Public Service Vehicle Hailing System for People with Disabilities: A Case in Kenya

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Submitted in partial fulfilment of the requirements of the Bachelor of Science in Informatics and Computer Science at Strathmore University

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Nairobi, Kenya

July 2021

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 proposal contains no material previously published or written by another person except where due reference is made in the research proposal itself.

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Abstract

Boarding a public service vehicle for the majority Kenyans is a straightforward process. One who wishes to travel goes to the respective stops for the routes used by public service vehicles. Passengers board at these stops and alight at their respective destinations after payment.

In contrary, for people with disabilities the process can be gruesome and exhausting. Despite the law requiring public service vehicle operators to adapt to suit persons with disabilities, close to none have adhered to it. Therefore, the operators are not sensitized to the plight of people living with disabilities. However, there are a few kindhearted operators that carry the persons with disabilities at no extra charge. This system lacks structure as there is no platform that links persons with disabilities and the volunteer operators.

The proposed system will be a mobile based solution that will enable volunteer operators to register their vehicles. Persons living with disabilities registered on the platform can request for a seat reservation in one of these vehicles for a trip at a given time and route. The proposed system will be developed using the incremental model based on OOAD, as it makes it easier to incorporate new requirements when they arise.

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List of Abbreviations

ERD – Entity Relationship Diagram

GPS – Global Positioning System

PWD – People with Disabilities

UML – Unified Modeling Language

UNHCR - United Nations High Commissioner for Refugee

Chapter 1: Introduction

1.1 Background Information

Public transportation has been the most common form of transport in Kenya. Public transport vehicles in Kenya range from taxis to minibuses to buses. 90% of households have matatus or buses available within their vicinity in urban Kenya (Salon & Gulyani, 2019). “Matatu”, as Kenyans call it, was derived from the English number “three” as people used to pay three coins to use it. It is the preferred form of transport for Kenyans as they commute in the cities to meet their daily needs because they are affordable (Tripadvisor, 2021).

In the country, bus stops have been put in specific places to accommodate boarding and alighting of passengers in a matatu. Matatus have specific routes to various destinations with several stops along the way. During transit, the conductor collects fare from the passengers. Fare charged on passengers varies depending on conditions such as distance, capacity, and fuel price (Wambugi, 2017).

Passengers are a key factor in public transport. One of the users of public transport are persons living with disabilities. According to UNHCR, these are people having long-term physical, mental, intellectual, or sensory impairments which in interaction with various barriers hinders their full and effective participation in society on an equal basis with other members of society (UNHCR, 2021).

According to the 2019 census, 918270 Kenyans are living with some form of disability. 42% of people living with disabilities, 0.4 million Kenyans, are reported to have mobility issues (Owino, 2020). These people use walking sticks, frame guides, wheelchairs, or crutches to aid in their movement (National Council for Persons with Disabilities, 2021). This often proves difficult when boarding and alighting matatus. Public service vehicle operators are required to adapt to suit persons with disabilities (Kenya Law Reports, 2010). They may do so by including low floors, automated wheelchair ramps, rail compartments, wheelchair space and wide aisles to their vehicles (The Kenya Institute for Public Policy Research and Analysis, 2020).

Despite these regulations provided by the law, there are no wheelchair accessible buses and taxis in the entire Nairobi city (Mwangi, 2016). PWDs are therefore forced to make do with the available public service vehicles which poses various challenges to them. Some find alternative methods to commute such as using tricycles which are difficult to use on unpaved streets with dirt and potholes (The Kenya Institute for Public Policy Research and Analysis,

2020). They are also impractical for long distances. Some travel organizations such as Uber have provided a feature that supports them known as 'UberAssist' (Uber Blog, 2019). However, this is an expensive alternative that most people with disabilities cannot afford, as approximately 67% of persons with disabilities in Kenya are destitute (Kabare, 2018).

These people have the right to use public transport but are often overlooked hence they are not able access the same rights as other members of society.

Following this, a system that offers easier and inclusive transport options for people with disabilities is essential. A system that will connect people with disabilities to public service operators that are willing to assist. This will change the norm that people with disabilities face as it will offer convenience and stability by enabling them to plan and schedule their trips ahead of time.

1.2 Problem Statement

Due to the lack of inclusivity in the public transportation sector, people with disabilities find it difficult to commute. Boarding and alighting of public service vehicles is time consuming for people with mobility challenges. Due to this many public service vehicle drivers will not take disabled passengers and when they do, they charge extra . In an interview by BBC News Africa (Mwangi, 2016), a matatu driver in Kenya caters for disabled passengers at no extra cost. Time invested in helping these passengers in boarding and alighting causes him to make fewer trips. This in turn reduces his profit margin.

Volunteer drivers have become an essential option for people with disabilities. This system, however, is unstructured as there are only a few volunteer drivers that cater for their own routes and at their own availability. There lacks a platform that provides structure to volunteer drivers and their beneficiaries.

1.3 Objectives

1.3.1 General Objectives

To develop a mobile application that aids people with disabilities in commuting by enabling them to book a seat in matatus and buses registered on the system.

1.3.2 Specific Objectives

i. To investigate how people with disabilities have commuted in the past.
ii. To investigate the challenges in the current systems that have aided in commuting of people with disabilities.

iii. To design a mobile based public service vehicle hailing application for people with disabilities.
iv. To develop a mobile based public service vehicle hailing application for people with disabilities.
v. To test the developed mobile based public service vehicle hailing application for people with disabilities.

1.3.3 Research Questions

i. How have people with disabilities commuted in the past?
ii. What are the challenges in the current systems that have aided in commuting of people with disabilities?
iii. How will a mobile based public service vehicle hailing application for people with disabilities be designed?
iv. How will a mobile based public service vehicle hailing application for people with disabilities be developed?
v. How will the developed mobile based public service vehicle hailing application for people with disabilities be tested?

1.4 Justification

People with disabilities may end up not finding a matatu that is willing to let them board. Our platform will enable them to have access to drivers that will assure them of a seat when they want to commute making it easier and efficient to use. This is because they will be picked at a specific time and not have to wait for hours as they are being shunned by matatu operators (National Gender and Equality Commision Communications, 2019). The platform will offer standard rates making it cheaper to use as normally they are demanded to pay twice the standard fare (National Gender and Equality Commision Communications, 2019).

The platform will provide structure to volunteer drivers and their beneficiaries. Volunteer drivers on the platform will be able to state their availability and the routes they will operate on. Therefore, people with disabilities using the platform will be availed options that are relevant to the routes and time of their commute.

1.5 Scope and Limitations

The system will allow volunteer operators to register their vehicles. Registered persons with disabilities on the system will be able to book seats from the matatus and buses available on their routes. The system will not integrate any payment options.

The system will be available for android devices. It will require internet connectivity and access to the device’s location.

Chapter 2: Literature Review

2.1 Introduction

This chapter analyzes how people with disabilities have commuted in the past. It also discusses how current solutions have aided in commuting of people with disabilities and the gaps in these solutions.

2.2 Current State of Matatu Operation in Kenya

The leading mode of public transportation in Kenya is the matatu industry. The industry is a major employer with close to 350,000 workers. These workers include drivers, conductors, and office staff. Matatus are run by either Sacco arrangements or registered companies. These matatus come in different sizes and brandings (International Labour Organization, 2021).

Matatus have come up with several ways to appeal to their riders. These include Wi-Fi installations, setting up of music systems, plastering of artwork on the interiors and exteriors and fitting of large screen monitors in the vehicles (Wambugi, 2017).

Matatus have different carrying capacities. Some can carry only 14 passengers while others carry over 30 passengers. At the terminals, matatus wait for passengers until they fill up before they depart. Due to the onset of the COVID-19 pandemic, matatus must adhere to the regulations set by the Kenyan authorities. One of these regulations being that matatus can only carry 60% of their total capacity (Bastmeijer, 2020).

Matatus have specific routes to various destinations with several stops along the way. In the country, bus stops have been put in specific places to accommodate boarding and alighting of passengers in a matatu. During transit, the conductor collects fare from the passengers. Fare charged on passengers varies depending on conditions such as distance, capacity, and fuel price (Wambugi, 2017).

2.3 Past Commuting Methods for People with Disabilities

People with disabilities have in the past used various methods in commuting. Some of these methods include use of tricycles, personal vehicles, and public service vehicles.

2.3.1 Use of Tricycles

One of the assistive devices that people with disabilities use is tricycles. As seen on Figure 2.1 the tricycle requires the user to pedal themselves using their hands. This is however posed with a lot of difficulties from unpaved streets with dirt and potholes to heavy traffic and reckless road users (The Kenya Institute for Public Policy Research and Analysis, 2020).

Figure 2.1: Tricycle for PWDs (Association for the Physically Disabled of Kenya, 2021)

2.3.2 Use of Personal Vehicles

People with disabilities use personal vehicles to commute. These vehicles are modified to enable people with physical disabilities to commute as shown in **Error! Reference source not found.**. They are mostly imported, and the Kenya Revenue Authority exempts persons with disabilities from paying duty for importation (Omulo, 2017).

Figure 2.2: PWD Friendly Vehicle (Integrity Exports, 2021)

2.3.3 Use of Public Service Vehicles

People with disabilities can board the public service vehicles available at bus stops (Mwangi, 2016).

2.4 Related Works

There are a few systems in place that have tried to solve this problem either within Kenya or in other countries. This section gives a brief explanation on how they operate.

2.4.1 ASSISTIVEtravel

ASSISTIVEtravel is an application for visual, hearing and mobility impaired riders (INIT, 2021). The app provides barrier free mobility for riders. For example, persons with mobility impairments can alert a driver that they are in a wheelchair before the bus arrives. In turn, the driver can respond that there is available wheelchair space and help them board when necessary (Pennecke, 2020).

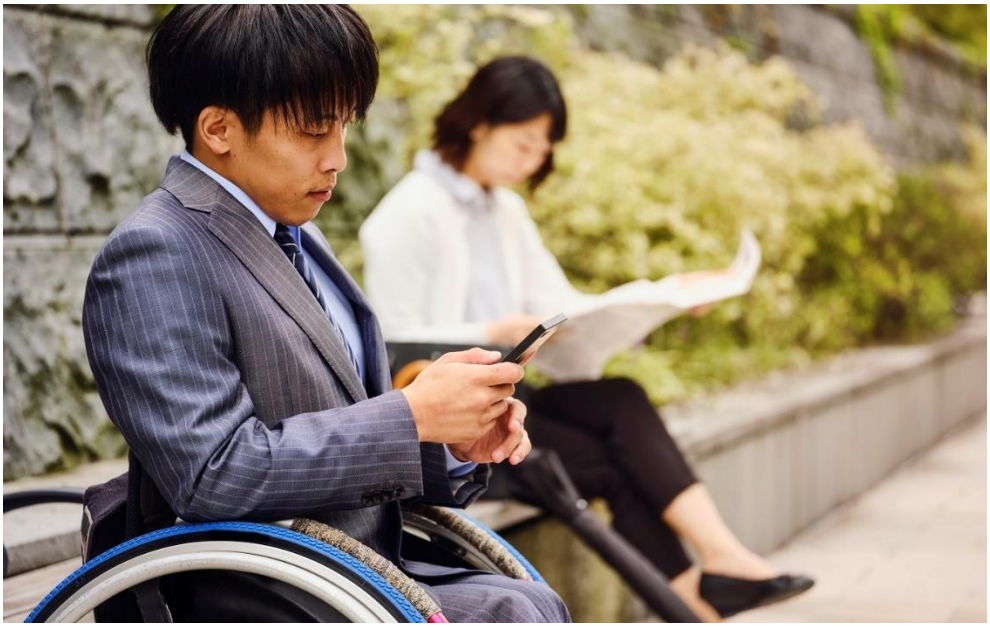

Figure 2.3: ASSISTIVEtravel User (INIT, 2021)

2.4.2 Taxi Hailing Apps – Uber

Uber is an American technology company that offers an assortment of services. These services include ride-hailing, package and food delivery, couriers etc. For the ride-hailing service, they offer a provision for the disabled and senior communities that require assistance. This feature is known as UberAssist as seen in Figure 2.4. Trained drivers help riders when getting into their vehicle and can accommodate folding wheelchairs and walkers in their vehicle (Uber Blog, 2019).

Figure 2.4: UberAssist Feature (Uber, 2021)

2.4.3 Volunteer Public Service Operators

Some public service operators are willing to carry the people with disabilities. In an interview by NTV Kenya, one such driver, Anthony, explains his daily evening trips to the Association for the Physically Disabled of Kenya to carry people with disabilities working there to their homes (Gikonyo, 2021).

2.5 Gaps in Related Works

Approximately 67% of persons with disabilities in Kenya are destitute (Kabare, 2018). For any trip made on Uber, the minimum amount of fare one expects to pay is one hundred and fifty shillings (Maina, 2019). This is costly for one to pay on a daily basis when commuting to and from work. Therefore, UberAssist is an expensive option that most people with disabilities cannot afford to use on a daily basis.

Some systems work for a few that have access to them. For example, in the case of Anthony (Gikonyo, 2021), only people with disabilities that live in Kinoo and know him personally can benefit from his service. Therefore, people with disabilities that have no way of accessing these systems are at a disadvantage.

In addition, some of the available systems lack structure. This lack of structure causes inconvenience to the people with disabilities. In the case of Anthony, (Gikonyo, 2021), the people with disabilities contact him via call. In the case that they are unable to reach him, their transit plans are disrupted.

2.6 Technologies to be Used

The proposed system will incorporate specific technologies that will offer seamless use of the system. These technologies will include Android and GPS.

2.6.1 Android

Android is an open-source operating system based on Linux. It is created for a variety of devices and comprises of several components such as System Apps and Java API Framework (Android Developers, 2021). Android has released various versions over the years. The latest, Android 11, was released on September 8, 2020, (Summerson & Duino, 2020).

The proposed system will be available for Android devices running on API level 16 and above following the discontinuation of updates for API levels 14 and 15 by Google Play services (Spencer, 2018). Once complete the platform will be available on Google Play Store.

In Kenya, there is widespread use of Android devices. As of June 2021, 89.01% of the mobile operating system market in Kenya was accounted for by Android (O'Dea, 2021). Therefore, the Android platform is suitable as it will reach many of the targeted users.

2.6.2 Global Positioning System

GPS is a global navigation satellite system that provides location, velocity, and time synchronization. GPS is made up of three elements which include, satellites, ground control and user equipment. Satellites transmit signals on geographical position and time of day to users. Ground control comprises of monitoring stations that keep track of satellites in space and their transmissions. Finally, user equipment such as smartphones and watches act as GPS receivers and transmitters (Geotab Team, 2020).

User devices near or on the earth’s surface read signals from at least 4 satellites to calculate location. This is achieved through a technique known as trilateration. A single satellite cannot give accurate information about a location as a GPS device only gives data about distance from satellites. The three satellites create spheres that intersect at two points. The intersection closest to earth is then picked as the actual location. The fourth satellite validates the information (Geotab Team, 2020).

GPS offers several features that will be incorporated in the proposed system. It will be used to determine pickup point locations which will be visible to both the drivers and people with disabilities. It will also aid in navigation from one point to another by giving directions. In addition, the driver’s location will be tracked while in transit. Finally, by use of GPS, people with disabilities can get time estimates on when their booked ride will arrive.

2.7 Conceptual Framework

Volunteer public service vehicle operators register their vehicles on the platform. They specify the routes they operate on and their availability. They also specify the number of seats available for people with disabilities. This data is stored on a remote database.

People with disabilities register themselves on the platform. Once registered, they can view the available vehicle and the routes they operate on. They are also able to see the availability of those vehicles. This data is retrieved from a remote database. The conceptual framework is illustrated in Figure 2.5 below.

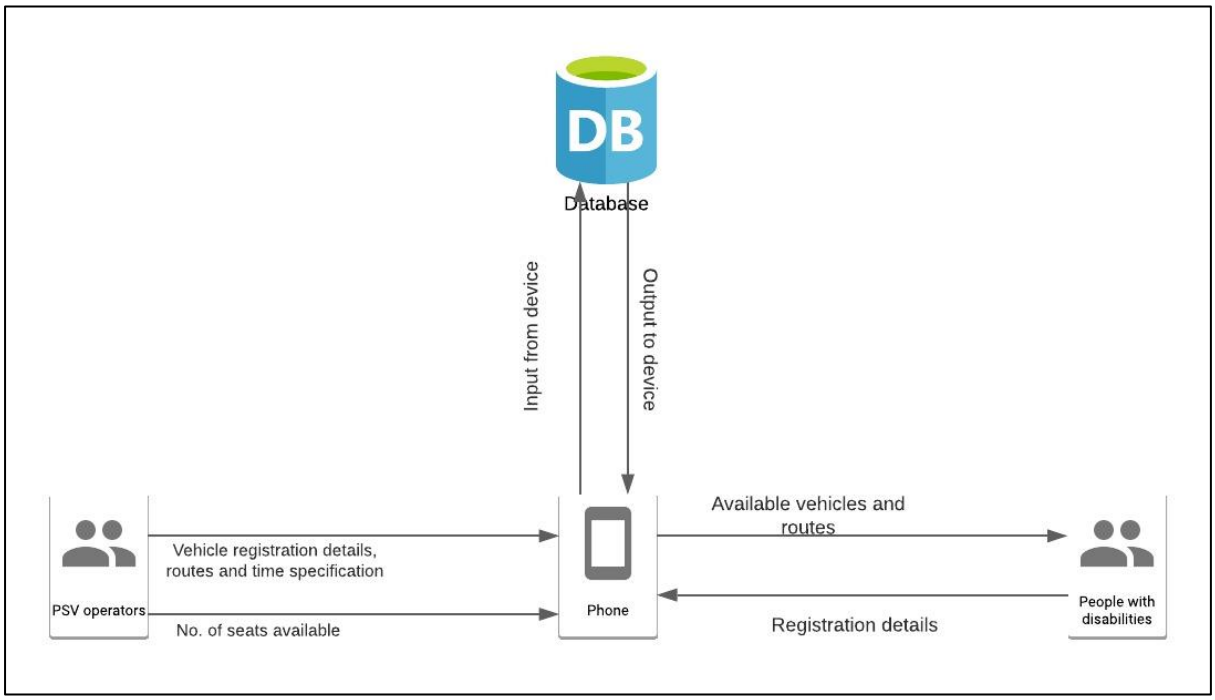

Figure 2.5: Conceptual Framework

Chapter 3: Methodology

3.1 Introduction

This chapter describes the Software Development Methodology that will be applied in the proposed project. It will also discuss the applied development approach to be used and the system analysis, design, and its deliverables.

3.1.1 Object-Oriented Analysis and Design

This is a technical approach used in analysis and design of a system. It describes information systems by identifying objects which can represent people, events, or places. Objects can include data and processes that affect data. It uses UML to develop object models to visualize and document a system (Rosenblatt & Shelly, 2012).

This methodology is suitable for the proposed system as it provides principles of encapsulation and abstraction. This allows for modularization that reduces problem complexity.

3.2 Applied Development Approach to be Used

The applied development approach to be used is incremental development model. This model involves producing and delivering of the system in small increments. It focuses on essential features first with additional functionality being added when and if necessary (van Vliet, 2007).

This development model is suitable for the proposed system as it is based on OOAD. It also allows for quick development within the minimal allocated time. In addition, it is easier to make changes during development thus easier to incorporate new requirements when they arise.

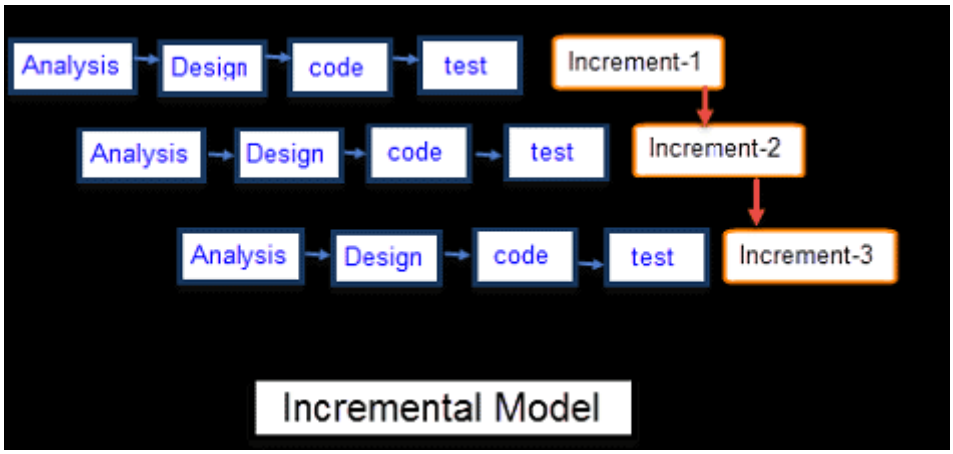

Figure 3.1: Steps in Incremental Model (Salman, 2021)

3.2.1 Requirement Analysis

This step involves identifying system requirements. For the proposed system, functional requirements for both the public service vehicle operators and the persons with disabilities are identified. This step also identifies the unique modules that need to be developed in their order of priority.

3.2.2 Design

This step involves drafting the design of a system. In the proposed system, the design will be drafted to meet the requirements identified in the requirement phase.

3.2.3 Implementation

The proposed system will be coded ensuring constraints defined in the design are met. All the features specified for each specific module for example the public service operator module will be implemented. It will be coded in Java programming language for Android devices.

3.2.4 Testing

This step involves checking the performance of all functions. The modules of the proposed system are tested at a time to ensure functionality meets requirements. After each increment is complete, regression testing done to ensure that it works seamlessly with the prior increments.

3.3 System Analysis

This section involves analysis of the requirements for the system. This section discusses some of the modeling tools and techniques such as use case diagram, sequence diagram and system sequence diagram that will illustrate the requirements of the proposed system and user interaction with the system.

3.3.1 Use Case Diagram

A use case diagram is a visual representation of various related use cases . It illustrates the tasks that actors of a system perform (Rosenblatt & Shelly, 2012). This will be implemented in the proposed system to illustrate how the actors, public service operators and people with disabilities, will interact with the system.

3.3.2 Sequence Diagram

This is an interaction diagram that describes how a group of objects work together in specified period. It visually represents use case by showing the classes, messages, and timing in a system (Rosenblatt & Shelly, 2012). It will be used in the proposed system to show the interaction between the public service vehicle operators and people with disabilities at a particular time.

3.3.3 System Sequence Diagram

This is a sequence diagram that demonstrates when and how tasks relating to a use case are accomplished (Lucidchart Software Inc., 2021). For the proposed system, a system sequence diagram will be used to illustrate the various use cases. For example, when persons with disabilities book seats and how the system handles the process.

3.3.4 Entity Relationship Diagram

This is a model that demonstrates the logical relationships among system entities stored in a database and their interactions (Rosenblatt & Shelly, 2012). For the proposed system, an ERD will demonstrate the relationship of the entities in the system. For example, the relationship between public service vehicle and trips will be one to many. This means that one public service vehicle can make many trips in a day.

3.3.5 Class Diagram

Class Diagram is a diagram that gives deeper details of a use case by showing operations of classes and their relationship (Rosenblatt & Shelly, 2012). A class diagram will show the orientation of the different classes in the system such as routes, trips people with disabilities.

3.3.6 Activity Diagram

This is a flowchart that illustrates the activities involved in a system and their flow from one to another (Rosenblatt & Shelly, 2012). This in the proposed system, will show the sequence of activities involved. For example, sequence of activities from person with disabilities logging in, to booking.

3.4 System Design

This phase focuses on providing models such as user interfaces that satisfy all the documented requirements for the system and demonstrate the outputs, inputs, and processes. These models are illustrated using wireframes, database schema, and system architecture.

3.4.1 Database Schema

This is a schema that describes the logical constraints that apply to the data stored. It defines views, integrity constraints and tables (Lucid Software Inc., 2021). This will describe the logical constraints for the data in the proposed system. For example, data on people with disabilities and public service vehicles registered on the system.

3.4.2 Wireframes

This is a blueprint that assists in visualizing the functionality and structure of an application. In the proposed system, wireframes will be used to map out the various screens in the system and their functionality.

3.4.3 System Architecture

This is an illustration of the physical structure including hardware, software, and processing methods of a system (Rosenblatt & Shelly, 2012). This will be used in the proposed system to conceptualize the structure. It will capture the details of the user interaction with the system and how the system will prepare the data requested by the user.

3.5 System Deliverables

This section describes the various deliverables for the proposed system that will satisfy the system requirements.

3.5.1 System Proposal

This is a documentation that gives details about a proposed system. It will show the problem the proposed system is aiming to solve and its purpose.

3.5.2 Authentication Module

This includes registration and login. Registration allows for new users of a system to register on the platform. Login allows registered users to access the system.

3.5.3 Public Service Vehicle Operator Module

This module will allow matatu operators to specify details of their vehicles, routes, trips, and availability.

3.5.4 Person with Disability Module

This module will allow persons with disabilities to book seats in matatus and view offered trips and routes.

3.5.5 Geolocation Module

This module will allow the matatu operator to view the live location of persons with disabilities who have booked seats at their pickup points. It will also allow persons with disabilities to view live location of the matatu they booked.

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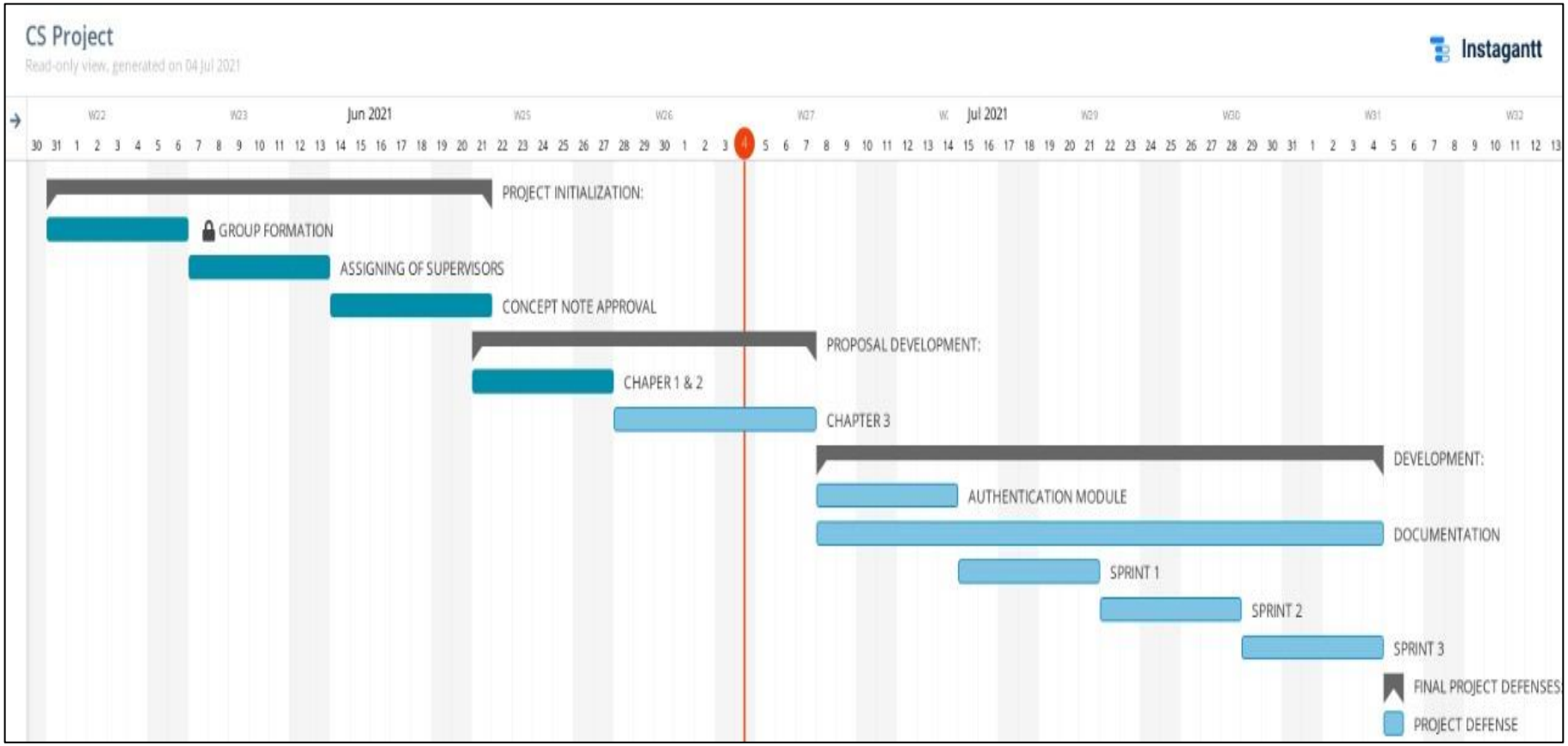
Appendix

Appendix 1: Gantt Chart



Appendix 1: Gantt Chart