UNIVERSITY of RWANDA
COLLEGE OF SCIENCE AND TECHNOLOGY

ACEIoT

Website: www.aceiot.ur.ac.rw
Mail: aceiot@ur.ac.rw

AFRICAN CENTER OF EXCELLENCE IN INTERNET OF THINGS

ENHANCING PUBLIC TRANSPORT IN RWANDA USING IOT FOR IMPROVED SERVICES AT BUS STOPS AND BUS STATIONS

A dissertation submitted in partial fulfilment of the requirements for the degree of

Masters in Internet of Things

With specialization in Wireless Intelligent Sensors Networks

Submitted By:

Emmanuel Rugema Mbarushimana

Ref: **220018751**

November 2021

UNIVERSITY of RWANDA
COLLEGE OF SCIENCE AND TECHNOLOGY

ACEIoT

Website: www.aceiot.ur.ac.rw
Mail: aceiot@ur.ac.rw

AFRICAN CENTER OF EXCELLENCE IN INTERNET OF THINGS

ENHANCING PUBLIC TRANSPORT IN RWANDA USING IOT FOR IMPROVED SERVICES AT BUS STOPS AND BUS STATIONS

A dissertation submitted in partial fulfilment of the requirements for the degree of

Masters in Internet of Things

With specialization in Wireless Intelligent Sensors Networks

Emmanuel Rugema Mbarushimana

Ref: **220018751**

Supervisor: **Dr. Pierre BAKUNZIBAKE**

Co-Supervisor: **Dr. Emmanuel NDASHIMYE**

November 2021

BONAFIDE CERTIFICATE

This is to certify that the project work entitled "Enhancing Public Transport in Rwanda using IoT for Improved Services at Bus Stops and Bus Stations" is a record of the original work done by **RUGEMA MBARUSHIMANA Emmanuel** with the registration number **220018751**. It is in partial fulfillment of the requirement for the award of a master's with honors in **Wireless Intelligent Sensors Networks (WiSeNet)** at the African Center of Excellence in Internet of Things, (ACEIoT), College of Science and Technology at the University of Rwanda during the academic year 2020 - 2021.

Supervisors

Dr. Pierre BAKUNZIBAKE

Signature 15.10.2022

Dr. Emmanuel NDASHIMYE

Signature 07/11/22

The Head of Masters and Trainings ACEIoT

Dr. James RWIGEMA

Signature

AFRICAN CENTER OF EXCELLENCE IN INTERNET OF THINGS ACEIoT UNIVERSITY OF RWANDA

DECLARATION

I declare that this research project report entitled "**Enhancing Public Transport in Rwanda using IoT for Improved Service at Bus Stop and Bus Stop**" presented for the award of a Master's degree in Internet of Things at the African Center of Excellence in Internet of Things, with a specialization in **Wireless Intelligent Sensor Networking**, by the University of Rwanda, is my work. It has never been presented nor submitted to any other Institution of High learning for a similar award.

Declared by:

RUGEMA MBARUSHIMANA Emmanuel

No:220018751

University of Rwanda - UR

Internet of Things at African Center of Excellence in Internet of Things – ACEIoT

November 30th, 2021

ACKNOWLEDGEMENTS

I would like to first thank the leadership of the government of Rwanda for the vision of our country, and the establishment of the African Centers of Excellence at the University of Rwanda. I am grateful to the African Center of Excellence in Internet of Things faculty and staff members, especially my supervisors **Dr. Pierre BAKUNZIBAKE** and **Dr. Emmanuel NDASHIMYE** for guiding and assisting me in my research project. I am thankful to my classmates for their collaboration during the program, and to my family for their support.

ABSTRACT

As cities develop, the public transport system becomes challenging as the number of people who need to move from one place to another increase. Timeliness, availability, convenience, and flexible payment modalities become important aspects of public transport services. In Rwanda, many people use public transport, especially in the city of Kigali. However, it is common to experience poor services such as waiting for the bus for a very long time at the bus stop or bus station. Using IoT-based solutions, existing issues in public transport services mainly at bus stops and bus stations can be resolved. Passengers can get information that allows them to avoid spending much time waiting for the next bus in a long queue. In line with Rwanda's vision to develop smart cities and use digital technologies to improve services, during our study, we developed an internet of things (IoT) based solution to help passengers have information about buses while waiting at the bus stop or bus station. The solution is composed of three main parts including a web application, an IoT module, and a database. Passengers log in to the application and search for information about the next bus on the route. The proximity sensors deployed in buses, cameras at the bus stops and bus stations, Raspberry Pi, and wireless access point components, all together form the IoT module that gathers data about the bus. The database contains the collected data which is used to communicate to passengers the information about buses via the e-transport web platform.

The passenger logs in to his account on the e-transport using a username and a password through a smartphone or a computer and then gets access to a dashboard that displays the plate numbers of buses on the route he wants to use, the locations of buses, the number of passengers on board, the available seats in each bus, and estimated time of arrival depending on where he wants to take the bus from. The same information is displayed on screens at bus stop or bus station. As buses pass by different bus stops and bus stations, the collected data from different sources is consolidated to inform passengers about the location, seats availability, and time for the bus to reach the next bus stop or station. The camera took pictures of the bus, the Raspberry Pi verified and validate the bus plate number from the database, similarly, the sensors in the bus collected data on free seats, and the information was used to communicate to the passengers through the web application about the location seat availability, as well as time of the next bus. The designed IoT-based prototype solution can contribute to improving services in public bus transport in Rwanda, by helping passengers not waste time waiting for buses while not knowing when they are coming. It will help passengers to plan their travel journeys and get a chance to choose to take a bus that has some seats available. Further studies should consider the potential to support bus operators and assess case for sustainable implementation of the designed IoT-based solution to improve public bus transport in

Rwanda.

LIST OF ACRONYMS

AC	:	Alternating current
ACE-IoT	:	African Center of Excellence in Internet of Things
Ag	:	Acting
API	:	Application Program Interface
DBMS	:	Database Management System
DC	:	Direct current
DFD	:	Data Flow Diagram
Dr	:	Doctor
E.G	:	Example
GPS	:	Global Positioning System
GSM	:	Global System for Mobile communication
HTML	:	Hypertext markup language
HTTP	:	Hypertext transfer protocol
ICT	:	Information and Communication Technology
IoT	:	Internet of Things
LCD	:	Liquid Crystal Display
MCU	:	Micro-controller unit
Md5()	:	Message-Digest Algorithm
OS	:	Operating system
RTC	:	Real-time clock
RURA	:	Rwanda utilities Regulatory Authority
SOC	:	System on a Chip
UML	:	Unified modeling language
UR	:	University of Rwanda
Wi-Fi	:	Wireless Fidelity
4GLTE	:	Fourth generation long-term evolution

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENT

CHAPTER I. INTRODUCTION

Background

Rwanda set policies and strategies to use ICT for the development of the country. The policy of the ICT sector in 2015, the smart Rwanda master plan, highlights smart cities and communities as one of the areas of priority for future planning, using research and development, and leveraging new technologies including the Internet of Things (IoT) [1]. Also, under the Smart Africa Alliance, Rwanda leads the smart cities flagship initiative. Rwanda has launched the smart cities blueprint with three main pillars including smart governance and planning, smart and efficient services and utilities, and localized innovation for social and economic development [2].

Among the building blocks of a smart city is efficient and greener transportation and mobility. These allow for a good passenger experience, help city managers to minimize transport management costs, and enables green cities by reducing individual cars usage. As the digital transformation continues to impact the different aspects of everyday life, Internet access becoming ubiquitous mainly in cities, and more citizens getting connected, some public transport challenges should be removed by leveraging technology solutions. IoT-based solution have a number of benefits in the transportation industry, and specifically in public transport. They are used to solve issues related to information gaps in the public transport systems enabling passengers to have well planned travel schedules.

IoT-based solutions allow bus operators to efficiently use their company vehicles and city managers to better use the road infrastructures. The authorities in charge also have visibility and predictions of key aspects of the public transport services to improve city transport planning for improved quality. Based on data there is also possibility to further improve the passengers experience by providing them with personized travel information. There are many existing smart public transport solutions such as smart transport tracking systems, smart bus stops systems, and more, using IoT. Though, the adoption of the various existing solution might not be that straight forward and requires consideration of the context in each country or region.

Motivation

As cities develop, on one hand, the public transport system becomes challenging as the number of people who need to use public buses to move from one place to another increase. On the other hand, the authorities want to make cities green but the number of people owning their personal cars that pollute the environment also increases. Hence, there have to be solutions that make public transport convenient enough and attractive for everyone leaving in the cities. People need quality public transport services, that are reliable and suitable.

In Rwanda, many people use public transport, especially in Kigali. According to the Rwanda Utilities Regulatory Authority (RURA), around 4,498,360 citizens use public buses per month, on average there are 145,850 people using public buses daily [3]. Unfortunately, it is very common to expect delays when taking a public bus while traveling in the city of Kigali. This is mainly due to long queues at bus stops at specific hours like in the morning when people go to work, and in the evening when people come from work. During the day, most of the buses also travel with many empty seats. Figure1 is a picture reflecting the situation in most of Kigali bus stops and bus stations when people are waiting for buses, and it provides the image of how serious the issue can get.

Figure 1. Passengers waiting for buses after work hours in Down-Town bus station

The reality is that passengers are waiting without knowing when the buses will come nor whether there will be some free seats. Payment for public bus transport in Kigali has been digitized since 2015, the Tap and Go cards are used [4], where money is pre-loaded on the card through an agent. However, there is no platform to allow to leverage the digital payment solution for booking a ride or a seat on the bus. Additionally, it requires the passenger to always carry the physical card for tapping at the entrance of the bus. There could be other diversified ways to pay for public bus transport and provide passengers with enough flexibility using a mobile application or direct payments through online banking.

Problem Statement

In public transport, a safe and comfortable journey without any delay is the ideal experience expected by any passenger. However, public transport services in Kigali are usually reported to be poor [5] [6]. Generally, it happens that passengers arrive at the bus stops or bus stations almost at the same time since none knows when exactly the bus is going to arrive at the bus stop or if it will have available seats. In addition, passengers' convenience also cannot be guaranteed as passengers cannot be sure to get a seat on the bus coming next. In some cases, payment on public transport still involves human-to-human interaction. Passengers are not the only ones affected; public transport companies also lose clients who decide to use alternative transport means like motorbikes when they are not able to wait any longer. Without well managed public transport systems, people continue to rely on individual car transport arrangements, as the best solution. The public transport system in Rwanda, services, and management, do not reflect the expected level of digital transformation, even though cities in Rwanda are all well covered by Internet infrastructure. Despite efforts to equip public transport buses in Kigali with open wireless internet connectivity¸ the bus scheduling from bus stations is not informed by the availability of passengers at bus stops [6]. Additionally, the city manager does not have full visibility of public transport services nor real-time data about public bus operations to be able to improve their organization.

Study objectives

1.1.1. General Objectives

The core objective of this project is to design an IoT-based system for improved services at the bus stops and bus stations, by leveraging real-time information about the bus location, and seat booking.

1.1.2. Specific Objectives

With this project we want to achieve the following:

i. Facilitate passengers to get details on seat availability in public transport buses, for convenient experience
ii. Develop and test a working prototype of an IoT-based solution to improve public transport services at bus stops and bus stations for better management of bus services
iii. Provide passengers with the information they need to better plan their trips, and efficiently manage their time

Hypothesis

The 95% 4GLTE population coverage in Rwanda [7], can be leveraged to create IoT-based solutions to address challenges in different sectors including public transport services. The persistent challenges in the public transport system can be resolved by giving passengers access to the information that allows them to avoid spending much time waiting for the next bus in long queues. The IoT-based solution for enhanced services at bus stops and bus stations will provide benefits including enhanced public transport services, better passengers' time management, passengers' convenience through bus seat booking, and creating a case for digital payment services diversification, all without additional heavy investments.

Scope of the Study

This project focuses on developing a solution for enhancing the public transport services in Rwandan cities, starting with Kigali, through the application of IoT-based solution to improve services at bus stops and bus stations. The initial steps and first part of the study aimed to evidence the problem stated under this study leveraging personal experience, observation, and reports in the media. Similar case studies and previous works on the same subject were also gathered to further inform our study on key aspects to be considered about the passengers concerns and expectations on improved public bus transport services. The second part involved working on the prototype and running it. Different approaches and techniques were explored for the solution design. Due to the constraints caused by the Covid-19 pandemic that affected our study plan, the scope of our study was narrowed, and in order to achieve our study objectives the project was implemented using one bus, one bus park and one bus stop. The route between Gikondo bus station and Kinamba bus stop is the one used in our study. The designed IoT-based solution focused on providing passengers with the information about the bus location, the bus arrival time at the bus stop or bus station, and the available seats on the specific bus. This way, the

passenger is able to plan accordingly and have better experience while traveling using public bus transport services.

Significance of the Study

The successful implementation of this project will contribute to the development of smart cities by enhancement of public transport in Kigali and Rwanda at large. Specifically, this project will enable better services delivery to passengers at bus stops and bus stations. Very importantly, this study is timely, as the world is experiencing the impact of the Covid-19 pandemic, where its confinement measures require buses to only onboard a limited number of passengers in order to respect the social distancing. Hence making it even harder for the passenger to catch the bus at the desired time. Using the designed IoT-based solution, citizens will be able to take advantage of the usually wasted time at bus stops for other economically benefiting activities and will be able to enjoy good experience while traveling in cities by public transport buses. In particular during this pandemic period, our solution will contribute to stopping the spread of infection, by avoiding having many people crowded at bus stops and bus stations waiting for buses.

Only people who were able to schedule and planned to be on the next bus coming are the ones to be present at the bus stop or bus station. Even the infections traceability will become simpler from the records of passengers on each bus. Our solution has the potential to also benefit public transport buses operators, as well as city managers. The collected data can be used to provide insightful information on their businesses and enable them to better serve their clients and the community at large. Moreover, new businesses may develop form adoption of our IoT-based solutions in the public transport services, as well as in other transport sector industries, and create job opportunities for more Rwandans.

Organization of the study

The first chapter is the introductory chapter. It describes the background of the study, the problem statement, the objectives of the study, the scope of the study, the significance of the study, including project interest, and the organization of the study. The chapter two is about the literature review. This chapter covers the different works done by other researchers on the IoT based solutions in smart public transport. The chapter three on research methodology, shows the methodology used during this study, it also includes the definitions of key terms used in our study. The fourth chapter focuses on the actual IoT solution system design, it describes the solution prototype, and the corresponding dashboards. Chapter five presents the results observed by running the prototype and the corresponding analysis. The last chapter, six, is the conclusion of our study and contains the observations and recommendations for future researchers.

CHAPTER II. LITERATURE REVIEW

2.1. Related work

In many cities, the transport infrastructure, and systems available are sufficient to serve the needs of passengers. However, gaps in having timely data from both the operator and the passenger makes it a very complex system and difficult to organize. Current digital and technology advancements allow for multiple channels to enable access to information including audio broadcasting, smart display, and mobile applications. With IoT-based solutions and system it is possible to bridge the above-mentioned gaps. Enhancing public transport using technology is a subject that has been worked on by many researchers. Specifically, the use of IoT is emerging in many cities across the world to address issues in the various aspects of the public bus transportation systems. Cities are envisaged to become smarter, with smart infrastructure, smart transport systems, and promote the use of smart vehicles. People leaving in cities also expect to experience better services as digital solutions have shown high potential for improved and smart delivery in different areas including public transport.

The IoT-based solutions offer responses to the transport sector challenges, from infrastructure management, to traffic management and accident prevention, vehicle tracking and smart parking, and to improved passenger experience [8] [9]. The IoT is looked at as the key enabler of smart cities, and it had been estimated to become market of multiple hundreds of billions of dollars by 2020 [10]. It has been estimated that smart solutions for transport systems would contribute to 15% reduction on the amount of money spent each year due to road traffic jams [11]. The IoT in transportation functioning process includes five key steps, according to Nallapaneni M.K and Archana D. [12] It stars with sensing the needed data from the bus, measuring the collected data, sharing the information from collected data, performing the analysis to take appropriate actions, and responding to as per the appropriate choices.

In their work, smart public transportation system, Sanket et. al, built a system with four main features including the location of the bus, the arrival time of the bus, number of passengers in the bus, and automatic wiper [13]. The system uses google map to find information about the locations of both the passenger and the bus, the number of passengers is counted using an RFID tag where the bus driver has to ensure all passengers press the button at entrance, and each passenger gets a token that has to be put back in a box when off boarding the bus. This system could be improved as it may not be practical in rush hours or at crowded bus stations and bus stops. The smart local transport tracking system using IoT-based technique by Dr. I. Lakshmi used an announcement system to help passengers get

information about the location of the buses in real-time, to help them decide regarding waiting or not [14]. This solution could only benefit passengers that have arrived at the bus stop or bus station.

In their study called Intelligent public transportation systems: a review of architectures and enabling technologies, Sabeur and Saber defined a system that includes a decision support system, automatic vehicle location, traveler information system, variable message sign, automatic passenger counter, geographic information system, and closed-circuit television [15], however, it did not include seats management and digital payment. Their focus has been on controlling public transport networks, to maintain their performance, while providing passengers and bus operators with the general information on the situation in the different networks. Miraal et.al. proposed an IoT solution for smart bus stops services and operations improvement. The system provides means to remotely operate, monitor, and maintain bus stop utilities such as air conditioners [16]. This could be a good idea to consider as part of the making the travel pleasant for passengers with healthy conditions for the time spent in the bus.

The smart public transport system using the android application by Amruta et. al. defined a system that used mobile technologies and IoT to provide information about the location of the nearest buses to the bus stop and the average traveling time, on the passengers' mobile application [17]. The passenger could be informed about the waiting time, but still not have information about the availability of seats on the bus, and no digital payment was involved. In their work, Parag Gawade and Prof. Meeankshi, built a smart system to control public buses and with features including alcohol detection for drivers, GPS tracking, GSM acknowledgment, and ramp for the handicapped [18]. The smart information system for public transportation using IoT, by Lavanya et. al., provided passengers with information about the actual bus location, time to reach the bus stop, as well as the crowd level inside the bus [19]. The IoT for the development of a smart public transportation system was also analyzed by Dina et. al., in a systematic literature review, to explore opportunities and challenges for IoT application in public transport. They highlighted the opportunities to utilize IoT to reduce passengers' waiting time, bus schedules, bus presence detection, booking seats, and payment. The paper proposes platforms integration to enable IoT applications for the various fields of public transport [20].

Public buses transportation services continue to not provide the expected comfort and convenience, as passengers still struggle to control on their time, which is the main consideration of the travel experience [21]. It is predicted that the trend of increasingly fast-paced lifestyle is not going to slow down. This creates a necessity for quick information to help people maximize time and manage their lives smarter

[22]. The contribution of IoT-based solution in accelerating improvements in transport industry is real and has created opportunities for more innovations. From smart phones in the hands of passengers using public transport, to smart cars, and connected objects, the huge amount of data that is collected is used to provide solutions aiming at improving the quality of public transport services and reducing delays for passengers [22] [23].

Dina et.al, conducted a survey on issues related to the usage of IoT based solutions in public transport. They found out that initially IoT-based solutions were mainly used to avoid road accidents, and now are more into intelligent transport system including bus scheduling, seats booking, and reducing wasted time of passengers. Their research proposes to integrate the concept of IoT into platforms of the public transport actors, to harness the power of IoT in creating smart cities [24], similarly to the work by V. Pawar and V.A, Bhosale who described IoT-based intelligent transportation systems as tools to support the smart city vision [25]. In their work, Parag and Prof. Meeankshi highlighted important aspects to be considered while designing an IoT-based solutions. The first is to choose system components that are efficient in terms of energy requirements, and secondly to design a secure solution [11]. Ganesh and Balaji implemented an IoT based passenger information system optimized for Indian metros using GPS, android application, and the electronic ticketing system [26]. Their system was able to provide passengers with real-time information to allow them to decide on whether to go with the current bus, which is full, or wait for the next one.

The application of an IoT platform as service (PaaS) requires additional components like real-time processing engine to guarantee automation for machine-to-machine communications, as well as big data tools to handle and store the large amounts of IoT data [22]. These are beyond the scope of our work but could be interesting to explore the IoT PaaS for public transport as it offers advanced transport business intelligence to produce a dashboard and interactive reporting. The solution in [26], provided data analytics that provided insights on balancing passengers load on metros, which can be applied in public bus transport system too. The IoT market is perceived with huge potential market for impressive innovation. However, coming up with strong and sustainable business models remain a big challenge [10] [27]. Deployment of IoT-based solutions to improve public transport services require upfront investments and consideration of interlinkages between different transport systems such for goods, individual cars, motorcycles, and pedestrians [28]. Existing smart solutions for improved public transport services such as payment using Tap & Go cards and open Wi-Fi in buses in Kigali [29] [30] are commendable, but passengers are still challenged by the waiting in long queues at bus stops and

terminals.

In summary, most of the solutions from the reviewed literature may not be directly deployed in Rwanda as the context and factors considered are different from the realities on the ground. For example, most of the solutions are applied in cities with advanced transport infrastructure and developed urban planning settlement. Many of the solutions use mobile applications to inform passengers about the location of the buses, yet in most of the passengers traveling with public buses may not have smartphones to be able to use the application. Some of the immediately applicable solutions such as the GPS-based announcing system, to communicate to the passengers at bus stops and bus stations about the location of the buses in real-time could be improved for customized broadcasting to all relevant bus stops and bus stations using IoT-based solution. Though this would again require the passenger to be physically present on site to get this information. Generally, the seats management as an important feature to promote inclusion in the society, was not exhausted in the reviewed studies. Hence with this project, our IoT-based solution will help passengers have timely information about arrivals at bus stop and bus station, and about seats availability.

The literature review confirms the IoT-based solutions role in achieving improved public bus transport services at bus stop and bus station. Through sensing, measuring, sharing, and analyzing the data about the specific aspect of the needs to be responding to, the gathered information is used as input to the decision support systems. IoT-based solutions were used to announce to passengers waiting at bus stops or bus stations the general information about locations of buses. They were also used to control public bus networks and share the information with passengers on screens showing the buses across cities. Using mobile applications, IoT-based solutions were also used to provide passengers with information on the nearest bus and its arriving time, but without real information about seats availability. Other studies realized the potential of IoT-based solutions in smart cities development where the opportunity created by huge data collected is beyond just addressing public transport service issues, to enable interactive reporting, intelligent cities planning and management. Further studies are recommended to establish practical and sustainable business models of IoT-based solutions which responds to different cities' settings.

CHAPTER III. RESEARCH METHODOLOGY

3.1. Introduction

In this project we designed an IoT based solution to enhance public transport in Rwanda, through improved services at bus stops and terminals. Using IoT based technology, the purpose of the developed solution is to enable better time management of passengers using public bus transport. The solution looks into allowing seats booking and helping to understand better more about challenges that may hinder IoT deployment in public transport in Rwanda.

3.2. Research design

Key Definitions

Solution Component	Image (where applicable)
Internet of Things: The Internet of Things is the grouping of the smart devices that are communicating and switching the data via the internet channel within short or long distances. In our solution sensors, smart phones, and computers are used to collect and share data over internet about available seats and bus location.	
Smart Device: Smart devices refer to some electronic components that can be connected to the Internet to interact with other devices and with humans using them. In this study, we used the GSM module, or smart phone, and computer, are used as the smart devices.	
Global System for Mobile communication (GSM): The GSM is a digital radio network system used by wireless carriers for transmitting mobile voice and data services. The GSM module used is the smartphone with capabilities to access the web application, and to navigate the platform.	
A liquid-crystal display (LCD): The LCD is an electronic display device that operates by applying a varying electric voltage to a layer of liquid crystal, that becomes visible when electricity passes through them as it	

induces changes in its optical properties and display the information on a screen. In the designed solution the data about the bus and seats available are displayed on screen.	
Authentication Process: The authentication technology provides access control to systems by checking user credentials in a database of authorized users. In this project Message-Digest Algorithm (md5()) is the authentication technology. Each user is authenticated and provided with access credentials before starting to use the system.	
Camera: The camera is used to capture and record images. In this study we used the OV7670 camera, a small size, highly sensitive, low voltage image sensor that can be programmed in Raspberry pi. It has a mechanism for controlling and taking a picture of an object's surface. The dimensions of the opening can be enlarged or narrowed to let light into the camera.	 **Figure 3.1:** the OV7670 image sensor used as system camera
Raspberry Pi: The Rasberry Pi is a type of microprocessor used to interface sensors, which forms an embedded system. It analyses the data received from each sensor connected to it and sends it to the database over the wireless network. It interfaces the system components and orchestrates the data exchange among the components. It includes a processor, memory, and input and output peripherals.	 **Figure 3.2:** Raspberry Pi
Proximity sensor: Sensors are devices used to respond to stimulus in different forms such detecting an event or recording a change or measurement. In this research solution, the proximity sensors are used to detect the seats occupancy in a bus.	 **Figure 3.3:** the proximity sensor
Node Micro-Controller Unit (MCU): The node MCU connects objects and let data transfer using wireless network, specifically Wi-Fi protocol. It is used to enable the transfer of data wirelessly from the sensors, cameras, and Raspberry Pi to the server, so it can be processed and displayed for user information.	 **Figure 3.4: the node MCU**
Power supply unit: The power supply unit is the component that	

converts alternating high voltage current (AC) into direct current (DC) and regulates DC output voltage to the fine tolerances required for computing device used in the designed solution.	
Real-time clock (RTC): RTC is an electronic and integrated circuit designed to measure the passage of time is a system even when the power is off. A real-time clock (RTC) is an integrated circuit that is designed to keep track of time accurately. It is used to keep track of all time from the year down to the second and it's a very versatile chip. The recorded information is read by the microprocessor over a serial interface to facilitate the software performing time-dependent functions.	
Database: The database is a collection of data, or information, that is specially organized for rapid search and retrieval by a computer. In our study, the database is structured to facilitate the storage, retrieval, modification, and deletion of data in conjunction with various data-processing operations of the designed solution.	
Wireless network: Wireless network is used to provide Internet connectivity needed among different components of the system. The designed solution is such that smart devices are connect and share data via internet without wires.	

Table 1. Key Definitions

3.3. Approaches and Techniques

The information was gathered through desk-research about the challenges in public transport in Rwanda. Initially we had planned to conduct interviews to collect inputs form the passengers, public transport operators, as well as city managers in charge of public transport. However, due to limitations beyond our control imposed by the Covid-19 pandemic, we instead ended up using our own observations while using the public bus transport services, public information, reports and information from RURA publications on the issue [3] [6] [7]. Constraints in public buses transport system, specifically at bus stop and bus stations were identified, mainly passengers long waiting in queues due to lack of information and inconvenience is getting a seat on the bus. The approach for the solution development was focused

on designing and testing a solution prototype responding to the defined requirements to track the bus at the bus stop, providing the passenger with information on when the bus will reach the destination and seats availability.

3.4. Procedure for Data Analytics

Our study involves both qualitative given that is bases on similar previous academic research with the aim to develop a solution that takes into consideration the Rwandan context in terms of Internet connectivity readiness, public transport organization, and passengers appreciation of the solution to address their needs. It also involves quantitative data from the different data sets of the IoT solution including the number of buses, trips, passengers, bus stops, etc. The data is analyzed to validate the assumptions and to find an appropriate model of the public transport constraints and categorization based on similar research works and other existing IoT solutions for improving public transport services at bus stops and terminals. Finally, the outlined conceptual framework for the IoT solution to improve public transport services at bus stops and terminals in Kigali is structured based on the findings.

3.5. The solution design

The designed IoT-based solution is a system composed by two main parts, one is made by the electronic components, and the other one is the software part. The electronic components involve both the IoT devices and physical devices, from power supply, the passenger's smart device (computer or smart phone); the IoT module including the wireless network access point used, the camera for taking plate number image and Raspberry Pi for collecting data from camera and sending to website for user, both are at the bus stop and bus station; as well as proximity sensors, sensing the seat usability or presence send all data to the website using the node MCU and wireless network access point inside the bus. The passengers can access a website e-transport online using smart device.

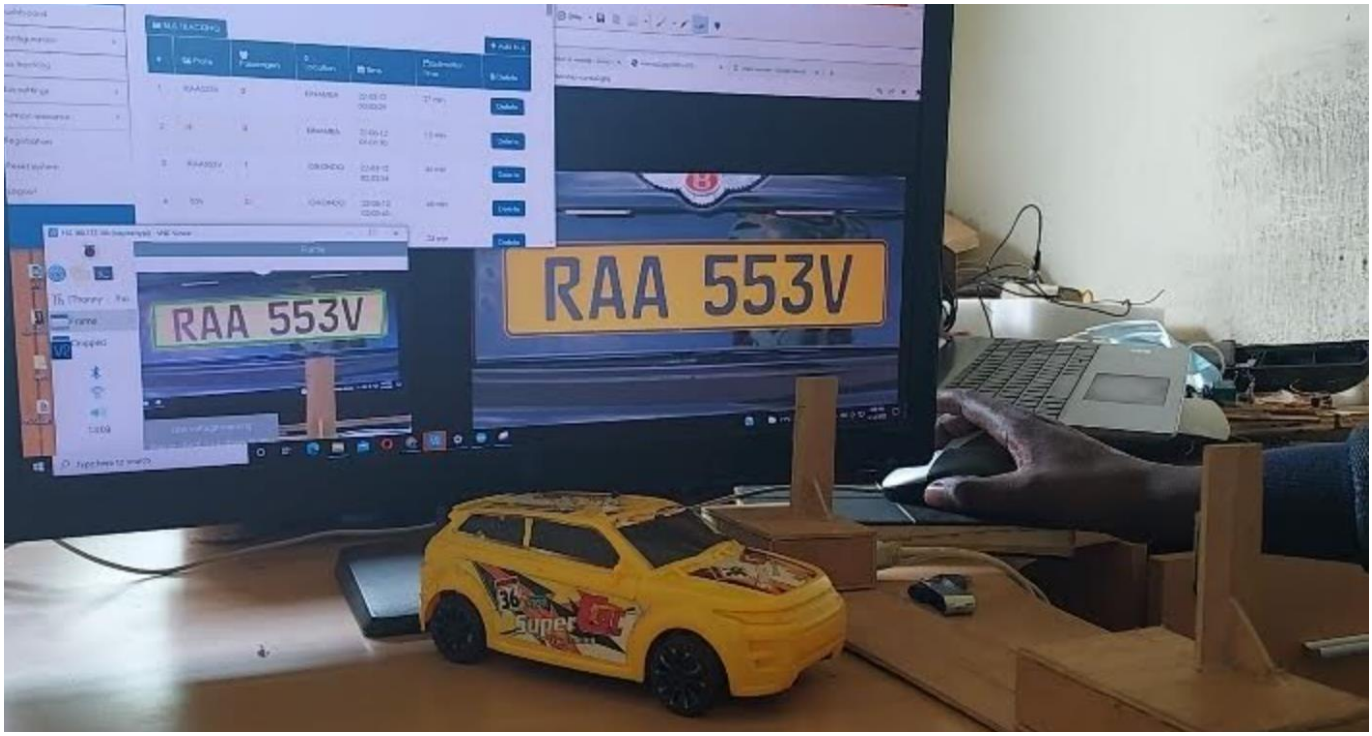

Figure 2. The high-level design of the solution

The software part includes mainly the database containing all data being collected and key information about the bus such as its plate number, number of seats, the identification of the driver, the departure station and destination terminal of the bus, as well as the e-transport web application, which is the interface for information and updates access by passengers which are hosted on a local server.

3.6. How the system works

In the designed solution, the bus is equipped with proximity sensors, a node MCU on all passengers' seats, and Wi-Fi for Internet connectivity. The proximity sensor is used to collect information on whether the seat is occupied or not. The node MCU helps in collect data from the proximity sensor and sending it to the system database using WiFi. Each bus is also uniquely identified using the normal car plate number. At all bus stations and bus stops there is Internet connectivity deployed through Wi-Fi access points. There are also cameras installed, that takes images of buses passing by, capturing the plate numbers.

3.7. Database

The system database stores all the different system's data including each Raspberry Pi identification

according to the bus station or bus stop name, location, and time, the data collected from the proximity sensors in buses about seats, and the data about bus identification and locations captured by cameras at bus stations and bus stops. The information in the system database gets continually updated each and every time the sensors sends new data. The bus has to stop at each bus park and bus stop to enable the continuous update of the data about the buses locations and time in the database.

3.8. Bus stop or bus stations

The camera takes the picture of each bus stopping at the bus stop. The image taken by the camera is sent to the Raspberry Pi that is also mounted at the bus station or bus stop. The Raspberry Pi processes the image to identify the bus by its plate number. The raspberry Pi then sends the plate number to the database for verification and authentication.

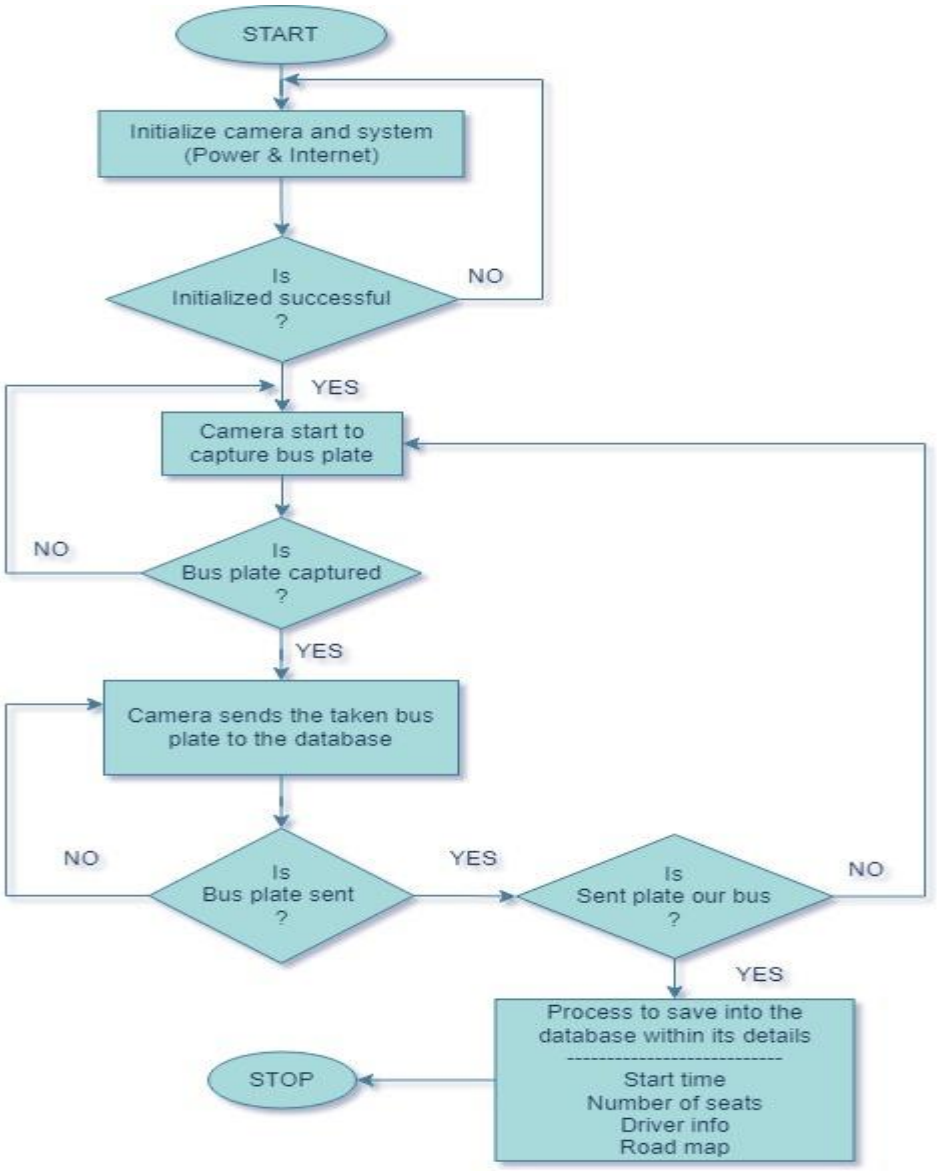

Figure 3. Flowchart of how the camera works

3.9. E-transport web application

The e-transport online platform was designed to allow passengers to have access to the information about buses locations and seats availability on the next bus coming. The passenger registers on the platform using a smart device (phone or computer) and creates an account with a username and password. The passenger logs in to the platform using the username and password, and immediately gets access to the dashboard, where the information about the bus's status on location, time, and seats for the different in-service buses are displayed. The designed solution allows the passenger to also see it there are free seats on the bus.

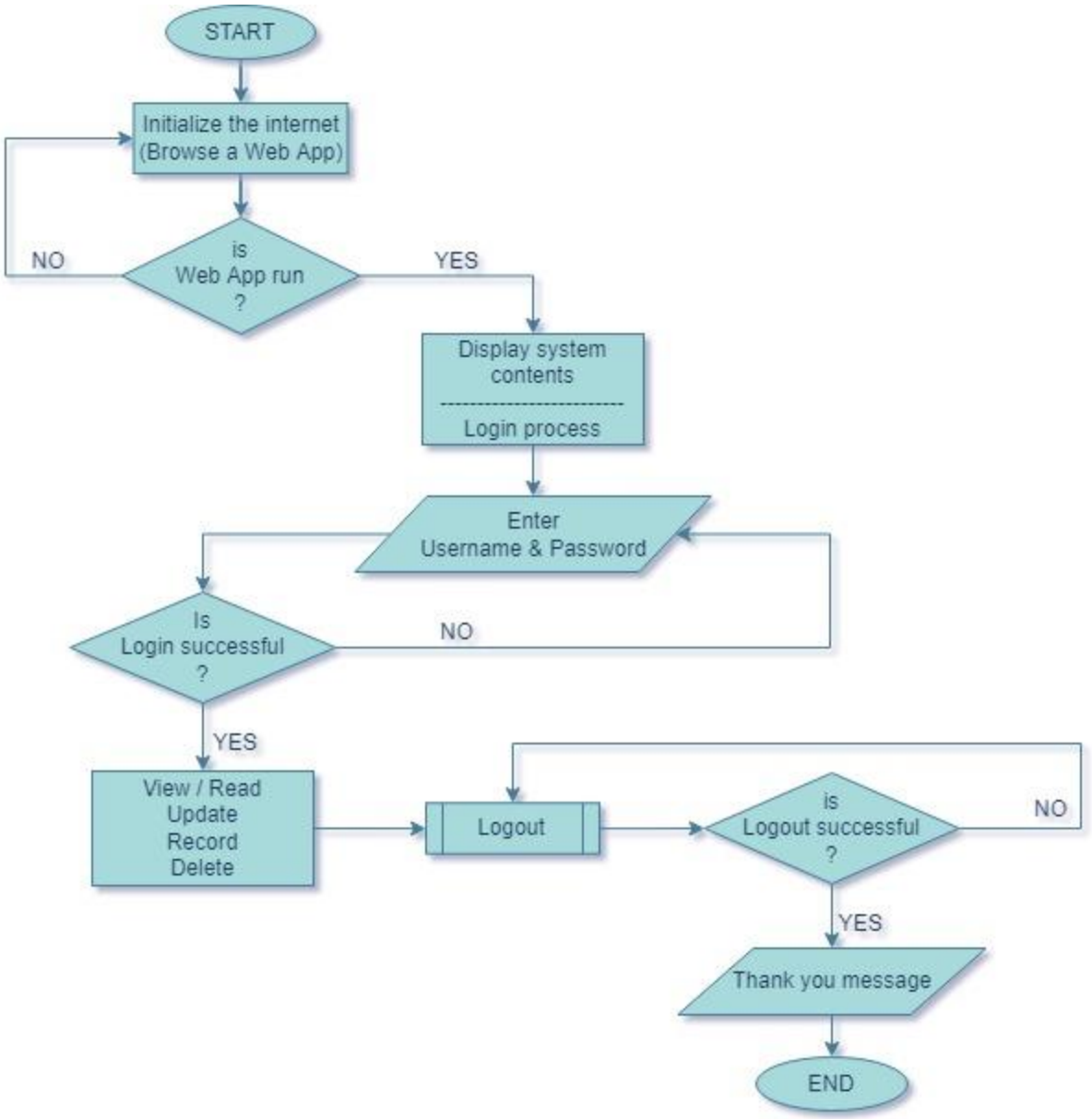

Figure 4. Flowchart of an e-transport web application

CHAPTER IV. THE SYSTEM RESULTS, ANALYSIS, AND DISCUSSIONS

4.1. Introduction

As part of the initial phase of our study, our solution system design components are the physical IoT devices, the web application, and physical devices. The passenger's physical access device in this case is a smartphone, and three IoT devices installed at each bus stop including the camera, Raspberry Pi, a Wi-Fi access point, and the screen. The camera and Raspberry Pi collect information about buses passing by. The Wi-Fi access point at the bus stop also is used to transfer data collected by the camera and the Raspberry Pi and receive updates on bused locations to be displayed on the screen through the Internet. When the bus reaches a certain bus stop, the camera captures its plate number and sends the information to be displayed on the next bus stop using raspberry connected to Wi-Fi, including estimated remaining time to reach the next stop.

4.2. The Solution diagrams

The following diagrams demonstrate the system diagram for the IoT modules in the bus and at the bus stop. They show the key parts of the of each system and their main components.

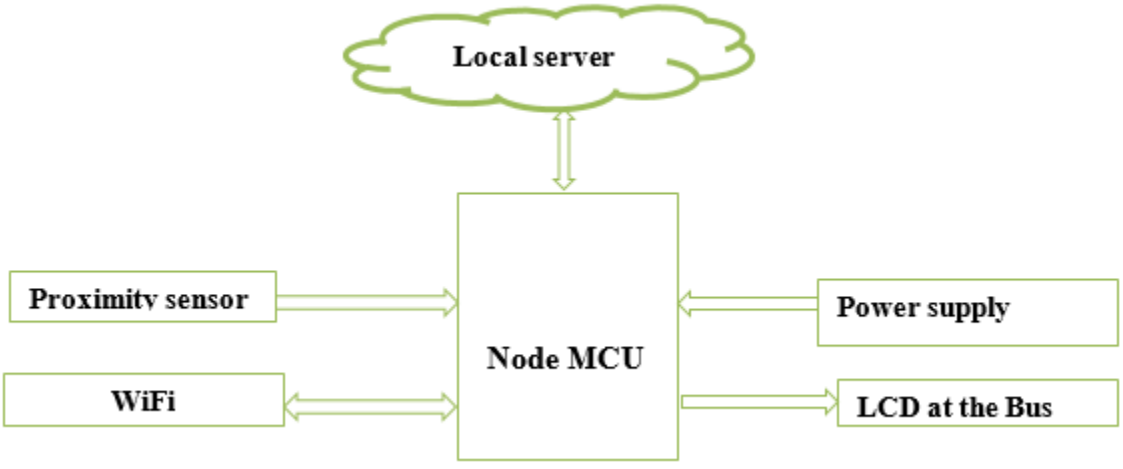

Figure 5. System diagram of the IoT module in the bus

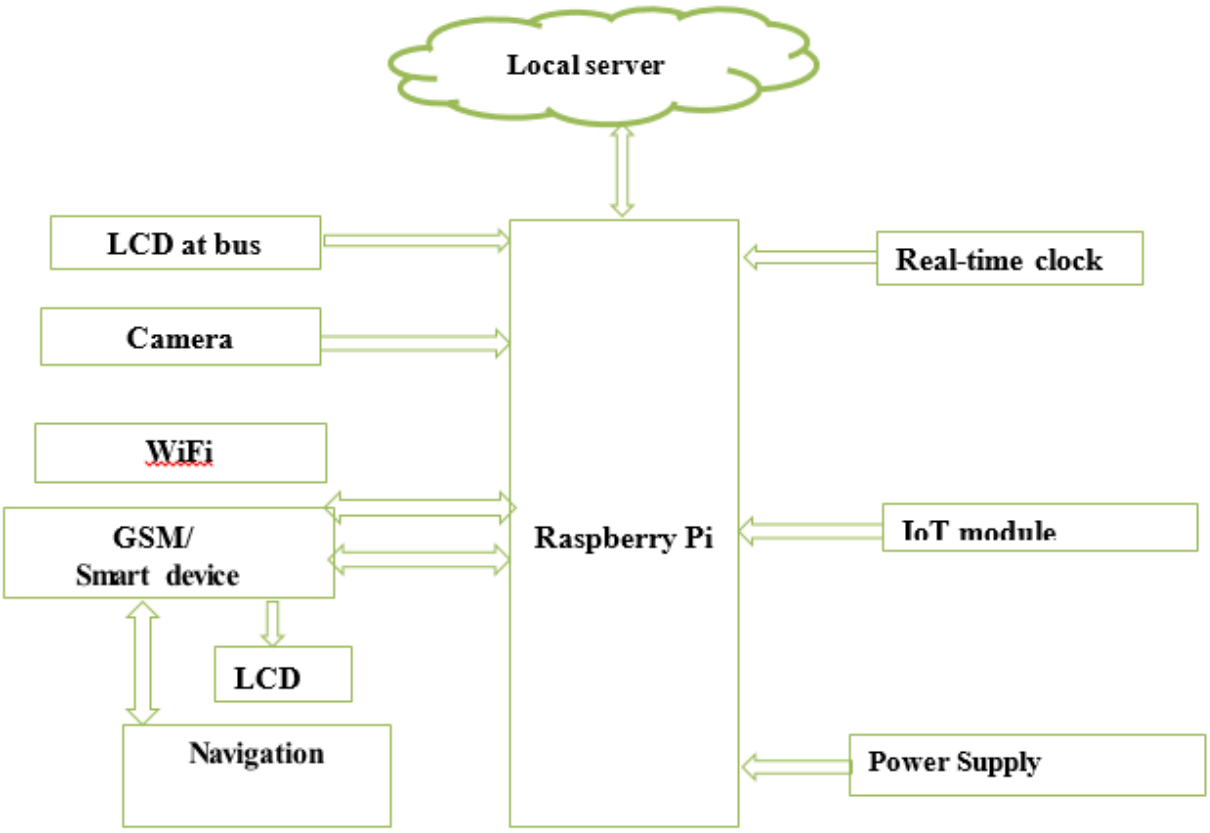

Figure 6. System diagram of the IoT module at the bus stop and bus station with Raspberry Pi

4.3. System setup

4.3.1. IoT module in the bus

In the following figure 9 shows a toy car figure 4.3 that is used as the bus, including the seats, each seat is equipped with one proximity sensor, and one node MCU to control the seat occupancy. The seat proximity sensor is connected to the node MCU as shown in figure 4.4 and the node MCU with blue light is powered by the power supply from the bus, the proximity sensor with green light is also connected to it, to form IoT module in the bus

Figure 7. The bus used in this project

Figure 8. IoT components in the bus

4.3.2. IoT module at bus stop and bus station

The IOT module deployed at the bus stop or bus stations include the camera that is connected to the Raspberry Pi in figure 4.5 The Raspberry Pi is connected to the powered by the power supply at the bus station or bus stop. The wireless network is also configured on the Raspberry Pi for internet connectivity access. The figure 4.6 shows IoT modules at the bus station and at the bus stop, both connected to the power supplies.

Figure 9. The camera connected to the Raspberry Pi

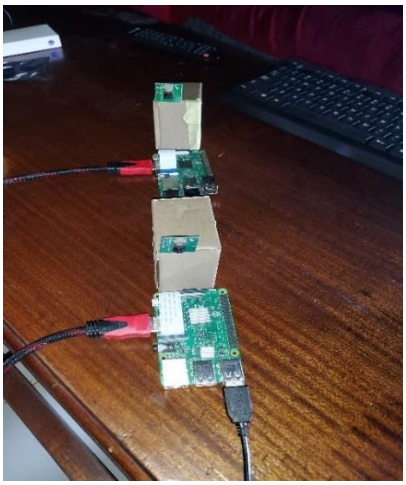

Figure 10. connection to the power supply

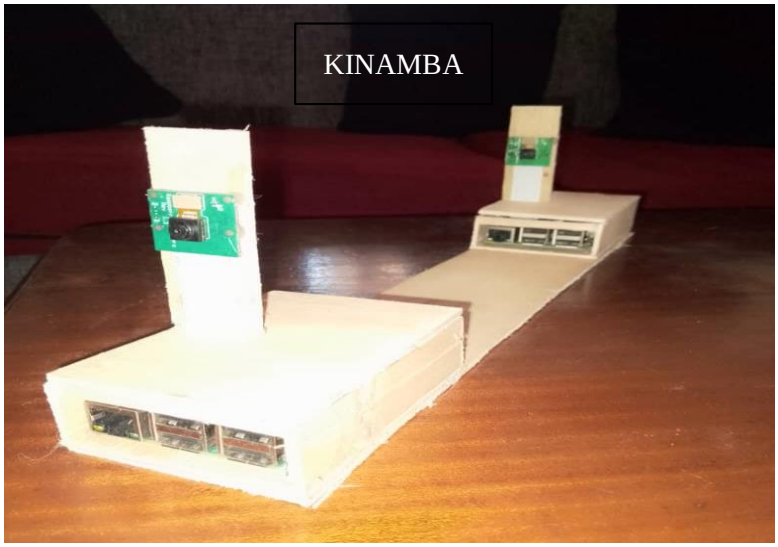

Figure 11. IoT main module set up at bus stop (KINAMBA) and bus station (GIKONDO)

The physical set up of the designed IoT solution to improve services at the bus stop and bus station between Gikondo and Kinamba. The IoT module is mounted to the bus stop or bus station in such a way that the camera can capture each and every bus that stops-by, with focus on the plate number on the vehicle; where the captured image is analyzed by the Raspberry Pi which identifies the plate number and using the wireless network at the bus stop or bus station, the data about the plate number, time and location of the bus is sent to the system database for verification and combination with the data from the node MCU about the number seats available in the same bus. This data is later used to provide passengers with access to information they need.

4.4.Results analysis

4.4.1. Data recording in the database

To start with, the system administrator records in the buses in the database with their identification including details such as the bus plate number, the driver as company personnel, the transport line where it operates, and the pricing for travel.

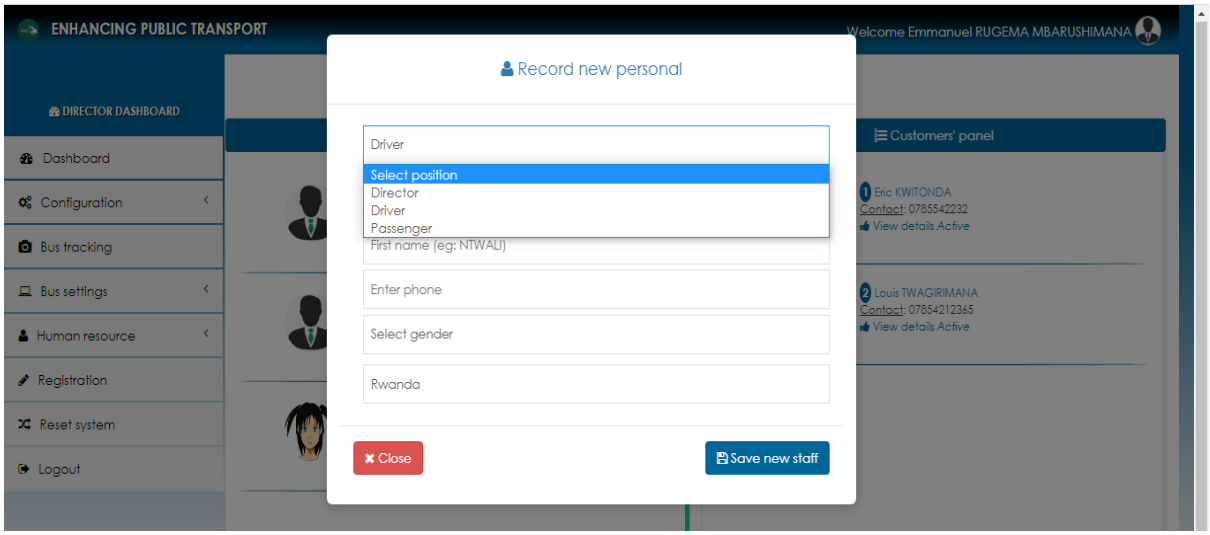

Figure 12. Record new user

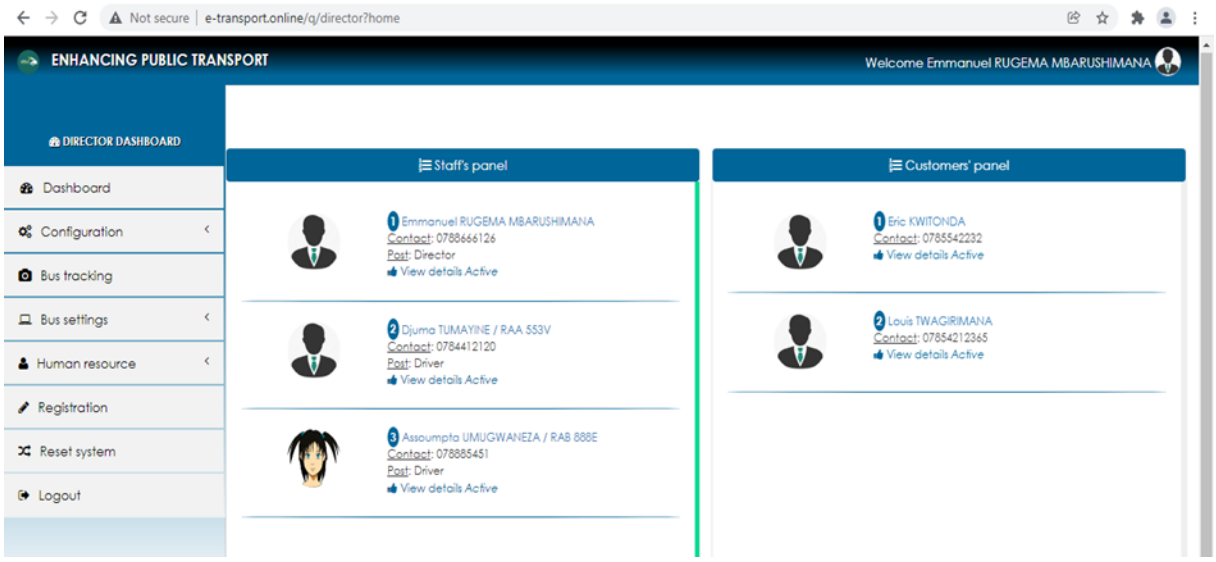

Figure 13. Summary of the recorded users

4.4.2. Full system set up without cover

After setting up the bus module and the bus stop module, the database as well as the web application, everything is now connected together to form e-transport online system.

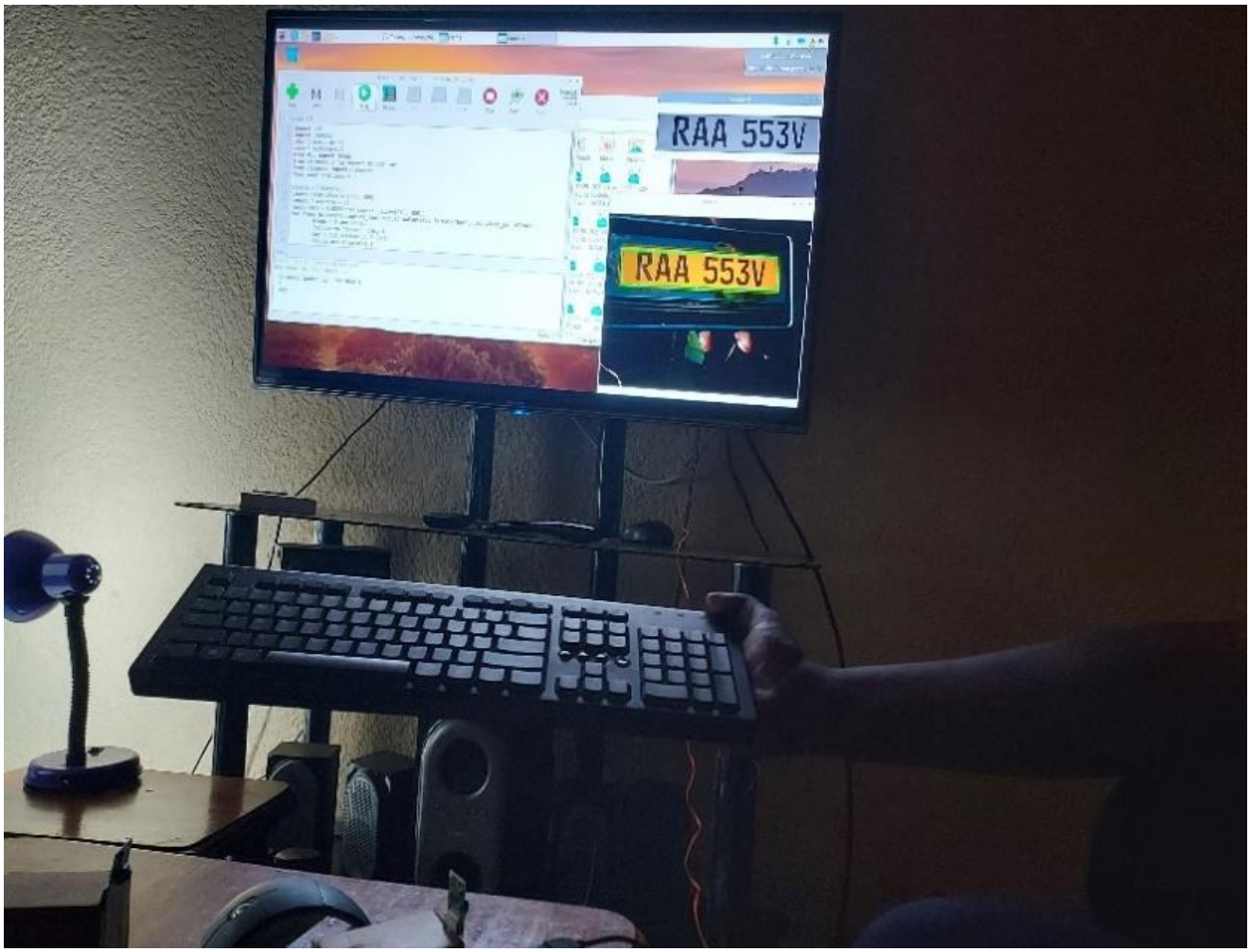

Figure 14. The designed IoT based e-transport online solution prototype

The system tart to operate and keeps updating the information as the bus passes by the bus stop. The bus stops are identified by the deployed Raspberry Pi which are recorded according to the name of the bus stop or bus stations. In the database, the system administrator is able to add or remove a bus on the travel line depending on the status of registered passengers, or in case the bus has an issue and is removed from service.

4.4.3. Detection of bus plate number by the Raspberry Pi

At the bus stop the plate, the picture captured by the camera is sent to the Raspberry Pi, where is the plate number is detected and thereafter sent to the database for verification and recording

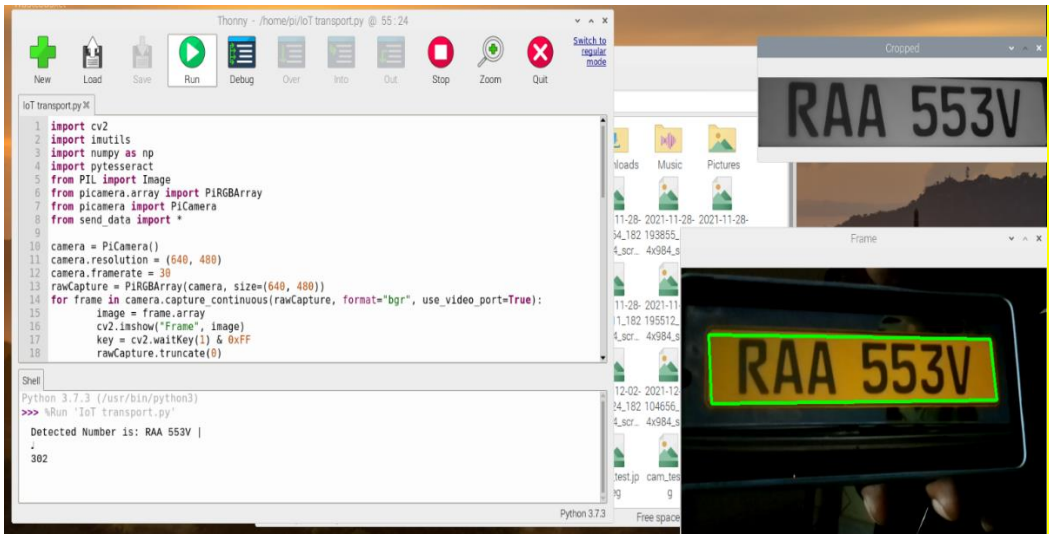

Figure 15. Detection of bus plate number by the Raspberry Pi

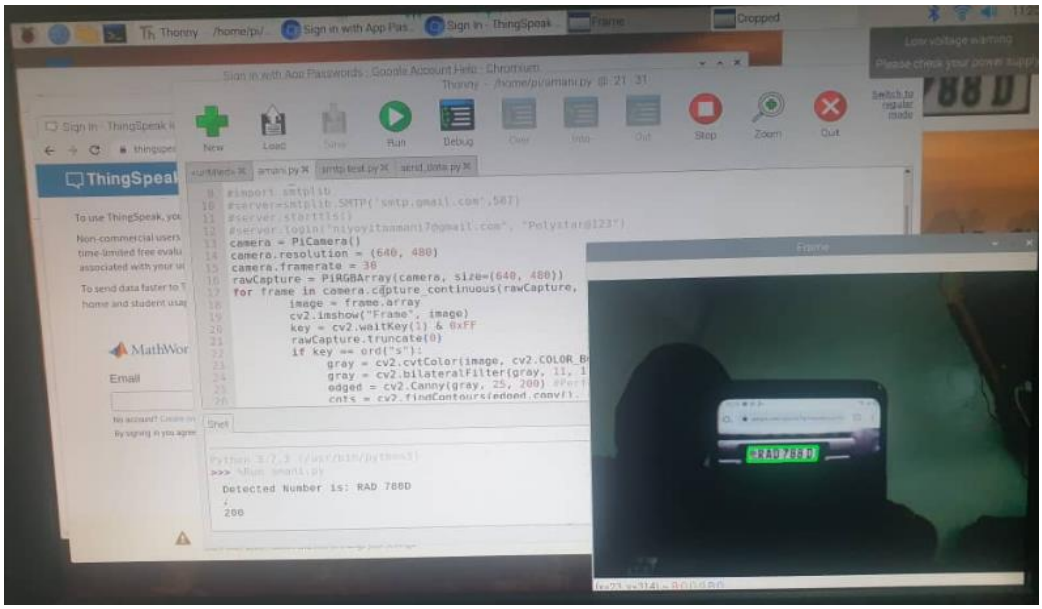

Figure 16. Bus plate number detection by the Raspberry Pi

4.4.4. e-transport online

4.4.4.1. The Web Application

The e-transport online web application was design and implemented to allow passengers to register in the system in order to get the information about the buses. In additional to the in-build database, where all information about the buses, bus stops, and bus stations, are pre-registered, as well as the information of bus drivers, and bus travel lines.

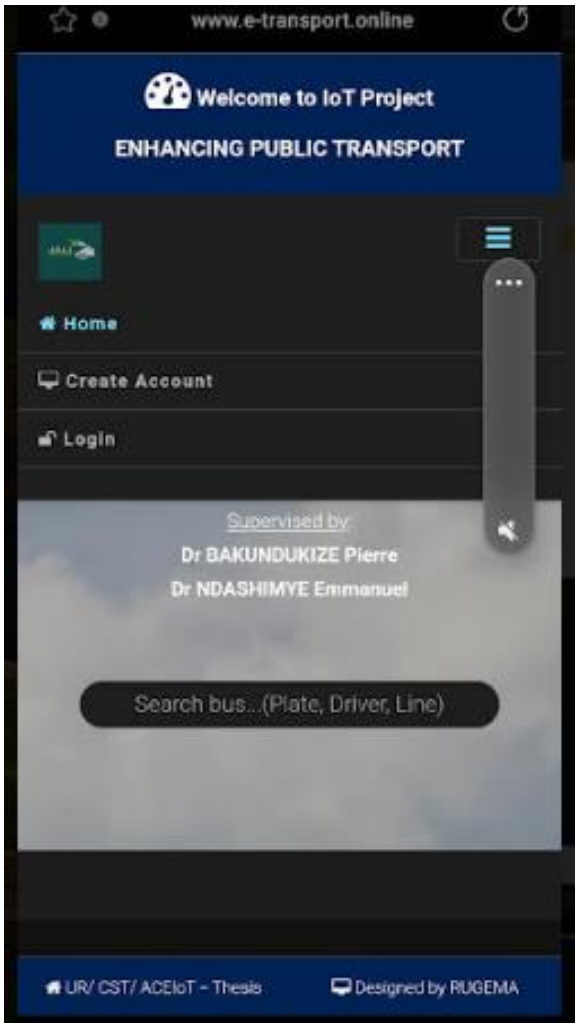

Figure 17. Web e-transport online application interface (http://e-transport.online)

4.4.4.2.Passenger login

The passenger registers on the e-transport online platform, by creating an account on the web application using a username and password.

Figure 18. Passenger creating an account on e-transport online

4.4.4.3. Passenger navigating the e-transport web application

Once logged in the e-transport web application system, the passenger can see the dashoard with latest updates of in service buses, their location, the record of the time when the bus passed by arrived the recorded location, and the estimated time of when the bus will get to the bus station or bus stop near the passenger. The passenger is also able to see also the number of passengers in the bus.

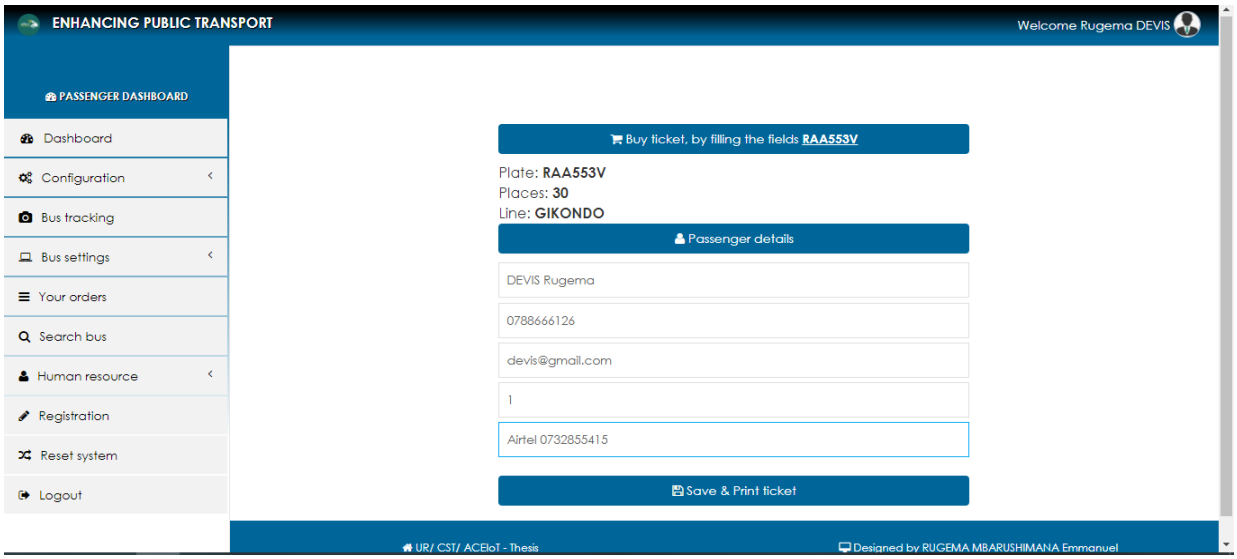

Figure 19. The e-transport online dashboard

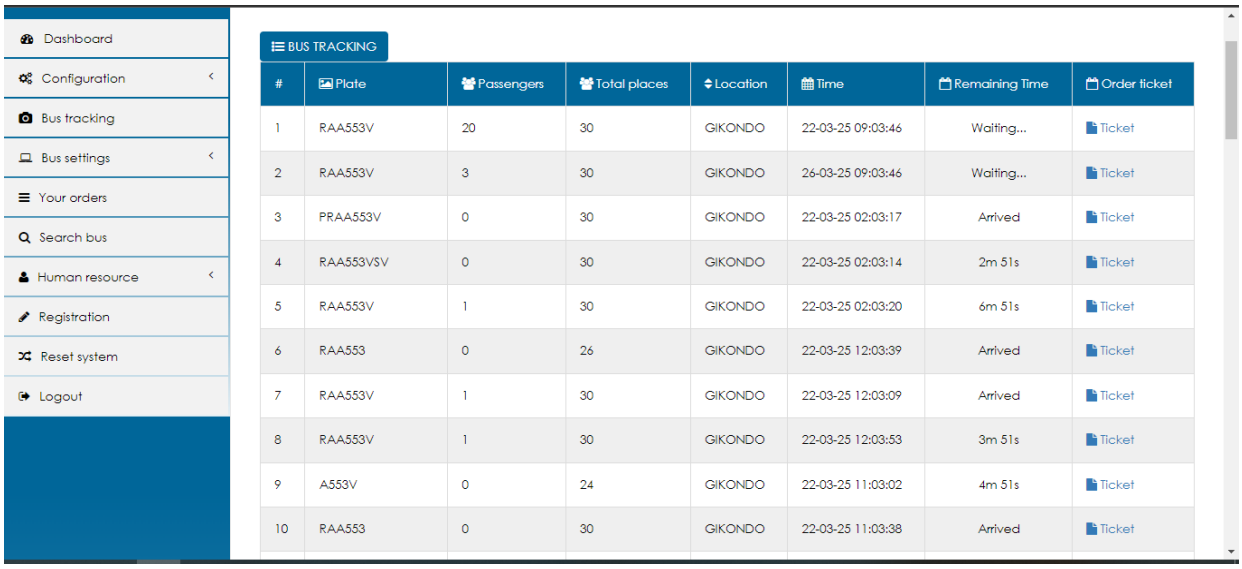

Figure 20. The e-transport online dashboard within the list of recorded buses

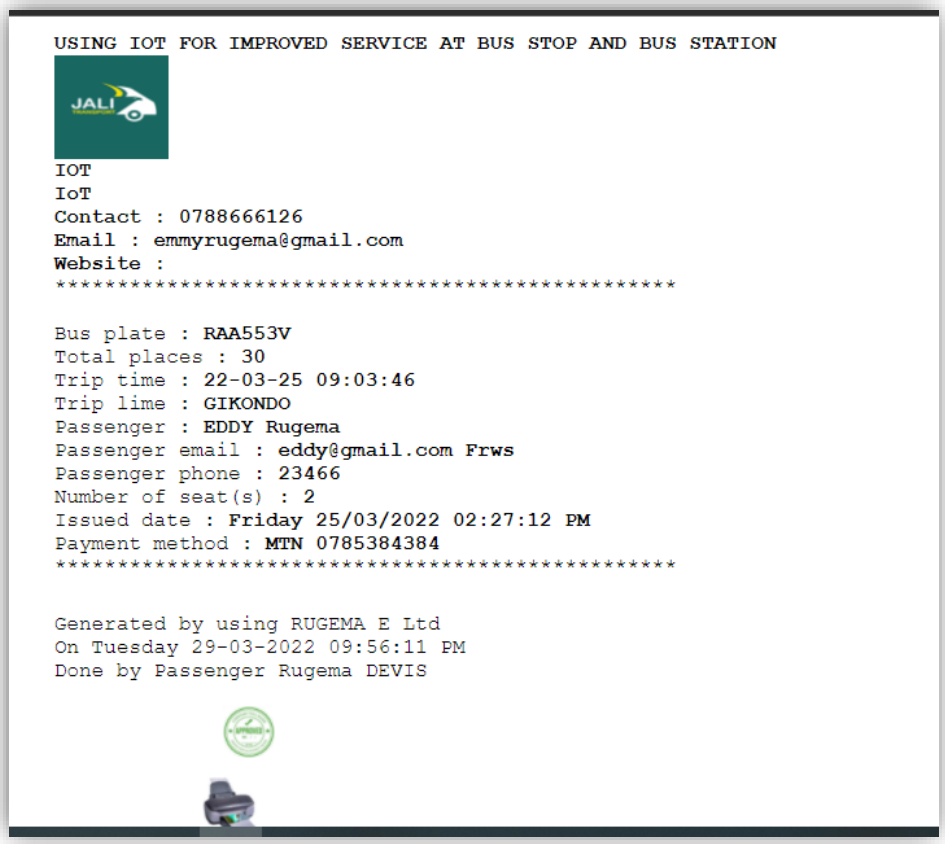

Figure 21. The e-ticket printable

The e-transport online dashboard provides the passenger with information about the bus, the different locations according to time, the number of passengers onboard and ordering a ticket. Through the e-transport online system, the passenger is able to see the status of the bus including its location and time when it reaches at a location, on his or her smart device. However, at this stage e-payment and seat booking features were implemented as the passenger can get information on availability of the seats and printed a ticket. Therefore, in order to have fully take advantage of the e-transport online solution passengers have to own a smart device, have access to internet, and have minimum digital skills to be able to use our solution. Passengers are also required to play their main part by well planning their travel and respecting the time, so that the solution can become meaningful, and serve for its purpose.

4.4.5. Discussion

In our project, we have been able to develop and deploy an IoT-based solution prototype that is contextualized to our environment where most of the buses in public transport are not smart by

design. The developed IoT-based solution was able to collect data and avail the information about the location, the time of arrival at the bus stop or bus station, and the seats available on the bus.

Most of the previous studies used GPS technology to determine the buses and the passengers' locations [8] [13] [18] [23], but our solution uses cameras deployed at bus stops and bus stations to locate the buses. The estimation of arrival time is also computed by the system based on the data collected about the bus movement as it passes by the bus stop or bus station, and not estimated based on the GPS coordinates between the bus and passengers' locations using an android application like in [17]. The seats availability and management has not been worked on thoroughly in the considered previous studies as they generally focused on in and out passenger counting like in [13]. Our solution provides information about seats availability in the bus, which was noted as an important feature for inclusion in [28] to enable for instance people with disabilities to conveniently travel in cities using public bus transportation. The information about the bus could be accessed through the web application using a smart phone or computer or displayed on LCD screen at the bus stop and bus station. Smart devices were used in most of the reviewed studies such as [10] [17] [22] [23], and audio announcement system at bus stations [14]

During our study, the entire solution was not fully developed and tested as initially conceptualized. Some of the initially set objectives were not met due to limited time and availability of some of the needed components such as the engine detection sensor that could not be found on the local market. Hence the module of booking seats was not implemented as planned. Also, the mobile payment aspect was not full real tested due to the provider delay. The covid-19 impact on public transport has also been among the constraints in our study as it hit during the time that we had plan for conducting extensive interviews and getting to test the prototype in the real-world environment.

The second part involving digital payment using mobile money and enabling bus managers to have full visibility of transactions of the buses' services, buses trips, and bus drivers' management, were not real implemented due to limitations presented before. On the side of the passengers, the module for automatic notification about each station passed by the bus, so for the passenger to know when the bus arrives at the desired destination, was implemented. Also, Nevertheless, we managed to test and prove the IoT solution's main aspect in improving services in public bus transport services by providing passengers with the information they need.

CHAPETER V. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

During our study on "Enhancing Public Transport in Rwanda Using IoT for Improved Services at Bus Stop and Bus stations" we were able to demonstrate how to provide the passengers with the information about the bus location and time of arrival at the bus stations through their smart device or LCD screen. The camera deployed at the bus stop, is connected to the Raspberry Pi that analysis the pictures taken to identify bus pate numbers and verify them in their registry in the database. The bus plate number is transmitted to the dashboard of next arrivals and time, at each of the bus stops for the information display. The passenger is able to access information about the bus location and arrival time at the bus stop, either through the smart device or the screen mounted at the bus stop.

The passenger can check through the web application on when the next bus will be arriving at the nearest bus station, before leaving his or her place, and can ordering a ticket and printed. The implementation of the IoT based solution to enhance bus services at the bus stops and bus stations will bring convenience and good experience to citizens using public bus transport, as the waiting queues will be significantly reduced by having people coming to the bus stations after checking the time of the next bus to arrive at the bus stop or bus station near them.

5.2. General recommendations

Successful smart cities deployment is achieved when citizens are able to see value from the different digital technology solutions. To achieve effective smart cities in Rwanda, efforts should prioritize most citizen needs like improving services in public bus transport. The following are recommendations from our study:

i. Citizens should be aware of the benefits of using IoT technology in their daily lives, and acquire basic tools such as smartphones, and learn to use IoT solutions, leveraging the available digital infrastructure.

ii. Public transport companies in Rwanda should invest in IoT solution adoption, to benefit from immense advantages acquired from having access to real data of all aspects of their business. This will be enabled by upskilling and training their staff members to remain up to date and ready for the adoption the technology advancement in public transport sector.

iii. Private companies should facilitate the availability of IoT devices and toolkits on the local market to unlock the potential of IoT industry development in Rwanda.

iv. The Government should promote IoT adoption in various sectors for better service delivery to citizens. Based on our solution enhancing public transport services at the bus stop and terminal, its applicability requires that the Government establishes smart public transport policies and regulations and work with the private sector to reduce the cost internet to allow efficient and sustainable deployment of IoT based solutions.

v. Academic institutions should establish IoT workshops and equip them to facilitate students to put in practice the different IoT concept the learn and to innovate solutions to our society problems; there should also be collaboration among institutions in charge, for the teaching of IoT basic concepts starting from the basic education.

5.3. Recommendations for future works

Future works should focus on:

i. The prototype be piloted with one of the public transport companies in Kigali to get comments and feedback from passengers and bus operators, and city managers, in order to improve it further.

ii. Complementing the solution adding the bus tracing in between the bus stations or bus stop.

iii. Developing the e-transport online mobile application, and USSD version for passengers using feature phones.

REFERENCE

[1] MINICT, "Smart Rwanda Master Plan Final," 2015. [Online]. Available: https://minict.gov.rw/fileadmin/Documents/Mitec2018/Policies _Publication/Strategy/SMART_RWAN DA_MASTER_PLAN_FINAL.pdf.. [Accessed 2020].

[2] MINICT-UNHABITAT, "Rwanda Smart Cities Master Plan," May 2019. [Online]. Available: https://unhabitat.org/sites/default/files/documents/2019-05/rwanda_smart_city-master_plan.pdf.. [Accessed 2020].

[3] RURA, Interviewee, Senior Manager, Data Analytics and Knowledge Management. [Interview]. 8 December 2021.

[4] A. Group, "About us," AC Group, [Online]. Available: https://www.tapandgoticketing.co.rw/pages.html.

[5] S. P. Kaliisa, "Kigalians weigh in on public transport ahead of fresh contract talks," News, 13 July 2019.

[6] T. Reporter, "Public transport woes continue to dog City of Kigali," The NewTimes, Kigali, 2015.

[7] RURA, "Statistics and Tarrif Information in Telecom, Media, and Postal Services and of the Fourth Quarter 2018," RURA, Kigali, 2018.

[8] J. Ahmed, "The Smart Transportation Using IoT and Intelligent Transport System in GPS Location," International Journal of Engineering Research in Computer Science and Engineering, vol. 4, no. 12, pp. 2394-2320, 2017.

[9] B. McGlynn, "How IoT Improves Public Transport for Pssengers," Davr, 2022. [Online]. Available: https://davra.com/how-the-internet-of-things-improves-public-transportation-for-passengers/?msclkid=3190c55fafb511ec9a7590695b6688cf. [Accessed 25 March 2022].

[10] N. B. A. C. L. V. M. Z. Andrea Zanella, "Internet of things for Smart Cities," IEEE Internet of Things Journal, vol. 1, no. 1, pp. 22-32, 2014.

[11] P. M. A. Parag Gawade, "IoT Based Smart Public Transport System," Internationl JOurnal of Scientific and Research Publications, vol. 7, no. 7, pp. 2250-3153, 2017.

[12] A. D. Nallapaneni Manoj Kumari, "Internet of Things: An Opportunity for Transportation and Logistics," in IEEE Xplore Compliant, 2017.

[13] V. A. Y. D. S. A. Sanket Dhanke, "Smart Public Transportation System," 2018.

[14] Lakshmi, "Smart Local Transporta Tracking System using IoT based Technique," IOSR-JECE, vol. 12, no. 6, pp. 12-15, 2017.

[15] S. D. Sabeur Elkosantini, "Intelligent public transport systems: a review of architectures and enabling technologies," 2013.

[16] M. A. H. M. T. S. Miraal Kamal, "IoT Based Smart City Bus Stops," Future Internet, 26 October 2019.

[17] S. A. K. K. S. S. B. H. Shinde Amruta, "Smart Public Transport System Using Android Application," International Journal of Innovative Reasearch in Computer and Communication Engineering, vol. 6, no. 5, pp. 51-58, 2018.

[18] P. M. A. Parag Gawade, "IoT Based Smart Public Transport System," International Journal of Scientific and Research Publications, vol. 7, no. 7, pp. 390-396, 2017.

[19] S. S. R. K. G. R. B. D. Lavanya R, "A Smart Information System for Public Transportation using IoT," International JOurnal of Recent Trends in Engineering & Research , pp. 222-230, 2017.

[20] M. A. N. H. H. Dina Fitria Murad, "IoT for Development of Smart Public Transport System: A Systematic Literature Review," Journal of Pure and Applied Mathematics, vol. 118, no. 18, pp. 3591-3604, 2018.

[21] K. C. B. M. N. N. V. Bhat Apoorva, "A review on smart bus ticketing and tracking system using IoT," International Journal of Engineering Research and Technology, no. 2278-0181.

[22] I. a. T. T. Committee, The Internet of Things in Public Transport, Brussels, 2020.

[23] A. Sharma, "How IoT tracking devices can change the landscape of the fleet management business," Jungleworks, 4th April 2019. [Online]. Available: https://jungleworks.com/how-iot-tracking-devices-are-changing-the-landscape-of-the-fleet-management-business/#:~:text=Internet%20of%20things%20in%20the%20vehicle%20tracking%20system,GPS%20tracking%20solutions%20obtain%20real-time%20information%20on%20rout. [Accessed 25 March 2022].

[24] M. A. N. H. H. P. Dina Fitria Murad, "IoT for Development of Smart PUblic Transportation System: A Systematic Literature Review," International Journal of Pure and Applied Mathematics, vol. 118, no. 18, pp. 3591-3604, 2018.

[25] S. A. B. Vishal Pawar, "Smart Local Bus Tranportation Sustem Based on IoT," Internation Journl of Research in Electronics and COmputer Engineering, vol. 6, no. 3, pp. 2393-9028, 2018.

[26] B. G. R. Ganesh Venkat Sundat, "IoT Based Passenger Information System Oprimized for Indian Metros," Internationa Conference on Electronics, Communication and Aerospace TEchnology, 2017.

[27] Tele2, "Business Models for IoT," [Online]. Available: https://tele2iot.com/article/business-models-for-iot/?msclkid=de7dd349af8611ec91848af790651b07. [Accessed 25 March 2022].

[28] J. Clark, "Connecting commuting:IoT and smart transport," IBM, 7 September 2016. [Online]. Available: https://www.ibm.com/blogs/internet-of-things/connected-transport/?msclkid=f0f22a65afb311eca070473f6627c019. [Accessed 25 March 2022].

[29] A. Group, "Defining Smart Transport," AC Group, 2022. [Online]. Available: https://www.acgroup.rw/?page_id=26. [Accessed 25 March 2022].

[30] A. Group, "Tap&Go WIFi," AC Group, 2022. [Online]. Available: https://www.acgroup.rw/?page_id=24. [Accessed 25 March 2022].

Appendices

a. Connection page.

```
<?php
@session_start();
$DB_host = "localhost";
$DB_user = "root";
$DB_pass = "";
$DB_name = "bus_db";
try
{
$DB_con = new PDO("mysql:host={$DB_host};dbname={$DB_name}",$DB_user,$DB_pass);
$DB_con->setAttribute(PDO::ATTR_ERRMODE, PDO::ERRMODE_EXCEPTION);
$DB_con->setAttribute(PDO::ATTR_EMULATE_PREPARES, false);
}catch(PDOException $e){echo $e->getMessage();}



//=========================================================================
======== DETAILS
$view_bus_details = $DB_con->prepare("SELECT bus_details.bus_id, bus_details.bus_logo,
bus_details.bus_stamp, bus_details.bus_name, bus_details.bus_abbreviation, bus_details.bus_email,
bus_details.bus_phone, bus_details.bus_pobox, bus_details.bus_motto, bus_website,
bus_details.bus_izina_ry_ubutore, bus_details.bus_manager, bus_details.bus_font_family,
bus_details.bus_category, bus_cells.CellName, bus_sectors.SectorName, bus_district.DistrictName,
bus_province.ProvinceName FROM bus_details, bus_cells, bus_sectors, bus_district, bus_province
WHERE bus_details.bus_cell_id=bus_cells.Cell_ID AND bus_cells.Sector_ID=bus_sectors.Sector_ID
AND bus_sectors.District_ID=bus_district.DistrictID AND
bus_district.ProvinceID=bus_province.ProvinceID ORDER BY bus_details.bus_id ASC");
try {
$view_bus_details->execute(array());
$row_count_access = $view_bus_details->rowCount();
if ($row_count_access > 0)
{
$access_bus_details = $view_bus_details->fetch(PDO::FETCH_ASSOC);
@$bus_id = $access_bus_details['bus_id'];
@$bus_logox = $access_bus_details['bus_logo'];
@$bus_stampx = $access_bus_details['bus_stamp'];
if(@$bus_logox=='logo/'){@$bus_logo='images/ajax-loader-gears.gif';}
else{@$bus_logo=@$bus_logox;}
if(@$bus_stampx=='logo/'){@$bus_stamp='images/ajax-loader-gears.gif';}
else{@$bus_stamp=@$bus_stampx;}
@$bus_name = $access_bus_details['bus_name'];
@$bus_abbreviation = $access_bus_details['bus_abbreviation'];
@$bus_email = $access_bus_details['bus_email'];
@$bus_phone = $access_bus_details['bus_phone'];
```

```
@$bus_pobox = $access_bus_details['bus_pobox'];
@$bus_motto = $access_bus_details['bus_motto'];
@$bus_website = $access_bus_details['bus_website'];
@$bus_izina_ry_ubutore = $access_bus_details['bus_izina_ry_ubutore'];
@$bus_manager = $access_bus_details['bus_manager'];
@$bus_font_family = $access_bus_details['bus_font_family'];
@$bus_category = $access_bus_details['bus_category'];
@$CellName = $access_bus_details['CellName'];
@$SectorName = $access_bus_details['SectorName'];
@$DistrictName = $access_bus_details['DistrictName'];
@$ProvinceName = $access_bus_details['ProvinceName'];
} else{ echo "<center><span id='blink'><i class='fa fa-times'></i> No record
available!</span></center>"; }} catch (PDOException $ex){ $ex->getMessage(); }

$success='<div id="sms" ><img src="images/ajax-loader-gears.gif" height="auto" /><br /><br /> Well
successful!</div>';
$failed='<div id="smsx" ><img src="images/ajax-loader-gears.gif" height="auto" /><br /><br /> Not
done !</div>';
?>

<script> function goBack() { window.history.back() } </script>
```

b. Director page

```
<?php
if(isset($_GET['search'])) {    include 'search_bus.php';    }
if(isset($_GET['statistics']))  {   include('include_statistics.php');    }



if(isset($_GET['reset_whole_system']))
{
echo "<div id='sms'><i class='fa fa-question'></i> Are you sure, do you want to delete all data from
database ?<br><br>
<a href='director?ResetAllSystem=RESET SYSTEM' style='float:left;' class='btn btn2'><i class='fa fa-
check'></i> Yes</a>
<a href='director?bus_details=System details' style='float:right;' class='btn btn2' id='blink'><i class='fa
fa-times'></i> No</a><br><br>
</div>";
}


if(isset($_GET['ResetAllSystem'])){
@$bus_bus_category = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_bus_category");
@$bus_bus_category->execute();
```

```
@$bus_country = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_country"); @$bus_country->execute();
@$bus_bus = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_bus"); @$bus_bus->execute();
@$bus_details = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_details"); @$bus_details->execute();
@$bus_login = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_login"); @$bus_login->execute();
@$bus_payment_method = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_payment_method");
@$bus_payment_method->execute();
@$bus_position = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_position"); @$bus_position->execute();
@$bus_registration = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_registration");
@$bus_registration->execute();
@$bus_line = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_line"); @$bus_line->execute();
@$bus_trip = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_trip"); @$bus_trip->execute();
@$bus_ticket = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_ticket"); @$bus_ticket->execute();
echo $success.'<meta http-equiv="refresh"'.'content="1; URL=director?bus_details=System details">';
}



if(isset($_GET['DeleteAllTrips'])){
@$bus_trip = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_trip"); @$bus_trip->execute();
echo $success.'<meta http-equiv="refresh"'.'content="1; URL=director?bus_trip=BUS TRIP SETTINGS">';
}



if(isset($_GET['DeleteAllLines'])){
@$bus_line = $DB_con->prepare("TRUNCATE ".$DB_name.".bus_line"); @$bus_line->execute();
echo $success.'<meta http-equiv="refresh"'.'content="1; URL=director?bus_road=BUS LINE">';
}

//====================COUNTRY SETTINGS
if(isset($_GET['Deletecountry']))
{
$Deletecountry=$_GET['Deletecountry'];
$sql = "UPDATE bus_country SET country_status = 0 WHERE bus_country.country_id = :Deletecountry";
$stmt = $DB_con->prepare($sql);
$stmt->bindParam(':Deletecountry', $Deletecountry, PDO::PARAM_INT);
$stmt->execute();
echo $success.'<meta http-equiv="refresh"'.'content="0; URL=director?set_country=ENTER NEW COUNTRY">';
}
```

```
if(isset($_GET['Restorecountry']))
{
$Restorecountry=$_GET['Restorecountry'];
$sql = "UPDATE bus_country SET country_status = 1 WHERE bus_country.country_id =
:Restorecountry";
$stmt = $DB_con->prepare($sql);
$stmt->bindParam(':Restorecountry', $Restorecountry, PDO::PARAM_INT);
$stmt->execute();
echo $success.'<meta http-equiv="refresh"'.'content="0; URL=director?set_country=ENTER NEW
COUNTRY">';
}

if(isset($_POST['save_country_edit']))
{
$country_id=$_POST['country_id'];
$country_name=$_POST['country_name'];
$edit_country_check = $DB_con->prepare("SELECT * FROM bus_country WHERE
bus_country.country_name='".$country_name."'");
try {
$edit_country_check->execute(array());
$row_count_access = $edit_country_check->rowCount();
if ($row_count_access > 0) {
echo $failed.'<meta http-equiv="refresh"'.'content="1; URL=director?set_country=ENTER NEW
COUNTRY">';
}
else  {
$sql = "UPDATE bus_country SET country_name = :country_name WHERE bus_country.country_id =
:country_id";
$stmt = $DB_con->prepare($sql);
$stmt->bindParam(':country_id', $country_id, PDO::PARAM_INT);
$stmt->bindParam(':country_name', $country_name, PDO::PARAM_INT);
$stmt->execute();
echo $success.'<meta http-equiv="refresh"'.'content="0; URL=director?set_country=ENTER NEW
COUNTRY">';
}}  catch (PDOException $ex) {  $ex->getMessage(); }}


if(isset($_POST['save_country']))
{
$country_name=$_POST['country_name'];
$status=1;
$save_country_check = $DB_con->prepare("SELECT * FROM bus_country WHERE
bus_country.country_name='".$country_name."'");
try {
$save_country_check->execute(array());
$row_count_access = $save_country_check->rowCount();
```

```
if ($row_count_access > 0) {
echo $failed.'<meta http-equiv="refresh"'.'content="1; URL=director?set_country=ENTER NEW
COUNTRY">';
}
else{
$save_access= $DB_con->prepare("INSERT INTO bus_country (country_id, country_name,
country_status)
VALUES (?,?,?)");
$save_access->execute(array('',$country_name,$status));
echo $success.'<meta http-equiv="refresh"'.'content="0; URL=director?set_country=ENTER NEW
COUNTRY">';
}}  catch (PDOException $ex) {  $ex->getMessage(); }}
```