**GREGG SHORTHAND TRANSLATOR USING OPTICAL CHARACTER RECOGNITION**

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**Chapter 1**

**INTRODUCTION**

* 1. **Background of the Study**

Despite the advancement of automobiles and other forms of private transportation, the need for public transportation remains significant due to commuters. The transition from manual fare collection to automated fare collection has sparked interest, both in developed and developing countries. The emergence of new technologies affecting all modes of transportation has caught the interest of a wide range of stakeholders. This knowledge and interest are reflected in widespread media coverage and increasing speculation. The implications for everything from traffic safety to the fate of conventional automakers are growing (Polzin, 2016). In Manila, the Department of Transportation (DOTr) rolled out the use of beep cards in October 2015 to be used in railways to help the passengers to shorten the queuing time (Corrales, 2015).

Overcrowding is to be expected in places like public transportation terminals, particularly during rush hours. Metro Manila was classified as the world's second most congested city at the start of the year. Commuters are already used to waiting in long lines, riding in the back of the jeepneys, being crammed into trains and other PUVs. However, after the outbreak of infectious disease COVID-19, public transportation is only permitted to run at half its full capacity reducing the capacity modes of transportation (Doroteo, 2021). Aside from the health problems it has caused, the COVID-19 pandemic has highlighted the dangers and inaccessibility of our existing transportation networks (Cruz, 2020).

Public transportation in Bohol, like the bus, in particular, collects fares manually from passengers through conductors. Furthermore, while amid pandemic, traveling outside poses further risks of spreading the virus among the passengers, conductor, and drivers. As the pandemic spread, most public transportation in the country was eventually suspended via air, sea, and land. Since then, the Department of Transportation (DOTr) and its affiliated agencies have gradually resumed public transportation while complying with health protocols such as mandatory use of face masks and shields, no talking or eating, proper ventilation, regular disinfection, restricting passengers with Covid-19 symptoms, and physical distancing (Cruz, 2020). The City Government Of Tagbilaran, held by the City DRRM office, launched the Tagbilaran City Qr Code Contact Tracing System under City Executive Order No. 41 Series Of 2020. The method helped to speed up the contact tracing process for confirmed COVID-19 patients by employing digital technology to discover probable close connections and by eliminating traditional health declaration forms by entering public and private business establishments using digital records (The Bohol Times, 2021). However, this is restricted only to certain establishments in Tagbilaran City. A study conducted by Nakamoto et al. (2020) addresses the partial failures of using QR codes on one of the pandemic management tools, which is contact tracing. It was also supported by Rivett (2021) citing the limitations of QR Codes for contact tracing in terms of proximity issues, usability, and data privacy concerns.

To solve the gap of the problem in the existing system, the researchers will propose RFID–Based Bus Fare Collection with Covid-19 Contact Tracing Management System.

* 1. **Statement of the Problem**

Since the advent of the COVID-19 pandemic, cities around the world have had to impose severe restrictions on public transportation to reduce virus spread and ensure the safe passage of critical personnel during the emergency response (Bird, Kriticos, and Tsivanidis, 2020). For a passenger to be able to ride a bus, he or she must purchase a ticket from a ticket seller or a conductor. This fare system is fine but impractical throughout this pandemic period since people are advised to avoid contact with other people as much as possible to avoid COVID-19 exposure. For this reason, the researchers will be creating a system that would cater to this problem.

Particularly, the researchers aim to answer these questions:

1. What would be the design of the proposed system?
2. How accurate would the system in collecting the fare from the passengers?
3. How to secure the passenger’s data with respect to the COVID-19 Contact Tracing Management System?
   1. **Objectives of the Study**

This study aims to develop a system that automatically charge people for their fares and collects passenger details for the safe conduct of contract tracing in order to reduce people's interaction with COVID-19.

At the culmination of the study, the researchers aimed to achieve the following:

1. To design and develop an RFID-Based Bus Fare Collection with COVID-19 Contact Tracing Management System in terms of:

1.1 fare collection device;

1.2 a web-database application for the contact tracing;

1.3 notification system for the passengers.

2. Testing the functionality of the proposed system in terms of:

2.1 response time of RFID reader in reading the data from RFID cards

and its transmission to the server;

2.2 accuracy of the designed system in terms of the following:

2.2.1 accuracy of the location data of the passenger from origin to destination recorded from the GPS;

2.2.2 accuracy of the collection of fare from passenger

2.2.3 accuracy of SMS notification to the passenger for the deduction and remaining balance

2.2.4 accuracy of SMS notification about the COVID-19 infection update on the bus to the passenger.

2.3 security of the card of the passenger.

2.4 evaluate if there is a significate difference between the proposed system and the existing bus fare collection.

3. To be able to alert the passenger if there is a COVID-19 positive patient during the time of his/her ride on the bus.

**1.4 Scope and Limitation**

The research scope and limitation are enumerated as follows:

**1.4.1 Scope:**

A Radio Frequency Identification tag, specifically a unique read-only identifier tag will be used for the transaction. This card is intended only for one person containing UID (Unique IDentifier) known as the serial card. The card will be scanned through an RFID Reader and the data will be sent to the database server for fare collection and contact tracing. Before the card may be purchased, the card must first be activated by the admin/management through registration where personal information is required as well as the photograph of the buyer. Upon swiping the card, a monitor will display the name and the owner's photograph, which will be verified by the bus conductor.

A web design is used as an interface between the server and the passenger in the collection of fare and contact tracing. The system will automatically calculate the fare of the passenger according to their origin-destination location through GPS technology. The gathered data will be sent and saved in the database server. The system will send a notification to the passengers through SMS providing information in regards to the recent transaction as well as alerts if an individual is tested positive who rides the same bus as the other passengers. This also includes the contact information of the management where the user can report in case the passengers’ card is lost or used by someone else. In developing the system, the language to be used will be PHP along with HTML, CSS, and MySQL.

* + 1. **Limitations:**

Since the card is only intended for one person, the fare will be paid individually. This system is only limited to one bus. For experimental purposes, the route of the bus in this system will be from Tagbilaran Integrated Bus Terminal to Poblacion Ondol, Loboc, Bohol, and vice-versa. The web database server can only be accessed by the admin. The admin will also conduct the registration of the RFID Cards to the database.

The implementation of the system is limited only to the collection of fare and contact tracing. To report a lost card, the passenger must contact the admin/management through the contact information provided by the SMS notification. To avoid misinformation, the study will also limit the determining of a positive-cased passenger with the help of designated contact tracers along the area who will provide information to the management. The study will also limit the availability of the internet connection signal of the area.

* 1. **Significance of the Study**

The study will be beneficial to the following:

**Bus Passengers.** Bus passengers can pay their fares and exchange contact information in a short period of time, avoiding contact with another passenger; thus, this study will benefit them, especially if they are in a hurry.

**Bus Drivers.** The driver wouldn’t have to worry about collecting the fares manually and passing down the contact tracing paper for the passenger to write down.

**Bus Operators.** This study will benefit the bus business operators to abide by the rules to continually operate their business to comply with the IATF-EID (Inter-Agency Task Force on Emerging Infectious Diseases) rules.

**Front liners.** This research will, at the very least, alleviate their concerns about tracking people who may have had contact with a suspected or real COVID-19 carrier.

**The Researchers.** The researchers will be allowed to gain more knowledge and skills through this study.

**Future Researchers.** This research will be a useful reference to future researchers who will be working on a study involving fare collection and contact tracing.

* 1. **Theoretical Background**

Stated below are the articles, statements from various sources, and legal basis that supports the researchers’ study. To explain the concept and mechanism of the researchers’ proposed system and to understand how the system works, a conceptual framework is shown in figure 1.

**1.6.1 Radio Frequency Identification (RFID) Technology**

RFID is an acronym that stands for "radio frequency recognition." It is a technology that uses radio waves to capture digital data encoded in smart labels and RFID tags. The aim of any RFID device is to hold data in suitable transponders, commonly known as tags, and to retrieve data using machine-readable means at a suitable time and location, as well as to meet specific application needs (Mansuri, 2019).

**1.6.2 GPS (Global Positioning System) Technology**

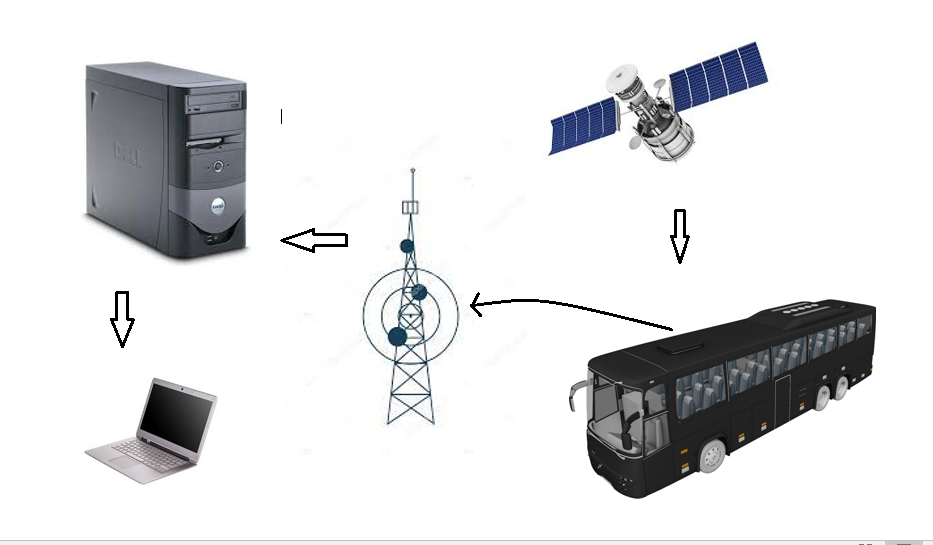
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Figure 1.2

Global Positioning System (GPS) is a mechanism of attaining the position of any object on or above the earth’s surface. There are many applications GPS is emerging, which require accuracy in the GPS position estimate, ranging from meters to centimeter level accuracy. The accuracy of GPS position estimate is influenced by various factors like satellite geometry, ionospheric delay and tropospheric delay, various multi-path effects, number of satellites in view and navigational solution employed (Kumar & Dutt, 2020).

**1.6.3 Microcontroller**

A microcontroller is an integrated circuit (IC) device used for controlling other portions of an electronic system, usually via a microprocessor unit (MPU), memory, and some peripherals (Keim, 2019). A timer module is used to allow the micro-controller to perform tasks for certain periods. A serial I/O port to allow data to flow between the controller and other devices such as a PIC or another micro-controller. An ADC is used to allow the micro-controller to accept analogue input data for processing (Nandhini A. et al., 2017).

**1.6.4 Wireless Communication**

Wireless Communication is the fastest growing and most vibrant technological area in the communication field. Wireless Communication is a method of transmitting information from one point to other. (Teja, 2021).

A wireless Wi-Fi adapter is connected to a computer without wireless hardware to a wireless network by transmitting a Wi-Fi the adapter receives signals from a wireless router or other wireless devices.

**1.6.5 GSM (Global System for Mobile Communication) Technology**

GSM (Global System for Mobile communication) is a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies: TDMA, GSM and code-division multiple access (CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its time slot. It operates at either the 900 megahertz (MHz) or 1,800 MHz frequency band (Ndungu & Mixon, 2021).

GSM technology will be used to notify the passenger about the amount deducted and the balance left on the card. This will also be needed to alert the card’s owner of the recent transaction as well as inform passengers if an individual who tested positive rides the same bus as them.

**1.6.6 Website Application**

A web application is a computer program that performs a specific purpose by using a web browser. A client-server program is what a web application is. It has both a client-side and a server-side. In this context, the word "client" refers to the software that the user uses to run the application. It is a component of the client-server environment, in which several computers exchange information. In the case of a database, for example, the client is the software through which the user enters data. The server is the program that stores the data (Santhosh et al., 2020).

A web application will be developed to determine the fare and obtain the information required from the passenger as a contact tracing for COVID-19. In addition, all data gathered will be saved in a database on a web application.

**1.6.7 Legal Basis**

In designing the project, there are laws considered by the researchers as a legal basis and foundation for the conduct of their study.

**Section 4a of Republic Act 11494,** states that:

“The DOH and DILG shall adopt a COVID-19 disease surveillance protocol that shall define minimum health standards for workplaces and business activities which shall include COVID-19 testing and the establishment of a contact tracing system including personal contact tracing whereby a person maintains a record of the places that he/she has been to and the people he/she had contact with”.

**Section 4a of Republic Act 11494**

“...shall include COVID-19 testing and the establishment of a contact tracing system including personal contact tracing whereby a person maintains a record of the places that he/she has been to and the people he/she had contact with…”

**Latitude and Longitude Points as Geographic Distance Calculation**

“To determine the distance between two points, this method employs spherical triangles…”

(Blitz, 2018)

**Wireless Communication**

(“Wireless Communication - Overview”, Teja, 2021)

Microcontroller

RFID Technology

Contact Tracing Module

Fare Collection Module with GPS

Website Application

SMS Notification

Design of RFID Based Bus Fare Collection with Secure Passenger Covid – 19 Contact Tracing Management System

Functionality Test of RFID Based Bus Fare Collection with Secure Passenger Covid – 19 Contact Tracing Management System

Action Plan

**Figure 1. Theoretical and Conceptual Framework**

**1.7** **Operational Definition of Terms**

The terminology that will be used in the study is defined based on the researchers' preferences on constructing process of the system.

**Contact Tracing Management System.** It is a way to get the information of the passenger such as contact details of the passenger and the time and date of bus ride during this COVID-19 pandemic.

**Database Server.** It is used to store the data gathered from RFID reader.

**Destination**. It is the last location of the passenger.

**Distance.** It is the origin to destination route of the passenger.

**Fare.** It is the money a passenger on public transportation has to pay.

**Origin.** It is the first location of the passenger.

**RFID Card/Tags.** It is a type of tracking system that uses smart barcodes in order to identify items. This will be used as a passenger’s card that contains the passenger’s unique identification and bus load.

**RFID Reader.** It is a reader that recognizes locations and identification of tagged items and it leverages low-power radio frequencies to collect and store data. This will be used to read the RFID card/tags.

**Transaction**. It refers to the collection of the fare and/or tracing of the contacts.

**Chapter 2**

**REVIEW OF RELATED LITERATURE**

**2.1 Introduction**

Most people without privately owned vehicles rely on public transit such as jeepneys, tricycles, public multi-cubs, and buses. People prefer the bus for long-distance travel, particularly if they have a lot of luggage. In December 2019, a virus emerges and becomes a global pandemic due to its contagiousness, high mortality rates, and lack of adequate vaccines or medications. The government proposed social isolation, self-quarantine, and work from home beginning in early March 2020. The COVID-19 pandemic poses a great challenge for contemporary public transportation worldwide, resulting from an unprecedented decline in demand and revenue. During this pandemic, transporting a large number of passengers increases the risk of contracting the COVID-19 disease (Tirachini, A., & Cats, O., 2020). As a result, having safety precautions conducted on a bus is very necessary to help not only the passengers but also the driver (Pulskamp, D., 2020).

Based on a recent article of the Asian Development Bank study, public transportation must adjust to a "new standard" in the aftermath of the coronavirus disease (COVID-19) pandemic and implement technology that will make it more environmentally friendly and immune to potential disasters. Although public transportation was once thought to be a large green, reliable, and inexpensive mode of transportation, initial patterns in cities that have reopened show that it is still considered relatively unsafe and is not bouncing back as rapidly as the use of private cars, cycling, and walking.

According to the ADB Vice-President for Knowledge Management and Sustainable Development Bambang Susantono (2020), the two major challenges that lie ahead are resolving capacity on public transportation to preserve healthy distancing standards and regaining public confidence to return to public transportation. More effort is needed in the short term to inform public transportation users of safety and to demonstrate clean and secure public transportation. Longer-term, technical advancements such as big data, artificial intelligence, digitalization, robotics, renewables, and electric power can provide new technologies to address changing needs, resulting in smarter cities (ADB, 2016).

To understand the significance, architecture, testing, and functionality of the system that will comprise the RFID-Based Bus Fare Collection with COVID-19 Contact Tracing Management System, the researchers referred to various studies, literature, and publications. The proposed study hopes to improve the service of public transports, solve the problems listed above, and achieve the objectives.

**2.2 Related Literature**

Urban areas around the world, in both developed and developing countries, have become overwhelmingly automobile-dominated. The economic development of developing cities is dependent on effective road-based public transportation. The majority of residents depend on road-based public transportation (bus and paratransit) to get to work, school, and other public services (Pojani and Stead, 2015). Currently, transportation integration in terms of technology advancement is important for the comfort of public transportation riders, especially in the Philippines, where most public transportation relies on the same old manual fare collection from passengers (Ingco, Magpantay, and Malijan, 2017).

Contact tracing is defined as ‘the identification and examination of relevant contacts of infectious cases, testing for the presence of infection or disease and, if necessary, provision of appropriate therapy before the occurrence of serious illness’ (Glasauer et al., 2020). Implicit in this definition is that contact tracing is a system in that it consists of a set of common interactive functions performed on contacts of a confirmed case positive person. Thus, conventional contact tracing administered by public health officials is viewed here as a bounded information system for collecting, processing, and disseminating information on contacts (Zoppi, B. L. A., 2021).

Filipinos have grown accustomed to waiting in long queues, riding in the back of jeepneys, overcrowding in trains and other PUVs, and traveling through hours and hours of traffic just to get home. However, due to the introduction of social distancing, the pandemic changed the situation for public transportation in terms of restricting the ability of passengers. Months have passed, and we are still grappling with the pandemic and have yet to return to normalcy. While restrictions in public utility vehicles are gradually easing, passengers must still adhere to mandatory protocols such as contact tracing, sanitation, and social distancing (Cruz, 2020).

The dynamic and rapidly changing nature of systems-driven research places unique demands on computational resources, including databases and web applications, in terms of technology, methodology, design, and architecture. It is proposed that if enough people use a contact-tracing app that creates a memory of nearby contacts and automatically notifies contacts of positive cases (Hart et al., 2020), infection prevention can be achieved (Ferretti et al., 2020). Immediate notification, which is possible with app-based methods, will aid in the tracing of pre-symptomatic contacts before transmission (Hinch et al., 2020). It is also argued that combining the app with group testing of index cases would have the greatest impact on the number of people in quarantine, as tests that prove negative for the index case will release their quarantined contacts (Hinch et al., 2020). This is particularly useful in congested areas such as public transportation. When the pandemic was announced, WHO Philippines has been developing ways for digitized contact tracing in the Philippines (WHO Philippines, 2020). However, a study conducted by Sapiezynski, et al, (2020) showed the fallibility tracing contacts

through applications.

The above-mentioned literature aided the researchers in developing basic concepts for dealing with the bus fare collection and touch tracing processes. Before undertaking a study, it is critical to have a broad knowledge base and a clear understanding of the study's goal. Moreover, the following related literature serves as a reference for researchers conducting deeper studies and various approaches to solving the issue.

**2.3 Related Studies**

**2.3.1 Transit Fare Payment System Technology**

According to Belda et al. (2015)'s study titled "Enhancing the Bus Payment Method Using Android and Rfid," public service buses in the Philippines use two payment methods: manual payment and automated payment. Fare collection processes are classified into two types: onboard systems and offboard systems.   Historically, onboard systems were handled by an inside-the-vehicle conductor who distributed paper tickets. Onboard systems can also include prepayment mechanisms such as smart cards or token readers (Wallischeck, E. Y., 2015). "Fare media" is the transit industry term for the stuff you use to pay for a ride on a bus or a train (Schultz, D). Cash, tokens, paper tickets, magnetic stripe cards, smart cards, bank cards, cell phones, and other electronic devices can all be used as fare media. Electronic fare media allow integration with trip planning and other transit details. Accepting multiple fare media can incur additional costs, such as additional programming and audit requirements (Wallischeck, E. Y., 2015).

In the study of Ferreira, et al (2017) “Evaluation of an integrated mobile payment, route planner and social network solution for public transport”, a Seamless Mobility platform is introduced that aims to facilitate and promote public transportation usage. The Seamless Mobility platform combines mobile payments, route planning, and social networking.

The ticketing system of the said study was favored over the current system by the vast majority of participants. There were some problems about whether or not the ticket was validated, deciding which type of ticket to buy for a particular trip, and the need to bring coins, as well as interpreting QR codes, such as correct location and distance to the code. According to the researchers of the said study, additional case studies will be needed to test the concepts' applicability to other modes of transportation to improve the approach based on the outcomes of the assessment procedures.

Furthermore, Karthikraja et al (2018) conducted another study titled “Smart Bus Fare Ticketing System Using Rfid Technology and GSM Module,” which provides the tickets automatically and deducts the fare for the distance traveled from the passenger's account. The key concept behind this project is to automatic

-ally collect the fare using RFID technology and a GSM modem.

The proposed system addresses the issue of manual fare collection raised by Ferreire et al., (2017) in their previous report. An innovative concept of an automated fare collection system for public transportation that uses a GSM modem and a smart card to minimize bus fare calculation and manpower. Pre-charge the card so that the passengers are aware of how much money they are spending on transportation. To ensure that no or few passengers do not travel without paying, a QR-based ticket system that must be checked before entering and exiting the bus can be implemented.

Another article is written by the team editor of Smart World Company (2017) titled "The Benefits of Automated Fare Collection" proves the efficacy of using AFC. It stated that AFC systems today use a more versatile contactless technology activated by smart cards to accept, register, and view fare-related queries to users and customers, as compared to the conventional magnetic token systems. The AFC setup is an end-to-end solution that includes fare collection and transaction validation through a station system that sends data to a central server. The administrator will have access to the server. The terminals in the chip embedded in a contactless smart card will initiate the transaction.

In correlation with the study of Automated Fare Collection, another study

was conducted by Luccio, M. (2020) where the concepts of location and proximity

are technologically expressed in two standard smartphone components: GPS receivers and Bluetooth transceivers. GPS-derived location data allows for the mapping and analysis of the movements of individuals and large groups of people, while Bluetooth's usage of low energy, which is normally a drawback, becomes an advantage. However, Bluetooth has a shorter range than GPS, making it unsuitable for outdoor use.

**2.3.2 Contact Tracing**

According to the World Health Organization Headquarters (2021), contact tracing along with the extensive testing, isolation, and treatment of cases is a crucial technique for interrupting SARS-CoV-2 transmission chains. The identification of a possible or confirmed case is the catalyst for starting contact tracing. As COVID-19 vaccines begin to be administered in several countries, it is critical to strengthen current public health strategies. Detecting unrecognized chains of transmission requires identifying the source of infection through case analysis. Case investigations can be an effective method of identifying contacts that are at a high risk of becoming ill with COVID-19.

The research “Contact tracing – Old models and new challenges” conducted by Müller & Kretzschmar (2021) offers awareness of risk factors as well as highlights the potential, infectivity, and generation durations of infectious disease. This analysis leads to the use of various contact tracing techniques in the study of Pokharel, et al (2020) entitled "A case for location-based contact tracing," describes the effectiveness of various contact tracing methods and measures the efficacy of contact tracing using simulations without a natural way to test their components. According to the findings, bulletin board contact tracing offers a more robust solution to the two main issues with contact tracing. By depending on people's memories of particular sites, it enhances contact set reconstruction. Individuals involved are only expected to reveal a negligible amount of information.

Sapiezynski et al. (2020) conduct another study titled “The Fallibility of Contact-Tracing Apps,” which evaluates the efficacy of another form of digital technology, highlighting the inefficiency of the use of software applications, necessitating a systematic and inclusive policy response that prioritizes the needs of the affected people.

The related studies listed above were beneficial to the researchers because they served as a guide for their analysis, especially for their methodology, which involved the process of designing a system that involved bus fare collection and contact tracing at the same time.

**Chapter 3**

**METHODOLOGY**

**3.1 Introduction**

\*\*\*\*\* This chapter will present an overview of the research process. It provides information about the process to be used in the conduction of the research as well as a rationale for using that method. The Chapter will discuss the various stages of the research, such as the experimental design, research procedure, site variables, environment and participants, researcher’s instruments, data gathering, statistical treatment and estimated bill of materials. The researchers explain the research design that will be proposed for this study, as well as the reasons for doing so. The purpose of this chapter is to understand the design process and methods of the proposed system for automatic fare collection and contact tracing among bus passengers. \*\*\*\*\*

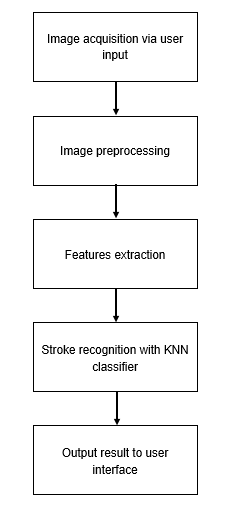
The main objective of this study is to create a system that translates an image of a Gregg shorthand stroke into its corresponding English word. This shall help in translating documents in Gregg shorthand easier for stenography newbies or even to non-shorthand writers. To accomplish this, the researchers shall use Optical Character Recognition (OCR) with k-Nearest Neighbors (k-NN) algorithm.

An overview of the research process shall be discussed in this chapter. Information regarding the \*insert parts here\* shall be provided. This chapter shall serve its purpose to explain the design and implementation process as well as the methods to be used to create the proposed system.

* 1. **Experimental Design**

Experimental method shall be applied for this study. Concepts that shall be utilized include computer vision, image processing, and machine learning. The researchers shall take into account factors that are vital to the integrity of the proposed system. Factors include diversity and amount of the training data, accuracy of the Gregg shorthand translation, and user satisfaction. In times when a Gregg shorthand document needs to be translated but a stenographer is not present, the proposed system shall alleviate such problem. For learners of the writing system, it can be used as a tool to aid learning.

**3.2.1 System Flow**

****

**Figure N System Flow Diagram**

As seen on Figure N, the system first acquires an image from the user which will then undergo preprocessing which includes converting to grayscale, blurring, thresholding, and converting to a binary image. After the features are extracted, these will be fed to the KNN classifier for the stroke to be recognized and translated to its corresponding English word. The result shall then be displayed to the user interface.

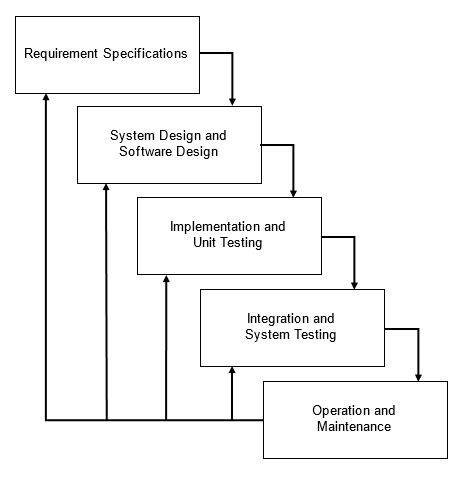
**Image Preprocessing**

\*\*\*\*\* The fare collection system of our study is the hardware side of our system. It allows bus passengers to pay their fare using their cards. The passenger must receive a card that has been registered to the system and has a load inside it for subsequent payment. Passengers would swipe their cards in front of the RFID reader prior to the journey. After detecting it, the RFID reader would then read the UID (Unique IDentifier) or the serial number from the card and store it on the database server. The GPS module would then obtain the coordinates of the passenger's origin, which would be saved on the database server and will be displayed on the LCD. \*\*\*\*\*

**K-Nearest Neighbours Classifier**

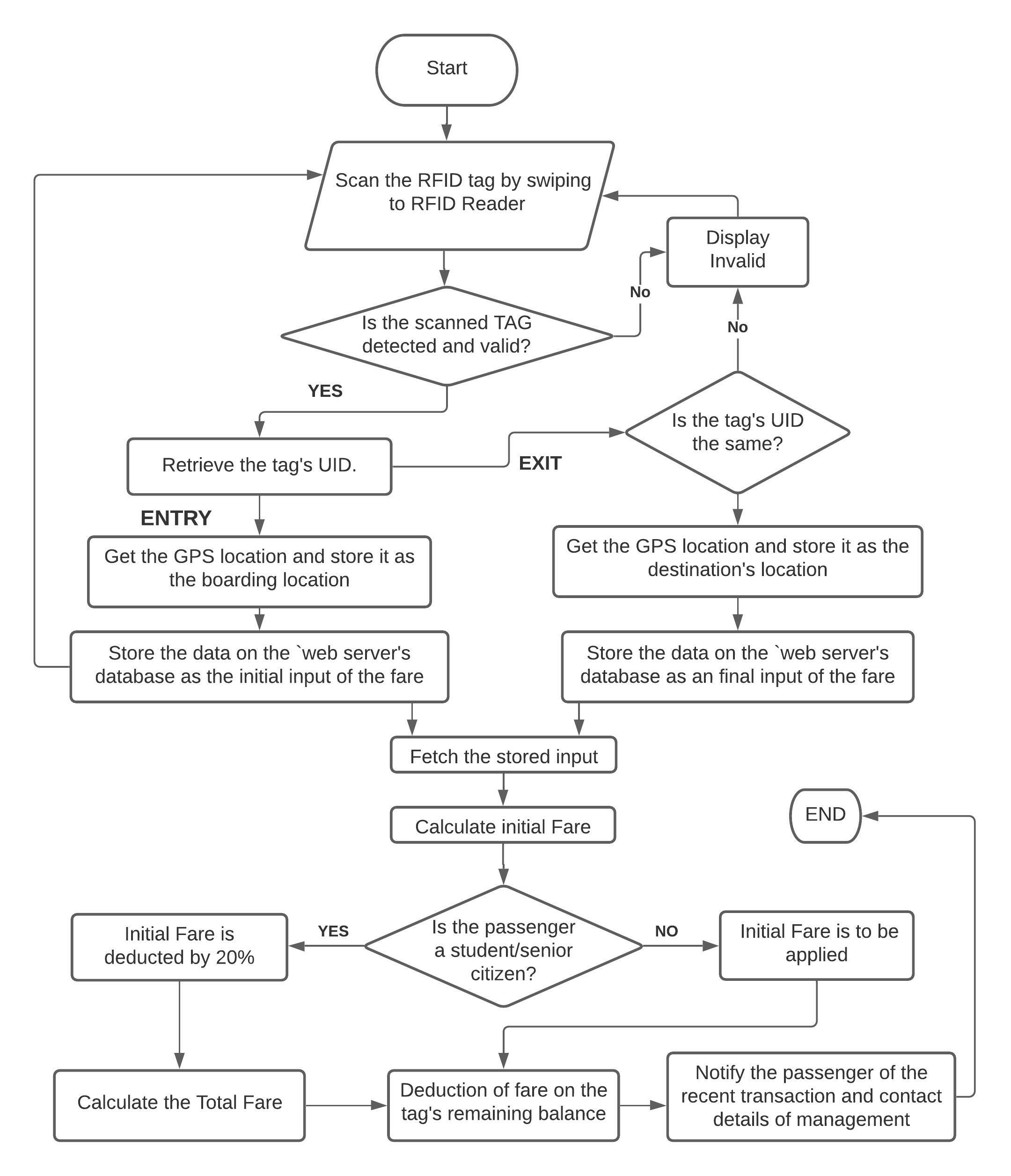
\*\*\*\*\* The management system is the software side of our system. This contains information about the fare collection data and contact tracing information. The fare collecting data is a section of the software that stores data that was gathered from the RFID reader and GPS module such as the number of passengers, the UID or card serial number of the passenger's card, their origin location, their destination location, and their total fare. The contact tracing information is a section in the software that will store the contact information of the passenger such as their UID or card serial number, date and time they entered the bus, their name, address and contact number. The software also has a section on registering the passenger’s card and the admin’s setting. \*\*\*\*\*

**3.2.2 Software Development Life Cycle**

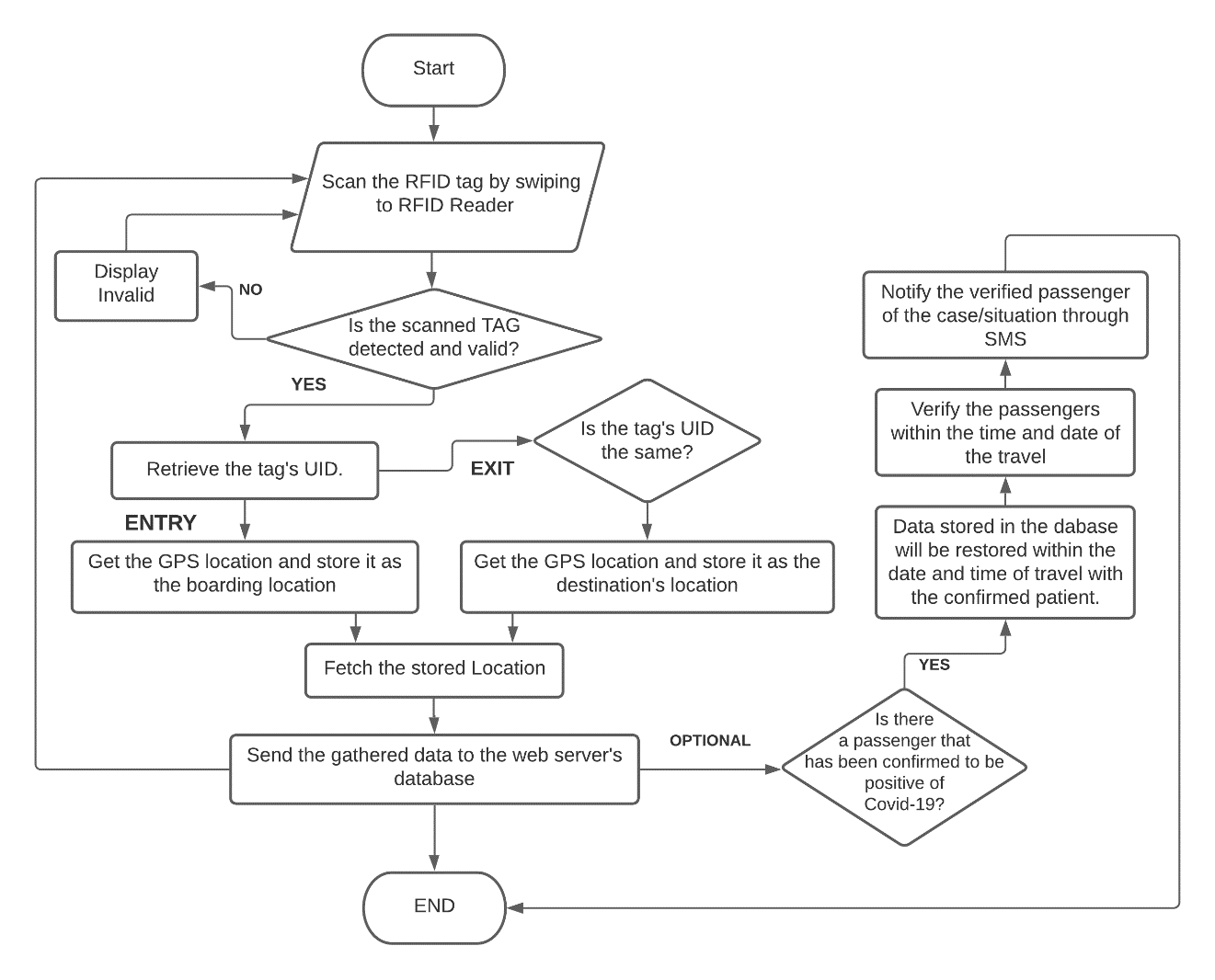
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**Figure N Iterative Waterfall Model**

For the life cycle of the software development, the iterative waterfall model shall be used as seen in Figure N. Similarly to the classical waterfall model, this model allows the researchers to approach the development of the system in an organized manner which also has the flexibility of going back to certain stages after gathering feedback which results to parts of the system that needs to be redone.

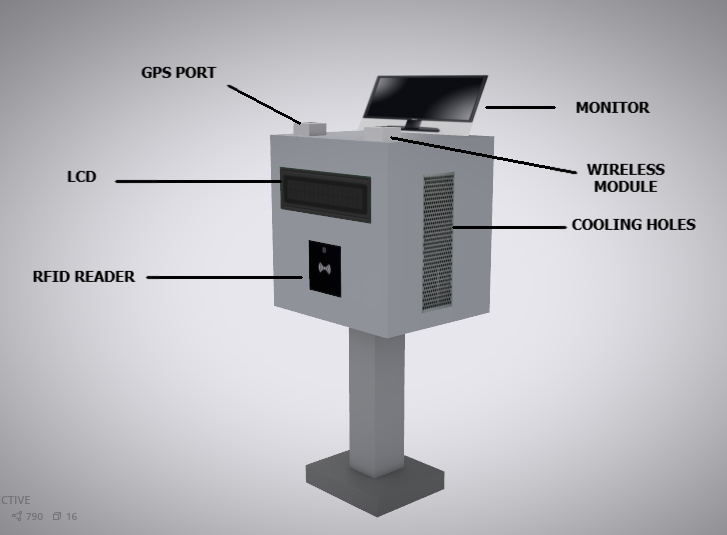
****

**Figure 3.3 Flow Chart of the Working Process of the Proposed System involving the Fare Collection of the study**

**Figure 3.4 Flow Chart of the working Process of the Proposed System involving the Contact Tracing of the study.**

Figures 3.3 and 3.4 show the Flowchart of working processes of the proposed system of the study involving the bus fare system and the tracing of contacts. This also includes the GSM module that updates the passengers of every transaction through SMS notification that will be sent to the passengers.

**3.2.3** **Proposed System Design for the Bus Fare Collection**

****

**Figure 3.5**

This depicts the study's proposed system design, emphasizing the components that will be used in the study. It is made up of a monitor that displays information of clients of the scanned card, a wireless module, and a GPS port for tracking the bus's location. It also includes an LCD that displays transaction data, cooling holes that aid in avoiding heat-related failure or reducing thermal damage, and an RFID reader that scans RFID cards.

**3.2.4 System Components**

The following components will be used in the RFID-Based Bus Fare Collection with COVID-19 Contact Tracing Management System:

**Arduino** - is an open-source electronics platform based on easy-to-use hardware and software. It is a board that sends a set of instructions to the controller using Arduino programming language and Arduino software integrated drive electronics (IDE). The researchers will use Arduino Mega as their microcontroller. It will serve the source code transmitter in the study.

**Global Positioning System Module** - modules that contain tiny processors and antennas that directly receive data sent by satellites through dedicated RF frequencies. The researchers will use GPS Module to locate available satellites to a GPS receiver installed in a bus to find out its current time and position on earth.

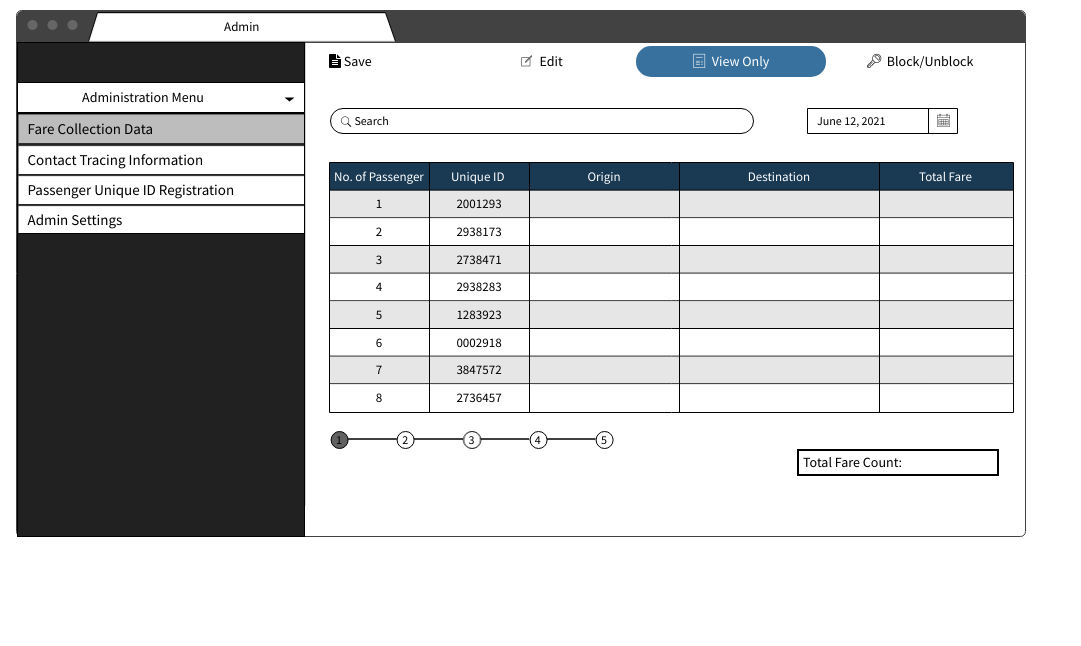
**Global Systems for Mobile Communications Module** - a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world. It uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies. The researchers will use GSM Module to send a SMS notification to the passenger with the necessary information.

**Liquid Crystal Display** - a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. This will be used to display data or information allocated in an RFID tag.

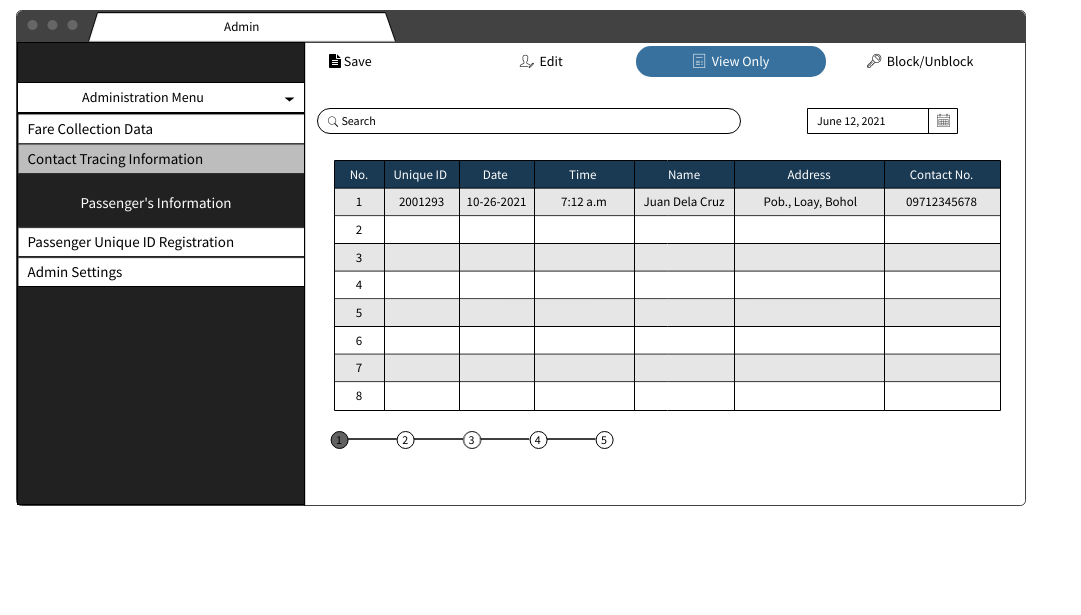
**Radio-Frequency Identification Reader** - a device used to gather information from an RFID tag, which is used to track individual objects. This will help the researchers to read the information of an individual's RFID Tag.

**Wi-Fi** - a wireless networking technology that allows devices such as computers (laptops and desktops), mobile devices (smart phones and wearables), and other equipment (printers and video cameras) to interface with the Internet. The researchers will use Wi-Fi to connect both GPS and the database server allowing the exchange of information with one another, creating a network.

**3.2.5** **Proposed Design of the Web Database Server**



**Figure 3.7 Proposed Layout of Fare Collection Data**



**Figure 3.8 Proposed Layout of Contact Tracing Information**

Figure 3.7 shows the proposed layout for the data of fare collection while the figure 3.8 shows the proposed layout of the passenger’s contact tracing management system. Both layout will be shown through a web-based design. To design this, PHP language will be used with HTML, CSS and MySQL. It is shown in this figure that only the admin has access to this software. The fare collection data has the table information of the number of passengers, unique ID from the RFID card, origin, destination, the total fare as well as the total count of collection of the fares. On the contact tracing information side, it has the table information of the numbers of passengers, UID (Unique Identifier) from the RFID card, date, time, name, address and contact number. The admin has the options available on the top, such as save, edit, view only, block and unblock.

* 1. **Research Procedure**

In creating and developing the RFID-Based Bus Fare Collection with COVID-19 Contact Tracing Management System, the researchers will follow this block diagram which contains the system development procedure:

Testing and Evaluation of the System

Building the System

Designing the System

Gathering of Required Data for the System

**Figure 3.9 Block Diagram of System Development Procedure**

Figure 3.9 shows the block diagram of the development of the system from gathering of data to designing the system, followed by the building of the said system and lastly, the testing and evaluation of the system.

**3.3.2 Gathering of Required Data for the System**

As an initial step in constructing the entire system, gathering all feasible required data or information for the system to be proposed is critical. In this phase, the researchers will be able to identify what data is required and have a thorough understanding of their topic. The researchers will have enough information on how to develop the system after collecting the relevant data.

**3.3.3 Designing the System**

The researchers will follow both qualitative and quantitative methodical approaches through interviews and surveys in order to carry out the processes necessary for attaining the goal of designing the system. The system device is composed of subsystems: fare collection system, management system, and notification system and the design would be processed accordingly.

**3.3.4 Testing and Evaluation of the System**

The system will be tested in order to assess the system's performance and functionality.

* 1. **Site Variables**

There are several variables that control the site conditions of this study. A brief explanation of each variable can be found below.

**3.4.1 RFID Reader Accuracy/Sensitivity**

The RFID Reader is used to read the unique ID of the RFID card in order to deduct fare from the card and obtain information for contact tracing. It should be correctly situated and calibrated to achieve more accurate sensing of the cards and precise data retrieval.

**3.4.2 GPS Location Accuracy**

The GPS is used to trace the location of the passenger from their origin to their destination. The locations detected or sensed and the actual location should be the same or at least not that far to achieve a more efficient result.

* 1. **Environment and Participants**

The study will be conducted through a bus that has a route from Tagbilaran Integrated Bus Terminal to Poblacion Ondol, Loboc, Bohol and vice versa. The participants of the study are the passengers and the bus operators taking this route. Participants may vary in age and gender. The first requirement is the passenger must possess his/her RFID cards that have been registered to the system with corresponding personal information.

* 1. **Researchers Instruments**

The instruments that will be used in conducting and gathering data in this study will be questionnaires for the prospect bus operator whose route will be from Tagbilaran Integrated Bus Terminal to Poblacion Ondol, Loboc, Bohol. To determine the system's functionality in our study, we researchers will use observation guides to gather, compare, analyze and conclude all the data that we will be presented and collected.

* 1. **Data Gathering**

|  |  |  |  |
| --- | --- | --- | --- |
| **Zone** | **KILOMETER** | **Fare**  **(1.85 php per km)** | **SC/SP 20%**  **Discount** |
| **From Tagbilaran - Loboc** | | | |
| Baclayon | 8 | 15 php | 12 php |
| Albuquerque | 13.5 | 25 php | 20 php |
| Loay | 20 | 37 php | 30 php |
| Loboc | 26 | 48 php | 38 php |
| **From Loboc – Tagbilaran** | | | |
| Loay | 6 | 11 php | 9 php |
| Albuquerque | 12.5 | 23 php | 18 php |
| Baclayon | 18 | 33 php | 26 php |
| Tagbilaran | 26 | 48 php | 38 php |

**Table 3.7.1 Fare Rates per Kilometer from Tagbilaran to Loboc and Vice Versa**

The previous table shows the passengers’ fare per kilometer in every town. The table will show the findings of the survey conducted by the researchers at Tagbilaran Integrated Bus Terminal among the bus operators of the Ceres bus line. According to researchers’ assessment of the Ceres bus operator, the typical bus fare is 1.85 Php per kilometer. Senior citizens and students rare given a 20% deduction as a discount of the regular fare.

**3.7.2 Data Analysis**

The testing results of the system will be tabulated and will be compared to test the functionality and accuracy of the device. The table 3.7.3 will be used in the data gathering process of this study.

The table is consisting of (5) five columns. First column will determine the number of trials the tag is scanned. The next two columns will be used to determine the response time in reading the data from RFID tags and transmitting the data to the server. The researchers will conduct trials by swiping the tags to the RFID reader and recording the time it takes for each tag to be scanned and the is transmitted to the server. The next column will be used to test the accuracy of the GPS device in calculating the location, the origin and the destination including the accuracy in the collection of fare. The last two column will be used to test the precision of the SMS notification that the passenger will receive after each transaction for monitoring purposes.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **NUMBER OF TRIALS** | **Response Time (ms)** | | **Is the location correct?** | | **Is the collection fare?** | | **Is the SMS Notification correct?** | |
| **EXPECTED** | **ACTUAL** | **EXPECTED**  **ORIGIN-DESTINATION** | **ACTUAL**  **ORIGIN-DESTINATION** | **EXPECTED FARE** | **ACTUAL**  **FARE** | **EXPECTED SMS NOTIFICATION** | **ACTUAL SMS NOTIFICATION RECEIVED** |
| 1 |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |
| 11 |  |  |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |  |  |
| 13 |  |  |  |  |  |  |  |  |
| 14 |  |  |  |  |  |  |  |  |
| 15 |  |  |  |  |  |  |  |  |

**Table 3.7.3 Gathering the Data for the Functionality of the System**

**3.8 Statistical Treatment**

The researchers will use the chi-square test to evaluate the difference between the proposed system and the existing fare collection based on the result of the data gathered in table 3.7.3.

Where:

𝜒 – Chi

Ai – the observed value

Ei – the expected value

For relative error would be computed.

**RE = (𝑂−𝐸 / 𝐸) x 100%**

Where:

RE - relative error

E - expected

O – observed

**3.9 Proposed Gantt Chart of Design Process**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **RFID-Based Bus Fare Collection with** | | | | | | | | | | | | | | | | | | |
| **Covid – 19 Contact Tracing Management System** | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | |
| **DESIGN PROCESS** | | | | | | | | | | | | | | | | | | |
| **ACTIVITY** | **OCT** | | | | **NOV** | | | | **DEC** | | | | **JAN** | | | | **FEB** | |
|  | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **1. Planning and Design** | | | | | | | | | | | | | | | | | | |
| 1.1 Evaluation of System Design for Revisions | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1.1.1 System Design |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1.1.2 Diagrams and Flowchart |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1.2 Evaluation of Material Availability |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **2. Preparation** | | | | | | | | | | | | | | | | | | |
| 2.1 Material Canvassing |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2.2 Testing of Sensors and Motors |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **3. Making of Prototype** | | | | | | | | | | | | | | | | | | |
| 3.1 Material Gathering |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3.2 Building the Prototype |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3.3 Installation of Modules |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **4. System Development** | | | | | | | | | | | | | | | | | | |
| 4.1 Coding for the system functionalities |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4.2. Designing for the User Interface |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **5. Testing** | | | | | | | | | | | | | | | | | | |
| 5.1 Functionality Testing |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5.2 System Maintenance |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| LEGEND: |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ONGCAL, QUEENIE ROSE |  | ONGCAL, QR - MANDIN, MJ | | | | | | | | | | | | | | | |  |
| MANDIN, MARY JANE |  | MANDIN, MJ – GARSUTA, JQ | | | | | | | | | | | | | | | |  |
| GARSUTA, JOYCE QUEENIE |  | ALL GROUP MEMBERS | | | | | | | | | | | | | | | |  |

**REFERENCE LISTS**

Octopus Holdings Limited. (2021a). *Intoduction to Octopus*. Octopus Holdings Corporate.https://www.octopus.com.hk/en/corporate/aboutoctopus/profile/i ndex.html

Corrales, N. (2015, October 2). LRT-1, LRT-2, MRT-3 to use ‘beep card’ starting Oct. 3. *INQUIRER.Net*. <https://newsinfo.inquirer.net/727063/lrt-1-lrt-2-mrt-3-to-use-beep-card-starting-oct-3>

*Philippines COVID-19 Humanitarian Response Plan (August 2020 Revision) Philippines*.(2020,August4).https://reliefweb.int/report/philippines/philippines-COVID-19-humanitarian-response-plan-august-2020-revision

Tavassoli, A., Alsger, A., Hickman, M., & Mesbah, M. (2016). Australasian Transport Research Forum 2016 Proceedings. *1 School of Civil Engineering, The University of Queensland, Brisbane, Australia*. Published. https://www.australasiantransportresearchforum.org.au/sites/default/files/ATRF2016\_Full\_papers\_resubmission\_103.pdf

Yam, E. (2020, August 6). Impact of COVID-19 on public transport. IGC. https://www.theigc.org/blog/impact-of-COVID-19-on-public-transport/

Ohio State University. (2020, November 18). *Pandemic has surprising impacts on public transit demand: South, Midwest retain more demand due to essential workers*. ScienceDaily. https://www.sciencedaily.com/releases/2020/11/201118141651.htm

Pandey, P., & Mahajan†, K. D. (2010, November). *Application of RFID Technology in Libraries and Role of Librarian*. ResearchGate. https://www.researchgate.net/publication/269571818\_Application\_of\_RFID\_Technology\_in\_Libraries\_and\_Role\_of\_Librarian

Maryland NRCS. (2007, August). *GPS - Natural Resources Conservation Service USDA* [Slides]. Microsoft PowerPoint Gps\_aug07.Ppt. https://www.nrcs.usda.gov/Internet/FSE\_DOCUMENTS/nrcs144p2\_024990.pdf

Keim, R. (2019, April 4). *What Is a Microcontroller? The Defining Characteristics and Architecture of a Common Component - Technical Articles*. Allaboutcircuits.Com. https://www.allaboutcircuits.com/technical-articles/what-is-a-microcontroller-introduction-component-characteristics-component/

*Wireless Communication - Overview*. (2021). Tutorialspoint.Com. https://www.tutorialspoint.com/wireless\_communication/wireless\_communication\_overview.htm

Briso-Rodríguez, C., Guan, K., Kurner, T., & Xuefeng, Y. (2017). Wireless Communications in Transportation Systems. *Wireless Communications and Mobile Computing*, *2017*, 1–2. <https://doi.org/10.1155/2017/4391402>

Blitz, S. (2021, April 8). *Latitude and Longitude Distance Calculation Explained* [Press release]. <https://www.sisense.com/blog/latitude-longitude-distance-calculation-explained/>

Agarwal, T. (2020, November 16). *What is GSM Technology : Architecture, Circuit Working & Its Applications*. ElProCus - Electronic Projects for Engineering Students. <https://www.elprocus.com/gsm-technology-architecture-its-applications/>

*What Is a Web Application? How It Works, Benefits and Examples*. (2021, April 13). Indeed Career Guide. <https://www.indeed.com/career-advice/career-development/what-is-web-application>

GOVPH. (n.d.). *THE 1987 CONSTITUTION OF THE REPUBLIC OF THE PHILIPPINES – ARTICLE XIV | GOVPH*. Official Gazette of the Republic of the Philippines. <https://www.officialgazette.gov.ph/constitutions/the-1987-constitution-of-the-republic-of-the-philippines/the-1987-constitution-of-the-republic-of-the-philippines-article-xiv/>

*Republic Act No. 11494 | GOVPH*. (2020, September 11). Official Gazette of the Republic of the Philippines. <https://www.officialgazette.gov.ph/2020/09/11/republic-act-no-11494/>

Shannon, C. E. (1948). A Mathematical Theory of Communication. *Bell System Technical Journal*, *27*(4), 623–656. <https://doi.org/10.1002/j.1538-7305.1948.tb00917.x>

*Public Transport Can Bounce Back from COVID-19 with New and Green*. (2020, November 17). Asian Development Bank. <https://www.adb.org/news/public-transport-can-bounce-back-covid-19-new-and-green-technology-says-adb>

Pojani, D., & Stead, D. (2015). Sustainable Urban Transport in the Developing World: Beyond Megacities. *Sustainability*, *7*(6), 7784–7805. <https://doi.org/10.3390/su7067784>

R. (2020, August 24). *Global Automated Fare Collection System Market By Technology Platform, By Component, By End User, By Region, Industry Analysis and Forecast, 2020 - 2026*. GlobeNewswire News Room. https://www.globenewswire.com/fr/newsrelease/2020/08/24/2082720/0/en/Global-Automated-Fare-Collection-System-Market-By-Technology-Platform-By-Component-By-End-User-By-Region-Industry-Analysis-and-Forecast-2020-2026.html

Verougstraete, M., & MacDonagh, E. (2016). Automatic Fare Collection System (AFCS): The Case of Manila. *Case Study #6*. Published. https://www.unescap.org/sites/default/d8files/Case%206%20Automated%20Fare%20Collection.pdf

Sreenivasaiah, P. R., & Kim, D. H. (2010). *Current Trends and New Challenges of Databases and Web Applications for Systems Driven Biological Research*. PubMed Central (PMC). <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3059952/>

*COVID Kaya: A digital platform for COVID-19 information management in the Philippines*. (2020, December 18). World Health Organization. https://www.who.int/philippines/news/feature-stories/detail/covid-kaya-adigital-platform-for-covid-19-information-management-in-the-philippines

Mariano, P. M. (2019a, March 14). *Modernizing Public Transport in the Philippines*. Changing Transport. <https://www.changing-transport.org/modernizing-public-transport-in-the-philippines/>

*What the pandemic is teaching us about urban transport planning*. (2020, September 22). Makesense Philippines.

<https://philippines.makesense.org/2020/09/21/what-the-pandemic-is-teaching-us-about-urban-transport-planning/>

Dellosa, R., Caldo, R., Belda, M. J., Pariño, R. J., Saul, X. M., & Villegas, M. R. (in press). ENHANCING THE BUS PAYMENT METHOD USING ANDROID AND RFID TECHNOLOGY. *LPU-Laguna Journal of Engineering and Computer Studies*.

Karthika, J., Varshanapriyaa, S., Sai Haran, S., & SuriyaPrakash, C. (in press). AUTOMATIC BUS FARE COLLECTION SYSTEM USING GPS AND RFID TECHNOLOGY. *International Journal of Pure and Applied Mathematics*.

Sreenivasaiah, P. K., & Kim, D. H. (2010, December 3). *Current Trends and New Challenges of Databases and Web Applications for Systems Driven Biological Research*. PubMed Central (PMC). <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3059952/>

Socong, J. A. O., Anunciado, V. J. L., Namocatcat, L. L., Fonghe, R. S., Miflores, M. N. B., Larican, J. S., Bernales, D., Corona, J. A., Ibarra, J. R., & Soria, R. C. (2017). Automated Bus Fare Collection System Utilizing Reloadable Radio Frequency Identification (RFID) Card. *ACADEME University of Bohol, Graduate School and Professional Studies*, *10*(1). <https://doi.org/10.15631/aubgsps.v10i1.55>

Editor Team. (2017, November 24). *The Benefits Of Automated Fare Collection*. Electronics For You’s SmartWorld. <https://smart.electronicsforu.com/benefits-automated-fare-collection/>

Hellmich, T. R., Clements, C. M., El-Sherif, N., Pasupathy, K. S., Nestler, D. M., Boggust, A., Ernste, V. K., Marisamy, G., Koenig, K. R., & Hallbeck, M. S. (2017). Contact tracing with a real-time location system: A case study of increasing relative effectiveness in an emergency department. *American Journal of Infection Control*, *45*(12), 1308–1311. <https://doi.org/10.1016/j.ajic.2017.08.014>

Arun Das, S., & Lingeswaran, K. (2014). GPS based Automated Public Transport Fare Collection Systems Based on Distance Travelled by Passenger Using Smart Card. *International Journal of Scientific Engineering and Research (IJSER)*, *2*(3). <https://www.ijser.in/archives/v2i3/MDExNDAzMTI=.pdf>

Magpantay, M., Ingco, R., & Malijan, M. H. (2018). PUJ FARE COLLECTION SYSTEM: AN IoT APPLICATION. *LPU–Laguna Journal of Engineering and Computer Studies*, *4*(1). <https://lpulaguna.edu.ph/wp-content/uploads/2018/12/1-PUJ-FARE-COLLECTION-SYSTEM.pdf>

Muwanula, P. (2013). *Automated Fare Collection Systems*. SlideShare. <https://www.slideshare.net/PeterMuwanula/automated-fare-collection-systems>

LOKESH, S., FERNANDAS, A., HARIKRISHNAN, N., & KARTHIKRAJA, M. (2018). SMART BUS FARE TICKETING SYSTEM USING RFID TECHNOLOGY AND GSM MODULE. *National Conference on Emerging Technologies for Sustainable Engineering & Management (NCETSEM’18)-2018*. Published. <http://www.ijetjournal.org/Special-Issues/NCETSEM18/NCETSEM22.pdf>

Tirachini, A., & Cats, O. (2020). COVID-19 and Public Transportation: Current Assessment, Prospects, and Research Needs. *Journal of Public Transportation*, *22*(1). <https://doi.org/10.5038/2375-0901.22.1.1>

Pulskamp, D. (2020, October 22). *Protecting the Safety of Passengers and Drivers Amid a Pandemic*. © 2021 Metro Magazine, Bobit Business Media. All Rights Reserved. <https://www.metro-magazine.com/10127418/protecting-the-safety-of-passengers-and-drivers-amid-a-pandemic>

Wallischeck, E. Y. (2015). Preliminary Strategic Analysis of Next Generation Fare Payment Systems for Public Transportation. *THE NATIONAL ACADEMIES PRESS*. Published. <https://doi.org/10.17226/22158>

Zoppi, B. L. A. (2021, March 3). *How Does Contact Tracing Work?* News-Medical.Net. <https://www.news-medical.net/health/How-does-Contact-Tracing-Work.aspx>

Aadamsoo, A. (2010). *WEB BASED PROJECT MANAGEMENT SYSTEM*. VAASAN AMMATTIKORKEAKOULU UNIVERSITY OF APPLIED SCIENCES Degree Program of Information Technology.

Morris, S. (2020, October 13). *Tech 101: The Ultimate Guide to CSS*. Skillcrush. <https://skillcrush.com/blog/css/>

Boyett, R. (2021, May 18). *What is MySQL: MySQL Explained For Beginners*. Hostinger Tutorials. <https://www.hostinger.ph/tutorials/what-is-mysql>

**Appendix A**

**Letter of Permission for Fare Survey at Tagbilaran Integrated Bus Terminal**

Republic of the Philippines

Bohol Island State University

Main Campus – Tagbilaran City, Bohol

College of Engineering and Architecture

May 29, 2021

The Management

Dao Integrated Bus Terminal

To whom it may concern,

Greetings!

We, the 4th year students of Bohol Island State University (BISU) taking up Bachelor of Science in Computer Engineering are developing a Thesis entitled **RFID Bus Fare Collection with Secure Passenger COVID-19 Contact Tracing Management System**, which is about transportation management.

In this regard, we would like to ask for your permission to allow us to conduct a survey about matters in relation to transportation details.

Your positive and immediate response to this request is highly appreciated.

Very Respectfully Yours,

Queenie Rose Ongcal

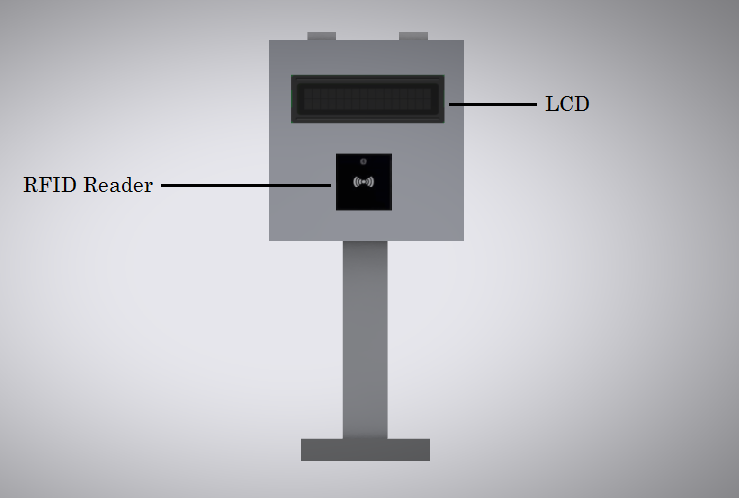
Mary Jane Mandin

Joyce Queenie Garsuta

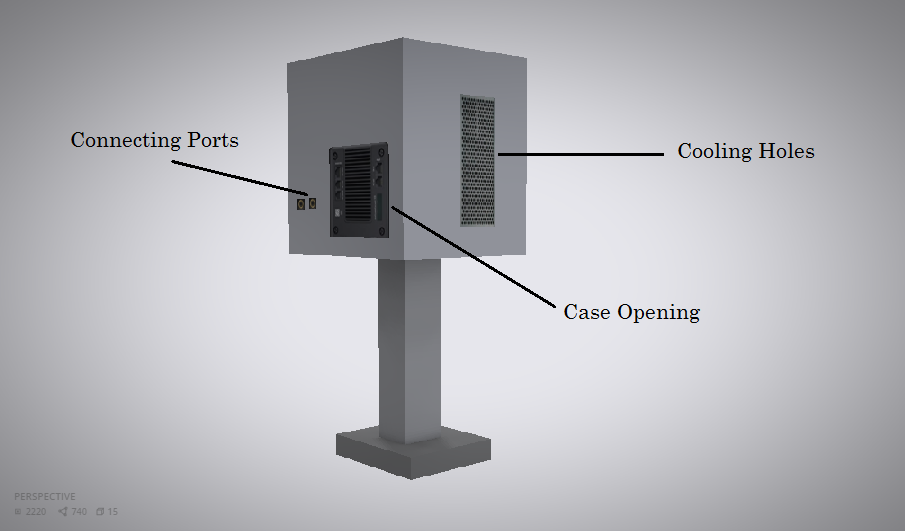
**Appendix B**

**Technical Design**

**Proposed System Design**

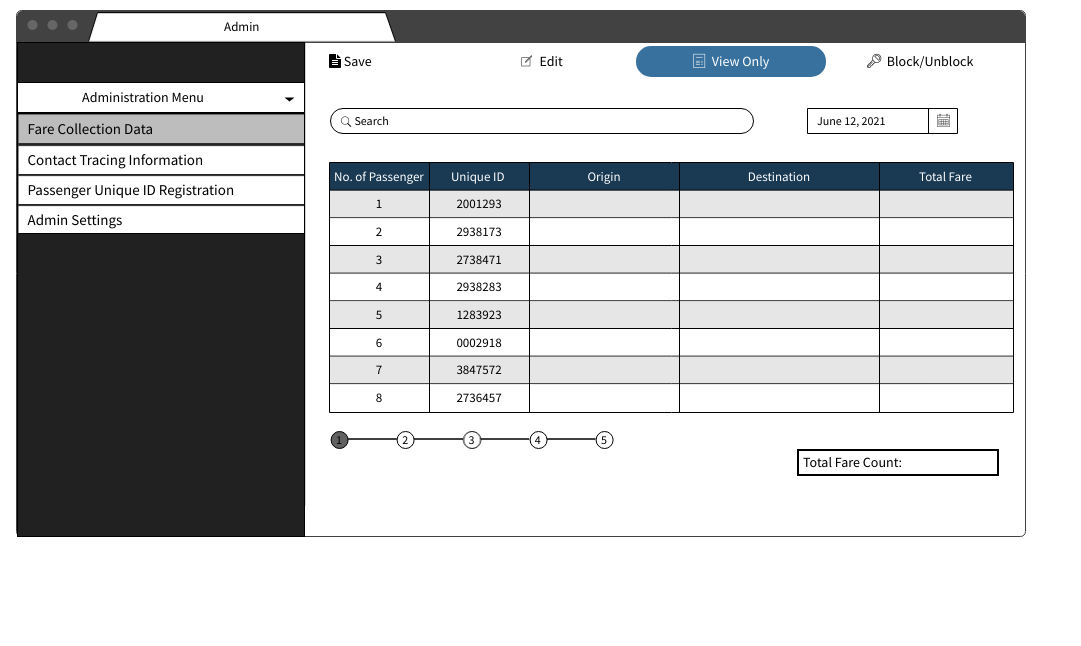


**Figure 3.4 Bus Fare Collection System Front View**

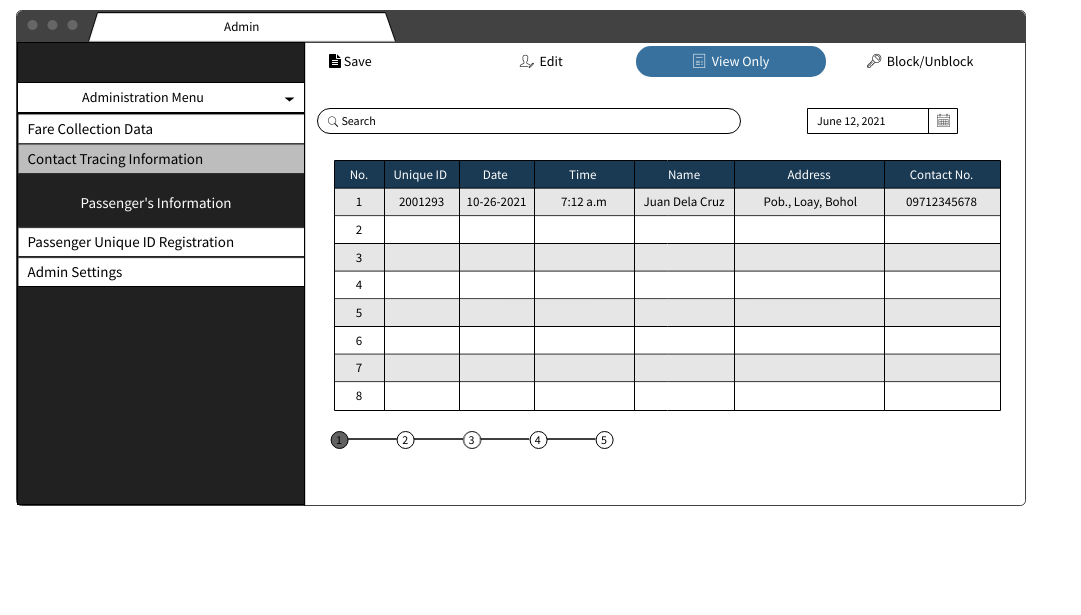


**Figure 3.5 Bus Fare Collection System Side and Back View**

**Proposed Design of the Web Database Server**



**Figure 3.7 Proposed Layout of Fare Collection Data**



**Figure 3.8 Proposed Layout of Contact Tracing Information**

**Estimated Bill of Materials**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Item Name** | **Item Description** | **Quantity** | **Unit** | **Amount / Quantity** | **Total Amount** |
| 1 | Arduino Mega | Microcontroller Board | 1 | piece/s | 570 | 570 |
| 2 | PCB |  | 2 | piece/s | 50 | 50 |
| 3 | Casing for the System |  |  |  |  | 450 |
| 4 | GPS Module |  | 1 | piece/s | 180 | 180 |
| 5 | GSM Module |  | 1 | piece/s | 630 | 630 |
| 6 | Jumper Wires |  | 50 | piece/s | 6 | 300 |
| 7 | LCD |  | 1 | piece/s | 150 | 150 |
| 8 | Power Bank | Power Supply | 1 | piece/s | 1000 | 1,000 |
| 9 | Resistors (220 Ω) |  | 5 | piece/s | 1 | 5 |
| 10 | RFID Reader Module |  | 1 | piece/s | 270 | 270 |
| 11 | RFID Cards |  | 10 | piece/s | 30 | 300 |
| 12 | Labor |  |  |  | 500 | 500 |
| **Estimated Total Cost:** | | | | | | Php 4,405 |