**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. \*\*\*\*\*

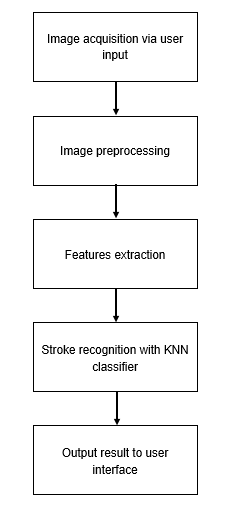
The main objective of this study is to create a system that translates an image of a Gregg shorthand stroke into its corresponding English word. This shall help in translating documents in Gregg shorthand easier for stenography newbies or even to non-shorthand writers. To accomplish this, the researchers 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**

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**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.

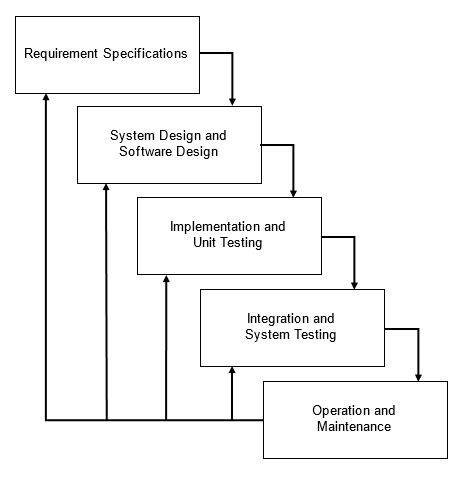
**Image Preprocessing**

\*\*\*\*\* 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**

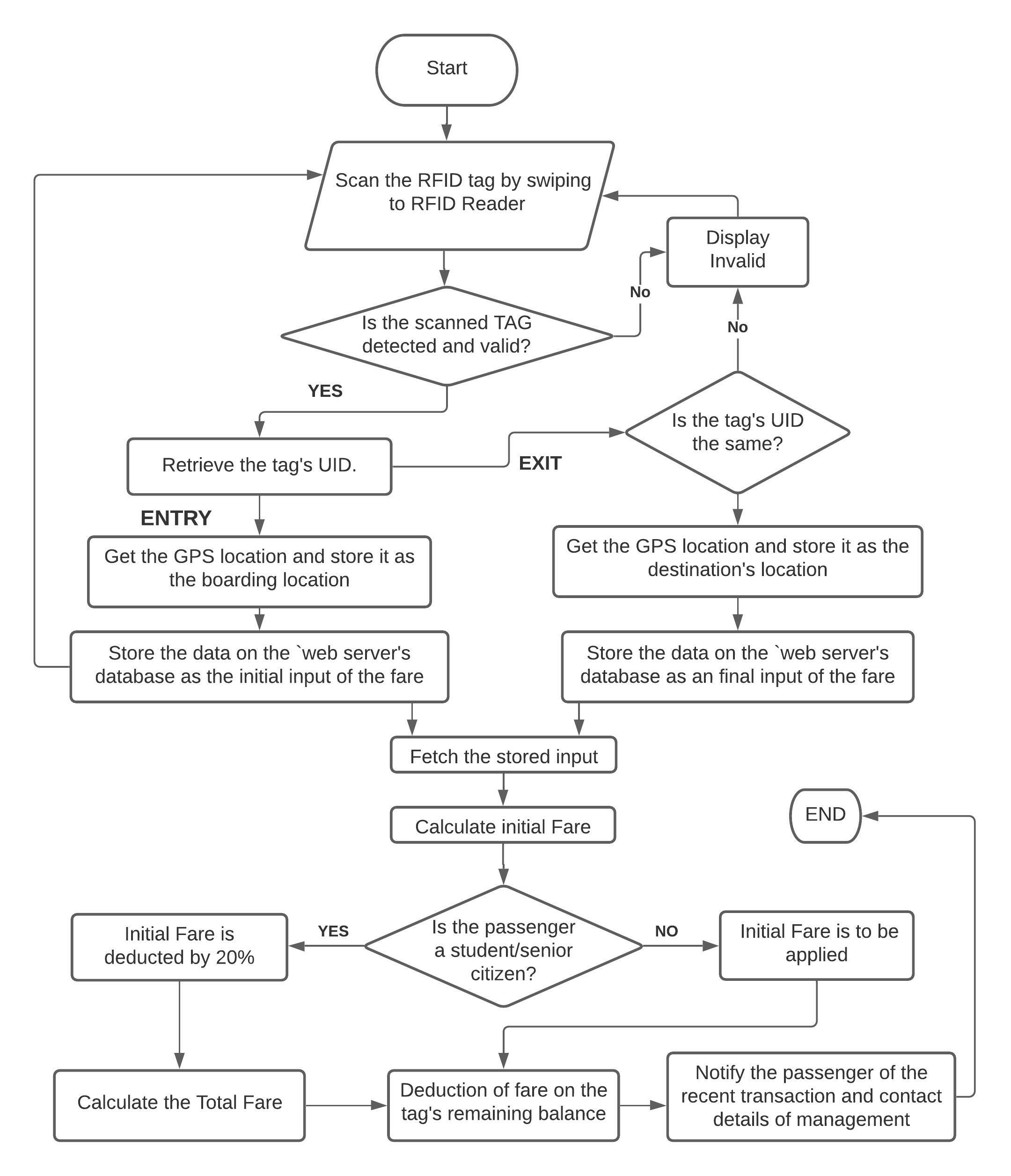
\*\*\*\*\* The management system is the software side of our system. This contains information about the fare collection data and contact tracing information. The fare collecting data is a section of the software that stores data that was gathered from the RFID reader and GPS module such as the number 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**

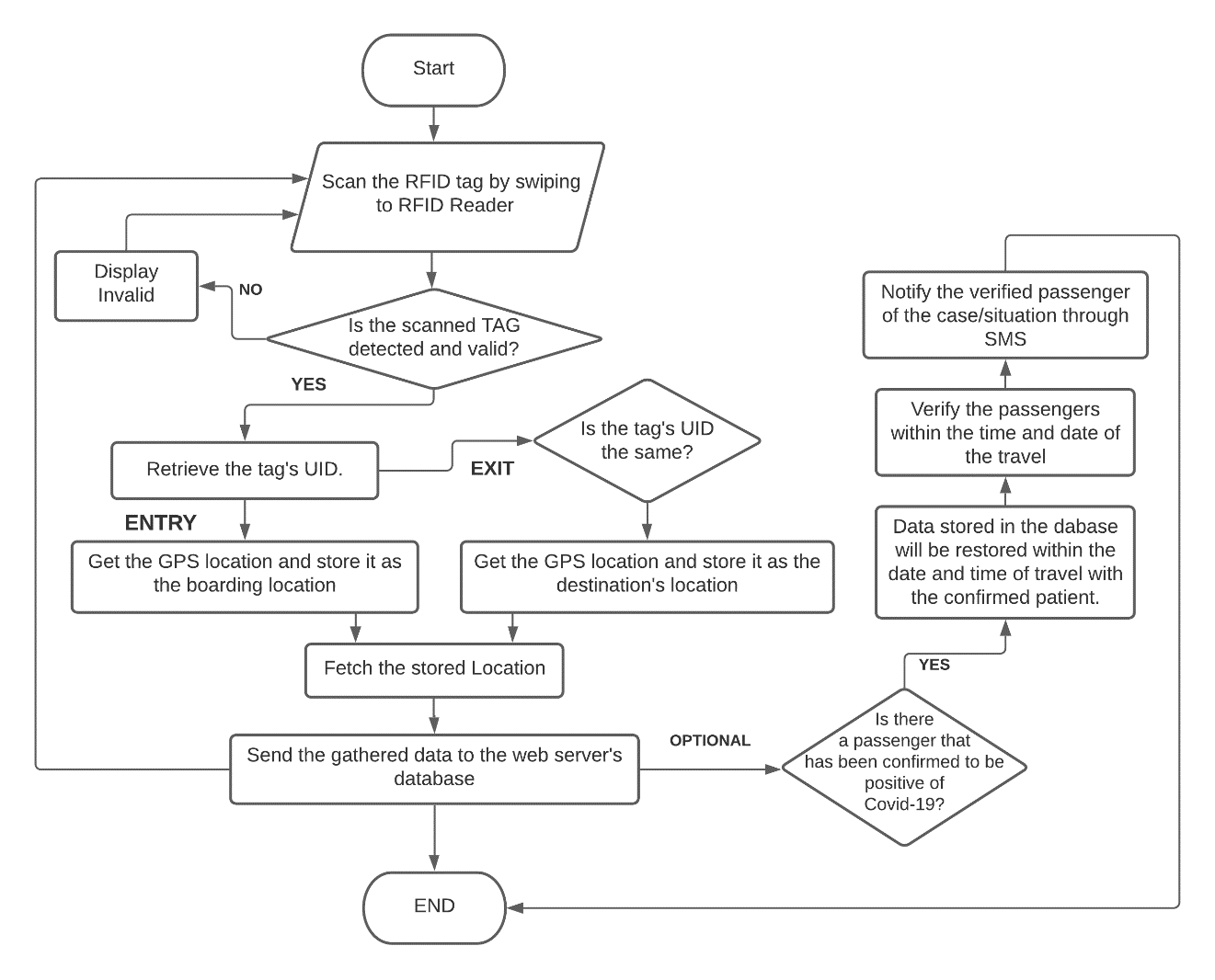
****

**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.

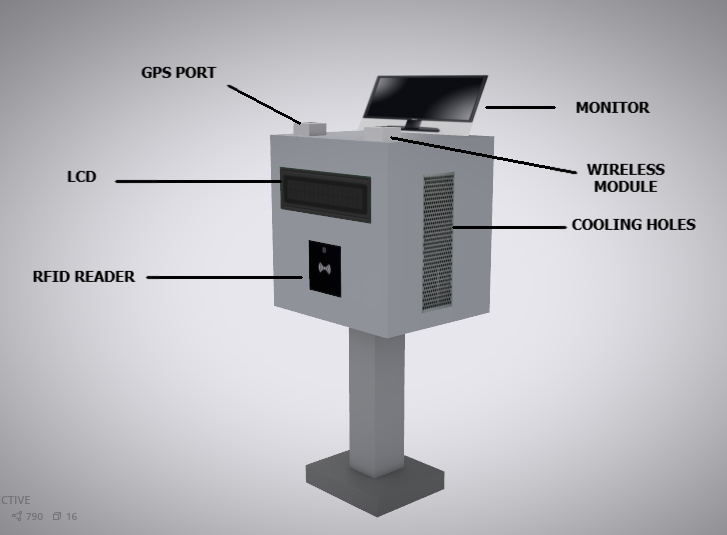
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**Figure 3.3 Flow Chart of the Working Process of the Proposed System involving the Fare Collection of the study**

**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**

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**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.

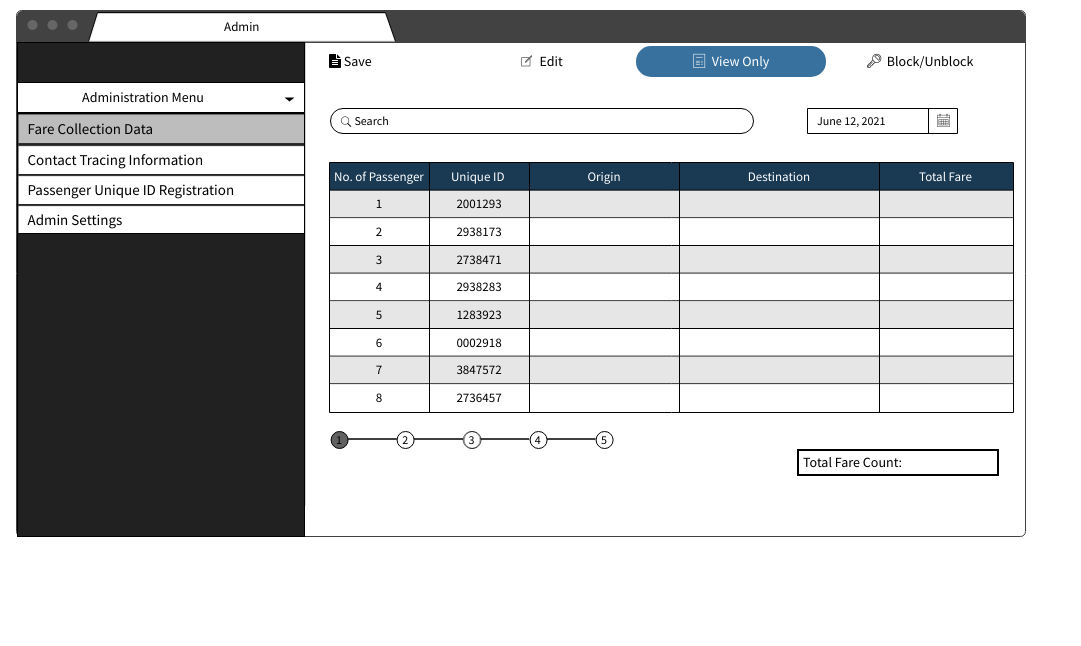
**Global Systems for Mobile Communications Module** - a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world. It uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies. 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.

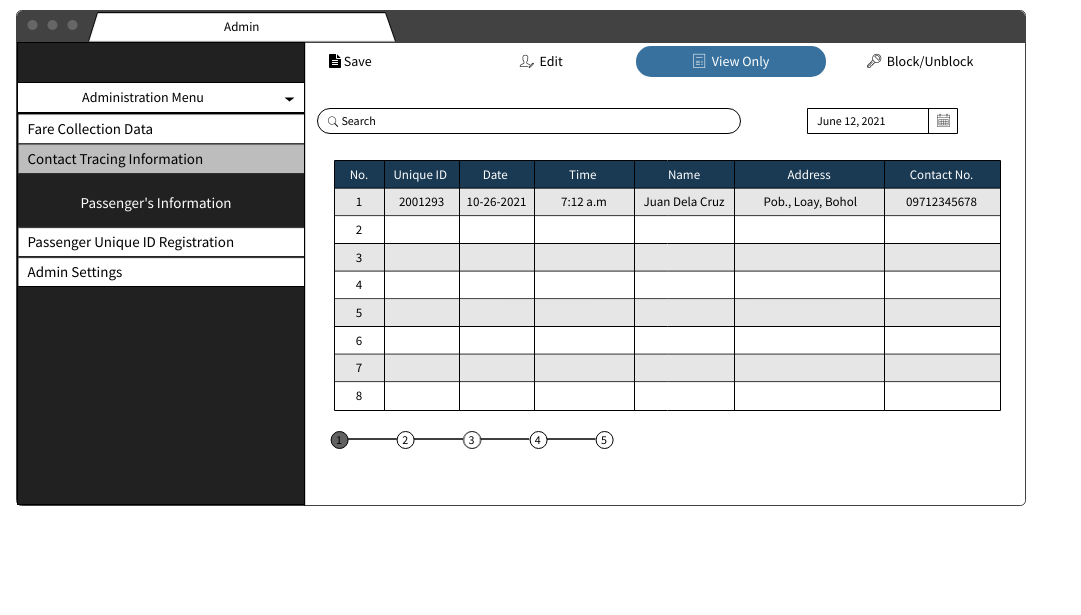
**Radio-Frequency Identification Reader** - a device used to gather information from an RFID tag, which is used to track individual objects. This will help the researchers to read the information of an individual's RFID Tag.

**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 | | | | | | | | | | | | | | | |  |

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**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

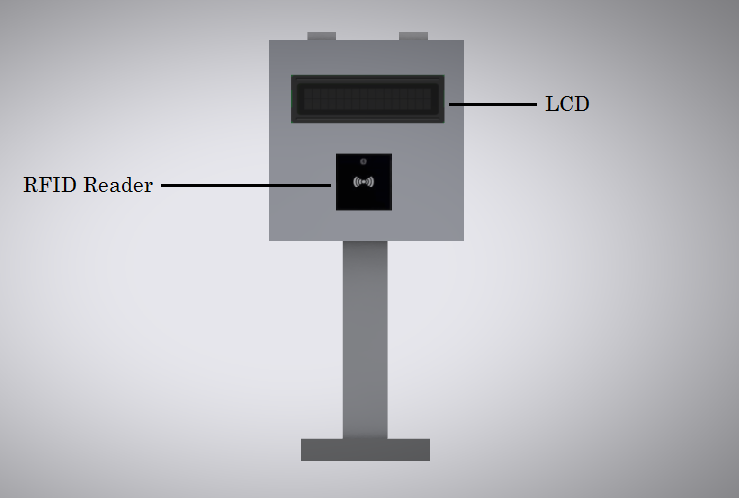
Mary Jane Mandin

Joyce Queenie Garsuta

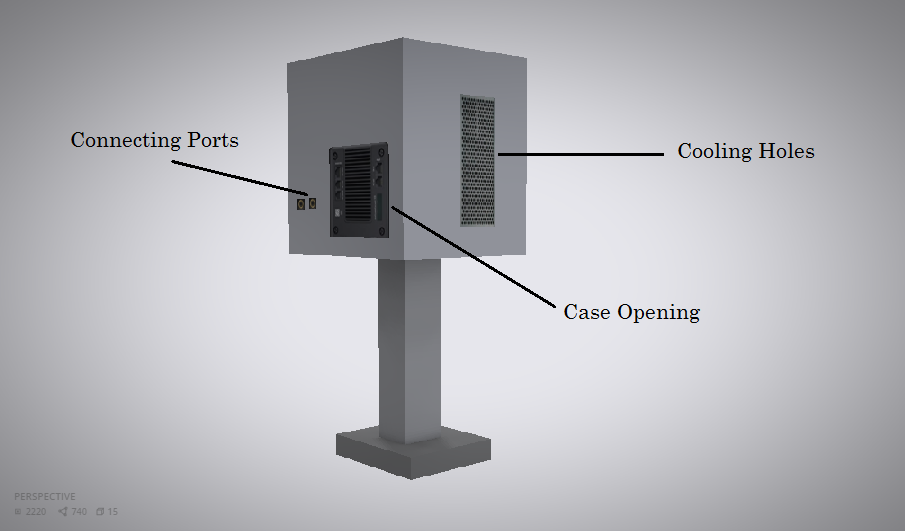
**Appendix B**

**Technical Design**

**Proposed System Design**

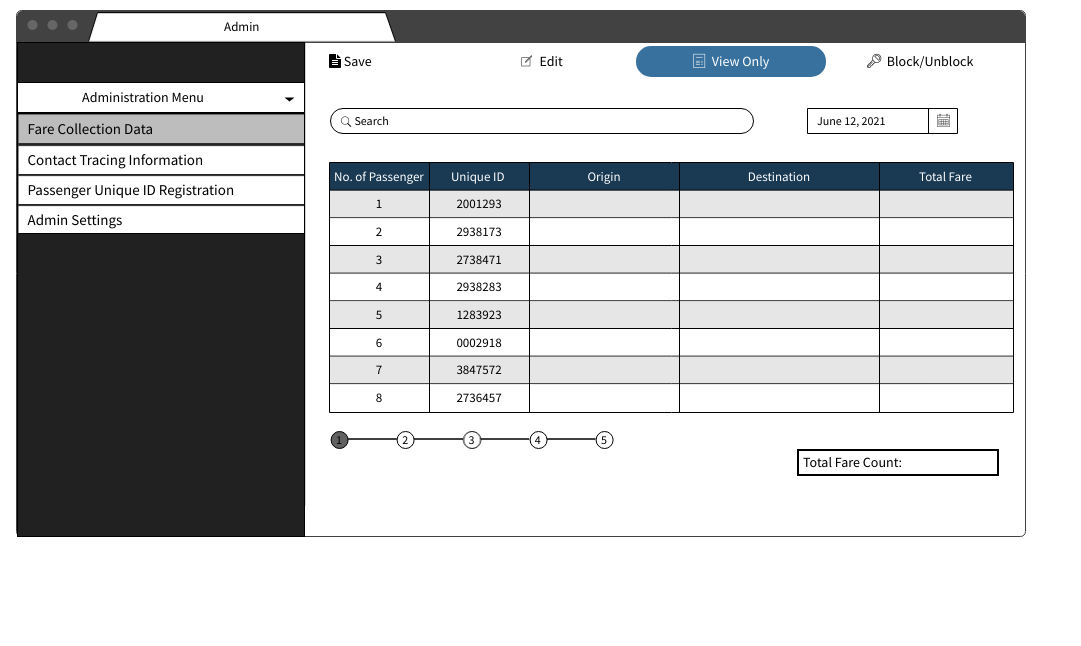


**Figure 3.4 Bus Fare Collection System Front View**

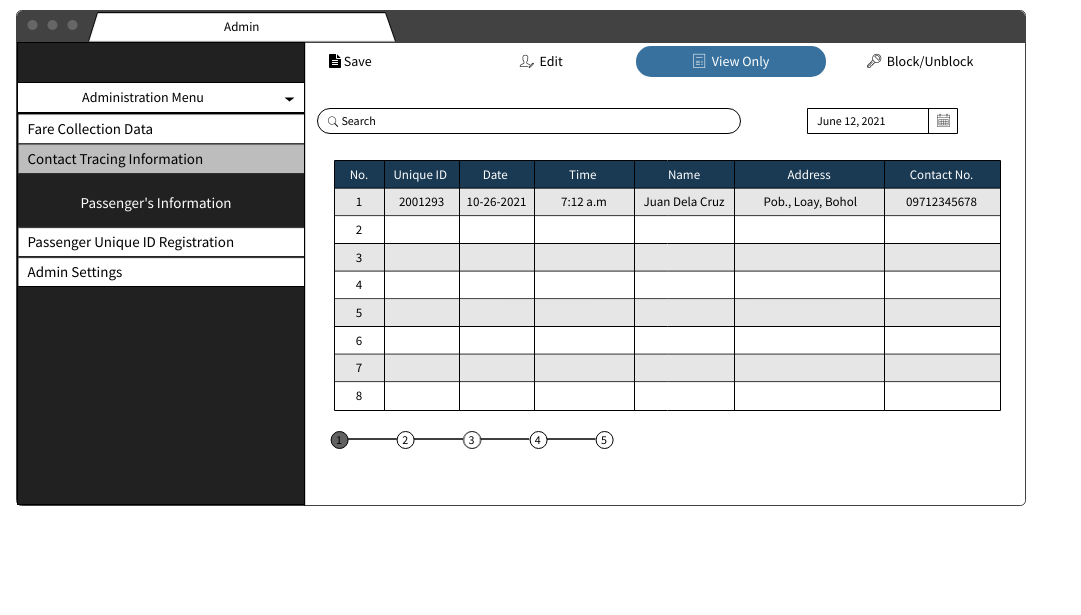


**Figure 3.5 Bus Fare Collection System Side and Back View**

**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 |