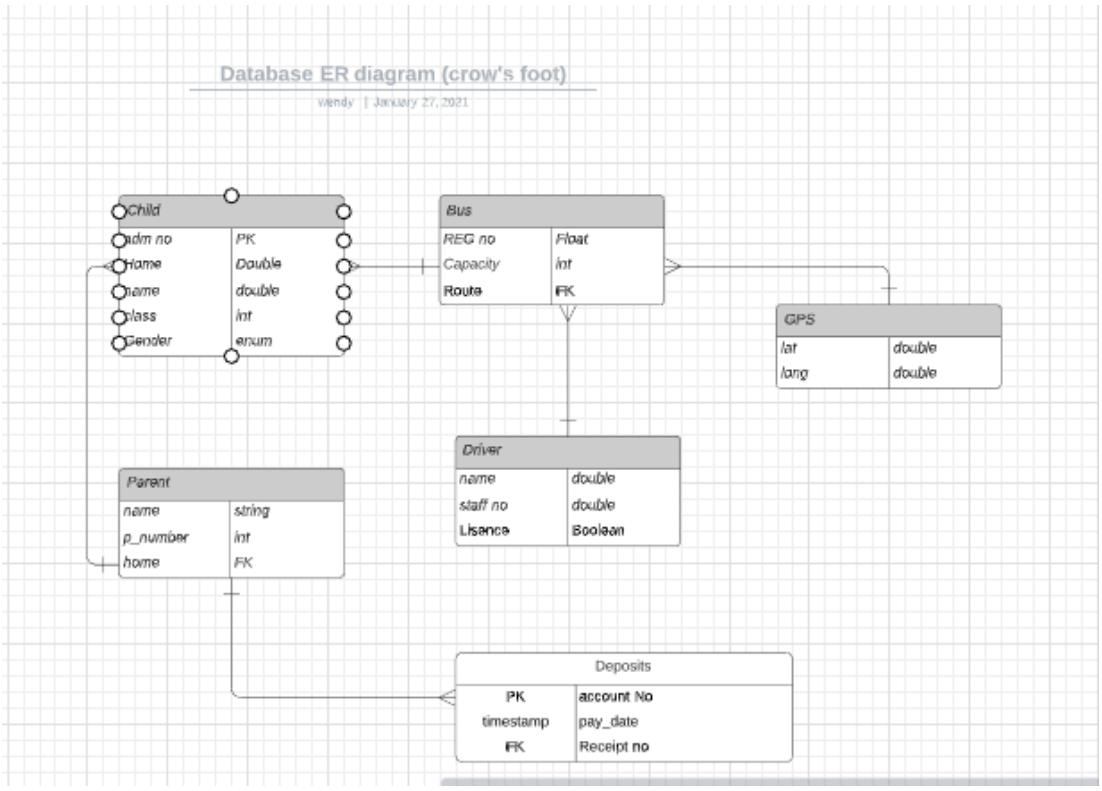


Fig 4.6: Entity Relationship Diagram

The figure above illustrates the design of the database for the location-based blood donation system; the system's entities, their interrelationships and how data is organized in the database.

Chapter 5: System Implementation and Testing

5.1 Introduction

The main purpose of this chapter is to describe the actual system design outlining the development procedure. It captures the tools and technologies that were used to develop the application. It also lists the Application Programming Interfaces (APIs) that was used between different applications modules incorporated in the system. The system employed an algorithm used to build the back-end which is the GPS tracking system and the front-end which serves the parents (user interface) of the tracking system. In addition, it includes a detailed description of how the system was tested to ensure it fulfilled the requirements and the overall goals it was set to accomplish.

5.2 System Implementation

The system was designed with adherence to the system analysis and design methodology that was incorporated at the commencement stages of implementation.

5.3 System Backend Construction

The system employed framework that entails positioning for its effective functioning. The model refers to the data-related logic that the system's user has to work with. On the other hand, the view refers to the logic behind the user-interfaces. Moreover, the controller refers to the interface between the model and the view that is involved in the processing of incoming requests, data manipulation employing the model component and rendering the final result through interaction with the view. The system's backend comprises of the logic behind the main functionalities of the location based tracking system as shown below.

5.3.1 Hashing

The security of passwords is a crucial subject in every simple application that ensure data protection and privacy in line with the applicable laws and regulations. It helps to protect user data from reaching unauthorized parties while ensuring the users passwords are strong enough to combat the techniques the hackers innovate.

Thus, the employment of a password policy that ensures the password for the user meets certain predefined criteria. The criteria employed for the password is;

- The length should be greater than 8 characters
- Tt should contain special characters
- The password should consist of both upper and lowercase letters

- The password should include special characters
- The password should not be common words that are easily identified e.g name of the user
- The criteria also includes the rule of password lifecycle. That is, the password has a lifetime of three months before its expiry after which the application prompts changing of the password by the user and uses the hashing technique to store the password.

5.3.2 GPS Real Time Tracking

The system incorporates a maps feature that updates every 30 seconds to facilitate in effective monitoring of the school bus location while in transit. This feature is enabled by the driver who logs in to the system, starts the trip and the parents can then monitor the location of the bus after which the driver ends the trip upon arrival at the school.

5.3.3 Distance algorithm

The system is incorporated with an algorithm that is integrated with the maps feature to enable the route taken by the driver was st suite both parties that is, the driver and the parents. This provides flexibility of use and accommodates changes that can occur therefore facilitating easier transition phases.

5.3.4 Mathematical Algorithm

The system has a feature for calculating transport fee based on a fixed rate that is incorporated to enhance accuracy of the transport fee management. It has different charges based on the proximity of the pickup location form the school. One major merit of the system being the capability to accommodate different amounts over a certain period of time thus children are not enclosed in pickup and drop-off on one single location only.

5.3.6 System Front End

This comprises of the features that are accessible to the parents. The features that enable active geolocation tracking and instant messaging between the parents and the driver improving its effectiveness.

5.3.7 User Interface

The system authentication and authorization of the user was accurately employed to ensure an automated process for login into the system by the parents.

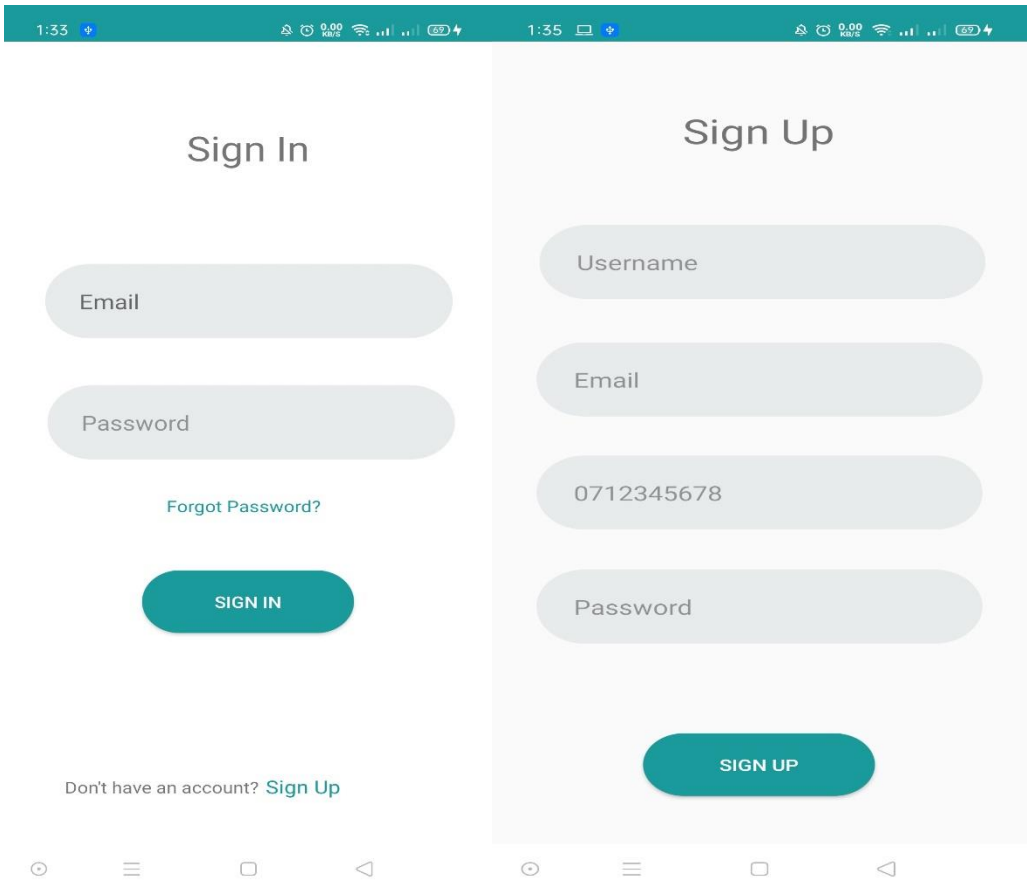


Fig 5.1: Parents Login and sign up pages

5.3.8 Instant Communication

The system allows the parent to easily change or confirm pickup /drop-off of their child at a certain stage. This is then updated on the driver side which eliminates the uncertainty when waiting for children thus becoming time saving. Nevertheless, it also facilitates for faster updates of the bus routing using the algorithm of best fits solution.

5.4 System Testing

Testing was conducted that provided an appropriate ground for evaluating the effectiveness of the solution when compared to the processes carried out and that the system meets the outlines requirements.

5.4.1 Functionality Testing

Geolocation which is the backbone of the real time tracking, was used and it was established that the location of the bus would be determined if the system is hosted on a live server rather than the local host.

The requirements that were satisfied include: super admin and admins being able to log in, send location requests, view responses, view and verify location activity. Other requirements

satisfied were parents being able to log in, view transport history of their children, alter pickup or drop off stages activity and view their profiles.

5.4.2 Usability Testing

The application was mainly tested on Samsung Galaxy J1 and Oppo F11Pro devices; one being the driver side and the latter serving as the parent/user side. Both results showed successful account creation utility and consecutive accurate geolocation positioning. The feedback retrieved from the prototype dissemination was as follows:

5.4.2.1 Ease of Use

Both parties found the application was very easy to use. This can be attributed to the basic functionalities of the application and ability to view the bus in transit on the map.

```
@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_navbar);
    Toolbar toolbar = findViewById(R.id.toolbar);
    setSupportActionBar(toolbar);
    DrawerLayout drawer = findViewById(R.id.drawer_layout);
    NavigationView navigationView = findViewById(R.id.nav_view);
    // Passing each menu ID as a set of Ids because each
    // menu should be considered as top level destinations.
    mAppBarConfiguration = new AppBarConfiguration.Builder(
            R.id.nav_home, R.id.nav_gallery, R.id.nav_slideshow,
            R.id.nav_tools, R.id.nav_share, R.id.nav_send)
            .setDrawerLayout(drawer)
            .build();
    NavController navController = Navigation.findNavController(this, R.id.nav_host_fragment);
    NavigationUI.setupActionBarWithNavController(this, navController, mAppBarConfiguration);
    NavigationUI.setupWithNavController(navigationView, navController);
```

Fig 5.2: Code for Navigation Menu Design

5.4.2.2 Location Pinpointing

The locations of the bus showed on the map of the bus were proven was accurate from both parties involved.

Fig 5.3: Bus Location Screenshot

5.4.2.3 Map Response Times

The updating of the bus response times which is currently set at intervals of 30 seconds. This is proven with keen observation of the bus movement on the map.

5.4.2.4 Notification Receipts

The parents receive notifications when the fee balance exceeds a certain specified limit which currently stands at ten thousand shillings. Moreover, they receive notifications when the bus arrives and leaves the designated stage of their children.

5.4.2.5 Application Usefulness

The application was proven to have very good utility with one parent commenting that it would be a great investment and they could regularly check in to monitor they children's whereabouts.

5.4.3 Unit Testing

The components of the location-based blood donation system functioned as per the specified requirements when working independently of each other.

5.4.3.1 Security Testing

The application was examined and tested to prove it is up to standards with the security of user data and it is in line with the data protection laws of Kenya. It was also tested on various platforms to ensure it has seamless implementation and that it is not easily corrupted by the most critical mobile threats.

5.5 Conclusion

This chapter has exhausted all the fully functional modules for the driver or school management and that of the parents present in the application. The customer testing has also depicted the successful implementation of the bus tracking location using the GPS.

This is bundled with subsequent tests depicting successful implementation of the platform accompanied by the validations from the user notifications that evidently proves a proactive and useful framework for tracking pupils in Nairobi.

Chapter 6: Conclusions, Recommendations and Future Works

6.1 Introduction

This chapter is set to summarize the discussion outlined in the research documentation with the particular highlights the observations that were noted throughout journey to move the system from an idea into reality. Furthermore, it seeks to delve into the technical aspects that will ensure the proper working of the system; the recommendations. Lastly, the chapter purposes to mention what can be done to enhance what the project aims to achieve in addressing the problem as mentioned in chapter 1 above.

6.2 Validations

Based on the requirements mentioned in the earlier, this is how the system seeks to achieve them;

i) The ability to authenticate the driver or support staff operating a bus during pickup and drop-off of the trips. The system identifies drivers using unique credentials and aids in tracking their movement via GPS.

ii) The ability to link and direct a bus to a designated route. The driver at the start of a trip selects a route to use. The route details are then linked to the parents to aid in tracking.

iii) Ability to track the bus at any point in time during the trip. The parents should be able to see the bus while in transit. The solution is GPS enabled and linked to Google Map Android API to facilitate visualization of the GPS location easily on the map.

iv) Ability to obtain a summary of the trip details that is; trip duration, number of students picked or dropped and route used.

v) Feedback obtained from the questionnaire attached in the appendix that was shared with the target group with respect to usability and functionality of the application. The target group, being the eventual potential users provided accurate and conclusive feedback on the success of the application.

vi) Rating of the application's victory provides sufficient validity to the successful implementation of the solution to track the children's whereabouts while in transit and notify parents accordingly.

The validation of the developed solution against its requirements based on the user feedback clearly provides verification that the system achieves its objective efficiently.

6.3 Conclusion

In the course of creating the solution, it was discovered that ensuring child safety an issue that often goes unnoticed is paramount in ensuring safety and security of the children at all times. Furthermore, in the process of analysing location sourcing techniques employed it was found that the use of technologies such as GPS, Smart-phone technology and machine learning aimed to address the need of locating voluntary non-remunerated easily.

6.4 Recommendations

For the location-based tracking system to work, the devices used by the users of the system while accessing the system are required was connected to the internet and have their location turned on. This is because the GPS technology that shall be used in the system requires an environment with a stable internet connection for it was able to track the location of the blood donors and it employs the location feature in smartphones during the tracking of location of the bus.

6.5 Future works

Despite this research aiming to solve problems arising while sourcing for blood donors such as the ease of locating bus movement, not all areas have been able was addressed due to the scope of the project. Therefore, the future work to enhance the research can entail the research and development of a location-based system that enables for offline methods of sending location requests to the voluntary non-remunerated parents within the locality, where tracking is urgently needed (this is for the web-based application accessed by the school administration). Such methods can involve the use of SMS or phone call feature in the smart phone in the course of sending requests to registered parents on the system.

The shifting of the solution from a mobile based serving one school to a web based platform that serves the majority of schools and other institutions. This will encouraged a large number of users having greater customer reach.

Advancement of the framework to include bus overloading detection mechanisms by comparing the bus capacity to the number of pupils taking a particular route. This provides efficient procumbent systems and allocation of school resources.

With the population increasing with each new dawn, children are enrolling in large numbers to schools especially public schools; this solution can be modified to include card readers or RFID tags that alert parents of pickup and drop-off. Eventually, it can be extended to track pupil’s attendance and access control mechanisms in institutions.

The platform used in the solution development is only for Android mobile users. The study can later be revolutionized to incorporate other operating systems like IOS while integrating different mapping and notification technologies.

References

A. Shafahi, Z. W. (2018). "A matching-based heuristic algorithm for school bus routing problems".

Adithya, M. S. (2018, September). "Real Time College Bus Monitoring and Notification System". *International Journal of Advance Research in Science and Engineering (IJARSE), vol. 7*(no. 4), pp. 14-16.

Anon. (2011). "Smart school bus monitoring and tracking system". *vol. 55*(no.9), pp. 200-205.

Berg, I. (2012). *Classification of Severe School Attendance Problem.* Cambridge Core, .

Building a Smarter (and Cheaper) School Bus System. (2019). 30-35.

Fedena. (2019, February). *School Bus Transport Managemnt System*. Retrieved from https://fedena.com/blog/2019/02/school-bus-transport-management-system-complete-guide.html

Godse, V. A. (2015, December). "A survey on enhance security and tracking system for school bus and children". *International Journal of Trend in Research and Development, vol. 2*(no. 6), pp. 272-276.

J. Desrosiers, J. F. (1981). *"An overview of a school busing system"*. Amsterdam: North-Holland.

K. Finkenzeller. (2010). *RFID Handbook Fundamentals and Applications in Contactless Smart Cards and Identification Radio Frequency Identification and Near-Field Communication.* John Wiley & Sons.

K. Shaaban, A. B. (2013, December). "Smart tracking system for school buses using passive RFID technology to enhance child safety". *Journal of Traffic and Logistics Engineering,, vol. 1*(no. 2), pp. 191-196.

K. Sridevi, A. J. (2018, March). "Smart Bus Tracking and Management System using Iot". *International Journal for Research in Applied Science & Engineering Technology (IJRASET), vol. 5*(no. III), pp. 372-374.

Kim, J. P. (2010). "The school bus routing problem: A review". *European Journal of Operational Research, 202*, pp. 311-319.

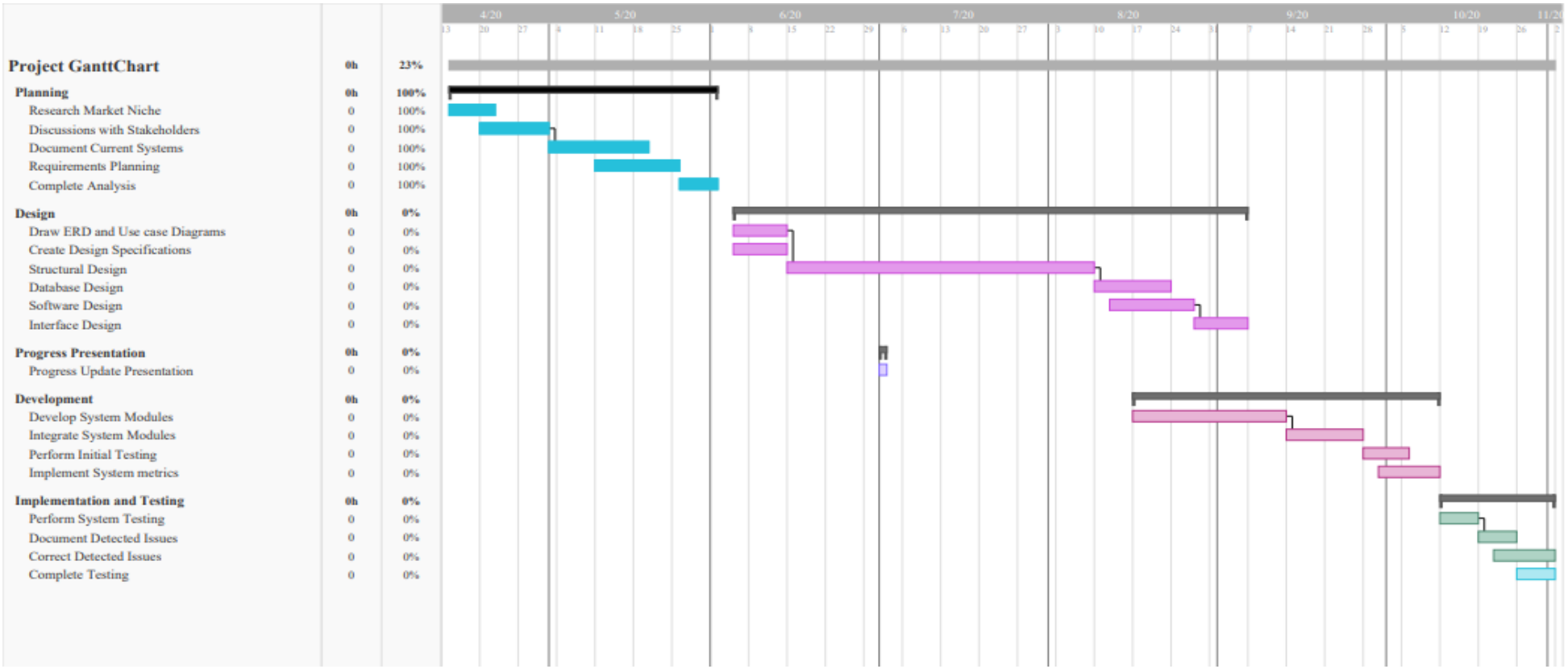
Mane, P. A. (2015). "Advanced vehicle monitoring and tracking system based on Raspberry Pi". *IEEE 9th International Conference on Intelligent System and Control (ISCO)*, (pp. pp. 1-6).

Periodontology., A. A. (2012). Clinical Science. *Population Based Surveillance*. .

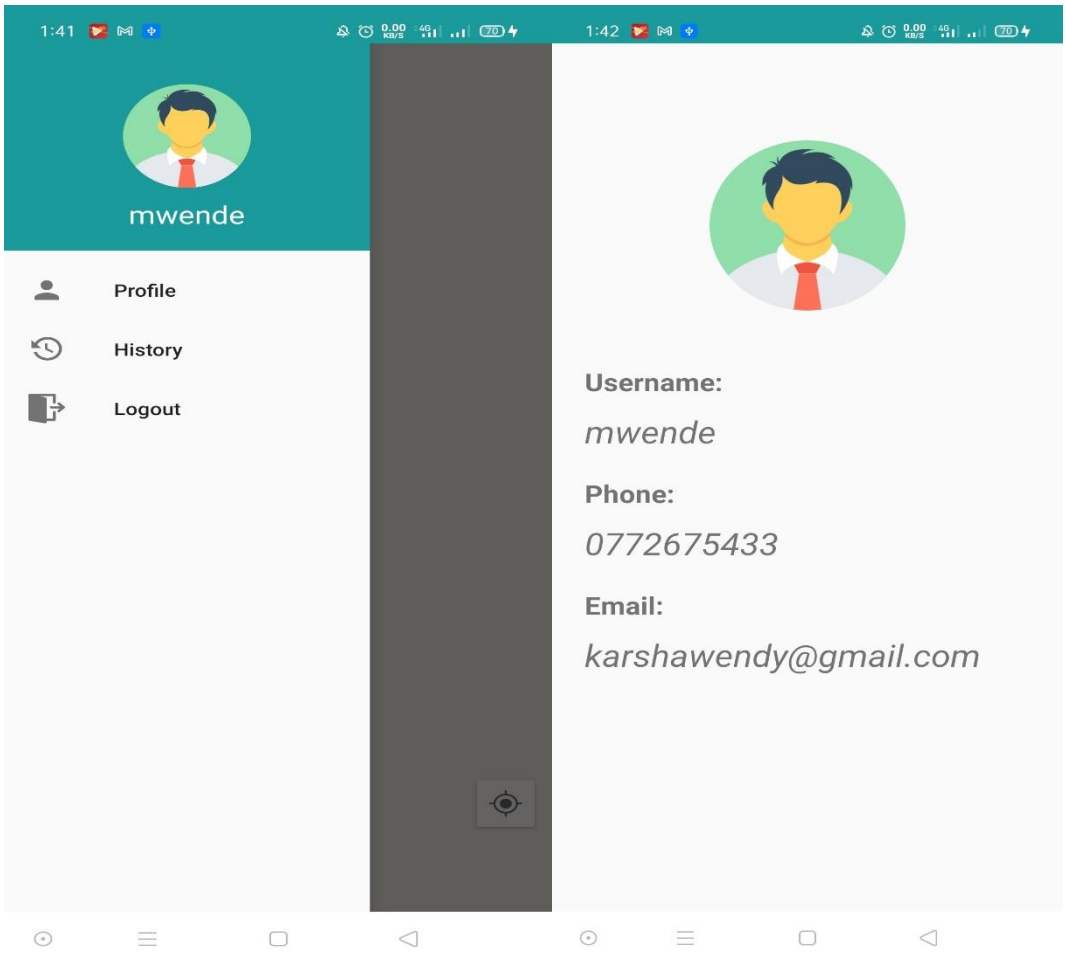
S. C. Savitha, S. N. (2014, June). "Smart College Bus Tracking Management System and its Application". *International Journal of Emerging Technologies and Engineering, vol. 1*(no. 5), pp. 142-147.

S. Sangeetha, S. K. (2018, March). "School Bus Tracking And Security System". *International Journal of Advance Research in Science and Engineering (IJARSE),*, pp. 218-227.

Appendix A: Timeline of Activities



Appendix B: Parent's Navigation and Profile



Appendix C: Parent's Feedback Questionnaire

a. Please state the make and model of the device you are using to test the application.

_____

b. Was the app easy to use?

- ☐ Yes
- ☐ NO

c. Were you able to locate the pupil using the map?

- ☐ Yes
- ☐ NO

d. How would you rate the map response times in locating the bus?

- ☐ Very Fast
- ☐ Moderately Fast
- ☐ Okay
- ☐ Moderately Slow
- ☐ Very Slow

e. Did you receive notification of pick up and drop off?

- ☐ YES
- ☐ NO

f. How would you rate the usefulness of the application?

- ☐ Very Useful
- ☐ Just Okay
- ☐ Not Useful

g. Please provide additional comments on your experience:

_____