The Nelson Mandela AFrican Institution of Science and Technology

NM-AIST Repository **https://dspace.mm-aist.ac.tz**

Computational and Communication Science Engineering Masters Theses and Dissertations [CoCSE]

2022-07

Internet of things based package and parcel tracking and monitoring system for public buses in Tanzania

Mandari, Annette

NM-AIST

https://doi.org/10.58694/20.500.12479/1577

Provided with love from The Nelson Mandela African Institution of Science and Technology

INTERNET OF THINGS BASED PACKAGE AND PARCEL TRACKING AND MONITORING SYSTEM FOR PUBLIC BUSES IN TANZANIA

Annette Godfrey Mandari

A Project Report Submitted in Partial Fulfillment of the Requirements of the Award the Degree of Master of Science in Embedded and Mobile Systems of The Nelson Mandela African Institution of Science and Technology

Arusha, Tanzania

July, 2022

ABSTRACT

This project developed and implemented Internet of Things (IoT)-based system for tracking and monitoring packages and parcels. In today's era where technology is continuously evolving and improving. The concept of the Internet of Things is ubiquitous in nature and numerous gadgets are capable of being connected together over the internet. Previously communications in Tanzania were un-reliable and limited to urban regions. Because of the current efforts made by the Tanzanian government a nation-wide coverage possible. In Tanzania the most cost-effective means of transporting packages and parcels is through public buses. However, a significant number of people experience afflictions with the service delivery thus, agree that a technology solution be utilized to improve service delivery. Purpose of this study is to come up with a digitized system for tracking, monitoring and managing packages and parcels until collection using the concept of the IoT. The proposed project uses both quantitative and qualitative methods of data collection so as to have a better understanding of the present logistics. Also, find inspirations from the Scrum Agile methodology. Key findings majorly from the respondents leaned towards the need of technology solutions in transportation of packages and parcels to reduce the afflictions they go through. This system communicates via Wi-Fi and it's based on the IoT to track and monitor packages and parcels. The monitoring tool is a web-based application and mobile application as an alternative. The system has been thoroughly tested against all of the key aspects of embedded and IoT systems. It is capable of sending package and parcel coordinates to the web-based application when there's and internet connection. Additionally, send data to the administrator's phone when there is an internet unavailability. This system will ease the burdens and be taken into further research to develop better systems for the transportation and logistics industry.

DECLARATION

I, Annette Godfrey Mandari, do hereby declare to the Senate of the Nelson Mandela African Institution of Science and Technology that this project report is my original work and that it has neither been submitted nor being concurrently submitted for a degree award in any other institution.

Annette Godfrey Mandari		28.07.2022
Name of Candidate	**Signature**	**Date**

The above declaration is confirmed by:

Dr. Ramadhani Sinde		31-07-2022
Name of Supervisor 1	**Signature**	**Date**

Dr. Elizabeth Mkoba		29.07.2022
Name of Supervisor 2	**Signature**	**Date**

COPYRIGHT

This project report is copyright material protected under the Berne Convention, the Copyright Act of 1999, and other international and national enactments, on behalf, of intellectual property. It must not be produced by any means, in full or in part, except for shorts extracts in fair dealing, for researcher private study, critical scholarly review, or discourse with an acknowledgment, without the written permission of the office of Deputy Vice-Chancellor for Academic, Research, and Innovation on behalf of the author and the Nelson Mandela African Institution of Science and Technology.

CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by The Nelson Mandela African Institution of Science and Technology, a project report titled **"*Internet of Things Based Package and Parcel Tracking and Monitoring System for Public Buses in Tanzania*"** in partial fulfillment of the requirements for the degree of Master of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology.

Dr. Ramadhani Sinde  31-07-2022

Name of Supervisor 1 **Signature** **Date**

Dr. Elizabeth Mkoba  29.07.2022

Name of Supervisor 2 **Signature** **Date**

ACKNOWLEDGEMENTS

First and foremost, I am thankful to the Almighty God for his life, strength and might that he has provided me during the whole project period.

I would like to express my gratitude to my supervisors at the Nelson Mandela African Institute of Science and Technology (NM-AIST) Dr. Ramadhani Sinde and Dr. Elizabeth Mkoba and also my academic advisor Dr. Judith Leo, for their willingness to supervise this project, their continuous support, guidance, valuable comments and suggestions throughout this project. My extended gratitude to the staff of school of Computation and Communication Science and Engineering (CoCSE) for their support whenever it was needed. I would also thank colleagues and everyone who participated in the surveys for their invaluable advice, encouragement and cooperation during the entire project period. I am indebted to the Center of Excellence for East Africa (CENIT@EA) and DAAD GIZ's scholarship program for funding the project and the Nelson Mandela African Institute of Science of Technology (NM-AIST) for providing me with a facility and a conducive environment that helped me complete my project.

I wish to thank my industrial supervisor at HEBO Group Company Limited, Mr. Martin Nihimba Hekeno for allowing me into his and his co-founder Ms. Bulla Boma Hekeno company and to use their resources throughout my project. I also extend my gratitude to all the HEBO Group Company Limited staff for their guidance and assistance.

Last but not least I would like to thank my parents Dr. Godfrey C.H. Mandari and Mrs. Appaa T.G. Mandari, my brother Dr. Gregory G. Mandari and his wife Dr. Tuganigwe A. Mwangota, my aunt Sifaeli Mhando and my fiancé Eng. Johnson Mwanri for their constant prayers, support and constant encouragement. May the Almighty God protect and bless everyone who contributed in one way or another abundantly.

DEDICATION

I dedicate this work to my parents Dr. Godfrey C.H. Mandari and Mrs. Appaa T.G. Mandari, my brother Dr. Gregory G. Mandari and his wife Dr. Tuganigwe Mwangota and to my fiancé Eng. Johnson Mwanri.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS AND SYMBOLS

AC	Alternating Current
ARM	Advanced RISC Machine
API	Application Programming Interface
CSS	Cascade Style Sheet
DIT	Dar-Es-Salaam Institute of Technology
FR	Functional Requirements
GPS	Global Positioning System
GPIO	General Purpose Input/Output
GSM	Global System for Mobile Communications
GUI	Graphical User Interfaces
HTML	Hypertext Markup Language
Hz	Hertz
IoT	Internet of Things
IR	Infrared
KB	Kilobyte
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MB	Megabyte
MCU	Micro Controller Unit
MNOs	Mobile Network Operators
NEPAD	New Partnership for Africa's Development
NFR	Non-Functional Requirements
NMEA	National Marine Electronics Association

OECD	Organization for Economic Co-operation and Development
PCB	Printed Circuit Board
PCB	Printed Circuit Board
PHP	Hypertext Preprocessor
PIC	Peripheral Interface Controller
PIC	Peripheral Interface Controller
QR	Quick Response
RF	Radio Frequency
RFID	Radio Frequency Identification System
RX	Receiver
SIM	Subscriber Identity/Identification Module
SMS	Short Message Service
SPI	Serial Peripheral Interface
SQL	Structures Query Language
TX	Transmitter
UART	Universal Asynchronous Receiver-Transmitter
URL	Uniform Resource Locator
USB	Universal Serial Bus
Wi-Fi	Wireless Fidelity
XAMPP	Cross Platform Apache MySQL PHP and Perl

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem

Today's era, technology is continuously evolving and improving. The Internet of Things (IoT) concept is ubiquitous in nature. It is capable of connecting numerous gadgets together over the internet, and this in turn can lead to spurs of innovation (Farooq *et al.*, 2015). Security is crucial and a matter of grave importance. Nowadays, people are concerned with the safety and security of their items and objects such as packages, parcels and forms of transport such as public buses. It becomes more pressing if the items and objects transported are of value (Mounika & Chepuru, 2019).

The installation of electronic parcel's tracking systems has been made compulsory in Kenya and its neighboring nations, Tanzania and Uganda (Kabiru, 2016). The main aim of their support would be to increase the business climate of their respective countries and trade routes by assisting with activities such as tax collection, improved cargo handling and general cargo assistance (Kabiru, 2016). Cities such as Dar-Es-Salaam, Arusha, Mbeya and Mwanza, among others have experienced substantial growth. The roads routes in which public buses commute has resulted in rapid growth creating more job opportunities and higher sources of income for migrants in the surrounding area (Msigwa, 2013) as shown in Fig. 1. Despite the numerous challenges of urban transportation, the demand to reach more sites continues to grow.

Figure 1: Regional bus spatial and frequency distribution (Mahapatro, 2011)

In the past, communication in Tanzania was sometimes unreliable, and it was limited to urban regions. Owing to the current efforts being made, Tanzania is on its way to reach a nation-wide mobile coverage (Mibei *et al.,* 2017). In the last decade technology has given rise to features such as calls, text messages, and internet access at various rates (Mibei *et al.,* 2017).

In the transportation and logistics industry in Tanzania, the most cost-effective means of transporting packages and parcels is the public buses. Tanzania is still developing despite the rapid growth of parts of its regions. As a result, a system that takes advantage of the existing resources is needed (Carlsson-kanyama & Defence, 2005). Practically there are many tracking and monitoring technologies available in the world. These technologies include the Global Positioning System (GPS), Radio Frequency Identification (RFID), Barcode (Kumar *et al.,* 2011), Quick Response (QR) code, Global System for Mobile communication (GSM). However, not all of these technologies are suitable for all transportation and logistics industries applications. In the transportation and logistics industry, tracking numbers are widely used. This tracking information is then integrated with the management system (M'hand *et al.,* 2019).

The proposed system based on three technologies. These technologies are GPS, GSM and Barcode. The GPS coordinates are delivered straight to the database or webserver if there is no internet access. When there is an availability of the internet access, the coordinates of the packages and parcels are sent to the office phone through SMS over the GSM. Continuous monitoring of the packages and parcels is done by a smartphone application known as Blynk. This IoT platform is for both iOS and Android smartphones and, it allows microcontrollers such as Arduino, NodeMCU and Raspberry Pi through the use of the internet to operate (Doshi *et al.,* 2017). The platform possesses widgets such as Map which is capable of displaying the geographical location of the packages and parcels in real time.

The proposed system will be beneficial to the public management in providing easiness in inventory keeping. Also, the reduced stress incurred on both sides of the senders and bus management from worrying about the safe travel of the packages and parcels. The monitoring is done in real-time. Once these packages and parcels arrive at the destination offices, they are stored and await their collection.

1.2 Statement of the Problem

Reflect back on how many times have you or someone you know has sent their package or parcel and it has either been lost, mishandled or misplaced. According to the results of the

survey and interviews which I had conducted, it is evident that the majority of the respondents agree that the use of technology would better the service delivery. In this century, the security in the transportation and logistics industry is becoming increasingly crucial as many people value their items of objects being secured through their transit (Kaley *et al.,* 2017).

Several studies regarding the tracking of items and objects such as vehicles (Pooja, 2013), baggage (Kumar *et al.,* 2011) and luggage (Senthilkumar *et al.,* 2017) to mention a few have attempted to solve the problems in the industry. And such systems have made a use of technologies for instance Global Positioning Systems GPS) and Global systems for Mobile communication (GSM) (Harshadbhai, 2013), Radio Frequency Identification (RFID) (Awadalla, 2018) to name a few. However, there are still gaps and areas that are lacking. Thus, there is a need of coming up with in built systems instead of relying on outsourced systems which often times than none are costly. This will help improve service delivery in a developing nation such as Tanzania. Cargo tracking solutions, for example, have a significant impact on boosting organizational value and the provision of services (Kabiru, 2016). Public buses are the preferred and most economical means of transporting items like packages and parcels in Tanzania. The results from the survey conducted showed that the majority of people still use manual methods, such as calling the conductor to check the status of their packages and other deliveries. It is due to these manual methods of operation that has led to several packages and parcels to be either misplaced or lost (Zainudin *et al.,* 2021). The present technological era has made tracking and monitoring convenient and easy to manage in real time (Kaley *et al.,* 2017)

According to a survey conducted with regards to the willingness to deploy technology to track items such as packages and parcels; 77.5% strongly agree to the deployment of technology, 18.6% agree, 2.9% were neutral and 1% disagreed. The proposed system focuses on the tracking, monitoring and management of packages and parcels for public buses in Tanzania. This system will in turn will assist the management in keeping proper records, and thus, come in handy when running inventory. Unfortunately, some recipients fail to collect their packages or parcels, resulting in a backlog of unclaimed packages or parcels at the administration office.

1.3 Justification of the Study

In light of the revised investment policy of 2013 collaboration between Tanzania and OECD and NEPAD (OECD, 2013) aimed to encourage investments in agriculture and infrastructure. The developing nation of Tanzania is also working towards improving the service delivery in

various sectors (Finance, 2020). Service delivery is an eye-catching arena, especially in the transportation and logistics field. A majority of Tanzanians use public buses to transport packages and parcels from one region to another because it is a cost-effective means of transportation for an ordinary citizen. However, they face afflictions while doing so agree to the use of technology to better the service delivery. Also, the public bus's management system record keeping is manual based. With that said, it means that technology needs to be integrated into the transportation and logistics industry of public busses to improve service delivery and management operations. This will improve and add value to their businesses and improve how they are currently operating.

1.4 Research Objectives

1.4.1 Main Objective

The main objective of the study is to develop an internet of things-based package and parcel tracking and monitoring system for public buses in Tanzania.

1.4.2 Specific Objectives

(i) To identify the system requirements for developing an IoT based package and parcel tracking and monitoring system for public buses in Tanzania.

(ii) To design and develop an IoT-based package and parcel tracking and monitoring system for public buses in Tanzania.

(iii) To validate the developed system.

1.5 Research Questions

(i) What are the requirements for developing and IoT-based package and monitoring system for public buses in Tanzania?

(ii) How to design and develop an IoT-based package and parcel tracking and monitoring system for public buses in Tanzania?

(iii) How to validate the developed system?

1.6 Significance of the Study

The developing nation of Tanzania has been working towards advancing it's technology in order to improve service delivery (Finance, 2020). The knowledge gained from reviewing the existing systems helps in the identification of the areas where the gaps lie. The project will contribute to boosting the additional value of delivery of services in Tanzania's public bus transportation and logistics industry. Additionally, they aid in inventory management and assist to generate literature for future research while also improving on existing material. Common technologies for instance Radio Frequency Identification (RFID), Global Positioning System (GPS) and Wireless Sensor Network (WSN) can be used for tracking items or objects. A gap identified from reviewing a number of papers and articles is the absence of a system which incorporates tracking and monitoring of items in transit and their management until their collection. A significant percentage of public bus users are afflicted with the service delivery offered by public buses as most companies lack proper management systems. And as a result, a substantial number of packages and parcels are either lost, misplaced or mishandled. The proposed system has a significant potential for tracking and monitoring packages and parcels while they are in transit from one region to another by gathering GPS data. And update their locations to the office phone when there is no internet access.

1.7 Delineation of the Study

The number of participants were limited because this was a modest project. Furthermore, the participants were mostly from urban and semi-urban areas, in Tanzania mainland with only 1% from rural areas. The ESP8266 microcontroller, GSM module, and GPS receiver module are all included in the developed system. In order to create a web-based monitoring system, these components were incorporated with a web-based application. The data were collected using a database server on the PC, and it will be available via a web page. The user can then download it to their devices.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Due to the rapid urbanization and industrialization in the world, industries in developing countries are expected to benefit from the use of technologies such as remote monitoring, inventory management and item/object tracking. This chapter reviews the related works that were carries out for the Internet of Things based package and parcel tracking and monitoring system for public buses in Tanzania project.

2.2 Related Works

Several past research in the realm of transportation and logistics have looked into parcel shipment tracking as well as cargo. And as a result, there are a number of tracking and monitoring systems present. Modern systems of parcel transportation in developed nations rely heavily on the US Postal Service (USPS), United Postal Service (UPS) and Federal Express (FedEx). In Europe the common parcel couriers are UPS, DHL, TNT and FedEx whereas in the United States according to their annual revenues, it is FedEx and UPS which are the largest companies (Li *et al.,* 2006). The reviews the differences between the two service delivery company's ratings for both incoming and outgoing shipment; and concludes that both companies hold an equally dominant position in the market (Li *et al.,* 2006).

The process of tracking items such as packages and parcels are carried out manually here in Tanzania. There are numerous technologies which have been used to track items and objects such as baggage, luggage, vehicles and shipments, among other things. Historically, determining the location of items was difficult, but now, thanks to the GPS technology, tracking items and objects is relatively easy (Mounika & Chepuru, 2019). Many studies have stressed the uptake of tracking systems, with the majority of these studies focusing on technologies (M'hand *et al.,* 2019) such as Radio Frequency Identification (RFID), Near-field Communication (NFC), Global Positioning System (GPS), Wireless Fidelity (Wi-Fi), and Real-Time Location System (RTLS). The following are the existing systems related to the proposed systems.

2.2.1 Internet of Things Based Vehicle Tracking and Monitoring System using GPS and GSM

Mounika and Chepuru (2019) describes the usage of a Vehicle Tracking and Monitoring System for the identification of vehicle theft through the implementation of an anti-system. The GPS module is used to track the location of the car using coordinates like latitude and longitude. Using a GSM modem and the mobile network, these values are sent to the user. The system also includes a variety of sensors that may be used to both the identification of an accident and also the detection of alcohol consumption (Mounika & Chepuru, 2019). Anybody from anywhere in the world is capable of checking these sensor values via a platform known as ThingSpeak. The car monitoring and anti-theft system is made more secure with the use of RFID technology. When theft is detected through the ignition key, then the vehicle can be remotely controlled using the GSM control software (Mounika & Chepuru, 2019).

2.2.2 Design of the Global Position System and Global System for Mobile Communication Vehicle Tracking System

This system uses a radio frequency transmitter that's attached to a vehicle. It sends data about the car to a dedicated receiver. This method is used to track down stolen cars (Harshadbhai, 2013). This system uses a radio frequency transmitter that's attached to a vehicle. It involves the installation of electronic devices in a vehicle(s) with the goal of allowing the owner or third party to track the whereabouts of the vehicle while also capturing the data in the process (Harshadbhai, 2013).The vehicle's location is gathered by the Global Positioning System (GPS) module which can broadcast in real-time. Using the Global System for Mobile communications (GSM) network, the data is sent to the tracking server through an SMS or TCP/IP direct connection (Harshadbhai, 2013). In addition, the tracking server features a GSM/GPRS modem to collect the vehicle location date which then records them in the database. Only the authorized users are able to access this information online via a web page.

2.2.3 The Luggage Tracking System using the IoT article

The study by Senthilkumar *et al.* (2017), the luggage tracking system using IoT was created to locate the lost or stolen bags and luggage from the public and other locations. This proposed approach is designed to take into consideration the risk of luggage and bag theft that exists whenever individuals travel. The Arduino Uno board and GPS module are used to set the alarm which operate on an alarm basis (Senthilkumar *et al.,* 2017).. Moreover, the moment the bag is

stolen and leaves a specific area, the alarm is activated. Also, a map is generated to allow the bag's progress away from its owner to be monitored through a mobile application (Senthilkumar *et al.*, 2017).

2.2.4 Internet of Things based Smart Object Tracking System Paper

The primary focus of this study is on the security of the passenger's bags. An RFID technology is used by the smart object tracking system to enhance the airport's security as well as speed up the retrieval of the passenger luggage (Poonkodi *et al.,* 2019). The device is made up of an RFID tag and a reader module (Poonkodi *et al.,* 2019). The RFID reader detects the tag, transmits signals to the microcontroller, which them delivers a specific tag ID to the Liquid Crystal Display (LCD). This also sends the tag information to the administrator and an SMS to the passenger informing them of the location of their luggage via the GSM module (Poonkodi *et al.,* 2019).

2.2.5 Courier Tracking Management System with Notification Using Barcode Scanner

This web-based system is intended to not only ease the handle of the incoming and outgoing parcels but also, to assist the management and administrators in managing the parcels (Rabuan *et al.,* 2020). This study concentrates on tracking packages using barcode scanners that send SMS notifications to confirm delivery. The administrator will enter the barcode and phone number for the new package which has arrived (Rabuan *et al.,* 2020). The system will then send an automated SMS to the parcel receiver. New users must sign up using the URL provided in the SMS notification. For parcel pickup, the QR Code will be supplied through email (Rabuan *et al.,* 2020).

2.3 Identified Research Gap

Table 1 shows the summary of the existing systems along with their identified research gaps (limitations).

Table 1: Summary of the existing systems

Reference	Problem Addressed	Proposed Solution	Limitation of the study
Harshadbhai (2013)	Through combining the emerging technological technologies and forming a relatively accurate and efficient transportation system to increase the ties between people, automobiles, and routes.	To develop an autonomous vehicle positioning system that can deliver real-time location data using GSM and GPS technologies.	The absence of a database that stores information.
Senthilkumar *et al.* (2017)	To be able to track lost or stolen bags in public and other settings.	When the bag moves out of a specific range, such as 10 meters, 20 meters, or 30 meters, a luggage tracking system that employs IoT sends out a flag of messages and sounds and alarm.	It would be difficult to keep track of the bags once you passed the marks.
Mounika and Chepuru (2019)	The security issues present in both private and public vehicles that either get lost or hidden somewhere.	To develop a GPS and GSM-based IoT-based vehicle tracking and monitoring system. This technology will track the exact position of automobiles that have gone missing or have been concealed.	The system lacks an advanced technology that uses the Internet of Things to control the car remotely just about anywhere in the world.

Reference	Problem Addressed	Proposed Solution	Limitation of the study
Poonkodi *et al.* (2019)	Luggage surveillance as well as mistakes in luggage management.	Develop an IoT-based smart object tracking system to provide an efficient solution for tracking luggage in airports, minimizing luggage handling errors and misplacement.	• Changing from adhesive paper tags to digital tags to necessitate worker training. • This technology is difficult to setup. • These RFID tags may be physically damaged. • The RFID technology if not properly handled, it can be dangerous.
Rabuan *et al.* (2020)	Courier Tracking Management System with Notification Using Barcode Scanner	Develop a web-based application system that uses a barcode scanner to that send SMS notifications to confirm delivery. The system will then send an automated SMS which contains a URL link to the parcel receiver. For parcel pickup, the QR Code is given via email.	• The system does not provide a student and staff database that is connected with the current Campus Management System (CMS).

2.4 Proposed System

The suggested solution intends to address the identified difficulties and inadequacies in Tanzania's transportation and logistics industry. It employs the Internet of Things (IoT) technology to track packages and parcels in public buses until their collection. The proposed system overall has a tracking part, monitoring part and any inventory part. The tracking part involves the acquisition of the location of the packages and parcels using the GPS module from the satellites in real-time where this data is able to be analyzed and displayed on the map in the web-based application. The monitoring part is done the installed Google API application in the inventory system. The packages and parcels commute details can be viewed. In addition, a smartphone application known as Blynk can be used as a secondary monitoring tool. Lastly, the third part is the inventory system. This is a computerized web-based application used to manage the tracking and monitoring of the packages and parcels. it is also incorporated API application for monitoring the packages and parcel's commute. Packages and parcels are check-out using a barcode scanner when collected by the receiver.

2.4.1 Advantages of the Proposed System

The proposed system has a number of advantages, some of these advantages include:

(i) The precise location of packages and parcels can be determined using the Global Positioning System (GPS) technology.

(ii) Barcode and Quick Response code are additional features in the traceability as well as inventory management of the packages and parcels.

(iii) Packages and parcels are able to be tracked in real time.

(iv) The system can be accessed remotely.

2.4.2 Applications of the Proposed System

(i) Vehicle Tracking Systems.

(ii) Postal offices.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

The proposed system is discussed in detail in this chapter. The Global Positioning System (GPS) module and the Global System for Mobile Communication (GSM) module are serially connected to the microcontroller. The GSM sends the packages and parcels coordinates from a remote location to a monitoring station; whereas the GPS module constantly tracks the packages and parcel's coordinates with the help from the satellites. A tracking system collects data from the GPS and sends it to the mobile or laptop through the GSM module using mobile communications. The monitoring station utilizes various software or applications to plot the packages and parcels on a map; and the current location of the packages and parcels is transmitted via the Global Positioning System (GPS). Packages and parcels are received at the destination offices where they will be scanned into the system and temporarily stored until their collection.

3.2 Project Case Study

The project was carried out at the HEBO Group Company Limited and Dar-Es-Salaam Institute of Technology (DIT) which is located in Dar-Es-Salaam, Tanzania. The project aims to track, monitor and manage packages and parcels for Tanzanian public buses moving from one region to another. It also analyzes how to implement a tracking technology after packages and parcels arrive at an intermediary destination and stored until they are picked up by the responsible party. Both an online and individual survey was done to collect data regarding the package and parcel transportation using public buses in Tanzania. This was done in order to have a better understanding of the present logistics and also to find additional inspirations for the system design.

3.3 Research Methods

The project used both qualitative and quantitative methods to collect data regarding the package and parcel transportation using public buses in Tanzania. This was done in order to have a better understanding of the present logistics and also to find additional inspirations for the system design.

Interviews were used to collect qualitative data from users and employees of public buses. The interview guide is as shown Appendix 3 and Appendix 4. The document analysis involved reviewing of literature from numerous peer reviewed journal articles and books. The structured questionnaire was employed to collect quantitative data from users of public buses. The questionnaire is as shown in Appendix 2.

3.4 Data Collection Methods

Data collection is often a factor in determining the success of a research project. How data are collected and managed can have a significant impact on how the study is conducted and how it is performed (Wilcox *et al.,* 2012). This section describes the two kinds of data collection methods used for gathering information regarding the package and parcel transportation in Tanzania and they are as illustrated.

3.4.1 Secondary Data Sources

The secondary data were collected from journals, reports, books, websites and other related works.

3.4.2 Primary Data Sources

The primary data were collected using interviews and structured questionnaires which were administered to users and employees of public buses in Tanzania.

3.5 Data Analysis

The information in the tables above originated from a survey which was performed both online and on an individual basis. Online surveys were issued on Survey Monkey and Google form were analyzed every time the respondents submitted their response as shown in Appendix 2. The Google form platform analyzes the data by giving out an overall summary of all the respondent's responses, individual question response analysis; and individual response for each respondent. And the Survey Monkey analyses the questions and summaries giving out the summary of the statistics of the responses; insights and data trends which gives a total number of respondents, completion rate, total time spent and the most skipped question; and individual responses of all of the respondents to all the questions.

3.6 System Development Approach

The kind of approach used in this project is the Scrum agile software development. In this framework the project phases are broken down into cycles known as sprints and the process is done in iterations and also, the important features are developed first. I opted for the agile methodology because of its numerous advantages which it comes with. Some of these merits include; projects are done in iterations which in turn helps with building requirements as per the needs of the end users and that there is a reduction in failure of the project.

3.7 System Requirements

Any effective system requires both the hardware and software to operate. The proposed system is an example of one of the systems which requires both hardware and software to function. The system is controlled by a NodeMCU microcontroller and a database management system for information managing as well as an application known as Blynk for monitoring.

Figure 2 is a graphical representation highlight the various components as well as technologies which as used for the system's development.

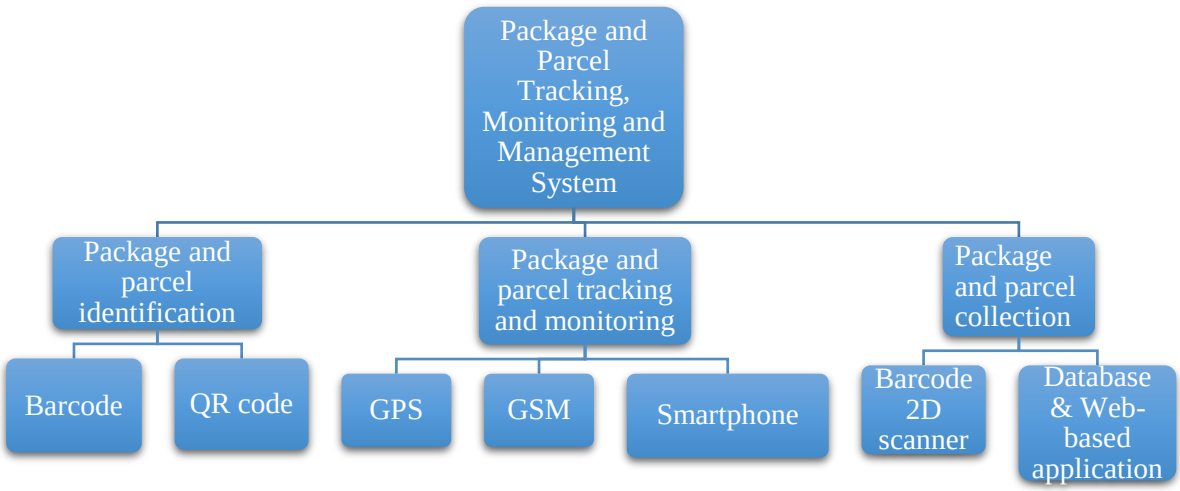


Figure 2: A graphical representation of the proposed project

3.7.1 Hardware Requirements

The major components necessary for the package and parcel tracking and monitoring system operation is as outlined in Table 2.

Table 2: Proposed system hardware components

S/N	Hardware Component	Specification
1	Microcontroller	NodeMCU
2	GPS	NEO-6M
3	Scanner	HP imaging barcode 2D scanner
4	Resistor	10K
5	GSM Module	SIM800L
6	Jumper wires	A few
7	Male to Male connectors	A few
8	Male to Female connectors	A few

(i) NodeMCU

This Esperessif IoT as shown in Fig. 3, is a tool includes a Wi-Fi module that is ideal for IoT applications (Padmaja *et al.*, 2019). It has the ability to transfer data to the cloud to be stored and analyzed (Mahammad, 2019). The NodeMCU receives the geolocation of the packages and parcels and then sends the information to the Blynk app. Also, through AT commands which drive the GSM it can send messages to the phone.

Figure 3: NodeMCU Development board (Pariha, 2020)

The ESP8266, like the other ESP microcontrollers, is powered by a USB port and has a 2.5V to 3.6V operational voltage range (Parihar, 2019). The board's operational voltage, however, is 3.3V and the pin specification is as shown in Fig. 4.

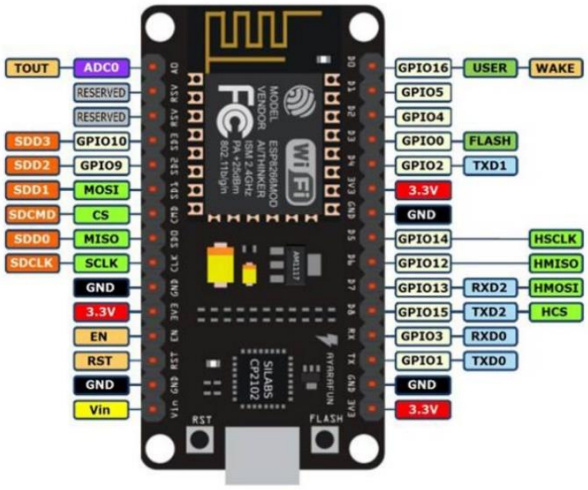


Figure 4: Pin specification of NodeMCU (Pariha, 2020)

(ii) GSM Module

This Global System for Mobile Communication includes a SIM card that sends and receives messages over a GSM network. Also, it is capable of making and receiving phone calls, as well as connect to the network through GPRS. SMS technology has grown in popularity as a result of its convinience, low cost, and ease of use. The commands which are used by the microcontroller to drive the GSM modem are known as AT commands (Mohammed *et al.*, 2017). The working voltage of the chip ranges from 3.4 Volts to 4.4 Volts.

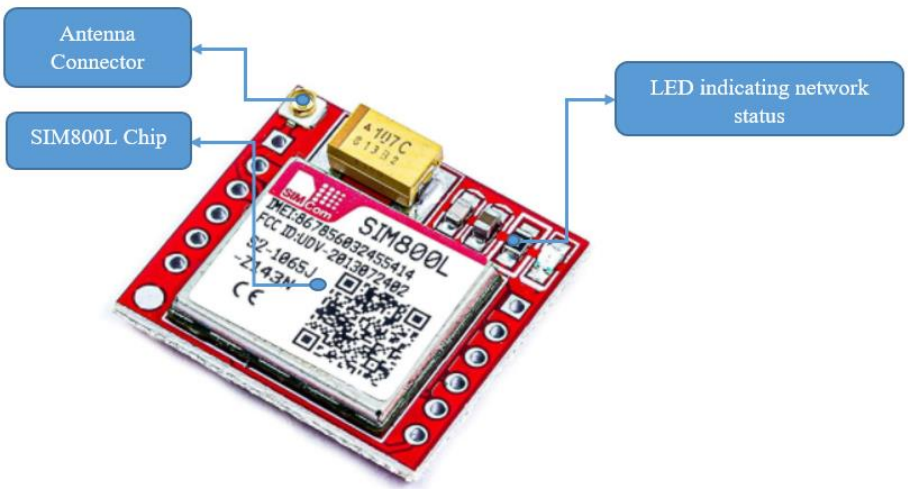


Figure 5: The SIM800L GSM Module (Kanani & Padole, 2020)

The network status is indicated by LEDs in the upper right corner of the GSM, with varied blink speeds representing different statuses as shown in Fig. 5. The LED blinks every 1 second to show that the module is on but has not yet connected to the cellular network. When the LED

blinks every 2 seconds, it shows that the GPRS connection requested is operational, and when it blinks every 3 seconds, it signifies that voice and SMS can be sent and received. The Table 3 shows how to connect the SIM800L module to the ESP 8266.

Table 3: Configuration of the GSM Module and ESP8266

GSM Module	ESP8266
Transmitter (TX)	RX
Receiver (RX)	TX
Ground (GND)	GND
Power (VCC)	5V

The anticipated AT commands for the proposed tracking and monitoring of packages and parcels project are described in Table 4.

Table 4: List of AT commands for the proposed project

AT Command	Response/Request
AT	To initialize the GSM
AT+CMGF	Setting GSM to text mode
AT+CMGS	Enter the receiver number

(iii) GPS Module

GPS makes use of the satellite-based navigation system in which signals can be traced from anywhere across the world. In the Arduino IDE a link is declared that links you to the Google Map of the whole world. Then listens for the GPS location for that particular time and sends you directly to that location. The NEO-6m GPS is a receiver module which is capable of establishing the geographical location and speed using data from the GPS satellites. It connects to the NodeMCU through the four pins and operates between 2.7 Volts and 3.6 Volts with a 3.3 Volts onboard operational voltage (Padmaja *et al.*, 2019).

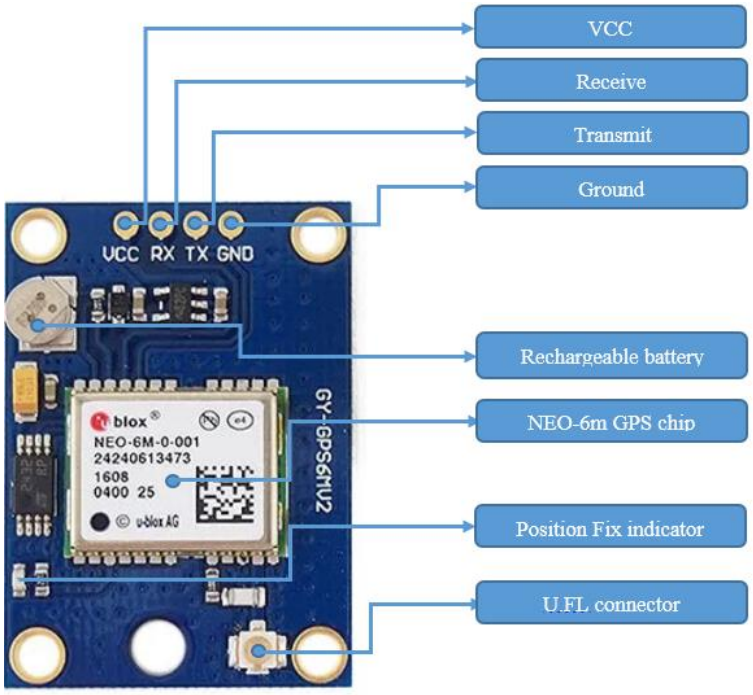


Figure 6: Global positioning system (GPS) Module (Kanani & Padole, 2020)

In the corner of the lower right of the GPS receiver, there is a light emitting diode (LED) which stands for the status of the receiver. When it blinks fast that indicates that the receiver is searching for satellites as shown in Fig. 6. When it's blink is solid, that indicates that the satellites are acquired. Table 5 shows how to connect the NEO-6m module to the ESP 8266.

Table 5: Interfacing the NEO-6m with ESP8266

NEO-6m GPS Module	NodeMCU Pin
Transmitter (TX)	D1
Receiver (RX)	D2
Ground (GND)	GND
Power (VCC)	5V

Key: D1: Digital pin number 1 and D2: Digital Pin number 2

(iv) Barcode Scanner

The scanner in hand is an HP imaging barcode 2D scanner, it reads both barcodes and QR codes as it is shown on Fig. 7. Due to its Omni-directional nature, it can scan both barcodes and QR codes and place these codes in the respective directed area to be pasted, this is made

possible through the drivers installed. When a barcode or QR code read is successful, the scanner gives out a tone accompanied by a green LED illumination and a visual shift from a red focused pattern into a green dot. This enables a fast and precise as well as an increased productivity ("QuickSpecs," 2017). When the items are scanned during running inventory, they are sent to the database.

Figure 7: HP Imaging Barcode Scanner (Kindberg & Barton, 2001)

(v) Power Supply

The system's circuit is powered off a 3.7V, 3700mA Lithium (Li) battery. The microcontroller, GPS & GSM is powered by a maximum voltage of 5Volts. However, these components operate at a voltage of 2.5 Volts to 3.6 Volts, 3.6 Volts and 3.4 Volts to 4.4 Volts respectively. Figure 8 shows the lithium batteries along with the battery holder.

Figure 8: Lithium Batteries and a battery holder (Fang *et al.*, 2020)

(vi) Resistor

A passive device that helps to reduce the flow of current and lower the levels of voltage to be within the means of the circuit. The value of resistance is measured in Ohms and the value of resistance as well as its tolerance is measured by the resistor color code system (Demir *et al.*, 2018) or using a multi-meter. Figure 9 shows the deciphering of the color coding of a resistor.

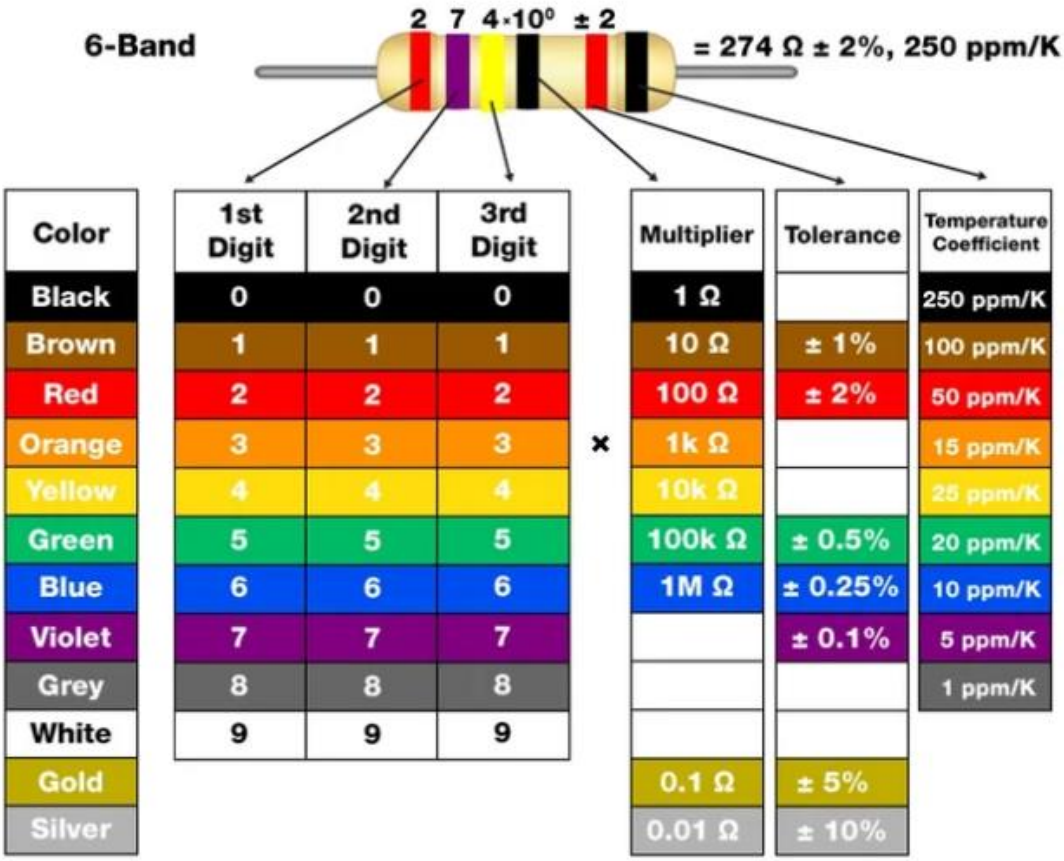


Figure 9: Deciphering the color coding of a resistor (Muminovic, 2019)

The hardware components used include NodeMCU, GSM module and GPS module. Table 6 is cited from (Ooko, 2019) shows the comparison between the development boards. In conclusion, the ESP8266 NodeMCU adopted for this project which is also compatible with the Arduino Development Environment (IDE).

Table 6: Comparison of the Development Boards

Item	Arduino	Raspberry Pi	ESP8266 Node MCU
Developer	Arduino	Raspberry Pi foundation	ESP8266 open-source community.
Type	Single board microcontroller	Single board microcontroller	Single board microcontroller
Operating system	None	Linux	XTOS
CPU	Atmel, ARM, Intel	ARM Cortex	ESP8266
Clock Speed	16MHz	1.2GHz	26 MHz - 52 MHz
Memory	32KB	1-4GB	Up to 128MB
Storage	1KB	Micro SDHC Slot	4MB
Power	USB, Battery, Power supply	USB, Power Supply	USB
Operating Voltage	5V	5V	3.3V, 5V
I/O Connectivity	SPI I2C UART GPIO	SPI DSI UART SDIOCSI GPIO	UART, GPIO

3.7.2 Software Requirements

The software requirements for this system includes programming languages and software used to make the software requirements a success. The program is written in C language and compiled using the Arduino Integrated Development Environment (IDE) which is an integrated applications software development system.

(i) Integrated Development Environment (IDE)

The Integrated Development Environment is an open-source software program where sketches are written for various Arduino boards as shown in Fig. 10. A text editor for writing code, a message box, a text console, a toolbar with buttons for basic functions are all included in the Integrated Development Environment. A connection is established within the hardware in order to upload the code and also enable communication. This software incorporates a tool kit for compiling the hexadecimal file (Veerasamy, 2015). The sketch programs developed in the

IDE's text editor are saved as .ino files (Veerasamy, 2015). After a sketch is written on the Arduino board as shown in Appendix 6, it is verified for errors and then uploaded to the board. The board used for this project is the NodeMCU (ESP8266) board.

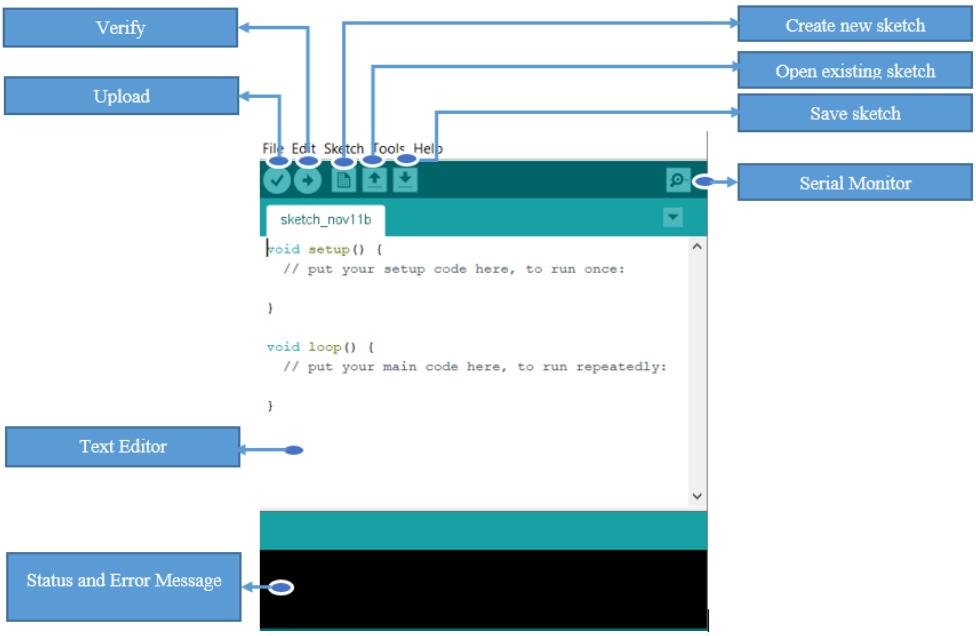


Figure 10: Labeled screenshot of the Arduino IDE (Fezari & Dahoud, 2018)

(ii) Proteus

Proteus is a system simulator that allows you to see the proposed system in virtual reality (Veerasamy, 2015) as shown in Fig. 11. A diagrammatic representation and a Printed Circuit Board (PCB) layout are included in this simulator. Libraries and embedded devices such as Peripherals Interface Controller (PIC) and Arduino boards are also supported. With few exceptions of devices example GSM module that have to be imported from external sources. The codes are written and compiled in the Arduino IDE and simulated in this simulator. The hexadecimal code is uploaded to the micrcontroller just as in real life. Furthermore, this tool was created with components or models that are as similar to reality as possible, resulting in more realistic results (Subramaniam & Derouich, 2020).

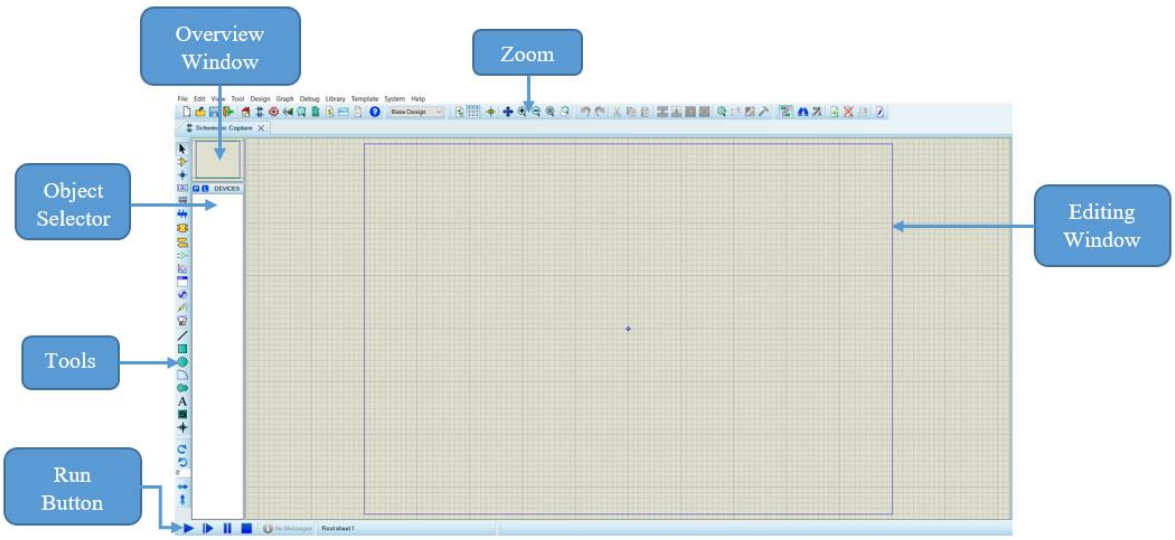


Figure 11: Screenshot of the Proteus simulation software (Mutie, 2020)

(iii) Blynk

Blynk is a mobile platform for Internet of Things projects that runs on either an iOS or Android phone (Fig. 12). It's used to operate Arduino, Raspberry Pi, NodeMCU and other microcontroller platforms. Through dragging and releasing widgets from this software, graphical user interfaces are able to be created for projects (Sharma & Kantha, 2020). The Blynk App, Blynk Server and Blynk Libraries are the three components of the Blynk app. Because Blynk operates through the internet, the hardware components you select must be able to connect to the internet. Each piece of hardware is given a unique token to communicate (Mahammad, 2019).

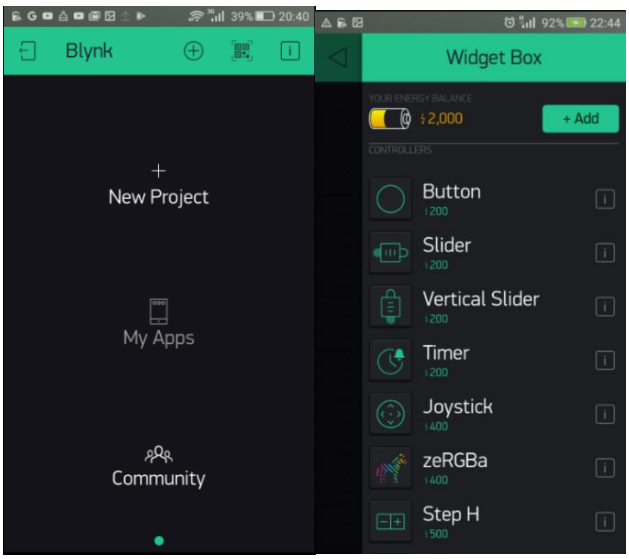


Figure 12: The Blynk application (Bohara & Maharjan, 2016)

(iv) Database

This database is a system which is responsible for the storage and data collection. The data stored includes user's login credentials, information regarding the user, tracking data and so forth. It is without a doubt that databases make the process of manipulating data a lot easier, and these data is represented in a tabular format. Data integrity is also enforced via databases, which ensure that data is collected and presented in a consistent manner (Salim & Idrees, 2013). It assists users and programmers in properly updating, retrieving, creating, and managing data. Databases are built and managed using a software program known as Database Management System (DBMS), and the database which I have used in my project is the MySQL.

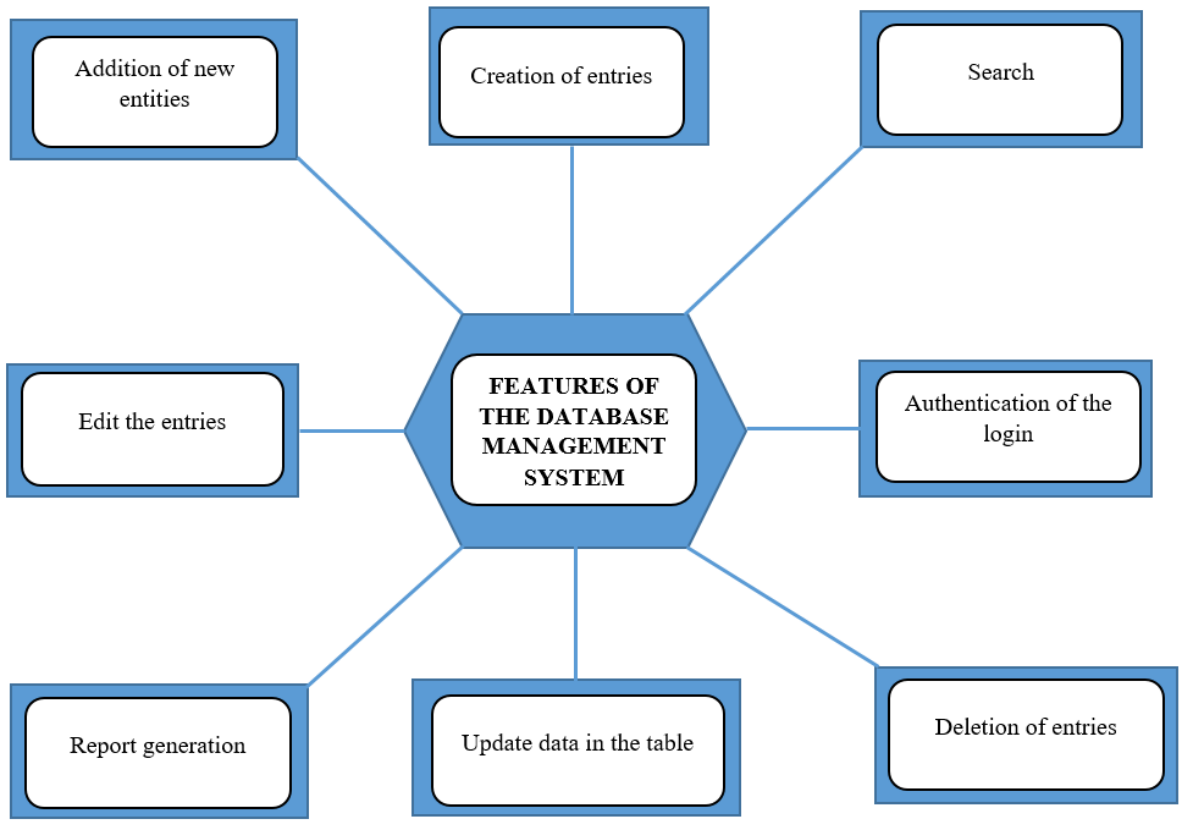


Figure 13: Database Block Diagram

Packages and parcels are registered into the system by the administrators. These administrators also have access to and can modify information about the package or parcel. An employee in the destination offices can log into the system using to update the status of the packages and parcels once they arrive. The database management system features are as shown in Fig. 13.

(v) Web-based Application

Various tools and software are involved to implement this system. This web-application uses JavaScript, Hypertext Preprocessor (PHP), Cascading Style Sheets (CSS), Hyper Text Markup Language (HTML) languages and a Laravel which is a PHP framework. The system's web-based application is shown in Fig. 14.

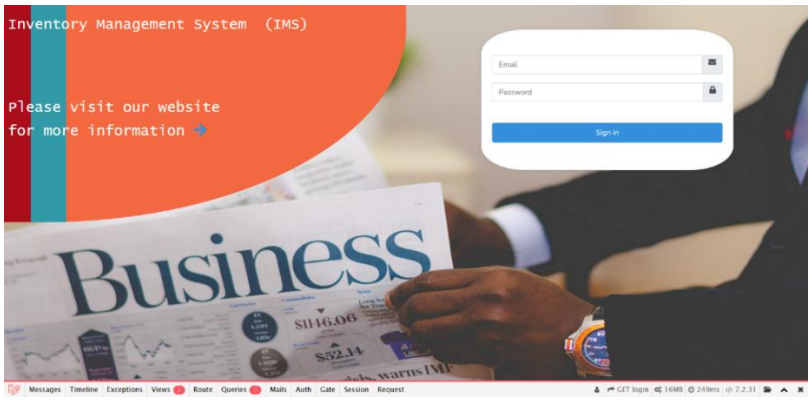


Figure 14: Web-based application

The Cross Platform Apache MySQL PHP and Perl is most popularly known as XAMPP. It is an easy to install platform for developers which is created using a PHP programming language. An advantage of using the PHP programming language is that it is an open source software that is used by many people and it is supported by many browsers as well (Matekuor-Kole, 2017). The Hypertext Markup Language (HMTL), Cascade Style Sheet (CSS), JavaScript and PHP code are all contained in the PHP file where actions such as reading, writing, deleting, open and create on the server can be done. The XAMPP control panel is used to check the status of the Apache and MySQL, also to start or stop them as shown in Fig. 15.

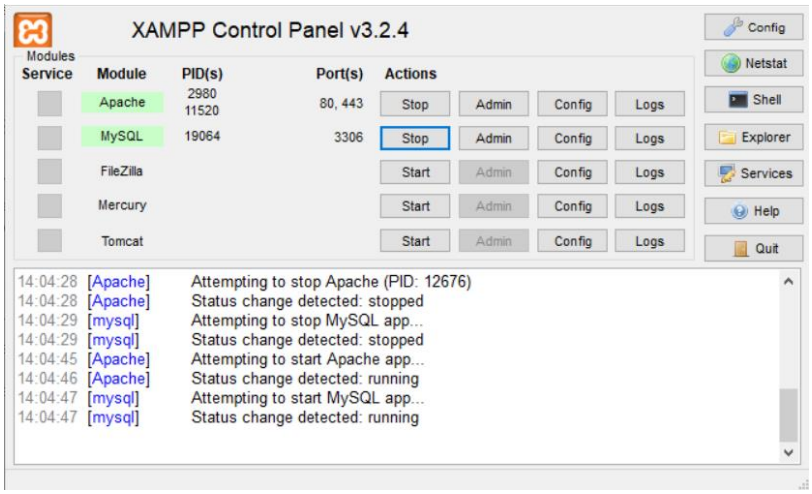


Figure 15: XAMPP Control Panel

3.8 Identified System Requirements

The requirement analysis of a system has a process which involves the identification of user requirements first and then developing a new or modified product according to those requirements. It is sub-categorized into functional requirements (FR) and non-functional requirements (NFR).

(i) Functional Requirements

A functional requirement is a set of requirements that describe how a system can operate while provides the customer with the best possible experience. This project's functional requirements are as illustrated in Table 7.

Table 7: Functional Requirements of the system

System Requirement	Requirement Description
Login.	The users are able to login to the system using their email addresses and password provided.
Ability to change password.	The users once registered are capable of changing their passwords into more customized ones of their fitting.
New user registration.	The administrator of the system will be responsible for all aspects of the web application including registrations.
Write, add, edit, and delete inventories.	The users are capable of writing, adding, editing and deleting inventories.
Downloading PDFs.	The users are capable of downloading PDFs of the inventories in the application.
Logout.	The users are capable of logging out of the application.

(ii) Non-Functional Requirements

Non-functional specifications describe the constraints and properties that a system must have to perform its intended function. The Table 8 shows the non-functional requirements of the system.

Table 8: Non-Function Requirement of the system

System Requirement	Requirement Description
Usability	The system is not compact and it is easy to learn
Performance	The system's response to a user interaction is fast. If the connection is slow, it will take a long time to respond.
Reliability	The web application is reliable to use,
Security	The login credentials of the user are safely guarded.

3.9 System Development

The Agile Scrum methodology is employed in the creating of Internet of Things Based Package and Parcel Tracking and Monitoring System for Public Buses in Tanzania because of its versatility and flexible nature.

Figure 16 depicts the complete project workflow. In accordance with how the flowchart is set up, the first step is to choose your area of interest, and the next step is to immerse yourself in the relevant research or study. Before developing and analyzing a system, you need to determine the hardware and software design. Testing follows after analysis. If the testing yields positive results, the cycle is complete; but, if not, you can go back and either update or adjust the system to identify the issue and resume conducting research.

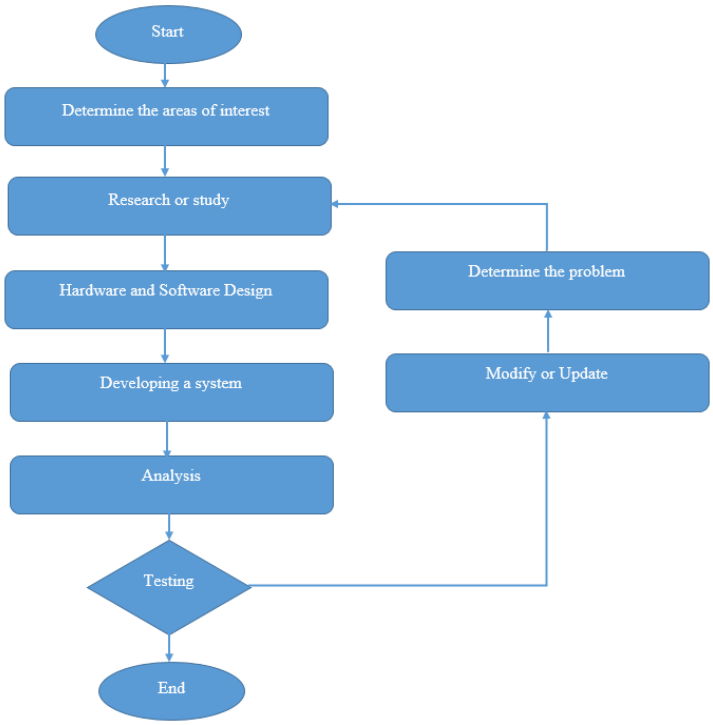


Figure 16: Flowchart of the overall project process

Figure 17 shows the proposed system's general design. Initialization is done for the GPS, GSM, and Wi-Fi. The Wi-Fi connectivity is examined. The system checks whether the GPS is available and if the Wi-Fi is active. If the GPS is available, it sends the package and parcel coordinates to the web-server/database and the web-based program handles the monitoring. If not, it reverts to initialization. On the other side, the system verifies the GSM module's availability if the Wi-Fi is not active. If not, the initialization stage is resumed. If it is, the GSM sends an SMS with the GPS coordinates and a URL link that may be viewed on Google Maps to the administrator's phone.

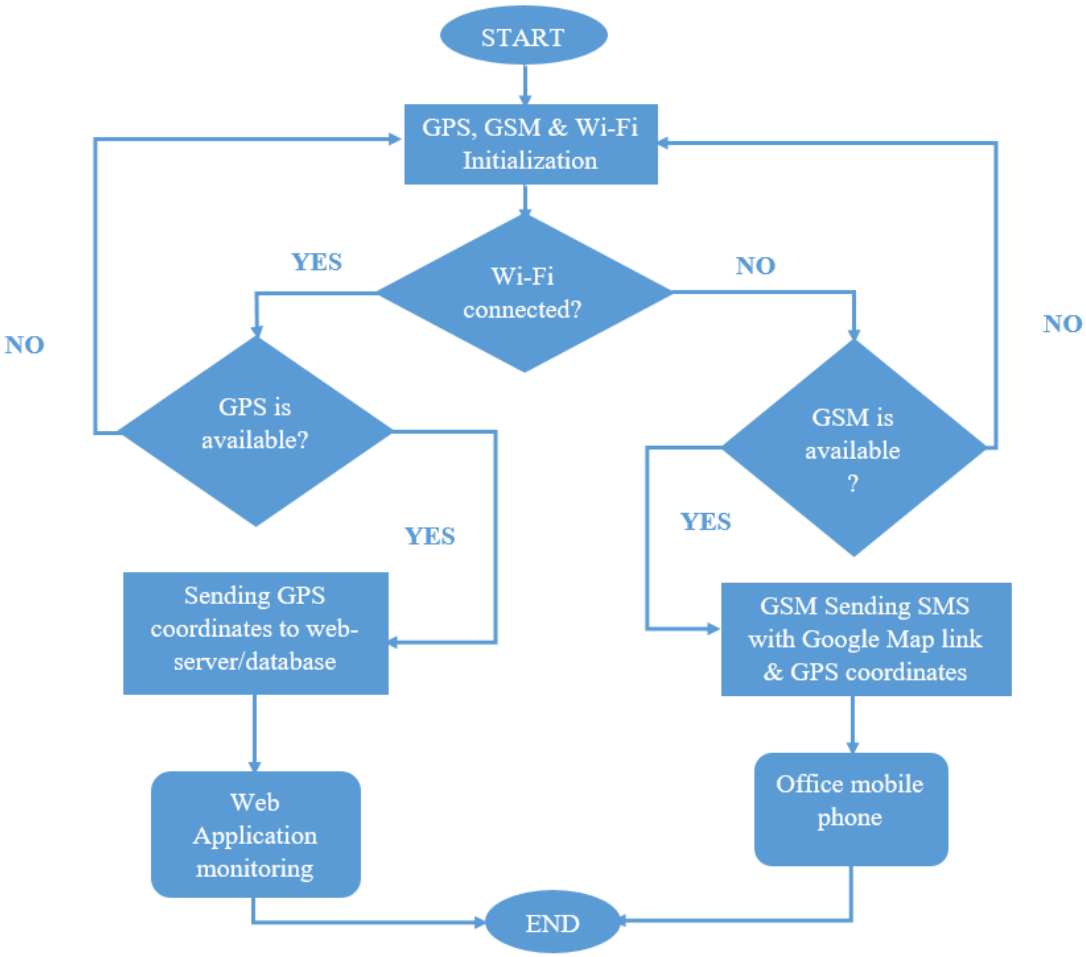


Figure 17: Flowchart of the overall proposed System

The basic diagram of the package and parcel tracking and monitoring system is shown in Fig. 18. The NodeMCU, GPS, and GSM are the three primary devices that are used and they are all interconnected. A web-based application gets coordinates in the form of latitude and longitude to indicate the whereabouts of the packages and parcels. Also, can be viewed on the API installed in the web-based application, and as and also on the smartphone as an alternative monitoring tool.

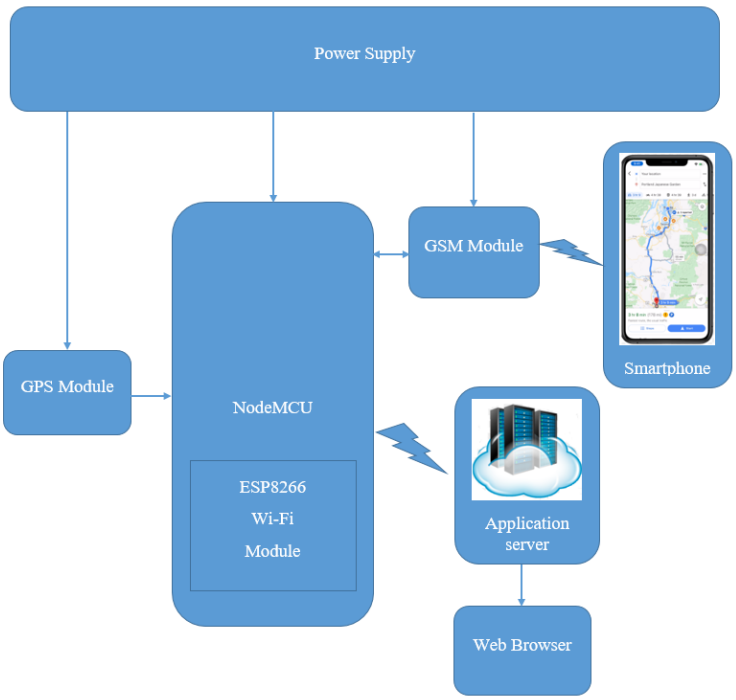


Figure 18: Block diagram of the tracking and monotoring unit of the packages and parcels

Figure 19 depicts the mechanical sketch of the hardware system. This mechanical sketch provides a visual representation of the components. Figure 19 shows the dimensions for each hardware component.

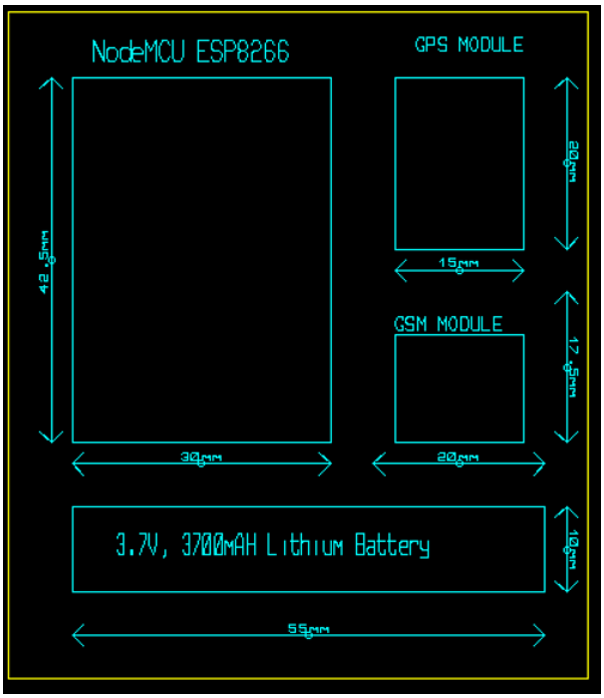


Figure 19: Mechanical Sketch of the package and parcel hardware system

Figure 20 shows the circuit diagram of the proposed system. The components of an electrical circuit are represented in this diagram, along with how they are connected to one another.

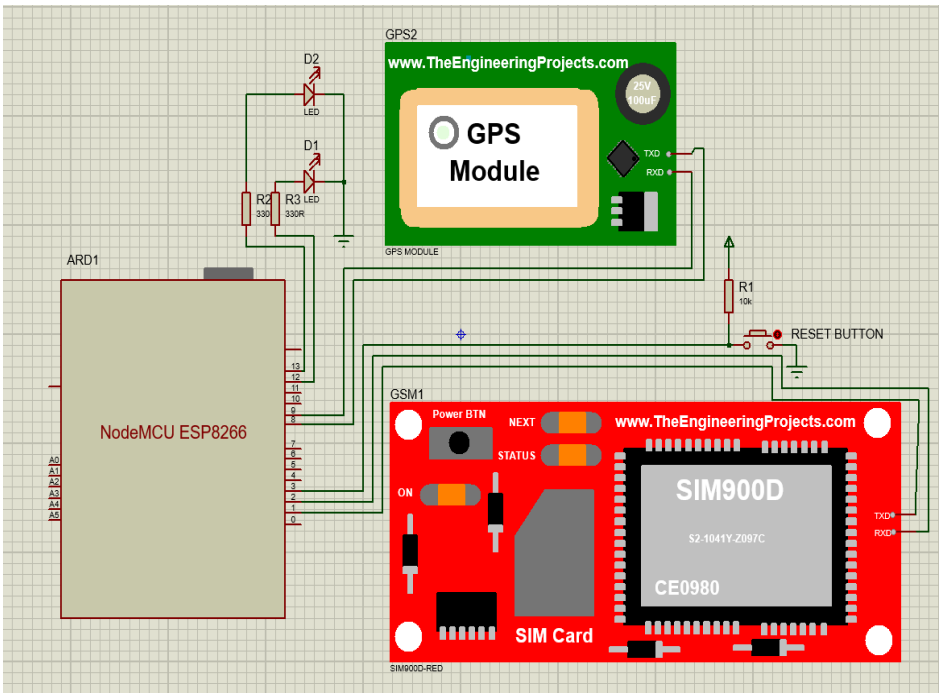


Figure 20: Circuit Schematic of the proposed system

The printed circuit board (PCB) design and layout are shown in Fig. 21. The electrical components of a circuit are connected to and mechanically supported by this PCB. The PCB enables for the routing of power and signals between actual physical devices and displays traces of the paths.

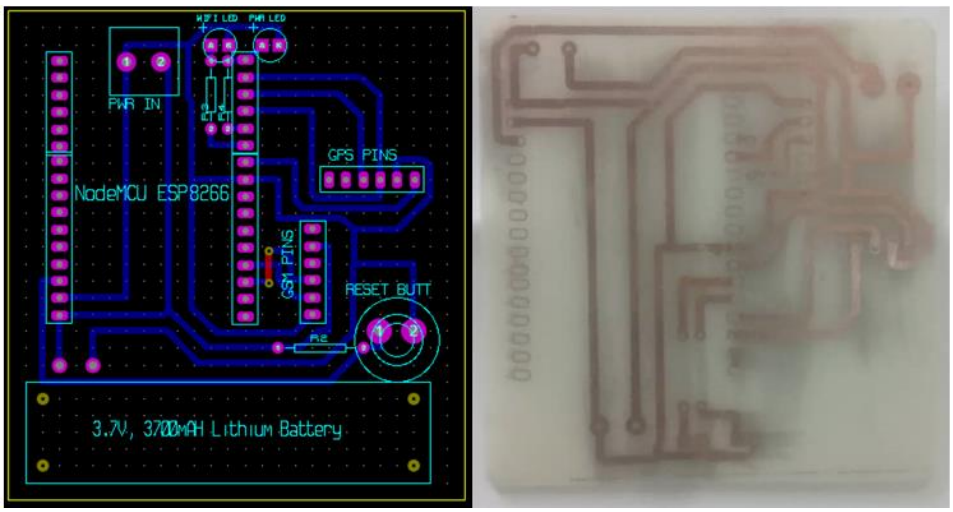


Figure 21: Printed circuit board (PCB) design and layout

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results

4.1.1 Results on the Use of Technology Solutions to Improve Tracking of Packages and Parcels

The various methods involved in data collection methods in chapter three (3) has led to the development of systems that can monitor and track packages and parcels. A random survey of **103** people was taken with regards to their experiences and afflictions using the public buses to transport packages and parcels. The survey question asked "*Do you suppose a technological solution is required to improve package and parcel tracking until the arrival at the collecting offices*?" had a significant response of 77.7% of the respondents which agreed with this statement as shown in (Table 9).

Table 9: Results from the survey asked relating to the use of technology solutions to improve tracking of packages and parcels

Degree	People's Frequency	Percentage (%)
SA	80	77.7
A	19	18.4
N	3	2.9
D	1	1
SD	0	0
Total	**103**	**100**

Also, a significant 55.3% strongly agree followed by 29.1 percent agree with the statement "*Do you think public bus companies as well as users will benefit from a system that uses technology to track these packages and parcels?*" and these resulted are shown on Table 10.

Table 10: Results obtained from the survey question asking if both bus companies and users will benefit from the system

Degree	People's Frequency	Percentage (%)
SA	57	55.3
A	30	29.1
N	16	15.5
D	0	0
SD	0	0
Total	103	100

Key:

SA: stands for "Strongly Agree".

A: stands for "Agree/Concur".

N: stands for "Neutral".

D: stands for "Disagree".

SD: stands for "Strongly Disagree".

4.1.2 Results from the Respondents on the Survey Conducted

During this big data era, surveyors and researchers are working with innovatively to collect data. Data was collected by employing quantitative approaches such as questionnaires and interviews for example. The main purpose of this survey was to discover the respondent's demographic information, the response to the methods used for receiving package and parcel updates and reports, awareness of existing package and parcel tracking and monitoring systems and a willingness to have technology systems track and monitor packages and parcels.

4.1.3 Respondent's Demographic Information

Area of residence and gender were the demographic information of the respondents which were taken into account. Figure 22 shows that there were 56.3% males and 43.7% females among the hundred and three (103) respondents who responded to the survey which was conducted. As shown in Table 7, majority of the respondents that responded to the survey were male leaving females behind by 12.6%. 92% of respondents live in cities (urban areas), 7% in rural areas, and 1% in semi-urban areas. The survey included a diverse group of public bus users. The Table 11 shows the respondent's demographic characteristics.

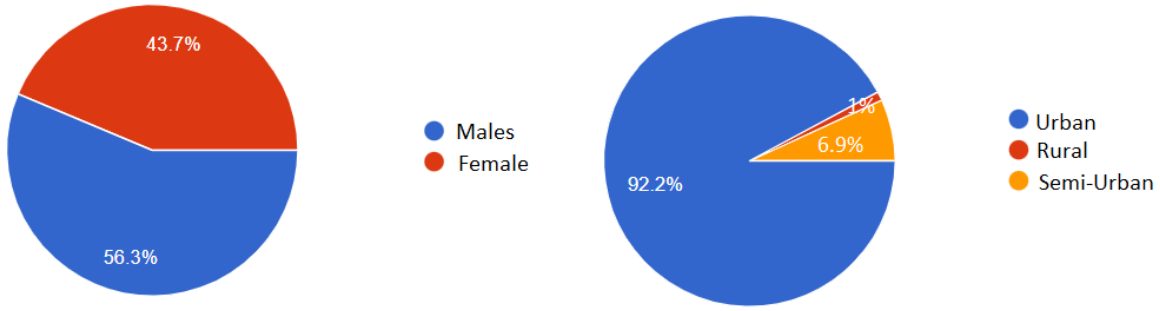


Figure 22: Respondent's demographic information

Table 11: Respondent's demographic characteristics

Demographic Characteristics	Respondents	Percentage (%)
Gender		
Male	57	56.3
Female	45	43.7
Area of residence		
Urban areas	93	92
Rural areas	1	1
Semi-urban areas	7	7

4.1.4 Methods used for receiving package and parcel updates and reports

The goal of the survey was to verify the present methods for getting package and parcel updates and reports. From the survey conducted half (50%) and 42.2% of the respondents agreed and strongly agreed respectively that the methods used to determine the arrival of a package or parcel is through either calling the conductor, the sender of the package or calling the bus's office. 4.9% were neutral, 2% disagreed and 1% strongly disagreed as illustrated on Fig. 23.

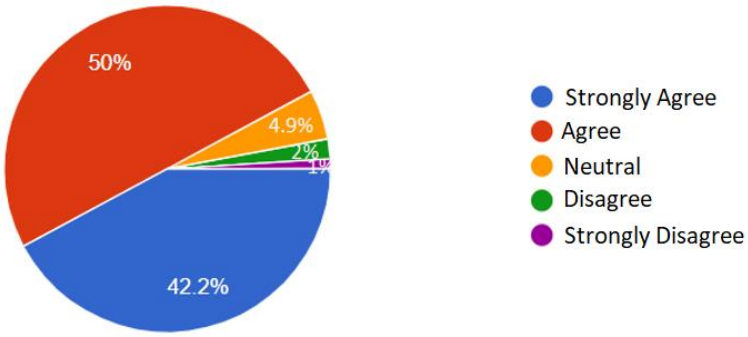


Figure 23: Response to the methods of getting package and parcel updates

4.1.5 Awareness of existing package and parcel tracking and monitoring systems

It is worth noting from the pie chart in Fig. 24, that a majority which is 46.1% of the total respondents are neutral/not sure on whether Tanzania has tracking systems for package and parcels. On the other hand, 17.6% of respondents who strongly disagreed with this statement.

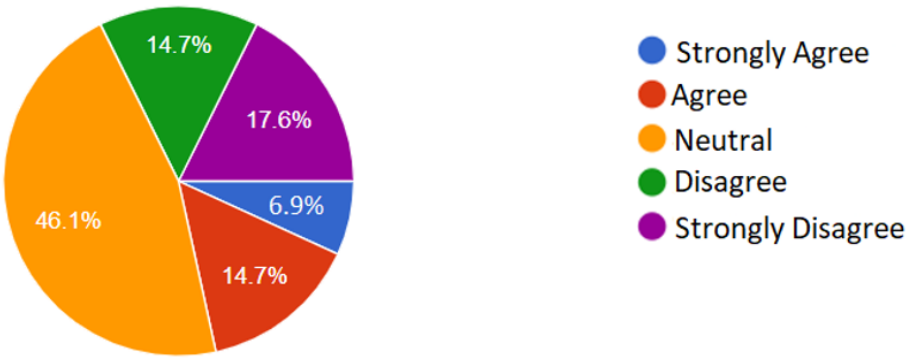


Figure 24: Response to the awareness regarding package and parcel tracking systems in Tanzania

4.1.6 Willingness to have a digital technology system for tracking and monitoring packages and parcels

According to the results of the survey, 77.5% of the respondents strongly agree and believe that digital technology systems should be used to track and monitor packages and parcels followed by an 18.6 % of the respondents also agree with the notion that digital technology should be used to track and monitor packages and parcels. However, 2.9 % were indifferent/neutral about the idea, and 1% of the respondents disagreed and this is seen in Fig. 25. The need for this system was supported by a large percentage of respondents who expressed a readiness to have technology systems to track and monitor packages and parcels in public buses.

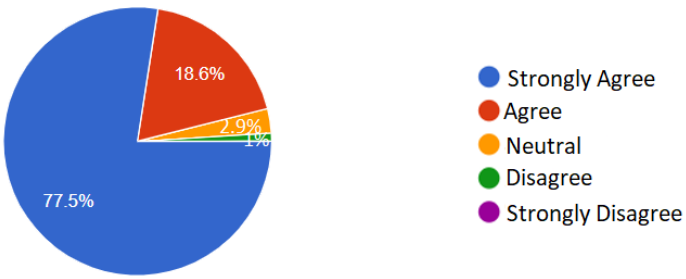


Figure 25: Response to the willingness to use technology system to track packages and parcels

4.1.7 Interview Results

Regarding technological solution systems for tracking packages and parcels, structured interviews were conducted for public bus company's employees and public bus users. The popular opinions gravitated along having a system which tracks packages and parcels, the use of barcode technology and having both the recipient and sender identified, this will help to avoid the risk of transporting harmful items such as bombs. All these suggestions were taken into consideration for the system developed.

The majority of the respondents were not aware whether there are existing systems for tracking items such as packages and parcels, this is according to an interview with randomly selected users of public buses. They also suggested that effective systems be developed by said: "*We need tracking technology systems from the moment we load the items into the buses until they arrive at the destination*", says the narrator. "*We need an efficient parcel tracking system*", said another respondent.

(i) Interview with one of the public bus user's respondent

Question: Have you ever used or transported packages or parcels using public buses?

Answer: "*Yes I have used public buses to transport packages before. It was to a relative of mine*".

Question: Do you think that public buses are a cost-effective method of transporting packages or parcels from one area or region to another?

Answer: "*Yes! I believe they are. Other means such as by air even though it is faster but it costs more for an ordinary Tanzanian*".

Question: Have you ever gone through struggles when it came to transporting your package or parcel?

Answer: "*Yes! I have a couple of times and it was very stressful*".

Question: Which is the most common method you use to know if your package or parcel has arrived?

Answer: "*For me it is calling the bus conductors or bus operators*"

Question: What do you thing should be done to improve the current systems for tracking items such as packages and parcels?

Answer: "*I think there should be an easy and efficient method of tracking packages and parcels for both senders and operators so as to reduce the inconveniences of having to call bus conductors and buses*".

(ii) Interview with one of the employees of the bus company respondent

Question: Do you think a technology system will help with efficiency?

Answer: "*It would definitely help, because sometimes packages are many to manage efficiently"*.

Question: Do you think both public buses and users who use public buses to transport packages or parcels can benefit from such a system?

Answer: "*Yes, it will help reduce the discomfort and inefficiencies"*.

Question: Which additional features for the monitoring system do you believe the tracking system should have?

Answer: "*In my opinion there should be an option to be able to know where your package or parcel is even when you do not have a smartphone"*.

4.1.8 System Architecture

The design for the platform architecture is shown in Fig. 26. According to the project's findings, Tanzania's transportation and logistics sector has issues with packages and parcels getting lost, misplaced, or handled improperly. Additionally, there are manual techniques used by people to check the status of packages and parcels. A system is created to track and monitor packages and parcels as well as manage inventory in order to address these problems.

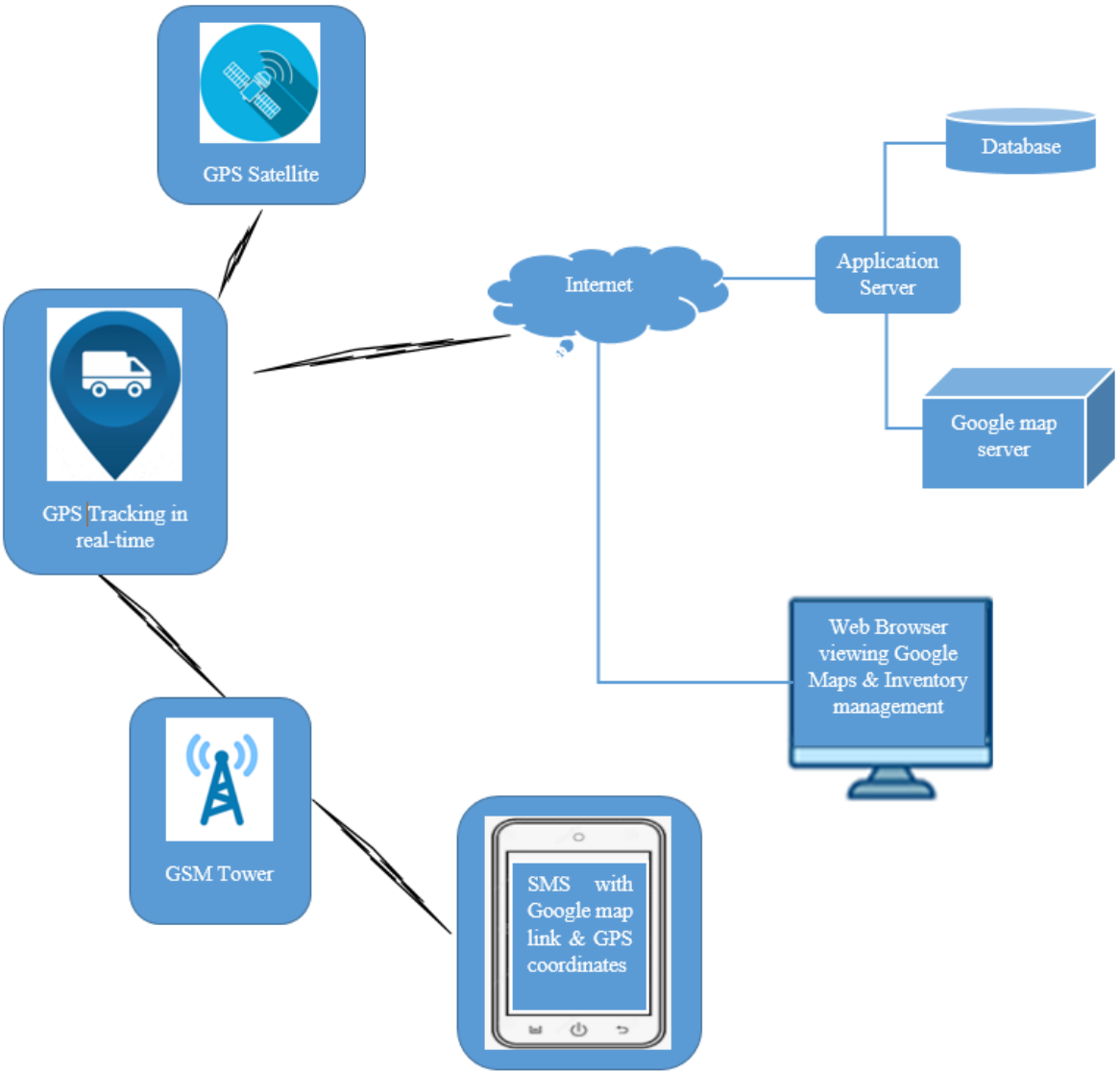


Figure 26: Overall system architecture

This proposed system consists of a GPS module which receives real-time data of the packages and parcels from satellites. This data is then analyzed by the geolocation API, which gives it a location name. This is then displayed/plotted on the map in the web-based application. The GSM module handles the mobile communications. When the public bus in commute enters an area where there is no internet access, the tracking system sends a message to the administrator's mobile phone. This message includes a URL as well as latitude and longitude coordinates. When packages reach the destination point and it is time for their collection, the attendant of the bus management in charge will scan out the package or parcel using a barcode scanner.

4.2 Discussions

There are a number of software that engineering students use for designing and simulating electronics and electrical circuits. For this project, the Proteus simulator is used to develop and test the design by assisting in the locating of the packages or parcels. This simulation has three major components; Arduino UNO, GSM module and GPS module. However, modules such as GSM and GPS are not found in the Proteus and therefore, they have to be downloaded. The downloadable GSM library only supports a few commands and only has single module, SIM900D, which can be used with various controllers such as Arduino or PIC microcontrollers. Once installed you can double click then navigate to the GSMLibraryTEP.hex file area in the program file and upload your program as illustrated in Fig. 27. Similarly, for GPS module and the controller.

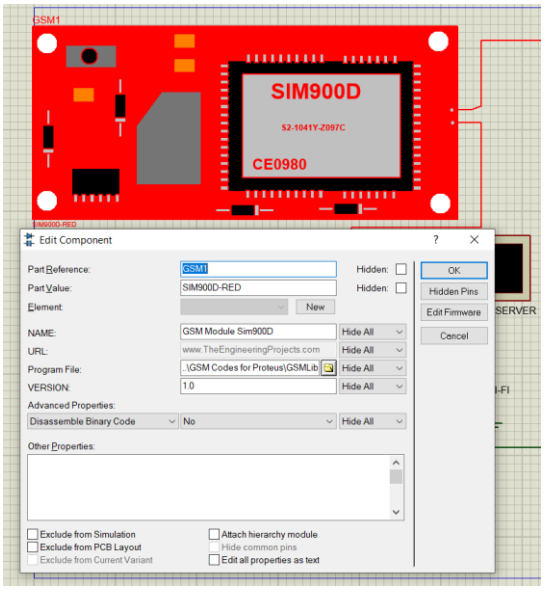


Figure 27: Navigation of the GSM file location

The virtual terminals represent the server and mobile phone respectively. The GPS collects the location of the packages and parcels and transmits these coordinates to the microcontroller which receives them from its receiver pin. The microcontroller checks for the internet availability, if the internet is present, it sends the coordinates to the app server otherwise to the mobile phone through the GSM module's transmitter pin as shown in Fig. 28.

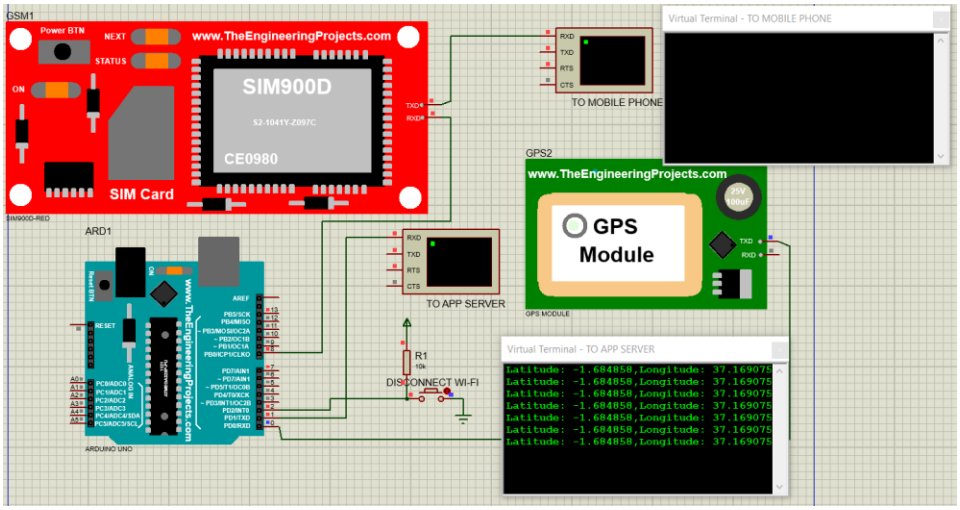


Figure 28: The circuit when the Wi-Fi is available

When the Wi-Fi of the simulation circuit is disconnected, the virtual terminal shows the AT commands which contains the mobile number that the SMS containing the link to the package and parcel's location as illustrated in the Fig. 29.

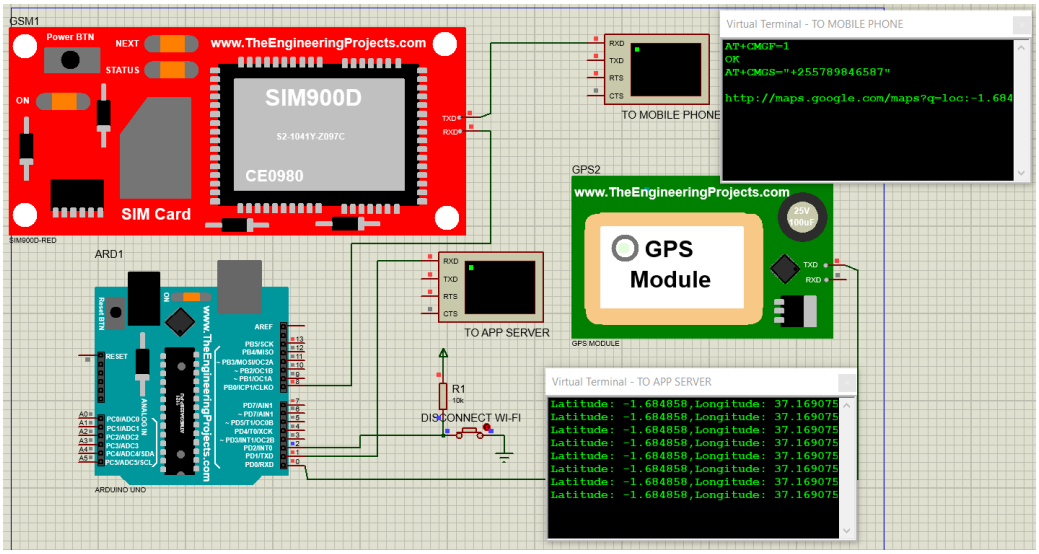


Figure 29: The circuit when Wi-Fi is disconnected or not available

4.2.1 Discussions and Outcomes for the Web-Based Application System

The login page, dashboard panel, menu board are all part of the proposed web-based application. This web-based application is intended to allow data to be transferred from a database. Users of various access levels are provided with login credentials in order to facilitate the login for the first time. However, it is recommended that the users change their passwords for both security reasons and preferences. The user profile is displayed in the navigation of the

web-based application to provide a sense of easiness of using the application while scrolling through it. The following are the primary components of the web-based application.

(i) Login Page

The user is prompted to enter their login credentials, which includes their email address and password, in order to advance to the main interface. The password is hashed using a cryptographic algorithm in the database, this is to ensure security by preventing intrusion. The frontend of the produced web application is built using the Laravel, Bootstrap, and jQuery frameworks, while the backend is built using the Laravel framework. The Fig. 30, represents the login page for the web-based application which all of the users are provides with.

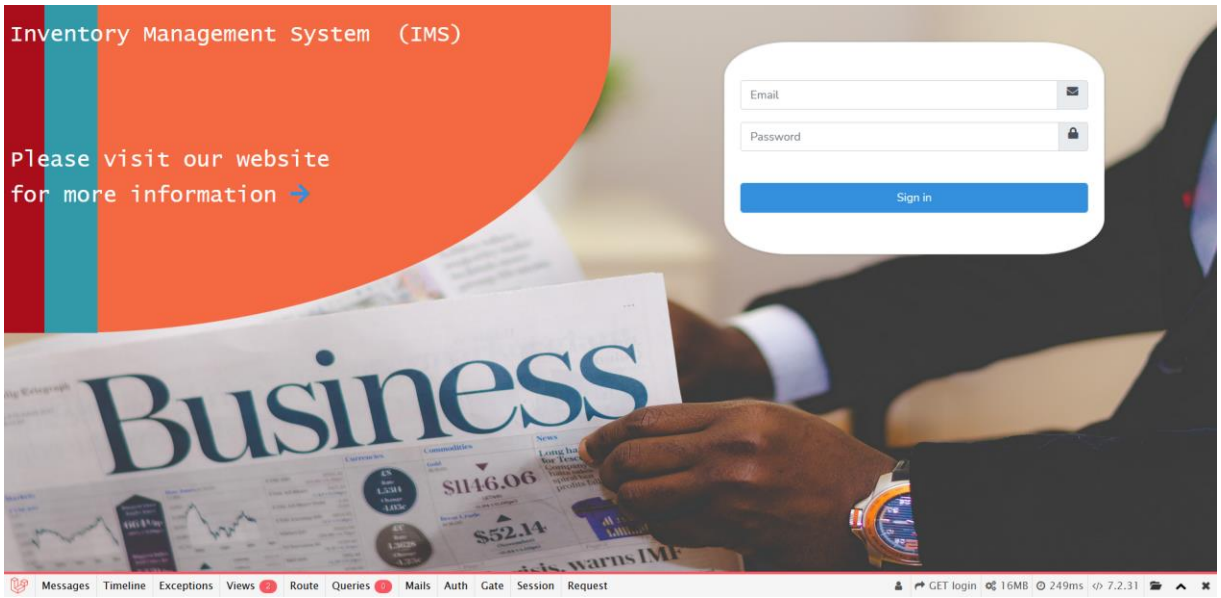


Figure 30: Web-based application login page

(ii) System Dashboard Panel

The users of the inventory management system (IMS) communicate with the web-based application via a convenient log in on the webpage. This dashboard is responsible for providing a clear view of the total number of staff, customers, warehouses, vehicles, parcels, and so forth to mention a few as shown in Fig. 31.

Figure 31: System Dashboard

(iii) Menu/Navigation Panel

This board comprises of the user profile where the picture is displayed, items settings where the categories for the packages and parcels details are inserted, followed by other navigational tools which are useful to the users as shown in Fig. 32. There is also a logout option which facilitates the exiting from the web application.

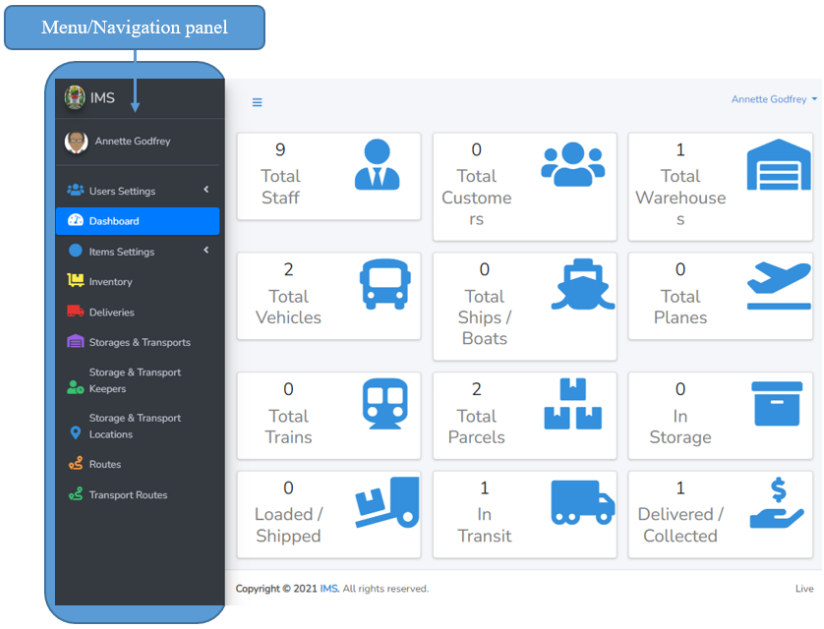


Figure 32: The menu board highlighted

(iv) Items Settings Module

This component allows the system administrator to create categories based on the various packages or parcels that need to be transported. It is divided into many categories, and the administrator has the ability to see, add, or delete any of the items entered as shown in Fig. 33.

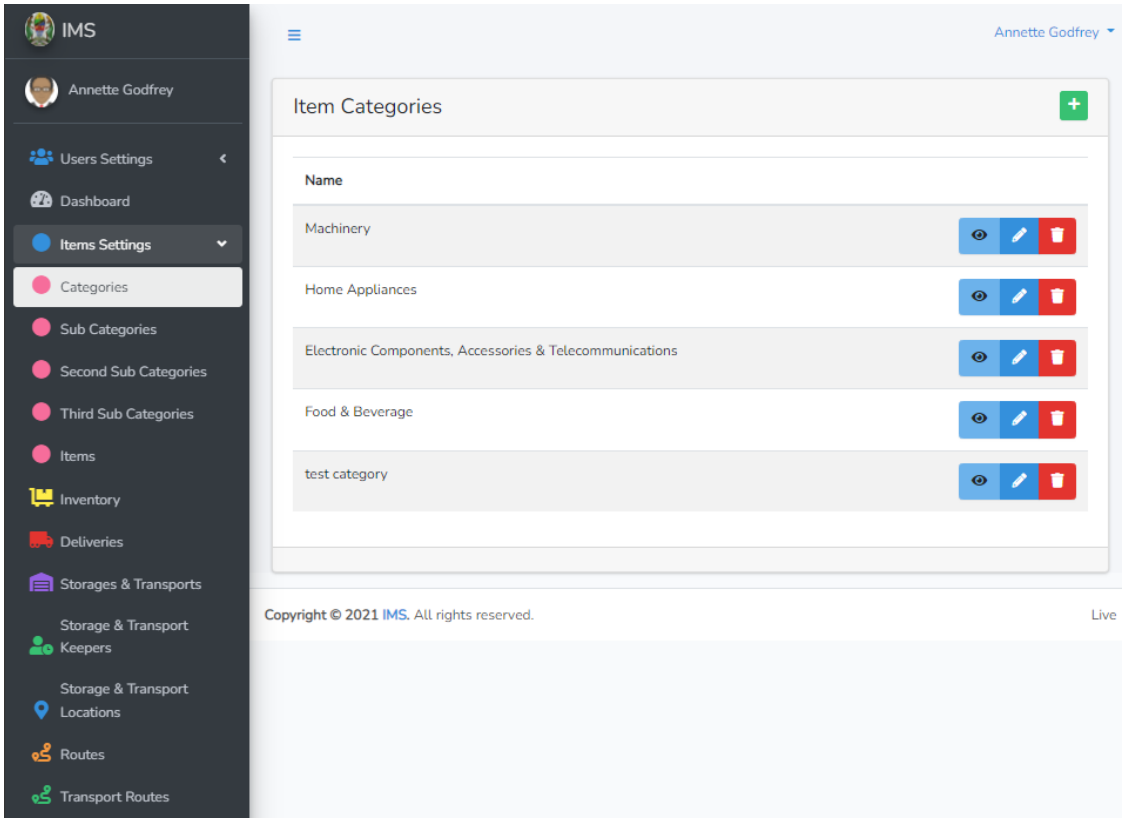


Figure 33: Items Settings list

(v) Inventory Module

The inventory component is where the inventory information such as item category, size, quantity and value in terms of cost of the item, also the delivery information. In this component, the administrator can view a list of all the items or individual items present in the system. Figure 34 shows the inventory page.

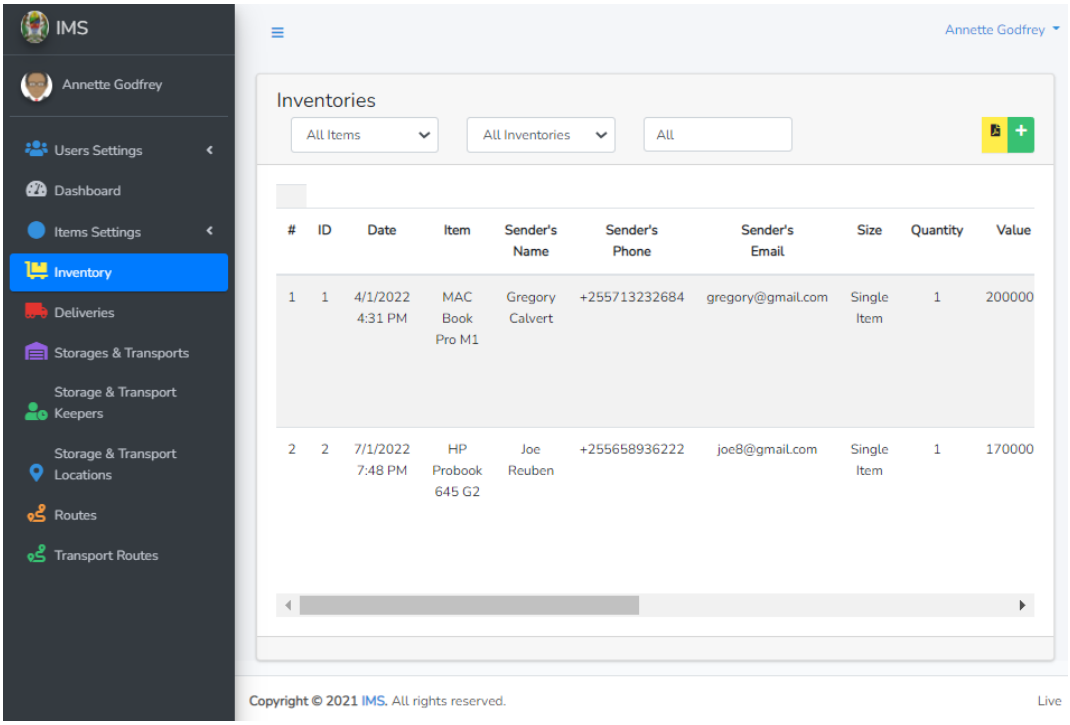


Figure 34: Inventory module appearance

(vi) Deliveries Module

The deliveries page in a nutshell it shows all the packages or parcels which have been delivered or which are in transit. In a nutshell, it provides an update status of the packages or parcels being transported as shown in Fig 35.

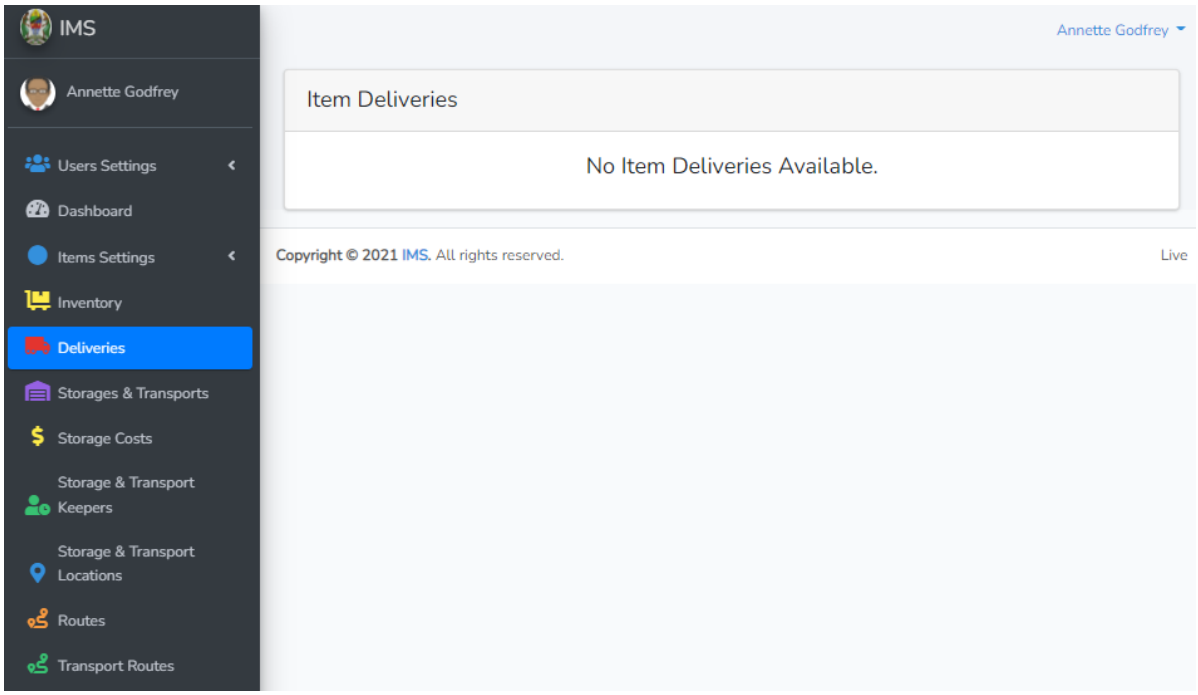


Figure 35: Delivery status module

(vii) Storage & Transport Module

The administrator(s) can view the kind of storage or transport available, whether it's an automobile or a warehouse. Storage type, the name of the storage or transport and the serial number along with its dimensions. It also calculates and informs the administrator of the available space, which is useful information for when allocating packages or parcels to be transported. The administrator(s) is also able to add, edit, delete any storage or transport unit. Figure 36 shows the storage and transport page. Also, calculation to determine the space of the storage & transport are done here as shown in Appendix 1.

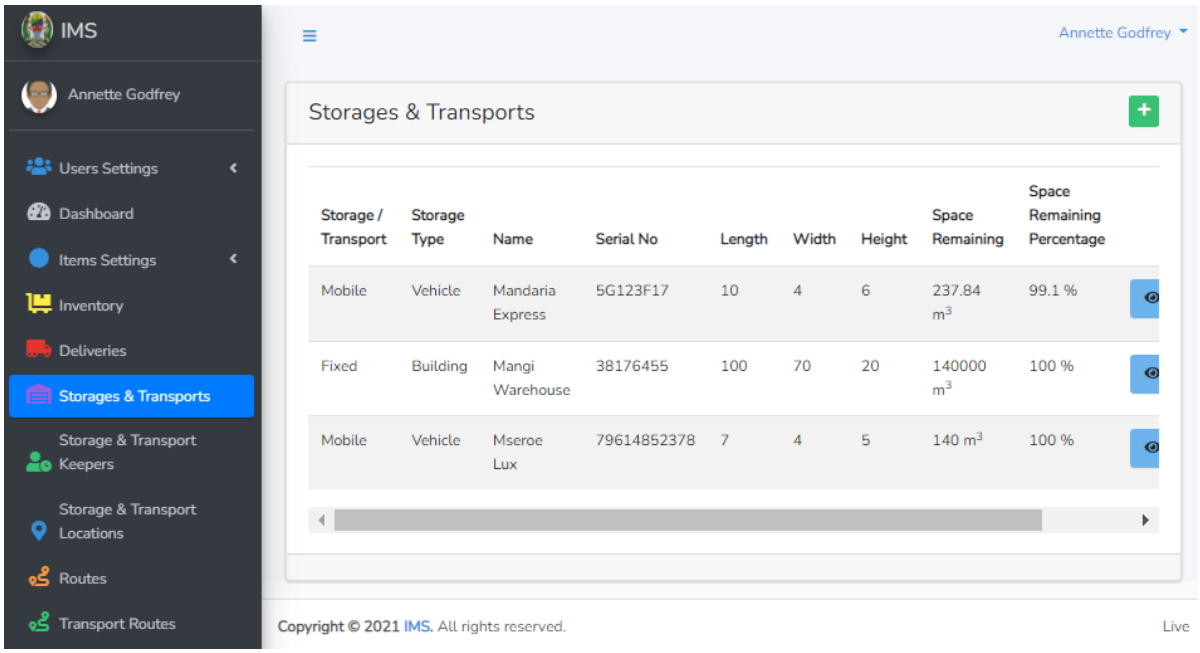


Figure 36: Storage & transport module appearance

(viii) Storage & Transport Keepers Module

This shows a list of all the storage keepers and the storages that they are registered under along with their statuses. The administrator is again able to view their details for instance when they were created into the system also when they were updated, add, edit the keepers and delete. In this module, it is up to the storage & transport keepers who scan the items in when received and collected as shown in Fig. 37.

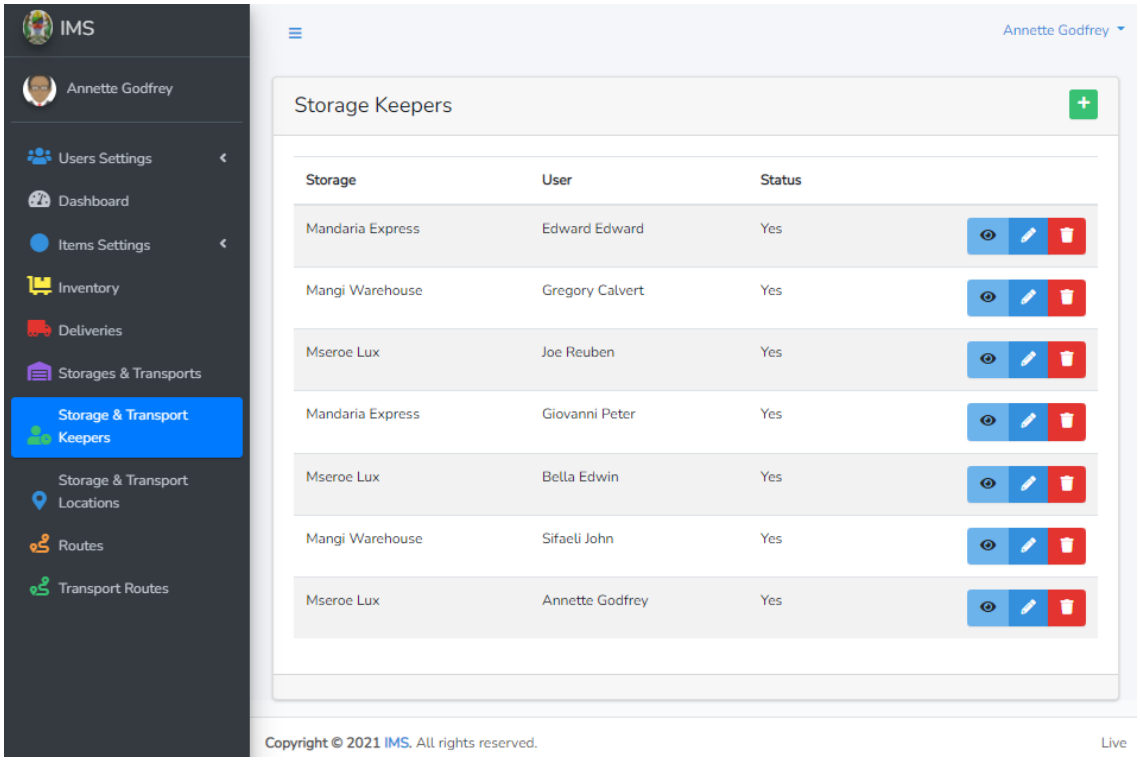


Figure 37: The storage and transport keeper's module

(ix) Storage & Transport Locations Module

This component shows where all of the transport locations are. The details contain information such as name of the area, its coordinates, time stamp and date as shown in Fig. 38.

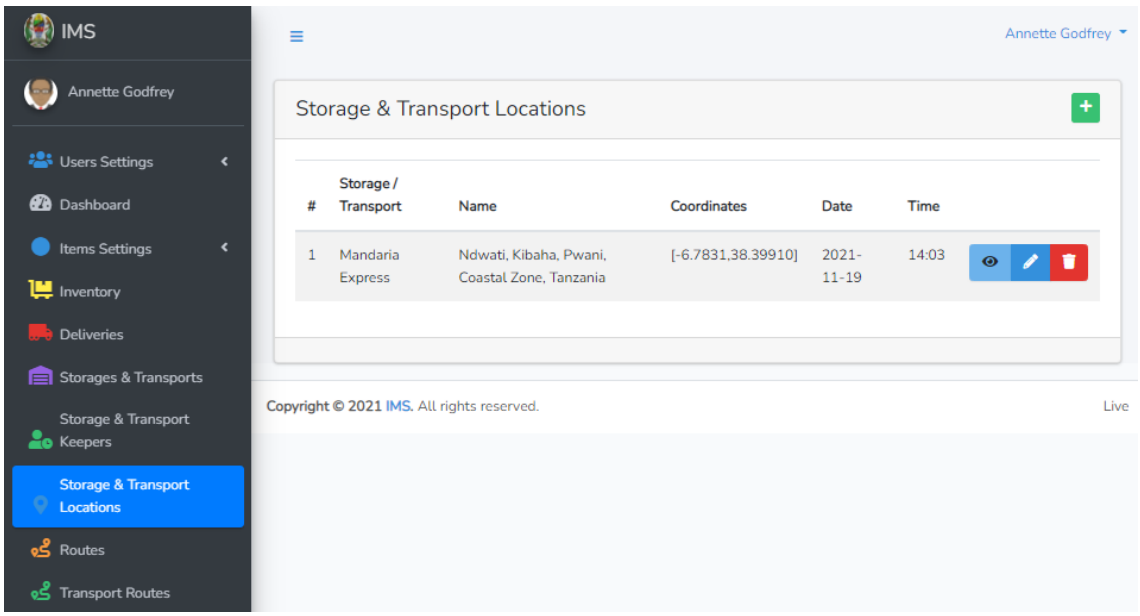


Figure 38: The storage and transport locations module

(x) Routes Module

All of the routes and their origins to destination points with their coordinates are illustrated as shown in the Fig. 39. New routes can be added to the list if needed.

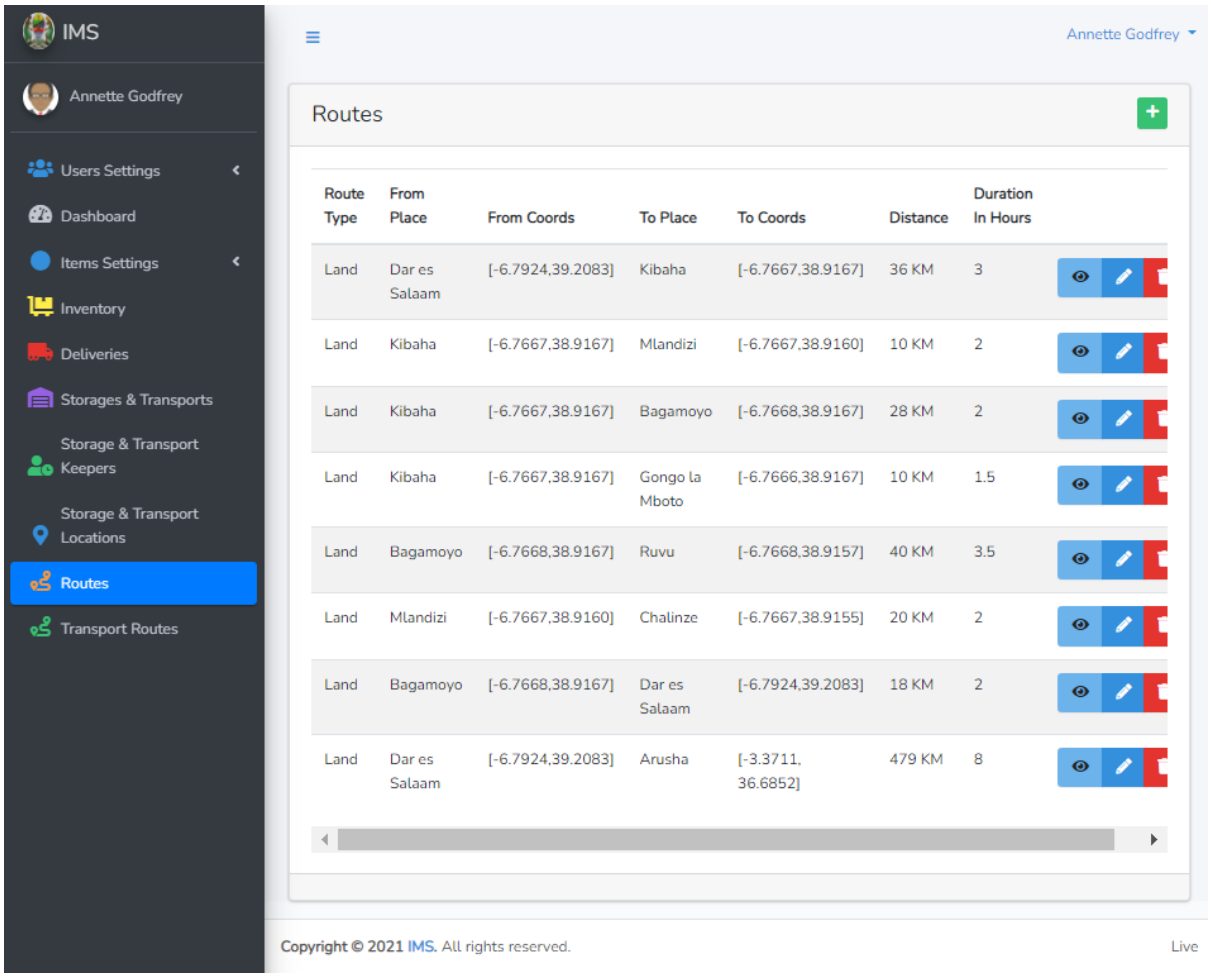


Figure 39: The routes module

(xi) Transport Routes Module

This unit as illustrated in the Fig. 40 shows all of the transports along with the route and whether they are in transit or they have completed their route.

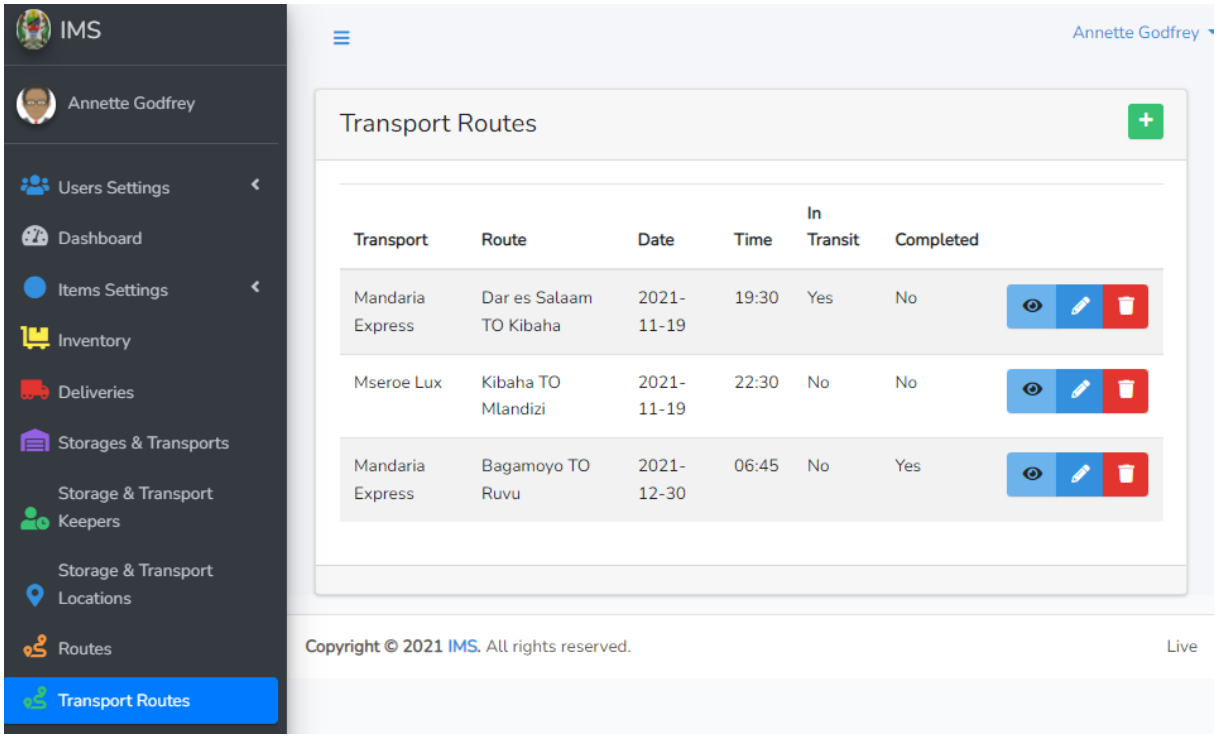


Figure 40: The transport routes

(xii) System Report

The web-based application allows the administrators to view the inventories statuses which can also be printed in a portable document format (PDF) as shown in Fig. 41.

INVENTORY MANAGEMENT SYSTEM (IMS)
INVENTORY LIST

#	ID	Date	Item	Sender's Name	Sender's Phone	Sender's Email	Size	Quantity	Cost	Receiver's Name	Receiver's Phone	Tracking Number	Destination Point	Status
1	1	4/1/2022 4:31 PM	MAC Book Pro M1	Gregory Calvert	+255713232684	gregory@gmail.com	Single Item	1	2000000	MINGA EDWARD	+255711273709	DT20220104160113PKG9974ec	KIBAHA	Delivered (8/1/2022 12:09 AM)
2	2	7/1/2022 7:48 PM	HP Probook 645 G2	Joe Reuben	+255658936222	joe8@gmail.com	Single Item	1	1700000	Joseph Joseph	0712456987	DT20220107190128PKG645fab	Tengeru	In Transit (Mandaria Express - Ndwati, Kibaha, Pwani, Coastal Zone, Tanzania)

Figure 41: Inventory status report

(xiii) MySQL Database

The MySQL database was used for the web-based applications to implement this system. the database has 57 tables as shows briefly in Fig. 42. The roles table is used to define the roles of the users, whereby every role is different and comes with different privileges.

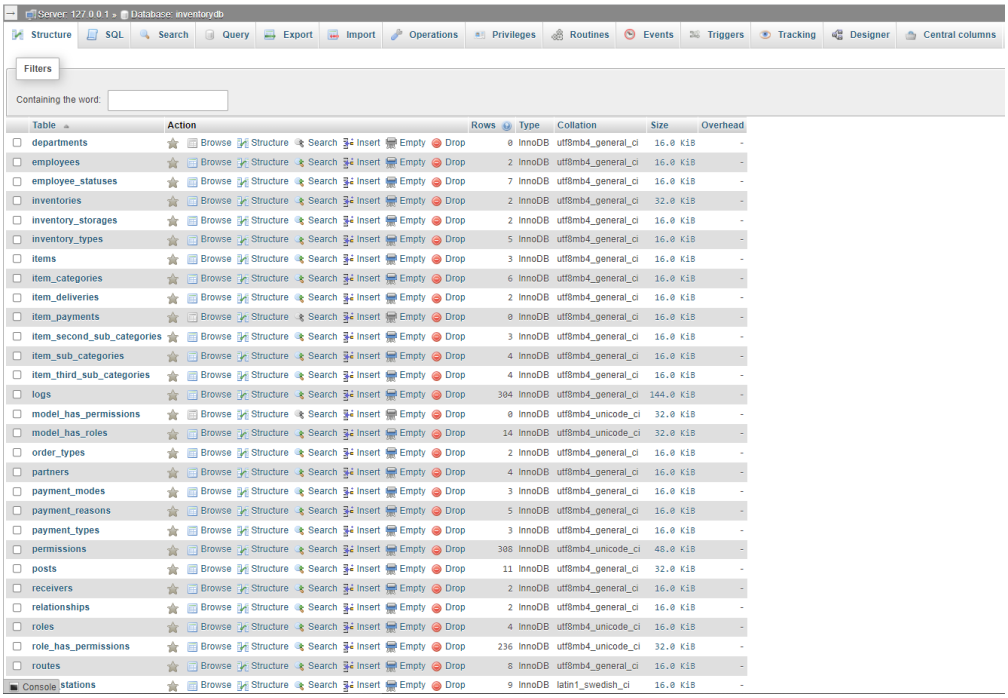


Figure 42: MySQL database tables

(xiv) Hardware Device

This project is based on the proposed system for parcel tracking and monitoring. The prototype size is shown in Fig. 43.

Figure 43: The prototype

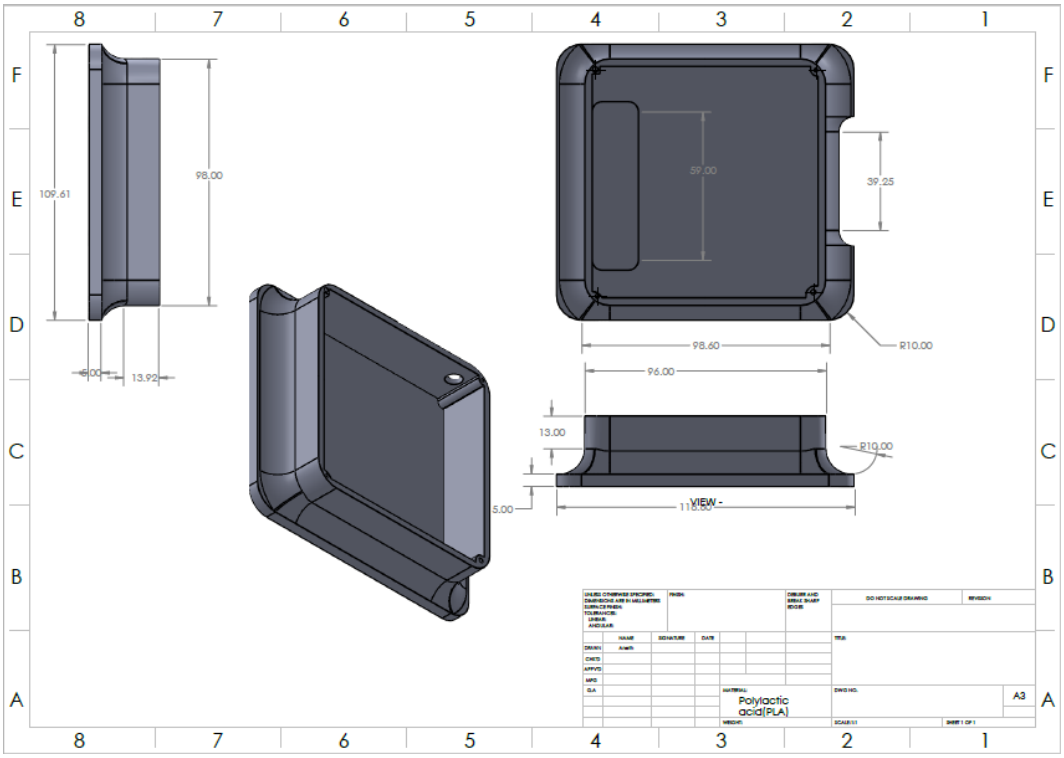


Figure 44: 3D printed prototype casing dimensions

Figure 44, shows the printed prototype casing dimension and the device used to print this prototype casing is shown in Appendix 7.

4.2.2 Validation and Testing

The process of evaluating the software and hardware while it is in the process of being developed is what is referred to as validation. Validation provides concrete evidence that the system satisfies or meets the requirements as shown in Appendix 5. During this process both software and hardware are tested to establish evidence of the desired results. It is the goal of the web-based application testing to demonstrate that it does what it is set out to do and find out any program bugs before the system is deployed as a way of doing a verification and validation on a general scale. A set of test activity steps including unit testing, integration testing and system testing were used to validate both the web-based application system and the hardware system.

(i) Unit Testing

Every unit of the prototype was checked to confirm whether they provided a viable output. This in turn be used to make a rough assessment of the functionality of the units. Testing of the

system is evaluated on the login, registration of the users, dashboard, report generation and so forth. Table 12 shows the results of unit for the user authentication process

Table 12: Unit testing for user authentication process

Unit Testing Areas	Outcome Test	Results
User registration	Register the user's full names, roles and system password.	PASS
Login the web application	Sign in with your email and password	PASS
Update user roles	The administrator can update the role of a user	PASS
Write, edit, delete actions	These actions are functional.	PASS
Logout	Users are capable of logging out of the web-based application.	PASS

(ii) Integration Testing

Integration testing ensures that two or more units operate effectively together (Nidhra, 2012). To ensure that when the packages or parcels when scanned the barcode captured can be pasted on the web-based application.

(iii) System Testing

This unit is the end result of the integrated components which have already passed the integration testing phase. The established system was fully tested to verify the functionality and consistency of the system. the focus being on the functionalities of the code which are visible to the user than the structural ones (Nidhra, 2012).

(iv) System Validation

Performance on validation is better than the traditional manual validation process. It also confirms the system's security and information assurance (Syaifudin *et al.*, 2021).

(v) User Acceptance

After the proposed system has been developed and undergone system testing, the system is then tested by the users in the transportation industry who use the public buses to transport their package and parcels. The results from this observation are as shown in the Fig. 45.

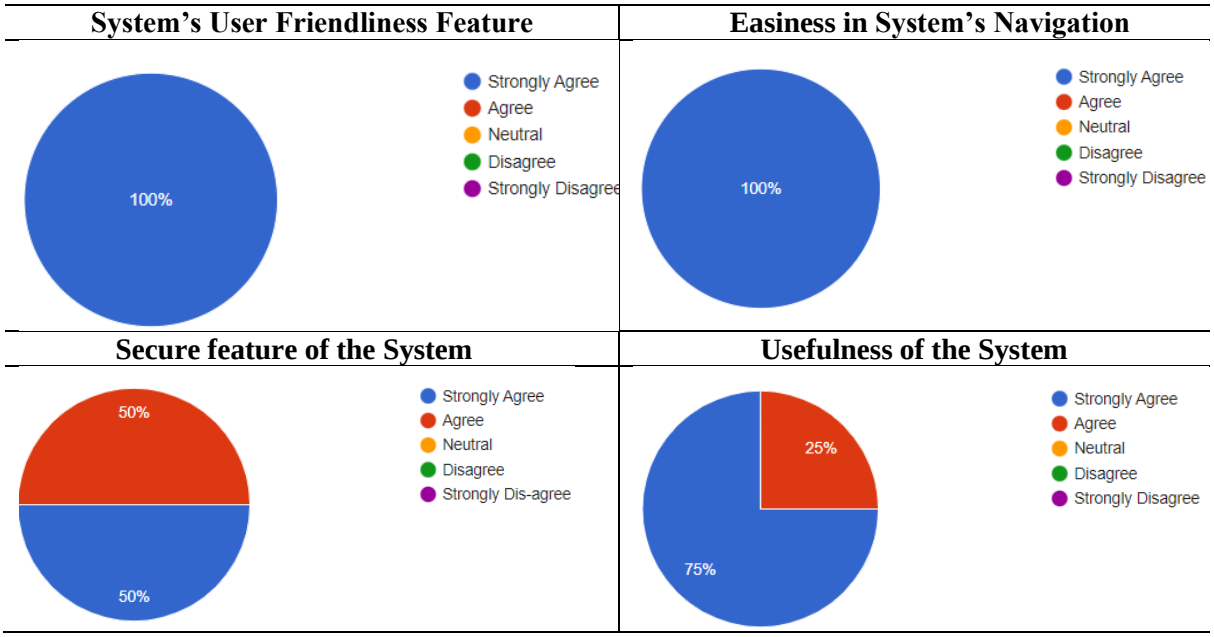


Figure 45: Results from user acceptance

Figure 45 depicts the results of the user acceptance. These results are presented on a pie chart on the system's user friendliness, navigation, secureness and usefulness of the system.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The rapid development and evolution of technology has enabled businesses to benefit from the increasing number of internet connections. Tanzania's public transportation system is one such example. From the related works it has shown a number of similar systems which reside in the transportation industry. However, the package and parcel monitoring system were designed to provide track and monitor items in real-time, as well as manage the inventory until their collection. A test was carried out to determine if a GPS receiver can transmit the coordinates of a moving object to a database after putting it in different places. Similarly, with the GSM, it was testing to determine its capability of sending SMS containing the package and parcel's location coordinates with a URL link. The results are indicated and the object's location is stored in the database. Aside from reducing errors, the system can also help improve the efficiency of the bus fleet by allowing the employees to easily locate and store data. The system was tested by the transportation industry users of public transportation on the system' user friendliness, usefulness, navigation and security.

5.2 Recommendations

5.2.1 Implications to the Policy Makers

The proposed system is portable and it can be installed in public buses to unburden the afflictions which come with tracking items such as packages and parcels. The Ministry of Transportation Regulatory Authority can come up with a policy for public buses to use the developed system. There is an abundance of public buses in Tanzania which if they would use such a system will help improve the service delivery and unburden both the public bus users and the public bus employees.

5.2.2 Implication to the Practitioners

Although the system is expected to have a significant impact on the industry, there are still many ways that the logistics industry can benefit from the system. One of these improvements is to allow clients to process their requests online for transporting their packages and parcels and send them alerts when their requests are accepted.

5.2.3 Future Research

For the future research the hardware device can be made able to detect fire. Aside from fire, proximity sensors can be used to notify the user about the location of the buses in case the bus has gotten involved in an accident. In addition, a two-factor authentication needs to be employed so as to increase the security aspect of the application.

5.2.4 Limitations of the Project

(i) If the battery of your GPS device is dead, then you might need to recharge using a power supply that's not always available.

(ii) Sometimes the GPS signals can get lost due to harsh weather conditions such as geomagnetic storms and other various factors such as obstacles for instance trees and buildings.

5.2.5 Scientific Contribution

This project provides a system that can ease the burden faced by the public bus parcel and packing management, tracking and monitoring. Also, it can be taken into further research to make it better so that better systems can be developed and employed in the transportation and logistics industry.

REFERENCES

Awadalla, M. H. A. (2018). Real time shipment tracking system using RFID. *International Journal of Computers and Technology*, *17*(1), 7163–7180. https://doi.org/10.24297/ijct.v17i1.7197

Bohara, B., & Maharjan, S. (2016). IoT Based Smart Home Using Blynk Framework. *Zerone Scholar*, *1*(1), 26–30.

Carlsson-kanyama, A., & Defence, S. (2005). *Public transport in Dar es Salaam , Tanzania - institutional challenges and opportunities* (G. J. & E. T. (Eds) (Ed.); Issue March 2018). Springer Verla.

Demir, M. F., Cankirli, A., Karabatak, B., Yavariabdi, A., Mendi, E., & Kusetogullari, H. (2018). Real-Time Resistor Color Code Recognition using Image Processing in Mobile Devices. *International Conference on Intelligent Systems (IS)*, 26–30. https://doi.org/10.1109/IS.2018.8710533

Doshi, H. S., Shah, M. S., & Shaikh, U. S. A. (2017). Internet of Things (IoT): Integration of blynk for domestic usability. *Journal of Engineering Research*, *1*(4), 149–157. http://103.97.164.116:10028/index.php/vjer/article/view/21

Fang, Z., Wang, J., Wu, H., Li, Q., Fan, S., & Wang, J. (2020). Progress and challenges of flexible lithium ion batteries. *Journal of Power Sources*, *454*, 227932. https://doi.org/10.1016/j.jpowsour.2020.227932

Farooq, M. U., Waseem, M., Mazhar, S., Khairi, A., & Kamal, T. (2015). A Review on Internet of Things (IoT). *International Jouranl of Computer Applications*, *113*(1), 1–7. https://doi.org/10.5120/19787-1571

Fezari, M., & Dahoud, A. Al. (2018). Integrated Development Environment " IDE " For Arduino. *WSN Applications*, *October*, 1–12.

Finance, M. O. F. (2020). *The united republic of Tanzania National five year*. *June 2016*.

Harshadbhai. (2013). Design of GPS and GSM Based Vehicle Location and Tracking System. *International Journal of Science and Research*, *2*(1), 165–168. www.ijsr.net

Kabiru, V. N. (2016). *Electronic Cargo Tracking System and Operational Peformance at Kenya Revenue Authority and on Transporters*. http://hdl.handle.net/11295/99446

Kaley, G., Nair, G., & Deshmukh, M. (2017). Internet of Things Based Vehicle Monitoring System. *International Research Journal of Engineering and Technology*, *04*(06), 127–130. https://www.irjet.net/archives/V4/i6/IRJET-V4I6289.pdf

Kanani, P., & Padole, M. (2020). Real-time Location Tracker for Critical Health Patient using Arduino , GPS Neo6m and GSM Sim800L in Health Care. *International Conference on Intelligent Computing and Control Systems*, 242–249. https://doi.org/10.1109/ICICCS48265.2020.9121128

Kindberg, T., & Barton, J. (2001). A Web-based nomadic computing system. *Computer Network*, *35*(4), 443–456.

Kumar, T. P., Sri, Y. S., Pravallika, D., & Harshavardhan, A. (2011). IoT for Baggage Tracking in Smart Cities. *International Journal of Engineering and Adanced Technology*.

Li, B., Riley, M. W., Lin, B., & Qi, E. (2006). A comparison study of customer satisfaction between the UPS and FedEx An empirical study among university customers. *Industrial Management & Data Systems*, *106*(2), 182–199.

M'hand, M. A., Boulmakoul, A., Badir, H., & Lbath, A. (2019). ScienceDirect A scalable scalable real-time real-time tracking tracking and and monitoring monitoring architecture architecture for for logistics and transport in RoRo terminals logistics and transport in RoRo terminals. *Procedia Computer Science*, *151*, 218–225. https://doi.org/10.1016/j.procs.2019.04.032

Mahammad, D. V. (2019). Design and Development of IoT based Geiger Muller counter. *International Research Journal of Engineering and Technology*, *06*(12), 2794–2798.

Mahapatro, G. K. (2011). A report on 3rd International Conference on Parthenium, 8-10 Dec 2010. *International Parthenium News*, 8–10. https://www.researchgate.net/publication/255485107_A_report_on_3rd_International_Conference_on_Parthenium_8-10_Dec_2010

Matekuor-Kole, G. Y. (2017). *E-Commerce for Canteen Services*.

Mibei, H., Karanja, L., Gakuo, S., Romney, D., Karanja, D., & Sones, K. (2017). *Mobile Landscape Analysis :* https://fdocuments.in/reader/full/mobile-landscape-tanzania-final-govuk-2018-05-18-mobile-landscape-analysis

Mohammed, Z., Al-balushi, K., Saeed, S., Al-taalei, K., & Jamaludeen, A. (2017). Tracking and Accident Detection in Automobiles Using GPS and GSM Technology. *Journal of Student Research*. https://doi.org/10.47611/JSR.VI.571

Mounika, A., & Chepuru, A. (2019). Iot Based Vehicle Tracking and Monitoring System Using GPS and GSM. *International Journal of Recent Technology and Engineering*, *8*(11), 2399–2403. https://doi.org/10.35940/ijrte.B1275.0982S1119

Msigwa, R. E. (2013). Challenges Facing Urban Transportation in Tanzania. *Mathematical Theory and Modeling*, *3*(5), 18–26.

Muminovic, M. (2019). Automatic Segmentation and Classification of Resistors in Digital Images. *International Conference on Information, Communication and Automation Technologies*, 1–6.

Mutie, N. A. (2020). Measurent of solar irradiation densities and solar energy generated using arduino based data logger. https://doi.org/10.13140/RG.2.2.31079.47528

Nidhra, S. (2012). Black Box and White Box Testing Techniques - A Literature Review B Lack box and w hite b ox t esting t echniques – a l iterature r eview. *International Journal of Embedded Systems and Applications*, *2*(2), 29–50. https://doi.org/10.5121/ijesa.2012.2204

OECD. (2013). *"Executive summary", in OECD Investment Policy Reviews: Tanzania 2013* (p. 312). OECD Publishing. https://doi.org/10.1787/9789264204348

Ooko, S. O. (2019). *A Comparison of Arduino , Raspberry Pi and ESP8266 Boards*. *December*, 3–5.

Padmaja, B. V. sai, Kolluru, V. R., & Kota, S. S. (2019). IoT based Implementation of Vehicle Monitoring and Tracking system using Node MCU. *International Journal of Innovative Technology and Exploring Engineering*, *8*(6), 446–450. https://www.ijitee.org/wp-content/uploads/papers/v8i6/F3569048619.pdf

Pariha, Y. S. (2020). Internet of Things and Nodemcu A review of use of Nodemcu ESP8266 in IoT products. *Journal of Emerging Technologies and Innovative Research*, *6*(6), 1085–1088. www.jetir.org

Parihar, Y. S. (2019). Internet of Things and Nodemcu A review of use of Nodemcu ESP8266 in IoT products. *Journal of Emerging Technonolies and Innovative Research*, *6*(6), 1085–1088. www.jetir.org

Pooja, S. (2013). Vehicle Tracking System Using GPS. *International Journal of Science and Research 2*(09). https://www.ijsr.net/search_index_results_paperid.php?id=12013152

Poonkodi, Devaki, & Karthika. (2019). IoT Based Smart Object Tracking System. *International Research Journal of Engineering and Technology*, *6*(2), 929–932. www.irjet.net

QuickSpecs. (2017). *HP Imaing Barcode Scanner*, 1–6.

Rabuan, E., Zainudin, J., Samad, H., Miserom, F., & Sabri, S. (2020). Courier tracking management system with notification using barcode scanner. *The Asian Journal of Professional and Business Studies*, *1*(1), 012039. http://www.kuptm.edu.my/images/Publication/AJPBS/Vol1-Ed1/Courier-Tracking-Management-System-With-Notification-Using-Barcode-Scanner.pdf

Salim, D. K. A., & Idrees, I. M. (2013). Design and Implementation of Web-Based GPS-GPRS Vehicle Tracking System. *International Journal of Computer Science Engineering and Technology*, *03*(12), 443–448.

Senthilkumar, S., K, B., R, R., R, C., & Jain, M. (2017). *luggage tracking system using iot* 49–55. *Journal of Critical Reviews.* http://www.ijpam.eu

Sharma, P., & Kantha, P. (2020). IRJET - "Blynk" Cloud Server based Monitoring and Control using ' NodeMCU. *Journal*, *07*(10).

Subramaniam, U., & Derouich, A. (2020). Trusted Simulation Using Proteus Model for a PV System : Test Case of an Improved HC MPPT Algorithm. *Energies*. https://doi.org/10.3390/en13081943

Syaifudin, Y. W., Malang, P. N., Funabiki, N., Mentari, M., Malang, P. N., Dien, H. E.,

Malang, P. N., & Monitoring, S. E. (2021). A Web-based Online Platform of Distribution, Collection, and Validation for Assignments in Android Programming Learning Assistance System. *Engineering Letters*, *29*(August), 1178–1183.

Veerasamy, S. P. (2015). Atmega 328 Based Industrial Conveyor Model Simulation in Proteus ISIS Atmega 328 Based Industrial Conveyor Model Simulation in PROTEUS. *International Journal for Scientific Research & Development*, *03*(02), 472–474. https://www.semanticscholar.org/paper/Atmega-328-Based-Industrial-Conveyor-Model-in-ISIS-Priyatharshini-Chettiar/3dbc0be1f148ac705d75774eb32c6fb330865228

Wilcox, A. B., Gallagher, K. D., Boden-Albala, B., & Bakken, S. R. (2012). Research Data Collection Methods From Paper to Tablet Computers. *Medical Care*, *50*, 68–73. https://doi.org/10.1097/MLR.0b013e318259c1e7

Zainudin, J., Samad, H., Miserom, F., & Sabri, S. (2021). Parcel Tracking System Using Barcode Scanner with Verified Notification. *IOP Conference Series: Materials Science and Engineering*, *1062*(1), 012039. https://doi.org/10.1088/1757-899X/1062/1/012039

APPENDICES

Appendix 1: Space Remaining and Space Remaining Percentage calculation

Space Remaining = Actual Space – Occupied Space

$$\textbf{Space Remaining Percentage} = \frac{\text{Space Remaining}}{\text{Actual Space}} \times 100\%$$

i. Space Remaining for Mandaria Express

Given:

Length (l) = 10m

Width (w) = 4m

Height (h) = 6m

Actual Space =?

Occupied Space=?

$$\textbf{Actual Space} = \textbf{Length * width * height}$$
$$= 10m * 4m * 6m$$
$$= 240m^3$$

To calculate the occupied space, you proceed as follows.

(a) Check for the inventories which are not delivered in that storage or transport unit i.e., Mandaria Express in the inventory module so as you can see how many items it contains.

(b) For the case of the Mandaria Express it had item HP Probook 645 G2. Find the dimensions of HP Probook 645 G2 and multiply by the total number of the Probook items.

(c) Go to Items Settings and find HP Probook 645 G2 and click to show item.

(d) Note down the dimensions of the item. And go to the inventory module and note down the quantity of this particular item.

HP Probook 645 G2 item dimension calculation

Item calculations = **Length * width * height**

= 2m * 1m * 1m

= $2m^3$

In Mandaria Express, the item quantity is a single unit (Quantity is 1). So multiply the dimensions by the total quantity present.

Space Remaining = **Actual Space – Occupied Space**

$(240m^3 – (2m^3 * 1))$

$240m^3 – 2m^3$

$238m^3$

Thus, the space remaining is $238m^3$

ii. Space Remaining Percentage for Mandaria Express

WKT:

$$\textbf{Space Remaining Percentage} = \frac{\text{Space Remaining}}{\text{Actual Space}} \times 100\%$$

Actual Space = $240m^3$

Space remaining = $238m^3$

$$\textbf{Space Remaining Percentage} = \frac{238m^3}{240m^3} \times 100\%$$

$$= 0.9916666 \times 100\%$$

$$= 99.17\%$$

Thus, the Space Remaining Percentage is 99.17% for Mandaria Express

Appendix 2: Online questionnaire for data collection for public bus users

DODOSO KWA AJILI YA HUDUMA YA UFATILIAJI WA VIFURUSHI NA MIZIGO

Habari, jina langu ni **Annette G. Mandari**, ni mwanafunzi wa shahada ya uzamili katika chuo cha The Nelson Mandela African Institution of Science and Technology (NM-AIST). Ninafanya utafiti unaohusu mifumo iliyopo kwenye usafirishaji wa mizigo hapa nchini Tanzania. Yafuatayo ni dodoso fupi na majibu yako ni ya muhimu na yatatumika kwa ajili ya utafiti bila kuhusishwa moja kwa moja na wewe unayejibu. Nashukuru kwa ushirikiano wako.

1. Jinsia yako ni ipi?
    - Mwanaume
    - Mwanamke
2. Aina ya eneo la makazi
    - Mjini
    - Vijijini
    - Nusu mjini
3. Mabasi ya mikoani ni njia rahisi na ya gharama nafuu ya kusafirisha vitu kama vile vifurushi au mizigo kutoka mkoa mmoja hadi mwingine nchini Tanzania.
    - Ninakubali Kabisa
    - Ninakubali
    - Sina Uhakika
    - Ninakataa
    - Ninakataa Kabisa
4. Tanzania ina mifumo ya ufatiliaji wa vifurushi na mizigo inavyotumwa kwa kutumia mabasi ya mikoani.
    - Ninakubali Kabisa
    - Ninakubali
    - Sina Uhakika
    - Ninakataa
    - Ninakataa Kabisa
5. Ili kujua kama kifurushi au mzigo wako umefika, umetumia njia za mwongozo kama vile kumpigia simu kondakta, kumpigia simu mtumaji wa kifurushi au mzigo, kuipiga simu ofisi lengwa na kadhalika

- Ninakubali Kabisa
- Ninakubali
- Sina Uhakika
- Ninakataa
- Ninakataa Kabisa

6. Ili kujua kama kifurushi au mzigo wako umefika, umetumia njia za mwongozo kama vile kumpigia simu kondakta, kumpigia simu mtumaji wa kifurushi au mzigo, kuipiga simu ofisi lengwa na kadhalika
    - Ninakubali Kabisa
    - Ninakubali
    - Sina Uhakika
    - Ninakataa
    - Ninakataa Kabisa
7. Kuna haja ya kutumia teknolojia ili kuboresha huduma za sekta ya usafirishaji wa vifurushi na mizigo hadi itakapowasili katika ofisi lengwa.
    - Ninakubali Kabisa
    - Ninakubali
    - Sina Uhakika
    - Ninakataa
    - Ninakataa Kabisa
8. Unafikiri makampuni ya mabasi ya mikoani na watumiaji wa mabasi haya ya mikoa watafaidika na mfumo unaotumia teknologia kufatilia mizigo au vifurushi hivi?
    - Ninakubali Kabisa
    - Ninakubali
    - Sina Uhakika
    - Ninakataa
    - Ninakataa Kabisa
9. Maoni: Unadhani nini kifanyike ili kuboresha jinsi ya ufatiliaji wa vifurushi na mizigo inayotumwa mikoani kwa kupitia mabasi?

    ……
    ……
    ……
    ……..
    …….....

Appendix 3: Interview questions for public bus users

Habari, jina langu ni **Annette G. Mandari**, ni mwanafunzi wa shahada ya uzamili katika chuo cha The Nelson Mandela African Institution of Science and Technology (NM-AIST). Ninafanya utafiti unaohusu mifumo iliyopo kwenye usafirishaji wa mizigo hapa nchini Tanzania. Ninayo dodoso fupi na majibu yako ni ya muhimu na yatatumika kwa ajili ya utafiti bila kuhusishwa moja kwa moja na wewe unayejibu. Nashukuru kwa ushirikiano wako.

Maswali:

1. Je, umeshawahi kutumia au kusafirishia vifurishi au mizigo kwa kutumia mabasi ya mikoani?
2. Je, unafikiri kwamba mabasi ya mikoani ni njia ya gharama nafuu ya kusafirisha vifurushi au mizigo kutoka mkoa mmoja hadi mwingine?
3. Je, umewahi kupitia changamoto zozote ilipokuja kwenye kusafirisha au kupokea mizigo wako?
4. Je, unatumia njia gani kujua kwamba mzigo au kifurushi chako kama kimefika?
5. Je, nini kifanyike ili kuboresha mifumo ya sasa ya kufuatilia vitu kama vifurushi na mizigo?

Appendix 4: Interview questions for public bus employees

Habari, jina langu ni **Annette G. Mandari**, ni mwanafunzi wa shahada ya uzamili katika chuo cha The Nelson Mandela African Institution of Science and Technology (NM-AIST). Ninafanya utafiti unaohusu mifumo iliyopo kwenye usafirishaji wa mizigo hapa nchini Tanzania. Ninayo mahojiano mafupi na majibu yako ni ya muhimu na yatatumika kwa ajili ya utafiti bila kuhusishwa moja kwa moja na wewe unayejibu. Nashukuru kwa ushirikiano wako.

Maswali:

1. Je, unafikiri mfumo wa teknologia utasaidia kuongeza ufanisi?
2. Je, unadhani mabasi ya mikoani na watumiaji wa haya mabasi kusafirishia vifurushi na mizigo watafaidika na mfumo wa kiteknolojia?
3. Ni vipengele vipi vya ziada vya mfumo wa ufuatiliai unaamini kuwa mfumo wa ufatiliaji unaopendelea kama mfumo ungekuwa nao?

Appendix 5: System validation questionnaire for public bus users

Habari, jina langu ni **Annette G. Mandari**, ni mwanafunzi wa shahada ya uzamili katika chuo cha The Nelson Mandela African Institution of Science and Technology (NM-AIST). Ninafanya utafiti unaohusu mifumo iliyopo kwenye usafirishaji wa mizigo hapa nchini Tanzania. Ninayo dodoso fupi na majibu yako ni ya muhimu na yatatumika kwa ajili ya utafiti bila kuhusishwa moja kwa moja na wewe unayejibu. Nashukuru kwa ushirikiano wako.

Swali	Ninakataa Kabisa	Ninakataa	Sina Uhakikaa	Ninakubali	Ninakubali Kabisa
	1	2	3	4	5
Matumizi ya mfumo huu yanaweza kusaidia kufatilia mizigona vifurushi kupitiamabasi ya mikoani.					
Ninafikiri matumizi ya mfumo huu utasaidia mabasi ya mikoani kuweza kufatilia mizogo na vifurushi kwa ufanisi zaidi.					
Ninafikiri ninaweza kujifunza kutumia mfumo huu nikielekezwa.					
Ninafikiri ni wazo zuri kutumia mfumo huu wa kiteknolojia uliotengenezwa kwa ajili ya kufatilia mizigo na vifurushi.					

Appendix 6: Sample codes for the Proteus simulation

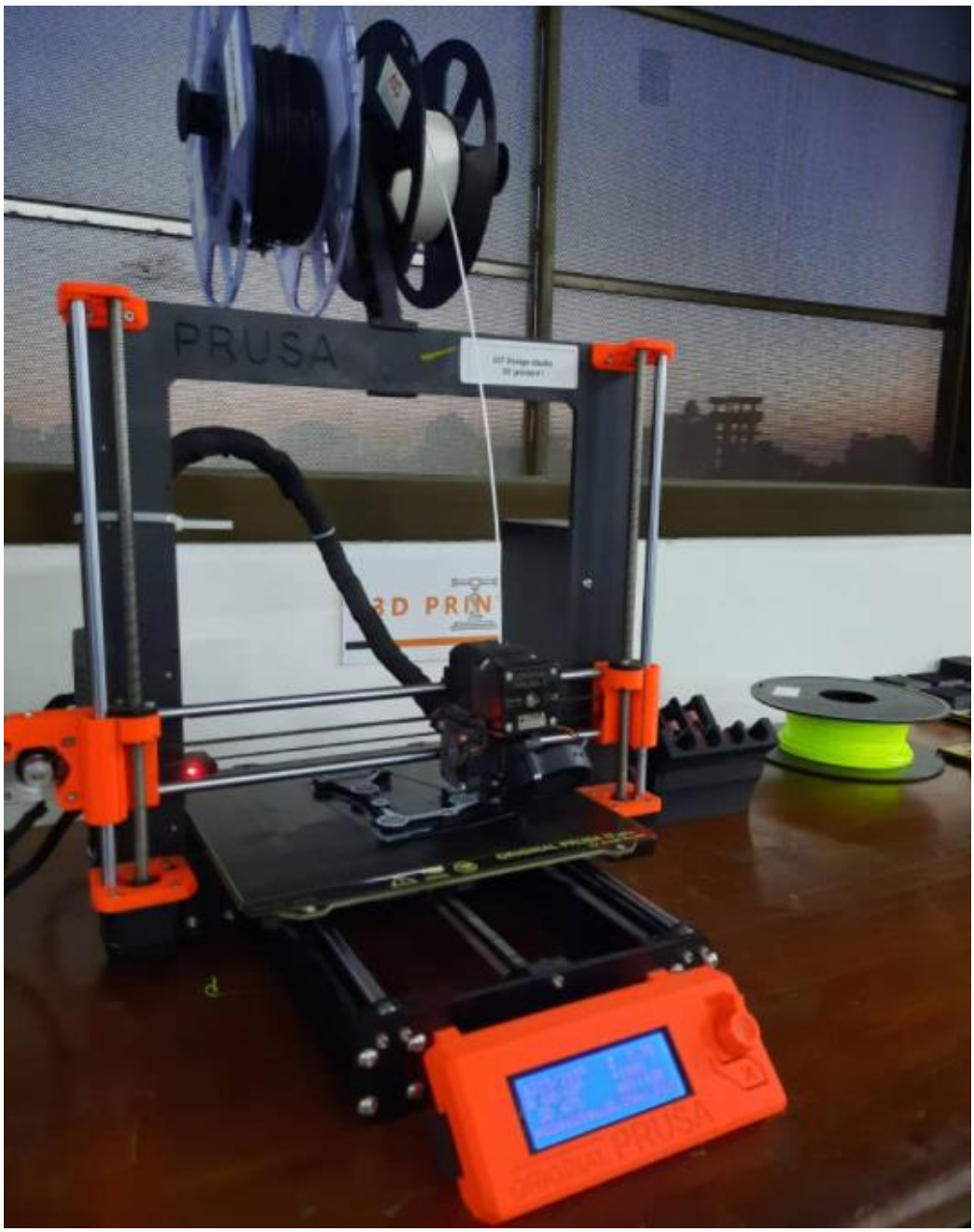
```
#include <SoftwareSerial.h>
#include <TinyGPS.h>
TinyGPS gps; //Creates a new instance of the TinyGPS object
float lat = -1.6848579, lon = 37.1690756;
SoftwareSerial mySerial(7, 8); //RX and TX pins respectively.
const int WiFiPin = 2;
void setup()
{
 pinMode(WiFiPin, INPUT);
 pinMode(WiFiPin, LOW);
 mySerial.begin(9600); // Setting the baud rate of GSM Module
 Serial.begin(9600); // Setting the baud rate of Serial Monitor (Arduino)
 delay(100);
}
void loop()
{
 if (Serial.available() > 0)
   switch (Serial.read())
   {
    if(WiFiPin == HIGH){
     Serial.println("No Internet");
    }
    else{
    String latitude = String(lat, 6);
    String longitude = String(lon, 6);
    //Serial.println("No Internet");
    mySerial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
    delay(1000); // Delay of 1 second
    mySerial.println("AT+CMGS=\"+255789846587\"\r"); //mobile number to send a text to
```

```
      delay(1000);
      mySerial.println("http://maps.google.com/maps?q=loc:-1.6848579,37.1690756");
      delay(1000);
      mySerial.println("Latitude: " + latitude + "," "Longitude: " + longitude);
      delay(100);
      mySerial.println((char)26);// ASCII code of CTRL+Z for saying the end of sms to  the module
      delay(1000);
      break;
      //      case 'r':
      //      case 'R':
      mySerial.println("AT+CNMI=2,2,0,0,0"); // AT Command to receive a live SMS
      delay(1000);
      break;
    }
  }
 if (mySerial.available() > 0)
   Serial.write(mySerial.read());
}
```

Appendix 7: Dependencies which support the web-based application built


```
{
    "name": "laravel/laravel",
    "type": "project",
    "description": "The Laravel Framework.",
    "keywords": [
        "framework",
        "laravel"
    ],
    "license": "MIT",
    "require": {
        "php": "^7.1.3",
        "consoletvs/charts": "6.*",
        "davejamesmiller/laravel-breadcrumbs": "5.*",
        "fideloper/proxy": "^4.0",
        "laravel-admin-ext/summernote": "^1.0",
        "laravel/framework": "5.8.*",
        "laravel/tinker": "^1.0",
        "niklasravnsborg/laravel-pdf": "^3.1",
        "reliese/laravel": "^0.0.16",
        "spatie/laravel-permission": "^2.37",
        "watson/active": "^3.0",
        "milon/barcode": "^7.0"
    },
    "require-dev": {
        "barryvdh/laravel-debugbar": "^3.2",
        "beyondcode/laravel-dump-server": "^1.0",
        "crestapps/laravel-code-generator": "^2.3",
        "filp/whoops": "^2.0",
        "fzaninotto/faker": "^1.4",
        "mockery/mockery": "^1.0",
        "nunomaduro/collision": "^2.0",
        "phpunit/phpunit": "^7.0"
    },
```

Appendix 8: Picture of a 3D printer



Appendix 9: Poster Publication

INTERNET OF THINGS BASED PACKAGE AND PARCEL TRACKING AND MONITORING SYSTEM FOR PUBLIC BUSES IN TANZANIA

Annette Godfrey Mandari [1]; Ramadhani Sinde [2]; Elizabeth Mkoba [3]
[1-3]The Nelson Mandela African Institute of Science and Technology
Nelson Mandela African Institution of Science and Technology. P. O. Box 447, Arusha , Tanzania.
Emails: mandaria@nm-aist.ac.tz; Ramadhani.sinde@nm-aist.ac.tz; Elizabeth.Mkoba@nm-aist.ac.tz

INTRODUCTION

Today's era, technology is continuously evolving and improving. The Internet of Things (IoT) concept is ubiquitous in nature. It is capable of connecting numerous gadgets together over the internet, and this in turn can lead to spurs of innovation (Farooq et al., 2015). Security is crucial and a matter of grave importance. Nowadays, people are concerned with the safety and security of their items and objects such as packages, parcels and forms of transport such as public buses. It becomes more pressing if the items and objects transported are of value (Mounika & Chepuru, 2019). Despite the numerous challenges of urban transportation, the demand to reach more sites continues to grow.

The proposed system will be beneficial to the public management in providing easiness in inventory keeping. Also, the reduced stress incurred on both sides of the senders and bus management from worrying about the safe travel of the packages and parcels. The monitoring is done in real-time. Once these packages and parcels arrive at the destination offices, they are stored and await their collection.

MATERIALS AND METHODS

The Global Positioning System (GPS) module and the Global System for Mobile Communication (GSM) module are serially connected to the microcontroller. The GSM sends the packages and parcels coordinates from a remote location to a monitoring station; whereas the GPS module constantly tracks the packages and parcel's coordinates with the help from the satellites. A tracking system collects data from the GPS and sends it to the mobile or laptop through the GSM module using mobile communications. The monitoring station utilizes various software or applications to plot the packages and parcels on a map; and the current location of the packages and parcels is transmitted via the Global Positioning System (GPS). Packages and parcels are received at the destination offices where they will be scanned into the system and temporarily stored until their collection.

RESULTS

A random survey of 103 people was taken with regards to their experiences and afflictions using the public buses to transport packages and parcels. The survey question asked "*Do you suppose a technological solution is required to improve package and parcel tracking until the arrival at the collecting offices*?" had a significant response of 77.7% of the respondents which agreed with this statement. According to the results of the survey, 77.5% of the respondents strongly agree and believe that digital technology systems should be used to track and monitor packages and parcels followed by an 18.6 % of the respondents also agree with the notion that digital technology should be used to track and monitor packages and parcels. However, 2.9 % were indifferent/neutral about the idea, and 1% of the respondents disagreed. The need for this system was supported by a large percentage of respondents who expressed a readiness to have technology systems to track and monitor packages and parcels in public buses.

DISCUSSION

There are a number of software that engineering students use for designing and simulating electronics and electrical circuits. For this project, the Proteus simulator is used to develop and test the design by assisting in the locating of the packages or parcels. This simulation has three major components; Arduino UNO, GSM module and GPS module. However, modules such as GSM and GPS are not found in the Proteus and therefore, they have to be downloaded. The downloadable GSM library only supports a few commands and only has single module, SIM900D, which can be used with various controllers such as Arduino or PIC microcontrollers. Once installed you can double click then navigate to the GSMLibraryTEP.hex file area in the program file and upload your program. Similarly, for GPS module and the controller. This web-based application is intended to allow data to be transferred from a database. Users of various access levels are provided with login credentials in order to facilitate the login for the first time. However, it is recommended that the users change their passwords for both security reasons and preferences.

CONCLUSION

The rapid development and evolution of technology has enabled businesses to benefit from the increasing number of internet connections. Tanzania's public transportation system is one such example. From the related works it has shown a number of similar systems which reside in the transportation industry. However, the package and parcel monitoring system was designed to provide track and monitor items in real-time, as well as manage the inventory until their collection. Tests were carried out to determine if a GPS receiver can transmit the coordinates of a moving object to a database after putting it in different places. Similarly, with the GSM, it was testing to determine its capability of sending SMS containing the package and parcel's location coordinates with a URL link. The results are indicated and the object's location is stored in the database. Aside from reducing errors, the system can also help improve the efficiency of the bus fleet by allowing the employees to easily locate and store data. The system was tested by the transportation industry users of public transportation on the system' user friendliness, usefulness, navigation and security.

REFERENCES

Awadalla, M. H. A. (2018). REAL TIME SHIPMENT TRACKING SYSTEM USING RFID. *International Journal of Computers and Technology*, *17*(1), 7163–7180. https://doi.org/10.24297/ijct.v17i1.7197

Bohara, B., & Maharjan, S. (2016). IoT Based Smart Home Using Blynk Framework. *Zerone Scholar*, *1*(1), 26–30.

Carlsson-kanyama, A., & Defence, S. (2005). *Public transport in Dar es Salaam , Tanzania -institutional challenges and opportunities* (G. J. & E. T. (Eds) (Ed.); Issue March 2018). Springer Verla.

Demir, M. F., Cankirli, A., Karabatak, B., Yavariabdi, A., Mendi, E., & Kusetogullari, H. (2018). Real-Time Resistor Color Code Recognition using Image Processing in Mobile Devices. *International Conference on Intelligent Systems (IS)*, 26–30. https://doi.org/10.1109/IS.2018.8710533

Doshi, H. S., Shah, M. S., & Shaikh, U. S. A. (2017). Internet of Things (IoT): Integration of blynk for domestic usability. *Journal of Engineering Research*, *1*(4), 149–157. http://103.97.164.116:10028/index.php/vjer/article/view/21