MakanikApp: An On-Road Mechanic Finder

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Declaration and Approval

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

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Abstract

It is inevitable for cars to break down on the road unexpectedly. When this happens, one calls a garage or a mechanic with whom they are familiar with. While travelling, it is not always possible to find your mechanic due to distance barriers or them being unavailable. Furthermore, while travelling in an unknown location, one is unfamiliar with the dynamics of the place and may not be able to assess the level of security at face level. The possibility of meeting fraud mechanics on the road is very high. Carjacking by fake mechanics may also happen especially if you are unfamiliar with the location. Moreover, finding good mechanics in remote locations is a challenge. The developed project provides an interface between stranded vehicles and mechanics on the road. Secondly, an Information System provides the user with quick tips on how to fix the car in case a mechanic is not needed. Rating of mechanics provides the customer with the best options of competent ones available.

The application was implemented as a mobile application to ease access by the customers and mechanics.

Keywords: Distance barriers, Unavailability, Carjacking, Stranded vehicles, Information System

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List of Abbreviations.

API- Application Program Interface

ERD- Entity Relationship Diagram

KCSE- Kenya Certificate of Secondary Education.

KNBS- Kenya National Bureau of Statistics

PCV- Positive Crankcase Ventilation

RPM- Revolutions per Minute

SDLC- Software Development Life Cycle

UAE- United Arab Emirates

UI – User Interface

UML- Unified Modelling Language

UN- United Nations

USA- United States of America

Wi-Fi- Wireless Fidelity

Chapter 1. Introduction

1.1 Background Information

There are many cars on the road every day in Kenya. As stated by Kenya National Bureau of Statistics, (2018), the number of motor vehicles registered was reported at 3,280,934.000 Unit in 2018. This records an increase from the previous number of 2,989,788.000 Unit for 2017. Car Registrations in Kenya also decreased to 18822 in February from 31896 in January of 2021. A report by the UN environment indicated that the annual vehicle fleet growth rate in Kenya is 12%. According to KNBS, motor and auto cycles are the largest automotive vehicles in Kenya, taking 46% of the automotive vehicles. Motor cars follow with them being 32%. Utilities, panels vans, pick-ups take up 10%. Lorries, trucks, and heavy vans are only 5% and buses and minibuses are only 3% of the total automotive vehicles (Kenya National Bureau of Statistics, 2021).

A report by the United Nations (UN) environment shows that more than 96% of vehicles imported into Kenya are used. In 2019, KMI reported a total of 12,981 units of new vehicle sales while the total new registration of motor vehicles recorded in the same year was 109,751. Therefore, new vehicle sales constituted only 12% of new registrations with the remainder (88%) being imports of used vehicles. This means they are prone to more on road breakdowns compared to new cars. Although Kenya is implementing an eight (8) years age limit for imported second vehicles, it does not affect the number of the existing ones. When vehicles break down, the owners tend to call mechanics or garages they are familiar with Baskin (2015).

To start a garage in Kenya, one requires a business plan that will state all the activities that they will be offering. Examples of these services include specialized services such as tire repairs, or oil changes or all car repair services. According to Neema, (2020), to start an average car repair business in Kenya, you need a capital investment of between Kshs. 150,000 to 250,000. For the smooth running, you will need to obtain auto repair business license and permit from the relevant authorities. You can obtain them from your county government offices or city council. The law does not require automotive technicians to have any particular qualifications but building up a base of trusting customers will be much easier if one can demonstrate your credentials. Even if they do not see your certificates hanging up on the wall, your expertise and confidence will be apparent in your actions and, ultimately, you will provide a higher level of service. This will not only boost one's own sense of achievement and self-worth, but the businesses' revenue too.

Motor vehicle mechanics in the informal sector (*Jua Kali*) have skills and competencies acquired through formal and informal training. However, the skills and levels of competencies of most mechanics cannot be ascertained. This is considering that the market of increasingly sophisticated imported vehicles is growing. Interaction with customers while on the field, and the market environment leads to questioning if the entry level skills of the mechanics have changed over time. It is the desire of the artisans to improve their skills, knowledge, and level of competencies so that they can serve their customers better. However, the formal education setup does not adequately accommodate trainees from the informal sector thereby limiting avenues for skills and competency development. The findings of a research by indicate that the skills gap does not match the rapidly changing technology in the automotive industry, moreover the training facilities in the training institutions do not meet the market requirements.

As stated in Careerpoint Solutions, (2017), in Kenya, the qualification to become a motor vehicle mechanic is Kenya Certificate of Secondary Education (KCSE) mean grade D+ (plus) or its equivalent from a recognized institution One also requires a Motor Vehicle Mechanic National Trade Test Certificate Grade III/ apprentice Certificate awarded by the Directorate of Industrial Training or its equivalent and relevant qualification from a recognized institution. This is according to Career Solutions. A job posting on LinkedIn by Co-operative University of Kenya, one of the requirements is a Motor Vehicle Mechanic Grade Test I certificate.

1.2 Problem Statement

When one's car breaks down, the vehicle driver or owner calls a garage or a mechanic with whom they are familiar with. However, if one is in an unfamiliar location, this is not always possible. The owner is forced to seek for help within the vicinity. This method has its disadvantages. The possibility of meeting fraud mechanics on the road is very high. Carjacking by fake mechanics may also happen as it is hard to distinguish between the qualified and the unqualified artisans. Moreover, finding verified mechanics in remote locations is a challenge as the artisans face no competition or may be located far from the place the vehicle broke down at. According to Google Maps, most garages are located in towns and cities. In the rural parts of Kenya, one or two garages serve a wide vicinity. The developed solution has provided the vehicle driver or owner with the available verified mechanics within both urban and rural areas of Kenya.

1.3 Objectives

1.3.1 General Objective

To provide an application to connect the vehicle drivers or owners and verified mechanics within a particular location.

1.3.2 Specific Objectives

i. To Investigate how vehicle owners or drivers responded to mechanical car breakdowns.
ii. To Study and Analyse the challenges with current response methods to mechanical car breakdowns by the owners or drivers.
iii. To Study and Analyse the related works.
iv. To Design and Build an application that assists the users to connect with verified mechanics.
v. To Test and Validate the created solution.

1.4 Research Questions

i. How have vehicle owners or drivers responded to mechanical car breakdowns?
ii. What are the challenges that the current response methods to mechanical car breakdowns face?
iii. What are the related works?
iv. How will the interface connect the vehicle drivers or owners with the verified mechanics?
v. How will the solution be tested and validated?

1.5 Justification

The implemented solution is needed as it helps users distinguish between verified and fraud mechanics. This reduces the number of incidents relates to fraud mechanics stealing from the users or damaging their cars. The North Carolina Consumers Council, (2021) states some phrases used by mechanics who may not have great intentions. Some mechanics, for example, have difficulty diagnosing problems and instead replace parts in the hope that it fixes the problem. Sometimes the problem is fixed, but other times it does not, and the mechanic tries to pass the cost on to you.

As the mechanic fills the repair form, it helps the user know exactly what changes the mechanic made. This can also be used by the next mechanic to understand any previous changes made to the vehicle. The mechanic also inputs the price they charged for the repairs which helps with accountability as other users can see this and decide if they are willing to pay that amount of

money. As stated by Martin, (2016), different car brands have different maintenance cost due to the different values of the vehicle parts. BMW in the most expensive one, followed by Mercedes-Benz and Cadillac. Maintenance costs also increase with age as the number of issues also increases. Hence a mechanic will also charge based on brand. Time spent and type of vehicle breakdown will also determine the total price.

Rating of mechanics helps them to strive for excellent service which benefits the user. The feedback offered by the user also helps us understand and notice any extra requirements they needed that we may have overlooked, improving our customer service.

1.6 Scope and Limitation

The implemented solution has connected vehicle owners or drivers with mechanics. Light weight cars, buses, minivans, trucks, trailers, and motorcycles are the vehicle types that are being catered for. This means that mechanics who have the skills and qualifications to fix them will also be included. It also contains records of previous fix ups done by other mechanics. An Information system provides the users with quick fix tips which they may need.

The solution is an online, mobile based application hence is only available on smart phones. One also requires mobile data or Wi-Fi to connect to the application. It is based in Kenya hence will not cover other countries.

Chapter 2. Literature Review

2.1 Introduction

This chapter discusses literature review and talks about the causes of vehicle breakdowns in Kenya and how drivers respond to them. It also discusses the challenges that the current solution has and how the interface has connected the vehicle drivers or owners with the verified mechanics.

2.2 Current Response Methods to Vehicle Breakdowns by Vehicle Owners in Kenya

2.2.1 Contact with Familiar Mechanics or Garages

AllState, (2020) states that the Insurance Information Institute (III) recommends that you avoid getting out of your vehicle to look at the damage or fix a mechanical problem. If you need to get out of the car, get your vehicle to a safe place and make sure the road around you is completely clear. Calling to get a tow truck, mechanic, or roadside assistance to come help. Your insurance company or other provider who may be able to help.

2.2.2 Contact with Nearby Garages

This can be done by pushing the car to the garage or being towed. The mechanics in that garage are given the power to investigate and probably fix the cause of the break down.

The North Carolina Consumers Council, (2021) states some actions and phrases that indicate that one needs a new mechanic. Some mechanics will tell you that your car can use any kind of oil, especially if it will save you money. There is only a little bit of truth to this. Mechanics know that most people do not know anything about their cars, so they prey on your fears that you will not want to break down on the side of the road. Sometimes you need to replace the entire exhaust system when something is wrong. But other times, a simple repair will cover it.

2.2.3 Self-Fix of the Vehicle

According to Family Handyman, (2018), one does not have to take their car into the shop for all your car problems. Some of these include replacing engine air filter, replacing the PCV valve, gas lifts, changing a wheel, replacing non- headlight bulbs, and replacing a broken antenna. This can also apply when the vehicle experiences trouble on the road, for example, changing a punctured tire.

2.3 Challenges facing the Current Response methods to Vehicle breakdowns

Contacting a mechanic or garage that the driver is familiar with is not always possible as the mechanic or garage you want to call may not be within the vicinity to assist you. This is especially common of one is travelling in rural areas, away from cities. If the driver opts to go

to a nearby garage, they do not have the luxury of seeking for second opinion and hence must depend on what the mechanic will state. This can be a problem if the mechanic has no idea what they are doing or if they have an intention of scamming the desperate driver. Self-fix is only possible if one has the knowledge and skills to fix the issue. Otherwise, they might end up damaging the car further.

2.4 Related Works

2.4.1 Eber

Eber is an application that allows customers to schedule their repair time for their vehicles by adding a scheduled request. They add the required service details and choose a time slot and date supporting your on-demand car repair service business by adding a flair of technical expertise to your qualified efforts as shown in Figure 2.1. The on-demand mechanics service app connects mechanics and customers within a single platform as shown in Figure 2.2. When a customer places a request, all nearby service providers receive the application and can accept it at their will. The admin assigns a service provider, or a user can choose a specific mechanic from the entire list. It also allows for integration of local payment gateways.

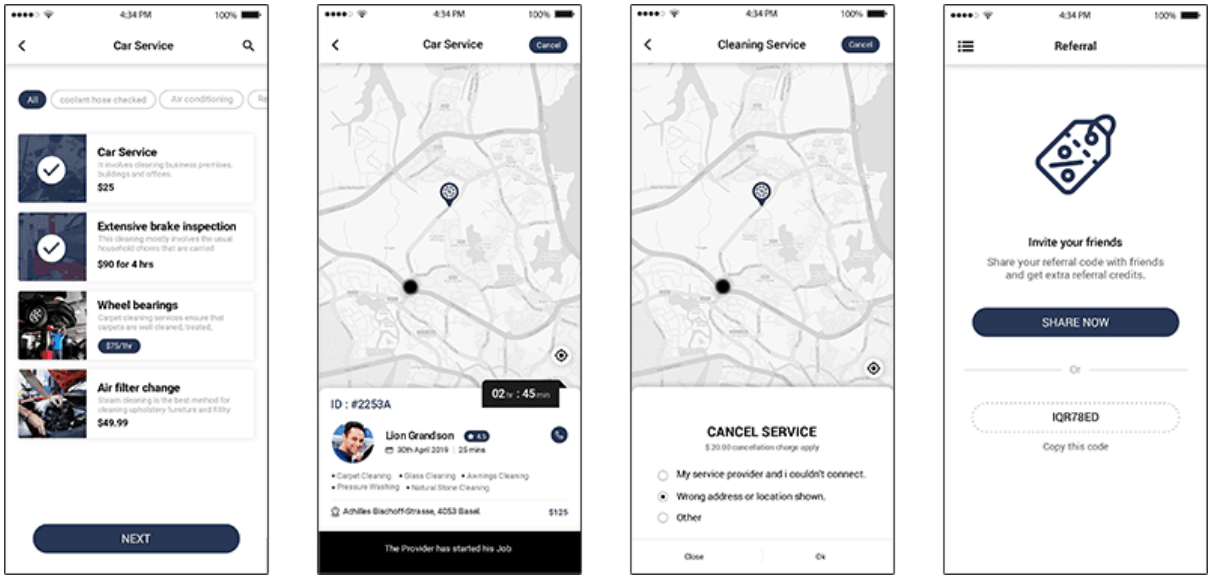

Figure 2.1 Eber User Module (Google, 2021)

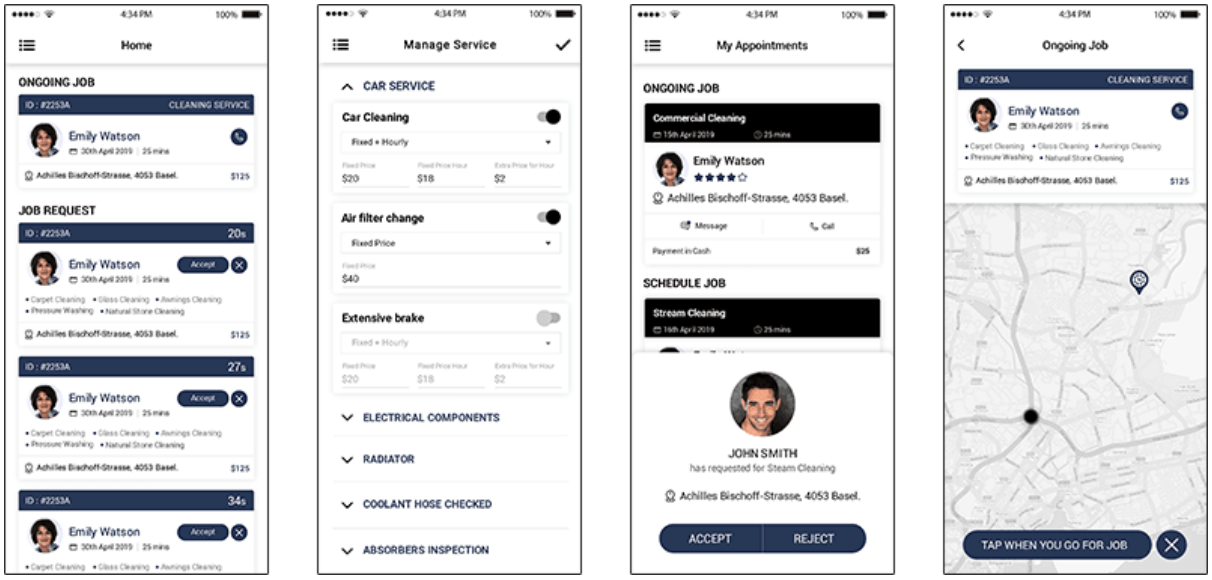

Figure 2.2 Eber Mechanic Module (Google, 2021)

2.4.2 Auto Connect: Car Repair Shops and Mechanic Finder

Auto Connect is an application that connects the user to a mechanic with a click of a button that allows them to book a service request and schedule appointments for their car on the go. The application allows users to upload the picture of their vehicle and add the vehicle details. The customer adds temporary outsourced services like tyres and wheel alignment, without changing their independent mechanics. The application allows users to request a service for their vehicle. Users can request for an emergency service if the vehicle needs immediate assistance for example car accidents or car breakdown. The customer can add an accident request with capturing back and front image of the vehicle registration license and give back feedback to members for their service as shown in Figure 2.3.

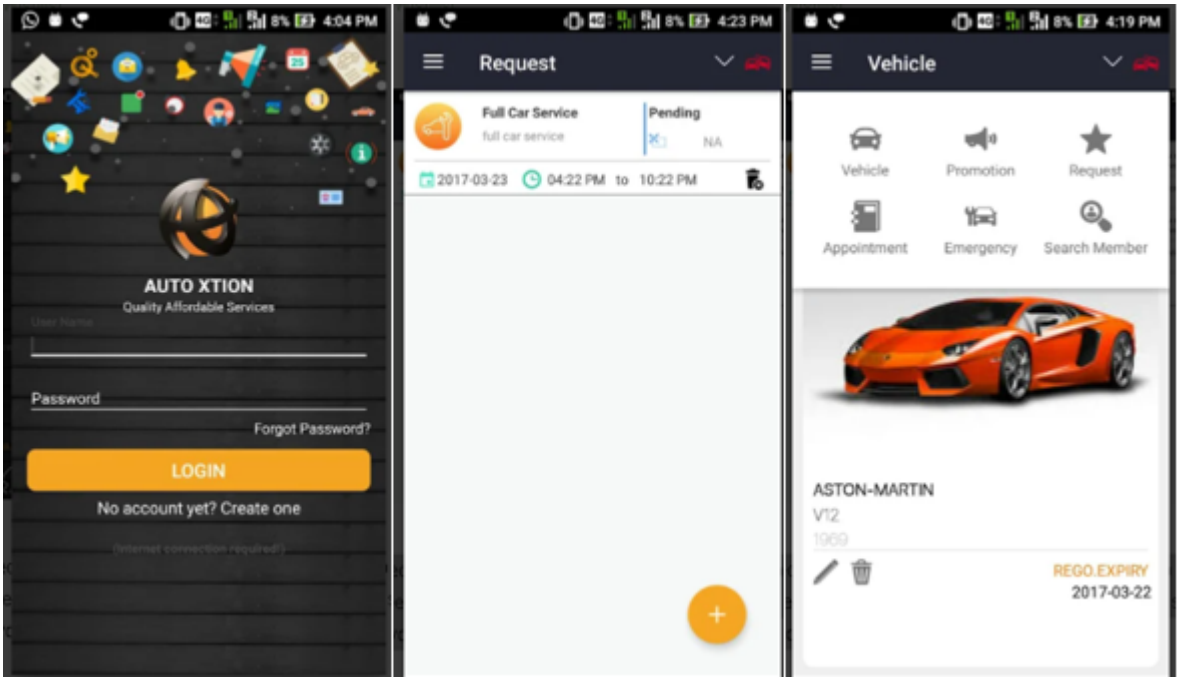

Figure 2.3 AutoConnect Application (Google, 2021)

2.4.3 Openbay: Shop for Auto Repair

Openbay is a mobile application that allows clients to find a high-quality local mechanic that can deliver top-notch service at a competitive price. The users can get instant price estimates, select the shop that meets their needs and book their appointments. The user enters their details like their vehicle information and zip code. The user can review a personalized list of trusted mechanics near them with accurate service estimates and reliable customer reviews. They choose the option that best suits their needs and book an appointment time. They enter their payment information in the Openbay secure system. The user then has to show up at the shop with their six-digit customer code and will not charge them until their service is complete. As shown in Figure 2.4.

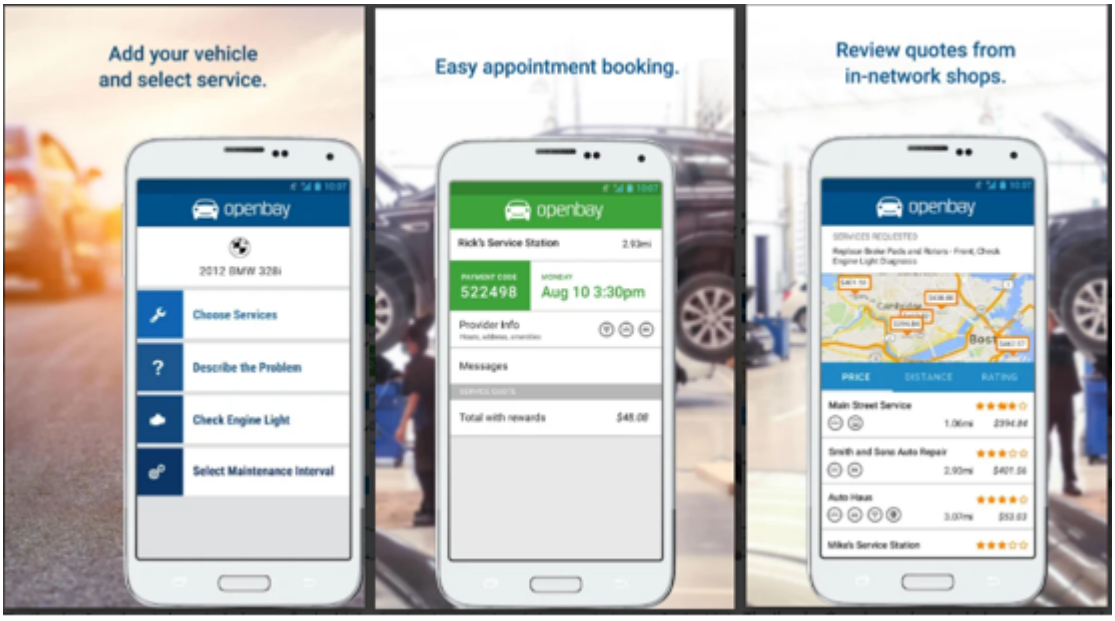

Figure 2.4 Openbay Application (Google, 2021)

2.5 Gaps in Related Work

As seen in Google, (2021), the reviews complained that although the shops had good ratings and a certification for operation, the individual mechanics did not have the required skill to service or attend to their vehicles. These applications are also not available to Kenya hence Kenyans cannot enjoy their services. Eber is only available in India, USA, Switzerland, Netherlands, Canada, Mexico, and UAE (Google, 2021).

2.6 Conceptual Framework

The user is authenticated into the application. They can either search for a mechanic or use the information system to do quick fixes. If the need a mechanic is, however, they can search for mechanics based on their current location. All mechanics within that vicinity will be listed from the highest rated to lowest. The user can then select a mechanic of their choice. The mechanic will then accept the call and go to the user's location. The mechanic will do the repair that is possible and needed. The artisan will then fill out a form on the details of the repair they have done and the price they are charging. After this, the user can rate the mechanic based on their

experience and may choose to leave an additional comment. This framework is demonstrated in Figure 2.5.

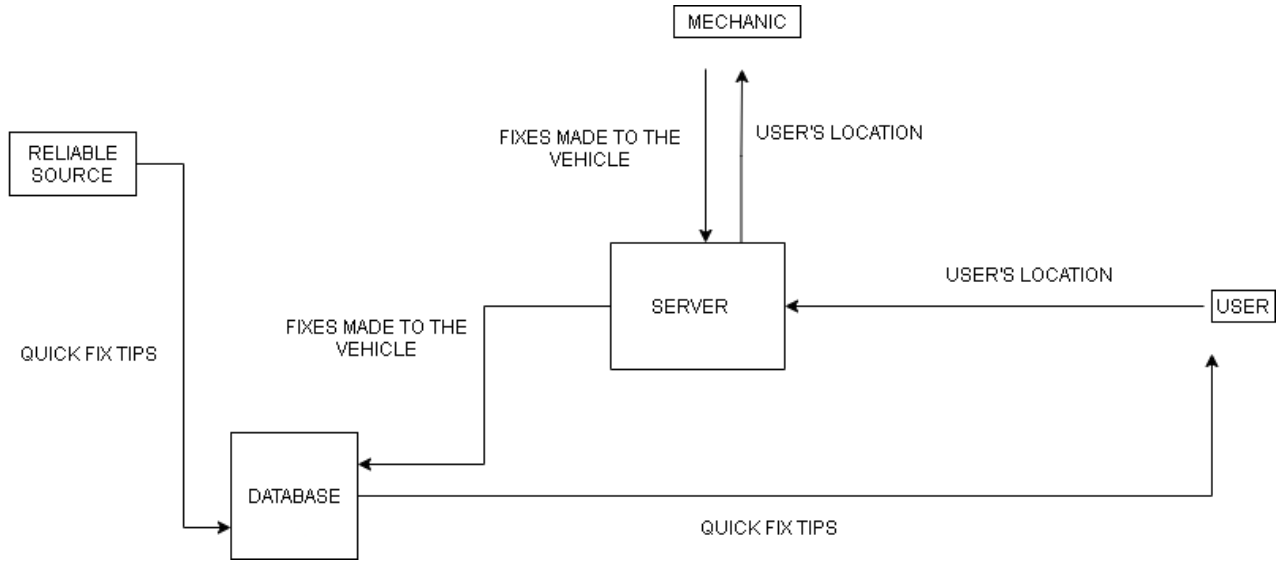

Figure 2.5 Conceptual Framework

Chapter 3. Methodology

3.1 Introduction

This chapter describes the steps taken in order to achieve the project's specific objectives. This included obtaining research about the problem, data collection and other processes. The methodology applied in the implemented solution is Object-Oriented Analysis and Design (OOAD). This methodology is preferred because.

i. It uses Incremental and Iterative methodologies that allow the breakdown of the software development of the project into small, manageable portions and activities to be repeated systematically in cycles.
ii. It is suitable for projects with well-defined requirements but are due to change with time.
iii. The risk in using this is low and reusability is high.

3.2 Applied Development Approach to be Used.

The applied development approach used was Incremental methodology. Incremental Methodology is a process in the software development process where the stated requirements are broken down into multiple modules that stand individually. Each iteration passes through the requirements, design, coding, and testing phases. And each subsequent release of the system adds function to the previous release until all designed functionality has been implemented. According to EBUCBA, (2020), each submodule is developed by following the software development life cycle process like analysis, design, code, and test. By doing this model we made sure that we were not missing any objective that is expected from the end of the software even though how minor objective it can be. Thus, we achieved 100% objective of the software with this model also since we tested aggressively after each stage, we made sure that the end software was defect-free and each stage was compatible with previously developed and future developing stages. At any given time, the plan could be laid out only for the existing increment without any long-term plans. So, the complete focus would be on the requirement that was being worked upon. This methodology was used because the requirements for the project were clear and well understood.

The development steps are requirements analysis, system design, system implementation, testing or verification as show in **Error! Reference source not found.**.

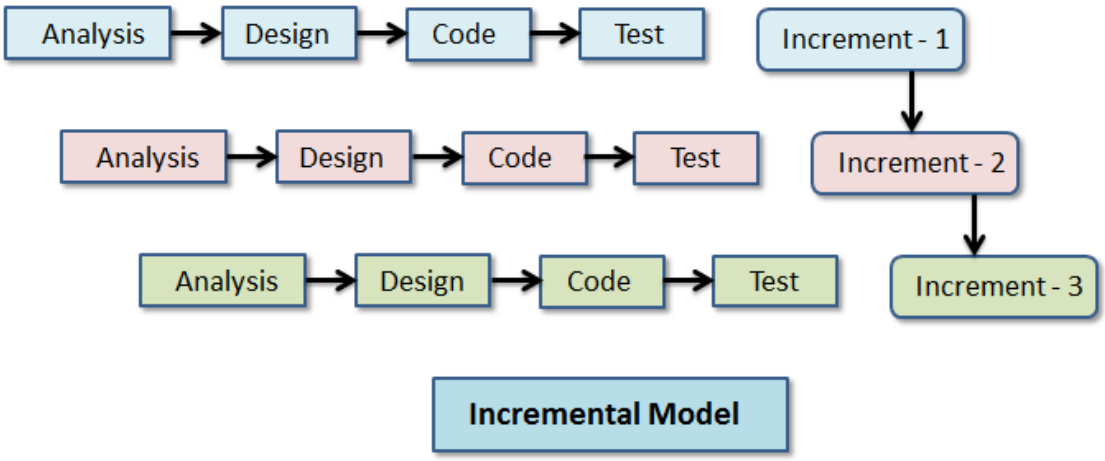

Figure 3.1 Incremental Model (EBUCBA, 2020)

3.2.1 Requirements Analysis

A complete analysis on the requirements was undertaken. The user needs were specified at this level in detail. This determined the information flow into and out of the system and the required data sources. It also ensured that the requirement would be compatible with the previously developed module. User requirements were collected through interviewing of mechanics and vehicle owners. Secondary sources such as journal articles, credited websites, and published papers were used to analyse the requirements.

3.2.2 System Design

Once the requirements of the particular module were understood, a clear design was drafted on how to implement these requirements. The system requirements that were documented during the Requirements Analysis Phase were further refined and allocated into system and database design specifications that were organized in a way suitable for implementation within the constraints of a physical environment.

As stated in Lucid Software Inc., (2021), a database schema is the logical configuration of a database. The logical schema explains the constraints applied to the database. This was used in the developed project to outline the integrity constraints that would be set on the different tables. It was also used to indicate the different views that would be used by the different modules.

Wireframes provided a clear overview of the page structure, layout, information architecture, user flow, functionality, and intended behaviours. As a wireframe usually represents the initial product concept, styling, colour, and graphics are kept to a minimum as described in Jaye, (2021). Wireframes are important as ensured that the UI created was user friendly and appealing. It also helped to ensure that the different users of the system had the pages for all their different functionalities.

The system architecture is an illustration of a structural design of a system and its behaviour. It explains how the applications and components are connected or integrated together, the types and the sensitivity of data stored in the system and the end-users of the system and where are they located as described in (IBM Corporation, 2013).

3.2.3 System Implementation

This is where coding was done to achieve the requirements following the standards and guidelines stated. The increments were coded in Java and Android languages. This is because the application built is a mobile application.

3.2.4 Testing

This is the last phase of the increment. Aggressive testing was done on the code that was developed. The main aim was to spot any defects which were be reported and resolved by the developers. Any forgotten functionality was also added at this phase. Black box and white box testing were the techniques used. White box testing is based on coverage of code statements, branches, paths, or conditions. The authentication module was tested using this paradigm. Black box testing is a testing technique where a tester does not have any information about the internal working of the software system as it focuses on the behaviour of the software. This testing was done for all the modules implemented in the system.

3.3 System Analysis

3.3.1 Use Case Diagram

A use case diagram as stated by Rosenblatt & Shelly, Use Case Diagram, (2012), visually represents the interaction between users and the information system. In a use case diagram, the user becomes an actor, with a specific role that describes how he or she interacts with the system. A use case diagram was implemented where it showed the different users, that is the mechanics, the vehicle owners and the administrators, and their various interactions with the system.

3.3.2 Class Diagram

A class diagram, as suggested by Rosenblatt & Shelly, (2012), shows the object classes and relationships involved in a use case diagram. A class diagram is a logical model, which evolves into a physical model and finally becomes a functioning information system. A class diagram was implemented where it showcased the different object classes and the relationships that were formulated from the use case diagram.

3.3.3 ERD Diagram

Rosenblatt & Shelly, ERD Diagram, (2012) explains that an ERD is a model that shows the logical relationships and interaction among the system entities. It provides an overall view of the system and a blueprint for creating the physical data structures. In the system, an ERD was implemented to show the relationships between the entities (one-to-one, one-to-many or many-to-many).

3.3.4 Sequence Diagram

A sequence diagram is a dynamic modelling tool that shows the interaction among classes during a specified time period (Rosenblatt & Shelly, Sequence Diagrams, 2012). It also can be used to show all possible outcomes or focus on a single scenario. A sequence diagram was implemented to show the timing of interactions between objects as they occur.

3.3.5 Activity Diagram

An activity diagram as stated in Rosenblatt & Shelly, Activity Diagram, (2012), is a dynamic modelling tool that shows the order in which the actions take place and identify the outcomes. The diagram will be implemented where it will show the actions and events involved.

3.4 System Deliverables/ Milestones

Some of the system deliverables and milestones expected in the implemented solution were:

3.4.1 System Proposal.

A System Proposal is a written statement of the system design that includes a statement that explains the purpose of the system. A proposal was needed to fully outline the background information and problems that led to developed solution.

3.4.2 Authentication Module.

The authentication module included the registration and login sub-modules. In the registration sub-module, the vehicle owner and the mechanic can register themselves using their credentials. Their details are saved in a database for easy retrieval during login. In the login

sub-module, the mentioned users are able to login in the system and are directed to their respective pages. In case one forgets their login credentials, the user can create a new password and it is be updated in the database.

3.4.3 Administrator Module.

The administrator module is only accessed by an admin. In the module, the admin has the following functions:

i) The administrator has the privilege to give roles and permissions to the various users.
ii) The administrator can add mechanics to the database after their verification has been done.
iii) The administrator can disable mechanics if there are a lot of complaints concerning the specific mechanics.

3.4.4 Mechanic Module

The mechanic module can be accessed by the mechanic or a garage. The mechanic has the following functions:

i) The mechanic views requests from the vehicle owners and has the power to either accept or decline them.
ii) The mechanic views his or her ratings after servicing the users.

3.4.5 User Module

The user module can be accessed by those who are travelling on the road or vehicle owners. The user has the following functions:

i) The user can request for a mechanic if they ever get stranded on the road.
ii) The user can use the Information System provided by the application in case he or she is familiar with the situation and does not need a mechanic.
iii) The user rates a mechanic after service depending on their performance and competence.

3.4.6 Payment Module

The payment module allows for users to pay for the service done by the mechanic. The user has the following functions:

i) The user inputs the amount charged.
ii) The user approves the payment by inputting their PIN number.

Chapter 4. System Analysis and Design

4.1 Introduction

This chapter gives a detailed explanation of the system analysis and design of the implemented system. System analysis is a problem-solving technique that decomposes a system into its component pieces for the purpose of the studying how well those component parts work and interact to accomplish their purpose. The diagrams drawn under the system analysis are the class diagram, Entity-Relationship diagram (ERD), use case diagram, sequence diagram and activity diagram. System design is concerned with the physical construction of the system, converting the requirements into a tangible reality. The diagram drawn under the system design is the Android Wireframe.

4.2 System Requirement

Some of the system requirements reviewed in the project include:

4.2.1 Functional Requirements

i) Authentication Module

The authentication module contains the login, forget password and registration pages. The user must register their correct credentials in order to login to the application successfully. Their credentials are then saved in the real-time database provided by Firebase. Verification is done during the login process where if the user enters the wrong details, they will not access the application. In case the user forgets the password, they used during registration, they can create a new password in the forget password page.

ii) Administrator Module

The administrator module contains the authentication module and the tables from the database. The administrator views the users, mechanics, payment and reported breakdown tables. The administrator is able to edit user details and disable them. They are also able to edit the mechanics' details, disable the mechanic and approve them once the mechanics are certified. The payments and reported breakdowns tables are only to be viewed hence the administrator cannot edit them.

iii) User Module

In the user module, the user can create an account in the registration page. They can also read their details which are stored in the database from the view profile page and can update their profile when need be. The user can request for service from a verified mechanic which

will direct them to the specific page. The user can then describe the problem they have using an image and/or a brief description and input the location which they are in. Thereafter, they will view the mechanics that are near them and send a request to their preferred mechanic. After being serviced, the user can rate the mechanic and give back feedback about the mechanic and the service offered. The user pays the mechanic through the application.

iv) Mechanic Module

In this module, the mechanic views requests within their location and is able to accept or deny. If they denied the request, it is removed from their requests list. If they accept however, the request will be removed from other mechanics request list. The location is given to the mechanic and they can go to the user. After the mechanic handles the breakdown, they fill the breakdowns report with the necessary details and is free to accept another request.

v) Payment Module

The payment module is connected to the Daraja API. The user enters the amount stipulated and the mechanic's number. After the confirm payment is clicked, a STK Push message is sent to the user where they are given the details of the payment and must input their M-Pesa pin. A message is sent to the user and mechanic to confirm that the payment has been made.

4.2.2 Non-Functional Requirements

These are the non-functional requirements of the application. This section deals with the quality of the application rather than the functionalities of the application.

i) Access Security

After registration, the user is sent a verification email that verifies the user. This therefore makes the account active. During the password changing process, the user uses their email account to change the password.

ii) Availability

The application is available if the user or mechanic is on Wi-Fi. Unless the system is non-operational, the application presents the user with a notification informing them that the system is unavailable.

iii) Confidentiality

The passwords inputted by the user are hashed to reduce the risk of their account being hacked.

iv) Efficiency

Any interface between a user and the application has a maximum response time of two seconds.

v) Integrity

All monetary amount inputs are accurate to two decimal places.

vi) Reliability

The probability of the application failing is 0.001 (1 out of 1000) when requesting for a mechanic.

vii) Usability

The application is easy to use by both the users and mechanics due to the large icons with clear distinct headers.

viii) Installable

It is possible for the application to be installed by a typical user and mechanic who has no special expertise. The installation process is convenient and involve the entry of little information by the user. The application can be downloaded from the Google Play Store.

4.3 System Analysis Diagrams

4.3.1 Use Case Diagram

The use case diagram shows the different users, that is the mechanics, the vehicle owners and the administrators, and their various interactions with the system. The diagram has three actors which are the user, the mechanic, and the admin. The user has eight different functions which are to register, login, view profile, edit profile call mechanic, view the information system, pay the mechanic and to view feedback. The mechanic has eight different functions which are to register, login, view profile, edit profile, accept, or decline requests if they are verified, receive payment from user and to view feedback given. The admin has two functions which are either to approve or to disable a mechanic. This is shown in Figure 4.1 Use Case Diagram.

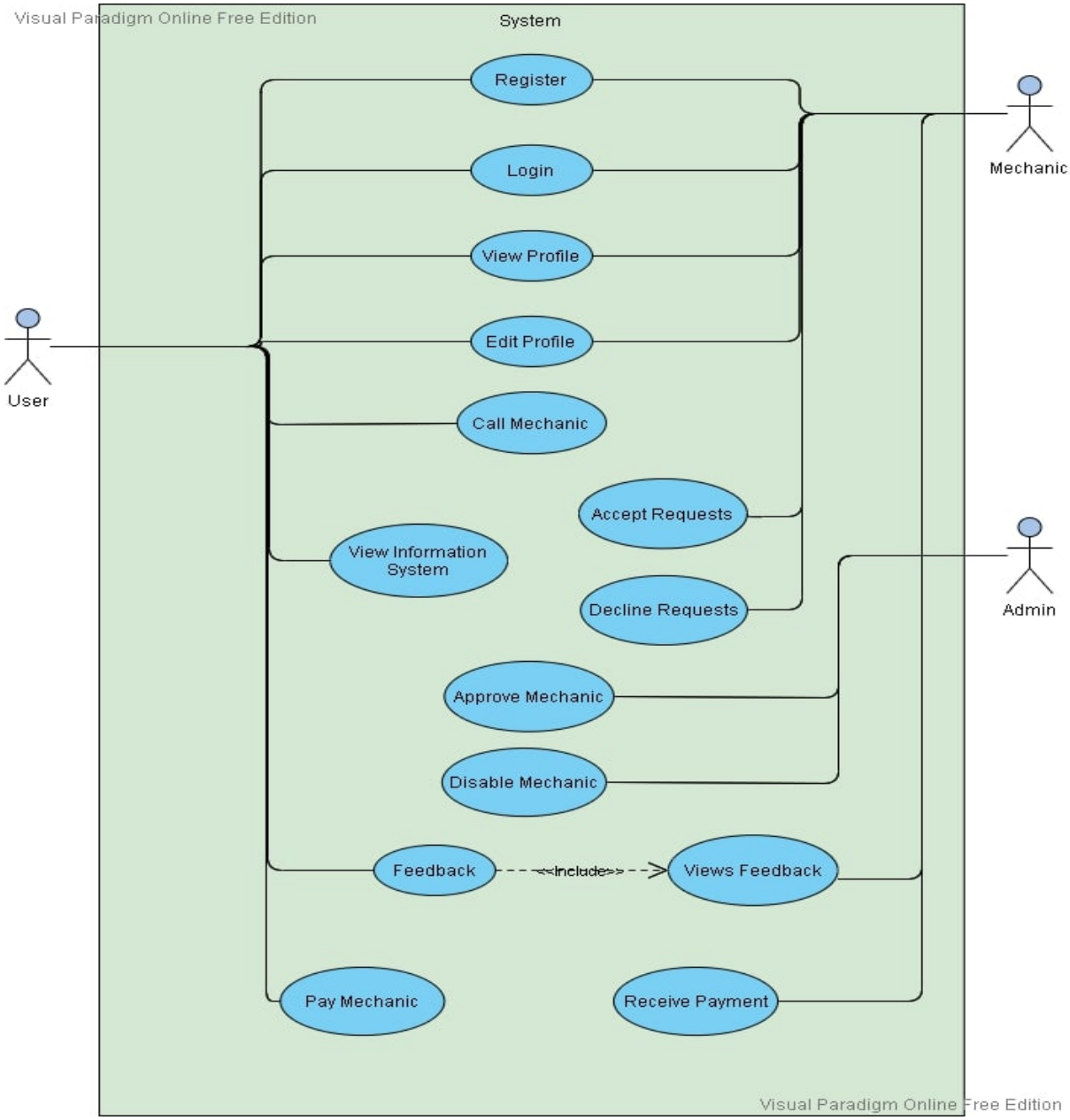

Figure 4.1 Use Case Diagram

4.3.2 Sequence Diagram

The sequence diagram, as shown in Figure 4.2 Sequence Diagram shows the timing of interactions between objects as they occur. The mechanic sends a request for approval to the admin. After verification the admin sends confirmation to the mechanic of the status of their approval. Thereafter, the user requests for service where they send their name, location, and the situation they are into a verified mechanic. The mechanic updates the user on whether the request is accepted or declined. If it is accepted and service has been done, the mechanic sets the payment details and sends them to the user. The user confirms the payment amount and makes the payment to the mechanic.

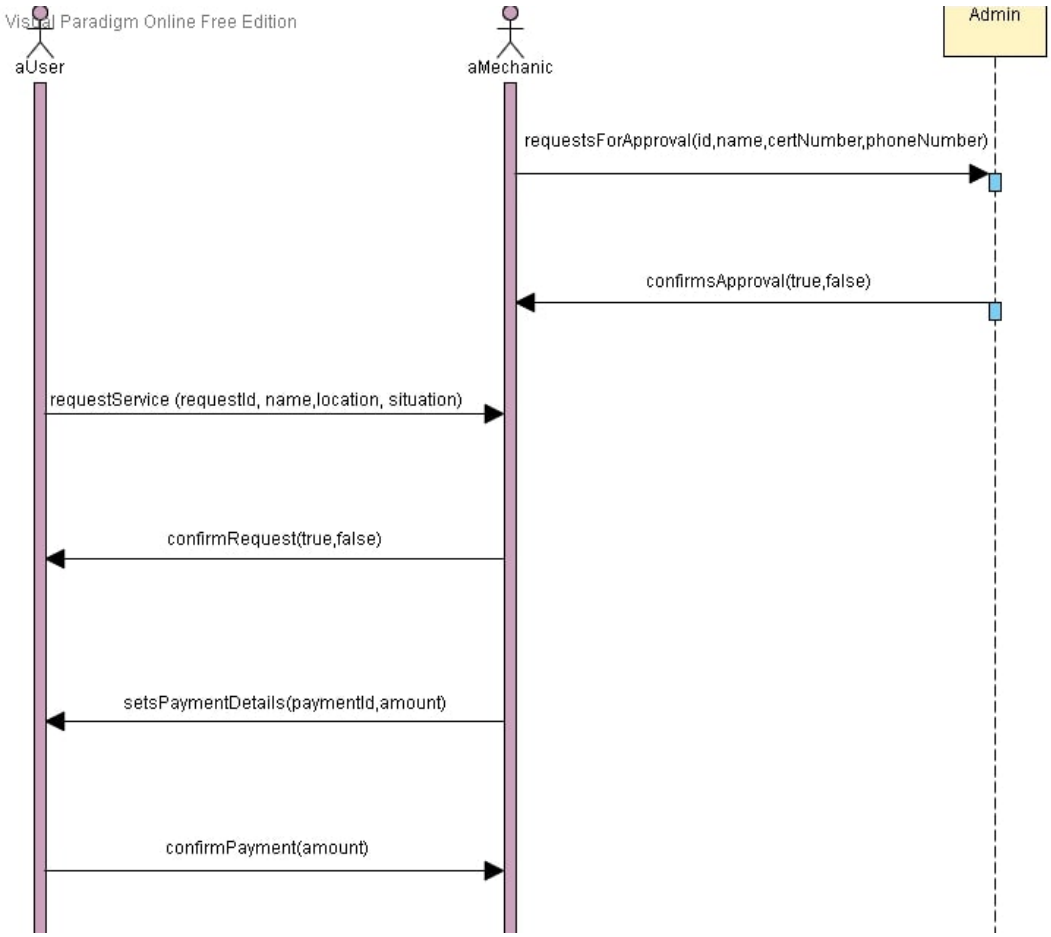

Figure 4.2 Sequence Diagram

4.3.3 Activity Diagram

The activity diagram shows the actions and events involved. The user has six activities, the mechanic has seven activities, and the admin has one activity.

Activities that the user are involved in are the register activity where the user creates a new account in the system, login activity where the user can enter correct credentials and after successful login can access the system, calling a mechanic where the user can request for service from a mechanic, viewing the payment method set by the mechanic after service has been done, making payment to the mechanic, and giving back feedback about the service of the mechanic.

Activities that the mechanic are involved in are the register activity where the mechanic creates a new account in the system, login activity where the mechanic can enter correct credentials and after successful login can access the system, the mechanic can receive requests from users and can have the option of accepting or declining them if verified by the admin, confirm the

request and sends back to the user and view the feedback given by the user based on the service that was offered. The admin receives request for approval from the mechanic after registration.

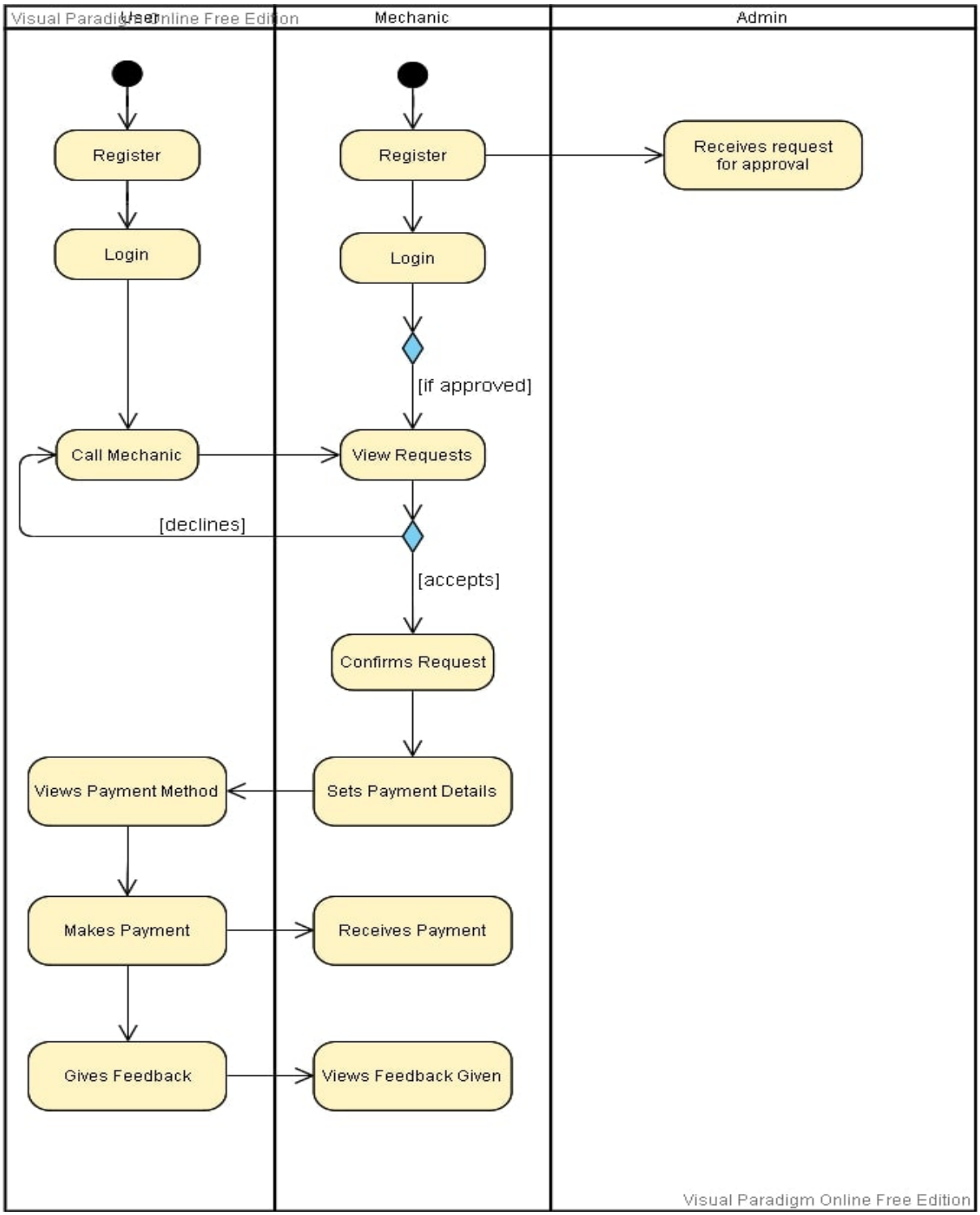

Figure 4.3 Activity Diagram

4.3.4 Entity- Relationship Diagram

The ERD as demonstrated in Figure 4.4 Entity-Relationship Diagram shows the relationships between the entities (one-to-one, one-to-many or many-to-many).

The ERD has six entities which are user, mechanic, admin, payment, request, and feedback, which are all related to each other. The user requests for service from the mechanic and the mechanic confirms the request sent. The user gives feedback and makes payment. The admin receives a request for approval from the mechanic and confirms the approval.

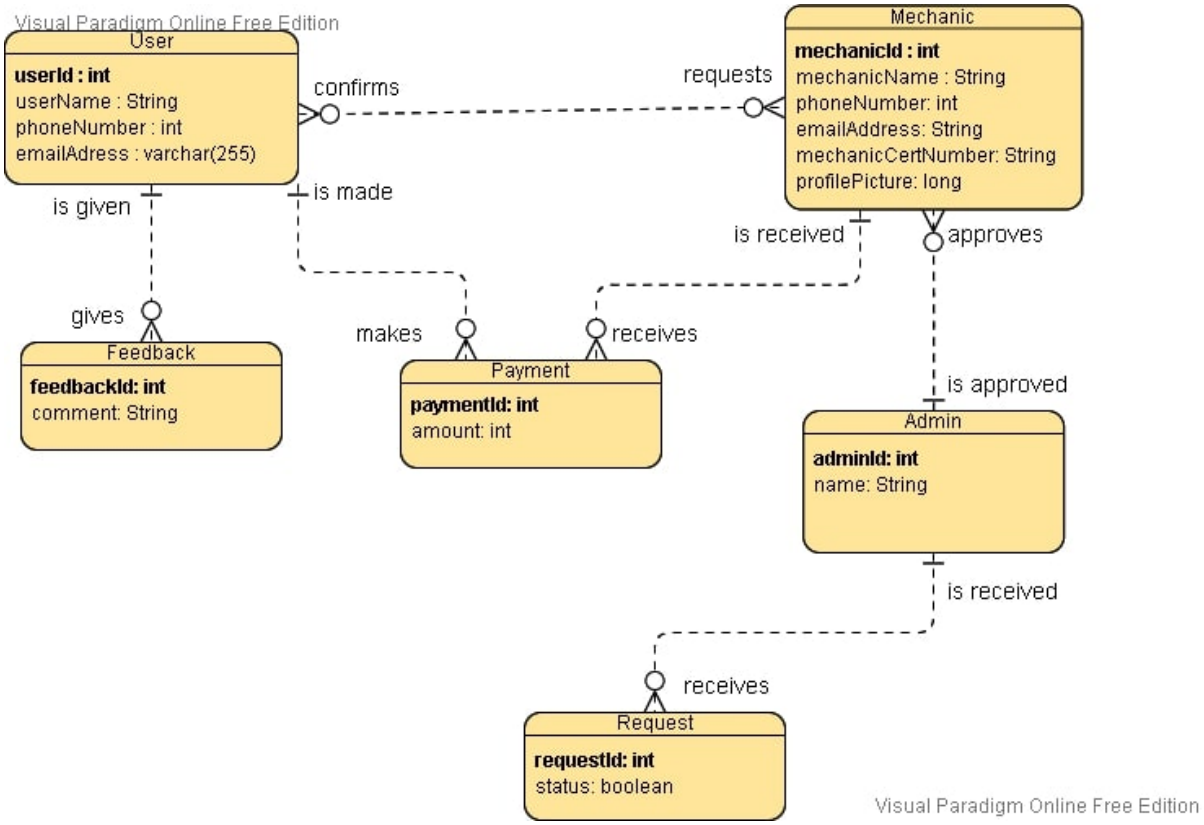

Figure 4.4 Entity-Relationship Diagram

4.3.5 Class Diagram

The class diagram showcases the different object classes and the relationships that are formulated from the use case diagram. The diagram contains six classes which are the user, mechanic, admin, payment, feedback, and request. The user class has four attributes which are the userId, name, phoneNumber and email. The user class has three operations which are to call a mechanic, to make payment and to give feedback. The mechanic class has six attributes which are the mechanicId, name, phoneNumber, email, mechanicCertNumber and profilePicture.

The mechanic class has five operations which are to approve a request, to decline a request, to set payment details, to receive payment and to view feedback given. The admin class has two attributes which are the adminId and name. The admin class has two operations which are to approve a mechanic and to disapprove a mechanic. The payment class has two attributes which are the paymentId and amount. The payment class does not have any operations. The feedback class has two attributes which are feedbackId and comment. The feedback class has only one operation which is to be rated based on service. The request class has two attributes which are the requestId and status. The request class has two operations which are to be approved and to be disapproved.

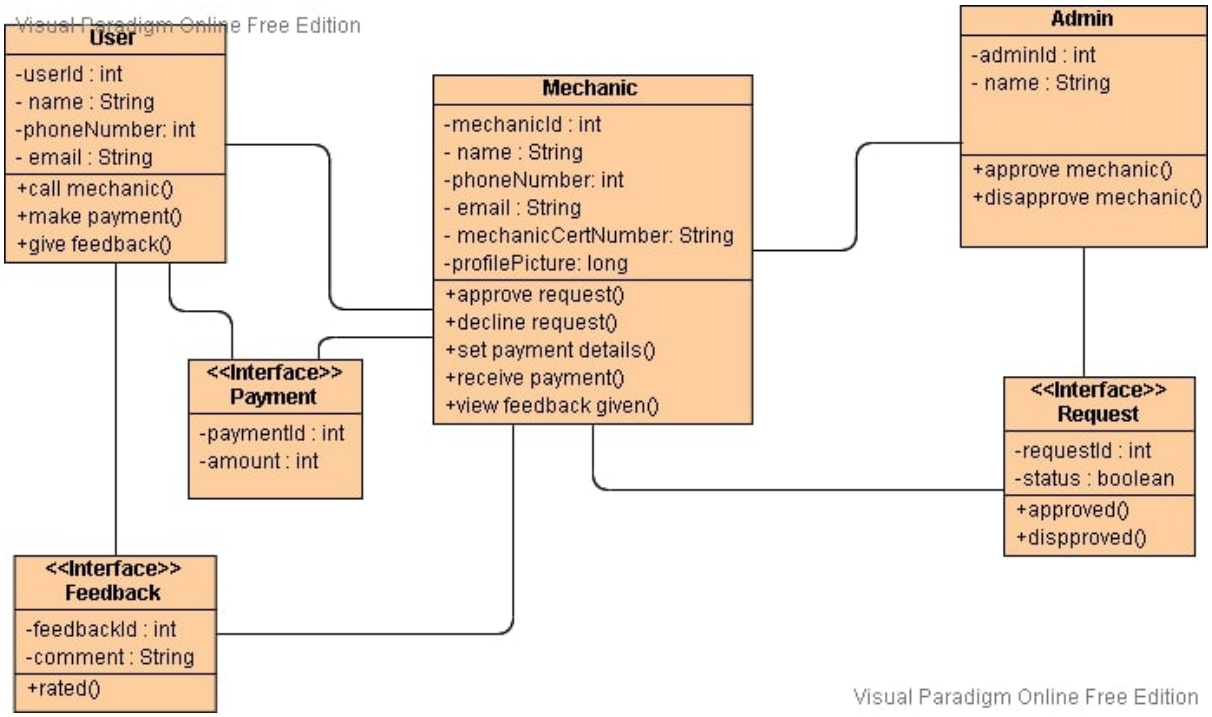

Figure 4.5 Class Diagram

4.4 System Design Diagrams

The aim of conducting system design for the developed solution is to primarily focus on how the system will work. Some of the diagrams include wireframes, database schema and system architecture. Each will focus on how to accomplish the objectives of the system.

4.4.1 Database Schema

This project uses a NOSQL database, Firebase. Generally, NoSQL databases are not modelled like SQL hence the data is not structured. This means that there is no logical database schema. The database has categories, user, mechanic, admin, breakdowns, customer_requests, and

mechanic_available which store their respective information as show in Table 4.1 MakanikApp Database Schema.

Table 4.1 MakanikApp Database Schema

users	**mechanic**	**admin**

ObjectId{
“firstName”: String,
“lastName”: String,
“email”: String,
“phoneNumber”: int
}
	ObjectId{
	“firstName”: String,
	“lastName”: String,
	“email”: String,
	“phoneNumber”: int,
	“approved”: String,
	“status”: String
	}
		ObjectId{
		“firstName”: String,
		“lastName”: String,
		“email”: String,
		“phoneNumber”: int
		}

breakdowns	**customer_requests**	**mechanic_available**

ObjectId{
“mechanicID”: String,
“userID”: String,
“time”: ”:[{
“date”: int,
“day”: int,
“hours”: int,
“minutes”: int,
“months”: int,
“seconds”: int,
“time”: int,
“timezoneOffset”: int,
“year”: int
}],
“date”: String
“userlocationLattitude”: String
“userlocationLongtude”: String
	ObjectId{
	“g”: String,
	“l”:[
	{
	“0”: Double,
	“1”: Double
	}
	]
	}
		ObjectId{
		“g”: String,
		“l”:[
		{
		“0”: Double,
		“1”: Double
		}
		]
		}

}		

4.4.2 Android Wireframes

4.4.2.1 Splash Screen

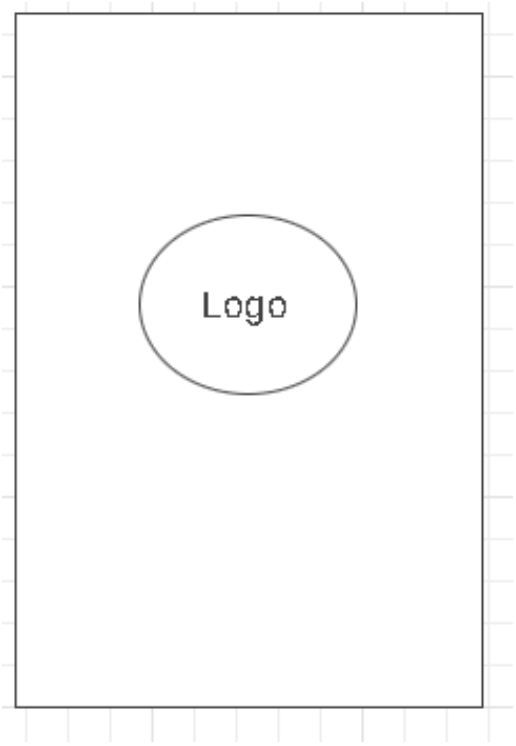

Figure 4.6 Splash Screen Wireframe

4.4.2.2 Log In

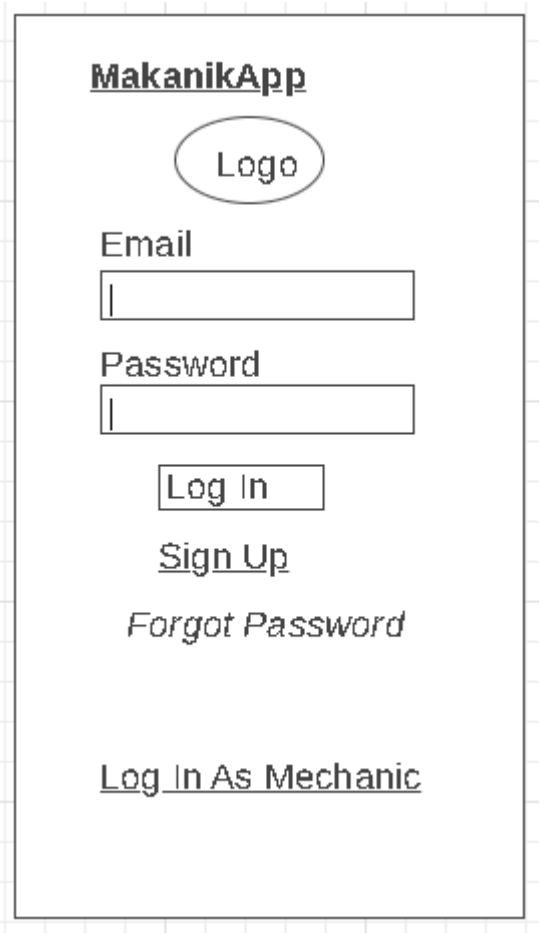

Figure 4.7 Log In Page Wireframe

4.4.2.3 Registration Page

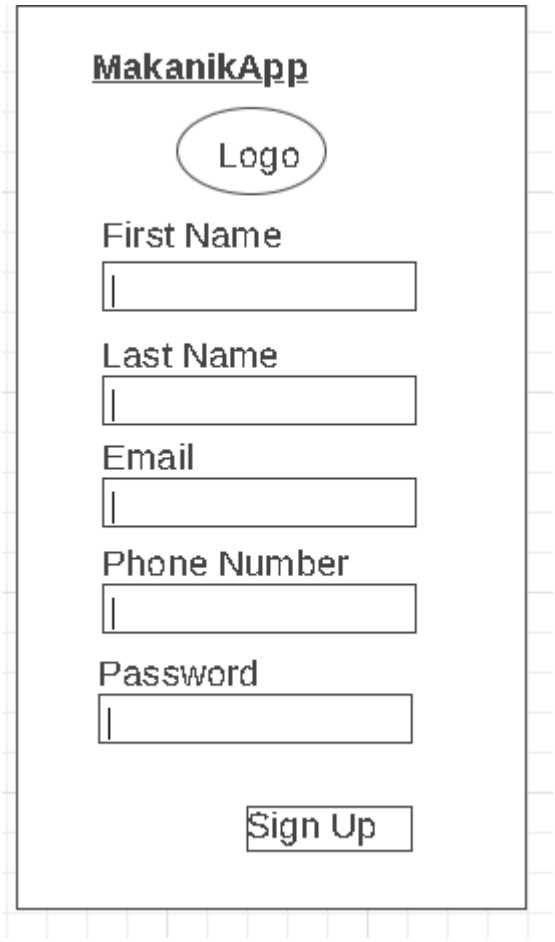

Figure 4.8 Registration Page Wireframe

4.4.2.4 Forgot Password Page

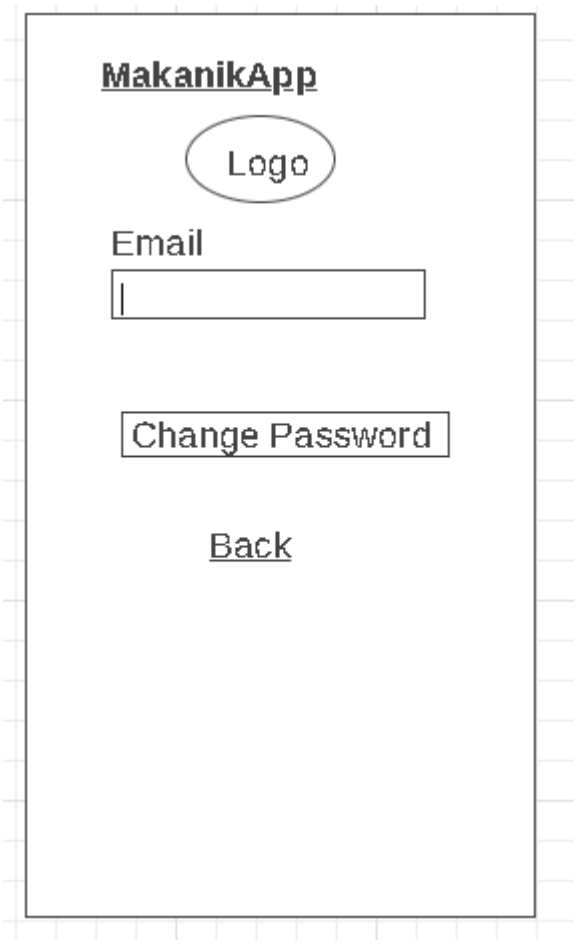

Figure 4.9 Forgot Password Wireframe

4.4.2.5 User Landing Page

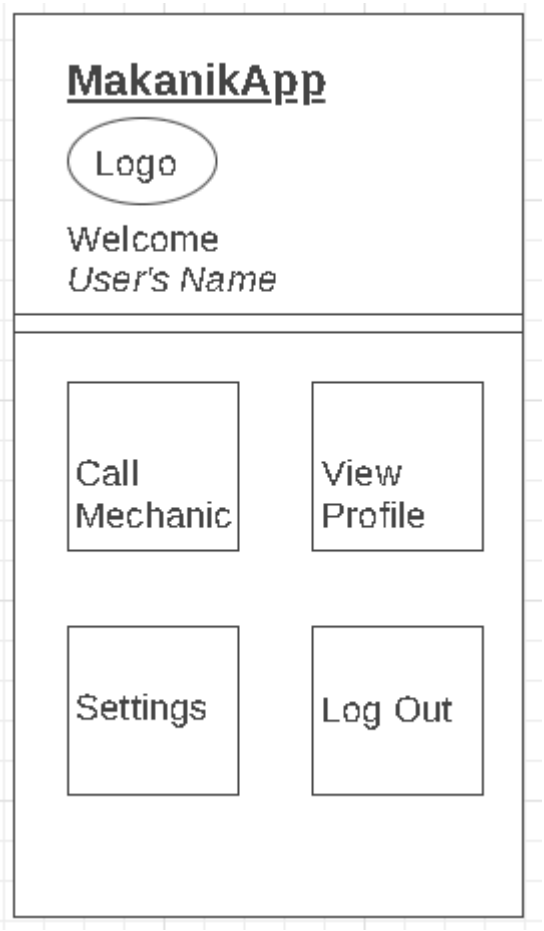

Figure 4.10 User Landing Page Wireframe

4.4.2.6 Request Mechanic Page

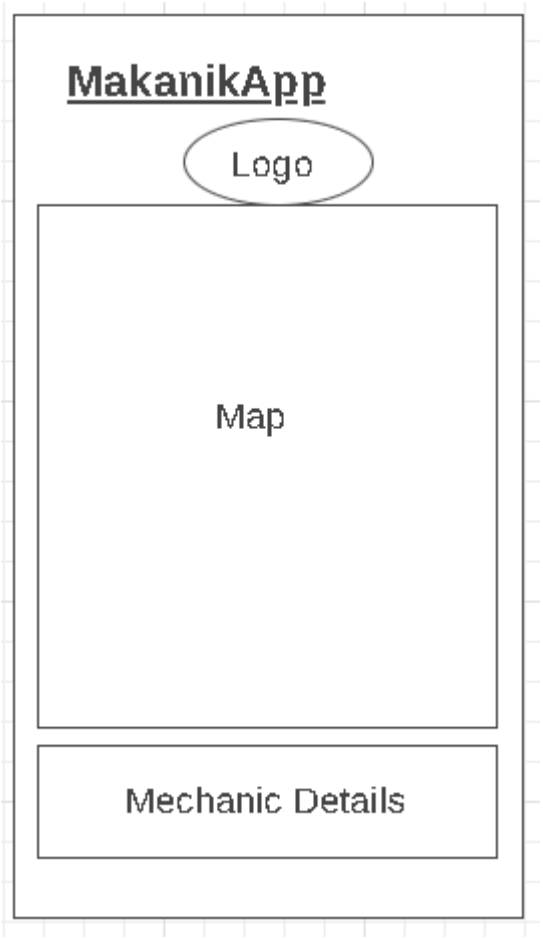

Figure 4.11 Request Mechanic Page Wireframe

4.4.2.7 Mechanic Landing Page

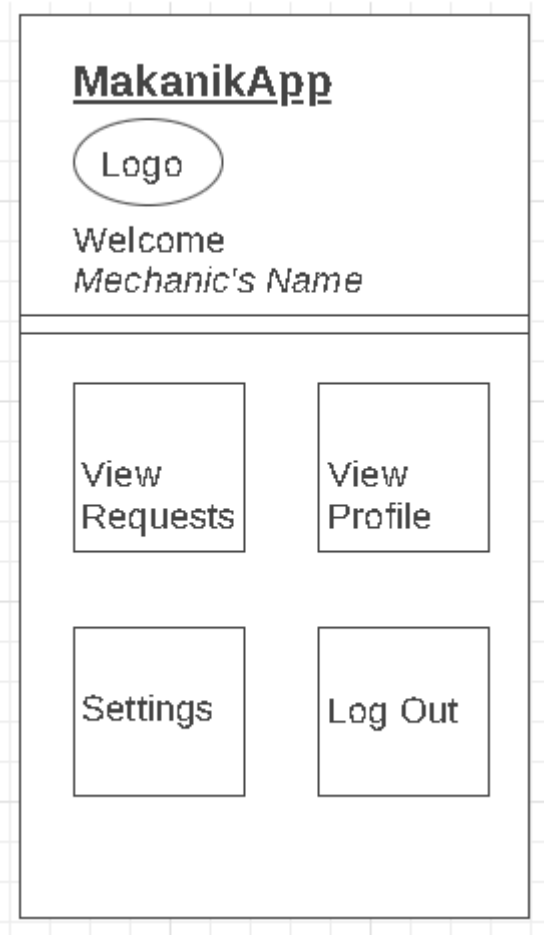

Figure 4.12 Mechanic Landing Page

4.4.2.8 View Customer Requests Page

Figure 4.13 View Customer Requests Wireframe

4.4.2.9 Payment Page

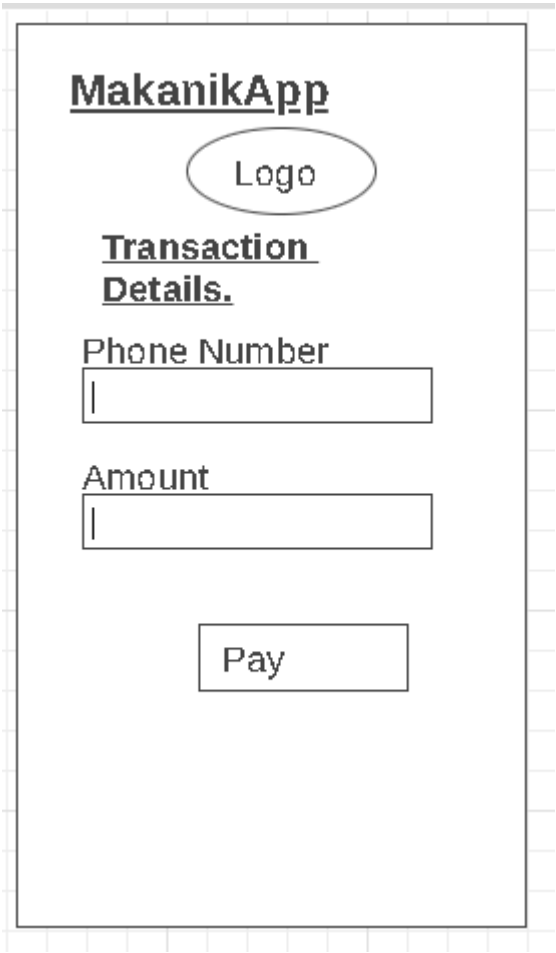

Figure 4.14 Payment Page Wireframe

4.4.2.10 Admin Dashboard

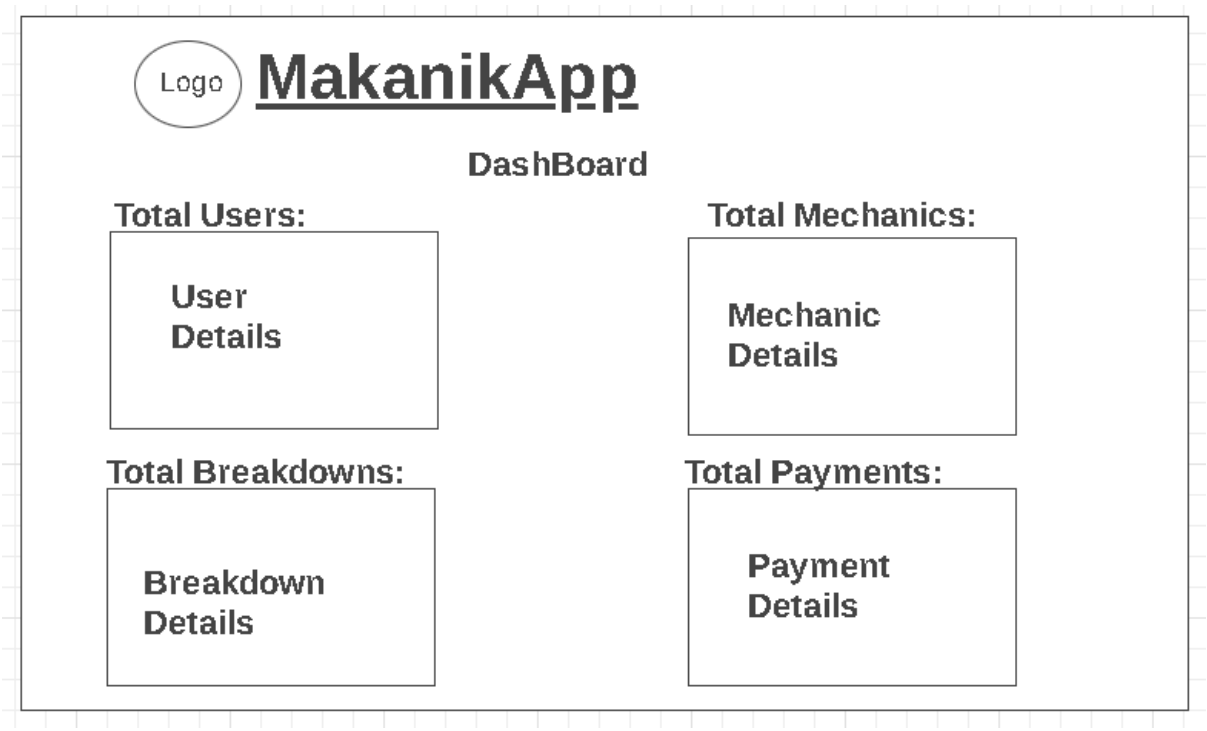

Figure 4.15 Administrator's Dashboard Wireframe

4.4.3 System Architecture

This diagram as shown in illustrates the physical structure, hardware, and processing methods of the system. It shows data preparation process of requests by the user and by the mechanic. The user has to be connected to the internet in order to use the application. This is because the application communicates with the Firebase Database which work when the device is online.

The Firebase Database has assisted in many application functionalities. This includes authentication and maps integration. Firebase offers authentication using email and password. It also provides password hashing techniques, ensuring that the user's information has been stored securely. Since Firebase is a Google service, it also ensures that integration of Google Maps is quite seamless.

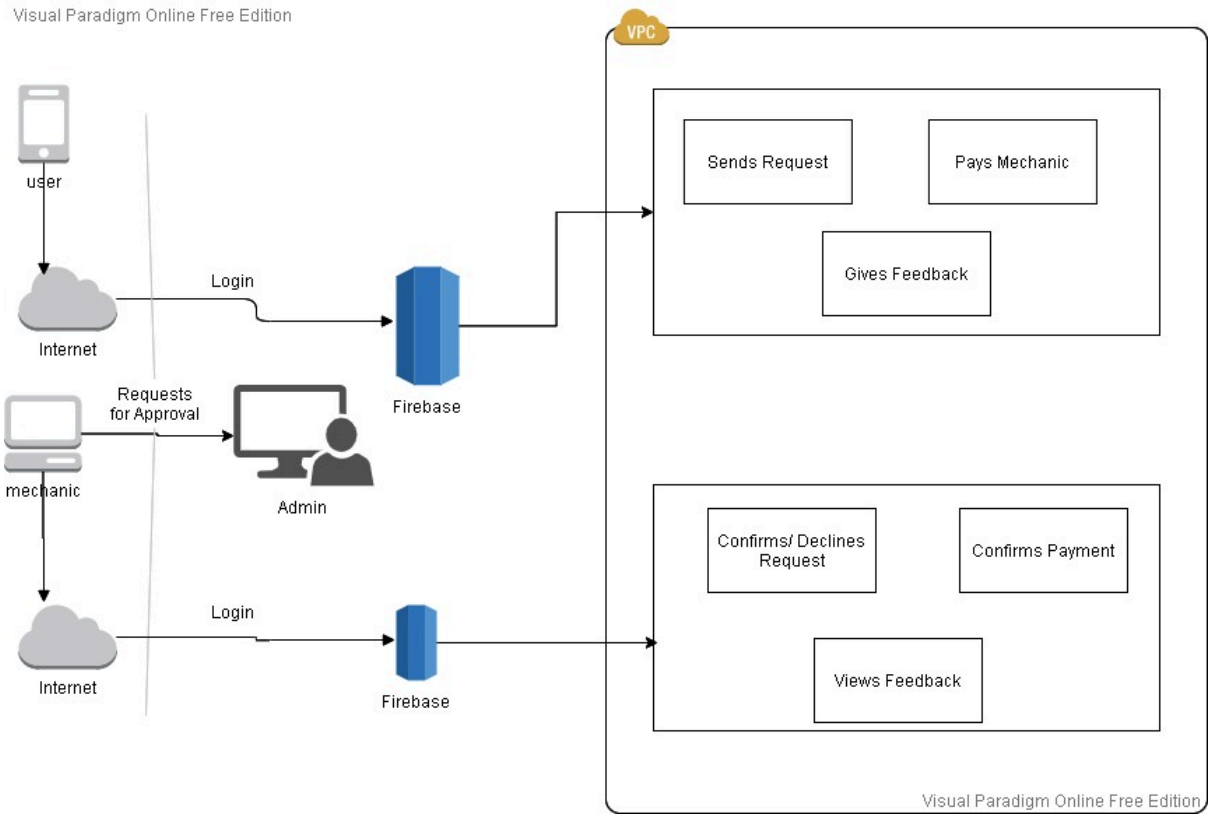

Figure 4.16 System Architecture

Chapter 5. System Implementation and Testing

5.1 Introduction

This section looks at how the system was tested after its implementation. System testing is the process of validating the functionality of the different modules in the system and ensuring that they conform to the specified functional and non-functional requirements. System implementation is the process of defining how the system should be built, ensuring that the system is operational and used and lastly ensuring that the system meets quality standards.

5.2 Description of the Implementation Environment

A testing environment is described for each class of model, where they can benefit from close links between each other and the modelling environments. It provides outline of the hardware and software identifications that are required for the system to be implemented and to be fully operational.

5.2.1 Hardware Specification

Table 5.1 Hardware Specification below shows the hardware specifications of the computer used to develop and test the MakanikApp system.

Table 5.1 Hardware Specification

Item	**Specifications**
Processor	Processor Intel(R) Core (TM) i3-6100U
RAM	RAM 4GB
Hard Disk Storage	Hard Disk Storage 1TB

5.2.2 Software Specification

The system was developed for an Android and Firebase environment.

5.2.2.1 Android Environment

The language used to develop the MakanikApp system was Java. It requires that the device should have an operating system of Android 4+.

5.2.2.2 Firebase Environment

The MakanikApp system was designed to work with the Firebase NoSQL database system.

5.3 Description of Testing

Testing for MakanikApp was done by providing the correct input and checking if the system behaved as expected. Incorrect input was also provided to the system to check if the system had correct error handling and would not crash. This was done for all implemented modules in the system. All modules were also tested to confirm whether they met the requirements specified.

5.3.1 Testing Paradigm

This section will discuss the testing paradigms used for testing of the system. The testing paradigms discussed are white box testing and black box testing.

a) White box testing - is a testing technique that checks the internal functioning of the system. The testing is based on coverage of code statements, branches, paths, or conditions. The authentication module was tested using this paradigm to ensure that there were no mistakes in the code that could lead to compromise of users' accounts.

b) Black box testing - is a testing technique where a tester does not have any information about the internal working of the software system. It focuses on the behaviour of the software. This testing was done for all the modules implemented in the system. Test data with predicted known output was used in testing. The expected output was compared with the system's actual output to understand system behaviour and identify possible errors. Non-functional requirements were tested by providing incorrect input to see whether the system would still perform optimally as stated in the non-functional requirements.

5.4 Testing Results

This section displays some of the tests done on the system and their outcomes:

5.4.1 Authentication Module

Table 5.2 Authentication Module Testing Results

Test Case ID	**Description**	**Test Data**	**Expected Outcome**	**Actual Results**	**Status (Pass or Fail)**
TC001	Check user login with valid data	Email =laurenblue811@gmail.com	User should receive a verification	As expected.	Pass

			link sent to their email and automatically login into the user landing page.		
TC002	Check mechanic login with valid data	Email =joanweruu@gmail.com	Mechanic should receive a verification link sent to their email and automatically login into the mechanic landing page.	As expected.	Pass
TC003	Check user login with invalid data	Email =laurenblue8@gmail.com	The system displays an error message.	As expected.	Pass
TC004	Check mechanic login with invalid data	Email =joanwru@gmail.com	The system displays an error message	As expected.	Pass
TC005	Check user registration with valid data	First Name = John Last Name = Doe Email = user1@gmail.com Mobile Number = 0712345678 Password = johnDoe23	The system should notify the user of successful registration with a toast message.	As expected.	Pass

TC006	Check mechanic registration with valid data	First Name = Jane Last Name = Baker Email = mechanic@gmail.com Phone Number =0787654321 Password = janeBaker32	The system should notify the mechanic of successful registration with a toast message.	As expected.	Pass
TC007	Check request for password change.	Email=mechanic@gmail.co m	The system should send an email to the stated email notifying them of a change password change request	As expected.	Pass
TC008	Check the password change module.	New password= janebaker33	The system should notify the user of a successful password change	As expected.	Pass

5.4.2 Administrator Module

Table 5.3 Administrator Module Testing Results

Test Case ID	**Description**	**Test Data**	**Expected Outcome**	**Actual Results**	**Status (Pass or Fail)**

TC009	Check admin login with valid data	email= nyamaidaystar@gmail.com	Admin should receive a verification link sent to their email and automatically login into the administrator dashboard.	As expected.	Pass
TC010	Check admin login with invalid data	Email =laurenblue8@gmail.com	The system displays an error message.	As expected.	Pass
TC011	Check admin registration with valid data	First Name = John Last Name = Doe Email = user1@gmail.com Phone Number = 0712345678 Password = johnDoe23	The system should notify the user of successful registration with a success message.	As expected.	Pass
TC012	Check request for password change.	Email= nyamaidaystar@gmail.com	The system should send an email to the stated email notifying them of a change password change request	As expected.	Pass

TC013	Check the password change module.	New password=adminNewPass	The system should notify the user of a successful password change	As expected.	Pass
TC014	Update user details	New Phone Number= 0712987876	The system should notify the user of a successful user details update.	As expected.	Pass
TC015	Update mechanic details	New Status= INACTIVE	The system should notify the admin of a successful mechanic details update.	As expected.	Pass

5.4.3 User Module

Table 5.4 User Module Testing Results

Test Case ID	**Description**	**Test Data**	**Expected Outcome**	**Actual Results**	**Status (Pass or Fail)**
TC016	Check if the user can upload a breakdown image.	Image from user's gallery	The user should be able to view the image that they had selected from	As expected.	Pass

			their gallery on the breakdown page.		
TC017	Check if the user can view their current location.	Current location displayed in user map page.	The user should be able to view their current location from the map.	As expected.	Pass
TC018	Check if the user can request for a mechanic	Image = A picture of a car with a puncture Description= Flat Tyre	After filling in the required details and clicking the Call Mechanic button, the user should be able to see the nearest mechanic to them.	As expected.	Pass
TC019	Check if the user can view their details and edit their email and phone number.	First Name = John Last Name = Doe Email = user2@gmail.com Mobile Number = 0787654321 Password = johnDoe23	The user should be able to view their details that are stored in the database and edit their phone number and email. The	As expected.	Pass

			new phone number and email should be viewed with the rest of the details.		

5.4.4 Mechanic Module

Table 5.5 Mechanic Module Testing results

Test Case ID	**Description**	**Test Data**	**Expected Outcome**	**Actual Results**	**Status (Pass or Fail)**
TC020	Check if the mechanic can view their current location.	Current location displayed in the mechanic map page.	The mechanic should be able to view their current location from the map.	As expected.	Pass
TC021	Check if the mechanic can view requests from a user	Image = A picture of a car with a puncture Description= Flat Tyre	The mechanic should be able to view a user's request with the image posted and brief description. The mechanic should also view the user's current location.	As expected.	Pass

TC022	Check if the mechanic can view their details and edit their phone number	First Name = Jane Last Name = Baker Email = mechanic2@gmail.com Mobile Number = 0712345678 Password = janebaker33	The mechanic should be able to view their details that are stored in the database and edit their phone number. The new phone number should be viewed with the rest of the details.	As expected.	Pass

5.4.5 Payment Module

Table 5.6 Payment Module Testing Results

Test Case ID	**Description**	**Test Data**	**Expected Outcome**	**Actual Results**	**Status (Pass or Fail)**
TC023	Check if the inputted phone number receives an STK Push message.	Phone Number= 0712345678 Amount = 50	The owner of the number should be able to receive the STK Push message indicating the amount that is supposed to be sent. The	As expected.	Pass

			user is prompted to input their correct MPESA pin for it to be a successful transaction.		

Chapter 6. Conclusions, Recommendations and Future Works.

6.1 Conclusions

Kenya currently does not have a way of connecting verified mechanics and drivers in unfamiliar situations. There are also no ways of knowing the level of expertise that the mechanics have. MakanikApp has created a bridge between mechanics and drivers wherever they may be. It has also brought a sense of security to the drivers by giving them the details of the mechanics and the feedback that other drivers have given them. It has also given mechanics a side hustle where they can grow their market, validate their trustworthiness, and earn money.

6.2 Recommendations

The application was built on Android and the minimum Android version was Android 6. It is recommended that for the best UI appearance and for efficiency in accessing the user's current location, the users and mechanics should use Android version 8 and above.

The Administrator's side was developed in a PHP 7 environment with some backward compatibility to PHP 5.6. The production server should have at least PHP 7.0.1 installed as a minimum to improve the user's experience.

6.3 Future Works

The application was developed with Kenya as its scope. This can be extended to other countries to help both drivers and mechanics out there to connect and network better. Integration of other modes of payment such as Airtel Money, Telkom Money, PayPal, and VISA cards should be included to cater for users who may not be using the M-PESA , for example tourists. A standard pricing system of the breakdowns will be a great addition to the system to enable both drivers and mechanics to prepare for the financial aspect of it.

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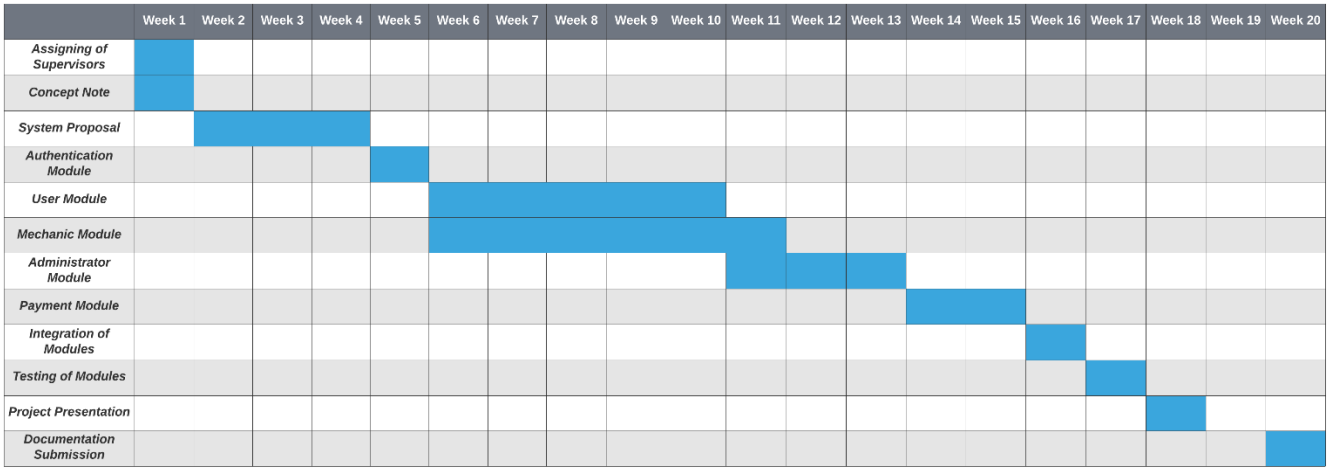
Appendix

Appendix 1. Gantt Chart



Appendix 1 Gantt Chart