# CHAPTER 1: INTRODUCTION TO THE STUDY

## Background of the Study

In the year 2019, the Corona virus or Covid-19 was first detected in China before the first case was detected in the Philippines in January of 2020. Covid-19 is a virus that can be easily transmitted through close physical contact. The pandemic paralyzed many industries and sectors including the transportation sector. In March 2020, the national government issued a lockdown which affected the transportation sector. All types of transportation were mandated to a travel standstill nation-wide. This was so because the current transportation system is vulnerable to the spread of the virus due to the close proximity and physical contact among passengers from fare payment to getting tickets.

Currently, in the case of a bus company here in Iloilo the payment method is via the conductor who issues tickets or the driver, who collects the payments from the passengers manually. Specifically, in the Ceres Bus Liner, an inspector will board the bus to inspect the tickets if issued correctly and if they match the number of passengers. Due to travel ban because of the pandemic, the company increased the fare in order to recover the losses but there were complaints arising

from this action. Some of the passengers complained that some buses, public utility jeepney, and other types of transportation do not offer discounts to students, senior citizens, and persons with disabilities which is an indication of inaccurate fare pricing. On the other hand, there were instances where passengers on the bus who are relative of those working for buses like the conductor, inspector, manager, etc., do not pay for the fare which is a form of cheating in the company.

Currently, in the case of the transportation vehicles here in Iloilo the payment method is done manually by collecting fares from passengers by fare collectors in the person of the conductor or the driver. Due to the pandemic different transportation companies opted to fare increase in order to augment the diminishing income of drivers. As the result of fare increases on transportation the discounts offered for senior citizens, students and PWD's were denied- which leads to inaccurate fare pricing on transportations. The current transport system of the Philippines is outdated in comparison with the country's neighboring countries like Singapore, Taiwan, China, Japan, Korea, etc. This is why the country’s transportation system was easily affected and to

some extent operations were paralyzed and seemed unable to recover unless the pandemic is over. In Manila, "Beep cards" by AF Payments Inc. was already implemented in MRT and LRT as early as 2015 and was further utilized in some buses during the pandemic to lessen physical contact but buying the card resulted in long queues because the system is manual which defeats the purpose of physical distancing.

Here in Iloilo City, a modernized jeep uses beep cards but is not implemented properly since the conductors are the ones who tap the beep card and input the fare price which defeats the purpose of automation. Therefore, passengers here in Iloilo are still practicing the manual way of payment which is very inconvenient and time-consuming. The manual payment may also result in corruption because the driver or the operator tend not to remit all the fare collection within that day. As a result, the owner of the transport unit may not get the desired amount of fare collection.

According to Manila Times, the pandemic caused the cost and demand of the beep card to increase and passengers were obliged to purchase because they do not have any other options. For these reasons, the study aimed to minimize the transmission of COVID-19 virus in the transportation sector.

The proposed systems were implemented for better fare payment and minimization of physical contact of all target users as well as for the improvement of the transportation system here in Iloilo. Faster, safer, and accurate fare collection is what the proponents are aiming for. The fare calculation will be based on distance-based fare rather than flat-rate fare because the infrastructure in the region is not yet ready and policies and the kind of system are not yet in place.

In addition, in order to allow the passengers to find the shortest path going to the place of destination the study aimed to implement a mobile app with a Pathfinding Algorithm. Pathfinding Algorithm uses the Dijkstra's Algorithm in order to show the possible shortest path. Dijkstra's algorithm is a step-by-step process used to find the shortest path between two vertices in a weighted graph. The Pathfinding Algorithm is just a simulation of how the shortest path works. The proponents used Haversine Algorithm in calculating distance when generating tickets as well as places API instead of Real Time Map. The calculation of the fare was based on LTFRB Regulation's fare tariff. To outlook monthly sales and to view sales forecasting, the Fare Management System was also be implemented with the use of the SARIMAX model. SARIMAX

model is a time series modeling which allows the proponents to visualize the forecasting of the sales. The SARIMAX model is a linear regression that best fits when used in seasonal trends or patterns. In addition, the Top-Up System is in-charge of adding load value to the user's account. As a result, the bus units for use may be air-conditioned or not, taxis, and jeepneys may be prepared and all the passengers may be accommodated.

## Theoretical Framework

Transportation system is one of the most important innovations in Western Visayas Region. In Iloilo, buses, jeepneys, and taxis are one of the most widely used modes of transportation when traveling in the provinces of Iloilo. The proponents identified that the manual method of fare collection used by the transportation companies was inefficient, inconvenient, and inaccurate. Behrens et., al (2017) in the study entitled "Exploring Cashless Fare Collection in the Context of Urban Public Transport Reform in South Africa'' have stated that vehicle owners experience depreciation despite the scale fare revenue for the driver always keep the balance of fare revenue after vehicle rental and fuel consumption payments. Nakamura et., al. (2011) in the study entitled "Study on the Impact of Fare Collection Process with Multiple Fare Media on the Passenger Service Time at Bus Stop" have stated that fare collection policies and systems are being developed to address the mentioned problems. Neighboring countries like Singapore, Japan, Taiwan, and Korea have already implemented automated fare collection and were even integrated to different modes of transportation.

The benefits of the automated fare collection systems were recognized by the Philippine public authorities according to the report of McDonaugh et., al (2016). In his study entitled "Automatic Fare Collection System (AFCS): The Case of Manila", automated fare collection systems have already been implemented on the major railways in the capital. Since the infrastructure, policies, and other modes of transportation in the region are still lacking, the proponents aimed to develop an automated fare collection system anchoring on distance-based fare rather than flat rate pricing that are used in some of the mentioned countries.

According Ingco et., al (2018) in the study entitled "PUJ Fare Collection System: An IoT Application" that since the Department of Trade and industry released a new design for Public Utility Jeepneys in 2017, the automated fare collection can be implemented to the modernized jeepneys. If the said system is implemented, the system will benefit both the drivers and passengers and will reduce confusion and time-consumption. Isern-Deya et., al (2013) discussed in the study entitled "A Secure Automatic Fare Collection System for Time-Based or Distance-Based Services with Revocable Anonymity for Users" that automated fare collection systems allows the use

of electronic tickets which helps to reduce the costs and improve the control the infrastructure. According to Andolilo et., al (2017) in the study entitled "Preliminary Study on the Cashless Payment as an Experience-Based Marketing Vehicle in Tourism Destination", cashless payment systems can strengthen a destination's connectivity and create a more seamless tourist experience. A memorable tourism experience has been argued to lead to destination loyalty. The authors discussed that tourism greatly benefits the study. According to Agarwal et., al (2021) entitled "Automatic Fare Collection in Metro System using QR Code" stated in their study that not all passengers have the token or smart cards as a payment especially those who are new to the city and other passengers have cash problems. With that regard, the authors decided to use QR codes as the main method of transport and payment. In the study entitled "Bus Ticket System for Public Transport Using QR Code", Mayan et., al (2019, it was proposed that QR reader could be used for a bus ticket instead of using paper tickets. The authors also stated that when the user completed the registration, their bank account would then be connected to the app where the passenger could add money to the wallet which then could be used when they travel. The payment would be automatically deducted on the passenger's wallet and would

proceed directly to the transport corporation on the basis of the conductor. The benefits of using QR code was discussed in the study of Rohadi (2020) entitled "Smart Bus Ticket System Using QR Code". Rohadi (2020) stated that QR code solved the issue of users that might accidentally lose the printed tickets purchased and also QR code helped the staff management to reduce the cost to buy paper to print the tickets.

In addition, according to Irungu (2016) in the study entitled "QR-Based Mobile Payment Application for Public Service Vehicles" QR code would help Public Service Vehicle (PSV) owners to breakdown the daily revenue of collection and it may overcome the challenges in cash payment and reduce the risks associated in the current fare system. In the study of Anuradha et., al (2018), entitled "Smart Bus Ticketing System Using QR Code in Android App" it was stated that QR code would increase the public transport usage since everything could be done independently and the passenger could check the available buses on their route by just entering the destination. According to Fitriani et., al (2017) in the study entitled "Haversine Method in Looking for the Nearest Masjid'' had stated that determination of the nearest distance is often a problem to get to somewhere especially

when the Muslims want to find Masjid when Muslims need to worship. With that regard, the authors used the Haversine method to calculate the distance based on the latitude and longitude.

The authors have concluded that it can be a great help in calculating the distance. The authors also stated that the Haversine's weakness was that the Haversine method cannot know the obstacles that may exist since it can only calculate distance based on a straight line. Armay et., al (2020) also stated in the study entitled "Resolving the Shortest Path Problem Using the Haversine Algorithm" that Haversine Algorithm can determine the distance between two locations in a straight line on the coordinates of the earth and ignores hills or valleys on the surface. In addition, the authors mentioned that the Haversine Algorithm is not suitable for measuring distances with units other than latitude and longitude.

## Objectives of the Study

The main objective of the study was to develop a fare management system that would manage and monitor the transportation payment and a mobile app that would show the shortest path as well as calculate the fare fastened on all transportation units here in Iloilo.

Specifically, this study aimed to:

1. Build a mobile app called the EzPay app for Philippine Transportation fare collection system integrated with Fare Calculation Algorithm using Haversine Algorithm to compute the passenger's fare based on the distance traveled by the passenger and calculate the fare based on LTFRB Regulation’s Fare Tariff and Dijkstra’s Algorithm for path-finding simulation.

2. Integrate a Top-up Cashless System into the proposed mobile app as a prepaid card for the passengers’ fare.

3. Integrate a Time Series, Linear Regression using SARIMAX model for decision support.

4. Implement the proposed system and perform user testing and evaluation using ISO-standard Usability Assessment Tool

based on system functionality, performance, usability, reliability, and maintainability

## Significance of the Study

The study would be beneficial to society considering that transportation plays a big role in the daily lives of people. The great demand for transportation innovations justifies the need for more effective and reliable service. The proposed system may provide an easy-to-use and easy-accessed system thus; transactions would be more reliable and faster so that conductors or drivers may not have a hard time collecting payments by themselves.

The proposed system would also provide more accuracy, consistency and secure mode of payment when traveling.

Passenger - The proposed system would be mainly beneficial to the passengers since the passengers are the main users of the system which is the Mobile App. The proposed system would provide an accurate, cashless and safe mode of payment.

Transportation Companies - The proposed systems would allow automation in the company's transportation system. Thus,

the systems may have an efficient, accurate and faster fare payment process for people using their service.

Drivers - The proposed system would allow drivers to collect fares in an efficient and faster way.

Future Researchers - The study could serve as a basis for further study on implementing an automated fare collection system in transportation services.

## Definition of Terms

For better understanding, the following terms were defined conceptually and operationally:

Database - This is also called electronic database, refers to any collection of data, or information, that is specially organized for rapid search and retrieval by a computer. Databases are structured to facilitate storage. (Anonymous. Database. Encyclopædia Britannica, Inc.)

In the study "database" is used in stocking data in the medium of tables.

SHA-256 algorithm (Secure Hash Algorithm 256-bit) - This a patented cryptographic hash function that outputs a value

that is 256 bits long. (Anonymous (2019). SHA-256 Algorithm Overview. N-able Solutions ULC and N-able Technologies Ltd.)

In the study, the "SHA-256" is used to encrypt the password.

Quick Response (QR) Code - This is a type of barcode that contains a matrix of dots. QR Code can be scanned using a QR scanner or a smartphone with built-in camera. Once scanned, software on the device converts the dots within the code into numbers or a string of characters. (Christensson, P. (2015). QR Code Definition. TechTerms.com)

In the study, "Quick Response (QR) Code" is scanned in the passenger's mobile phone in order to process the passenger's payment

Quick Response (QR) Code Scanner - This an optical scanning device that is able to read QR codes. Most tablets and smartphones have built-in QR code scanners in their cameras. (Scott (2020). What Is a QR Code? QR Code Meaning & Example. SproutQR, Inc.)

In the study, "Quick Response (QR) Code Scanner" is used to scan the QR Code found in the passenger's mobile phone to process their fare payment.

International Organization for Standardization ISO - This an independent, non-governmental, international organization that develops standards to ensure the quality, safety, and efficiency of products, services, and systems.

(Wilber, J. (2020). What Exactly Is ISO Certified? And Why Does It Matter? Mead Metals, Inc.)

In the study, "International Organization for Standardization (ISO)" is where the survey given to the respondents was based.

Transportation Companies - This term includes the movement of goods and services, people, and animals from one location to another by rail, road, air, sea, cable, space, or pipeline. Transportation services can be divided into three different areas: infrastructure, vehicles, and operations. (Fleming, E. (2019). What Do You Mean by Transportation Company? SidmartinBio.)

In this study, the "Transportation Company" is where the systems were initially aimed to be implemented.

Dijkstra's Algorithm - A step-by-step process used to find the shortest path between two vertices in a weighted graph. (Anonymous (2020). Finding Shortest Paths in Graphs (using Dijkstra's & BFS). Dev Community.)

In the study, "Dijkstra's Algorithm" is used to find the shortest path.

Seasonal Autoregressive Integrated Moving Average Exogenous model (SARIMAX model) - A linear regression model that uses a SARIMA-type process. The SARIMAX model is useful in cases where we suspect that residuals may exhibit a seasonal trend or pattern. (Mohamad (2016). Seasonal Autoregressive Integrated Moving Average Exogeneous (SARIMAX) Model. NumXL Spider Financial)

In the study, Seasonal Autoregressive Integrated Moving Average Exogenous model (SARIMAX model) is used for time series modeling.

Augmented Dickey-Fuller (ADF) Test - A common statistical test used to test whether a given Time series is stationary or not. (Prabhakaran, S. (2019). Augmented Dickey Fuller Test (ADF Test) – Must Read Guide. Machine Learning Plus.)

In the study, Augmented Dickey-Fuller Test is where the data is being trained and is being.

## Delimitation of the Study

The proponents proposed a system intended for transportation types such as buses, which may be an air conditioned or regular unit, taxis and jeepneys that only operate in all the terminals here in Iloilo. Due to the increasing rate of the Covid-19 patient, the proponents decided not to involve a specific company or organization in the duration of the study. The goal of the Top Up System was to add load and check the load balance on the user's account.

In the Fare Management System, the administrator could monitor and manage accounts as well as the databases. In addition, administrators could outlook monthly sales and view the forecasting of the sales with the use of Seasonal Autoregressive Integrated Moving Average Exogenous (SARIMAX) model. The Sales Forecasting have a user interface and the variables were based on the Top Up transaction or when the passengers added load to their account. The proponents used the Top Up transactions as the variables since no company or organization was involved in the study Likewise, the proponents were not allowed to gather data on different terminals as advised by the panels and the faculty. In order to train the data and to determine whether the data was

stationary or not the proponents used the Augmented-Dickey Fuller (ADF) Test.

The Top Up System which would be used by the cashier or manager. The main function of the Mobile app or the EzPay was to generate tickets, collect payment through the QR code and simulate shortest path-finding algorithm with the use of Dijkstra's Algorithm. Haversine algorithm to compute the distance between two places using the values from places API from google. The Haversine algorithm does not take into consideration the road layout. The proponents used the Places API but the Places API adds operational expenses which may add to the company's burden. The EzPay was intended for passengers or commuters as well as the drivers.

The different proposed systems need stable internet connection in order to function properly. The proponents used Script in integrating the different systems. The study was not intended for deployment but served as a study of algorithms and was a proof of concept only.

The testing was done in Iloilo only and the respondents were the people who were close or relatives of the researchers due to the fact that they were not allowed to conduct the testing on the different terminals here in Iloilo. They chose

random people to become the respondents due to the increasing number of Covid-19 patient. In this regard, the proponents chose to follow the health protocols implemented by the government.

# CHAPTER 2: REVIEW OF RELATED STUDIES

## Review of Existing and Related Studies

### Local studies

*PUJ Fare Collection System: An IoT Application.*

According to Ingco et., al (2018), Electronic payment was implemented on different modes of transportation such as buses and trains yet the major mode of transportation here in the Philippines: the jeepney, still has a long way to go due to the design and way of payment which is very challenging to implement the electronic payment. Since the Department of Trade and Industry released a new design for the Public Utility Jeepneys in 2017, the Automated fare collection can be implemented to the modernized jeepneys. If the said system is implemented, the system would benefit both the drivers and passengers and reduce confusion and time-consumption.

*Automatic Fare Collection System (AFCS): The Case of Manila.*

In the study of McDonagh et., al (2016), Public authorities in the Philippines recognized the benefits of these smartcards and introduced the technology on three urban rail transit systems in Manila. The report stated that the system was able to offer efficient fare collection, more

informed transport planning, and enhance demand management for the government and the operator. The passengers could benefit as the system is user friendly or is an integrated ticketing system and could reduced journey time. The report also stated that the country's new automatic fare collection system would come at no cost to the passenger and the government and the private consortium can expect a return of capital which was invested in several areas such as commercial payments in the malls and others which was similar in the case of Octopus cards in Hong Kong.

Foreign Studies

*Preliminary Study on the Cashless Payment as an Experience-Based Marketing Vehicle in Tourism Destination.*

According to Andilolo et., al (2017), the payment system is one of the most important aspects of technological development and the governments were encouraging different sectors including tourism to adopt the cashless system. The authors discussed in the study that cashless systems are promoted on their effectiveness and inclusiveness. The development of ICT in the form of a cashless payment system can strengthen a destination's connectivity and create a more seamless tourist experience. A memorable tourism experience

has been argued to lead to destination loyalty. The study of cashless payments in other areas of tourism had been rarely explored. The study serves as a preliminary study to explore consumer behavior regarding cashless payment systems in island destinations. The study argued that the cashless payment system can enhance the vacation experience, which can *serve as a differential marketing value for a destination.*

*Exploring Cashless Fare Collection in the Context of Urban Public Transport Reform in South Africa.*

According to Behrens et., al (2017), in South Africa unscheduled paratransit drivers often keep the balance of fare revenue after vehicle rental and fuel consumption payments, while owners seldom include vehicle depreciation as a daily operating expense despite the scale fare revenue. The author also discussed that business owners had a hard time making operating decisions based on an income-expenditure ledger and principles of profit and loss. The paper aimed to determine the possibilities of various cashless fare collection (CFC) systems to alleviate these issues, as well as to analyze the existing technology alternatives.

*Study on the Impact of Fare Collection Process with Multiple Fare Media on the Passenger Service Time at Bus Stop.*

Nakamura et., al (2011) stated that one of the important factors for better performance of bus service and satisfaction of passengers was bus punctuality. Since one of the causes of delays is bus dwelling at the bus stop, fare collection policies and systems are being developed. The study identified that minimizing fare collection time was a key factor of improvement of bus services through reduction of bus dwell time at the bus stop. The electronic fare collection system has been said to be effective in reducing passenger service time and was already introduced on bus companies in Tokyo, Japan along with other existing methods of payments. According to the test, the smart cards or IC cards showed the least marginal alighting time taken and concluded that the fare collection process was affected by the pricing policy and type of technology adapted and stated that minimizing fare payment time would be the key to the bus service reliability. Therefore, bus companies in Japan are implementing advanced technology for fare payment such as smart cards for the purpose of reducing the passenger service time as well as reducing fare counterfeiting.

*A Secure Automatic Fare Collection System for Time-Based or Distance-Based Services with Revocable Anonymity for Users.*

Isern-Deya et., al (2013) stated that Automated Fare Collection Systems allowed the use of electronic tickets which helps to reduce the costs and improve the control of the infrastructure. The systems calculate the fare that the users must pay with regards to the time that the passenger aboard or the time the passenger exited. In the study, the proponents main goal was to identify the security requirements for the time-based and distance-based systems and have proposed a protocol for each of the AFC systems in order for them to protect the system against possible fraud as well as the proponents need to preserve the privacy of the users. The system was implemented in Android and the performance was evaluated with the use of two Android smartphones. The findings showed that protocols were adequate for usage on an AFC system with a medium-class mobile device, however a high-class smartphone provides a superior experience. Using the type of AFC system would eliminate the need for cash and vending machines, customer convenience, faster travel, and reduced the accounting efforts and back-office costs.

*Monitoring Public Transport Demand Using Data from Automated Fare Collection System.*

Alhusseini et., al (2018) mentioned in the study that the Automated Fare Collection system was widely used on public transportation. In the study, analyzing the sequence of payment transactions, which were recorded and saved by an automated fare collection system, determines the passenger's journey from the origin stop to the destination stop. Depending on the type of fare, the payment on the smart card or the non-cash payment can consist of one or more payments. In a fixed fare on which the trip is not dependent on the distance, the payment is made in a single operation, during which the location and time of the transaction, as well as the route and transport vehicle used for the trip, are recorded. On the other hand, the payment consists of two operations which are when the passenger aboard and when the passenger alights. With regards the case, all the necessary information about the trip is being recorded.

*Automatic Fare Collection in Metro System using QR Code.*

Agarwal et al. (2021) stated in their study that the number of passengers traveling through the metro transport system had increased rapidly over the past few decades. In the study, authors also discussed that not all passengers have the token or smart cards as a payment, especially those who are new to the city and other passengers have cash problems. With that regard, the authors decided to use QR codes as the main method of transport and payment. The proposed system QR code was used which would be generated in ones mobile phone to pass through the metro gates which have the scanning device inside. The said system would not only have solved the problem of wasting time in collecting passengers' payment but may also be more convenient both for the passengers and drivers.

*Bus Ticket System for Public Transport Using QR Code.*

Mayan et., al (2019) proposed QR reader for a bus ticket instead of using tickets in the study. In the proposed application, when the user completes the registration, their bank account will be attached to the app and they can add money to the wallet. In line with the study, users could use the app wherever they will travel using a bus. Passengers

only need to select the destination's location and the payment per head will be generated. The QR code will be scanned by the conductor of the bus using a particular ID. The payment will be automatically deducted on the passenger's wallet and will proceed directly on the transport corporation on the basis of conductor ID. An SMS alert will be received as ticket payment proof. The calculation of the amount details will be done by the admin side or the Transportation Corporation through the use of web applications. The admin can calculate per day amount details of the Transport Corporation for buses.

*Smart Bus Ticket System Using QR Code.*

Rohadi (2020) developed a ticketing system using the QR code in order to solve the issue of users that might accidentally lose the printed tickets purchased. The developed system also helped the staff management to reduce the cost to buy paper to print the tickets and also passengers can purchase a ticket by just clicking a button in the new mobile application. The said developed system has been proved to help the passengers save more time and effort in just purchasing tickets, reduce the workload of the staff, and most importantly, the developed system can improve efficiency. The author stated that the passengers will not

receive a notification about the seats that are available and also, there will be a greater chance that a ticket will be duplicated especially when there is somebody who is *knowledgeable about the encryption key used in the app.*

*QR-Based Mobile Payment Application for Public Service Vehicles.*

Irungu (2016) proposed a mobile solution called "KommutePal" that allowed passengers to settle fare using a smartphone. The proposed system allowed conductors to validate and collect fare by just scanning an electronic ticket found on the passengers' phone. In addition, the proposed system would help Public Service Vehicle (PSV) owners to break down the daily revenue of collection. The authors also stated that the "KommutePal" overcame challenges in cash payment and reduced the risks associated with the said system.

*Smart Bus Ticketing System Using QR Code in Android App.*

Anuradha et., al (2018) proposed a system that provides a web application as well as an android application that enables passengers to buy tickets online in order to combat the current issues in the bus ticketing system. The ticket

will be gathered once the passenger has already traveled and that is the time the payment will be gathered and the passenger will be notified with a message alert. Using the QR-based code will increase the public transport usage since everything can be done independently and the passenger can check the available buses on their route by just entering the destination. The proposed system, the usage of paper tickets would be minimized.

*Resolving the Shortest Path Problem Using the Haversine Algorithm.*

Armay et., al (2020) propose a study which shows how Haversine Algorithm could determine the distance between two locations in a straight line on the coordinates of the earth and ignores hills or valleys on the surface. The authors determine the distance between two objects based on the longitude and the latitude. The study used the unit of kilometers in determining the results of the distance test between two coordinates. With the result obtained in determining the distance between two points, authors were able to conclude that the Haversine Algorithm is a great algorithm in terms of determining the distance between two points and has an excellent accuracy but is not suitable for

measuring distances with units other than latitude and longitude.

*Haversine Method in Looking for the Nearest Masjid.*

Fitriani et., al (2017) mentioned that the determination of the nearest distance was often a problem to get to somewhere especially when Muslims want to find masjid when Muslims need to worship. In order to give solutions to the problem, authors used the Haversine method and the method would calculate the distance with the help of Euclidean distance algorithm based on the latitude and longitude of the earth. The authors mentioned that the Haversine method was helpful to find the nearest masjid in their position or location and was an excellent method for finding the nearest place based on the coordinates of the earth. However, the weakness of the algorithm according to the authors was that the Haversine method cannot know the obstacles that exist into the nearest masjid and only calculates the distance based on a straight line.

*Shortest Path Algorithms: State of the Art.*

Agung prasetyo et., al (2017) mentioned that people's travel activities have an impact on high economic growth,

which can cause congestion to rise as a result of poor route selection, leading in vehicle building on particular highways, resulting in ineffective travel. Authors stated that Dijkstra's algorithm is one of the most popular algorithms used to solve the shortest path problem with the aim to find the shortest path based on the smallest weight from one point to another. The only problem is that the algorithm can only be used on graphs with no negative edge values.

# CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

## Description of the Proposed Study

The proposed system focused on the implementation of the mobile application called the EzPay app intended for buses, taxis, and jeepneys here in Iloilo. The Ezpay app has the feature to visualize how a pathfinding algorithm worked using Dijkstra's Algorithm and to generate QR code. Haversine Algorithm was used when calculating the distance traveled and the fare was be based on the LTFRB regulation’s fare tariff. On the other hand, Places API was used to get the coordinates. The proponents also proposed the Top-up system which allowed users to add load value and check the balance for the existing users.

The main purpose of the proposed system was to modernize the existing system used by the buses which is the paper based ticketing system and manual fare collection for the taxis and jeepneys. In addition, the proposed system would help the operation become accurate and efficient. On the part of the passenger, the proposed system would enable them to monitor their accounts and with that regards, the driver, conductor in the bus company, and the passenger may be able to develop trust on the different transportation sectors here in Iloilo.

The proposed study could be the basis for policy making and allow modernization of transportation here in Iloilo to take place.

## Methods and Proposed Enhancements

Data gathering or data collection was the process of gathering and collecting information. Information was collected, to keep on record and used to make decisions. In the study the proponents used research, observation, and testing.

The first method used was the "Research", research can be defined to be search for knowledge or any systematic investigations to establish facts. The primary purpose for applied research is discovering, interpreting and the development of methods and systems for the advancement of human knowledge on a wide variety of scientific matters. In the Research phase, the proponent used a search engine to search information with regards to the system. The other one was the "Observation", observation refers to the systematic examination of real time processes or operations with the goal of identifying needs/challenges. The last method used was the "Testing", testing is where the proponents take measures to check the quality, performance or the reliability

of the system in accordance with the ISO-standard User Acceptability Evaluation Tool.

One of the algorithms used in implementing the systems was the SARIMAX model. Note that in the study, SARIMAX model is a time series modeling which allows the proponents to visualize the forecasting of the sales. The SARIMAX model is a linear regression that is best fit when used in seasonal trends or patterns. the formula for SARIMAX model is:

$$w_t = y_t - \beta_1 x_{1,t} - \beta_2 x_{2,t} - \cdots - \beta_b x_{b,t}$$

$$(1 - \sum_{i=1}^{p} \phi_i L^i)(1 - \sum_{j=1}^{P} \Phi_j L^{j \times s})(1 - L)^d (1 - L^s)^D w_t - \eta$$

$$= (1 + \sum_{i=1}^{q} \theta_i L^i)(1 + \sum_{j=1}^{Q} \Theta_j L^{j \times s}) a_t$$

$$a_t \sim \text{i.i.d} \sim \Phi(0, \sigma^2)$$

*Figure 1:* SARIMAX Model Formula

Where:

- L is the lag (aka back-shift) operator.
- ytyt is the observed output at time t.
- xk,t is the k-th exogenous input variable at time t.

- βk is the coefficient value for the k-th exogenous input variable.
- b is the number of exogenous input variables.
- wt is the auto-correlated regression residuals.
- p is the order of the non-seasonal AR component.
- P is the order of the seasonal AR component.
- q is the order of the non-seasonal MA component.
- Q is the order of the seasonal MA component.
- s is the seasonal length.
- D is the seasonal integration order of the time series.
- η is a constant in the SARIMA model
- at is the innovation, shock or error term at time t.
- {at}time series observations are independent and identically distributed and follow a Gaussian distribution (i.e. Φ (0, σ2) Φ (0, σ2))

$$\operatorname{haversin}\left(\frac{d}{r}\right) = \operatorname{haversin}(\phi_2 - \phi_1) + \cos(\phi_1)\cos(\phi_2)\operatorname{haversin}(\lambda_2 - \lambda_1)$$

*Figure 2.* Haversine Algorithm formula

Where:

- r is the radius of the earth.
- d is the distance between two points.
- is the latitude of two points.
- λ1 λ2 is the longitude of two points.

The proponents also used the Haversine Algorithm. In order to calculate the geographic distance on earth, the Haversine algorithm was used. The Haversine algorithm was also used in the study in order to calculate the distance from the initial location going to the final destination factoring the curvature of the earth. The result generated by the Haversine would be used in computing the fare.

$$\Theta((|V| + |E|) \log |V|)$$

*Figure 3.* Dijkstra's Algorithm Formula

Another algorithm used in the study was Dijkstra's algorithm. The said algorithm was used in order to find the shortest path from a node called the "source node" to the destination node by traversing all the nodes in the graph. In the study, Dijkstra's algorithm was used in visualizing the

shortest path. The method kept track the current shortest distance between each node and the source node and updated these values whenever a shorter path is discovered.

## Assumptions and Preconditions

The proponents assumed that the system's outcome would meet the following criteria:

1. The Fare Collection Management System would be replacing the existing manual fare collection system that uses tickets or using money in order to pay for the travel which would result in a faster, accurate and efficient fare collection.

2. The Fare Collection Management System would be the first step in developing policies and modernizing the transportation system here in Iloilo.

3. Transactions done with the system would and should remain anonymous. Personal information from the passenger would not be gathered and would not be tracked in accordance with the Data Privacy Law.

4. PUV owners would have more revenue collected as the Automated Fare Collection System would ensure the accuracy of fare collection and decrease the delays on the bus operation.

5. The Haversine Algorithm would be used in generating tickets on all transportation units not only in Iloilo to easily calculate the point-to-point distance. The LTFRB regulation's fare tariff would be the basis for the fare.

6. The Pathfinding Algorithm with the help of the Dijkstra's Algorithm would visualize all the possible shortest path or route that the bus or any transportation units would travel.

7. The number of travelers will increase due to QR Code used in booking and payment for Public Utility Vehicles.

8. The QR Code implemented would help PUV owners to track and check their day-to-day sales revenue.

9. Due to QR Code that is implemented, overloading would be prevented in the PUV's.

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## Components and Design

### Software Architecture

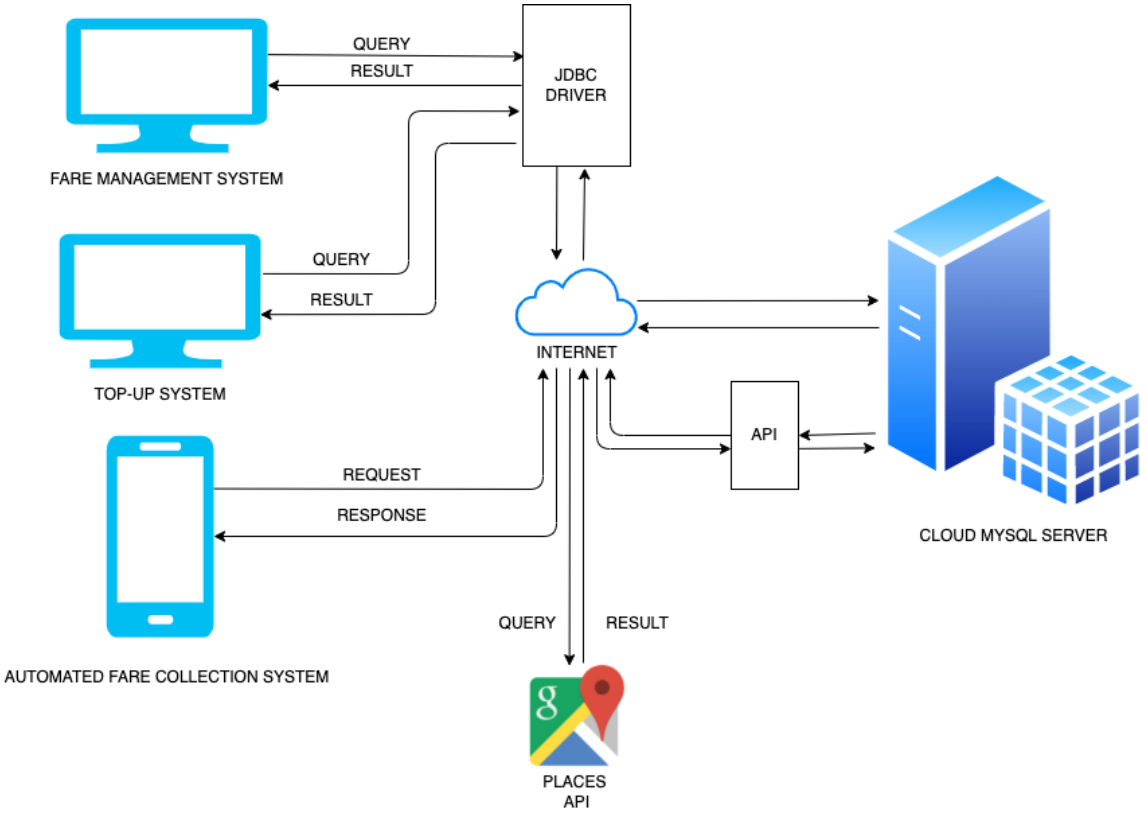


*Figure 4.* Software Architecture of the Proposed System

Figure 4 shows the software architecture of the proposed system. The proposed system was implemented in the cloud which needs internet connection to be accessed and used. All three systems are interconnected via the cloud database. In the mobile application, Places API by google has been used to query locations and a custom API was made so that the app can communicate with the server. Meanwhile, the result of the

sales prediction can be viewed on the fare management system. The fare management system and top-up system connects to the server via the jdbc driver.

System Architecture

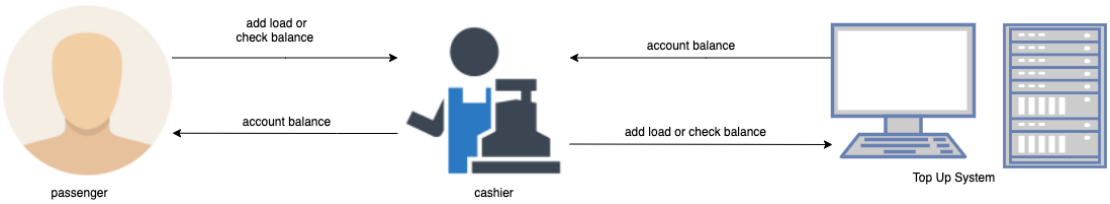


*Figure 5.* System Architecture of the Proposed System - Top Up System

Figure 5 shows the architectural design for the Top up system. The passenger can either add load or check the account's balance to the cashier. The cashier has the ability to process the user's transaction. If the cashier commits an error, the manager can void the transaction.

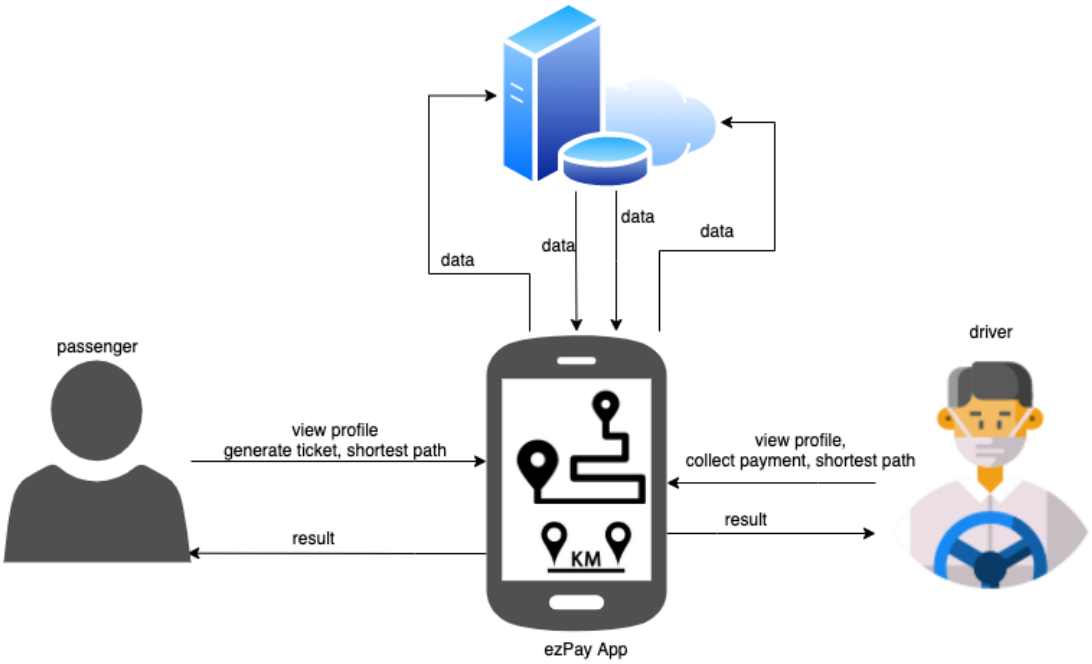


*Figure 6.* System Architecture of the Proposed System - Mobile App

Figure 6 shows the architectural design of the Mobile app or EzPay. EzPay is available to both the passenger and the driver. The passenger can generate a ticket which will be scanned by the driver. The driver can collect payment by scanning the QR code generated by the passenger. Both the driver and the passenger can use the additional feature to visualize the shortest path.

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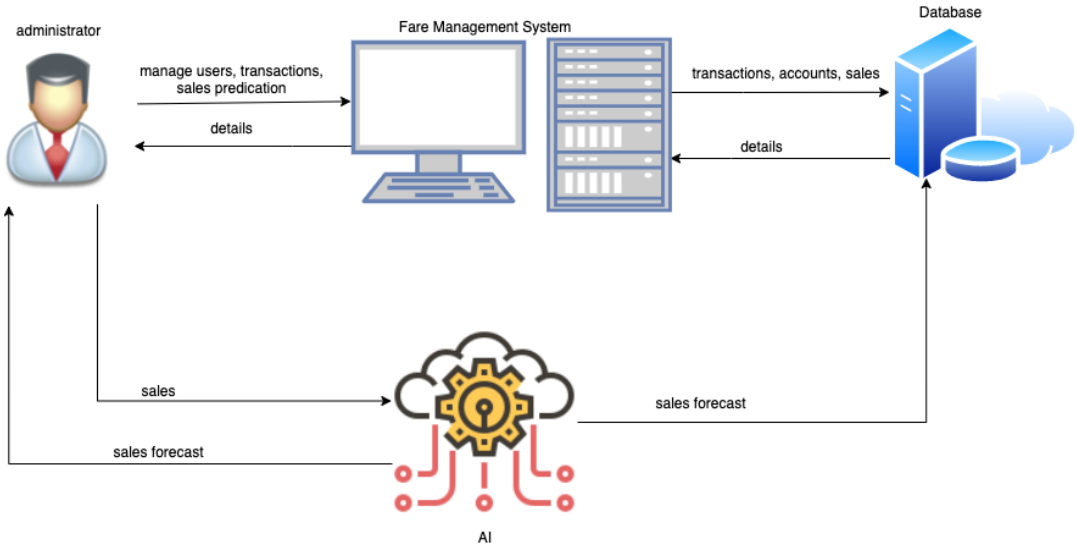


*Figure 7.* System Architecture of the Proposed System – Fare Management System (Artificial Intelligence (AI))

Figure 7 shows the architectural design of the Fare Management System. The system will display all the transactions in every terminal, sales forecast, as well as the monthly sales. The administrator has the authority to use the Fare Management System and can also create other accounts of the cashier and manager from the top-up system and other administrator accounts in the fare management system.

Database Design

| # | Name | type |
|---|---|---|
| 1 | transaction_id | text |
| 2 | Fare | text |
| 3 | mobile_number | text |
| 4 | initial_location | text |
| 5 | destination | text |
| 6 | Status | text |
| 7 | Distance | text |

*Table 1: Database Design of the Proposed System* Transactions Database

Table 1 shows the contents of the afcs_transactiondb which was used in the Automated Fare Collection System.

| # | Name | Type |
|---|---|---|
| 1 | user_id | varchar(255) |
| 2 | User | varchar(255) |
| 3 | Password | varchar(255) |
| 4 | Location | Varchar(255) |
| 5 | Usertype | varchar(255) |

*Table 2: Database Design of the Proposed System – Top Up Database*

Table 2 shows the contents of the accounddb table which was used in the Top-up system.

| # | Name | Type |
|---|---|---|
| 1 | Id | int(11) |
| 2 | Username | varchar(255) |
| 3 | Password | varchar(255) |

*Table 3: Database Design of the Proposed System-Administrator User Database*

Table 3 shows the contents of admindb table which was used in the fare management system.

| # | Name | Type |
|---|---|---|
| 1 | Id | int(11) |
| 2 | Image | longblob |

*Table 4: Database Design of the Proposed System – Current Prediction Database*

Table 4 shows the contents of the current prediction table which was used in the fare management system.

| # | Name | Type |
|---|---|---|
| 1 | Id | int(11) |
| 2 | Image | longblob |

*Table 5: Database Design of the Proposed System – Future Prediction Database*

Table 5 shows the contents of the future prediction table which was used in the fare management system.

| # | Name | Type |
|---|---|---|
| 1 | Id | int(11) |
| 2 | Date | date |
| 3 | Sales | float |

*Table 6: Database Design of the Proposed System – MonthlySales Database*

Table 6 shows the contents of the monthly sales table which was used in the fare management system.

| # | Name | Type |
|---|---|---|
| 1 | account_id | int(255) |
| 2 | complete_name | varchar(255) |
| 3 | Username | varchar(255) |
| 4 | mobile_num | text |

| | | |
|---|---|---|
| 5 | user_type | varchar(255) |
| 6 | Balance | text |

*Table 7: Database Design of the Proposed System – Mobile Users Database*

Table 7 shows the contents of the mobile users table which was used in the fare management system.

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Procedural and Object-Oriented Design

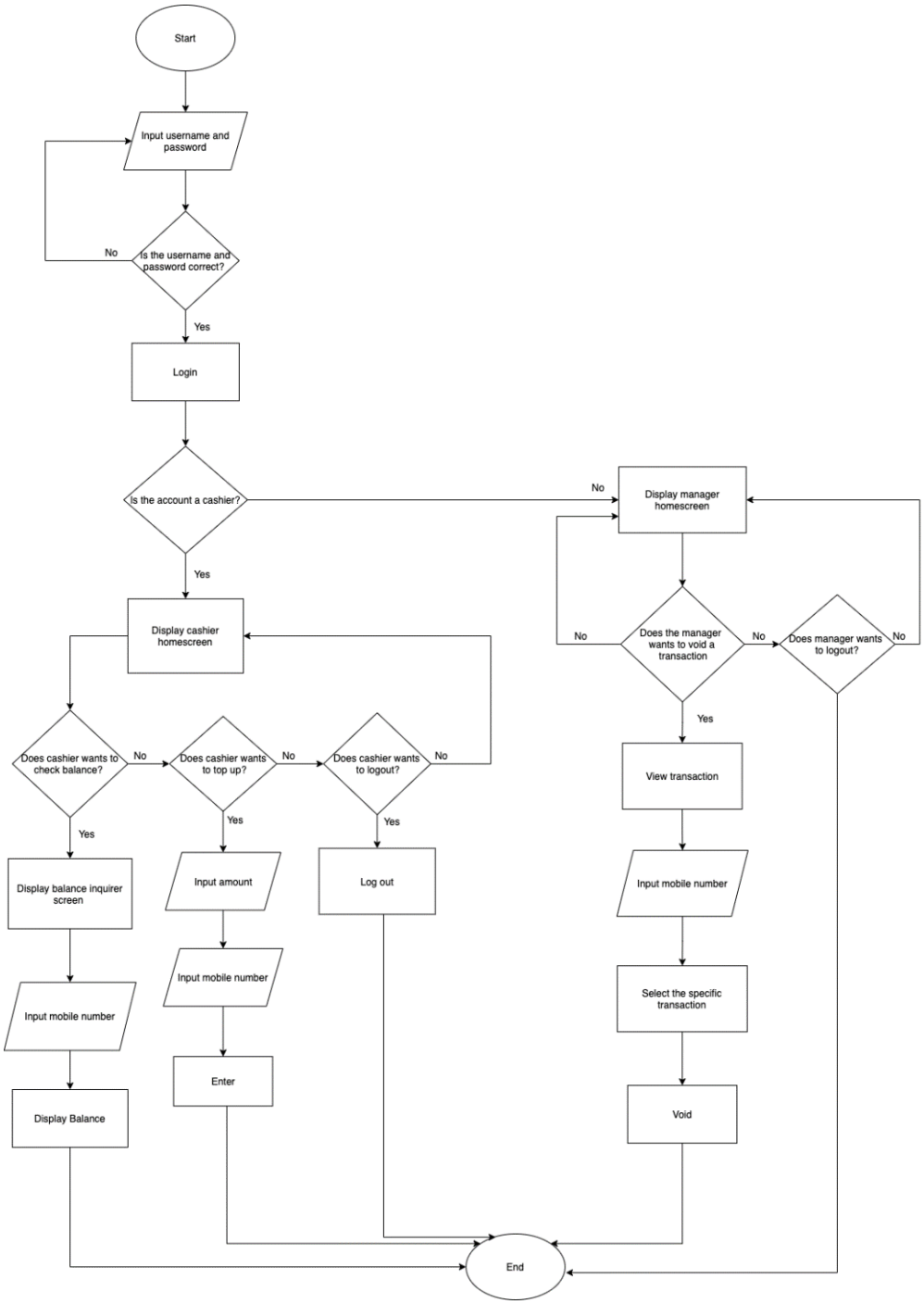


*Figure 8.* Flowchart of the Proposed - Top Up System

Figure 8 shows the Flowchart of the Top up System. As shown in figure above, cashiers and the managers can use the Top up System. The flowchart shows an overview of how the users interact with the system.

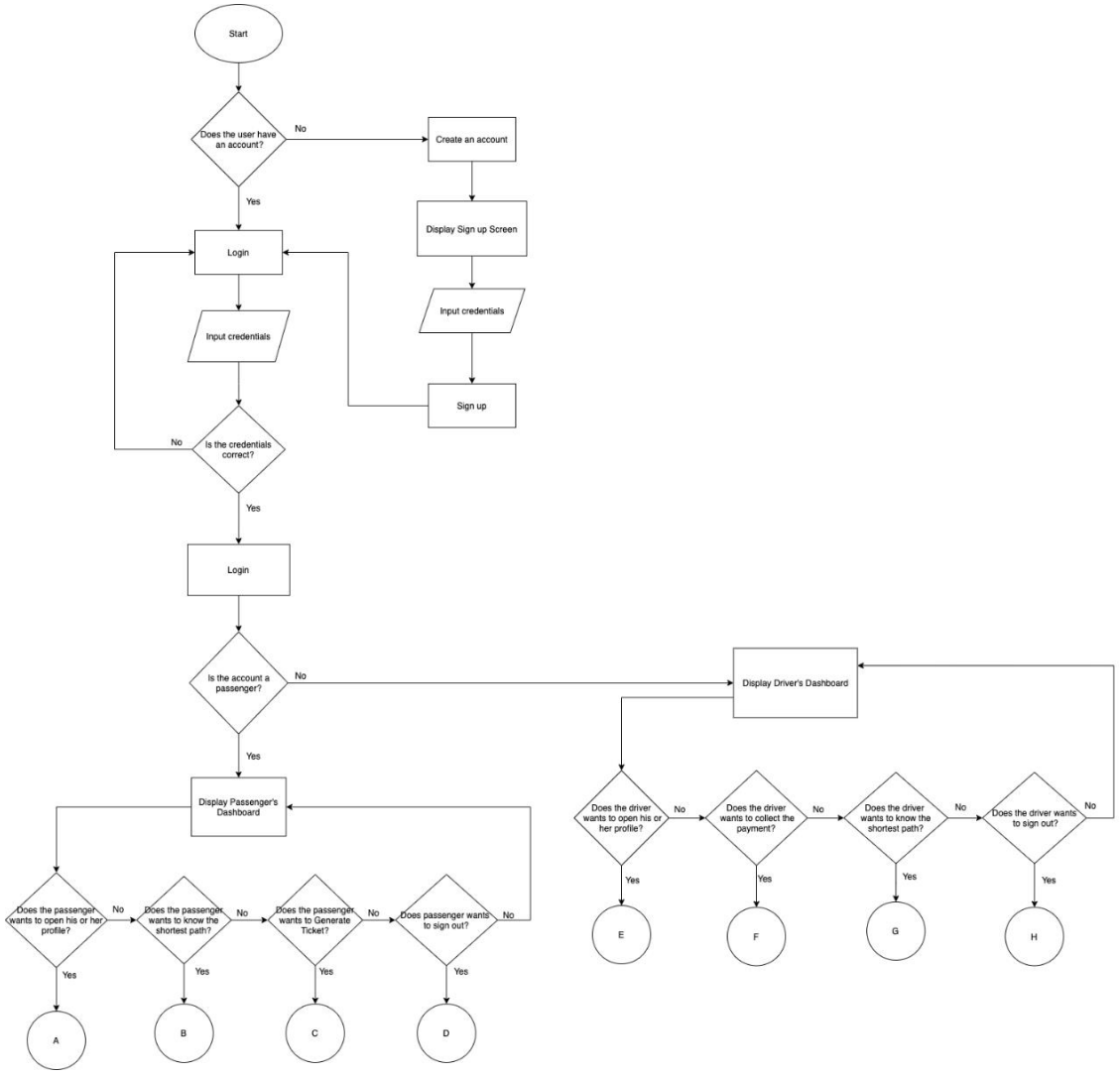


*Figure 9.* Flowchart of the Proposed System - Mobile App

Figure 9 shows the Flowchart of the Mobile App or the Ezpay. As shown in the figure above, passengers and drivers can use the Ezpay. The flowchart shows an overview of how the users interact with the system.

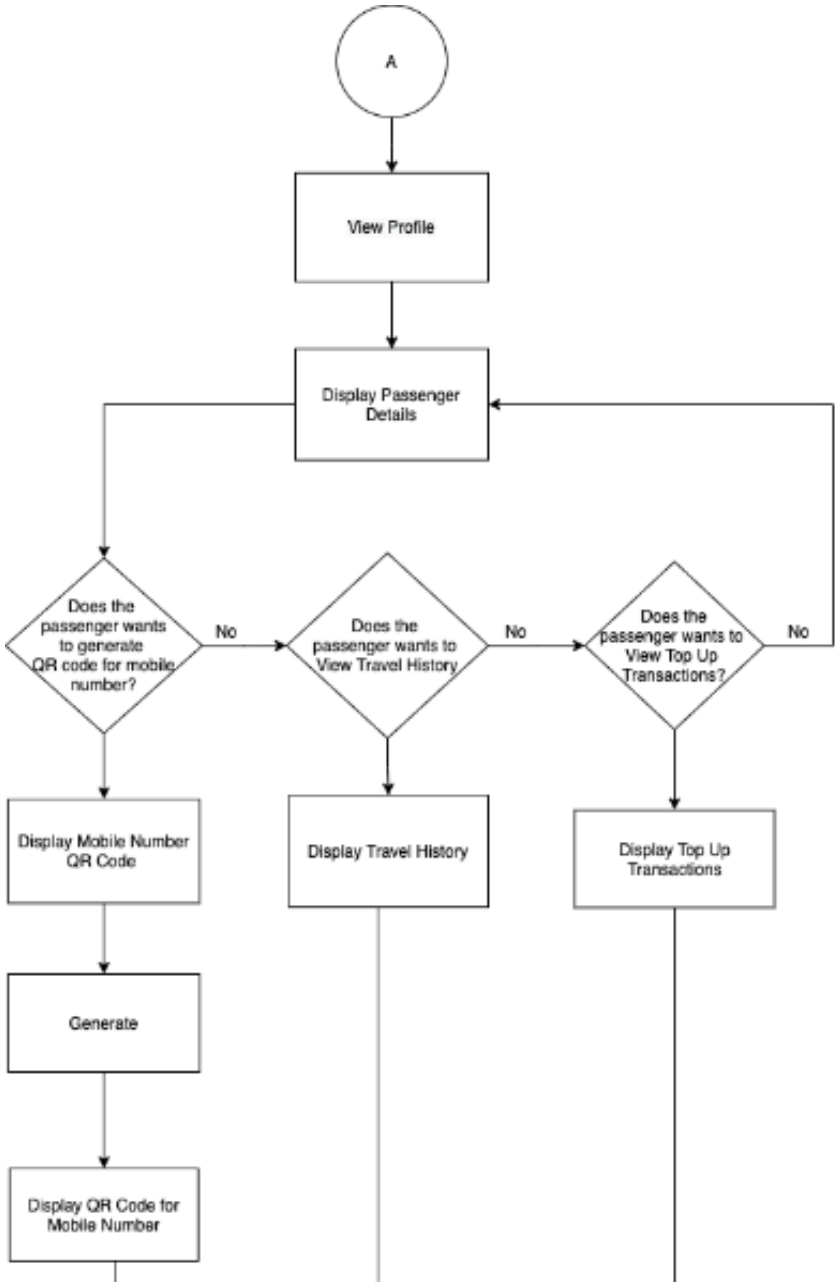

*Figure 9.1.* Flowchart of the Proposed System - Mobile App

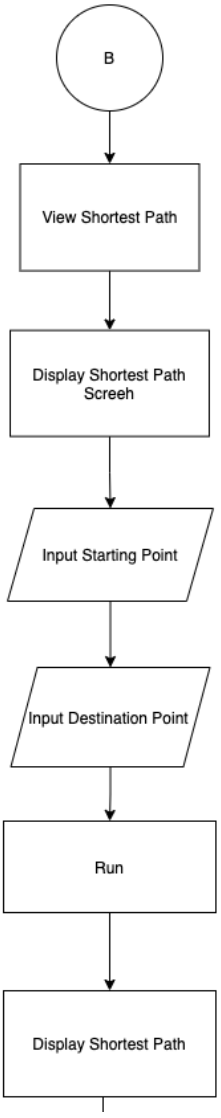


*Figure 9.2.* Flowchart of the Proposed System - Mobile App

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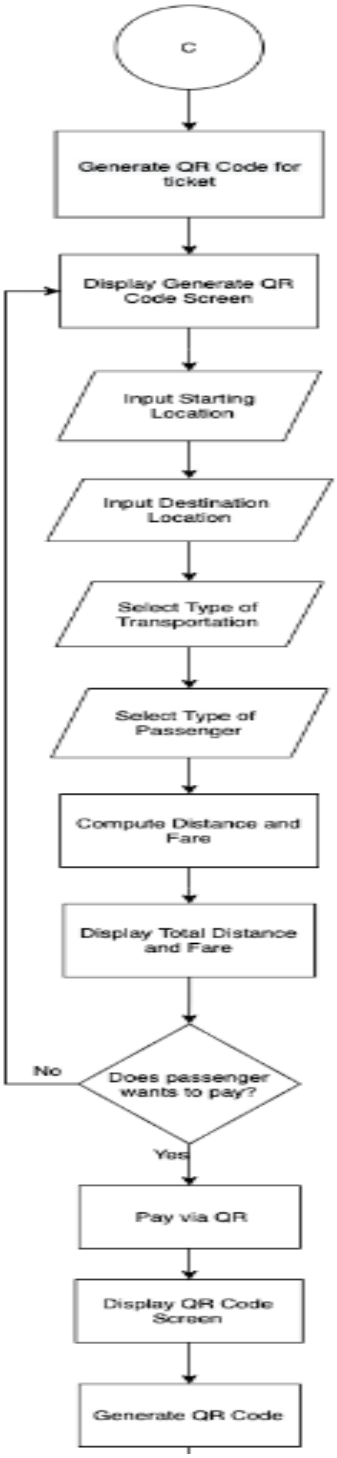

*Figure 9.3.* Flowchart of the Proposed System - Mobile App

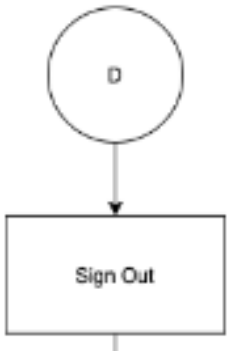


*Figure 9.4.* Flowchart of the Proposed System - Mobile App

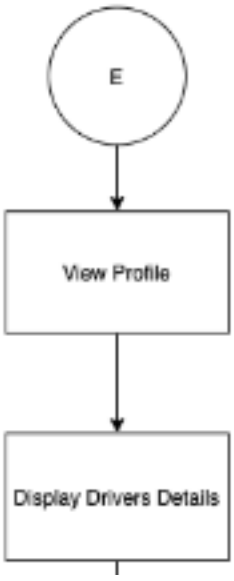


*Figure 9.5.* Flowchart of the Proposed System - Mobile App

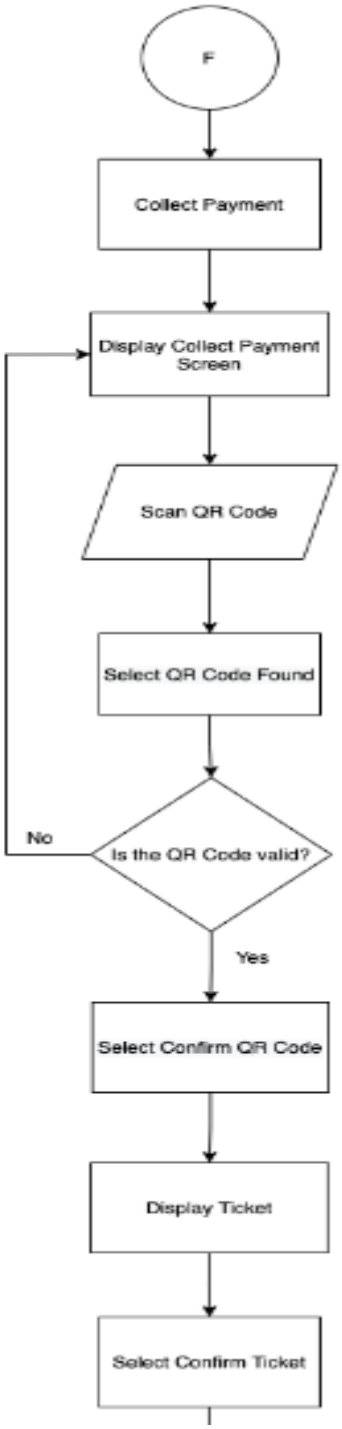


*Figure 9.6.* Flowchart of the Proposed System - Mobile App

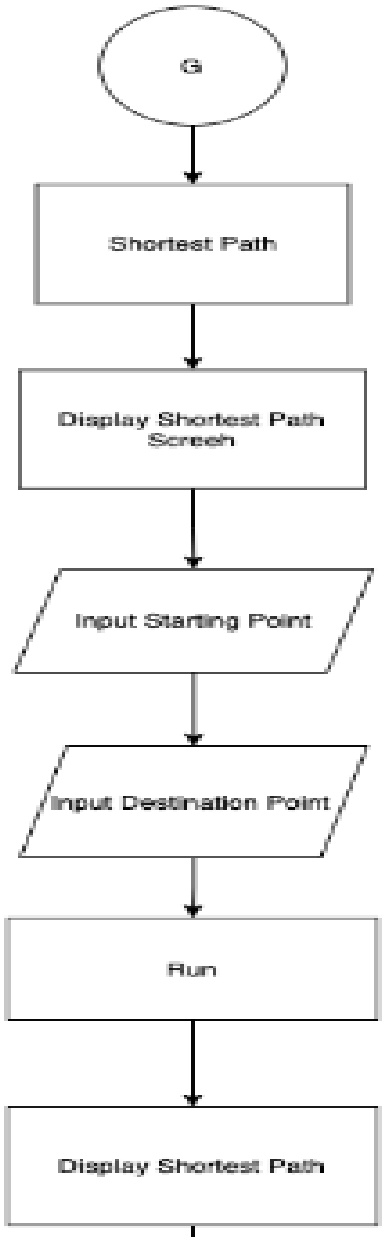


*Figure 9.7.* Flowchart of the Proposed System - Mobile App

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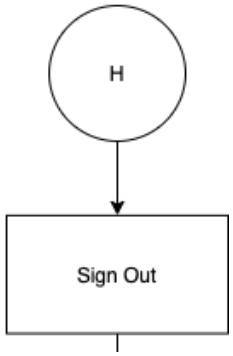


*Figure 9.8.* Flowchart of the Proposed System - Mobile App

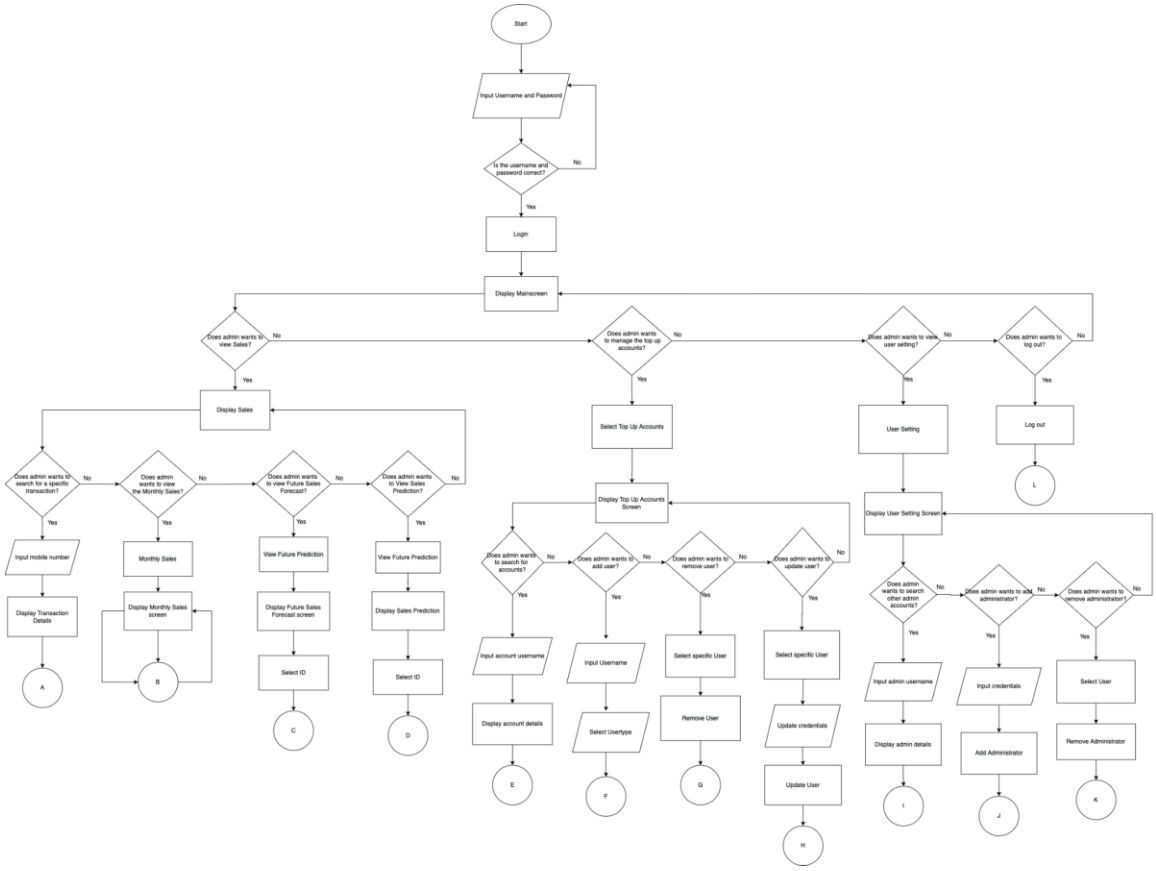


*Figure 10.* Flowchart of the Proposed System – Fare Management System

Figure 10 shows the Flowchart of the Fare Management System. The system shows an overview of the process of how the

administrator manages the fare management system and the top-up system. The flowchart shows an overview on how the administrator interacts with the system.

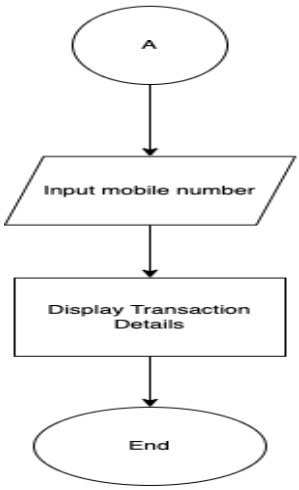


*Figure 10.1*. Flowchart of the Proposed System – Fare Management System

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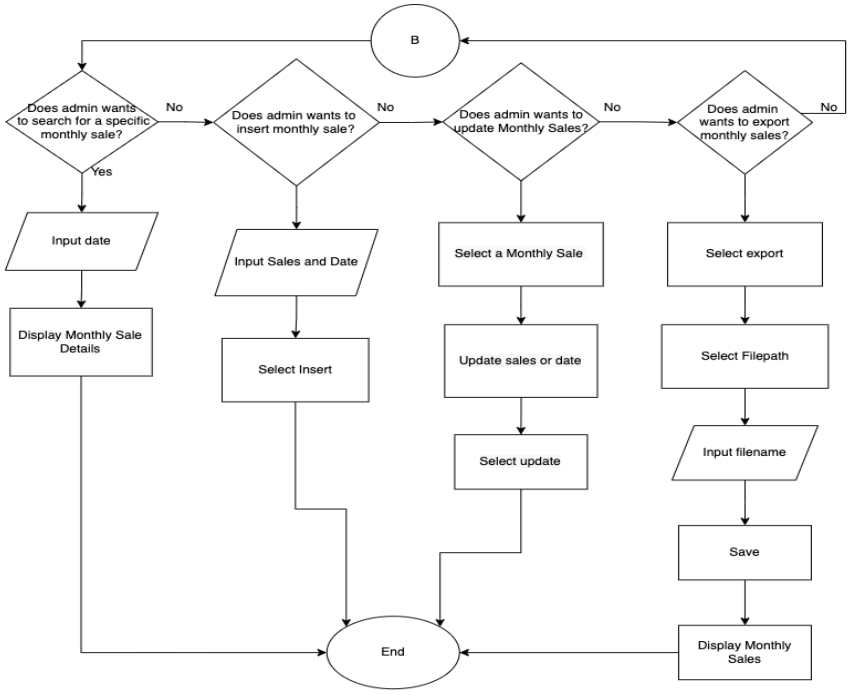


*Figure 10.2.* Flowchart of the Proposed System – Fare Management System

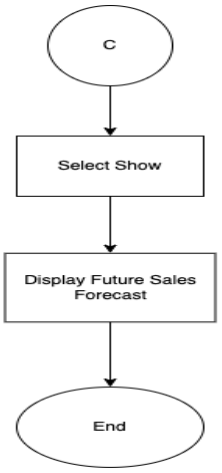


*Figure 10.3*. Flowchart of the Proposed System – Fare Management System

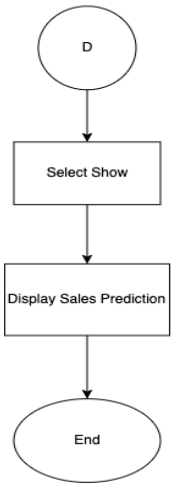


*Figure 10.4*. Flowchart of the Proposed System – Fare Management System

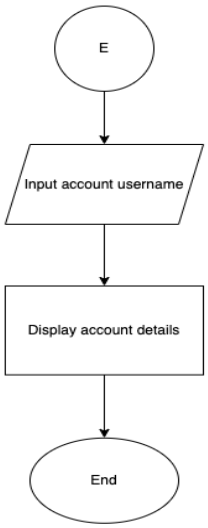


*Figure 10.5*. Flowchart of the Proposed System – Fare Management System

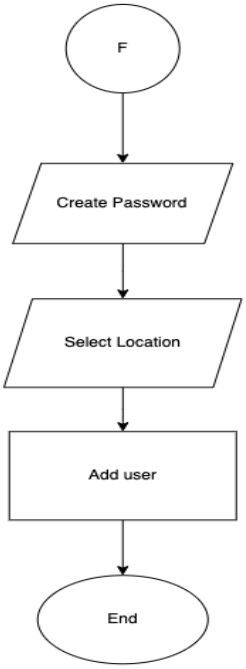


*Figure 10.6.* Flowchart of the Proposed System – Fare Management System

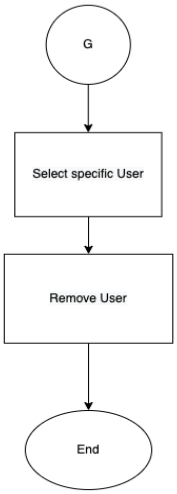


*Figure 10.7.* Flowchart of the Proposed System – Fare Management System

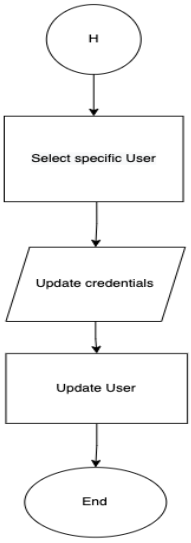


*Figure 10.8*. Flowchart of the Proposed System – Fare Management System

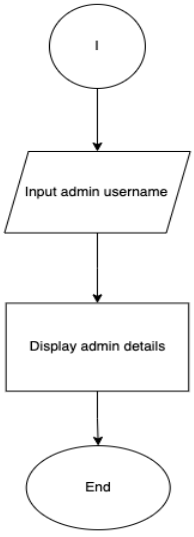


*Figure 10.9*. Flowchart of the Proposed System – Fare Management System

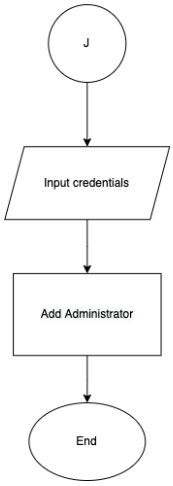


*Figure 10.10.* Flowchart of the Proposed System – Fare Management System

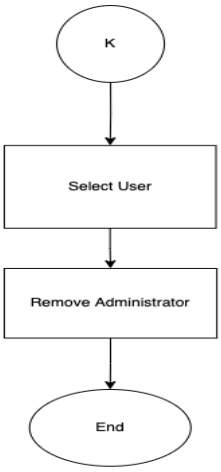


*Figure 10.11.* Flowchart of the Proposed System – Fare Management System

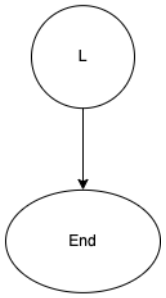


*Figure 10.12.* Flowchart of the Proposed System – Fare Management System

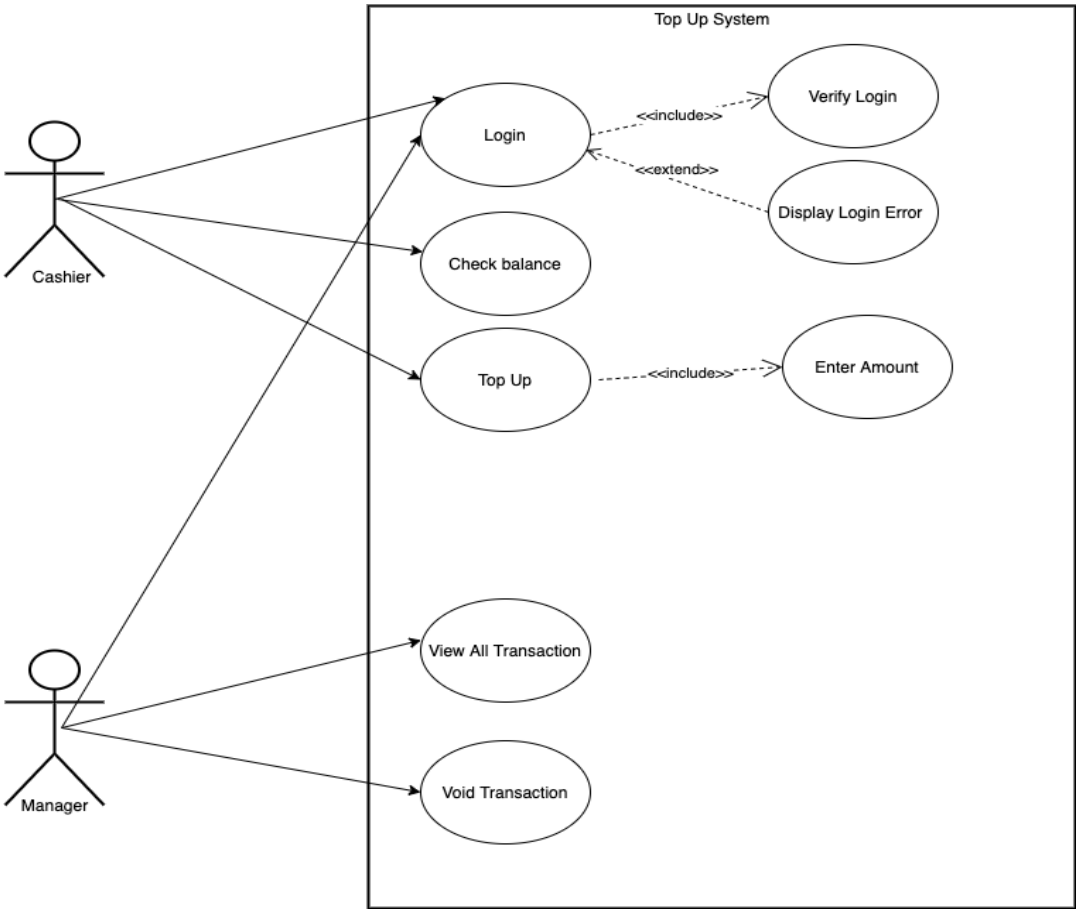


*Figure 11.* Unified Modeling Language(UML)of the Proposed System – Top Up System (Use Case UML)

Figure 11 shows the use case diagram of the Top up system. The cashier and manager have access to the system. Cashiers use the system to add and check load balance while the manager uses the system to view and void transactions made through Top up.

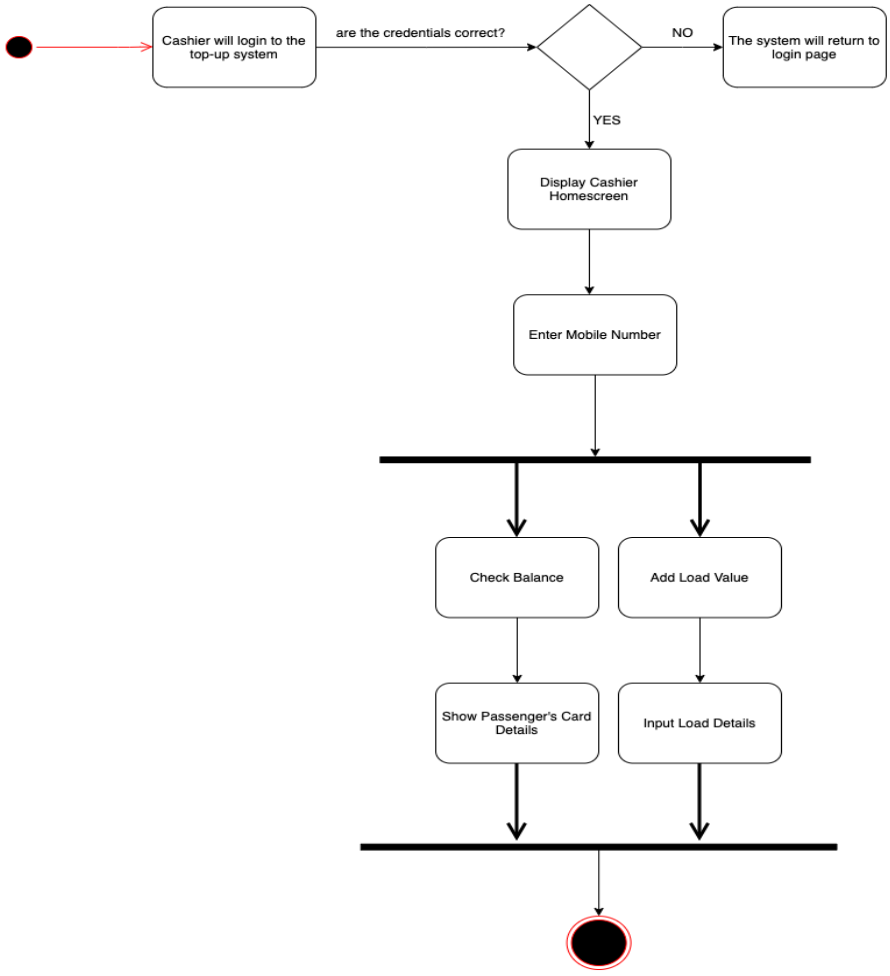


*Figure 12.* Unified Modeling Language(UML)of the Proposed System - Top up System (Cashier Activity Diagram)

Figure 12 shows the activity diagram of the Cashier in the Top up system. The activity diagram shows the workflow of the cashier in the Top up system.

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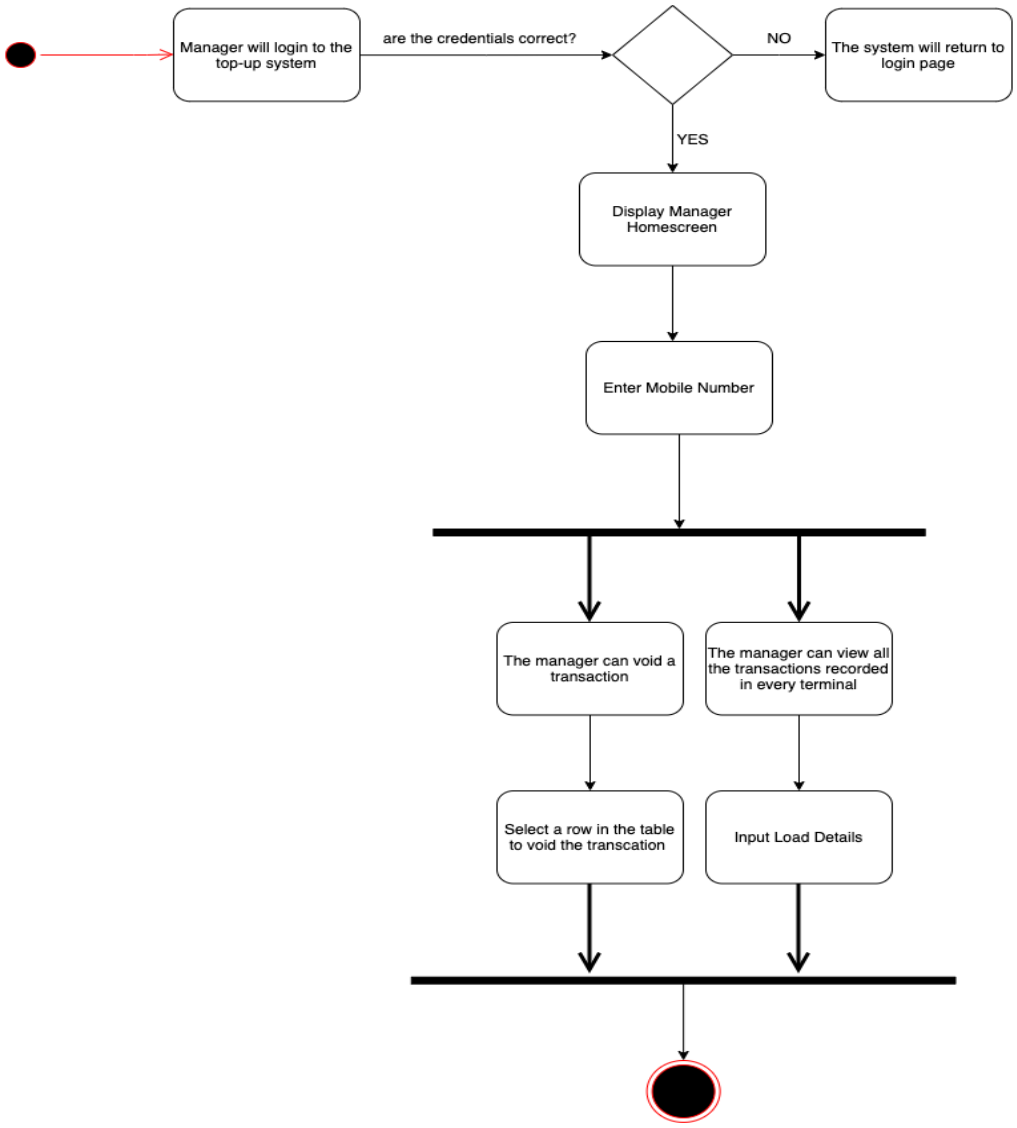


*Figure 13.* Unified Modeling Language(UML)of the Proposed System - Top Up System (Manager Activity Diagram)

Figure 13 shows the activity diagram of the Manager in the Top up system. The activity diagram shows the workflow of the manager in the Top up system.

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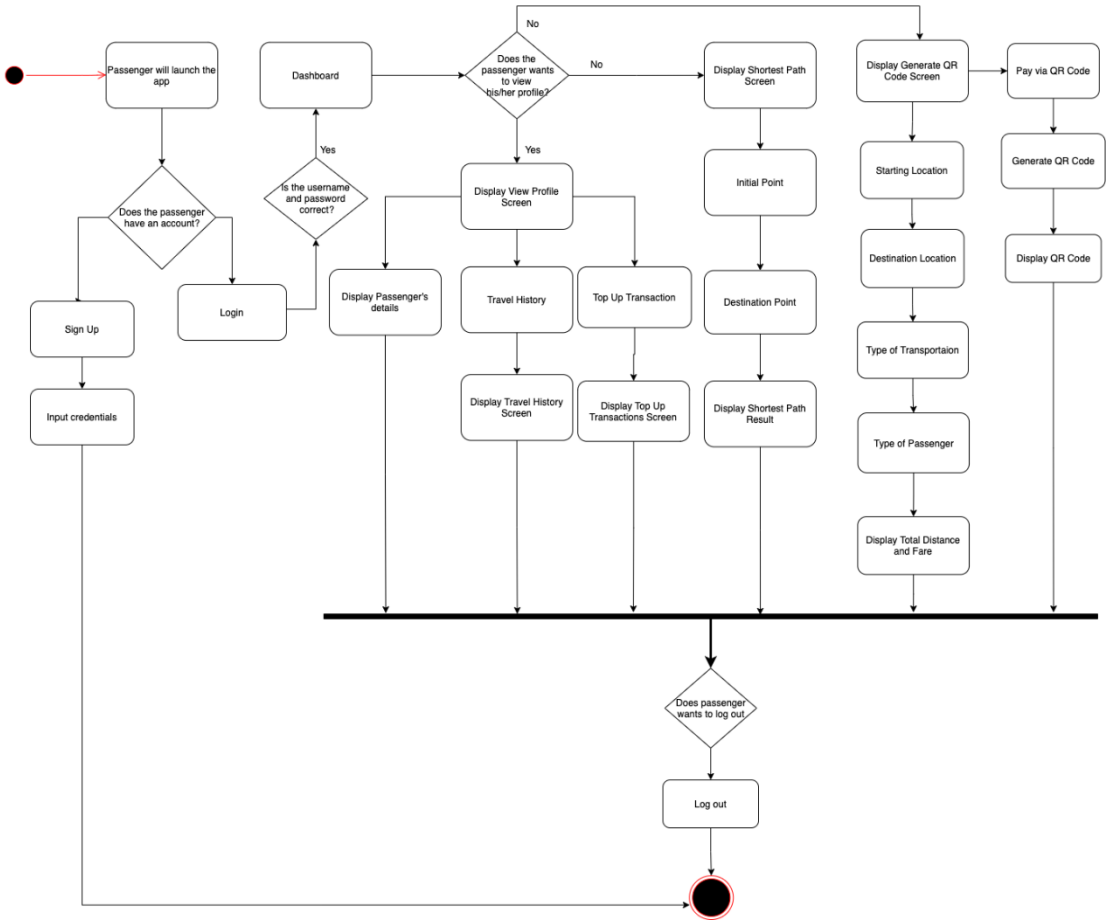


*Figure 14.* Unified Modeling Language(UML)of the Proposed System - Mobile App (Passenger Activity Diagram)

Figure 14 shows the activity diagram of the Passenger in Mobile app or EzPay. The activity diagram shows the workflow of the passenger in EzPay.

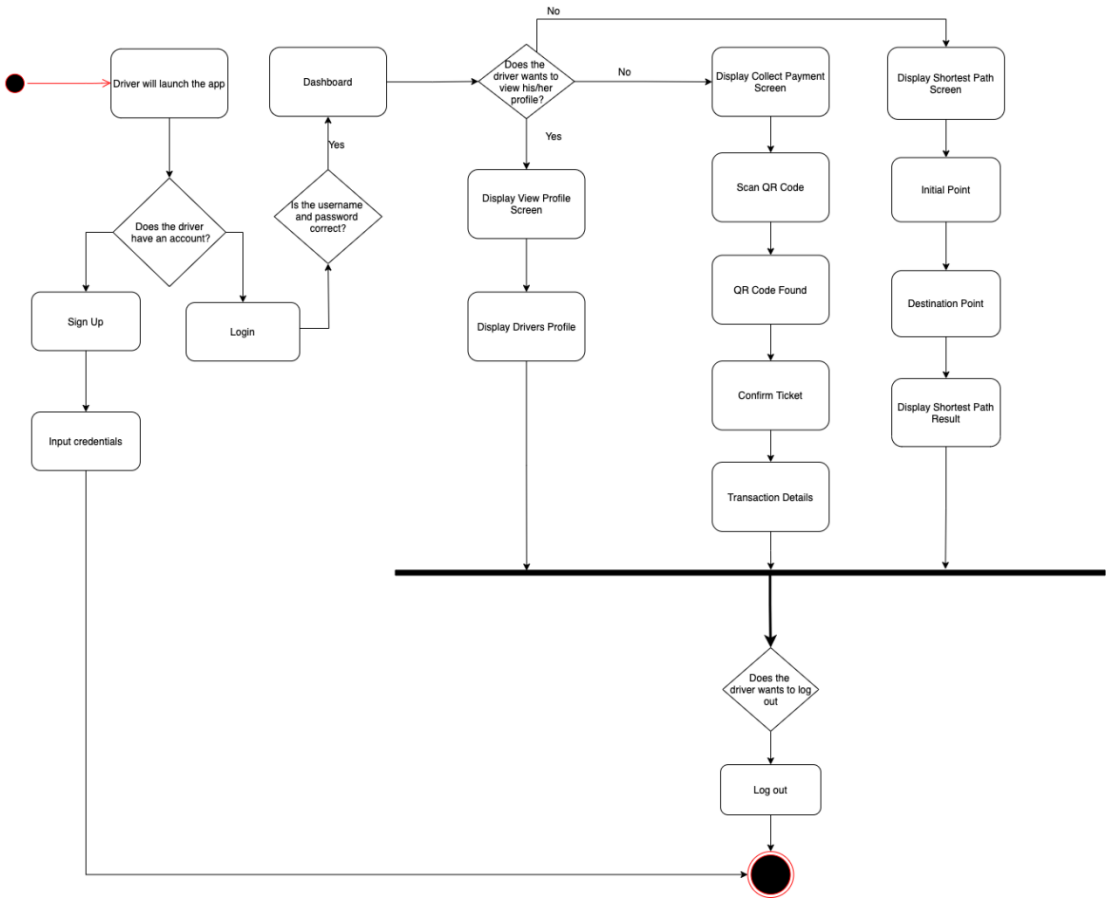


*Figure 15.* Unified Modeling Language(UML)of the Proposed System - Mobile App (Driver Activity Diagram)

Figure 15 shows the activity diagram of the Driver in Mobile app or EzPay. The activity diagram shows the workflow of the driver in EzPay.

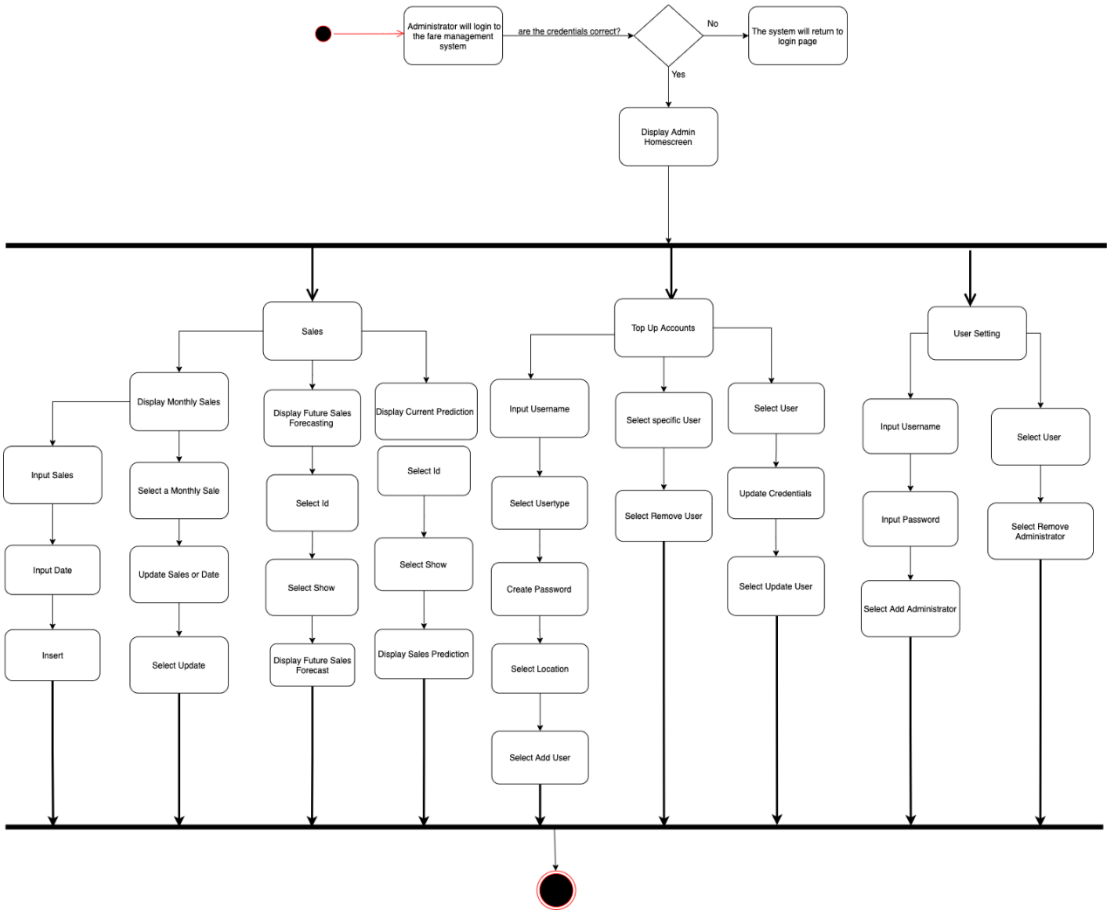


*Figure 16.* Unified Modeling Language(UML)of the Proposed System – Fare Management System (Administrator Activity Diagram)

Figure 16 shows the activity diagram of the Administrator in the Fare Management System. The activity diagram shows the workflow of the administrator in the Fare Management System.

Process Design (DFD)

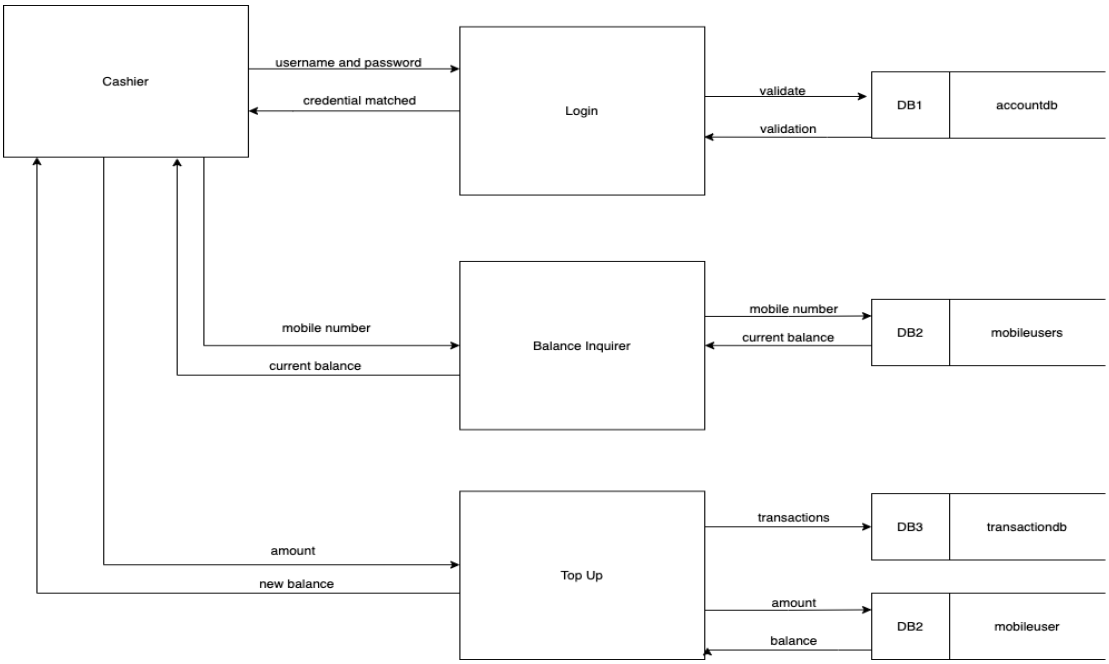


*Figure 17*. Level 0 Diagram of the Proposed System – Top Up System (Cashier)

Figure 17 shows the level 0 of the Cashier in the Top up system. The level 0 shows how the detailed process on the cashier interacts with the Top-up system.

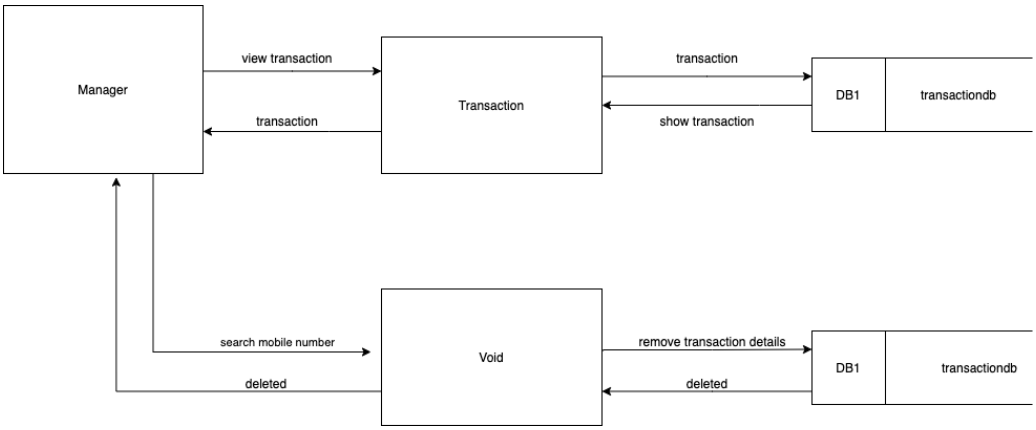


*Figure 18*. Level 0 of the Proposed System – Top Up System (Manager)

Figure 18 shows the level 0 of the Manager in the Top up system. The level 0 shows the detailed process on how the manager interacts with the Top-up system.

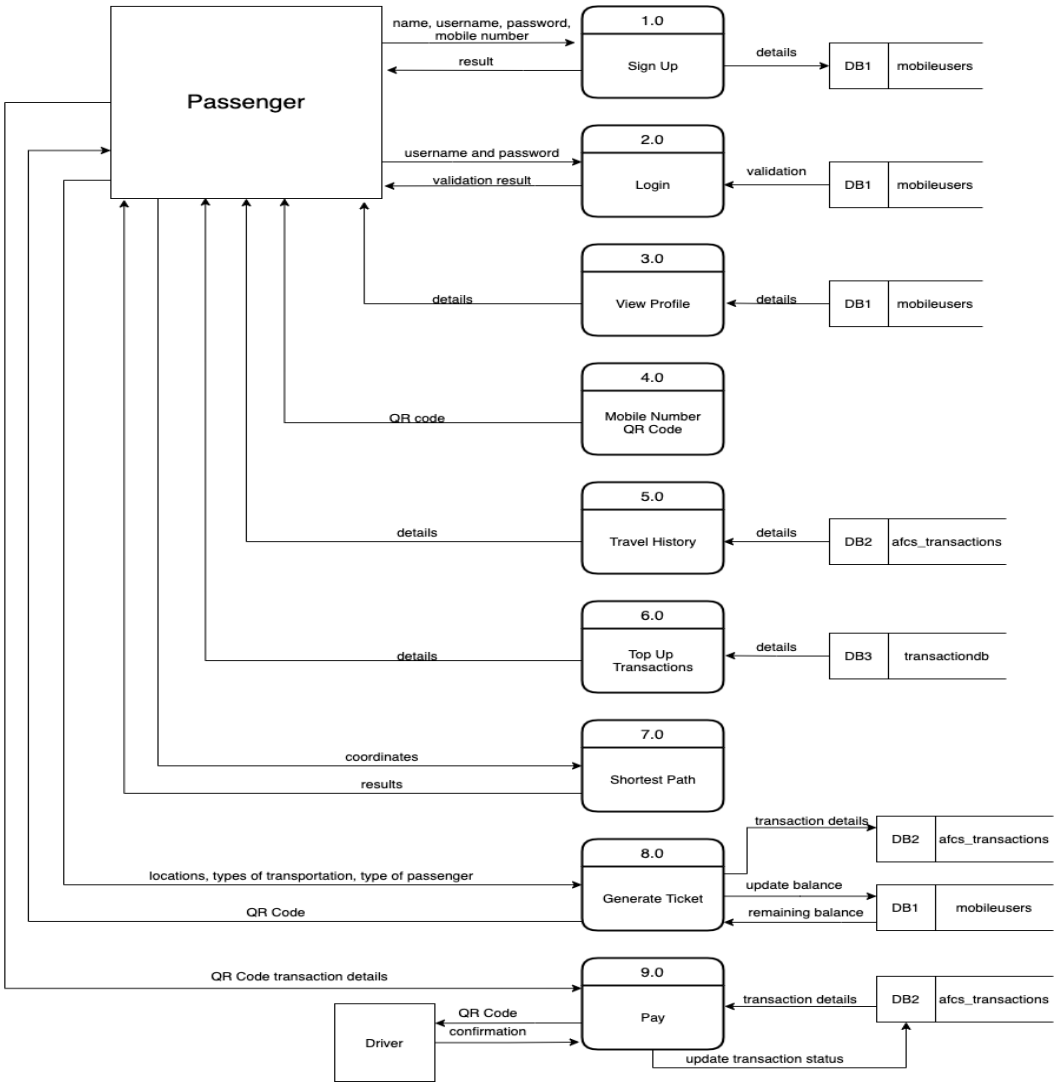


*Figure 19.* Level 0 of the Proposed System – Mobile App (Passenger)

Figure 19 shows the level 0 of the Passenger in Mobile app or EzPay. The level 0 shows the detailed process on how the passenger interacts with EzPay.

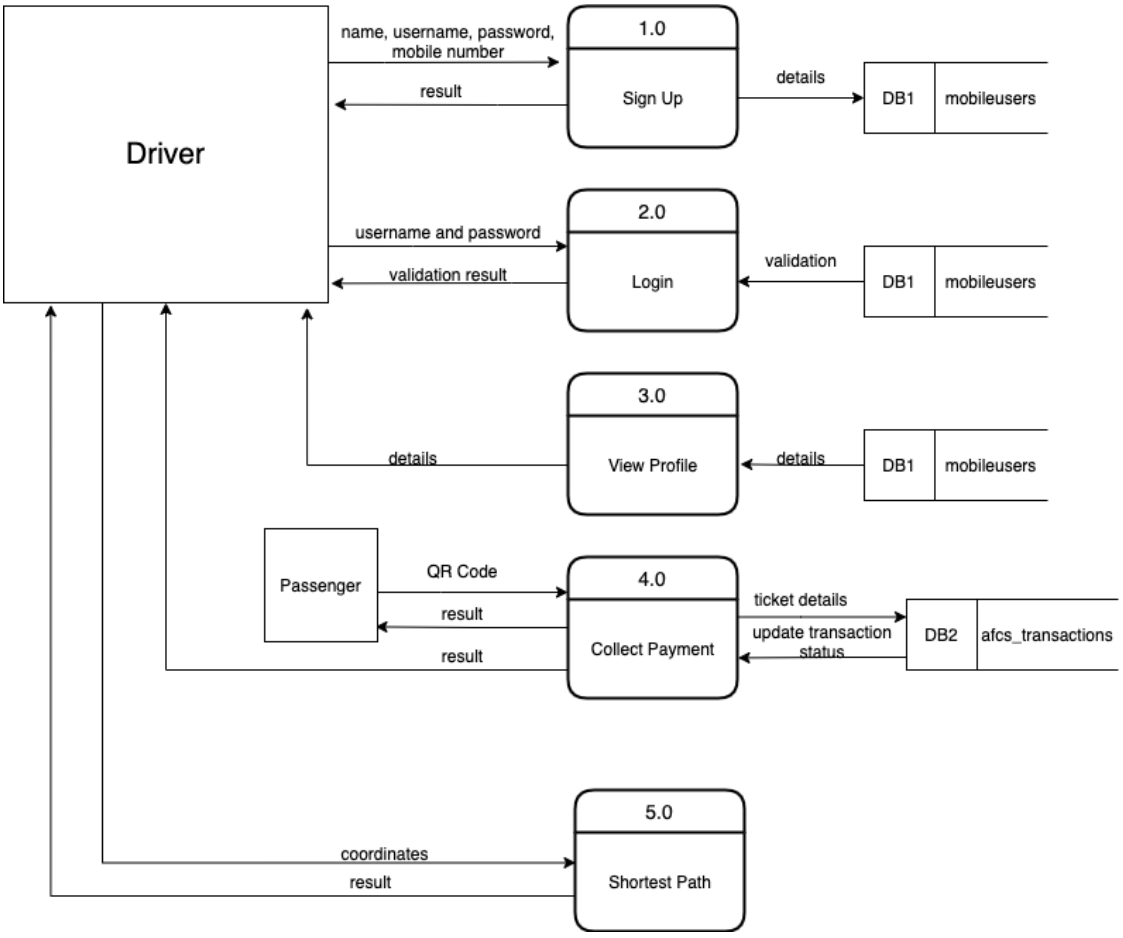


*Figure 20*. Level 0 of the Proposed System – Mobile App (Driver)

Figure 20 shows the level 0 of the Driver in Mobile app or EzPay. The level 0 shows the detailed process on how the driver interacts with EzPay.

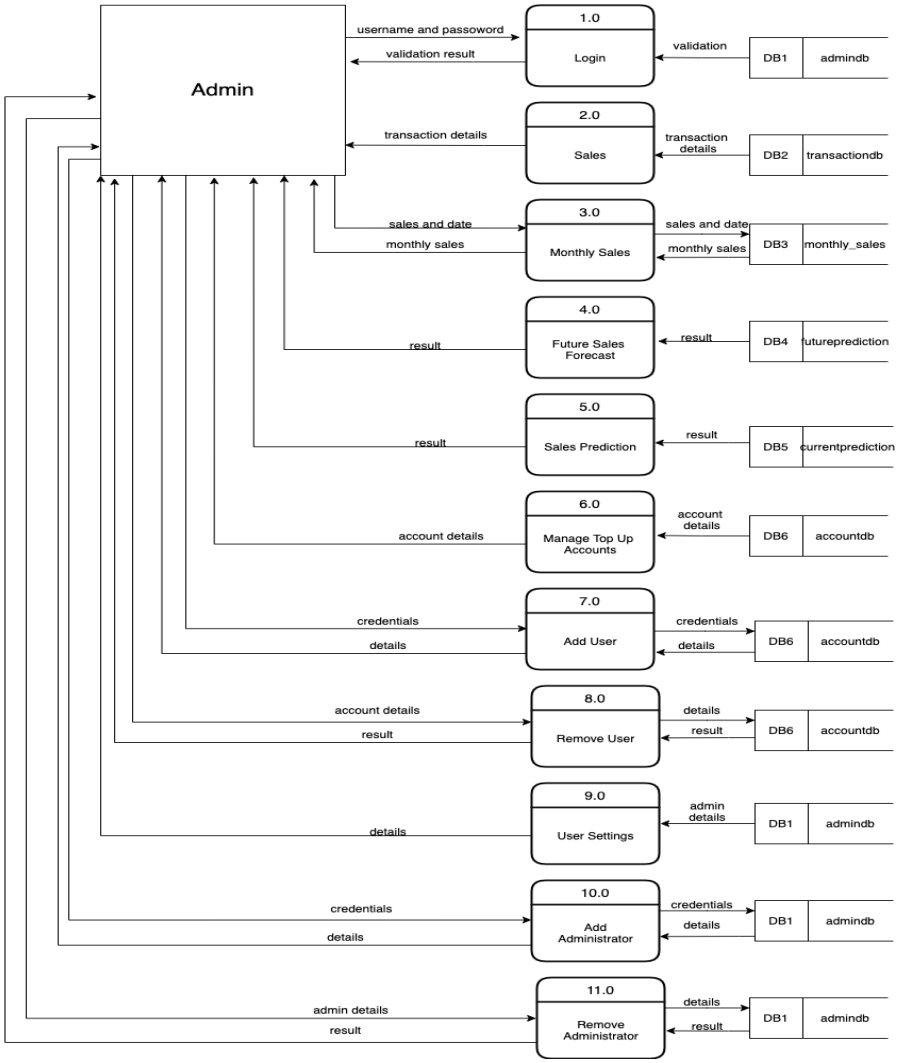


*Figure 21*. Level 0 of the Proposed System – Fare Management System (Administrator)

Figure 21 shows the level 0 of the Administrator in the Fare Management System. The level 0 shows the detailed process on how the administrator interacts with the fare management system.

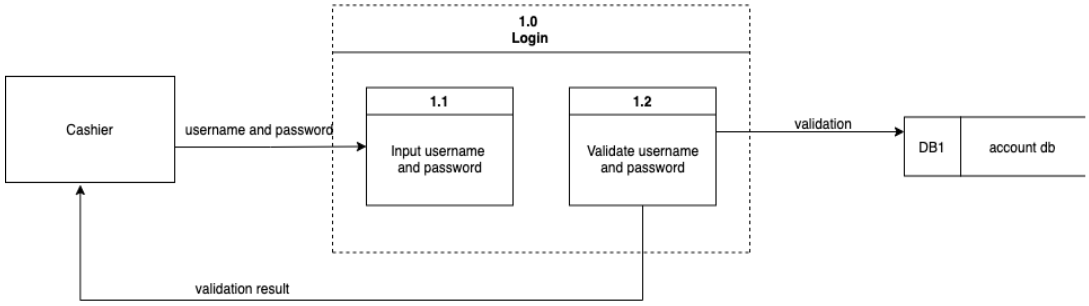


*Figure 22.* Level 1 Diagram of the Proposed System – Top Up System (Cashier Login)

Figure 22 shows the login process of the cashier in the top up system.

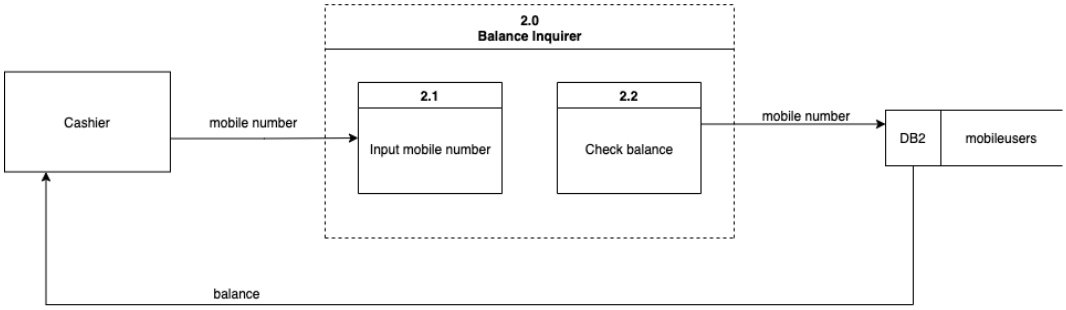


*Figure 22.1.* Level 1 Diagram of the Proposed System – Top Up System (Balance Inquirer)

Figure 22.1 shows the process of how the balance inquirer works in the Top-up system.

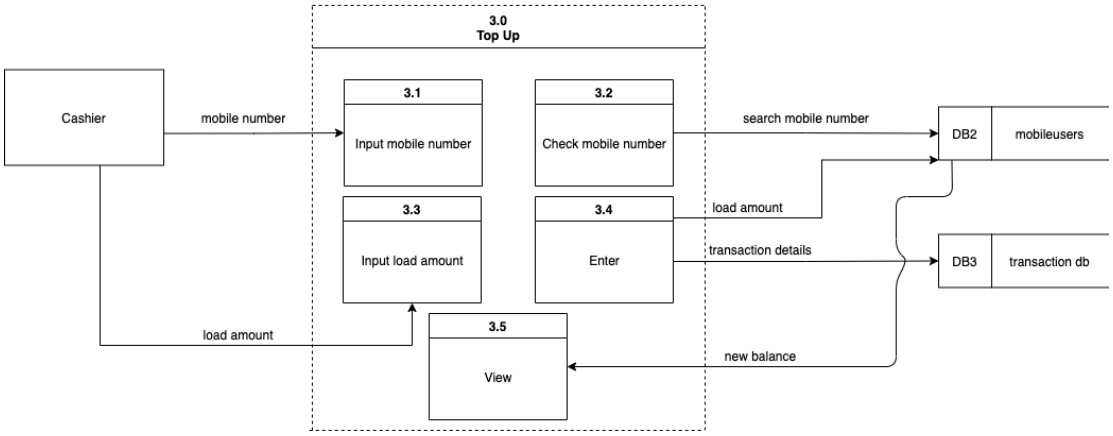


*Figure 22.2.* Level 1 Diagram of the Proposed System – Top Up System (Top Up)

Figure 22.2 shows how to use the top-up process in the top-up system.

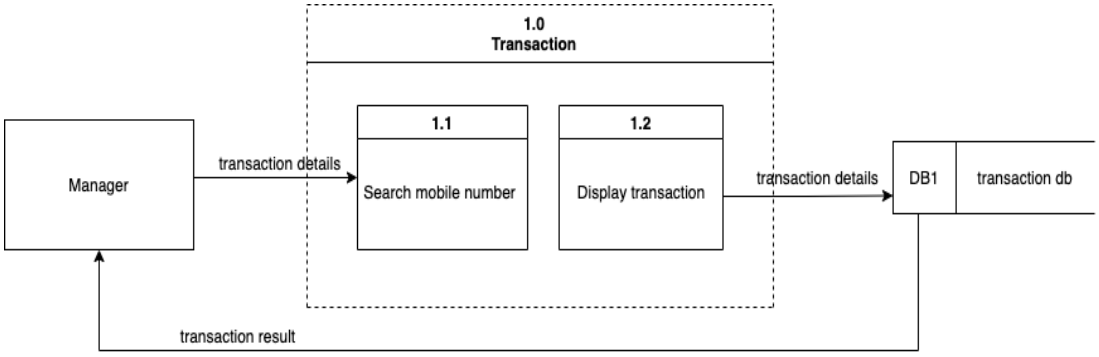


*Figure 22.3.* Level 1 Diagram of the Proposed System –Top Up System (Transaction)

Figure 22.3 shows how the manager interacts with the transaction process in the Top-up system. the level 1 diagram of the Top up system cashier transaction.

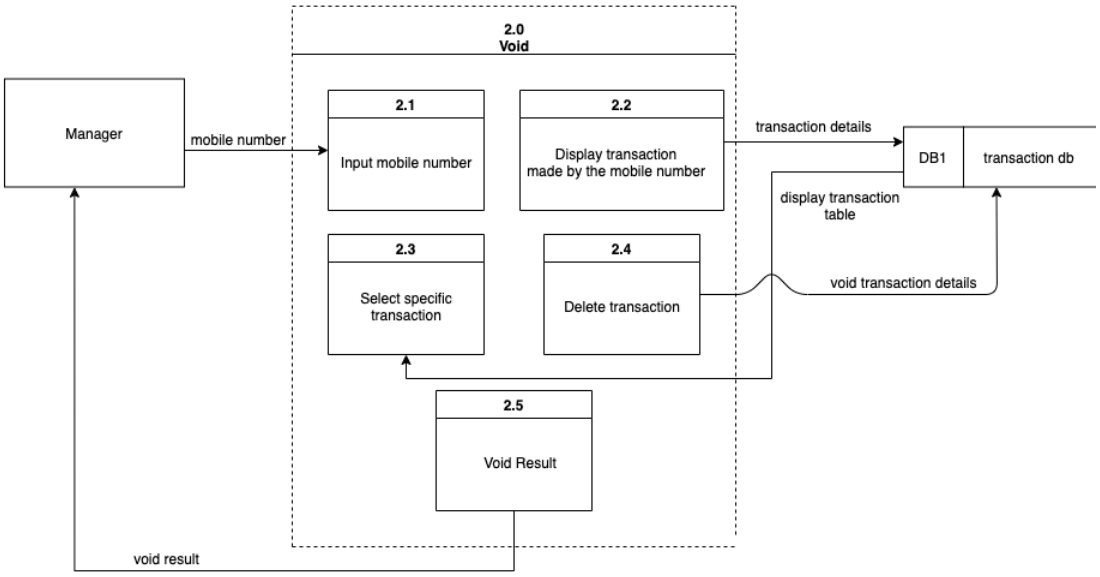


*Figure 22.4*. Level 1 Diagram of the Proposed System – Top Up System (Void)

Figure 22.4 shows how the manager voids transactions in the Top-up system.

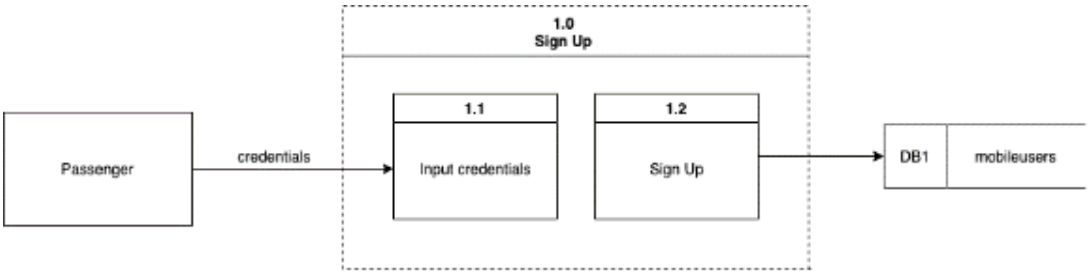


*Figure 23*. Level 1 Diagram of the Proposed System - Mobile App (Passenger Sign Up)

Figure 23 shows how the signup process of the passenger in Ezpay.

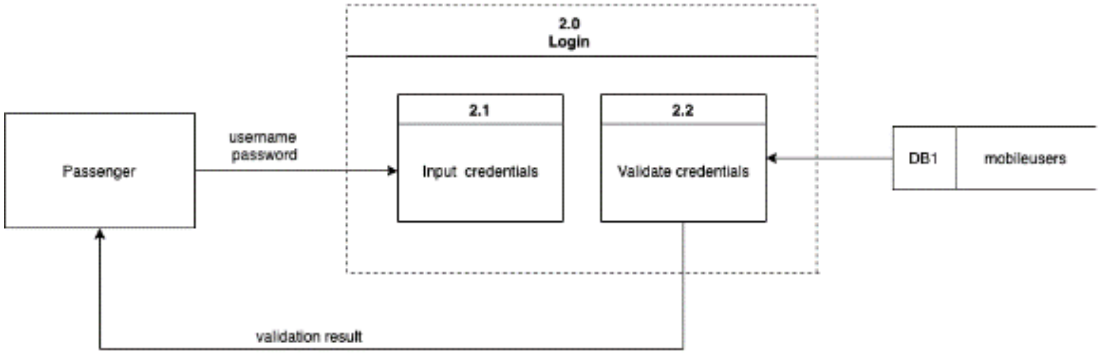


*Figure 23.1.* Level Diagram the Proposed System - Mobile App (Login)

Figure 23.1 shows the login process in Ezpay.

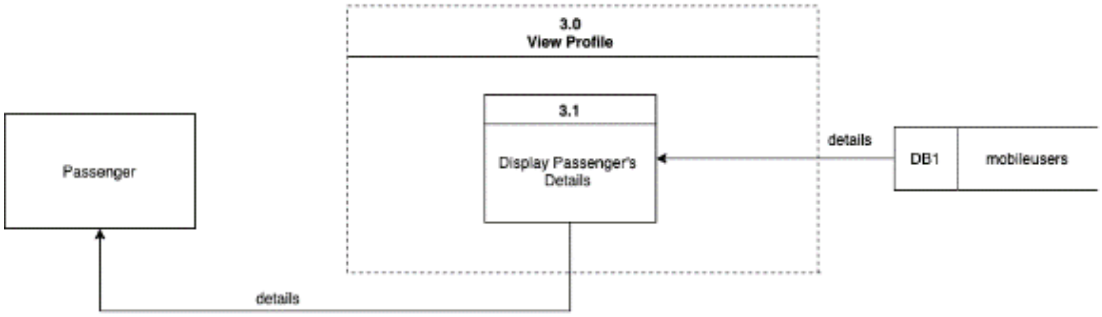


*Figure 23.2*. Level 1 Diagram of the Proposed System - Mobile App (View Profile)

Figure 23.2 shows the process on how the passenger can view profiles in the system.

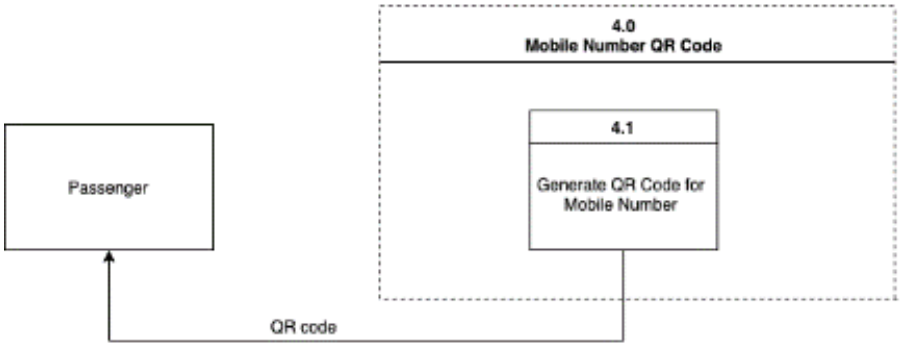


*Figure 23.3*. Level 1 Diagram of the Proposed System - Mobile App (Mobile Number QR Code)

Figure 23.3 shows the process of how the passenger generates QR code in EzPay.

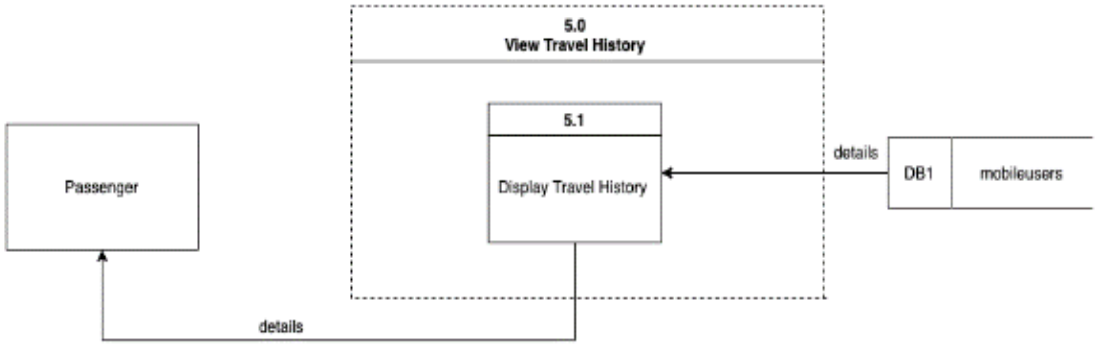


*Figure 23.4*. Level 1 Diagram of the Proposed System - Mobile App (View Travel History)

Figure 23.4 shows the process on how the passenger views the travel history in Ezpay.

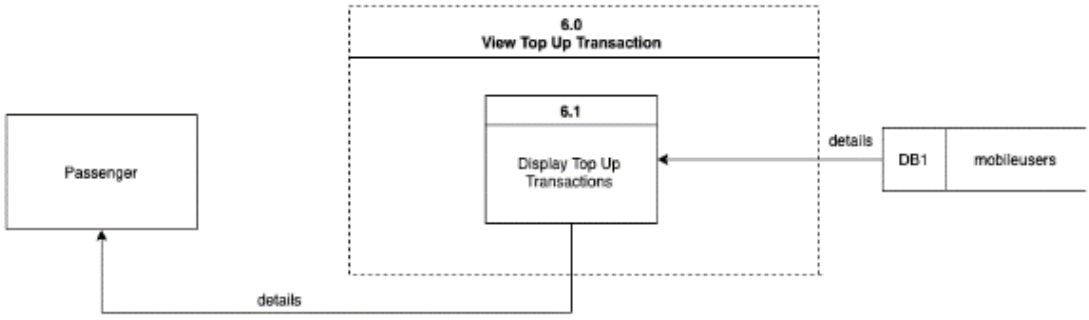


*Figure 23.5.* Level 1 Diagram of the Proposed System - Mobile App (View Top Up Transaction)

Figure 23.5 shows the process on how the passenger can view top up transactions in Ezpay.

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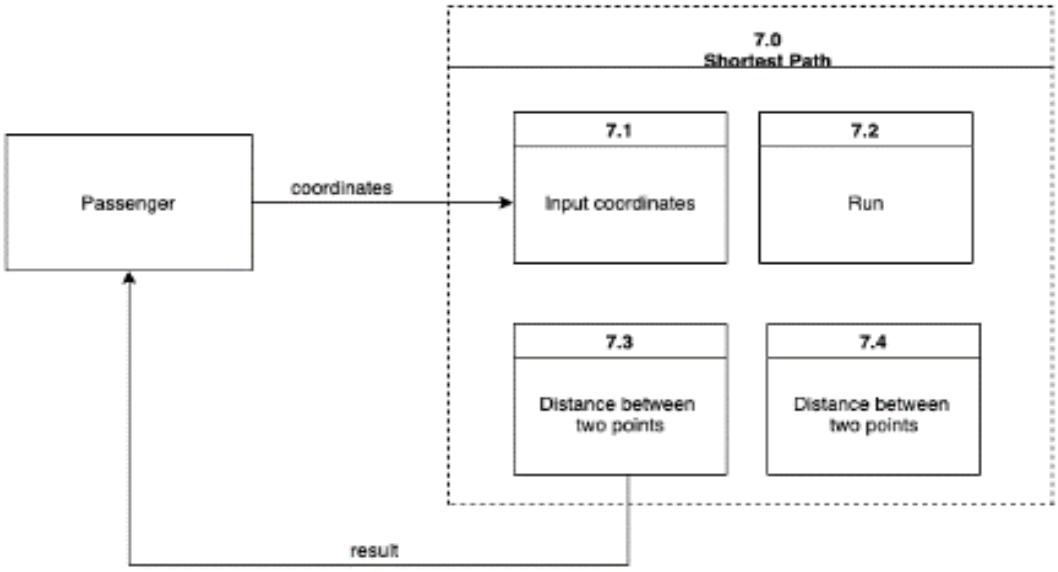


*Figure 23.6*. Level 1 Diagram of the Proposed System - Mobile App (Shortest Path)

Figure 23.6 shows the process on how the passenger can simulate the shortest path in Ezpay.

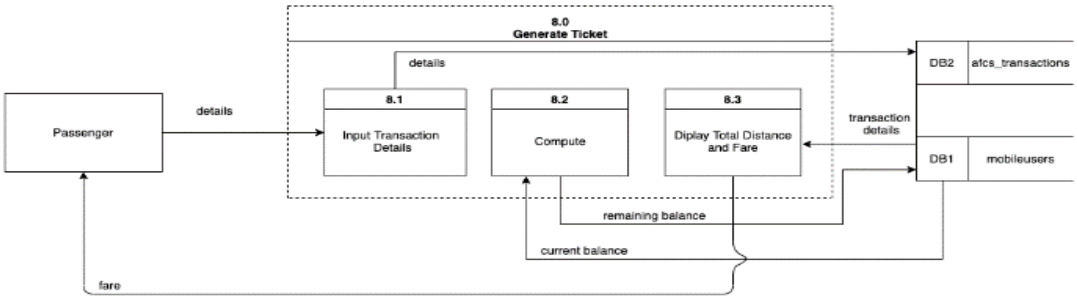


*Figure 23.7*. Level 1 Diagram of the Proposed System - Mobile App (Generate Ticket)

Figure 23.7 shows the process on how the passenger can generate a ticket in Ezpay.

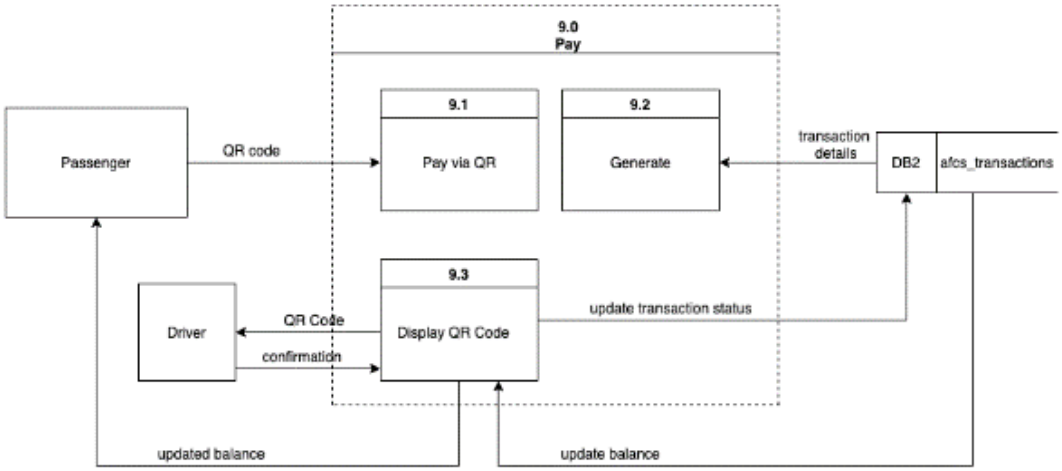


*Figure 23.8.* Level 1 Diagram of the Proposed System - Mobile App (Pay)

Figure 23.8 shows the process of how the passengers pay in Ezpay.

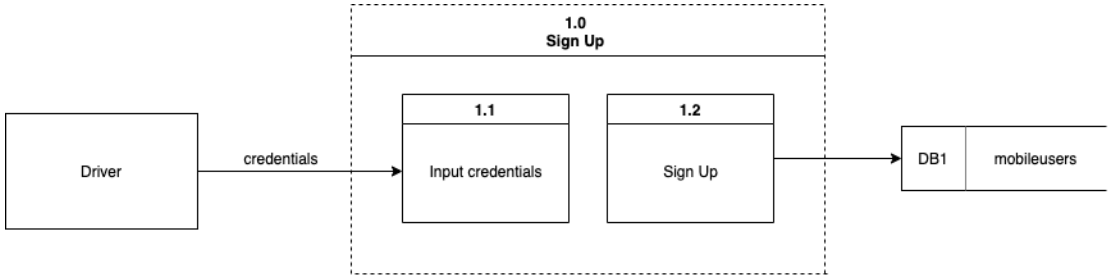


*Figure 24.* Level 1 Diagram of the Proposed System – Mobile App (Driver Sign Up)

Figure 24 shows the process of driver signup in Ezpay.

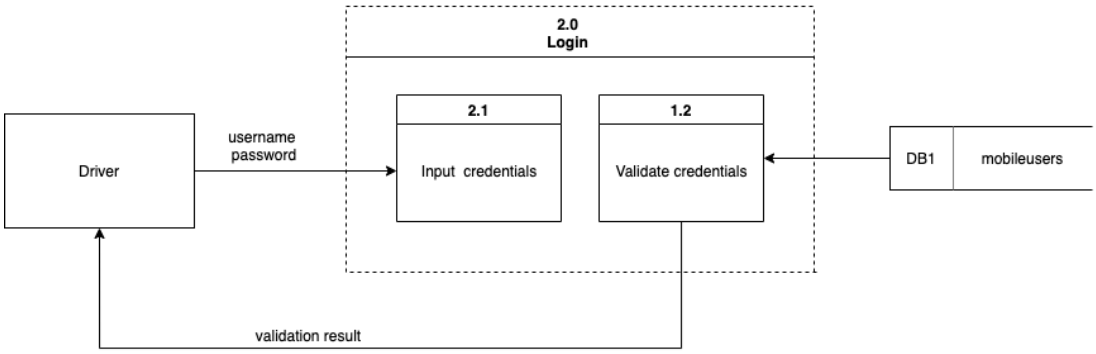


*Figure 24.1.* Level 1 Diagram of the Proposed System – Mobile App (Login)

Figure 24.1 shows the process on how drivers login in Ezpay.

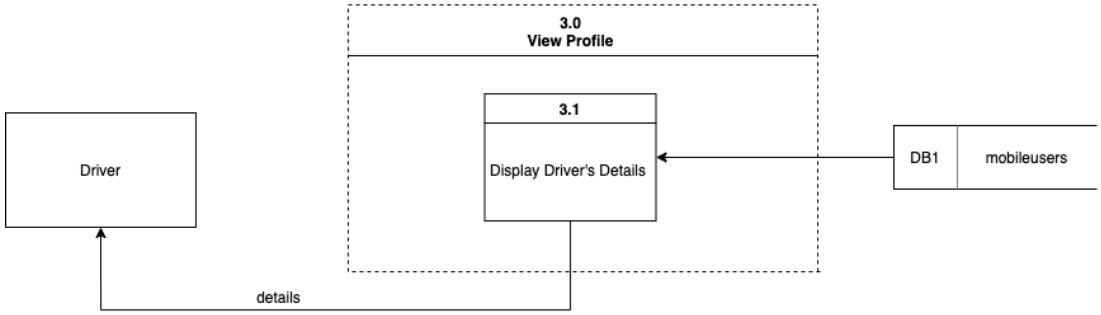


*Figure 24.2.* Level 1 Diagram of the Proposed System – Mobile App (View Profile)

Figure 24.2 shows the process on how the driver can view profiles in Ezpay

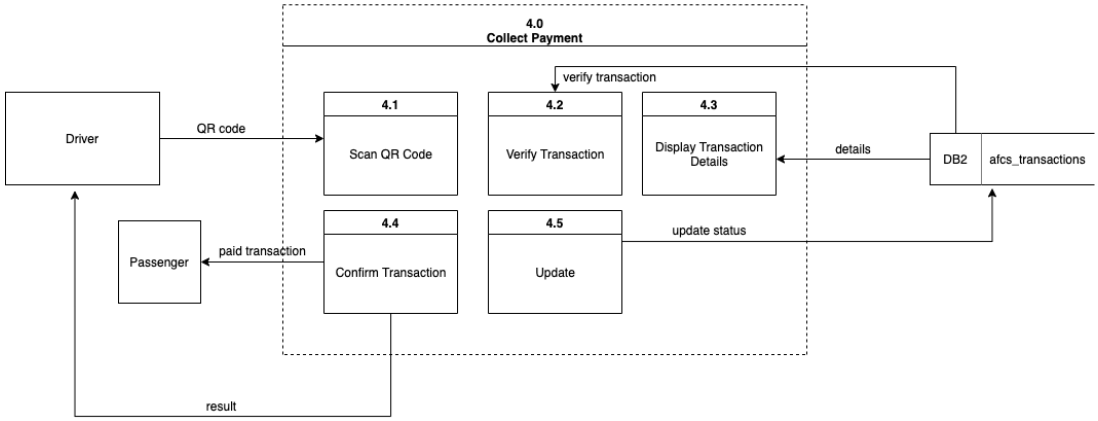


*Figure 24.3*. Level 1 Diagram of the Proposed System – Mobile App (Collect Payment)

Figure 24.3 shows the process of collecting payment by the driver in Ezpay.

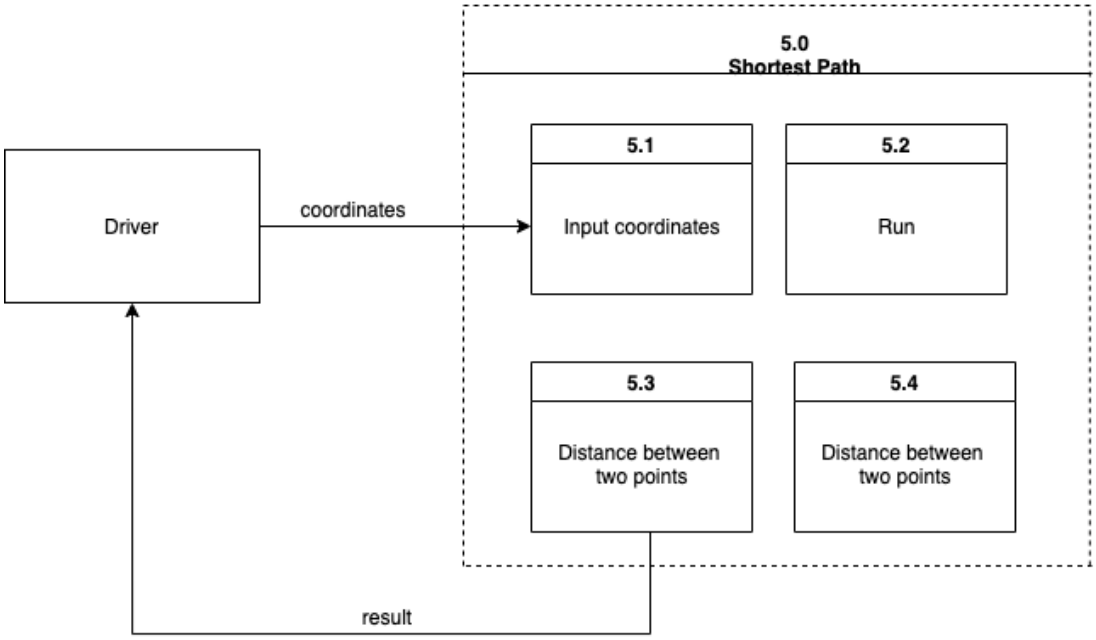


*Figure 24.4.* Level 1 Diagram of the Proposed System – Mobile App (Shortest Path)

Figure 24.4 shows the process on how the driver can simulate the shortest path in Ezpay.

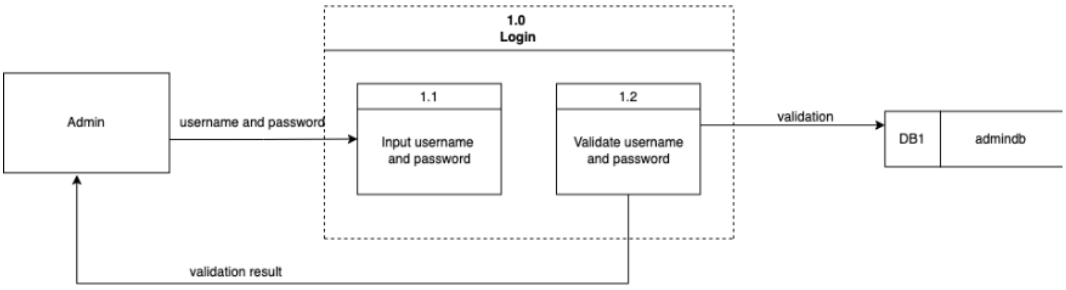


*Figure 25.* Level 1 Diagram of the Proposed System – Fare Management System (Login)

Figure 25 shows the login process of the administrator in the fare management system.

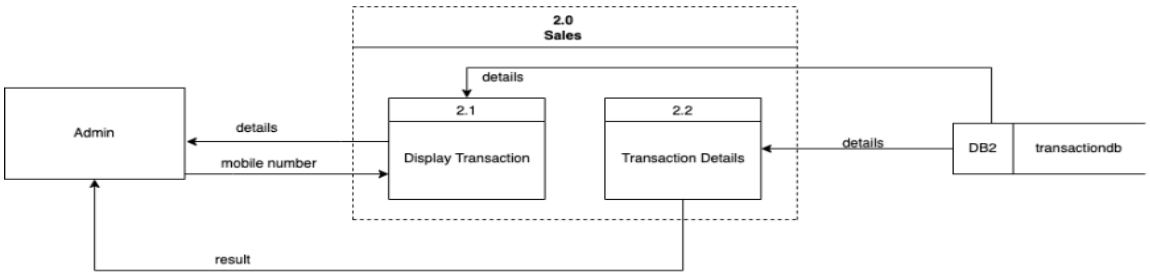


*Figure 25.1.* Level 1 Diagram of the Proposed System – Fare Management System (Sales)

Figure 25.1 shows the process on how the administrator can monitor the sales in the fare management system.

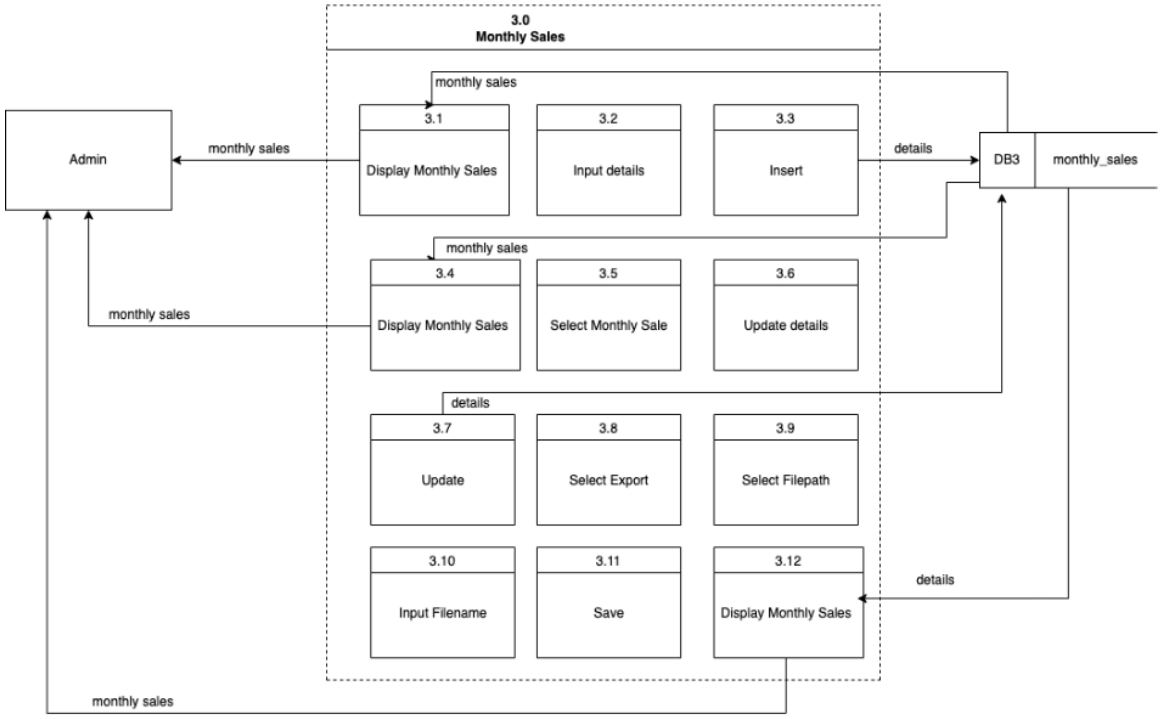


*Figure 25.2*. Level 1 Diagram of the Proposed System – Fare Management System (Monthly Sales)

Figure 25.2 shows the process on how to manage monthly sales.

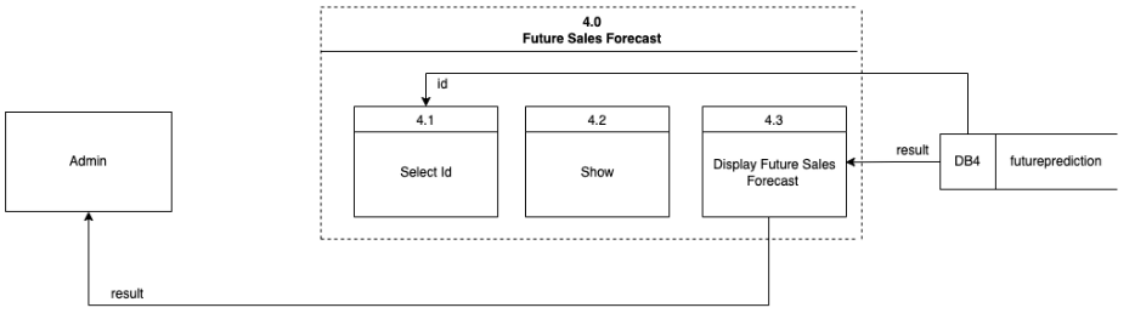


*Figure 25.3.* Level 1 Diagram of the Proposed System – Fare Management System (Future Sales Forecast)

Figure 25.3 shows the process of viewing future sale forecasts by the administrator of the fare management system.

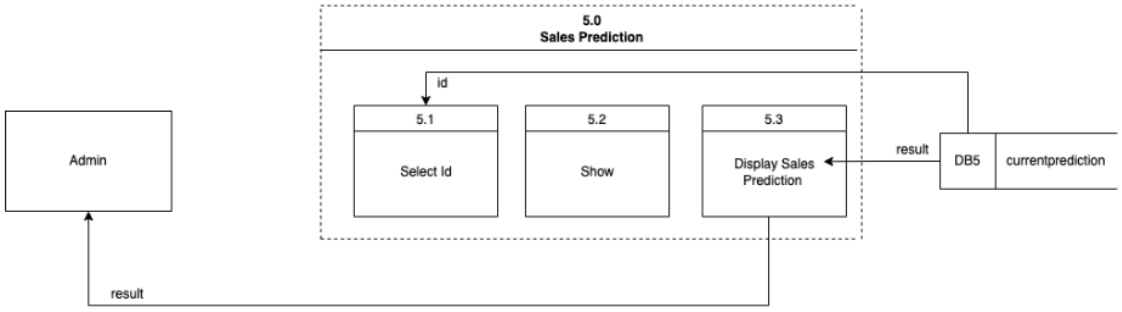


*Figure 25.4.* Level 1 Diagram of the Proposed System – Fare Management System (Sales Prediction)

Figure 25.4 shows the process on how the administrator can view how accurate the sale forecast is in the fare management system.

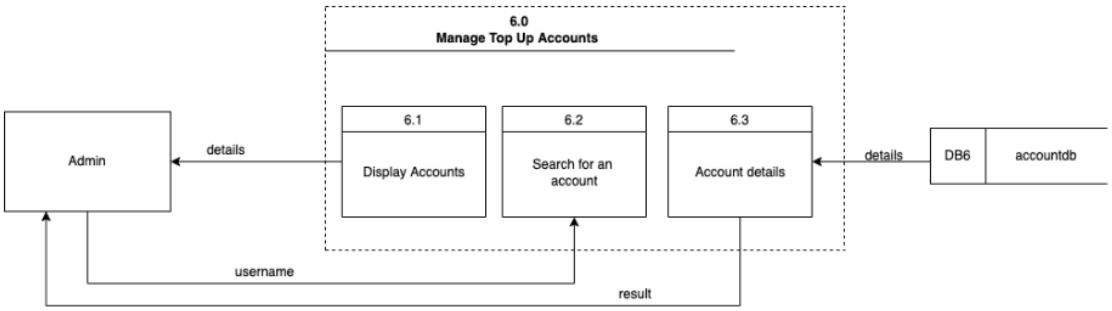


*Figure 25.5.* Level 1 Diagram of the Proposed System – Fare Management System (Manage Top Up Accounts)

Figure 25.5 shows the process on managing the top up accounts of the cashiers in top up system by the administrator on the fare management system

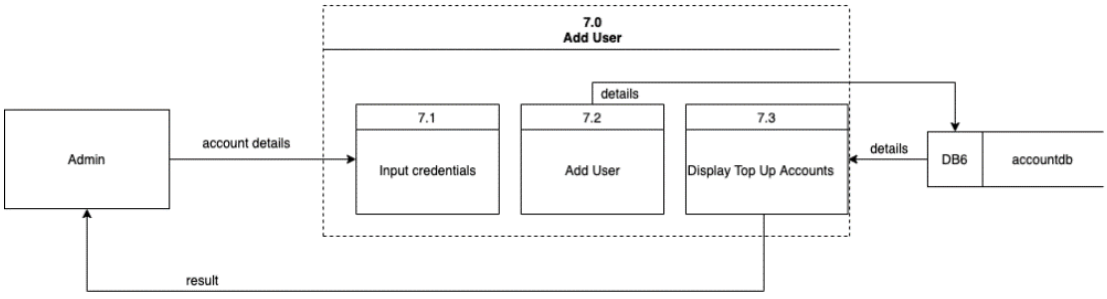


*Figure 25.6.* Level 1 Diagram of the Proposed System – Fare Management System (Add User)

Figure 25.6 shows the process of adding users in top up systems by the administrator on the fare management system.

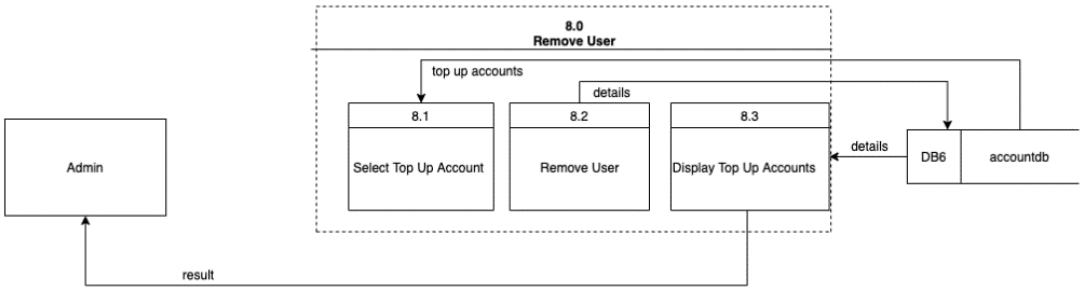


*Figure 25.7.* Level 1 Diagram of the Proposed System – Fare Management System (Remove User)

Figure 25.7 shows the process of removing users in the top up system by the administrator on the fare management system.

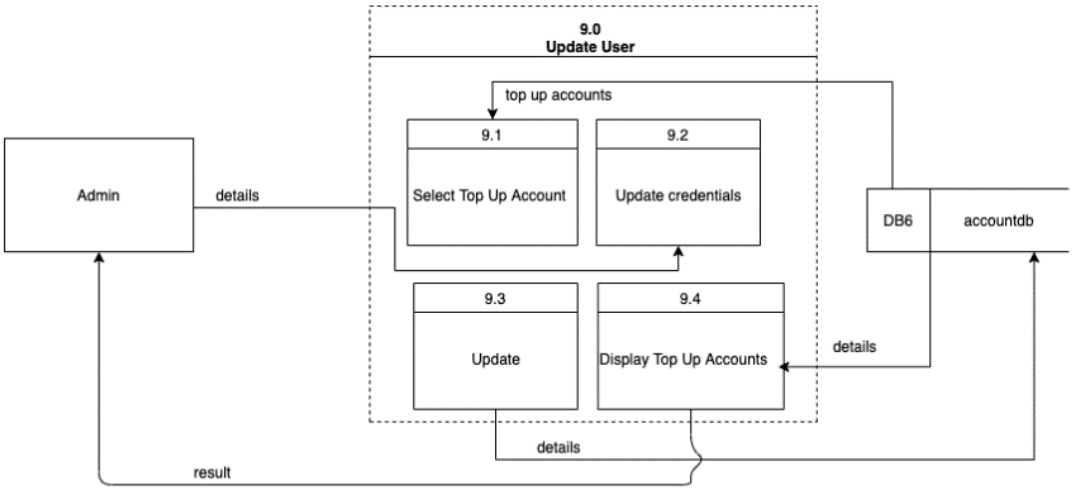


*Figure 25.8.* Level 1 Diagram of the Proposed System – Fare Management System (Update User)

Figure 25.8 shows the process of updating users in the top up system by the administrator on the fare management system.

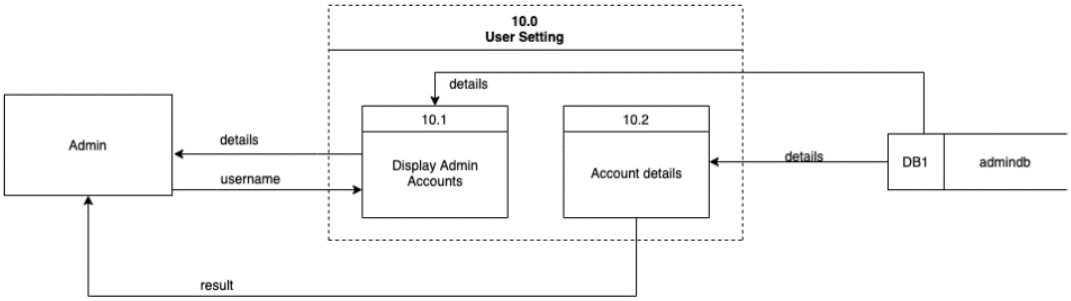


*Figure 25.9.* Level 1 Diagram of the Proposed System – Fare Management System (User Setting)

Figure 25.9 shows the process on how the administrator monitors accounts on the fare management system.

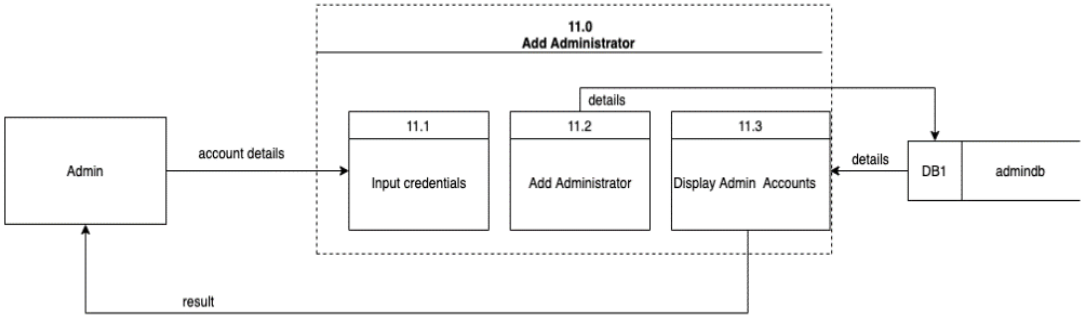


*Figure 25.10.* Level 1 Diagram of the Proposed System – Fare Management System (Add Administrator)

Figure 25.10 shows the process on how the administrator adds accounts on the fare management system.

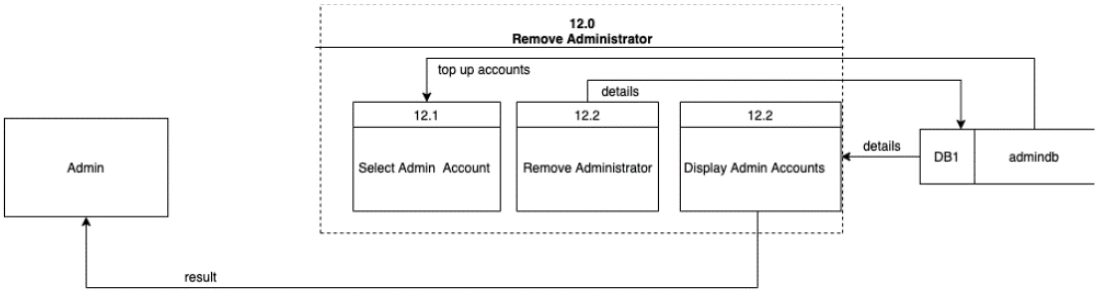


*Figure 25.11*. Level 1 Diagram of the Proposed System – Fare Management System (Remove Administrator)

Figure 25.11 shows the process on how the administrator remove accounts in the fare management system.

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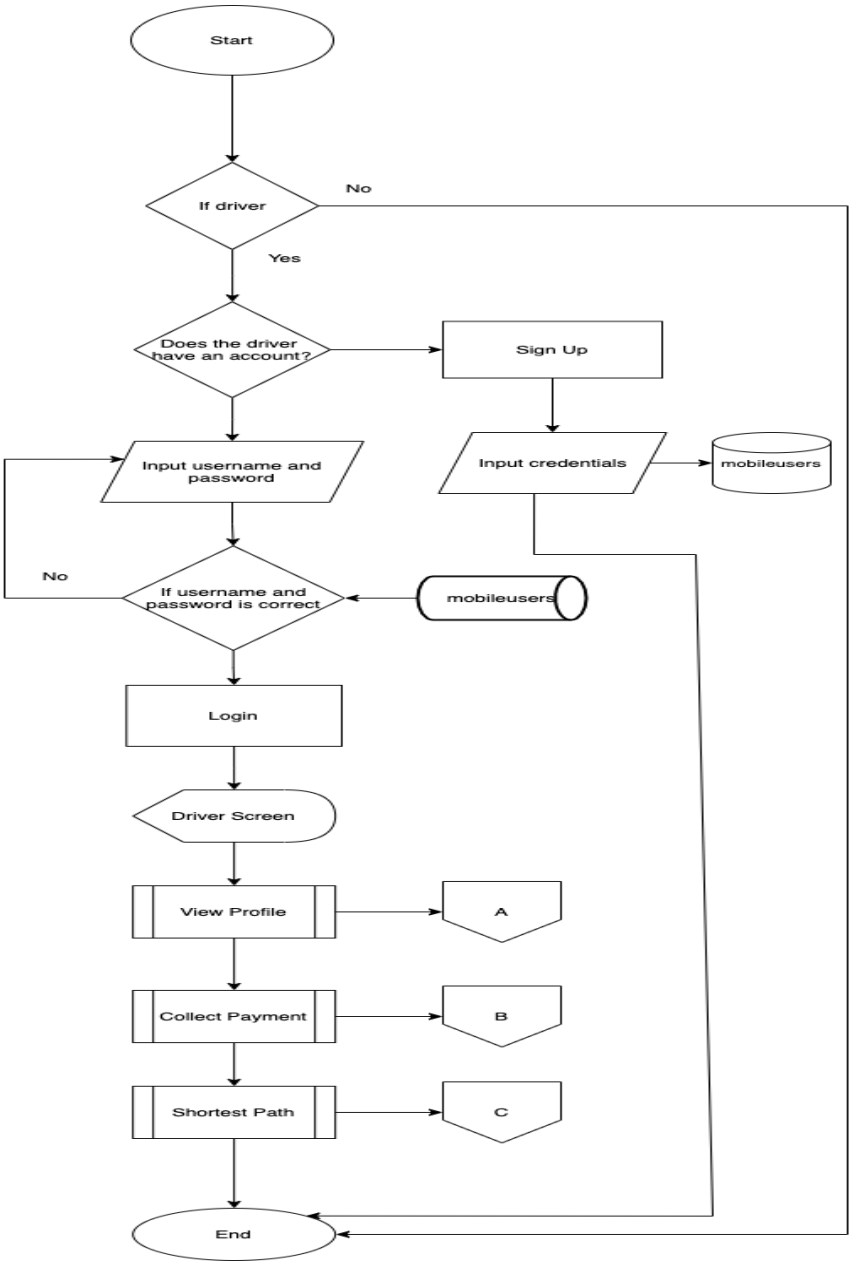


*Figure 26.* Procedural Design of the Proposed System – Mobile App (Driver)

Figure 26. shows the step by step process on how the driver interacts in the EzPay.

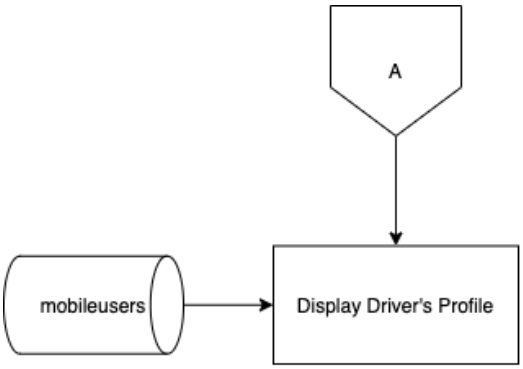


*Figure 26.1.* Procedural Design of the Proposed System – Mobile App (Driver)

Figure 26.1. shows the process on how the driver can view profile in the EzPay

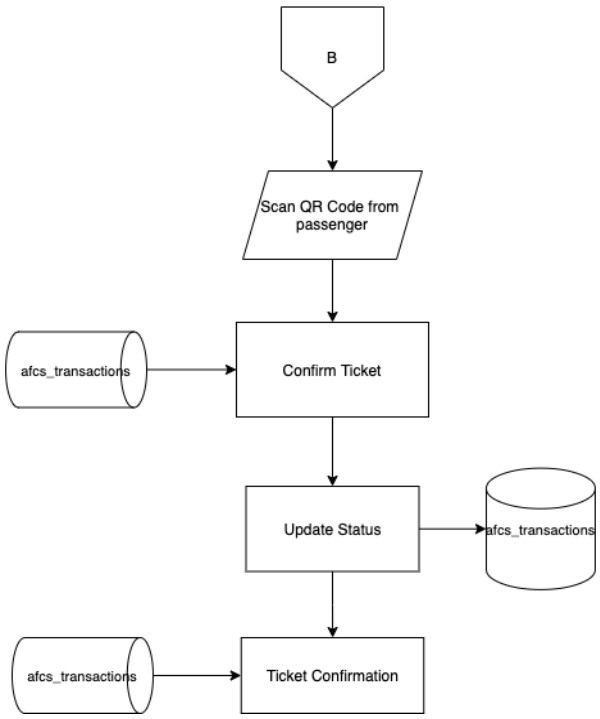


*Figure 26.2.* Procedural Design of the Proposed System – Mobile App (Driver)

Figure 26.2 shows the process on how the driver can collect payment in the EzPay.

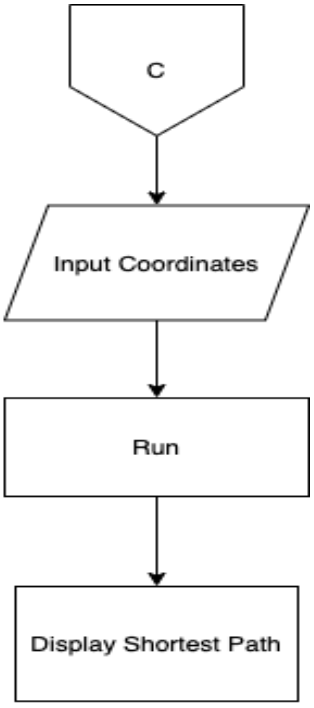


*Figure 26.3.* Procedural Design of the Proposed System – Mobile App (Driver)

Figure 26.3 shows how the driver interacts in the shortest path simulator in the EzPay.

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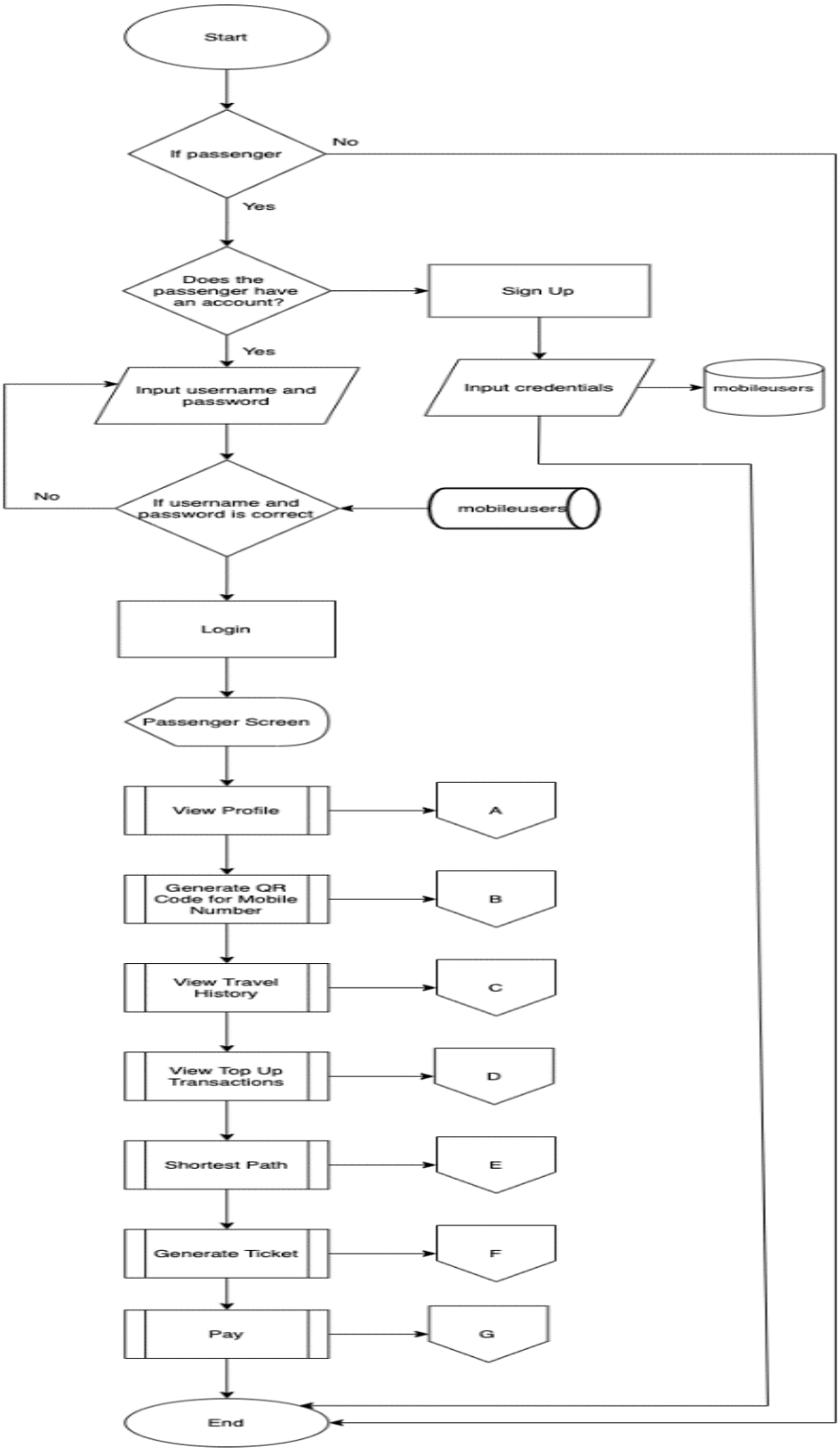

*Figure 27.* Procedural Design of the Proposed System –Mobile App (Passenger)

Figure 27. shows the step by step process on how the passenger interacts in the EzPay.

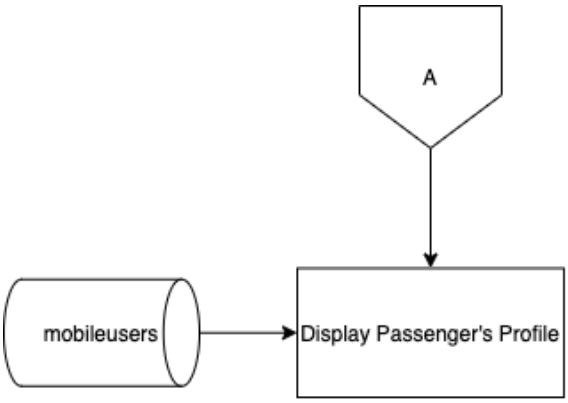


*Figure 27.1.* Procedural Design of the Proposed System - Mobile App (Passenger)

Figure 27.1 shows the process on how passengers can view profile in the EzPay.

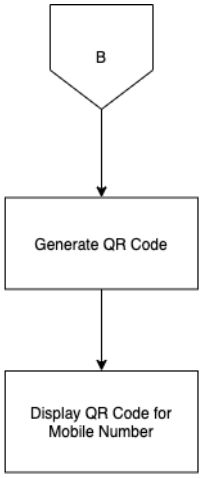


*Figure 27.2.* Procedural Design of the Proposed System -Mobile App (Passenger)

Figure 27.2 shows the process on how the passenger can generate mobile QR code in the EzPay.

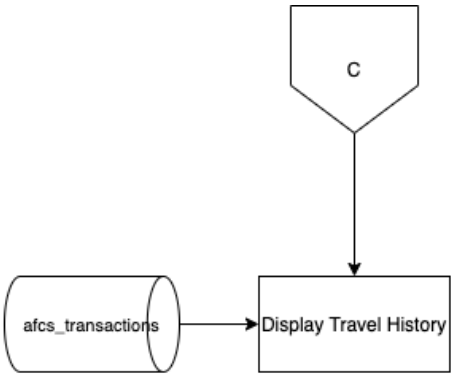


*Figure 27.3.* Procedural Design of the Proposed System - Mobile App (Passenger)

Figure 27.3 shows the process on how the passenger can view travel history in the EzPay.

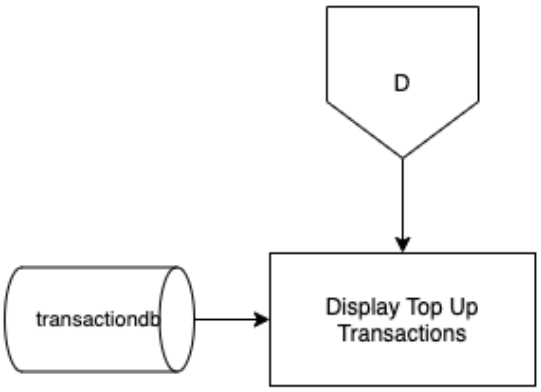


*Figure 27.4*. Procedural Design of the Proposed System -Mobile App (Passenger)

Figure 27.4. shows the process on how passengers can view top-up transactions in the EzPay.

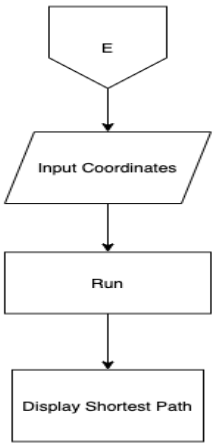


*Figure 27.5*. Procedural Design of the Proposed System Mobile App (Passenger)

Figure 27.5 shows how the passenger interacts in the shortest path simulator in the EzPay.

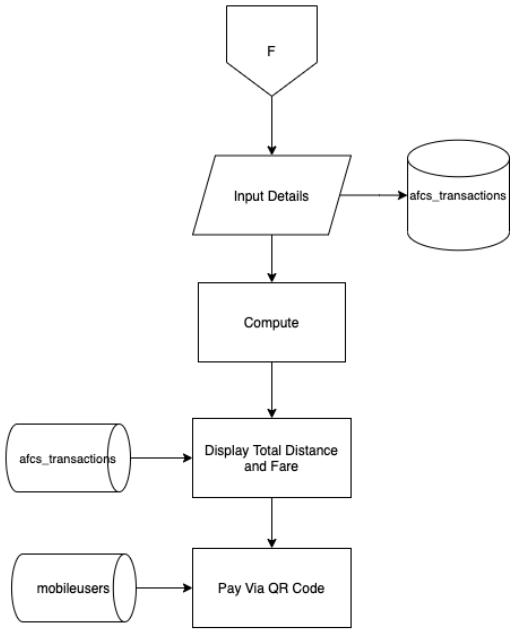

*Figure 27.6*. Procedural Design of the Proposed System –Mobile App (Passenger)

Figure 27.6 shows the process on how the passenger can generate ticket in the EzPay

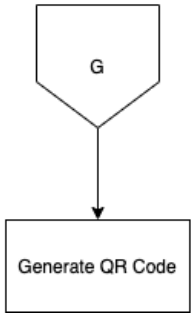


*Figure 27.7*. Procedural Design of the Proposed System –Mobile App (Passenger)

Figure 27.7 shows the process on how passengers can pay the ticket generated in the EzPay.

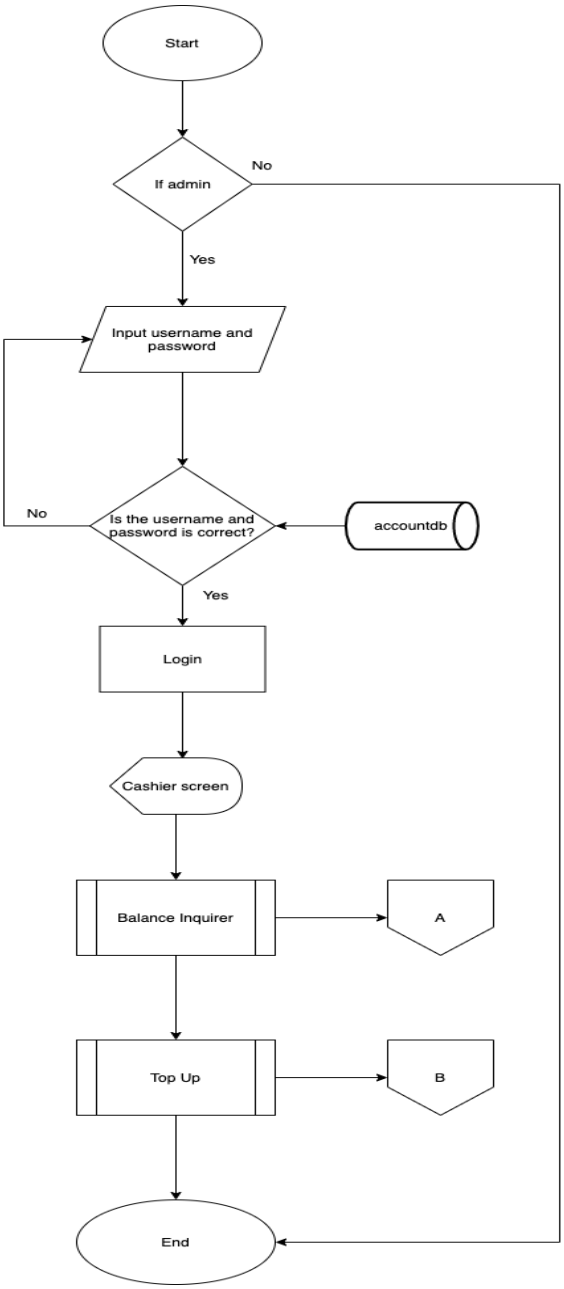


*Figure 28.* Procedural Design of the Proposed System – Top Up System (Cashier)

Figure 28 shows the step by step process on how the cashier interacts in the Top-up System.

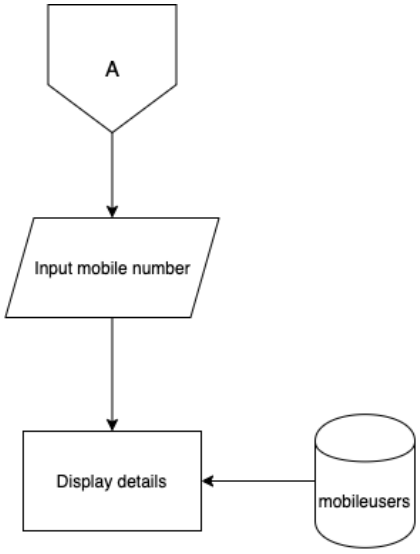


*Figure 28.1.* Procedural Design of the Proposed System – Top Up System (Cashier)

Figure 28.1 shows the process on how the cashier can use the balance inquirer in the Top-up System.

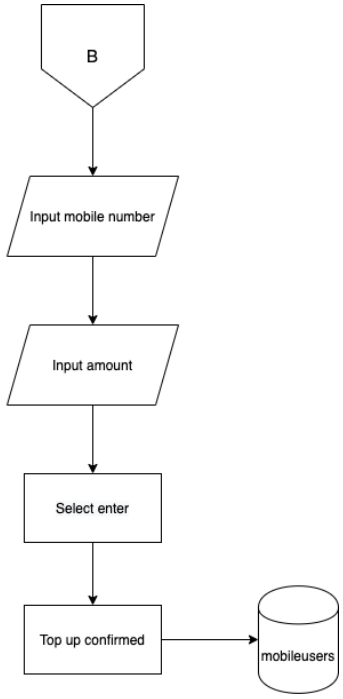


*Figure 28.2.* Procedural Design of the Proposed System – Top Up System (Cashier)

Figure 28.2 shows the process on how the cashier can use the Top-up feature to add load value to passengers in the Top-up system.

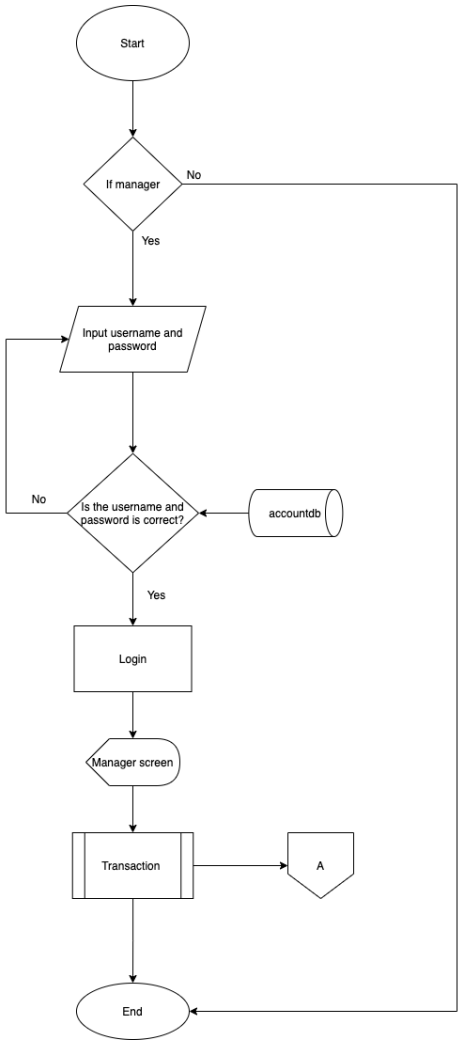


*Figure 29.* Procedural Design of the Proposed System – Top Up System (Manager)

Figure 29. shows the step by step process on how the manager interacts in the Top-up System.

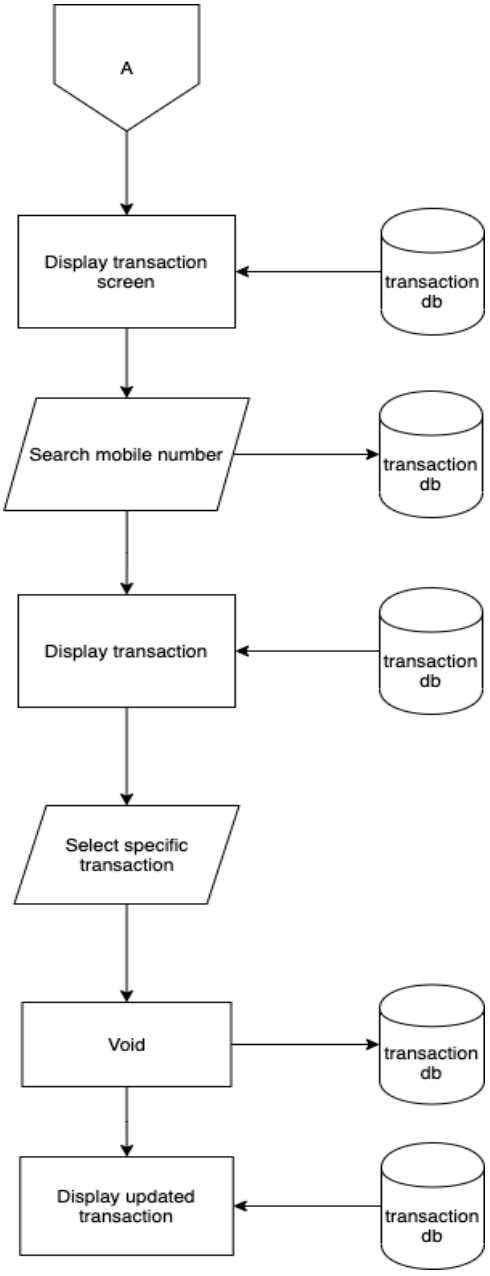


*Figure 29.1.* Procedural Design of the Proposed System – Top Up System (Manager)

Figure 29.1 shows the process on how the manager can manage the transactions in the Top-up system.

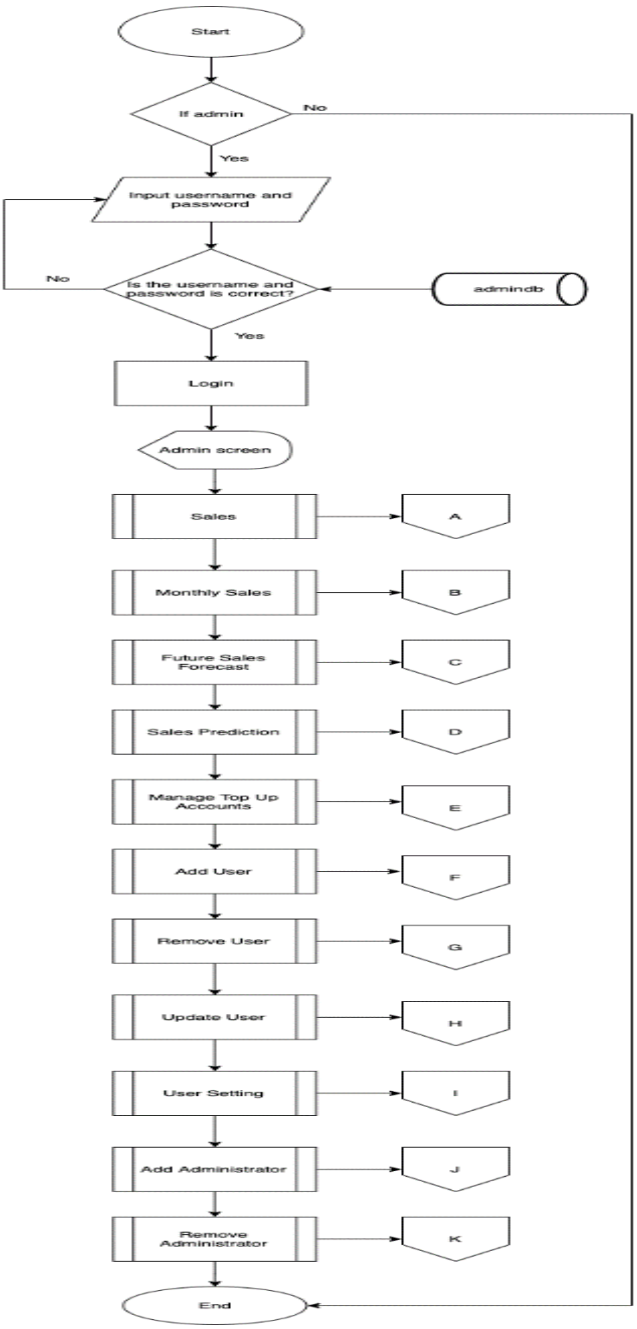

*Figure 30*. Procedural Design of the Proposed System – Fare Management System (Artificial Intelligence (AI))

Figure 30 shows the step by step process on how the administrator interacts in the Fare Management System.

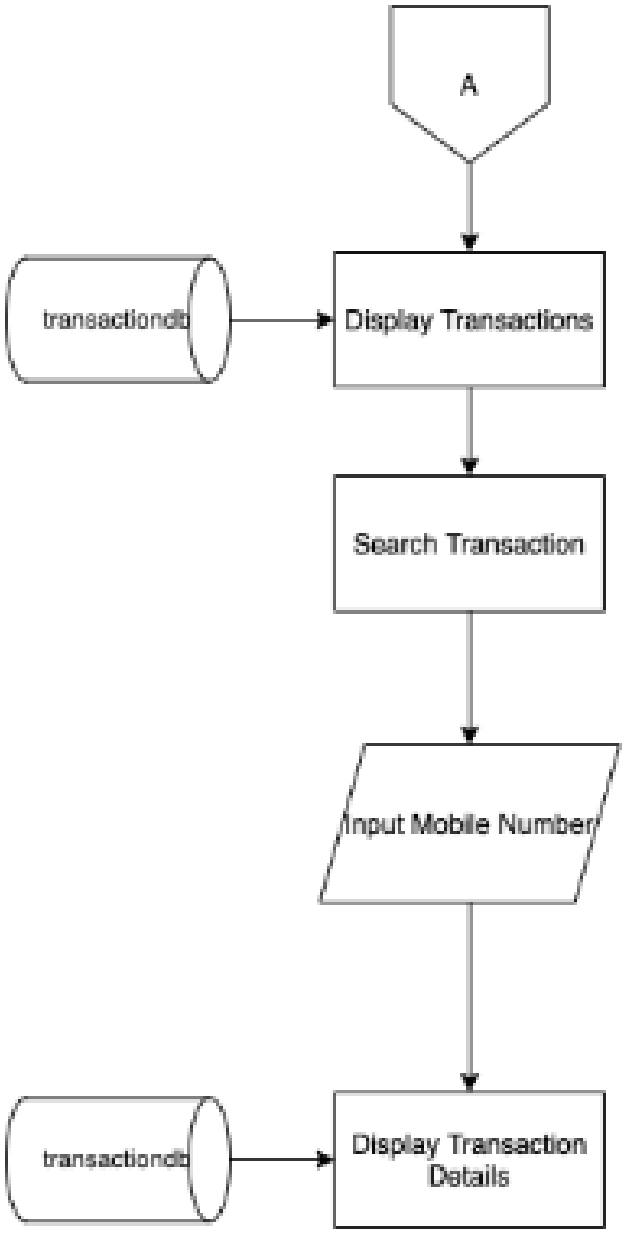

*Figure 30.1.* Procedural Design of the Proposed System – Fare Management System (Artificial Intelligence (AI))

Figure 30.1 shows the process on how the admin can view or manage the transactions in the Fare Management System.

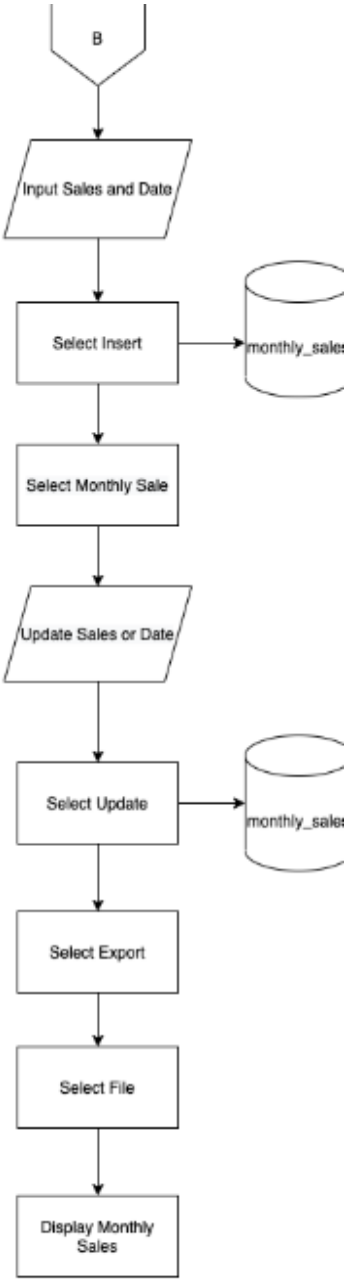

*Figure 30.2.* Procedural Design of the Proposed System – Fare Management System (Artificial Intelligence (AI))

Figure 30.2 shows the process on how the admin can manage the monthly sales in the Fare Management System.

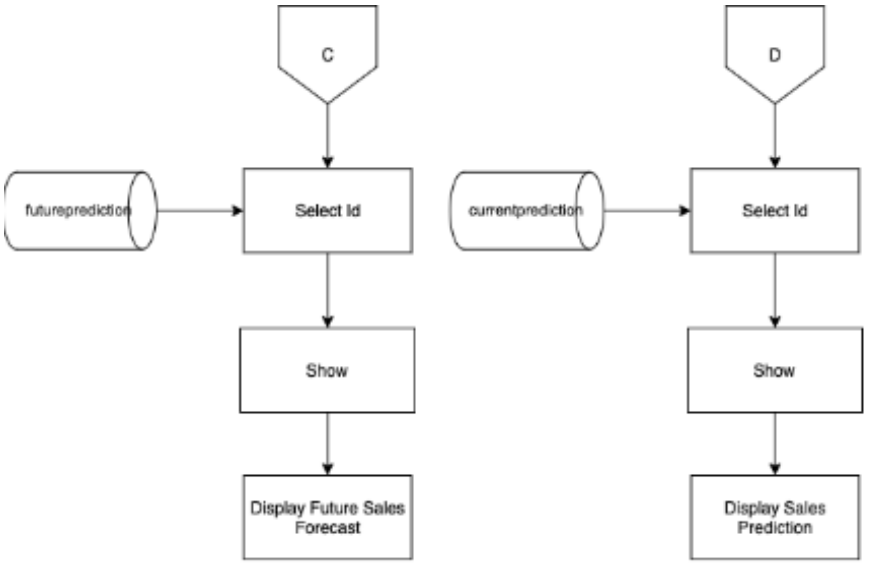


*Figure 30.3.* Procedural Design of the Proposed System – Fare Management System (Artificial Intelligence (AI))

Figure 30.3 shows the process on how the admin can view the future sales prediction in the Fare Management System.

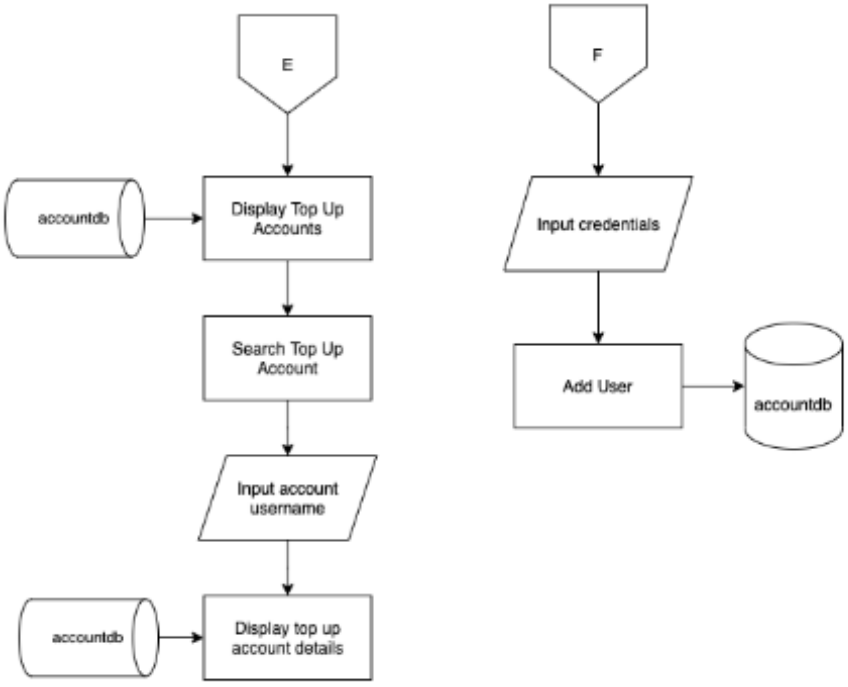


*Figure 30.4.* Procedural Design of the Proposed System – Fare Management System (Artificial Intelligence (AI))

Figure 30.4shows the process on how the admin can manage the accounts of Top-up users in the Fare Management System.

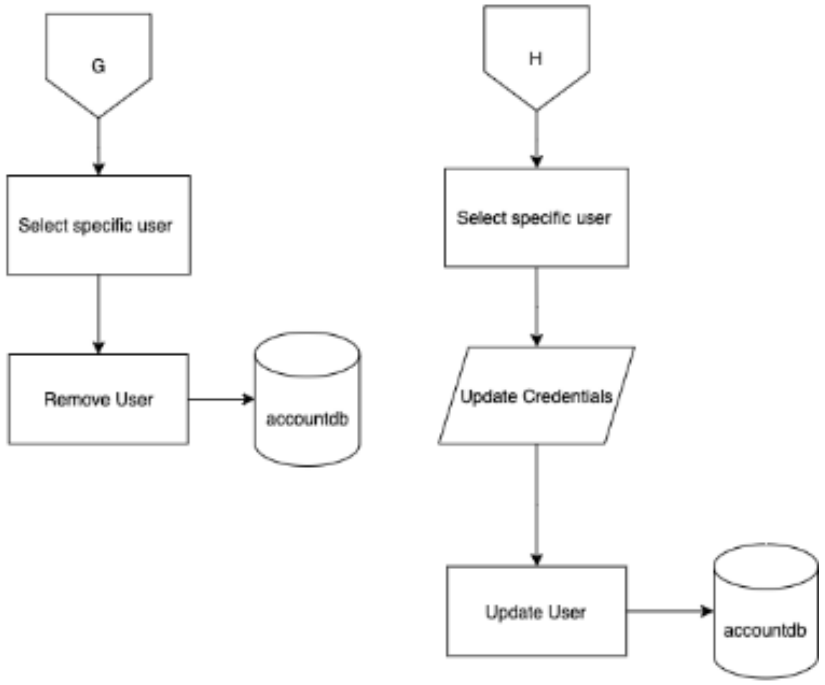


*Figure 30.5.* Procedural Design of the Proposed System – Fare Management System (Artificial Intelligence (AI))

Figure 30.5 shows the process on how the admin can manage the accounts of Top-up users in the Fare Management System.

System Development Life Cycle

The researcher's proposed system was developed on Agile Software Development Methodology approaches that employ continual planning, learning, improvement, team collaboration, evolutionary development, and early delivery. Each of these phases requires proper documentation to ensure the validity of the process.

The first stage in the system development life was planning. Researchers acknowledged and classified the problems. Researchers also identified the users of the current program and evaluated the overall scope of the program. After the problem was recognized, researchers determine what would be the goal outcome or improvement that would help enhance or solve the problem.

The second stage was the learning. In the second phase, the researchers studied the major and minor problems and the factors that may influence the study.

The third stage was improvement. Researchers focused on the design of the program and functions that need modification and enhancements in the third phase.

The fourth stage was the team collaboration. In the fourth stage, the researchers brainstormed what designs, programming languages to use and how to implement the system. Every researcher suggested and eventually chose the best among the suggestions.

The fifth stage was evolutionary development. During the fifth phase, the researchers continued conducting the research study and continuously develop the system.

The sixth stage was early delivery. Researchers were testing and continuously improving by debugging the system. Researchers continuously studied or debugged the system to determine whether the system has a problem that needs modification or none.

# CHAPTER 4: RESULTS AND DISCUSSION

## Implementation

Implementation of the system required the proponents to test the mobile application or the Ezpay app. Ezpay is responsible for visualizing the shortest path with the use of Dijkstra's Algorithm and to generate QR code. The distance was calculated with the help of Haversine Algorithm. Android studio IDE was used to develop the system while Java was used as the programming language. The mobile app also has specific specifications which includes the resolution of 1080x2220:440dpi, the API level is 30, the target platform is Android 11.0 (Google Play), and the CPU/ABI is x86. The passengers input the credentials in the app in order to make a transaction. Passengers that did not have an account need to create a new account. Personal information like full name, username, password, and phone number was required in order to create an account. Once the account was created, passengers can now make transactions like develop the shortest path, and make payments of their travel via QR code. Once the passenger finished generating the QR code the driver could now collect the passenger's payment by scanning the QR Code. After which, the passenger's balance and travel history may now updated.

Both the driver and the passenger can view their profile and the shortest path but only the passenger's account will show their current balance and travel history.

The Fare Management System developed by the proponents can only be used by the administrator. The Fare Management System enables the administrator to view monthly sales and to visualize the sales forecasting with the use of the SARIMAX model. The programming language used in sales forecasting is Python. The administrator has the ability to add or remove the account of another administrator and to add, remove or update the user's account. The Top-Up System is also developed by the proponents which is responsible for adding load value to the user's account and checking the load balance. The Top-Up System can only be used by the cashier or the manager. The programming language used in Top-Up System is Java. Both the Fare Management System and the Top-Up System are developed on the Netbeans IDE.

The Goddady server was used to host the three (3) systems. Windows 10 device with 4gb RAM and has 2 cores of CPU, a stable internet connection is needed, and 10gb of disk space needs to be allocated in order for the three (3) systems to run or function properly.

In order to test the Mobile app, proponents allow at least thirty (30) respondents to use the mobile app and after using the app, they answered a survey question prepared by the proponents. The users rated the system based on their experience after using the app. Five (5) is the highest which is Excellent, four (4) is Very Good, three (3) is Good, two (2) is Fair, and lastly, one (1) is Poor.

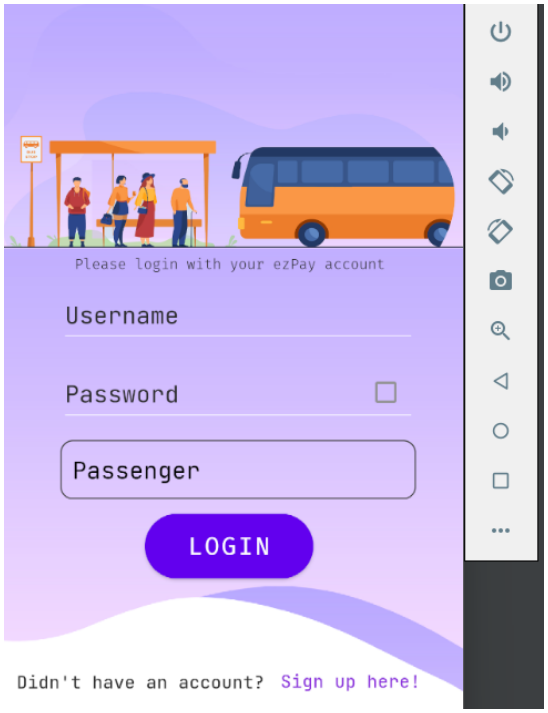


*Figure 31*. Dashboard of the Mobile app

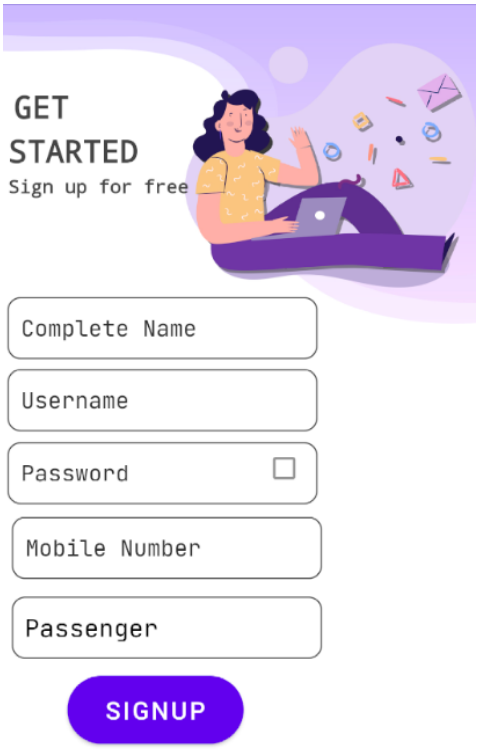


*Figure 31.1*. Sign Up page in Mobile app

The Dashboard of the Mobile app as shown in Figure 31 is the starting point in using the said app. The user can log in into the app if the user already has an existing account. If the user does not have an account, the user must sign up first or simply create an account by just clicking the sign up sign on the dashboard, the user may then be redirected to the Signing Up page. In order to sign up or create an account the user needs to fill up the necessary information like Complete Name, Username, Password, and Mobile Number as shown in Figure

31.1. There is a need to choose whether the user or a passenger in order to proceed to the next transaction.


*Figure 32*. Passenger's Profile in Mobile app

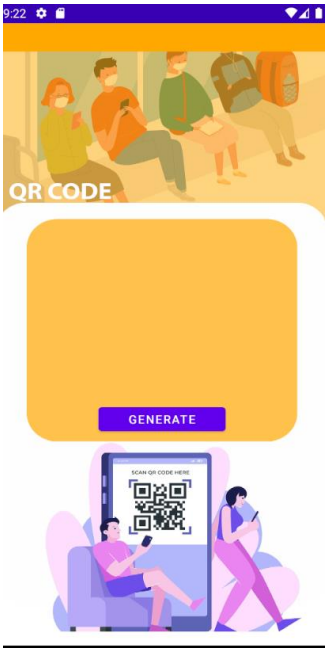


*Figure 32.1.* Mobile Number QR Code in Mobile App

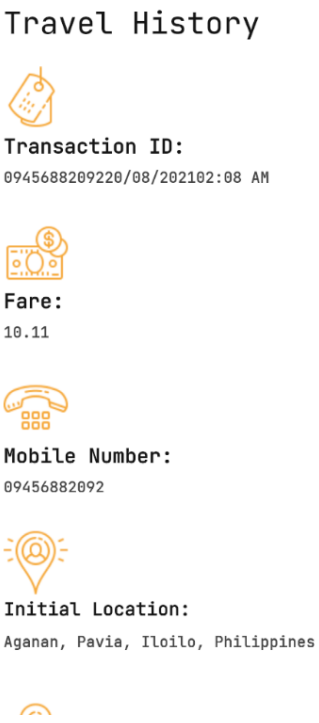


*Figure 32.2.* Travel History in Mobile App

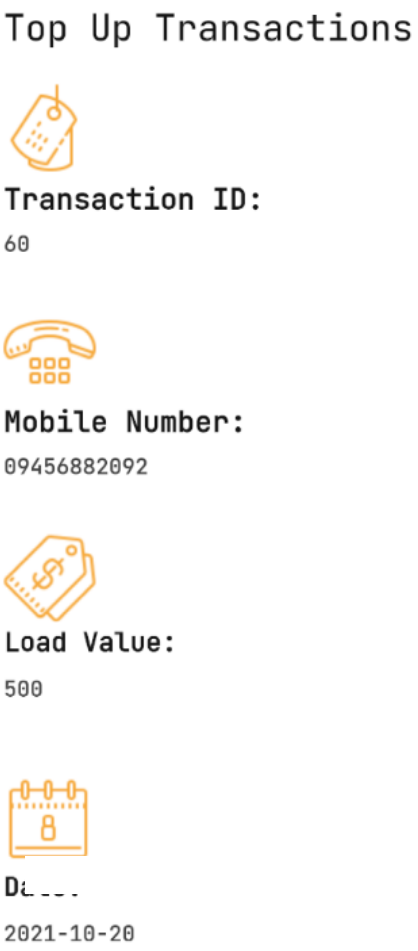


*Figure 32.3.* Top Up Transactions in Mobile app

Figure 32 shows what the Passenger's Profile looks like after the passenger logs in. The Passenger's name, username, and the current balance is displayed in the Profile. Under the Passenger Profile, the passenger can find the Mobile Number QR Code, Travel History and the Top up Transactions. Mobile Number QR Code as shown in Figure 32.1 enables the

passenger to generate QR Code by just using mobile number. Figure 32.2 shows the Travel History that contains the information of the passenger's travel for example, the Transaction ID, Fare, Mobile Number, Initial Location, Destination, Status, and the Distance in kilometer. Figure 32.3 shows Top Up Transactions which contains the Transaction ID, Mobile Number, Load Value, Date of the transaction, Cashier Name, and the Terminal.

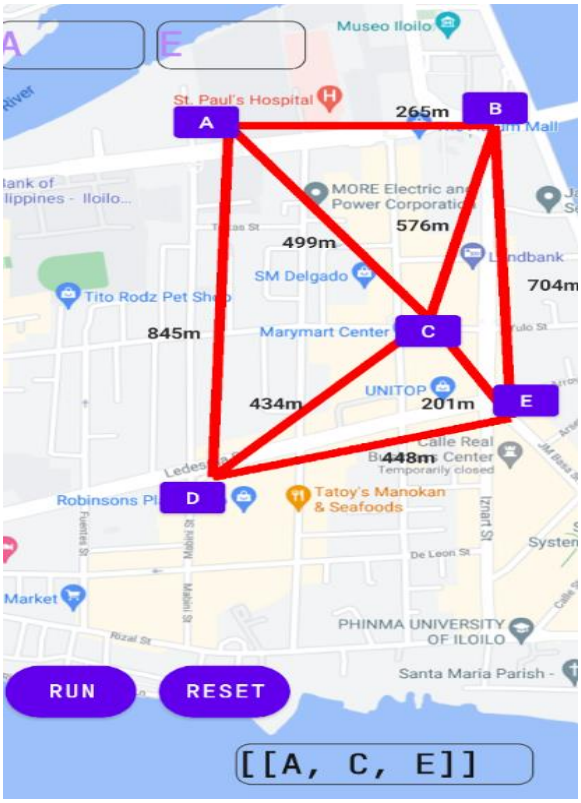


*Figure 33*. Shortest Path in Mobile app

The Shortest Path as shown in Figure 33, simulates how the path-finding algorithm works. Shortest Path can be also found both in passenger and driver's accounts.

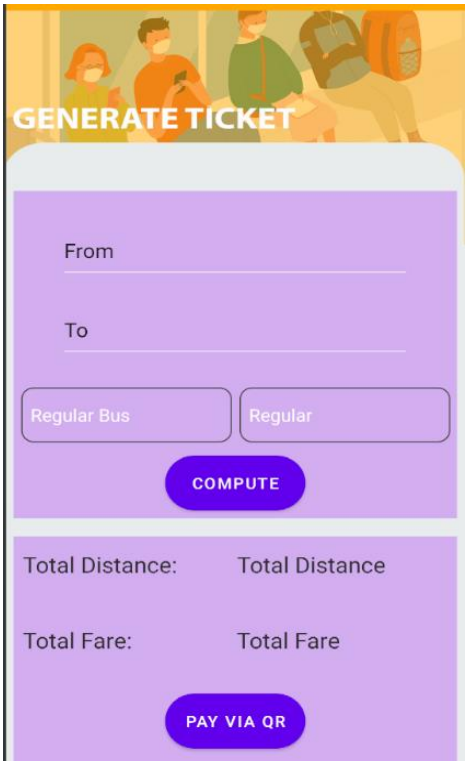


*Figure 34*. Generate Ticket in Mobile app

As shown in Figure 34, the last step in the passenger account is to generate the ticket or a QR code in order for the driver to collect the payment for the travel. The passenger just needs to input the initial location and the destination. After which, the passenger will choose on what type of PUV to ride and if the passenger is a regular or a

discounted one. Discounted means that you belong to Persons with Disabilities (PWD) and senior citizens. And finally, the passenger will click the Pay Via QR button to generate QR code.

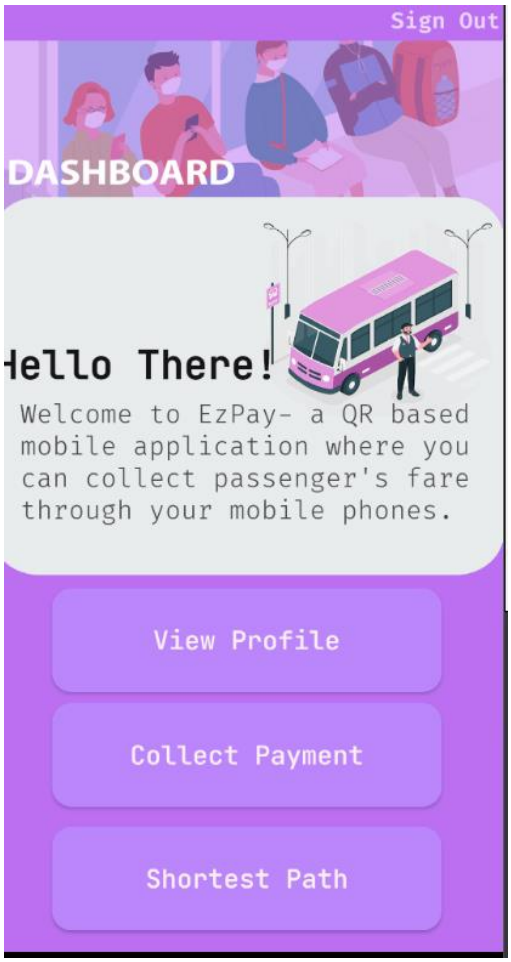


*Figure 35*. Driver's Dashboard in Mobile app

As shown in Figure 35, the Driver's Dashboard only includes the View Profile, Collect Payment, and the Shortest Path option.


*Figure 36*. Driver's Profile in Mobile app

The Driver's Profile as shown in Figure 36, only shows the driver's name and the mobile number.

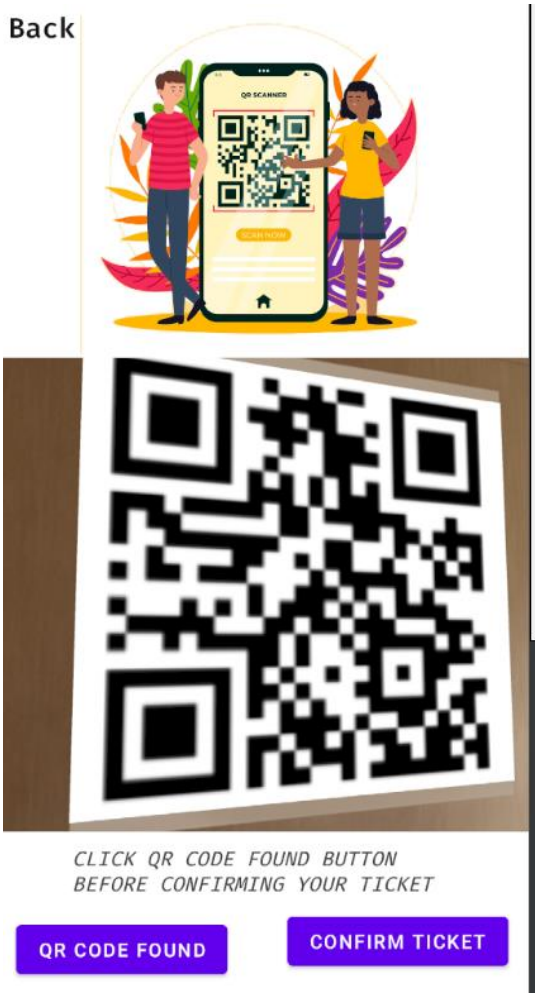


*Figure 37*. Collect Payment in Mobile app

In order to Collect Payment as shown in Figure 37, the driver needs to scan the passenger's QR code. Once the QR Code is found, the driver will click the Confirm Ticket button then the fare will be deducted on the passenger's balance. After that the passenger can now board.

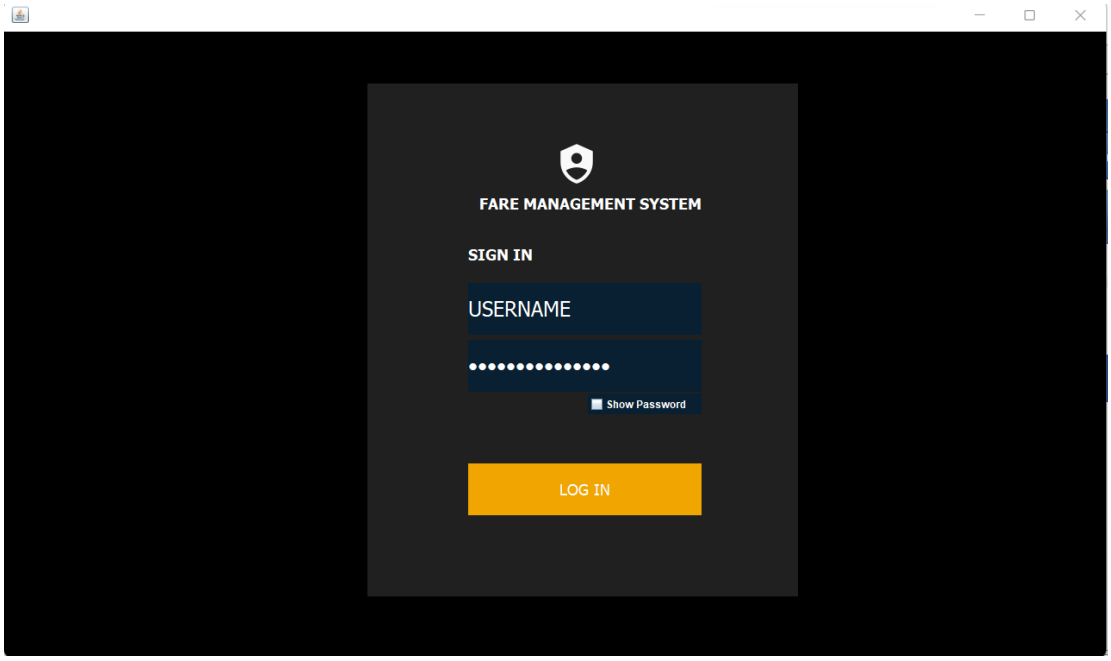


*Figure 38.* Dashboard of the Fare Management System

As shown in Figure 38, the dashboard of the Fare Management System requires the username and the password of the administrator in order to proceed to the next transactions. Note that the administrator only has the authority to view and use the Fare Management System.

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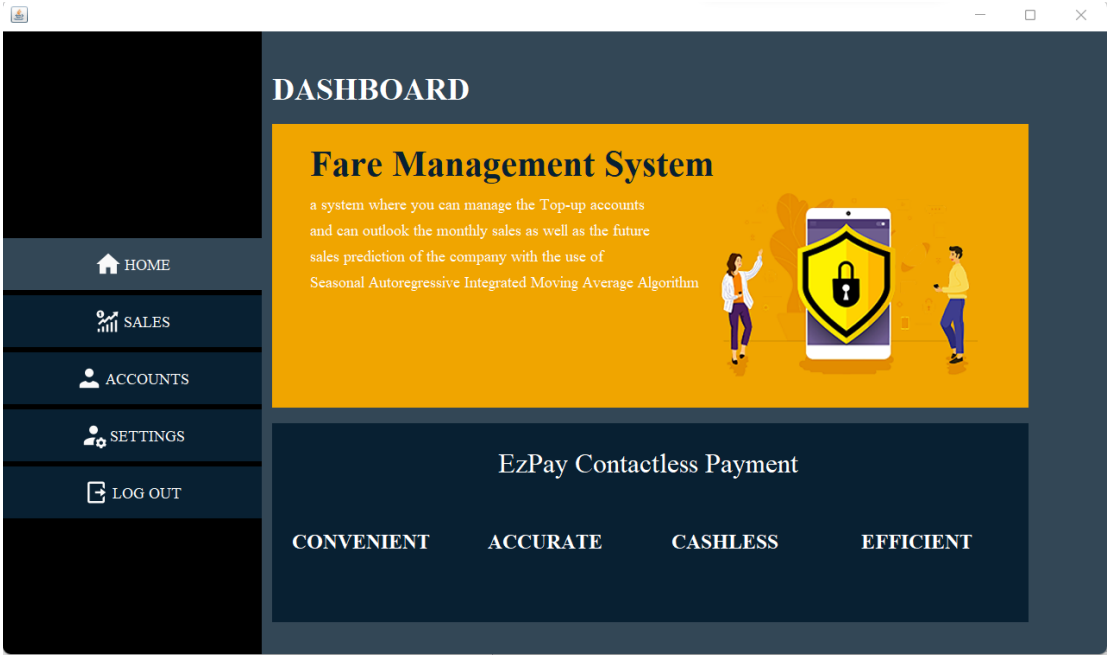


*Figure 39.* Home Button in Fare Management System

The home button in the Fare Management System as shown in Figure 39, displays words that describe the system.

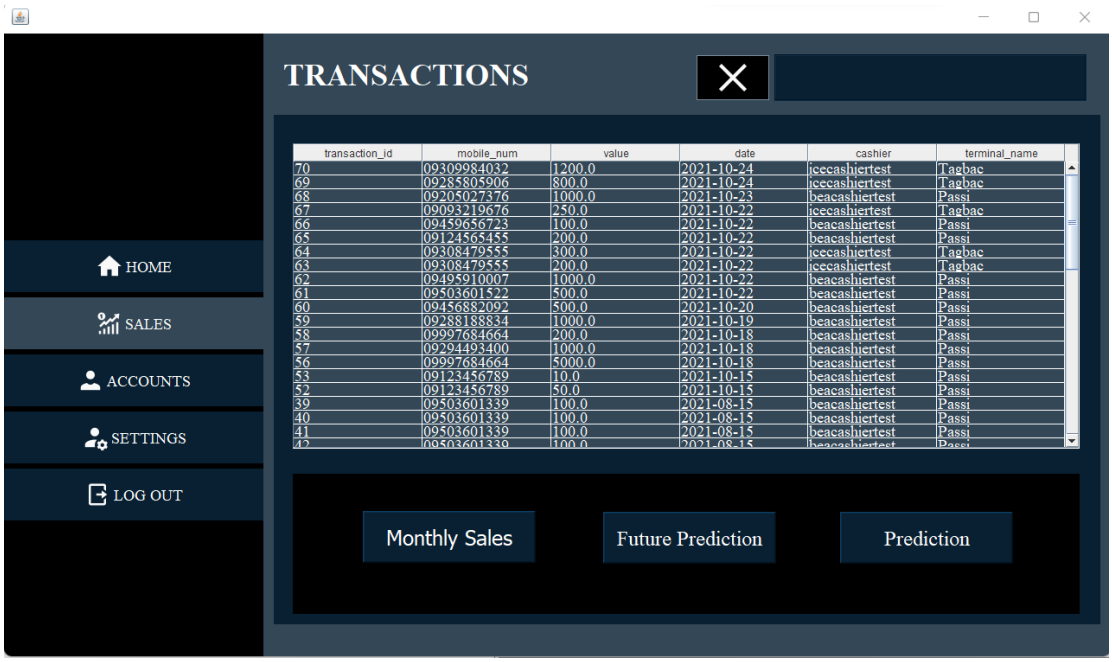


*Figure 40.* Transactions in Fare Management System

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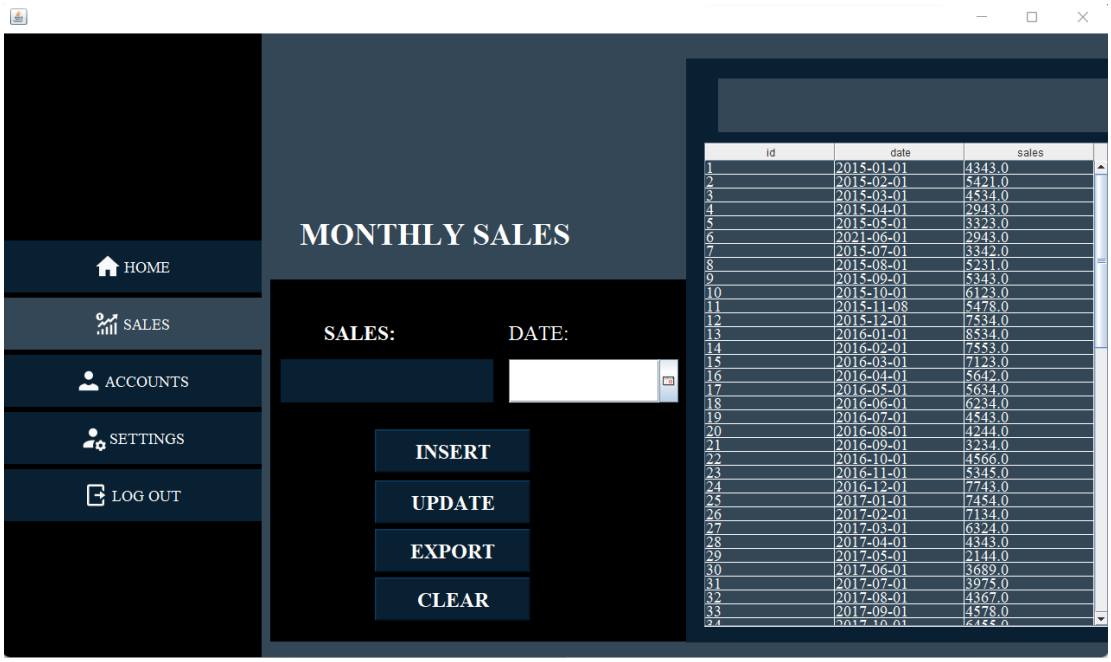


*Figure 40.1.* Monthly Sales in Fare Management System

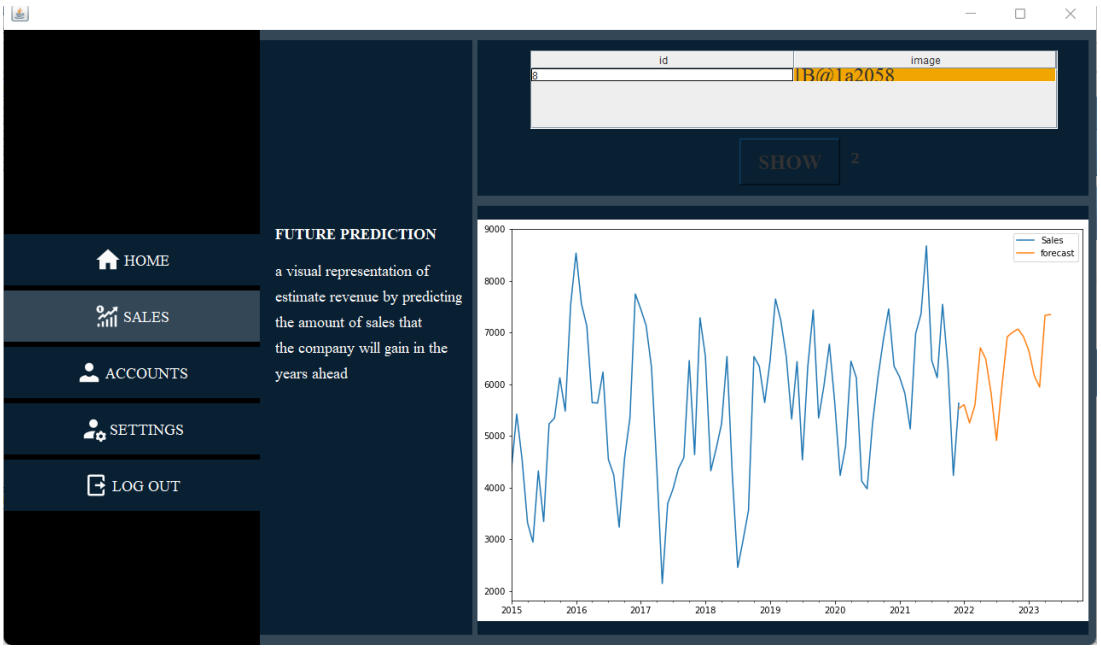


*Figure 40.2.* Future Prediction in Fare Management System

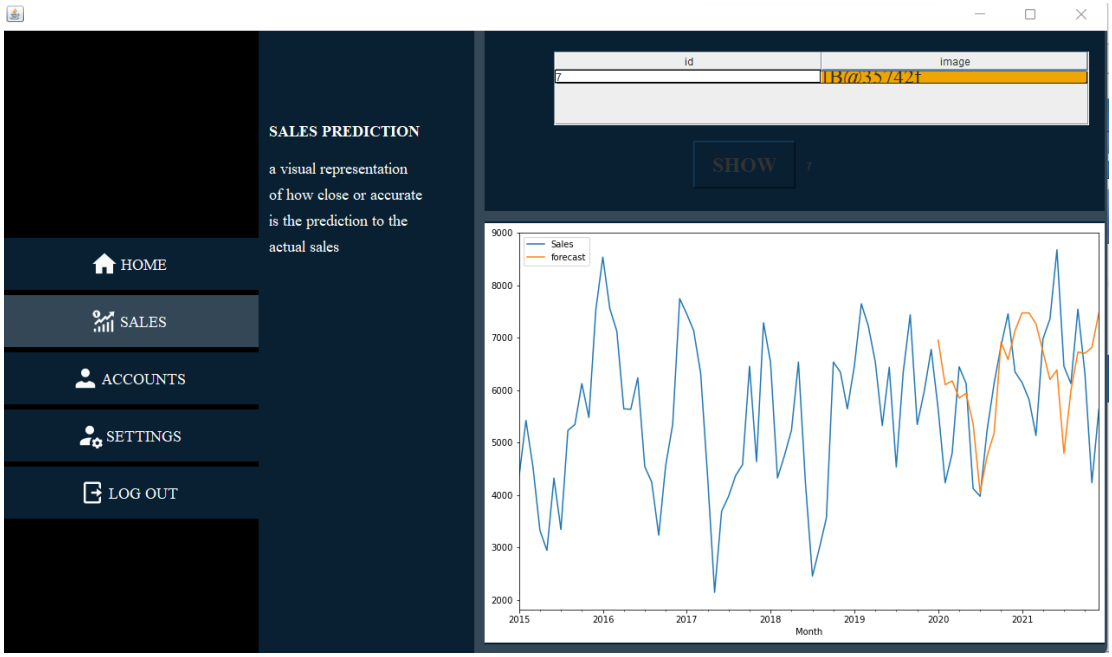


*Figure 40.3*. Sales Prediction in Fare Management System

As shown in Figure 40, the administrator can view the transactions made by the passenger just like the user's transaction ID, mobile number of the user, value which is added to the user's account, date the transaction was made, cashier's name during the transaction, and where did the transaction happen. Administrators can also view monthly sales as shown in Figure 40.1. Monthly sales enable the administrator to insert, update, and export monthly sales to csv file. In Figure 40.2, future prediction with the use of the SARIMAX model visualizes the representation of estimated revenue by predicting the amount of sales that a company will

gain in the years ahead. In addition, administrators can also view the sales prediction as shown in 40.3. Sales Prediction is a visual representation of how close or accurate in the prediction compared to the actual sales.

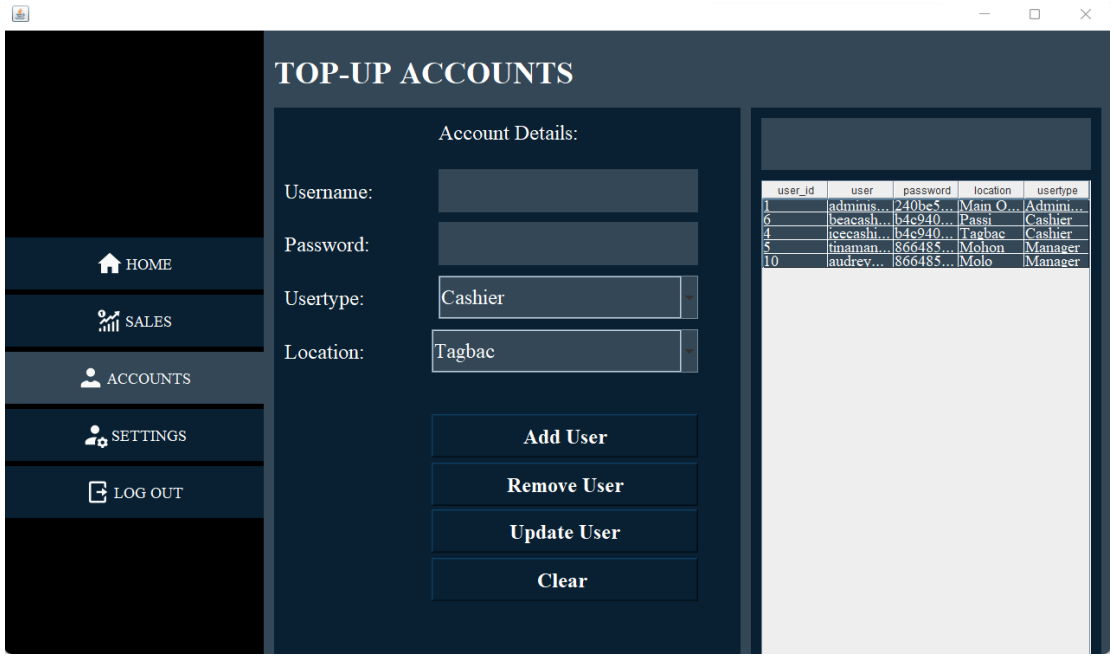


*Figure 41.* Top-Up Accounts in Fare Management System

The Top-Up Accounts tab in the Fare Management System as shown in Figure 41, enables the administrator to add, remove and update a user's account that may be a cashier or a manager.

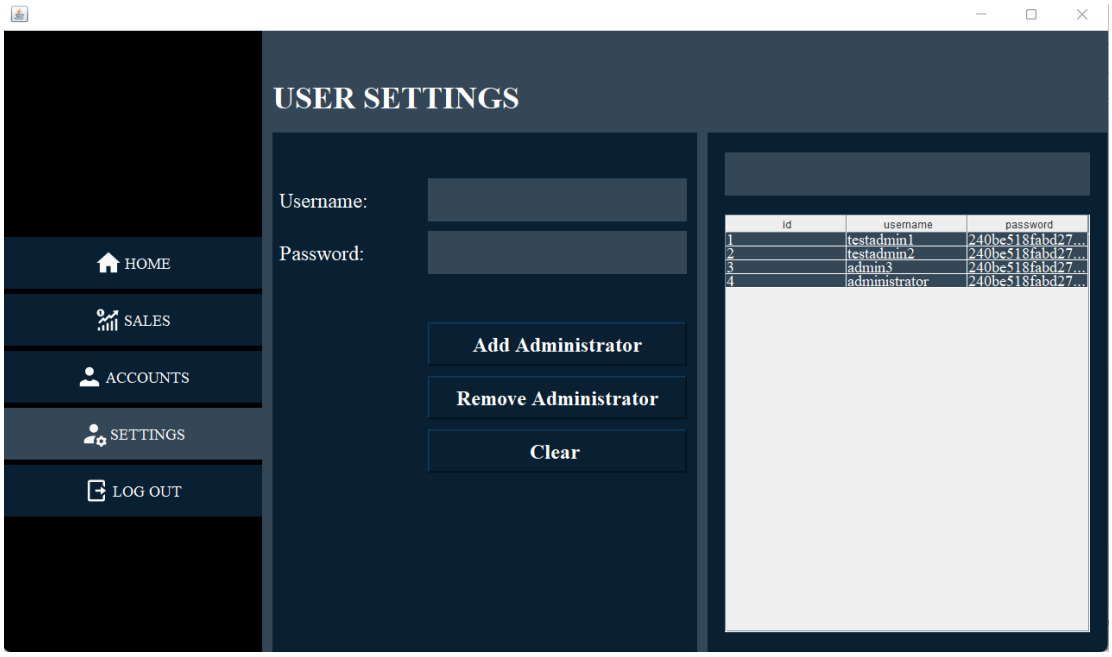


*Figure 42.* User Settings in Fare Management System

In the User Settings tab, as shown in Figure 42, an administrator can add and remove the account of another administrator. The administrator's username and password is needed to add and remove an account.

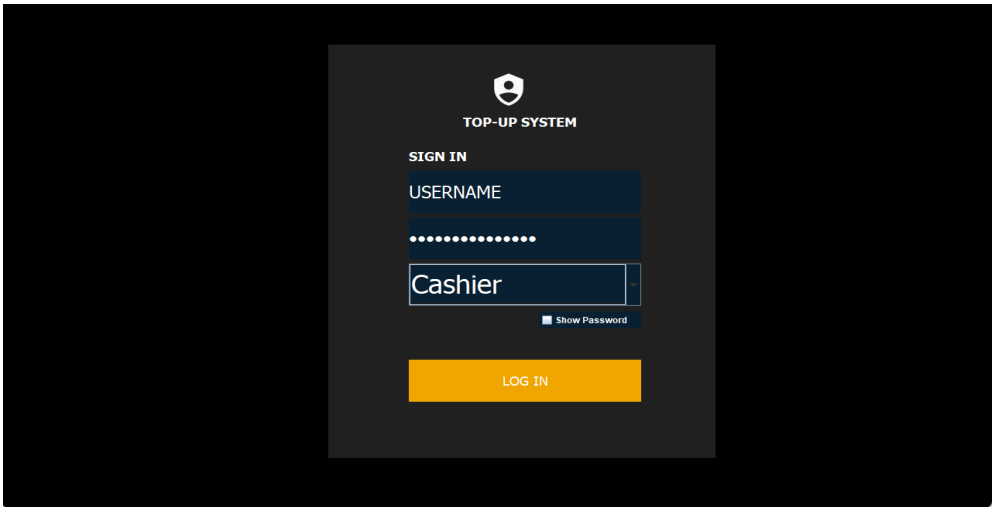


*Figure 43.* Login in Top-Up System

The first step in the Top-Up system is the Login. Username and the password is required to login as shown in Figure 43. The Top-Up System also requires input whether the user is the cashier or the manager in order to proceed to the next tab.

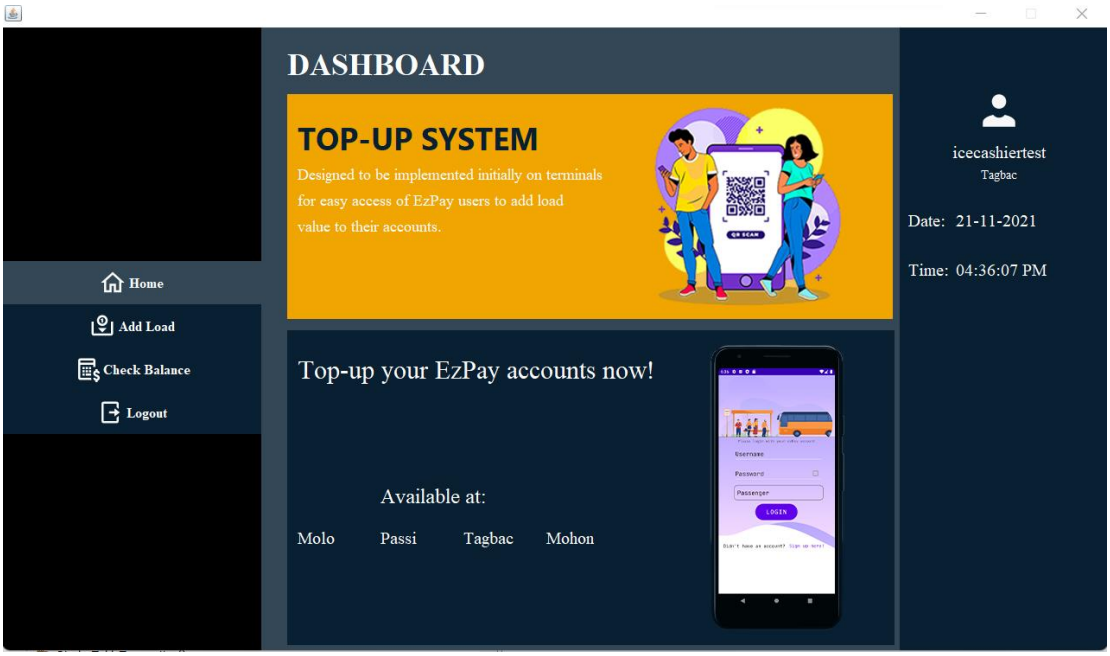


Figure 44. Dashboard of Top-Up System

As shown in Figure 44, the cashier dashboard displays the name of the cashier who logged in, the time and the date of the log in, and where the cashier logged in.

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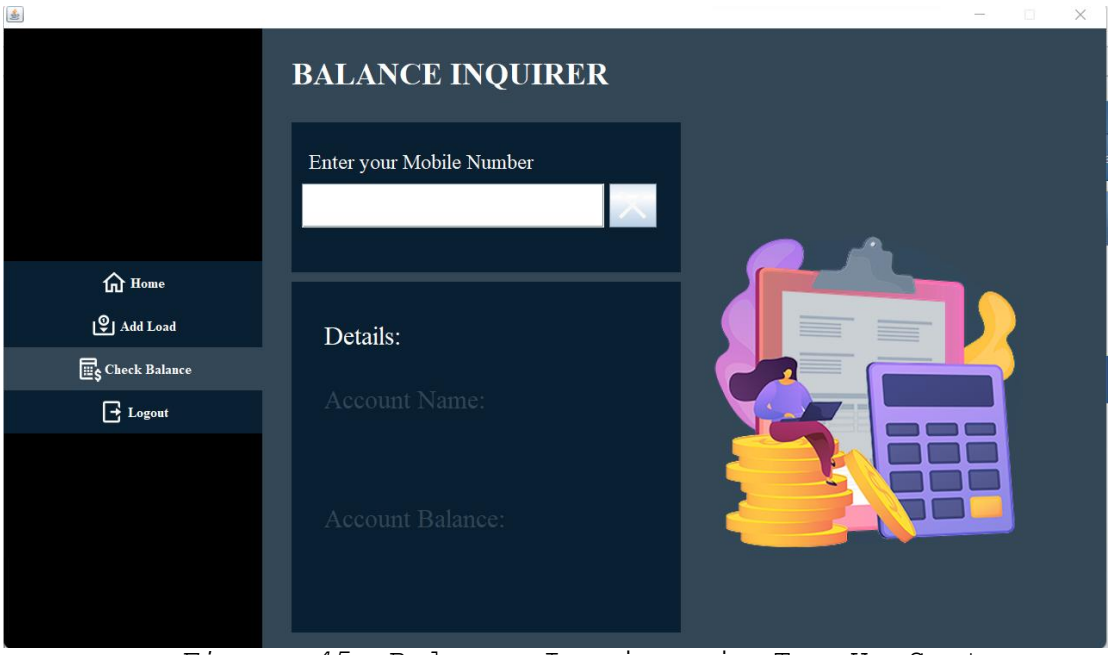


*Figure 45*. Balance Inquirer in Top-Up System

The balance inquirer as shown in Figure 45, needs the cashier to enter the user's mobile number to determine the user's account balance as well as the user's name.

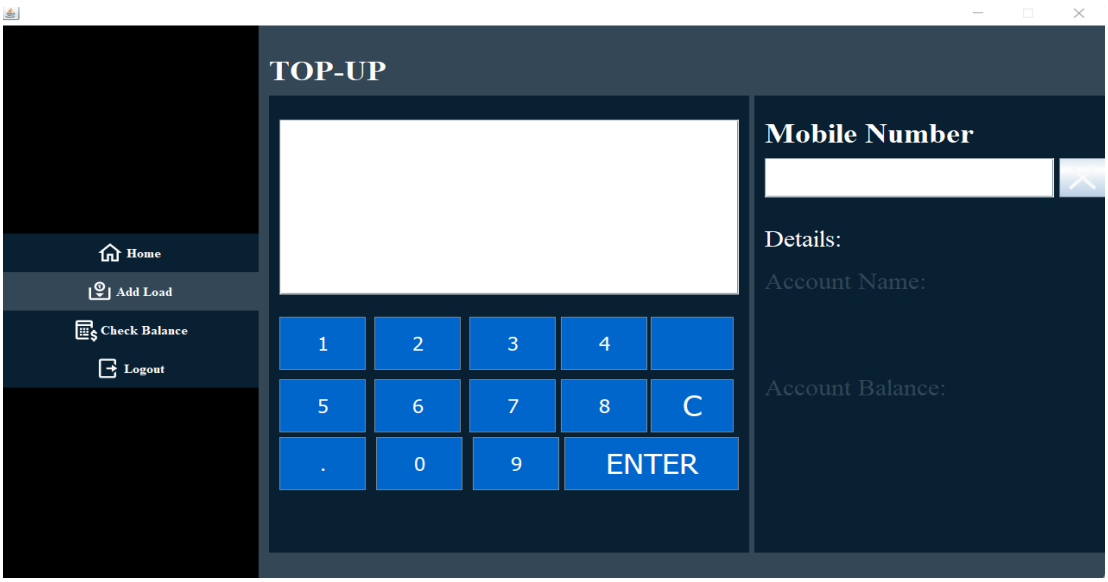


*Figure 46*. Top-Up in the Top-up System

The Top-up as shown in Figure 46, enables the cashier to add load to the user's account. The cashier just needs to input the user's mobile number and enter the amount of load to be added. After that, there is a confirmation that pops up to confirm that the transaction is successfully made. The balance will automatically update after the transaction.

Results Interpretation and Analysis

Thirty-five (35) respondents were able to test the system and all of the respondents answered the survey form right after the testing of the said system. The survey form that the respondents answered are in google docs form. The Survey form was based on the ISO-standard usability assessment tool to ensure the quality of the system. Proponents are able to obtain the following results after a series of testing.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.411764706 | 4 | 4 | 0.608905977 |

Table 4. *Functional Completeness*

Table 4 shows Functional Completeness which means that after the testing, respondents believed that the EzPay is a complete package in terms of collection of fare since users can check the account's balance, the distance traveled, as well as the travel history.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.5 | 4.5 | 4 | 0.507519219 |

Table 5. *Functional Correctness*

Table 5 shows Functional Correctness which means that the system can calculate the exact fare based on the distance traveled since the fare is based on the LTFRB's fare tariff.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.529411765 | 5 | 5 | 0.563285498 |

Table 6. *Functional Appropriateness*

Table 6 Functional Appropriateness implies that the respondents are satisfied with how the EzPay calculates the

fare. Respondents are amazed that the EzPay can calculate the exact fare and the distance between a certain location going to another location is appropriate which means that the EzPay functions as intended to be.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.294117647 | 4 | 4 | 0.629064325 |

Table 7. *Time Behavior*

Table 7 Time Behavior implies that the EzPay functions fast when the internet connection is fast but if the internet connection is slow, the EzPay will also function slowly.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.705882353 | 5 | 5 | 0.46249729 |

Table 8. *Resource Utilization*

Table 8 Resource Utilization means that the EzPay maximizes all the resources in order to give the best service

in terms of calculating the fare, visualizing the shortest path, and determining the distance traveled.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.205882353 | 4 | 4 | 0.640994103 |

Table 9. *Interoperability*

Table 9 Interoperability means that the system has the ability to interact with specified systems which mean users can use the EzPay on different terminals. EzPay shares information of the user on the different terminals.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.647058824 | 5 | 5 | 0.543967075 |

Table 10 *Capacity*

Table 10 Capacity means that the EzPay can accommodate a large number of users and can store different information.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.441176471 | 5 | 5 | 0.660173369 |

Table 11. *Co-existence*

Table 11 Co-existence implies that different users can use the EzPay simultaneously without affecting the performance of the app.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.558823529 | 5 | 5 | 0.612554338 |

Table 12. *Appropriateness Recognizability*

Table 12 Appropriateness Recognizability means that the user believes the EzPay is appropriate for the user's needs.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.5 | 5 | 5 | 0.662867965 |

Table 13. *Learnability*

Table 13 Learnability shows that learning the EzPay is very easy. Proponents may first discuss how the app works then allow the respondents to navigate the app without the proponents teaching. The user gets familiar with the EzPay easily.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.647058824 | 5 | 5 | 0.73370595 |

Table 14. *Operability*

Table 14 Operability shows that the EzPay can be easily operated or navigated whether the user is new to the app or not, and users who are young or those who are older.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.029411765 | 4 | 4 | 0.869876136 |

Table 15. *User Error Protection*

Table 15 User Error Protection means that the EzPay app's appearance helps the user to not to commit or minimize any error when using the app.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.588235294 | 5 | 5 | 0.656789577 |

Table 16. *User Interface Aesthetics*

Table 16 User Interface Aesthetics means that the user likes how the EzPay looks. The appearance of the said app is pleasing to the eye of the user.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.5 | 4.5 | 5 | 0.507519219 |

Table 17. Accessibility

Table 17 Accessibility implies that the EzPay can be easily accessed by the users since the EzPay will be installed on the user's smartphones once the EzPay will be deployed. Users can access the EzPay and check account's balance as well as the travel history wherever the user is but of course the user must have an internet connection.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.5 | 5 | 5 | 0.662867965 |

Table 18. *Availability*

Table 18 Availability implies that the EzPay is available 24/7 wherever the user is and whenever the user needs to access the EzPay but internet connection is a must.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4 | 4 | 4 | 0.651338947 |

Table 19. *Fault Tolerance*

Table 19 Fault Tolerance means that the EzPay can continue operating even if the other components of the EzPay are not working properly.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 3.5 | 4 | 4 | 1.05169416 |

Table 20. *Recoverability*

Table 20 Recoverability means that the EzPay does not have the option to recover the forgotten user's password since the password that the user typed during the sign up process

is automatically hashed by the system which resulted in Recoverability to have the lowest score as shown in Table 20.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.705882353 | 5 | 5 | 0.629064325 |

Table 21. Confidentiality

Table 21 means that the respondents believed that the personal information provided during the sign up process is safe when using the EzPay. All the personal information is protected by the system and no one can access other accounts. Hence, respondents gave Confidentiality a high score.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.558823529 | 5 | 5 | 0.612554338 |

Table 22. *Integrity*

Table 22 Integrity means that the calculation of fare, determining of the distance traveled, and visualization of shortest path under the EzPay works as one in order to give the user better service in terms of fare collection.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.382352941 | 4.5 | 5 | 0.696950321 |

Table 23. Non-repudiation

Table 23 Non-repudiation means that the user can check the EzPay in the Top up Transactions under the Passenger Profile if the transaction is successful.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.411764706 | 4.5 | 5 | 0.701411869 |

Table 24. *Accountability*

Table 24 Accountability means that the user is held accountable for whatever may happen to the account. Users only have access to their account.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.588235294 | 5 | 5 | 0.608905977 |

Table 25. *Authenticity*

Table 25 Authenticity shows that the EzPay is very unique and original which was developed by the proponents.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.558823529 | 5 | 5 | 0.612554338 |

Table 26. *Authenticity*

Table 25 Authenticity shows that the EzPay is very unique and original as it was developed by the proponents.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.5 | 5 | 5 | 0.564076075 |

Table 27. *Modularity*

Table 27 Modularity implies that the combination of fare calculation, determining the distance traveled, and visualization of the shortest path works as one to complete the function of the EzPay.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.558823529 | 5 | 5 | 0.612554338 |

Table 28. *Reusability*

Table 28 Reusability means that the EzPay can be used again after one transaction is made and after one user is

finished with the transaction. Users can check the account's balance, check the travel history, determine the distance between two points, and visualize how the shortest path works.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.588235294 | 5 | 5 | 0.608905977 |

Table 29. *Analyzability*

Table 29 Analyzability means that the EzPay can be easily analyzed by the user. And the user can navigate the app without anyone guiding him/her. The EzPay also analyzed the distance between two locations and computed the fare correctly.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 35 | 4.529411765 | 5 | 5 | 0.74814089 2 |

Table 30. *Modifiability*

Table 30 Modifiability means that the EzPay does not have the option to be modified by the user. In line with this, users can freely use the app without the fear of destroying the appearance of the app.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.470588235 | 5 | 5 | 0.66219534 4 |

Table 31. *Adaptability*

Table 31 Adaptability means that the EzPay can adapt to any environment but it only needs good internet connection to function properly and fast.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 35 | 4.5 | 5 | 5 | 0.707106781 |

Table 32. *Installability*

Table 32 Installability shows that once the EzPay is out for deployment, users can freely install the app on user's smartphones.

| No. of Respondents | Mean | Median | Mode | Standard Deviation |
|---|---|---|---|---|
| 35 | 4.411764706 | 5 | 5 | 0.891632723 |

Table 33. *Replaceability*

Table 33 Replaceability shows that the EzPay is irreplaceable. EzPay will be changed if and only if the proponents will edit the EzPay.

Based on the overall results of the survey acquired by the proponents that is shown in the tables, the user rates the system mostly with five (5) which corresponds to Excellent. The results only mean that users are satisfied with how the Mobile app works and how the appearance looks.

Out of the different functions and features indicated in the Google Form, Confidentiality has the highest score and on the other hand, the Recoverability has the lowest score. The problems that might probably be encountered is that once the user forget the password, there might be no way to recover the account since the password that the user inputted is hashed for security purposes. To ensure that the system works properly, the proponents allow some experts in the field of transportation (driver) and in the field of IT to test it. Based on the sentiments or comments of the drivers, they were satisfied with the functionality of the system. And the drivers also wished that the system would be implemented soon. The IT experts were also satisfied with the system's functionality and recommended that if ever the system would be implemented, it may need further improvement just like the integration of other payment options. In addition, internet connection may also affect how the EzPay, Fare Management System, and the Top-Up System function. Once both the user and the proponents have slow internet connection, the three (3) systems may take some time to load. But if the user and the proponents have a good internet connection, all the systems may run smoothly.

# Chapter 5: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

## Summary of the Proposed Study Design, and Implementation

The study entitled "Implementation of Haversine, Dijkstra's Algorithm and SARIMAX for Philippine Transport and Fare Collection System" that aimed to modernize and to make the manual system cashless, efficient, accurate, and convenient was developed using the server called the Goddady. The programming language used were Java and Python. SARIMAX model was used in sales forecasting, Haversine Algorithm, to calculate the distance between the initial and final location and the Dijkstra's Algorithm was used to simulate how the pathfinding algorithm works. When the user generates a QR code all the information just like distance between initial location and the destination, the fare, the kind of transportation mode the user wishes to ride, whether the user belongs to Persons with Disabilities (PWD) or not appear. After the driver scans the QR code, all the data will be recorded on the user's account. The implementation aims at a real time use of QR Code and does not put the user's personal information at stake. The use of QR code also does not comprise security. With that regard, QR code guarantees us that the study may be simple, effective, and cost-efficient.

## Summary of Findings

The thirty-five (35) respondents were given a chance to test the system and after the testing, the user answered a survey questionnaire through Google Forms. The result was automatically recorded in the proponents' email account. The overall result was in the form of Microsoft Excel. The proponents then computed the result using the Mean, Median, Mode, and Standard Deviation. After the computation, the results were interpreted. The Recoverability has the lowest score where the mean was shown at (M=3.5), and the standard deviation is 1.05169416. While the Confidentiality garnered the highest score where the mean is (M-4.705882353) and the standard deviation is 0.629064325. The main purpose of the proponents in allowing the respondents used the system and answered the survey questionnaire afterwards was to determine whether or not the system functions properly and accurately based on different circumstances. Based on the results of the survey, the system works as the proponents perceived the system to work.

## Conclusions

After testing the functionality of the system, the proponents therefore concluded that the system works as intended. The proponents successfully implemented a system that manages and monitors the fare payment, uses a mobile app that simulates how the shortest path works utilizing Dijkstra's Algorithm, and calculates the fare in accordance with the LTFB regulation's fare tariff in air-conditioned bus or not, taxis and jeepneys. The Haversine Algorithm can really determine the point-to-point distance when calculating. And the SARIMAX model visualizes the forecasting of the sales as expected. Next, the system is timely and appropriate in pandemic time since the proponents integrate a Top Up Cashless system.

## Recommendations

The following are the proponents' recommendations for future researchers.

1. Improve algorithms that are used in finding the shortest path, and predicting the future sales.

2. Use IDE that allows users to transfer codes from one IDE to another without compiling errors or is available to all devices

3. Add additional features in the system just like a notification through messages to ensure that the transaction was made.

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# APPENDICES

## Appendix A:

## Letter to the Adviser

| | | | |
|---|---|---|---|
| | INVITATION LETTER FOR ADVISER | Document No. | WVSU-ICT-SOI-03-F03 |
| | | Issue No. | 1 |
| | | Revision No. | 0 |
| | WEST VISAYAS STATE UNIVERSITY | Date of Effectivity: | April 27, 2018 |
| | | Issued by: | CICT |
| | | Page No. | Page 1 of 1 |

March 05, 2021

Evans Sansolis
Professor
West Visayas State University
La Paz, Iloilo City

Dear Madam/Sir,

The undersigned are BS in Computer Science Research 1/Thesis 1 students of CICT, this university. Our thesis/capstone project title is *"EzPay: Automated Fare Collection System for Ceres Bus Liner in Iloilo"*.

Knowing of your expertise in research and on the subject matter, we would like to request you to be our **ADVISER**.

We are positively hoping for your acceptance. Kindly check the corresponding box and affix your signature in the space provided. Thank you very much.

Respectfully yours,

1. Darle, Clarice Jane D.
2. Recabar, Bea Merr S.
3. Salcedo, Audrey B.
4. Santisteban, Tina Marie F.

PS:

*Advisers, are task to work with the students in providing direction and assistance as needed in their thesis/capstone project. They shall meet with the students weekly or as needed to provide direction, check on progress and assist in resolving problems until such a time that the students passed their defenses and submit their final requirements, as well as, preparing their evaluations and grades.*

Action Taken:
● I Accept.
❍ Sorry. I don't accept.

EVANS B. SANSOLIS
Signature over printed name of the Adviser

CC:

CICT Dean
Research Coordinator
Group
**To be accomplished in 4 copies*

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# Appendix B:

## Letter to the Technical Editor

| | | | |
|---|---|---|---|
| | TECHNICAL EDITOR'S ENDORSEMENT FORM (For Thesis Manuscript) | Document No. | WVSU-ICT-SOI-03-F11 |
| | | Issue No. | 1 |
| | | | |
| | | Revision No. | 0 |
| | WEST VISAYAS STATE UNIVERSITY | Date of Effectivity: | April 27, 2018 |
| | | Issued by: | CICT |
| | | Page No. | Page 1 of 1 |

Respectfully endorsed to the **English Editor**, the attached manuscript of the thesis entitled:

"Implementation of Haversine, Dijkstra's Algorithm and SARIMAX Model for Philippine Transport and Fare Collection System"

Said manuscript was presented to me and was reviewed and edited in terms of technical specifications, correctness of diagrams and other technical matters. The corrections and suggestions was carried and implemented by the proponents whose names are listed hereunder.

Now therefore, I hereby **ENDORSE** the said thesis manuscript to the English Editor/Grammarian for **English Grammar Editing.**

Dr. Frank L. Elijorde
Technical Editor's Name & Signature

Date: ___January 25, 2022___

Group Members:
1. 1. Audrey B. Salcedo
2. Bea Merr S. Recabar
3. Clarice Jane D. Darle
4. Tina Marie F. Santisteban

Note: *This form should be accomplished and signed if the corrections and changes made by the Technical Editor have been implemented and a new copy of the document have been printed for checking and submission to the next editor.*

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# Appendix C:

## Letter to the English Editor

| | | | |
|---|---|---|---|
| | ENGLISH EDITOR/GRAMMARIAN'S ENDORSEMENT FORM (For Thesis Manuscript) | Document No. | WVSU-ICT-SOI-03-F12 |
| | | Issue No. | 1 |
| | | | |
| | | Revision No. | 0 |
| | WEST VISAYAS STATE UNIVERSITY | Date of Effectivity: | April 27, 2018 |
| | | Issued by: | CICT |
| | | Page No. | Page 1 of 1 |

Respectfully endorsed to the **Thesis Format Editor**, the attached manuscript of the thesis entitled:

"Implementation of Haversine, Dijkstra's Algorithm and SARIMAX Model for Philippine Transport and Fare Collection System"

Said manuscript was presented to me for English grammar editing, corrections has been made and the proponents whose names are listed hereunder implemented said corrections and changes in the revised manuscript.

Now therefore, I hereby **ENDORSE** the said thesis manuscript for **Thesis Format Editing**.

PROF. MARIEVIC VIOLETA
English Editor/Grammarian's Name and Signature

Date: March 14, 2022

Group Members:
1. Audrey B. Salcedo
2. Bea Merr S. Recabar
3. Clarice Jane D. Darle
4. Tina Marie F. Santisteban

Note: *This form should be accomplished and signed if the corrections and changes made by the English Editor have been implemented and a new copy of the document have been printed for checking and submission to the next editor. .*

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# Appendix D:

## Letter to the Format Editor

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# Appendix E:

## Letter to the Thesis Coordinator

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Appendix F:

Gantt Chart

| | January, 2021 | February, 2021 | March, 2021 | April, 2021 | May, 2021 | June, 2021 | July, 2021 | August, 2021 | September, 2021 | October, 2021 | November, 2021 | December, 2021 | January, 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Preparation of Thesis proposal | | | | | | | | | | | | | |
| Presentation of | | | | | | | | | | | | | |

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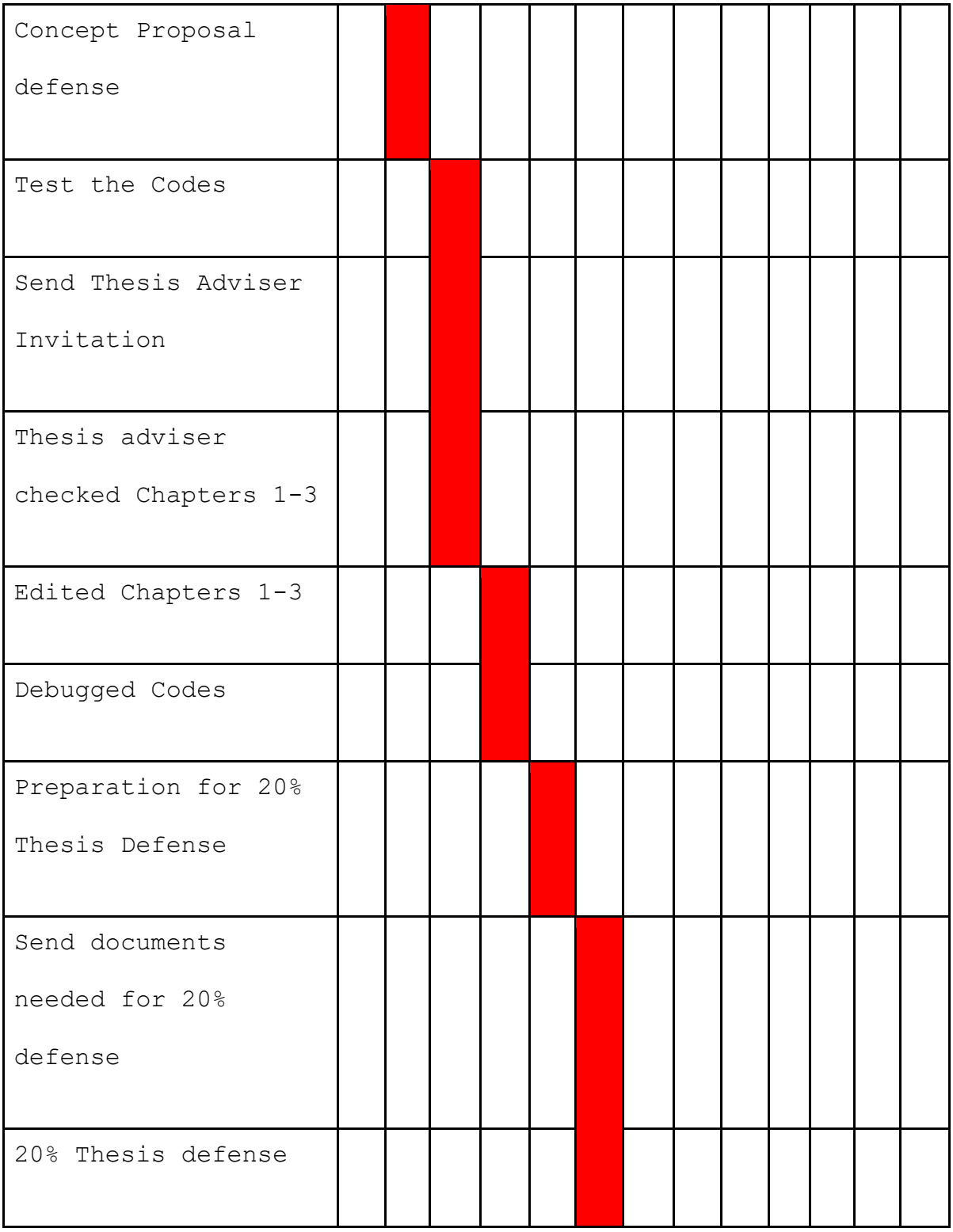

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Edited the panelist's recommendation on both the manuscript and the system | | | | | | | | | | | | | |
| Preparation for 50% defense | | | | | | | | | | | | | |
| Finalize the system | | | | | | | | | | | | | |
| Debugged the codes | | | | | | | | | | | | | |
| Create an account for the driver in the Mobile app | | | | | | | | | | | | | |
| Put the records for the driver | | | | | | | | | | | | | |
| Improve manuscript | | | | | | | | | | | | | |
| Finished the Mobile | | | | | | | | | | | | | |

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| App | | | | | | | | | | | | | |
| Preparation for the testing | | | | | | | | | | | | | |
| Finding respondents | | | | | | | | | | | | | |
| Data Collection | | | | | | | | | | | | | |
| Recording error encountered during testing | | | | | | | | | | | | | |
| Data analysis | | | | | | | | | | | | | |
| Results added to the manuscript | | | | | | | | | | | | | |
| Fixed the error based on the testing | | | | | | | | | | | | | |
| Edited the manuscript | | | | | | | | | | | | | |

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Preparation for Final defense | | | | | | | | | | | | | |
| Finalize the manuscript | | | | | | | | | | | | | |
| Manuscript editing (Grammarian, Technical editor, Format editor, etc.) | | | | | | | | | | | | | |
| Preparation for bookbinding of the Thesis Paper | | | | | | | | | | | | | |

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Appendix G:

Data Dictionary / Production Cost Estimate

- Goddady – hosting service provider which was used to host the three (3) systems which are the Mobile app or the EzPay, the Fare Management System, and the Top up System.
- Places API - is a service that allows the users to query places by Google. Places are defined within this API as establishments, geographic locations, or prominent points of interest. Places API lets you bring location context into your applications with the speed and reliability you need to scale by providing rich, accurate, point of interest (POI) data that you can trust to meet your needs at any scale.

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# Appendix H:

## Sample Program Codes / Project Charter

```
package TOPUP.View;


import java.awt.Component;
import java.sql.Connection;
import java.sql.DriverManager;
import javax.swing.JOptionPane;


public class dbConnection {
    public static Connection connect(){
        Connection conn= null;
        try{
            conn = DriverManager.getConnection("jdbc:mysql://184.168.102.151/ezpaydb","ezpaydbadmin","WvsuCictThesis2020");
            Component rootPane=null;

            System.out.println("Connected");

        }catch(Exception ex){
            JOptionPane.showMessageDialog(null,ex);

    }
       return conn;

}
}
```

This figure shows a sample code from the Top-Up system.

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Appendix I:

Software Quality Evaluation Form

Implementation of Haversine, Dijkstra's Algorithm and SARIMAX for Philippine Transport and Fare Collection System

Please rate the following software characteristics. The objective of this survey is to evaluate the quality of the developed software based on ISO Standards.

*ALL INDIVIDUAL RESPONSES WILL REMAIN CONFIDENTIAL.*

Name(Optional)_____

Gender: []Male []Female

| Scale | Description |
|---|---|
| 5 | Excellent |
| 4 | Very Good |
| 3 | Good |
| 2 | Fair |

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| | |
|---|---|
| 1 | Poor |

| Characteristics | Sub-Characteristics | Rating | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Functional Suitability | Functional completeness | | | | | |
| | Functional correctness | | | | | |
| | Functional appropriateness | | | | | |
| Performance Efficiency | Time behavior | | | | | |
| | Resource utilization | | | | | |
| | Capacity | | | | | |
| Compatibility | Co-existence | | | | | |
| | Interoperability | | | | | |
| | Interoperability | | | | | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Usability | Appropriateness recognizability | | | | | |
| | Learnability | | | | | |
| | Operability | | | | | |
| | User error protection | | | | | |
| | User interface aesthetics | | | | | |
| | Accessibility | | | | | |

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| Characteristic | Sub-characteristics | Rating | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Reliability | Availability | | | | | |
| | Fault Tolerance | | | | | |
| | Recoverability | | | | | |
| | Confidentiality | | | | | |
| | Integrity | | | | | |
| | Non-repudiation | | | | | |
| | Accountability | | | | | |
| | Authenticity | | | | | |
| | Modularity | | | | | |
| | Reusability | | | | | |
| | Analyzability | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Maintainability | Modifiability | | | | | |
| Portability | Adaptability | | | | | |
| | Installability | | | | | |
| | Replaceability | | | | | |

This figure shows the questionnaire that was used during user testing.

West Visayas State University
COLLEGE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
La Paz, Iloilo City

Appendix J

Disclaimer

This software project and its corresponding documentation entitled "Implementation of Haversine, Dijkstra's Algorithm and SARIMAX for Philippine Transport and Fare Collection System" is submitted to the College of Information and Communications Technology, West Visayas State University, in partial fulfillment of the requirements for the degree, Bachelor of Science in Computer Science. It is the product of our own work, except where indicated text.

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Bea Merr S. Recabar

Audrey B. Salcedo

Tina Marie F. Santisteban

Clarice Jane D. Darle

West Visayas State University
COLLEGE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
La Paz, Iloilo City

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West Visayas State University
COLLEGE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
La Paz, Iloilo City