Bus Tracking and Ticket Payment System for UTAR

BY

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A REPORT

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BIS (Hons) Information Systems Engineering
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DECLARATION OF ORIGINALITY

I declare that this report entitled "Bus Tracking and Ticket Payment System for UTAR" is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

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Abstracts

This project is a software based system which will be used to revolutionize the current old Utar bus system. Currently Utar is still using the traditional ticketing system and the services provided are rather poor since the bus often scale out of the planned schedule. This causes the passengers to get frustrated since most students are impatient to get to their destination. Moreover students have to eagerly wait for the bus and they can't tell the estimated time of arrival of the bus. Furthermore the tickets can only be obtain only in the finance block whereby students have to walk a distance just to get the tickets and what's worst is the tickets are in paper form which is not green to the environment

Thus a system to solve this issues will be created compromising of three modules which are the paying module, GPS module and the information web module.

The paying module will be a web based webpage which will be used by a smartphone. The phone will be connected to a barcode scanner which will scan the student card to make the payment. The GPS module on the other hand will be used to track the position of the bus. The coordinates are obtain by the GPS sensor in the phone and the phone will process the location of the bus and then sends back to the server. Lastly the server which holds the bus information location will publish the bus location for user to keep a look out on where is the bus latest location.

The paying module, GPS module and the information web module will be integrated and the system should be able to provide a better bus service for the students and the management level. The output material of the project would be asp/jsp dev tools and eclipse mobile.

LIST OF TABLES

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

LIST OF FIGURES

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

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LIST OF ABBREVIATION

UTAR   Universiti Tunku Abdul Rahman

CCTV   Closed-circuit Television

GPS   Global Positioning System

RFID   Radio-Frequency Identification

IT   Information Technology

ID   Identification

GUI   Graphical User Interface

DSA   Department of Student Affairs

KL   Kuala Lumpur

IDE   Integrated Development Environment

OS   Operating System

JSP   JavaServer Pages

ASP   Active Server Pages

CPU   Central Processing Unit

GLONASS   Global Navigation Satellite System

RAM   Ramdom-access Memory

ERD   Entity Relationship Diagram

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

Contents

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

Chapter 1: Introduction

1.1 Overview

Bus is one of the most preferred public transport in Malaysia. With its cheap rates and comfortable rides, most bus user are satisfy to travel in a bus no matter its long distance or short distance. In Malaysia, most of the bus are equipped with high tech gadgets eg wifi, CCTV, GPS tracker, advertisement screens and card payment system. What will be concentrated in this overview will be GPS tracker and card payment system. GPS was first introduce in the 1959 by the navy to locate submarines and in the 1963, its used to locate vehicles (Sullivan 2012) which is similar to how we use GPS these days. The GPS (Global Positioning System) is a system which uses satellite in the users air space to get the user location and sometimes it is also use to obtain time or weather. GPS works by obtaining data from a minimum of 4 satellite which will be used to triangulate the position of the user on earth surface (Yao 2002). Extra signal from the satellite will be used to improve the accuracy of the user's location. GPS also can only work if there are no obstruction on the line to the satellite. For example, if a person is in a building, most likely that person won't have any signal from the satellite since there are obstruction which is the building itself. The GPS will type which will be concentrate will be GLONASS which is The Russian Global Navigation Satellite System. Most smartphone in Malaysia are using GLONASS to run. There are other system available out there such as India's Indian Regional Navigation Satellite System, European Union Galileo positioning system, and the Chinese BeiDou Navigation Satellite System but GLONASS is used since it has the complete coverage of the globe.

Another section which will be concentrated in this overview is the card payment system. In Malaysia, there are various payment method which are available for example by using touch and go, Master card, Visa Card and Rapid Bus card. These cards usually implement microchip technology, RFID, or magnetic strip for authentication purposes. When a user uses the card, data in the cards will be collected by the terminal and the data are processed to see if the card is valid or not. These cards are preferred by most since in compared to cash, cash tend to attract more crime (Russell 2014).

In UTAR there are several mode of transport to the university. These mode of transport includes car, motorcycle, bus, e-bike, bicycle and by foot. However the main mode of transport are bicycle

and bus since parking for cars and motorcycle are limited while e-bike are not affordable for some individuals and by foot, the individual would be tired before reaching the university. UTAR bus service started since 2007. The ticket price was 70 cents at first which soon increased to 80 cents due to increase in petrol price. The bus operates from Monday to Saturday weekly and the bus operates from 7.00am to 9.00pm. The bus will also operate if there is an event or if there are any field trips organized by UTAR clubs or society. The bus usually shuttle within Eastlake, Westlake, Kampar new town and the bus or train station. According to DSA, currently the bus is sufficient but in the future there will be more bus allocated in the Perak campus.

1.2 Problem Statement

Currently there are few main issue which is faced by the bus service in UTAR. The problems include:

1. **Bus Delays-** One of the most noticeable problem is at peak times, the bus are often off from the scheduled time. Assume a bus which is supposed to reach bus stop one at 6.00p.m, the bus might delay around 15-45 mins depending on the situation. This is mainly because there are traffic jams along Jalan University as a lot of students are also on their way back contributes to them jam since a large number of students are driving a car. Not to mention one of the road lane are also being obstructed by hawker stalls along the road and some people park the car along the road to go fishing or do any recreation activity along the lake. The guards in the housing area are also forcing residents who are using car without resident card to fill in forms to log their entry, car number plate, vehicle owner name and house number. This contribute to a long wait and queue along the road. Not to mention, most cyclist also dominate the road these days since most of the time the vehicle have to stop for the cyclist instead of cyclist waiting for the vehicle to pass. This upsets a lot of student as some student can't reach their destination in time. Students also may no longer estimate the time or the bus arrival. The inconsistent schedule also contribute to more students waiting at the bus stop. Some students even need to wait for the second bus before they can catch the bus as sometimes the bus are overload and can't fit all the students which are waiting in the bus stop. Some on the other hand have to wait a long period of time in the bus stop since they might not know that the bus just left that stop. It is also said that if a person is waiting in a bus stop and not doing anything, the waiting time feels longer than the actual time itself which makes student feel even more uncomfortable when waiting for a bus in the bus stop (Norman 2008, p 7).

2. **Paper ticketing-** Another problem is students are required to use traditional printed paper tickets to pay their bus trips. Using these paper tickets are not green to the environment since paper are constantly used to pay the rides. Besides that, the ticket booklet also consist of one piece of unused paper which serve as the foundation of the ticket booklet. This piece of paper is sometimes not disposed properly by the students and contribute as rubbish in the bus or bus stop itself. According to Macia` Mut-Puigserver, production of paper tickets are low but in great amount, the cost can be taken into account. (Mut-Puigserver 2012, p 925). In the end, these tickets are not reused and disposed to recycling bins only making the ticket a onetime use only. The tickets are usually sold in a stack of 10. The stack of tickets are around 2mm in thickness which occupies quite some space in wallets or purse. Besides that the tickets are also easily separated from the stack since the glue holding the tickets together are not strong and often cause a mess in the wallet or purse. Moreover to buy these tickets, student have to go all the way to Block F to get the tickets. It's the only place to get bus tickets in UTAR.

UTAR is a well-known studying institute since UTAR is ranked in one of the top 300 Universities in Asia by QS University ranking (QS University Rankings: Asia 2013). To live up to that name, the university technology infrastructure should be as advance as possible since it can promote a better learning environment. UTAR have quite a number of advance technology infrastructure for example they have a Huawei lab, Microsoft lab and etc.

However UTAR bus service are still not up satisfaction level and did not meet most of the expectation. The bus service is considered very inefficient and is still using traditional ticketing system. Besides that there are a lot of improvement that can be implement to the current traditional bus system which is currently still running in UTAR. With all these issues, certain technology could be implemented to the system to improve the system future.

Thus a system on the bus system will be developed and implement to improve the bus system and at the same time hope the system can improve the bus user experience

1.3 Project Objectives

As mention in Problem statement, the bus service has a lot of room for improvement. Thus a system is created for the bus service to solve this issues which includes the following features which are also the objective of my project.

1   **To implement a digital payment system to replace traditional paper ticketing system by using the student card** - The current payment system is by using traditional paper ticket and it will be replace with digital payment system. The digital payment system refers to payment of the bus ticket through Identification Card since all student have one and it is also unique among all the student and staffs. Besides that, the card has a barcode which can be utilize together with a barcode scanner to make the payment.

2   **To create a system which is able to pin point the bus location for administration purposes** – A smartphone with GPS and GSM/EDGE/HSDPA/LTE (internet network) capability will be place in the bus. The smartphone will be pinging back the location of the bus back to the server in a specific interval with the help of GSM/EDGE/HSDPA/LTE. The server will than record these data which will be uses for bus location display purposes.

3   **To create a system which publish the bus location for user to track the bus location** – Since the server has the records on the bus location, the server will post the location of the bus on the bus tracking webpage which allows the user to track the bus location according to real-time.

With these objectives, it is hoped that the system can be used to solve the problems based on the problem statement.

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

1.4 Project Scope

The system will be used by two categories of people which are the students and administrators. Both will have different level of authorisation which allows the user to either read, write or update the information in the system. Basically the system have two main implementation which are digitalising the ticketing system to replace the old ticketing system and the other implementation is using GPS to locate the bus location.

i.   The system should be able to authenticate the student card based on the barcode. The student just have to flash their card on the bar code scanner and the details on the student should be displayed for authentication purpose.

ii. The system will allow student to use their student card to pay their rides. The system should be able to retrieve data based on the student ID and update the data accordingly if the student uses the bus.

iii. The system should be able to record the user rides, time of usage and location. As the student uses the bus, the additional data are recorded together for future references.

iv. The system should include a simple user interface for staff to do reload service for the student. The system should also include checking balance money stored in the student card.

v.   The system should be able to accommodate GPS. Since the system relies on GPS and at the same time the system is built on mobile platform, the system should be able to read data from the GPS receiver.

vi. The system should be able to update the bus location. As the bus moves, the position of the bus is constantly changing and the system should be able to keep track on these movement.

vii. The system should be able to post up the bus location periodically in the form of webpage which is readily access by any device.

1.5 Impact, Significance and Contribution

With this system which have been proposed, firstly it stand a chance to improve the ticketing system. The university can cut cost on print of tickets since long term printing of tickets are more expensive in compared to implementing a simple system. Moreover elimination of using traditional paper ticket are also green to environment since used ticket end up in the recycling bin. Moreover this also promotes student to bring or wear their student card along with them since its being used for payment. Besides that students also don't need to carry a stack of tickets with them since it occupies space in their wallet or can be easily misplaced. Students can also reload a large amount of money onto their card too. It will also improve the university image which utilize simple yet advance system.

Security will also improve since non-UTARian will no long able to access the bus since an authentication card is needed compared to last time, a person only needs a ticket to board the bus regardless if he or she is a UTARian. The bus driver also will no longer need to collect the bus ticket which simplify the bus driver job. With the system also, the admins can mine data from the data collected from the system for example the admin can track how frequent a student use a bus or is the student still using the bus service after a certain time.

Besides that, with the tracking system being implemented, the system will broadcast the bus location which will allow students to plan their time better before going to the bus stop. Thus students don't need to wait at the bus stop for a long time since some intervals can be as long as 30 minutes to 45 minutes. Students also will get to check their balance online.

Chapter 2: Literature Review

2.1 Introduction

Bus is one of the main public transportation in the world. Nearly every part of the world offers bus services because it's one of the cheapest mode of transport and it's also reliable. It may be cheap and reliable as it gets the passenger to its destination but the question arises is how efficient it is and will the bus management system be good enough to leave a good impression on the user. Service is important since it promotes repeat business which will contribute to greater sales and profits (Suttle n.d). Most bus system are still using traditional payment method except for Rapid KL and Rapid Penang which allows user to pay using their cash card like Touch and Go. Moreover, a lot of busses only provide a timetable on the bus which is often not followed since the traffic condition and the number of stops by the bus will upset the time predicted on the time table.

Digital payment system for busses are rather common around the world but GPS tracking system for busses are rather not so common since most companies thinks that bus tracking is unnecessary for bus users. However, there are some university which have implemented these tracking system on their university busses for the convenience of the student. A total of 5 university have been identified which uses this tracking system which are:

➤ Western Michigan University (located at Kalamazoo, Michigan, United States)
➤ Lehigh University (located at Bethlehem, Pennsylvania, United States)
➤ University of Rochester (located Rochester, New York, United States)
➤ Nanyang Technological University (Singapore)
➤ National University of Singapore (Singapore)

2.1.1 Western Michigan University
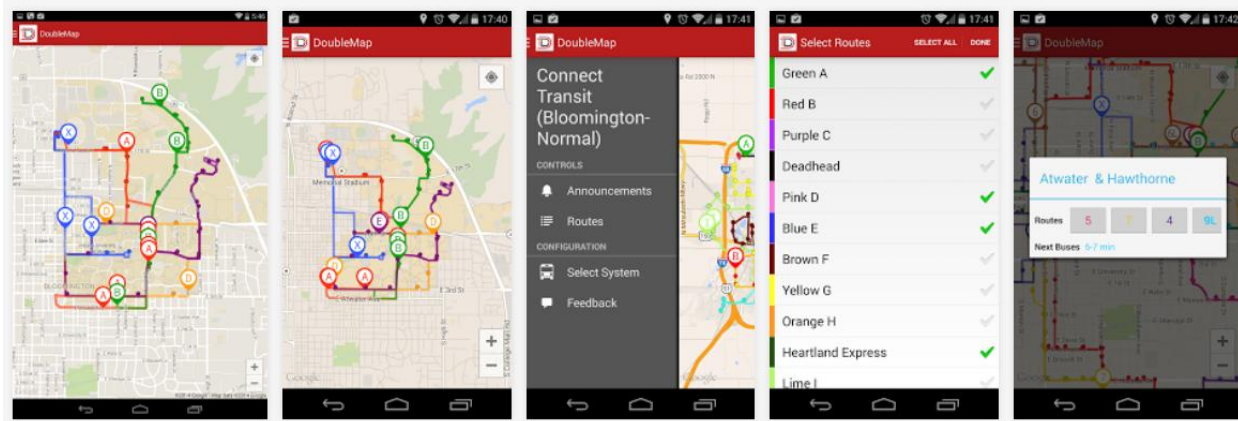
Figure 2.2.1: Western Michigan University bus system app screenshot

Firstly Western Michigan University implements their tracking system based on mobile apps which is limited to IPhone or Android phones only. The good thing about the mobile apps is they are lighter on the device compared to tracking based on desktop pages. The app allows users to customise the highlighted route for easy screening which is convenience for the user. However when the app starts, all the route and busses are highlighted which can confuse users since there are a number of route and busses. The user have to un-highlight the unwanted route before they can see clearly on their bus which they are after. Besides that the university block are not highlighted for user to see and doesn't allows user to visualise how the map orientation is like. There is also no table which simplify the location of the bus location. However there seems like there is no option to view the buses on desktop since only mobile app is only offered. There is also no information regarding the bus distance from one location to another. A table to display all the bus at its respective location is also not available. (Western Michigan University webpage 2015)

2.1.2 Lehigh University
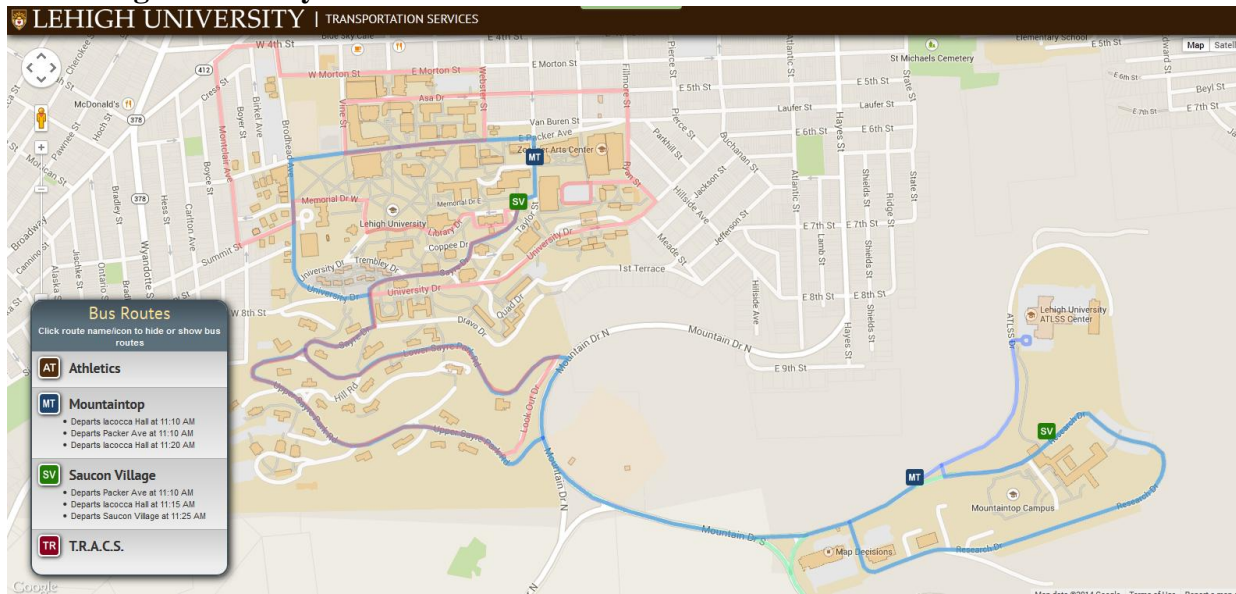
Figure 2.2.2: Lehigh University bus system screenshot

Second we have Lehigh University which implement their tracking system based on desktop environment. The system is very simple and clear to see as shown in the figure above mainly because the university blocks are located far apart and there are not much bus route. Moreover the system also shows the departure time from each location according to the bus destination. Besides that, the bus speed, last stop, current location will also be displayed if the bus is being clicked. However there is no mobile app for mobile device which may be a disadvantage since when a mobile phone is used to track the bus, the page is slow and laggy because of layers of api and application layers running on the web page which makes it not feasible to view in a mobile device. Again the map dosen't show more details on the building blocks in the university. As we can see in the map, the university have only one highlighted building for example Mountaintop campus. The page dosen't mention anything on the distance left of the bus current location to another location. A table to display all the bus at its respective location is available in the corner left. (Lehigh University webpage 2015)

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

2.1.3 University of Rochester
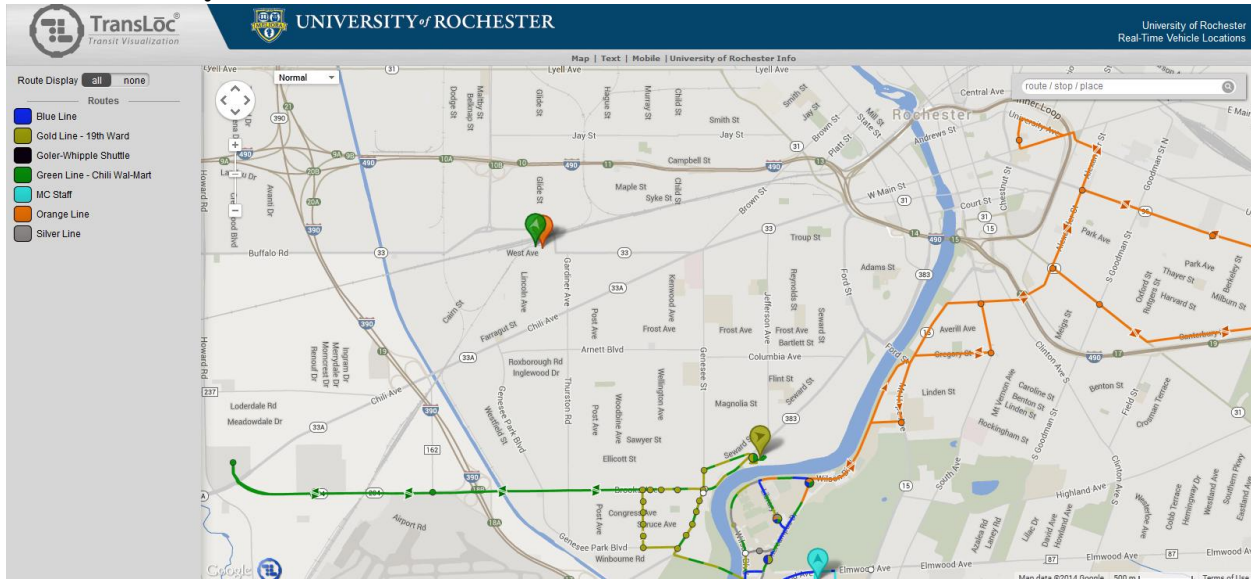
Figure 2.2.3: University of Rochester bus system screenshot

Thirdly we have University of Rochester which implement their system on desktops and mobile device at the same time. The advantage of this system is that we can see the bus direction heading to which location and coupled up with the highlighted route, one can easily determine the bus destination. The user can also check if the bus load if the mouse is hovered to the bus symbols. However the system doesn't show if the bus is in stationary position. After observing for some time, some bus position just remain at its same position for quite some time which make the data accuracy questionable. Moreover the bus can be out of route as shown in the figure above makes it even questionable. Again in the map, there is no labelling on the university building. A table to display all the bus at its respective location is also not available. There is also no details on the distance left from the bus to another location. There is also no estimate time of arrival of the bus to a specific location. (University of Rochester webpage 2015)

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

2.1.4 Nanyang Technology University
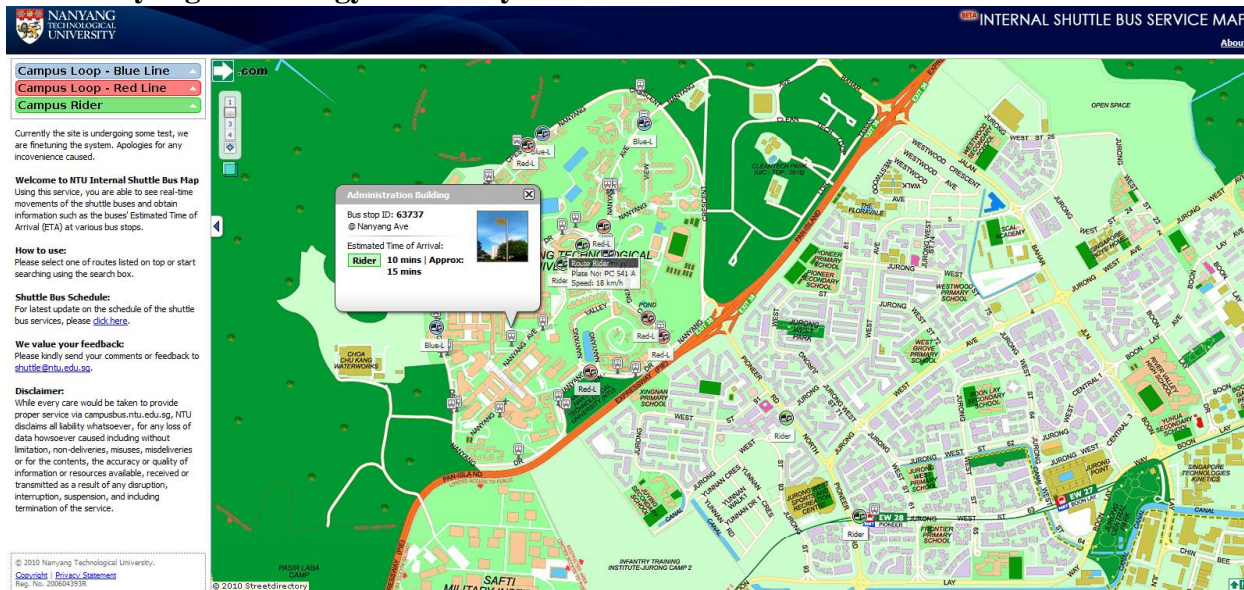
Figure 2.2.4: Nanyang Technology University bus system screenshot

Fourth we have Nanyang Technology University which implement their bus system based on desktop view. Just like others, the route of the bus can be viewed by clicking on the top left options. However there is no dedicated application for smartphone and it can only be browse through mobile brower. When a mobile is use to access the page, the user can only select the bus and information will be displayed. There is no map available for guidance. The main advantage of this system is the map is very detailed since every single building in the university is labelled which is good to guide students and allows the students to visualise the map easier. The webpage does not show the distance left from the bus to another location. A table to display all the bus at its respective location is also not available. When the bus operate, the route of the bus will be highlighted. (Nanyang Technology University webpage 2010)

2.1.5 National University of Singapore
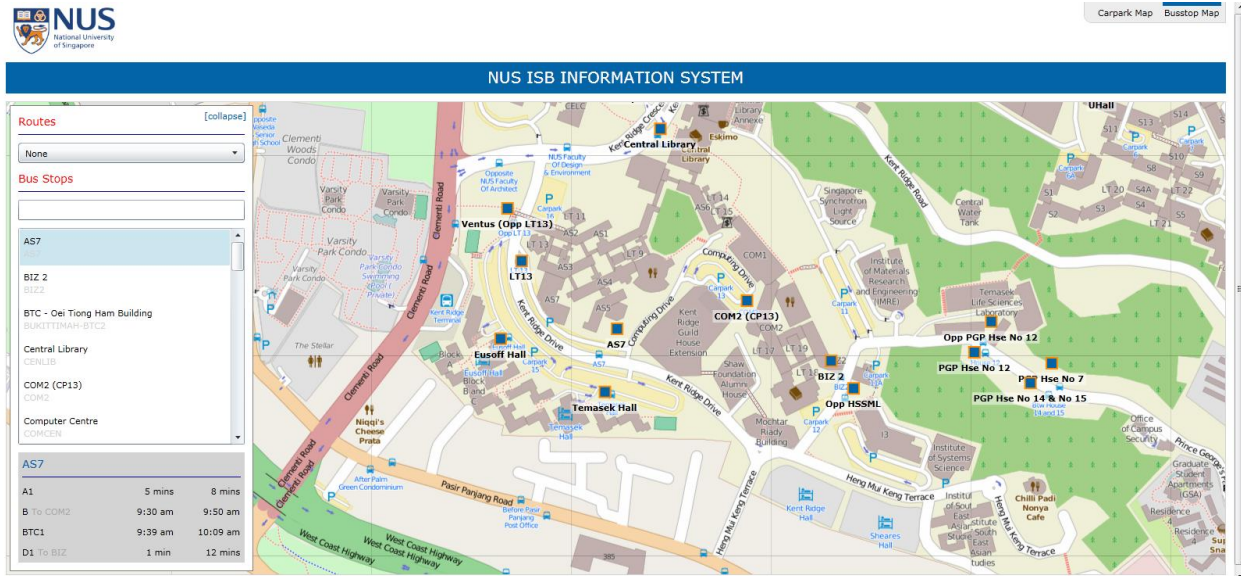
Figure 2.2.5: National University of Singapore bus system screenshot

Lastly we have National University of Singapore. They implemented their system on both mobile and desktop. Compared to the rest of the system, this system have some of the most complete features eg routing, detailed map and estimated time of arrival. Besides bus system, they also implemented car parking map together with how many car park slots available which is impressive. The system have a lot of features but for the mobile version, a lot of user have issues with the app. According to google play store, a lot of students face timing issues which are generated. The system also provide the information on the distance left from of the bus to the next location and a bus location table. (National University of Singapore webpage N.D)

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

2.2 Systems Comparison

University / Feature	Western Michigan University	Lehigh University	University of Rochester	Nanyang Technological University	National University of Singapore
Mobile app	√	X	√	X	√
Display on desktop	X	√	√	√	√
Estimate time of arrival	√	√	X	√	√
Distance left	X	X	X	X	√
Bus Route	√	√	√	√	√
Bus Location Table	X	√	X	X	√

Table 2.2.1: Features on different university bus system

As the table shows, all the system have its strength and its weaknesses.

Western Michigan University, University of Rochester and National University of Singapore have provide their services through mobile app while Lehigh University and Nanyang Technological University have not offered any mobile service. As a student, mobile accessibility is important since not all the student will be tracking the bus from their home or track from their laptop. Currently as a student, nearly 90% of the university students are using smartphone and most of it are high end phones since Malaysia tend to spend a lot on phones. All these phone can either be Windows, IOS, or Android which supports various apps or webpage. Most would preferred to just use their smartphone and track the bus using their phone since it's easier and faster.

University of Rochester, National University of Singapore, Lehigh University and Nanyang Technological University provide desktop web services on their bus tracking but Western Michigan University didn't not offer any desktop web services on their bus tracking. Desktop web services on their bus tracking is important since its considered as one compulsory value added feature since it provides alternative to track the bus. Besides that user who do not wish to install the mobile app can go to these webpage to track the bus instead since most smartphone are capable of viewing webpage just like a desktop although user experience may not be too good since it may not be smooth.

Western Michigan University, National University of Singapore, Lehigh University and Nanyang Technological University have all implemented the feature to track the estimated time of arrival of the bus while University of Rochester did not implement this feature on the system. In Kampar, to determine the exact time of arrival is relatively hard since there are a lot of external factors such as vehicle jam along the main road, traffic light, high volume of cyclist crossing road and peak time. All these factors are not controllable and estimating the time of arrival will be hard to predict. At the same time predicting a wrong time for the bus arrival would mean that students will no longer trust the estimate time of arrival feature on the system. This may also give pressure to the bus driver since the bus driver have to try to fulfil the estimate time of arrival.

Western Michigan University, Lehigh University, Nanyang Technological University and University of Rochester all did not implement the feature to track the bus distance to the next bus stop while National University of Singapore implemented this feature. Tracking the bus distance

25

to the next bus stop is just a value added feature since it's not really significant to students since students knows the bus location already by tracking on the bus. Moreover students might not be good at estimating the distance in meters or kilometres measurement. Estimating those length is not going to be easy.

Western Michigan University, Lehigh University, Nanyang Technological University, University of Rochester and National University of Singapore all have implemented the feature to display the bus route. It is important since it indicates the bus will be going to which location and which location will the bus stop.

Lehigh University and National University of Singapore have implemented a simplified table to display the location of the bus while Western Michigan University, Nanyang Technological University, University of Rochester did not implement this feature. In my opinion a table to display the bus location is important since it provides simplified information and easy to see. If compared to a map, a student must first find for his/her bus then after finding the bus, he/she have to see where is the bus by interpreting the map. Then after finding out the where is the bus, he/she have to estimate time to reach the bus stop where he/she is waiting. In compared to table, with the relevant details such as the bus number, route, location would make understanding it easier and clearer especially for those who are not good with reading maps.

2.3 Review Conclusion

In conclusion, based on most of the review on the bus systems, most of the system implement estimated time of arrival, distance left to arrive, and a map to locate the bus. These features are no doubt good but the accuracy of these data are questionable since as we know the traffic condition varies and the number passenger also can contributes to the changing factors. After seeing a lot of comments on each system, it can be concluded that all the system have issues with the inaccurate arrival time which makes student doubt the system.

 Therefore this project intend is to create a more simplified system for notifying the students on the position of the bus and at the same time integrating an added feature which is digital payment system which have yet to be implemented on UTAR bus system.

Chapter 3: Proposed Method/Approach

3.1 Methods

3.1.1 Software Methodology

- Prototyping

In this project, I will be using Prototyping model as my choice of software development methodology. The process includes planning, analysis, design, implementation and system prototype.

The prototyping model is illustrated as follow
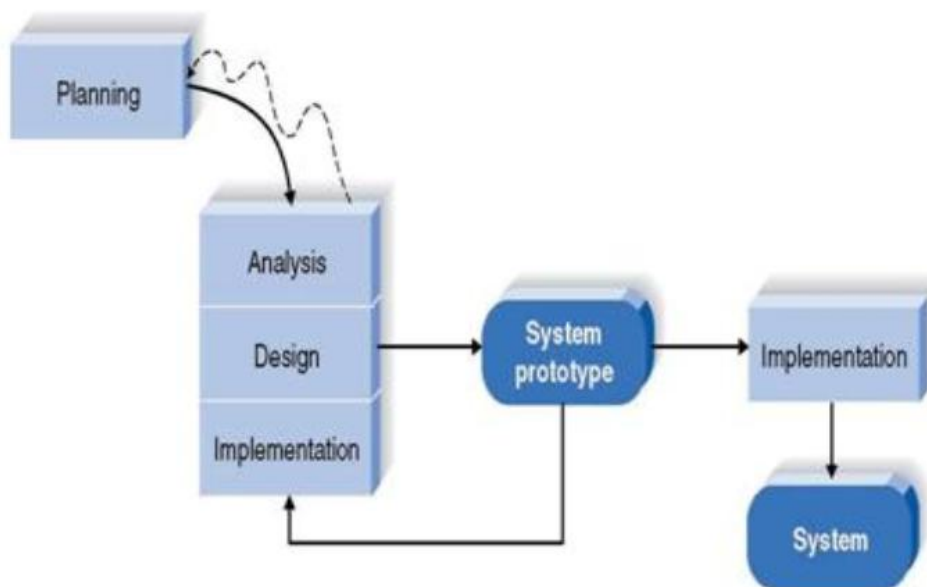
Figure 3.1.1 Prototyping model

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Faculty of Information and Communication Technology (Perak Campus), UTAR

Prototypes are built by using the know requirements. Through prototyping, user will get to know the system better since they can get to test or try the system hands on which promotes better understanding. This will lead to a more accurate approach to make the desired system.

The **advantage** of prototyping includes:

1. More actively involved in development
2. Working modules on the system are constantly developed and this allow testing by user which promotes better understanding on the system development
3. Detection of errors earlier
4. Allow quicker user feedback which lead to better solution
5. Missing feature or functions can be identified
6. Problematic function can be detected

The **disadvantage** of prototyping includes:

1. Implementation and repair implementation not so ideal
2. May increase the complexity of the whole system in terms of scope
3. Expanding beyond proposed plans

3.1.1.1 Prototype 1

Firstly, the project background, literature review, project scope and objectives, methods and technologies are identified. After that, the 1st prototype will be which is implementing the GPS tracker on the system. The requirement of the 1st prototype will include as bellow:

a. Creating GUI for display purpose
b. Collecting coordinates of all the road and building blocks for displaying location purposes (eg, block A coordinates from [2.997-101.786] to [2.301-101.798])
c. Implementing GPS on system
d. Displaying the specific location of the vehicle based on the GPS coordinates.

After the 1st prototype is completed, the system will be tested based on real data. The system will be tested in every location which is covered by the bus to see if the location displayed is valid.

3.1.1.2 Prototype 2

After the 1st prototype, the project continues with the next objective which is the digital payment system. The requirement of the 2nd prototype will include as below:

a. Creating GUI which is able to interact with user
b. Creating the system where it can connects to database for read, write and update purposes
c. The system is capable to read student's card barcode using barcode scanner

After the 2nd prototype is completed, the prototype is checked for bugs and test data are constantly input to see what data output will be obtain so that checking can be done.

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

3.1.1.3 Prototype 3

After the 2nd prototype, the project continues to the last objective which is adding auto publishing on the bus location periodically. The requirement of the 3nd prototype will include as below:

a. Obtaining location data from previous prototype and post it to the internet which is accessible for all student
b. Integration of the whole system
c. Full system implementation

After the 3rd prototype is completed, the system will be check if the data posted into the internet can be accessible by other parties.

Figure 3.2 Gantt chart 1

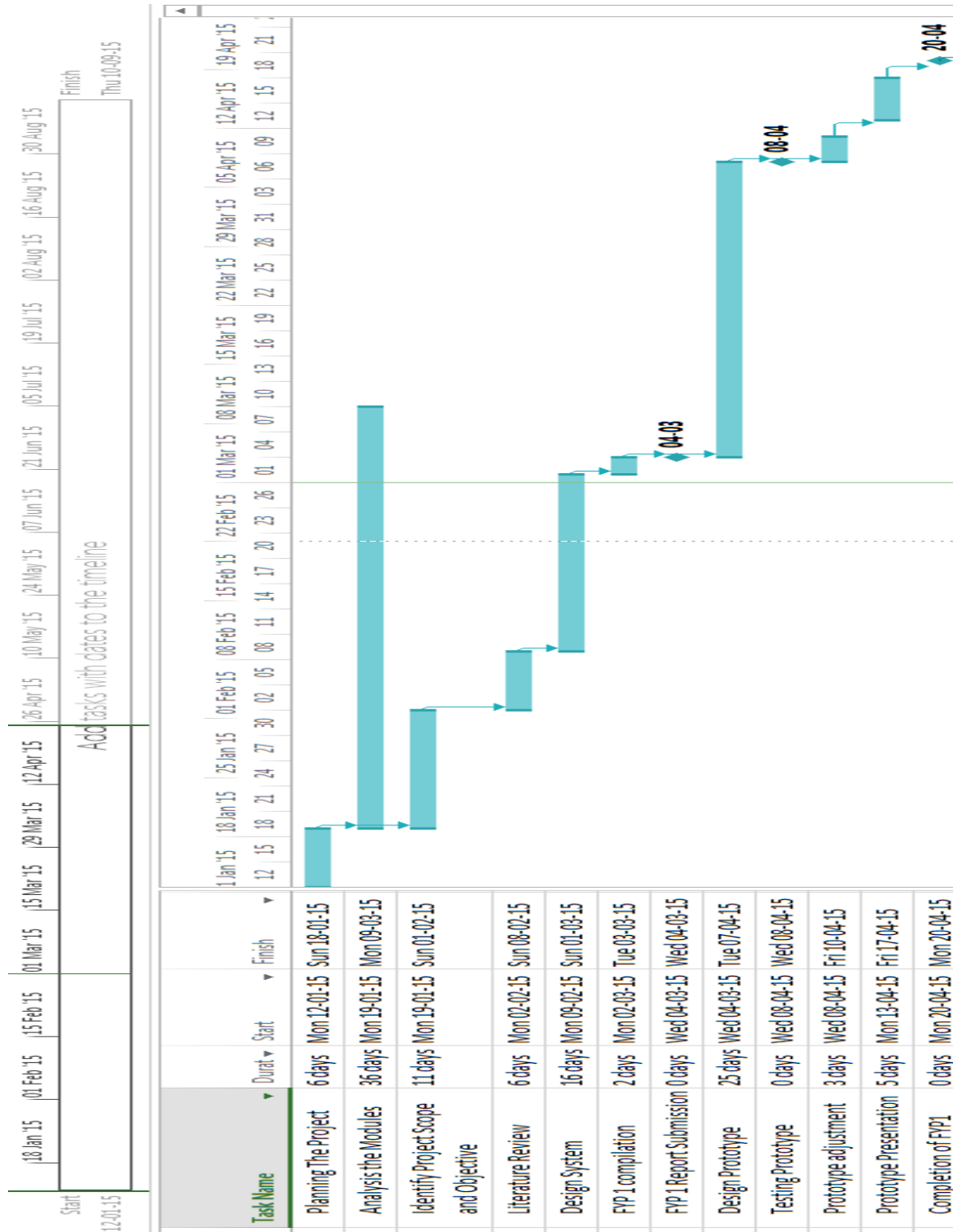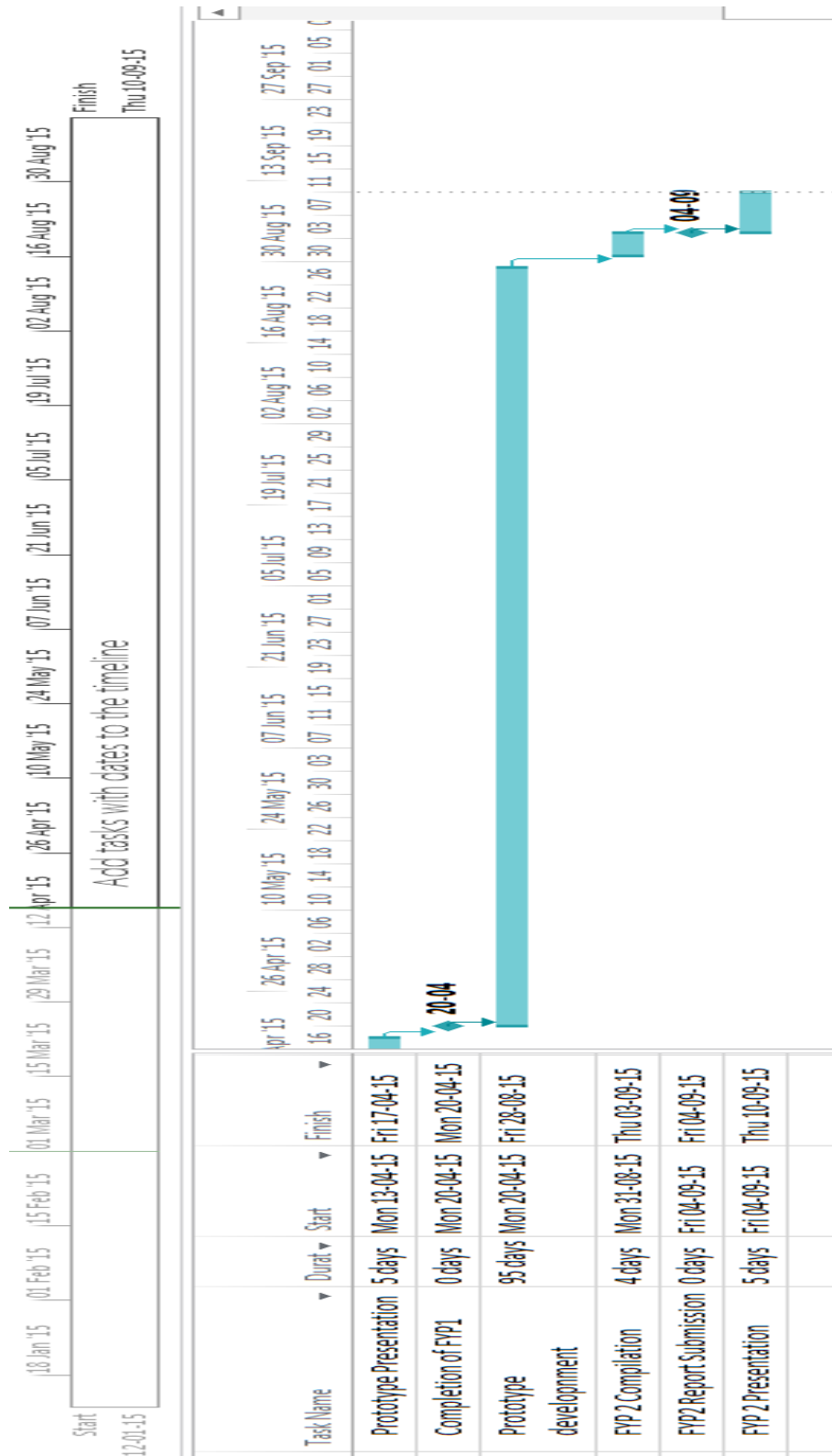BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

Figure 3.3 Gantt chart 2

BIS (Hons) Information Systems Engineering
Faculty of Information and Communication Technology (Perak Campus), UTAR

3.2 Required Tools

3.2.1 Software

- Eclipse
  - ➤ Eclipse developed by eclipse foundation is use to write java codes on Windows, Mac, or Linux environment. It is based on an integrated development environment (IDE). Eclipse is chosen mainly because it provides various types of emulator for testing purpose.

- Windows 7
  - ➤ Windows 7 is chosen mainly because its availability and its more user friendly compared to any other available Windows version (Salisbury 2009). Another thing is that eclipse can easily run on Windows 7 provided there is java runtime environment which can be readily accessed by myself.

- Android OS 4.3 Jellybean
  - ➤ Android 4.3 Jellybean is chosen because of the selected phone use for testing will be based on this OS. Android is chosen also because most people are using Android over other OS (Smartphone OS Market Share,2014).

- Bluestacks
  - ➤ Bluestacks is software which can virtually run Android OS in Windows 7. It can be used for testing purposes after each prototype is developed.

- Visual Studio / Netbean
  - ➤ Both these software will be used to create the webpage which will be either in jsp, php or asp.

3.2.2 Hardware

- Qualcomm Snapdragon 400 chipset
  - ➢ The phone which will be used to test the prototype will be XiaoMi 1S which runs on snapdragon 400 chipset. With a total of 4 ARM® Cortex™ A7 CPU coupled up with Qualcomm® Adreno™ 306 GPU and 1gb of ram, it is more than sufficient for the software to run. Qualcomm is one of the top in the mobile industry and their products have been widely used in a lot of flagship smartphone (Savov 2014). Thus its reliability is not questioned.

- GPS sensor
  - ➢ The GPS sensor from the phone should be able to get the coordinates on the location. The XiaoMi 1s also has GLONASS ("Globalnaya navigatsionnaya sputnikovaya sistema" or "Global Navigation Satellite System") support which is use to speed up the location locking. With GLONASS, it is more reliable and has a higher success rate of locking the location (Pan 2014, p.17530).

- Computer (desktop)
  - ➢ A computer with a minimum specification of Intel i5 processor coupled up with 4GB ram should be sufficient to do the coding in eclipse and to emulate an android environment.

- Bar code scanner
  - ➢ A scanner will be used to attach to the phone to be used to read barcode on the student matrix card

Chapter 4: System Analysis and Design

4.1 Use Case
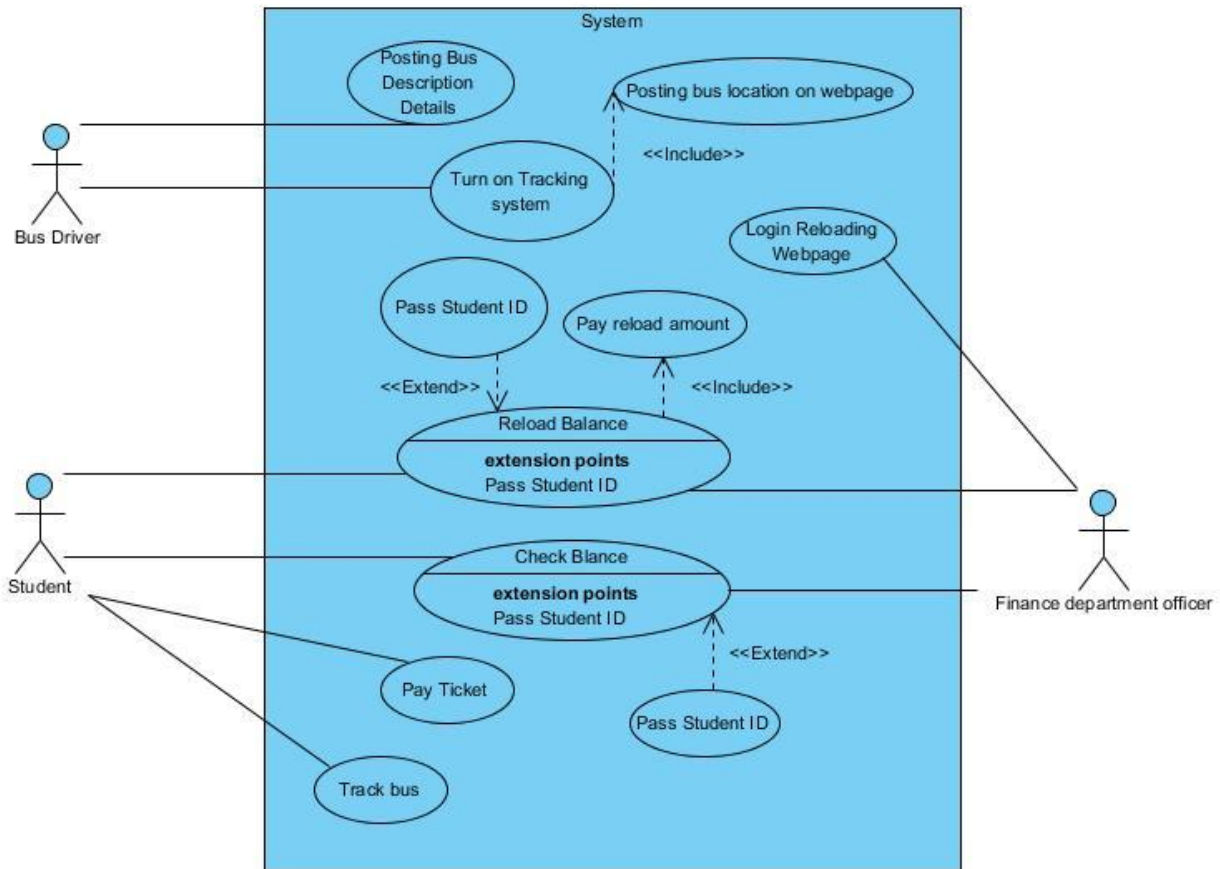
Figure 4.1.1 Use Case Diagram

As shown in the use case in figure 3.3.1.1, there are 3 actors which are the bus driver, student and finance department officer. Each and every actor has its own use case respectively.

The bus driver have two use case which are posting bus description details and turn on tracking system. In posting bus description, the bus driver is supposed to key in the respective details on the bus for example bus route, bus number, bus number plate and bus driver name so the system can initialize a session. In turn on tracking system, the system will work by its own on tracking the bus position and at the same time posting back the bus position to the server for webpage publishing purposes.

The student on the other hand have 4 use case which are reload balance, check balance, pay ticket and track bus. In reload balance, the student can go to the finance block and reload their balance informing the finance staff on the amount to be reloaded. The student will have to pay the finance staff when the reload is done. The student can opt to pass the student card to the finance staff to reload their balance or they can also mention the student id. Check balance is for student to check their remaining balance. Student can go to the finance staff and ask them to check their balance in their account. Pay ticket if for the student to pay their ticket when they board the bus. The student just need to flash their student id on the bar code scanner and the system will check the balance on the database server to see if the student have enough balance to pay for the trip. Lastly the student can also track the bus which will be in a form of webpage. The system will update the webpage on the position of the bus in 10 second interval.

Finally the finance department officer have three use case which are login reloading page, reload balance and check balance. Before the finance department office can reload or check balance for the student, he/she have to first login. A login page will first be load and the finance department officer have to key in the details and see if the details match the records. If all the details match, the login page will redirect to the check balance and reloading page. On reload balance, the finance department officer have to key in the student id on the reloading page and the amount paid by the student on the reloading page before submitting. On check balance, the finance department officer just have to get the student id and when submit, the webpage will load on the details on the student's balance.

4.1.1 Use case specification

Use Case Name: Posting bus description details	ID: 1	Importance Level: Medium
Primary Actor: Bus Driver	Use Case Type: Detail, Essential	
Stakeholders and Interests: Bus driver – key in the respective details on the bus for example bus route, bus number, us number plate and bus driver name so the system can initialize a session		
Brief Description: This use case describe how the bus driver initialize a session		
Trigger: Bus driver starts operating in the bus to fetch other student and starts the tracking system. Type: External		
Include: Extend:		
Normal Flow of Events: 1. The bus driver boards the bus. 2. The bus driver on the smartphone and starts the application. 3. The bus driver key in the bud driver name, bus route, bus number, bus number plate and driver name. 4. The application starts and turn on the tracking system.		
Alternate / Exceptional Flows:		

Use Case Name: Turn on Tracking System		ID: 2	Importance Level: High
Primary Actor: Bus Driver		Use Case Type: Detail, Essential	
Stakeholders and Interests: Bus driver – turns on the tracking system before the journey starts			
Brief Description: This use case describe how the tracking system works.			
Trigger: Bus driver starts operating in the bus to fetch other student and starts the tracking system. Type: External			
Include: posting bus location on webpage Extend:			
Normal Flow of Events: 1. The application starts when the bus driver turns it on. 2. The application starts the GPS module. 3. The application locks the bus location and changes the coordinates into location names.[A1] 4. The application sends the location name back to the server to update the records.			
Alternate / Exceptional Flows: [A1]: If the location coordinates are outside parameters which are keyed in, an error will be display.			

Use Case Name: Reload Balance		ID: 3	Importance Level: high
Primary Actor: Student		Use Case Type: Detail, Essential	
Stakeholders and Interests: Student – wants to reload their student id to pay for bus ticket Finance department officer – does the reloading session for the student			
Brief Description: This use case describe how the student reload their id and how the finance officer authorize the reload.			
Trigger: The student want to reload money into their card for further use Type: External			
Include: pay reload amount Extend: pass student id			

Normal Flow of Events:
   1. The student wants to reload their id.
   2. The student goes to the finance department and tell the finance department officer that he or she wants to reload his or her card.
   3. He or she passes the amount which he or her wants to reload
   4. He or she can either give their student id or tell the finance department officer their student id
   5. The finance officer loads the reloading page
   6. The finance officer keys in the id and the amount which is paid by the student
   7. If all the information is correct, the finance officer submit the information
   8. The server updates and sends back the updated record and display on the reloading page
   9. The finance officer then pass back the student id and tell the student on the updated balance			

Alternate / Exceptional Flows: -			

Use Case Name: Check Balance	ID: 4	Importance Level: medium
Primary Actor: Student		Use Case Type: Detail, Essential

Use Case Name: Check Balance	ID: 4	Importance Level: medium
Primary Actor: Student	Use Case Type: Detail, Essential	
Stakeholders and Interests: Student – wants to check their student id balance Finance department officer – helps the student to check their balance		
Brief Description: This use case describe how the student can check their balance in their student id		
Trigger: The student want to check their card balance Type: External		
Include: Extend: pass student id		
Normal Flow of Events: 1. The student wants to check their balance in their id 2. The student goes to the finance officer and informs the finance officer on checking their balance 3. The student then can either pass their student id or mention their student id to the finance officer 4. The finance officer loads the check balance webpage 5. The finance officer enters the student id and submits it 6. The server search for the matching record and displays the record 7. The finance officer inform the student on the current balance		
Alternate / Exceptional Flows: -		

Use Case Name: Pay Ticket	ID: 5	Importance Level: High
Primary Actor: Student	Use Case Type: Detail, Essential	
Stakeholders and Interests: Student – wants to board the bus and uses their student card to pay the ticket		
Brief Description: This use case describe how the student pays the bus ticket using their student id		
Trigger: The student want to pay their bus ticket Type: External		
Include: Extend:		
Normal Flow of Events: 1. The student wants to board the bus to university 2. The student catch a bus and boards it 3. The student flash the student id on the bar code scanner 4. The mobile webpage will send the student id information to the server to process the payment [A1] 5. The server finds the matching record and deduct the balance in the student id 6. The mobile webpage displays payment successful and display the new balance		
Alternate / Exceptional Flows: [A1] If the student id does not have enough balance to make the payment, the server will return a false flag and the webpage will display balance is not enough.		

Use Case Name: Track Bus		ID: 6	Importance Level: High
Primary Actor: Student		Use Case Type: Detail, Essential	
Stakeholders and Interests: Student – wants to check the bus location			
Brief Description: This use case describe how the student can track the bus location			
Trigger: The student want to pay their bus ticket Type: External			
Include: Extend:			
Normal Flow of Events: 1. The student wants to track the bus location 2. The student loads the browser on their device and key in the bus tracking website 3. The web server search for the operating bus record and generates a table on all the operating bus together with their latest position and sends to the student browser to display.			
Alternate / Exceptional Flows: -			

Use Case Name: Login Reloading Webpage	ID: 7	Importance Level: High
Primary Actor: Finance staff	Use Case Type: Detail, Essential	
Stakeholders and Interests: Finance Staff- wants to login and operate on reloading session or check balance session		
Brief Description: This use case describe how the finance staff login before proceeding to reload session and check balance for student		
Trigger: The finance staff starts to operate Type: External		
Include: Extend:		
Normal Flow of Events: 1. The finance officer loads the webpage by keying in the URL on the browser 2. The webpage displays the login page 3. The finance officer key in the id and the password 4. The webpage compile the data and sends back to the server 5. The server compares the record and the information received in the database[A1] 6. The server redirects the finance officer to the reloading and check balance webpage		
Alternate / Exceptional Flows: [A1] If there is no matching record on the server database the webpage displays account mismatch and reloads the login webpage		

4.1.2 Data Flow Diagram
Context diagram of Bus Tracking and Ticket Payment System for UTAR
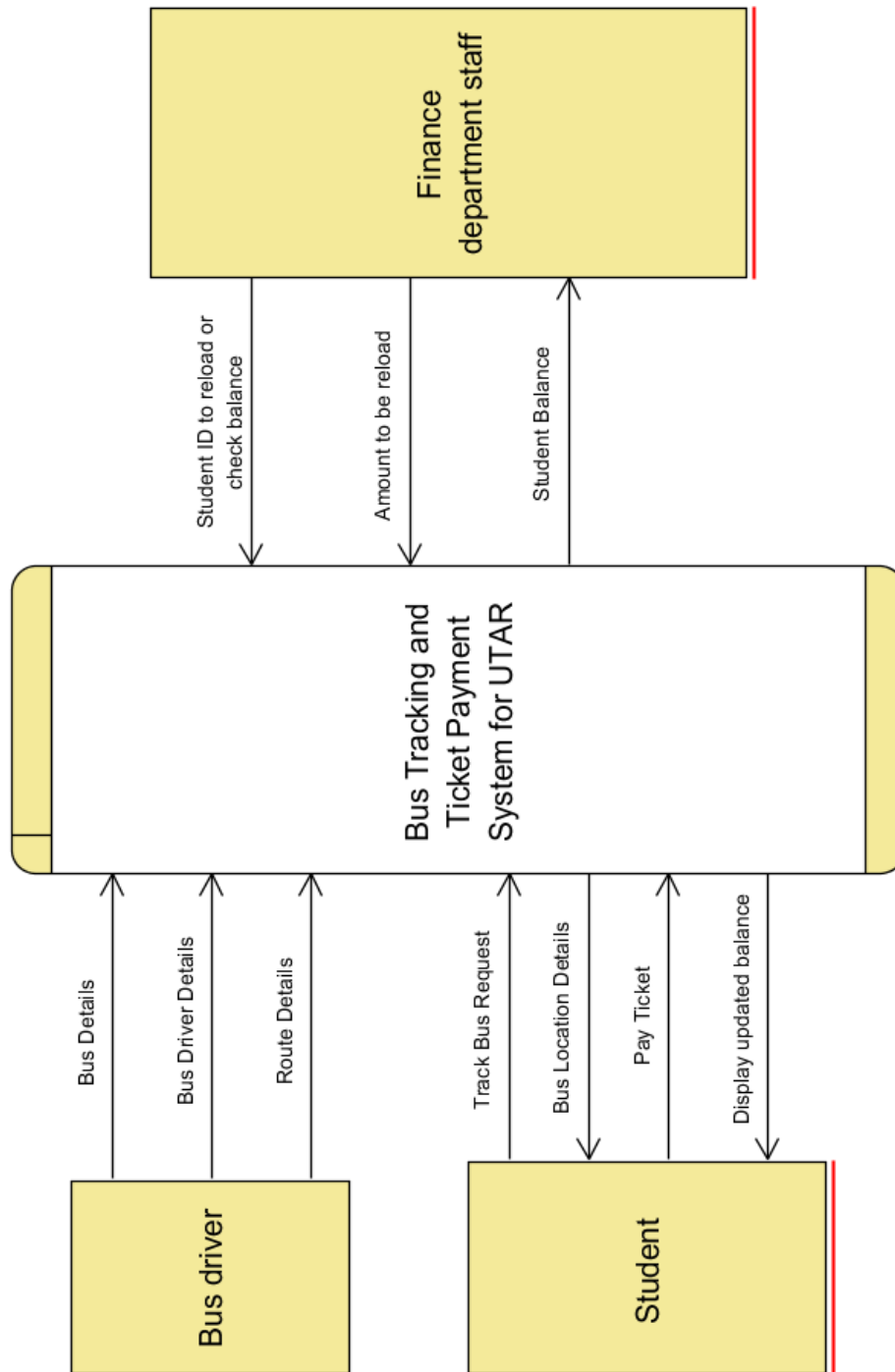
Figure 4.1.2.1 Context Diagram

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Level 0 diagram of Bus Tracking and Ticket Payment System for UTAR

Figure 4.1.2.1 Level 0 Diagram

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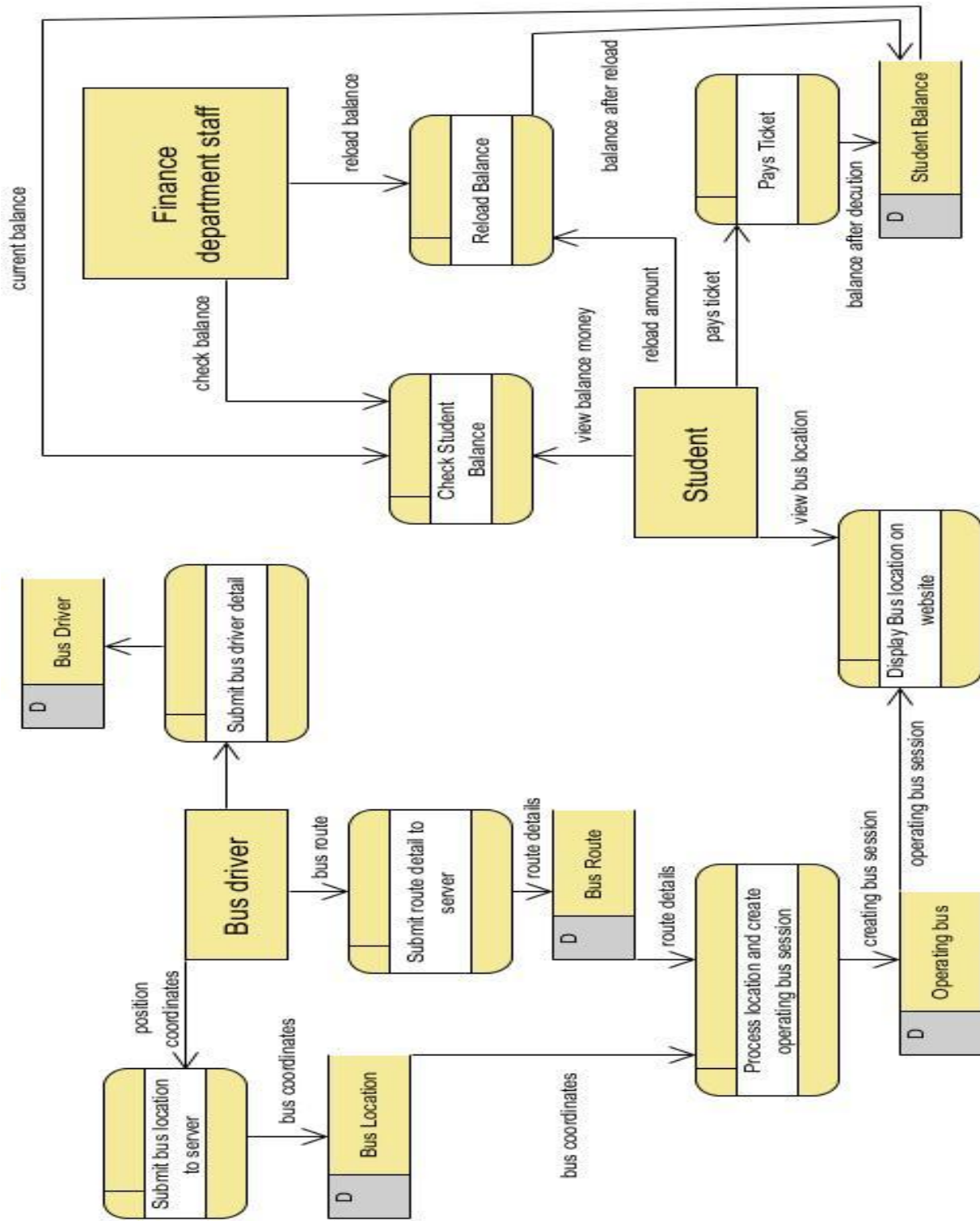
4.2 Activity Diagram

Activity diagram are diagrams which shows the workflow of the data and activity. As shown in the use case, each actor has its own use case and activity diagram is use to represent each and every use case which can be committed by the actor. Below are the activity diagrams.

Posting bus description details
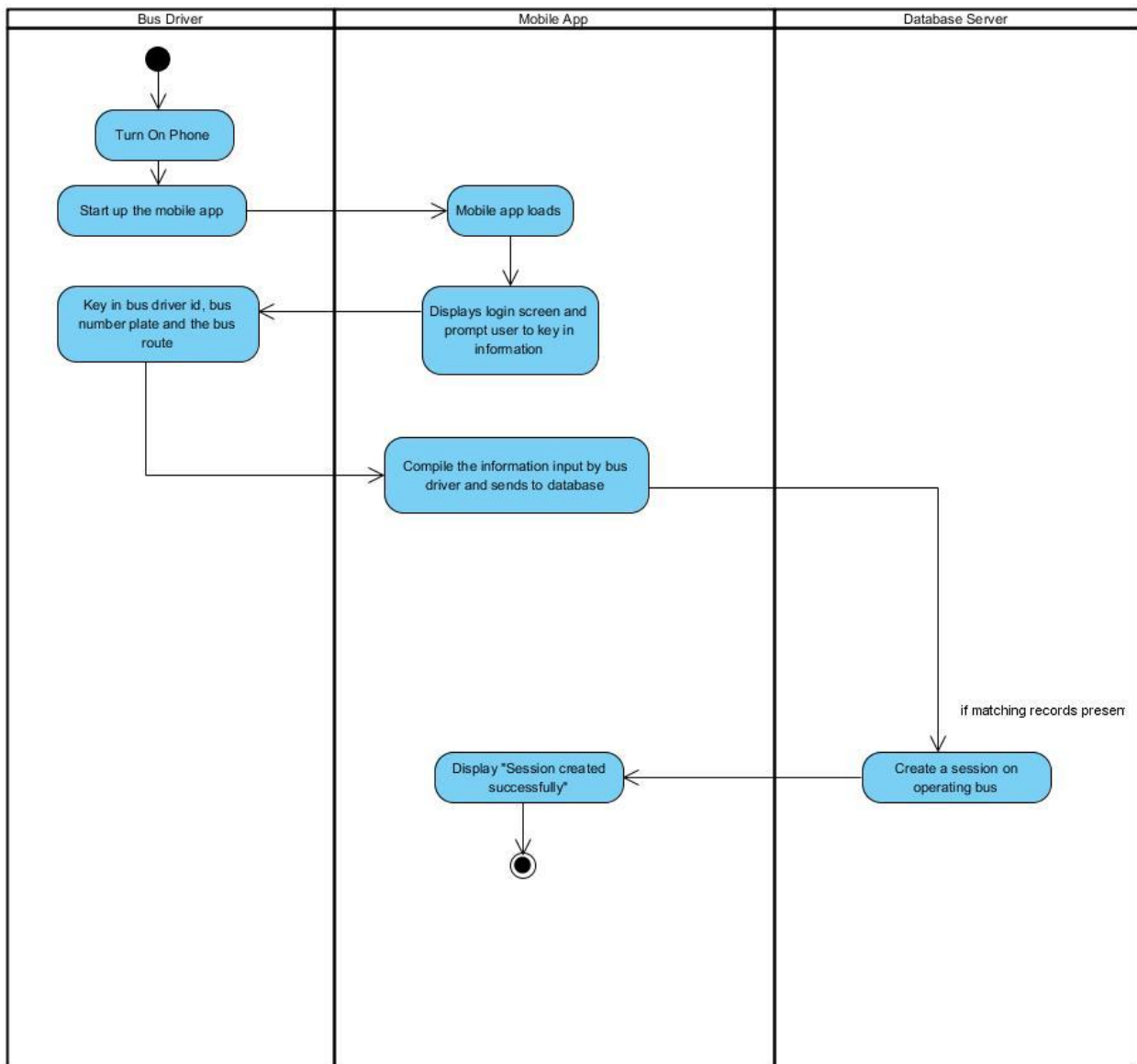
Figure 4.2.1: Posting bus description details

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Tracking system for bus driver
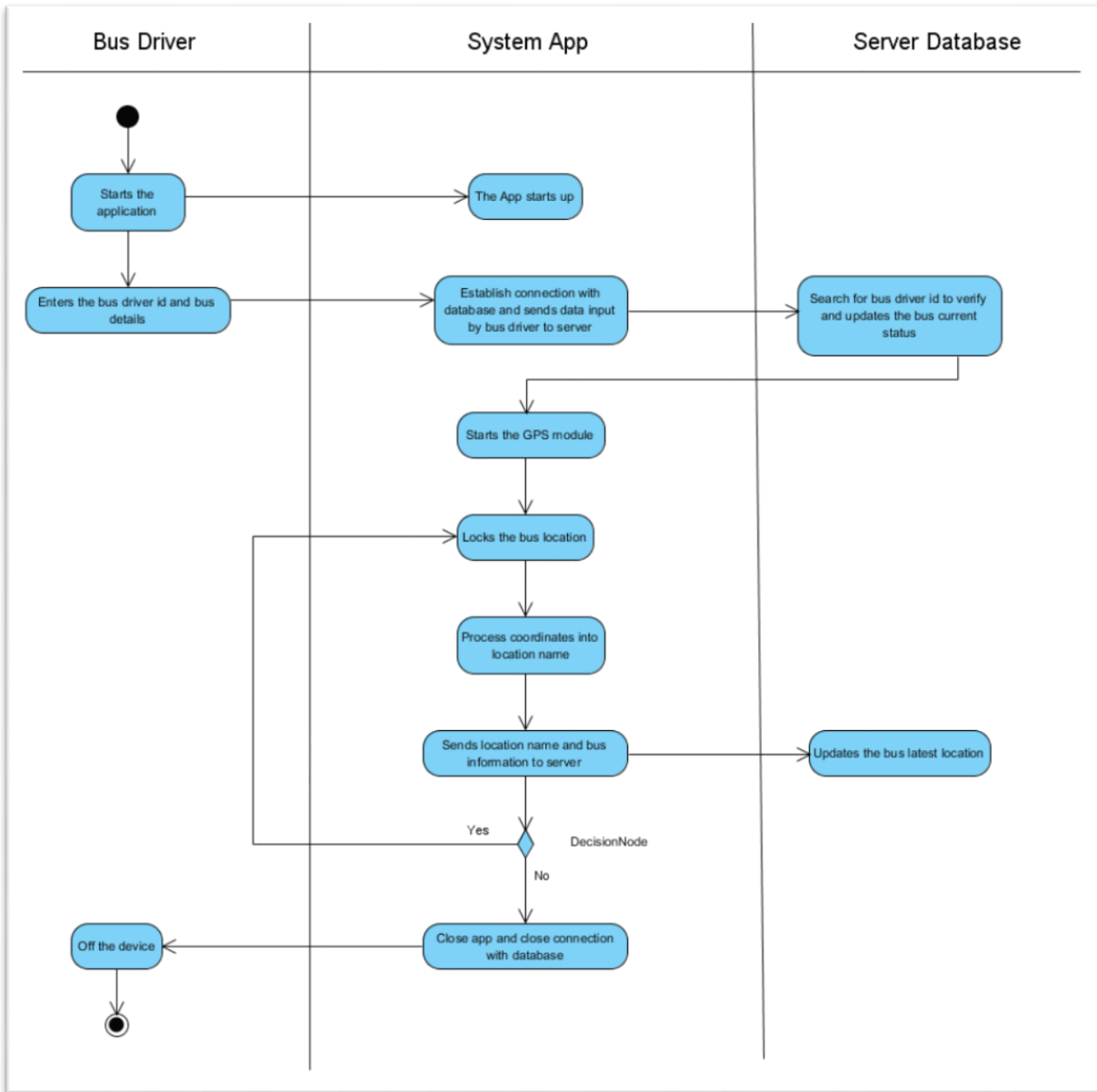
Figure 4.2.2: Tracking system for bus driver

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Reload balance for student and staff
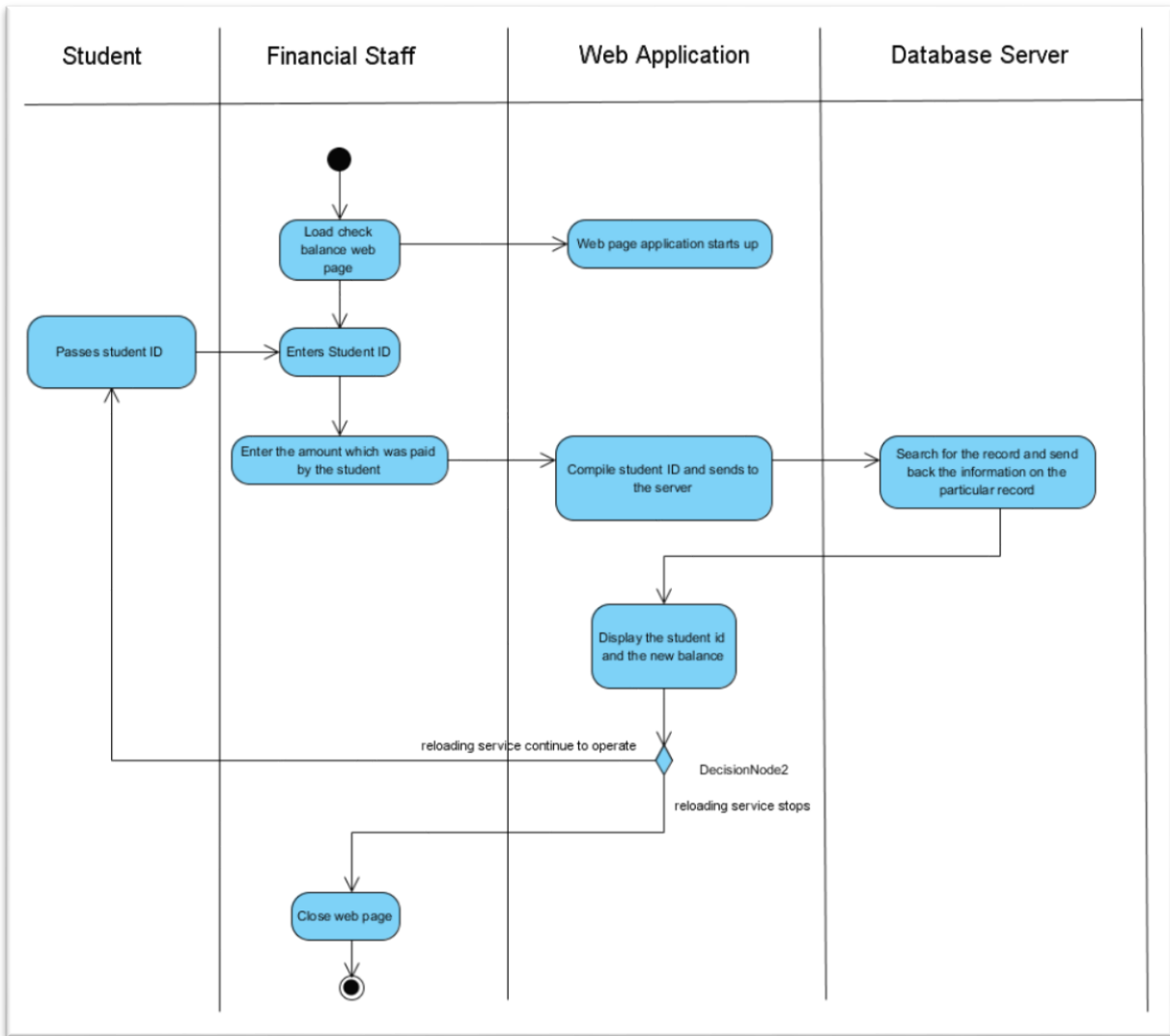
Figure 4.2.3: Reload balance for student and staff

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Check balance for student and staff
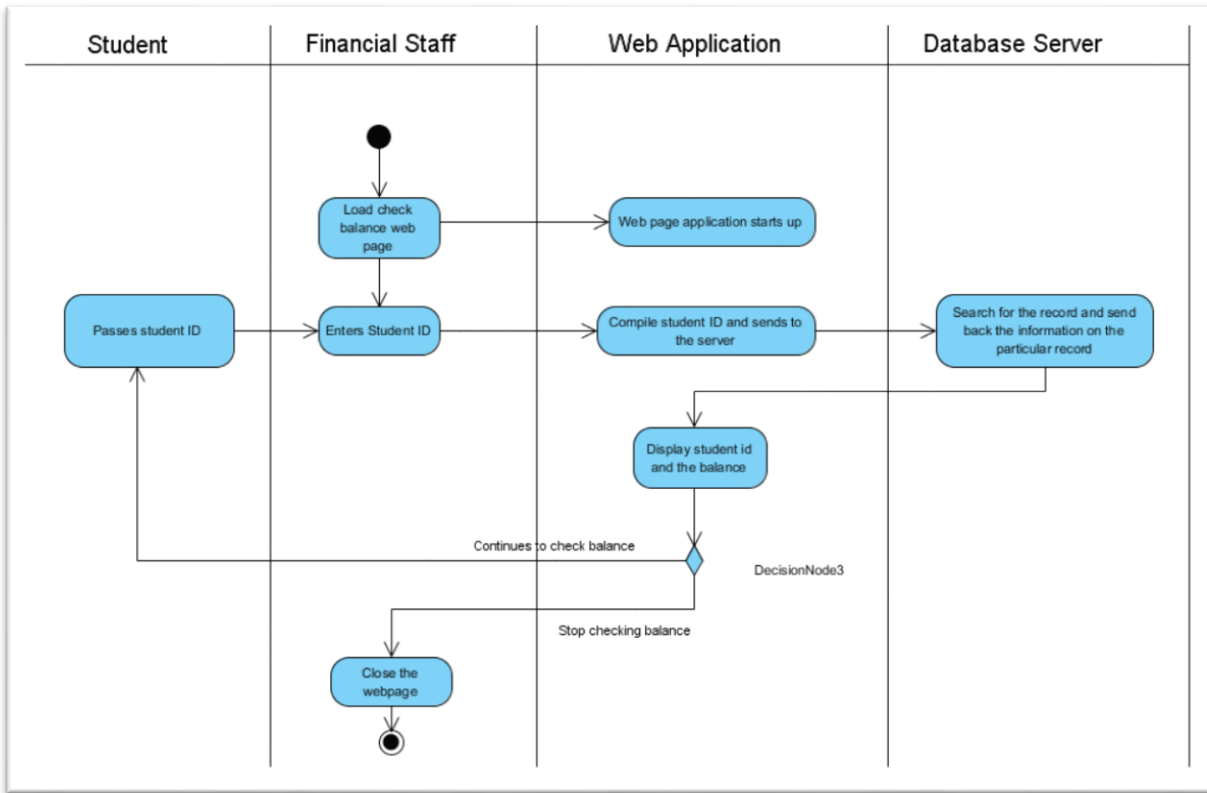
Figure 4.2.4: Check balance for student and staff

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Pay ticket for student
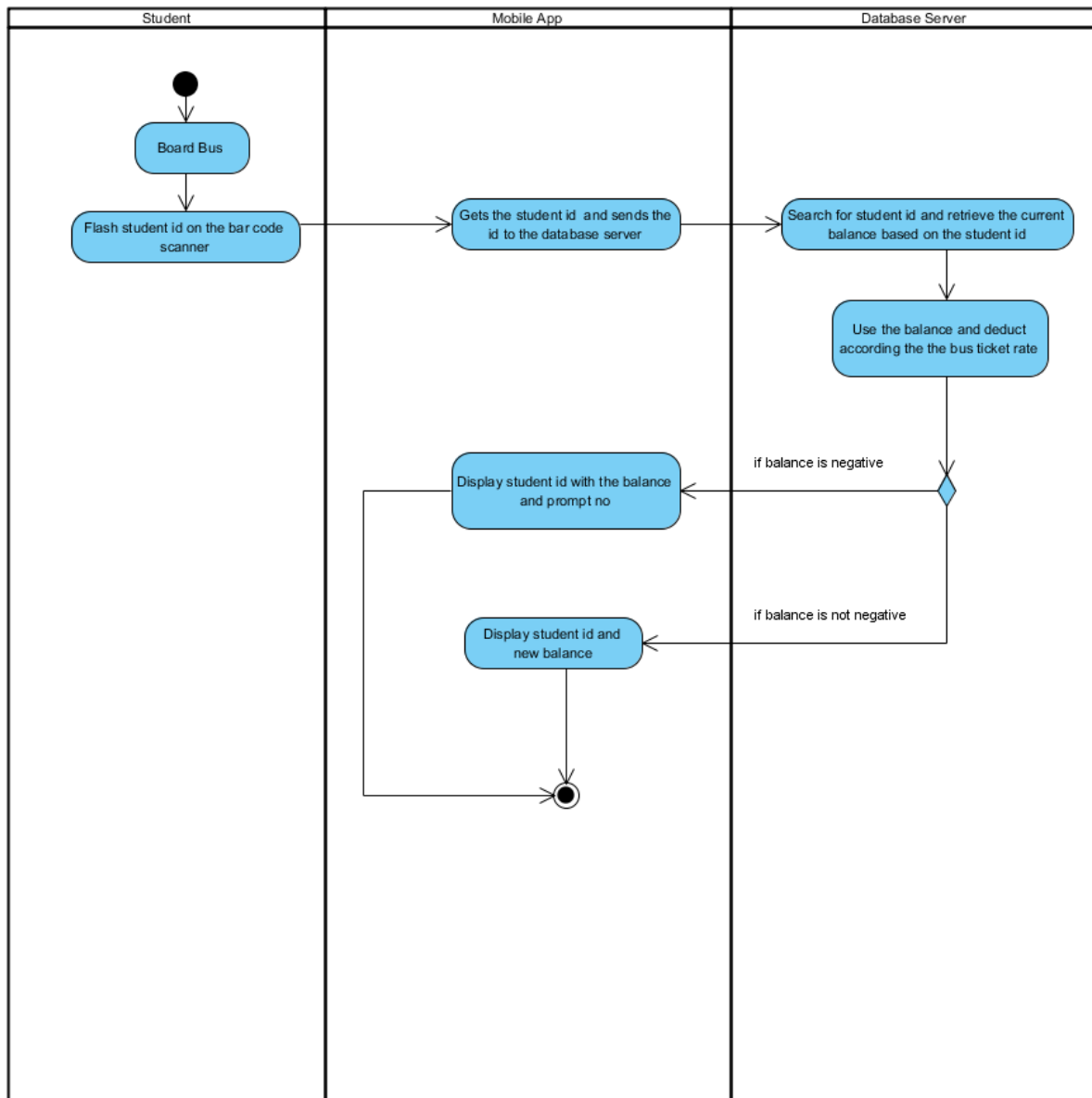
Figure 4.2.5: Pay ticket for student

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Finance staff login
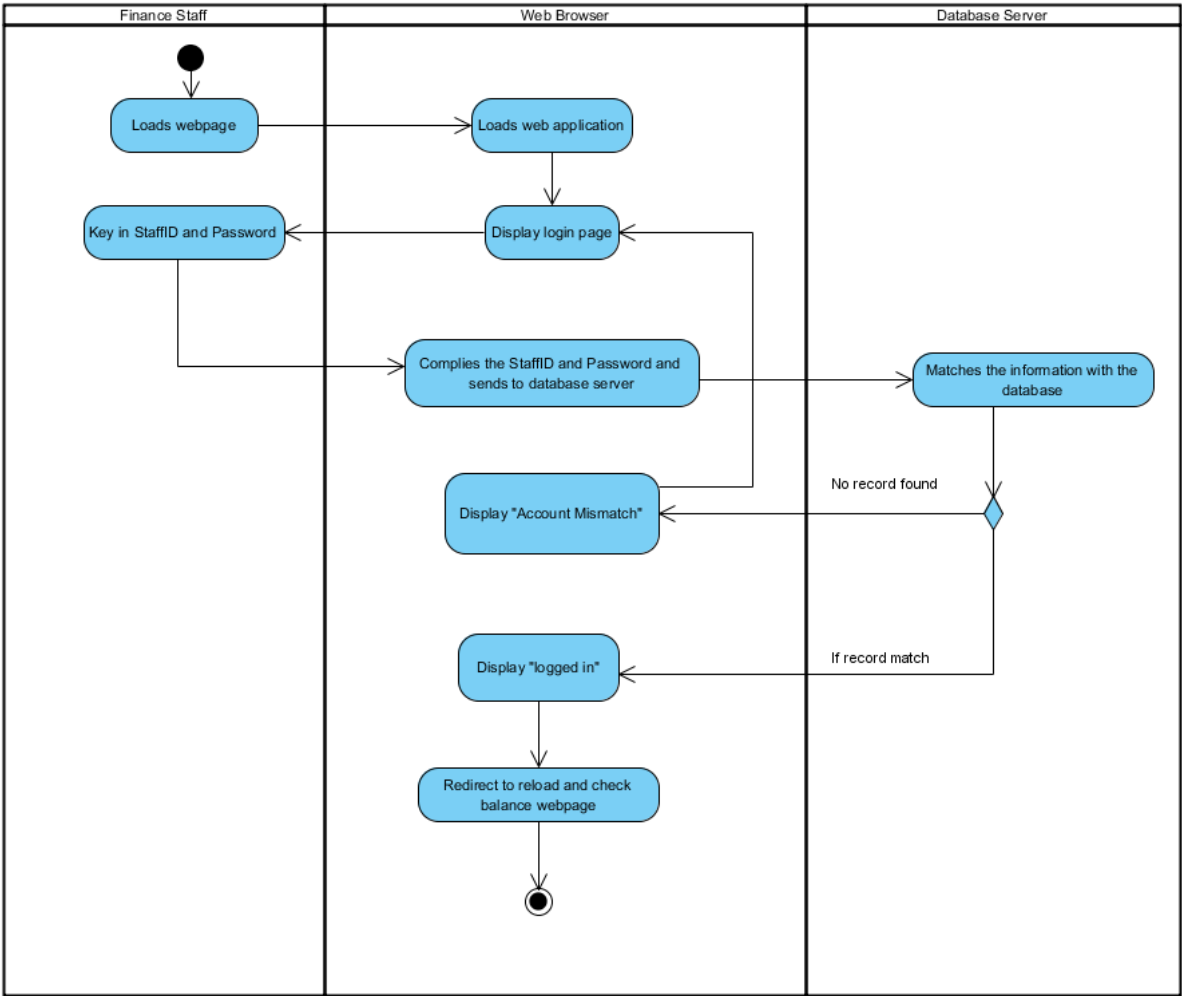
Figure 4.2.6: Finance staff login

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Student Bus Tracking Web

Figure 4.2.7: Student Bus Tracking Web

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4.3 Entity-Relationship-Diagram

Entity relationship diagram (ERD) is a data modelling which produce conceptual data model. In this case, the ERD is use to illustrate the database model of the whole system application. The following ERD is using Crow's Foot Model which allows viewers to illustrate the relationship between tables.

Figure 4.3.1: Database ERD model

4.4 Business Rules

Based on the entity relationship diagram, there are constrains and rules which is needed to be follow in order to satisfy some business aspects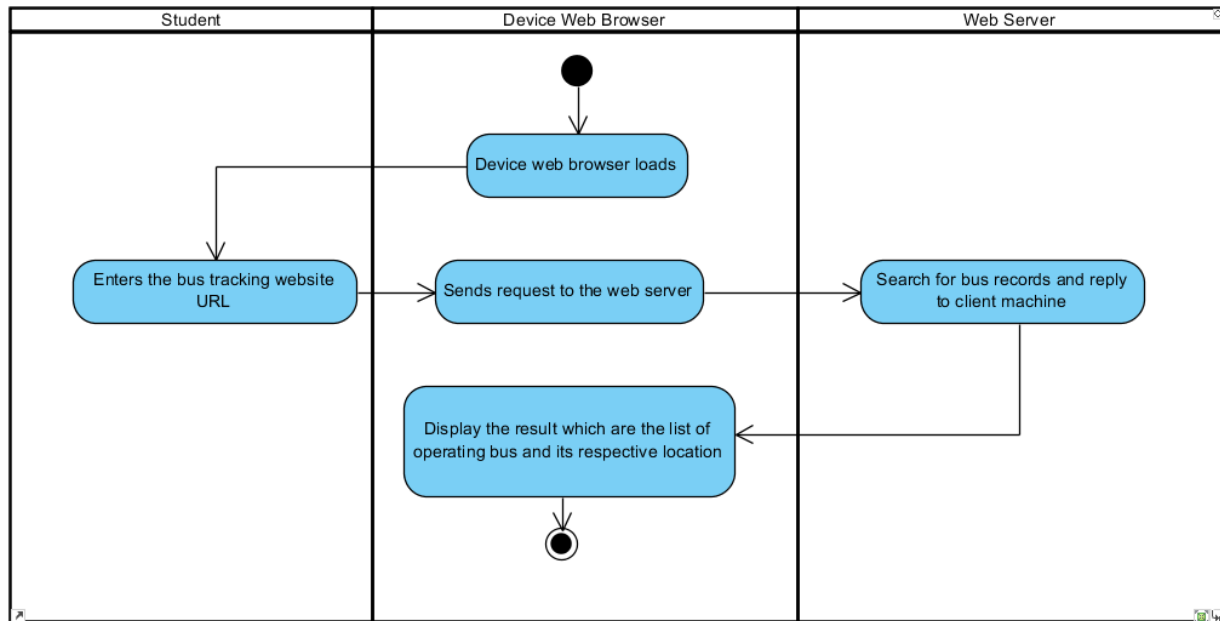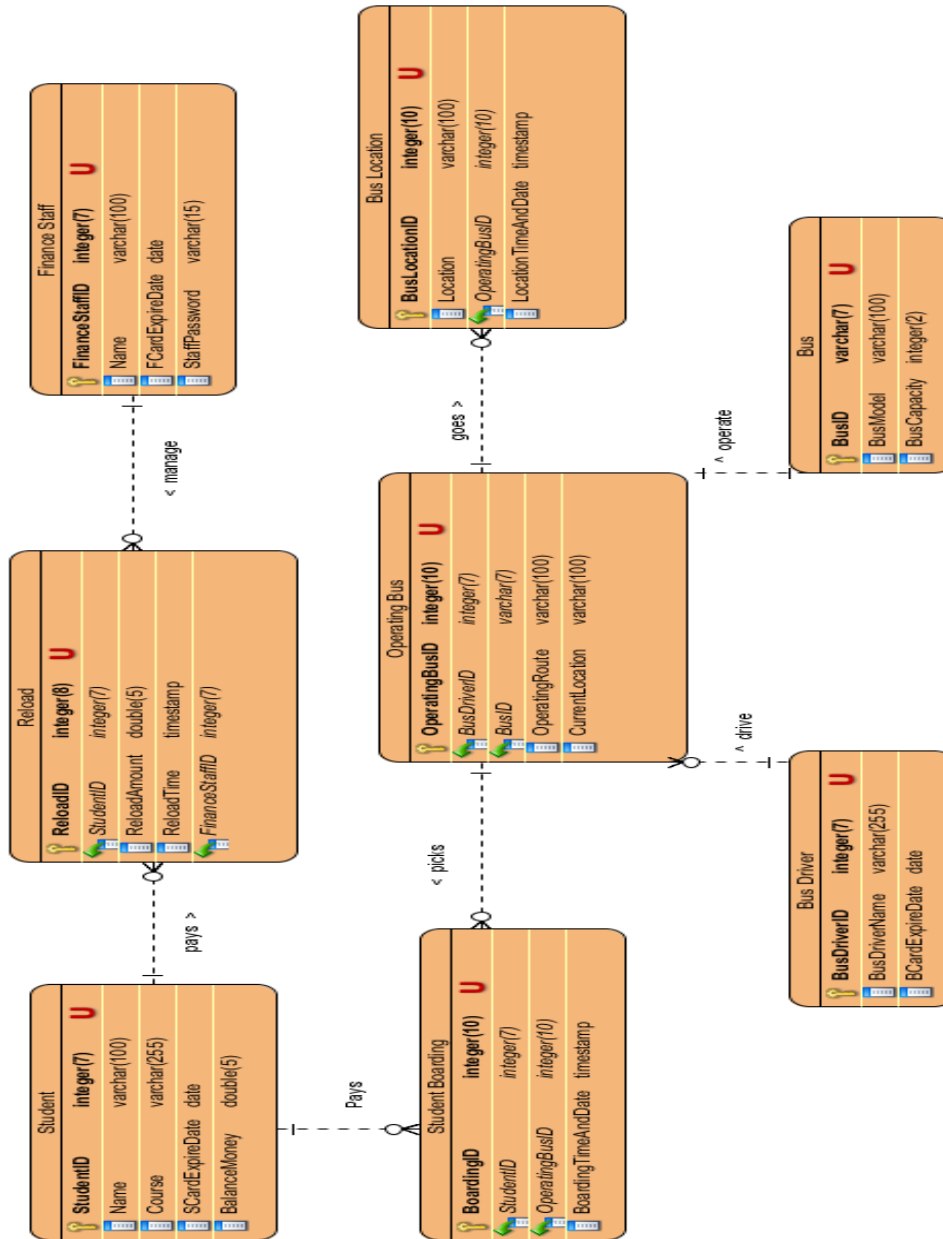. With these business rules, understanding the how data elements works together will be easier. Below are the list of business rules:

1. One finance staff can manage zero to many reload sessions.
2. One reload session can only be manage by one and only one finance staff.
3. Finance staff "StaffPassword" must not be longer than 15 character and can be alphanumeric.
4. The student can only reload maximum of RM999.00.
5. Student can reload amount of RM5.00, RM10.00, RM20.00 and RM50.00.
6. One reload session can only contain one student.
7. One student can have zero to many reload sessions.
8. One student can board the bus zero or many times. (Student to Student Boarding)
9. Student boarding table is for student who will board the bus.
10. A Student Boarding record can only contain one and only one student.
11. One operating bus can only pick up zero or many student (student boarding).
12. One student which is boarding the bus can only board into an operating bus.
13. One operating bus can only have one type of route.
14. The operating bus is supposed to follow the designed route only.
15. If the bus is to change the route, a new operating bus session creation is necessary.
16. The bus route can only be routes offered by the DSA.
17. The "CurrentLocation" update must be real-time so the tracking webpage can display the exact location of the bus on the particular time.
18. An operating bus can only be manage by one and only one bus driver.
19. A bus driver can drive zero to many operating bus.
20. A bus can only be operating on one operating bus at a time.
21. An operating bus can only be at a single location at a time (bus location).
22. The bus in a location (bus location record) can only be own by one and only one operating bus

4.5 Data Dictionary

Data dictionary is a description on the data objects or items. Below are the data dictionary which refers to the ERD.

Reload Table

Entity Name	Attribute	Data Type	Null	Description
Reload	ReloadID	integer(8)	no	unique id to identify reloads session
	StudentID	integer(7)	no	students id on the student card
	ReloadAmount	double(5)	no	amount reloaded by the student
	ReloadTime	timestamp	no	the time and date of the reloading session
	FinanceStaffID	integer(7)	no	finance staff which commit the reload session

Table 4.5.1: Reload Table

Student Table

Entity Name	Attribute	Data Type	Null	Description
Student	StudentID	integer(7)	no	students id on the student card
	Name	varchar(100)	no	students name
	Course	varchar(255)	no	course undertaking by student
	SCardExpireDate	date	no	expire date on student id
	BlalanceMoney	double(5)	no	balance money available on the student card

Table 4.5.2: Student Table

Finance Staff Table

Entity Name	Attribute	Data Type	Null	Description
Finance Staff	FinanceStaffID	integer(7)	no	staff id on the staff card
	Name	varchar(100)	no	staff name on staff card
	FCardExpireDate	date	no	expire date on staff card
	StaffPassword	varchar(15)	no	pass for loggin into the reloading system

Table 4.5.3: Finance Staff Table

Student Boarding Table

Entity Name	Attribute	Data Type	Null	Description
Student Boarding	BoardingID	integer(10)	no	unique id to determine the student boarding the bus
	StudentID	integer(7)	no	student id on the student card
	OperatingBusID	integer(10)	no	id of the bus which is operating on the particular time
	BoardingTimeAndDate	timestamp	no	time and date of the student boarding the bus

Table 4.5.4: Student Boarding Table

Operating Bus Table

Entity Name	Attribute	Data Type	Null	Description
Operating Bus	OperatingBusId	integer(10)	no	unique id on the bus operating on that particular day
	BusDriverID	integer(7)	no	bus driver staff card id
	BusID	varchar(7)	no	bus numberplate
	OperatingRoute	varchar(100)	no	the bus route eg westlake , kampar sutera etc
	CurrentLocation	varchar(100)	no	the exact current position of the bus eg block A

Table 4.5.5: Operating Bus Table

Bus Driver Table

Entity Name	Attribute	Data Type	Null	Description
Bus Driver	BusDriverID	integer(7)	no	bus driver staff card id
	BusDriverName	varchar(255)	no	bus driver name
	BCardExpireDate	date	no	bus driver staff card id expire date

Table 4.5.6: Bus Driver Table

Bus Table

Entity Name	Attribute	Data Type	Null	Description
Bus	BusID	varchar(7)	no	bus number plate
	BusModel	varchar(100)	no	bus brand or model
	BusCapacity	integer(2)	no	bus maximum capacity

Table 4.5.7: Bus Table

Bus Location Table

Entity Name	Attribute	Data Type	Null	Description
Bus Location	BusLocationID	integer(10)	no	unique identification for the bus as it operates
	Location	varchar(100)	no	exact location on the bus position eg block A
	OperatingBusID	integer(10)	no	unique id on the bus operating on that particular day
	LocationTimeAndDate	timestamp	no	bus location time and date on the particular time

Table 4.5.8: Bus Location Table

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Chapter 5: System Implementation and Testing

5.1 System Implementation

As mention the system consist of few modules. For implementation, the first module which will be deploy will be the server which will be used to get data from the phone through the mobile app in the bus. Data received from the mobile app will be stored into the server database which those data (bus coordinates) will be converted into meaning info which will be display in the webpage. The server will be used to host the webpage so students can access to the bus tracking website. Besides that the server will also be used to do reloading system or check balance system for the students by the finance staff. The server can be hosted either by the university themselves of source out but in the meantime it will be done locally to create a better stimulated environment. If the university choose to host the server themselves, they have to prepare servers along together with permanent public IP or they can choose some free web hosting service to do the job like 000webhost.com. IF the university plan to host a server a minimum specification of Intel Xeon 1230v2 3.8GHZ, 8GB DDR3 ram and a 1TB hard disc or greater is recommended. Next few mobile device should be prepared according to the number of bus operating. The mobile device should be Xiaomi 1s or models which have similar specification. These mobile device should be at least android 4.3 or above since android are backwards compatible, must be able to support USB OTG since a USB barcode scanner is being used , capable of going to the internet through GSM/EDGE/HSDPA/LTE so it can send back data to the server and a browser which support HTML. Thus depending on the number of bus and mobile device, data plan and SIM card are to be prepared for these devices. A phone mount to mount the phone to allow easy display for student is also needed together with a charger which is compatible with the bus power system to continuously charge the mobile device when in used. Besides that barcode scanner are also needed together with barcode scanner mount so that the barcode scanner can be mount and allow student to flash their student card easily.

Lastly for the finance department, a few computers with decent specification should be prepared so that the finance staff can do the reloading or check balance for the student. The machine should have network to connect to the server and a web browser to do the process. A computer with

59

specification of minimum Intel Core 2 duo 2.0 GHz/AMD Athlon X2 2.0GHZ, 1 GB DDR2 ram and 120 GB hard disc would be sufficient to do the work.
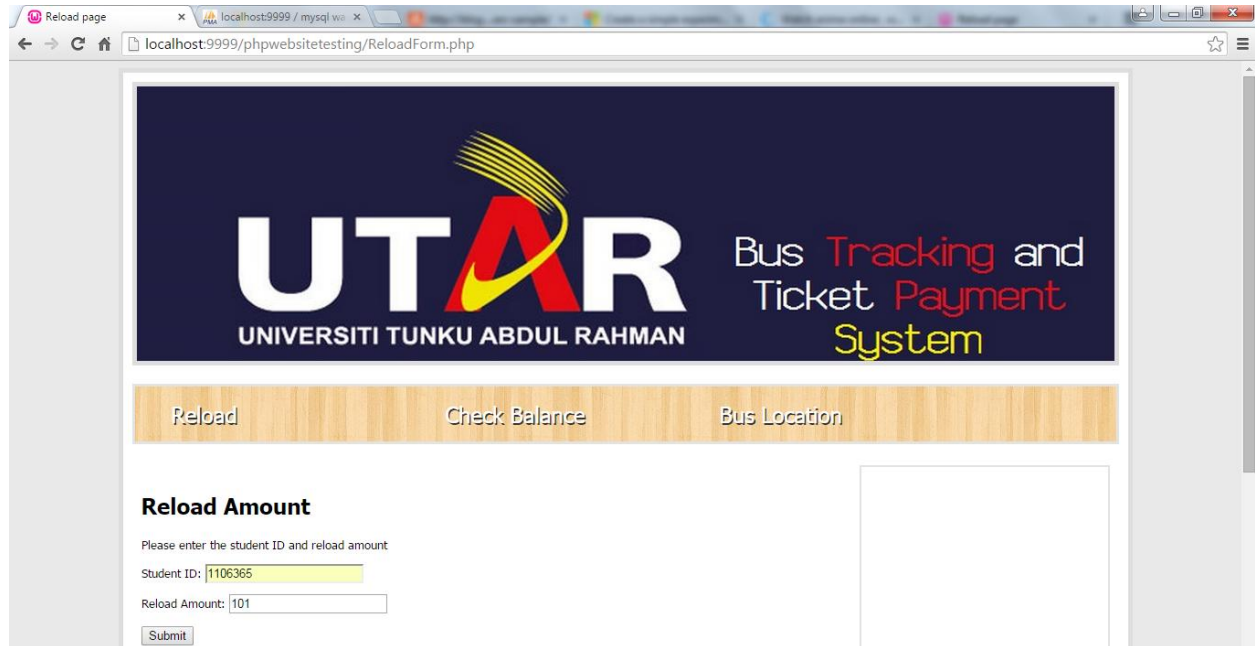
Reload module

Figure 5.1.1 Reload module screen shoot

In the reload module, the finance staff just have to insert the student ID and the amount to be reload and click on submit. The table reload in the database will then be updates by the details which was keyed in.

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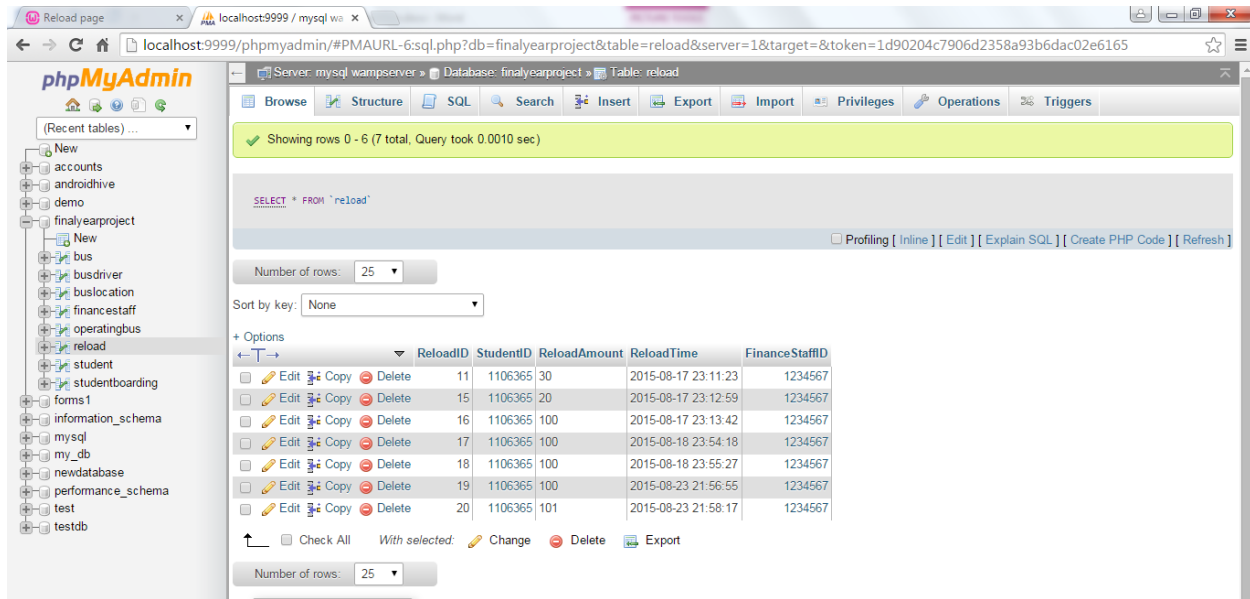Faculty of Information and Communication Technology (Perak Campus), UTAR

Figure 5.1.2 Reload Table in Database

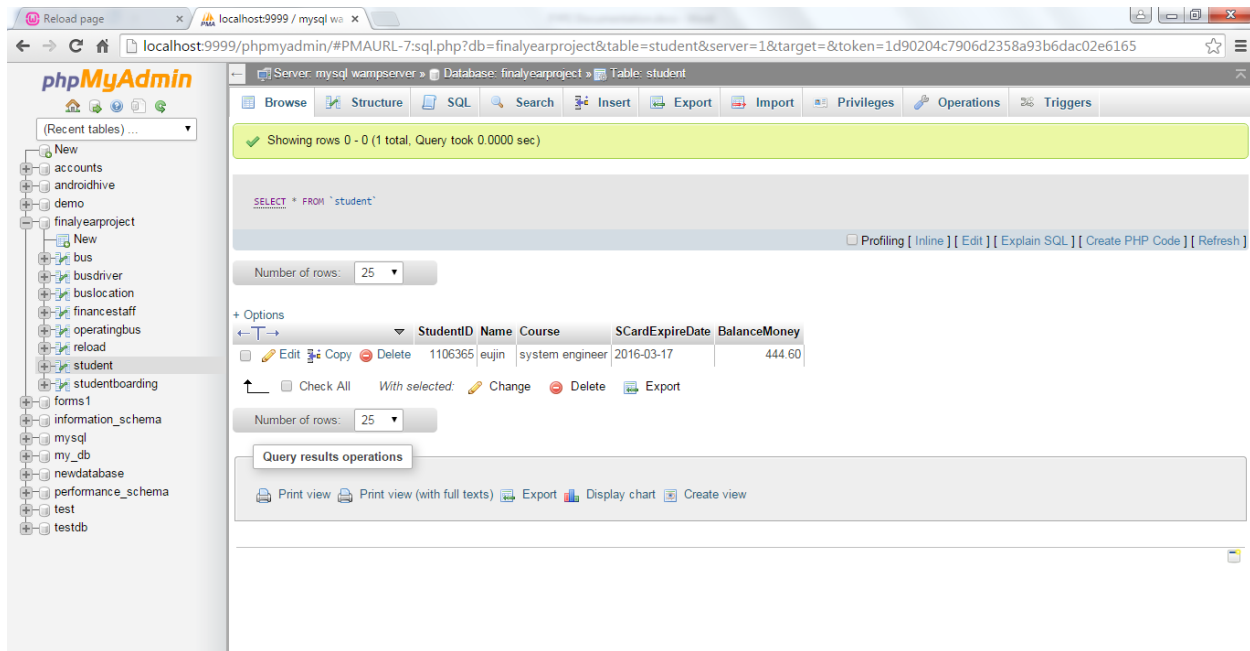At the same time the new balance money will be updated on the student table.

Figure 5.1.3 Student Table in Database

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Check balance module

Figure 5.1.4 Check Balance module screen shoot

In the check balance module, finance staff can just insert the student id to check the student balance money. Click on check balance and the page will display the balance amount by looking up the database and send back the result which is the student balance.
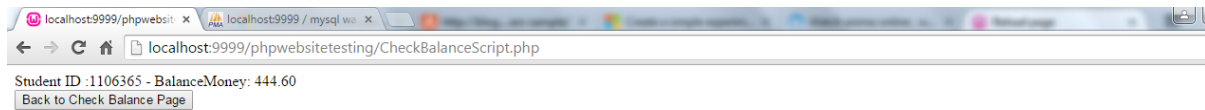

Figure 5.1.5 Check Balance module screen shoot 2

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Track bus module

Figure 5.1.6 Track bus module screen shoot

In the track bus module, a table will be generated to display the operating bus and its current location and its route. Data will be retrieved from the operating bus table to be displayed in this page.

Figure 5.1.7 Operating Bus table in Database
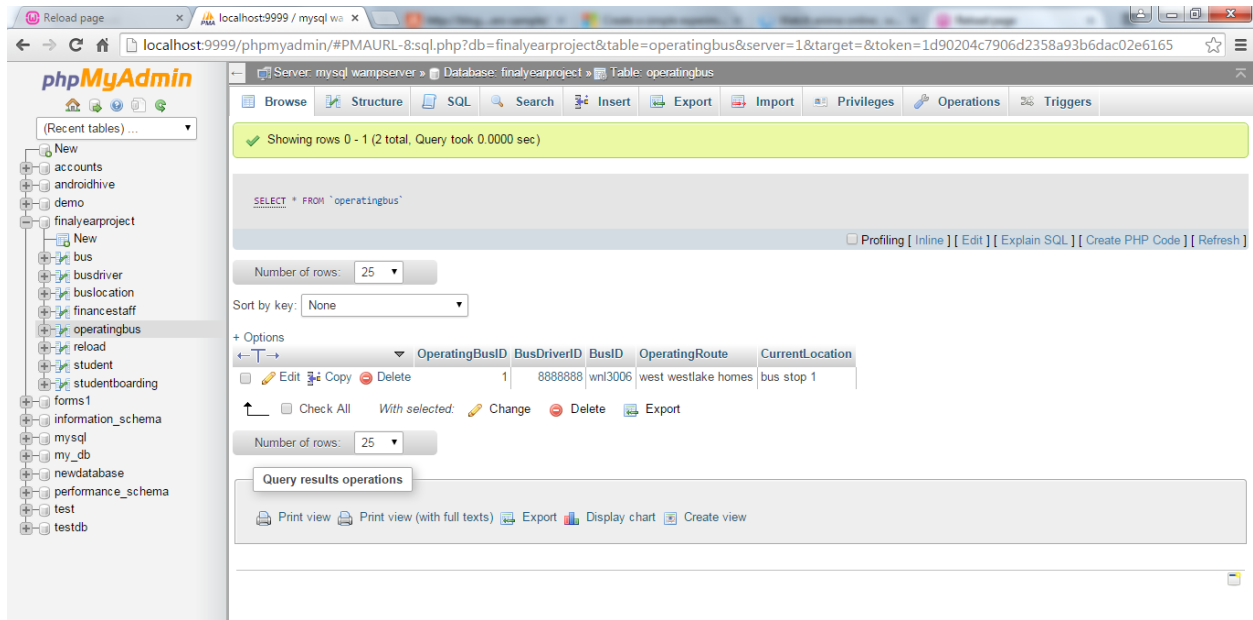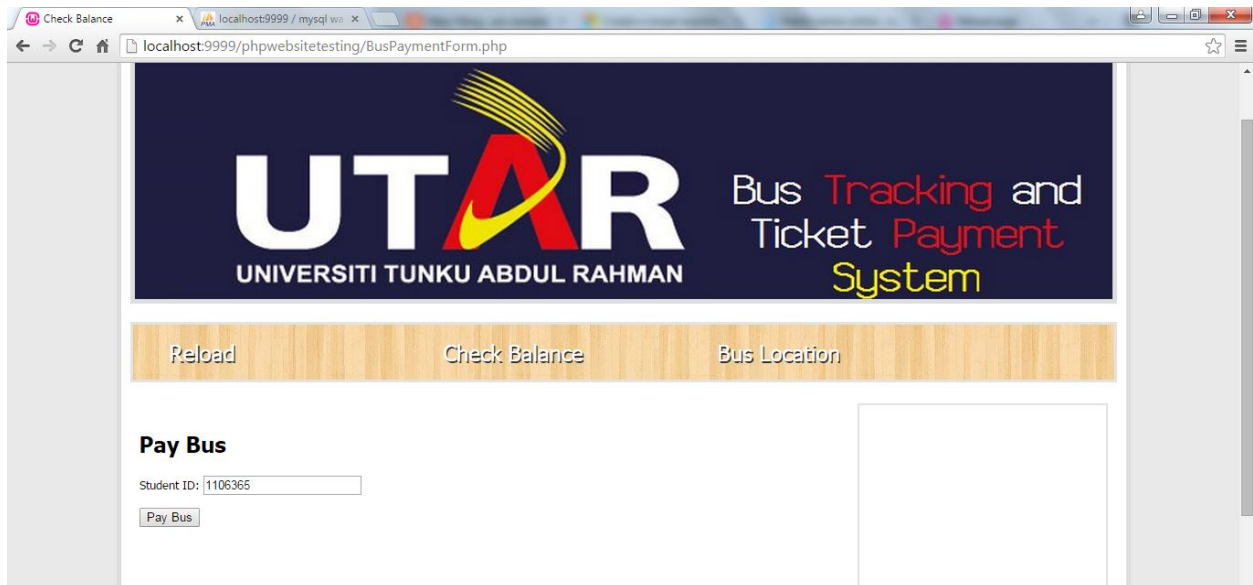
Bus Payment module

Figure 5.1.8 Bus Payment Module screen shoot

In the bus payment page, there will be a column to enter the student id. Once the id is entered, pay bus can be proceed and the student balance in the student table will be updated accordingly.

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Phone module on the bus
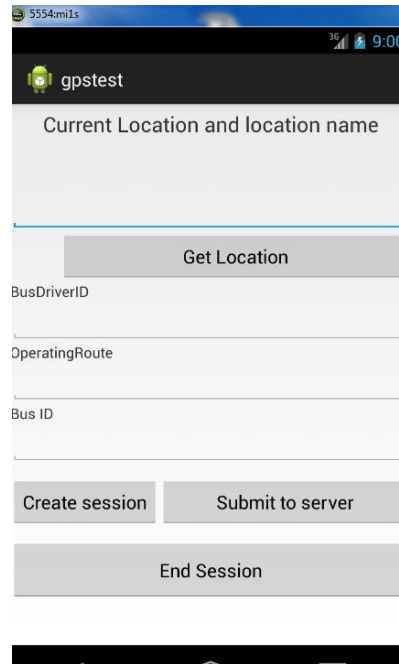
Figure 5.1.9 Mobile Application screen shoot 1

When the phone app is launch, the interface is as shown in the figure above. Before starting anything, the bus driver is supposed to turn on the mobile data and GPS. After that the bus driver can click on get location.
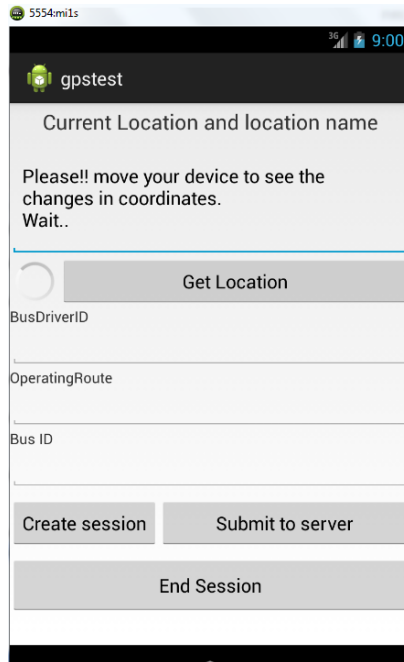
Figure 5.1.10 Mobile Application screen shoot 2

When get location is clicked, it will take some time to lock the bus location depending on the GPS signal strength.

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Figure 5.1.11 Mobile Application screen shoot 3

Once the coordinates are obtain, it will be changes to location names in which the above diagram shows that the bus is at Student Pavilion 2 / Block K / Block L. The coordinates will be constantly updated in real-time as the longitude and latitude changes.

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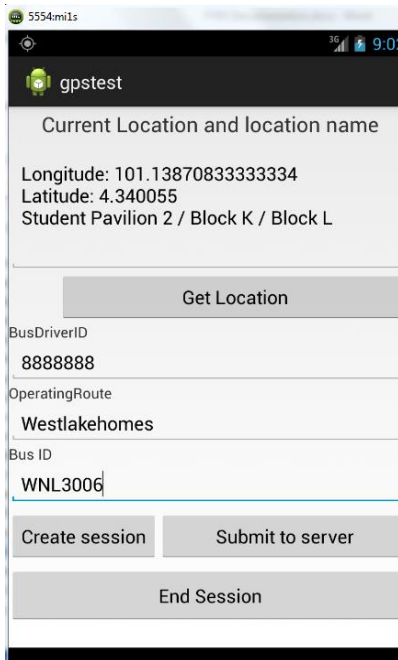
Figure 5.1.12 Mobile Application screen shoot 3

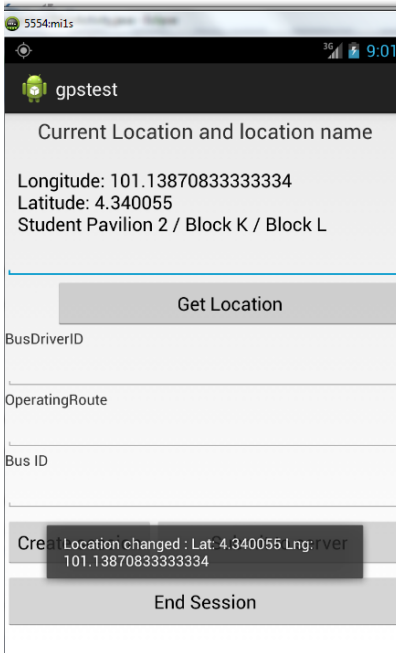After that the bus driver have to key in his/her ID, key in the bus operating route and bus ID. Then finally the bus driver can click on the "Create session" once and the application will create a single bus session in Operating Bus table. After that the bus driver can click "Submit to server". When this button is clicked the app will keep on sending data on the bus location back to the server in 5 second intervals. Lastly if the bus session has come to an end, the bus driver can click on "End Session". This will remove the session which is created in Operating bus table.

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5.2 Testing

In terms of testing, the black box testing method will be used to do the overall testing. Black-box testing examines the software functionality without peering internal structures and workings. It can be applied on any level such as unit, integration, system and acceptance. In black-box testing there are multiple techniques and the selected techniques is Test Case testing. Test case is a method where functions are being tested and what are the corresponding action. It allows the acceptance of test cases on the system.

Test ID	Description	Expected Results	Actual Results

Table 5.2.1 Black box testing Test Case illustration

Test case methodology can be illustrate as the figure above. It consist of test id which represent the testing unique id, description which represent the situation of the testing, expected result and actually result.

ID	Description	Expected Results	Actual Results
1	Staff reload for student	Record created on the table and student balance is updated	Record created on the table and student balance is updated

Table 5.2.2 Sample Test Case

A simple test case is show as above. Id represent its unique identification number, description states that "Staff reload for student" in which the case is that focus on creating a row in the reload table. Then the expected results is "Record created on the table and student balance is updated" which means if the staff reload for the student, the expected outcome will be a record is being created on the reload table and the student balance in the student table is being updated. Lastly the actual result is "Record created on the table and student balance is updated" means when the case

70

is tested on the main system, the actual result satisfy the expected result. If the actual result is different from expected result, a clarification will be mention on the actual result section.

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Faculty of Information and Communication Technology (Perak Campus), UTAR

ID	Description	Expected Results	Actual Results
1	Staff reload for student	Record created on the table and student balance is updated	Record created on the table and student balance is updated
2	Creating a reload record with invalid student id or finance staff	Error displayed	Error displayed
3	Reload value in string format with valid id	Error displayed	Error displayed
4	Balance money in student table be updated after reload	Display new balance	Display reload amount only (yet to implement)
5	Student flash id at barcode scanner	New record created in student boarding	New record created in student boarding
6	Balance money in student table be updated after paying ticket	Balance is deducted by 0.80 and balance in 2 decimal places	Balance is deducted by 0.80 and balance in 2 decimal places
7	Invalid id being used to pay	Error displayed	Error displayed
8	Creating an operating bus session	Record created in table operating bus with reference bus location table	All records are created as operating bus (progress still undergoing)
9	Creating an operating bus session with invalid bus driver or bus	Error displayed	Error displayed
10	Filtering bus location to the latest record	The last 10 record in bus location processed	Filtering result still not working
11	Using both AGPS and GPS to locate position	Location obtain in coordinate format	Location obtain in coordinate format
12	Browsing track bus webpage through mobile device	Bus location displayed	Bus location displayed but not in table form (yet to implement)

Table 5.2.3 Black box testing Test Case table

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Faculty of Information and Communication Technology (Perak Campus), UTAR

Chapter 6: Conclusion

With the proposed project, the project covers a wide range of language and modules which are still in learning process. For example introduction on mobile app have just been taken and time is still needed to be familiarise with it. At the same time web application and server related application are still new to me. It will be intensive to do this project since continuous study is also required and at the same time not ignoring other subjects being taken this semester.

Speak of the mobile application module, the challenges would be connecting back to the server database since a real or virtual server database would be needed and not to mention if the mobile app can read or write data from the particular server. Besides that the mobile app have to keep updating the table on the server would also be a challenge since updates are done in short intervals. As mention communication between the mobile app and the server is still an issue since the mobile app have trouble reading the JSON file which been sent by the server since it contain HTML related code. Currently other approach such as web based instead of mobile app are being use. Next maintaining the session for the finance staff to login into the reloading page is still not functioning. Creating the bootstrap for the page to optimize view for mobile device and desktop are still running off the expected view. Lastly the continuous update of the bus tracking webpage would be a challenge since the update is supposed to be done automatically. Implementing the database on PHP webpage is still not matured enough since some things are not automated.

As mention on title, the project aims to develop a simplified tracking system for students to track the bus and at the same time allow students to pay their tickets using their matrix card. Tracking system on the bus have been implemented on other universities as stated in the literature review but UTAR have not implement any of these system. With this project, bus system can be more efficient and students will be more persuaded to use the bus.

I hope that the project can solve the current issue which are replacing old bus ticket and simplify student's life by allowing them to track the bus so they will never need to miss the bus. It is hoped that this will give the university a better impression on the bus infrastructure since the university is diverting to a cashless community with the implementation of silverlake prepaid card.

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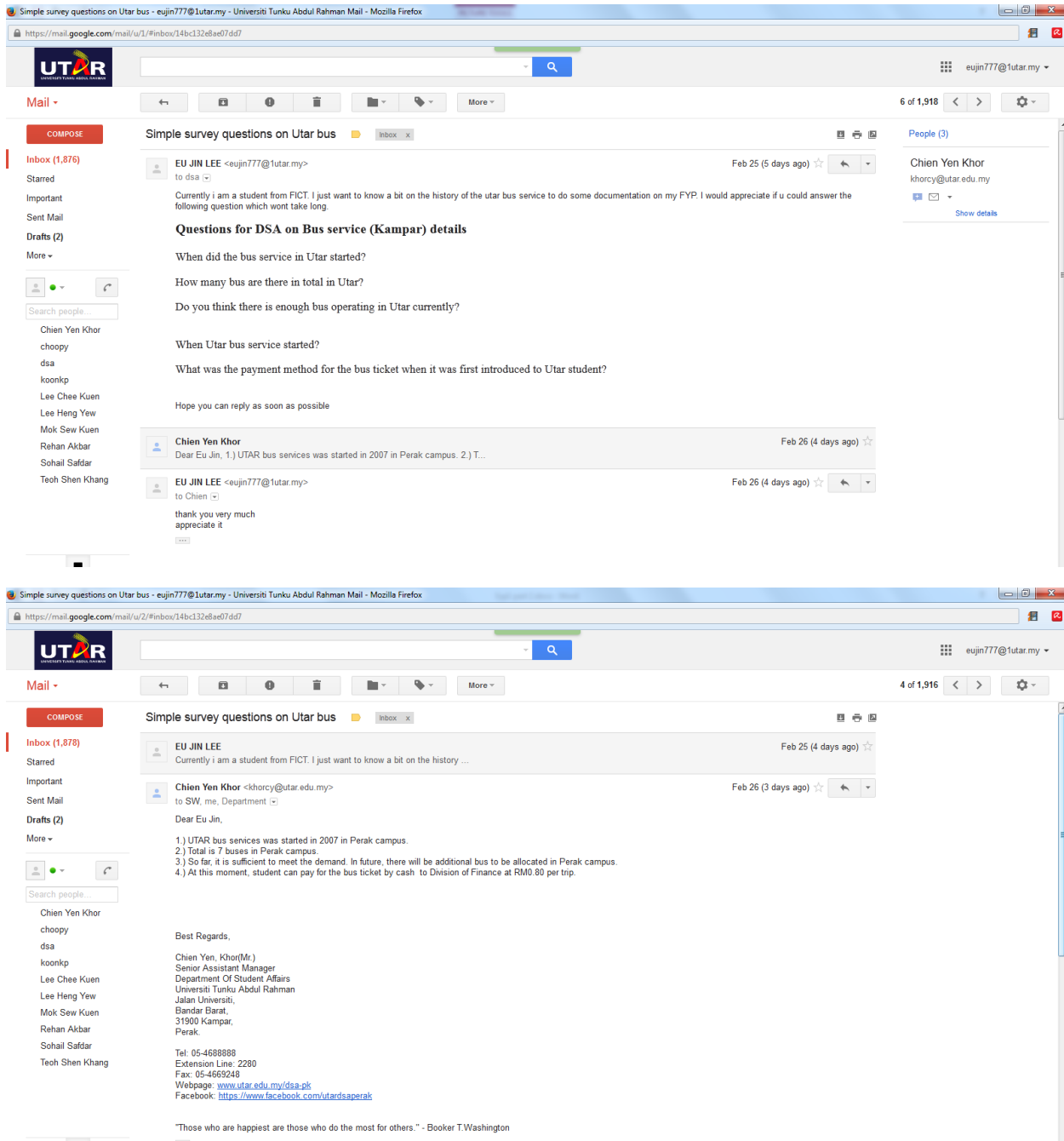Faculty of Information and Communication Technology (Perak Campus), UTAR

Appendix

Figure 7.1: Survey Question from DSA

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