Thesis for the Degree of Master of Engineering

Design and Implementation of Smart Bus Management Information Systems

by

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Interdisciplinary Program of Information Systems

The Graduate School

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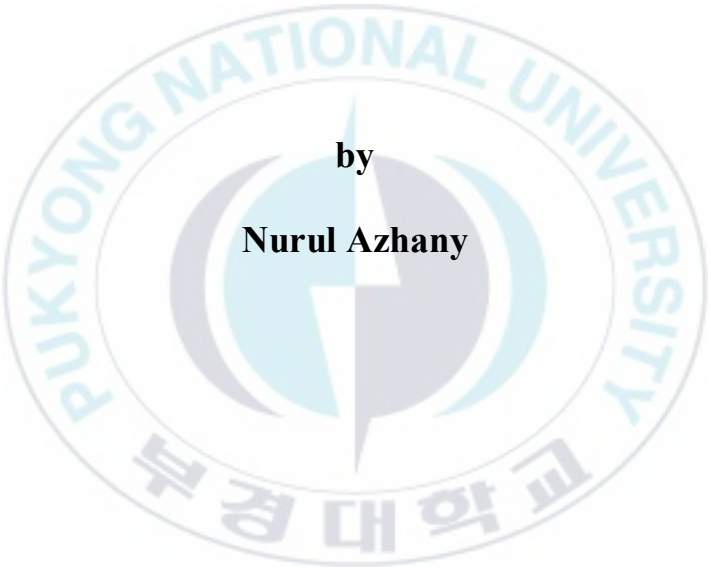
스마트 버스 관리 정보 시스템의 설계와 구현

Advisor : Prof. Man Gon Park



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Nurul Azhany

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26 February 2016

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스마트 버스 관리 정보 시스템의 설계와 구현

누룰 아자니

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요 약

인도네시아와 같은 개발도상국에서는 교통혼잡문제가 심각한 문제로 발견 되어지고 있는 상황이다. 이러한 교통혼잡문제의 주요 원인은 대중교통보다 개인 차량을 사용하는 사람들이라고 할 수 있다. 그러나, 개발도상국에서 대중교통은 대중교통의 기획 및 모니터링 시스템의 결여로 인해 적절하게 운영되지 못하고 있다. 그러므로 원활한 운영을 위하여 스마트 대중교통 시스템이 필요하게 되었다.

국민들이 그들 소유의 차량보다 대중교통을 사용하도록 하기 위한 방법으로는 대중교통에 관한 정보, 시설, 규제와 같은 대중 교통 시스템을 증진시키는 것이다. 대중교통 시스템을 증진시키기 위한 다른 방법으로는 우리 사회에서 중요한 부분이 되어가고 있는 스마트폰 기술의 사용이라고 할 수 있다. 더욱이, 이는 국민들이 개인 차량보다 대중교통 사용을 택하도록 만드는 데 있어 유용할 수 있게 된다.

대중교통 시스템은 아주 조직화가 잘 되어있고 또한 스마트폰 애플리케이션은 사람들이 쉽게 대중교통에 관한 정보를 획득하게 만들고 교통 혼잡문제도 줄이는 데 큰 도움이 된다. 체계화된 대중교통 시스템은 현재와 미래에 있어 큰 역할을 할 것으로 예상된다. 개선된 대중교통 시스템을 통하여 우리는 개인 차량의 사용 수를 줄일 수 있을 뿐 아니라 간접적으로 인도네시아의 교통혼잡문제를 완화하는데 큰 역할을 할 수 있을 것이다. 이 논문에서, 우리는 효과적인 결과를 얻기 위해, Wi-Fi 및 GPS 기술을 사용하여 버스 운송 시스템을 모니터링한다.

Design and Implementation of Smart Bus Management Information System

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Abstract

Traffic Congestion is one of the biggest problems found in developing countries such as Indonesia. One of the reasons for traffic congestion is people who prefer to use private vehicle rather than public transportation. However, in developing countries public transportation does not operate properly due to lack of planning and monitoring system of public transportation. Therefore, it needs a good and smart transportation system for smooth operations.

Some of the ways to attract the citizens to select to use public transportation than their own vehicle are improve the systems of the public transportation such as the regulation, vehicles, facility, and information about public transportation. The other way to improve the public transportation system is use the smartphone technology that is now becoming an important part in the community. Furthermore, it can useful to help to attract people in choosing public transportation rather than private vehicle.

A public transportation system that is well-organized and a smartphone application can help people to easily obtain all information about public transportation hope and also help the traffic congestion problem. A systematic public transportation plays an important role in a city for current and future planning. Through a good public transportation system, we can reduce the number of private vehicles usage but positively also indirectly help to condense the traffic congestion in Indonesia. In this study, we will use Wi-Fi and GPS technology to monitor the bus transportation system for effective results.

Chapter 1. Introduction

1.1 Background

The role of transport in the economic viability of an area is very important. An integrated transport system, efficient, and provides complete information and an affordable cost can assist in improving the living conditions of a country's economy. With shrinking the time required to take a trip, citizen can be able to reach the higher productivity [1]. The travel time also has a significant impact in the field of economy, namely the use of fuel and the distribution of goods. A rider who has the most minimum travel time on the way to make savings on fuel use. The use of high fuel effect on the level of an urban economy [2].

The travel time can be affected by a transportation system that is applied in the City. The transport system is defined as a business transfer or movement from one location to another by using a specific tool. Future transportation system should be able to provide the most reliable information about the condition of a road. Therefore, building an integrated intelligent transportation system is very important for a city [3].

In 2015, almost all developing nations such as Indonesia is still facing the classic problem in the field of transportation, especially public transportation. Due to the high the rate of population growth, the need for the availability of transportation facilities and infrastructure should be improved too. A significant increase of population growth leads the increasing of private vehicles, yet it is not followed by the addition of adequate public transportation infrastructure. As a consequence, traffic jam happens at many roads in the cities of Indonesia. Traffic congestion occurs

naturally impact in improving fuel consumption in the country, reduce leisure for the citizens, and increase the level of stress.

1.2 Problem Statement

Factors that makes people prefer to use private vehicles than public transportation are:

a. Transportation not scheduled well

   One of the main problem of public transportation is lack schedule for people to see what time will they bus coming. Occasionally, it makes people wait for a long time.

b. Public transportation can stop in any place they want.

   Another problem of public transportation in Indonesia is the public transportation not only stop on the bus stop. Public transportation always stop wherever they want to stop and wait for another passenger for a long time. It is make one line of way block and causes a traffic congestion. And in Indonesia almost all of public transportation do that.

c. Uncomfortable public transportation

   An old-fashioned and uncomfortable vehicle become one of the reasons of people use private vehicle.

1.3 Thesis Objective

The research project has five main objectives:

a. To design a smart public transportation system that is safe, convenient, and timely basis.

b. To develop an interface in order to provide information about the current bus position and the nearest bus stop.

1.4 Scope

In this design and develop of smart bus management information system, will use a Wi-Fi and GPS as a data sources for track the bus position. Develop the smartphone application to provide an information about the position of the bus which is being awaited by passengers, and this application will be made on a smartphone with an android operating system.

The smart bus management information system application provide an information about near bus stop, bus location, and bus route. All of this information will show in a map.

1.5 Thesis Outline

The thesis has been divided into six chapters which are:

Chapter I, Introduction

Introduction consists of thesis background, problem statement, thesis objective, scope, and thesis outline.

Chapter 2, Literature Reviews

Literature reviews explains the theoretical supports and methods. It includes explanation about bus management system

Chapter 3, System Requirements and Design

System requirements and Design consist of system architecture and functional requirements

Chapter 4, System Design

In this chapter explain overall system and features of system

Chapter 5, Implementation and System Analysis

System Implementation contains the process of development using , Web service Programming, and smartphone application programming.

Chapter 6, Conclusion and Future Work

This chapter contains conclusions and additional features that is required but not develop yet in this thesis.

Chapter 2. Literature Reviews

2.1 Bus Management System

Bus management system is included into the category of intelligent transportation systems, transportation control framework, and road traffic management [4]. Smart transportation allows diverse technologies applied to transportation systems and can be used as an information collecting and processing data.

Based on the rules of the Republic Indonesia number transport minister Year 2012 about minimum service standard road-based public transport, can be divided into several categories.

2.1.1 Security

a. Bus Stop

- Lighting

  Serves as a source of light in the shelter to provide security for passengers.

- Security officer

  The officer in charge of maintaining order and the smooth circulation of passengers at the bus stop.

- Emergency Response Information

  Information about the event of emergency situations such as a sticker containing a phone number or text message complaints affixed to the place that can be seen easily.

b. Bus

- Bus identity

  Bus number and the name of the route a sticker affixed to the windshield and rear.

- Driver identity

  Boards or identity card that contains the name of the driver and the driver identification numbers placed in the driver chamber.

- Light for warning signal

  Lamp information as a sign of danger in the form of a button that is placed in the driver chamber

- Lighting

  Serves as a source of light in the bus to provide security for service users

- Security

  The person in charge of maintaining order and security in the bus service users

- Tinted Window

  Glass coating on the vehicle in order to reduce direct sunlight

2.1.2 Safety

a. Human

- Standard Operational Procedure (SOP) of Bus Operation

  Rules operate buses that must be obeyed by the driver at least the specified load driving rules, rules raise and drop off passengers, etcetera.

- Standard Operational Procedure (SOP) of handling emergencies

  Procedures for handling emergencies for the safety of drivers and passengers, at least set contains procedures for handling faulty bus door, the bus caught fire and strikes, etcetera.

b. Bus

- Bus eligibility standards

  Vehicle before operating, must pass the feasibility test

- Safety Equipment

  Emergency rescue facility in danger, mounted in place which is easily accessible description of the procedure comes with the use of shaped sticker, and at least covering the glass-breaking hammer, a fire extinguisher, automatic door opener button

- Health Facilities

  Health facilities that are used for emergency in bus accidents, such as an equipment for first handling the accident.

- Emergency Response Information

  Information about the event of emergency situations such as a sticker containing a phone number or text message complaints affixed to the place that can be seen easily

- Facilities handgrip for standing passengers

  Tools for passengers who do not get a place to sit or have to stand in the bus.

c. Infrastructure

- Traffic equipment and buses

  Signs and symbols serve as a support in the operation of road-based public transport.

- Storage facilities and vehicle maintenance

  Aiming as storage, maintenance and repair of vehicles.

2.1.3 Convenience

a. Bus Stop

- Lighting

  Serves as a source of light in the shelter to provide comfort for the passengers.

- Room temperature control facilities and / or air vents

  Facilities for circulation of air inside bus stop using the air conditioner, fans and / or air vents.

- Sanitation

  Provide bins so that passengers do not littering and cleanliness of the stop is maintained.

b. Bus

- Lighting

  Serves as a source of light in the bus to provide comfort for the passengers.

- Bus capacity

  The number of passengers that can be carried by bus.

- Room temperature control
- Facilities for circulation of air inside bus using the air conditioner or fans.
- Sanitation

  Providing trash cans on the bus to keep the cleanliness of the bus.

2.1.4 Affordability

a. Facility for movement of passengers between the corridor

   Passenger accessibility in performing transfer between the corridors.

b. Integrated route

   Facility for access to change of public transport for passengers who have to transit.

c. Fare

   Cost charged to service users for one-way trip.

2.1.5 Equality

a. Priority seat

   A seat on the bus specifically designed for the disabled, the elderly, children, and pregnant women.

b. Special room for wheelchair

   Infrastructures at the bus stop and bus that cater for wheelchair passengers.

2.1.6 Regularity

a. Waiting time

   The time passengers takes for wait the bus.

b. Bus speed

   The average speed of the bus on the way and maximum speed.

c. Time stops at the bus stop

The time required to stop the bus at each stop.

d. information services

The information conveyed to the passengers in the bus stop, at least contain the name of the stop, the arrival and departure schedules, department / routes and corridors, migration corridors and terminals, fare and route map.

e. Bus arrival time information

Information reported in the shelter to passengers about the estimated time of waiting for the bus.

f. Information of bus stops that will be passed

Information about the next stop will be reported on the bus to facilitate passengers who do not know the intended area.

g. Information travel disruption

Facilities at the stops that provide information on the cause delays in bus travel schedule such as operational disruptions.

h. Payment system

Method of ticket purchase that provides ease in conducting transactions quickly and transparently.

2.2 Smartphone

Smartphone is a tool for voice communication or so-called cell phone, smartphone also comes with Mobile Outlook to read e-mail and Mobile Web for browsing internet. Besides being able to receive incoming calls and SMS, such as mobile

phones in general, Smartphone can also receive e-mail, and can also perform real time chat with friends who are online through MSN Messenger [5]. In other words, this mobile phone is a mini computer that has the capabilities of a phone. Growth in demand for sophisticated tool that is easy to carry everywhere makes major advances in processor, memory, display and operating systems that are out of cell phone lines for several years.

Modernization is accompanied industrialization, urbanization and increased education, forcing the particular mobile phone into something common and urgent in the society. Initially, it may be a means of communication is seen as a luxury item. But because of liberalization in all sectors, especially the liberalization of the market, the mobile phone is no longer a luxury item. Nowadays almost every family, perhaps every individual, has a mobile phone. Smartphone phenomenon is the fruit of developments in technology and informatics are more massive. People often call the smartphone as a mobile phone or smart phone smart. Called smart because this phone has a high ability in how it operate. In a simple smartphone is defined as a communication tool that integrates between computers (PC) and mobile phone, coupled with a particular operating system.

A striking difference between smartphones and regular phones lies in its ability when accessing and data connected with the internet [5]. Sometimes regular phones can access the Internet but its ability to slow and not able to access a variety of applications. Operating system (OS) smartphones integrate software and hardware on smartphones. Through the operating system (OS) smartphones similar to a computer device. Each of these smartphones have operating systems are different. Call it like a Blackberry with different operating systems in other smartphones. The explosion of the number of internet users have made the smartphone more attractive. With the

ability to super smart, smartphones have captured the heart of businessmen, academics, and society in general. In terms of age, the segmentation of smartphone users spanning from young people to old people. Initially smartphone famous only among businessmen who are trying to replace the supporting device activity with a smartphone. But over time smartphone that not only have the function of supporting business activity, began to spread to the outside businessmen.

Currently, a feature-rich smartphone functionality with communications devices. The addition of Internet access is the latest innovation in smartphone technology. Currently, users can surf the Internet with the same ease as when using a laptop or desktop computer. At the same time, many manufacturers of smartphone line has been working to improve the clarity and integrity of the base of the phone audio signals. This helps to ensure that even with the addition of any additional features, it is still possible to use a smartphone to make phone calls simply and expect the quality of the sound becomes clear and sharp.

2.3 Wi-Fi

Wi-Fi stands for Wireless Fidelity, has a sense that set of standards used for Wireless Local Networks (Wireless Local Area Networks - WLANs) based on IEEE 802.11 specification. The latest standards of specifications 802.11a or b, such as 802.16 g, is currently in preparation, the latest specification offers many improvements ranging from broad coverage further up the transfer speed [6].

Wi-Fi was originally intended for the use of wireless devices and networks Local (LAN), but now more widely used to access the Internet. It allows anyone with a computer with a wireless card (wireless card) or personal digital assistant (PDA) to

connect to the Internet using the access point (or known as hotspots) nearby. Wi-Fi (Wireless Fidelity) is a wireless connection such as mobile phones by using radio technology, so users can transfer data quickly and securely [6]. Wi-Fi not only allows you to access the Internet, Wi-Fi can also be used to create a wireless network in the company. Because of that many people associate with free Wi-Fi, because the Wi-Fi technology gives freedom to users to access the internet or transfer data from the meeting room, hotel rooms, campuses and other public spaces are marked with Wi-Fi Hot Spot.

One of the advantages of Wi-Fi is the speed which is several times more faster than the fastest cable modem. Wi-Fi so users no longer have to be in the office to work. But Wi-Fi can only be accessed with a computer, laptop, PDA or Cellphone that has been configured with Wi-Fi certified Radio. For Laptop, users can install a Wi-Fi PC Cards shaped card in the PCMCIA slot available. For PDA, using Compact Flash format can install Wi-Fi radio in a slot that has been available. For users whose computers or PDA is using Windows XP, simply by plugging the card into an available slot, Windows XP will automatically detect the area around you and look for a Wi-Fi network that is closest to you. It is very easy to find a sign of whether the device has Wi-Fi, namely by looking at Wi-Fi Certified logo on the packaging.

Technically operational, Wi-Fi is one variant of the technology communication and information work on the network and device WLANs (wireless local area network). In other words, the Wi-Fi is a trade name (certification) given to the device manufacturer of telecommunications (Internet) working in WLANs and network interoperability already meet the required quality.

Wi-Fi is designed based on the IEEE 802.11 specification. Now there are four variation of 802.11, namely: 802.11a, 802.11b, 802.11g, and 802.11n. Specifications

b is the first Wi-Fi products. Variations g and n is one product that has the most sales in 2005. More details can be seen in Table 2.2 below:

Table 2.1 Wi-Fi Specification

Specification	Speed	Frequency Band
802.11b	11 Mbps	2.4 GHz
802.11a	54 Mbps	5 GHz
802.11g	54Mbps	2.4 GHz
802.11n	100 Mbps	2.4 GHz

Internet technology-based Wi-Fi created and developed a group of US engineers who worked on the Institute of Electrical and Electronic Engineers (IEEE) based on technical standards numbered devices 802.11b, 802.11a and 802.16. Wi-Fi devices is not only able to work on WLAN networks, but also in network Wireless Metropolitan Area Network (WMAN).

Due to the technical standard 802.11b devices intended for devices WLAN is used at a frequency of 2.4 GHz or commonly called ISM (Industrial, Scientific and Medical). While technical standards for devices intended for 802.11a and 802.16 WMAN device or also called Wi-Max, which works around the 5 GHz frequency band.

There are four main components to build a Wi-Fi network, as follows:

a. Access point

   Components that function to receive and transmit data from the wireless adapter. Access Point converts radio frequency signals into digital signals and vice versa. The component has served as a hub / switch on the Ethernet network. One Access Point based on the theory can accommodate a few to

hundreds of clients. Nevertheless, the recommended access point can accommodate a maximum of 40 clients.

b. Wireless LAN interface

Wireless LAN interface is equipment installed on Desktop / mobile PCs, appliances developed mass is in the form of a PCMCIA (Personal Computer Memory Card International Association) card, a PCI card or via USB (Universal Serial Bus).

c. Mobile / desktop personal computer

Components for client access devices, mobile PCs in general are mounted port PCMCIA (Personal Computer Memory Card International Association), while desktop PC should be added PCI (Peripheral Component Interconnect) Card, and USB (Universal Serial Bus) adapter.

d. External antenna (optional)

The external antenna is used to amplify the transmit power. Antennas can be assembled by the user.

2.4 Global Position System (GPS)

Global Positioning System is satellite system that can give your position anywhere in the world. GPS satellite does not transmit your position information, which is transmitted satellite is a satellite position and distance of your GPS receiver from the satellite. This information is processed your GPS receiver and the results are displayed to you. GPS receivers acquire signals from several satellites orbiting the earth. Satellites that orbit around the earth on this short composition consists of 24

satellites, with 21 active satellites and 3 satellite as a backup. With the arrangement of certain orbit, the GPS satellites can be received throughout the earth's surface with the appearance of between 4 to 8 satellites. GPS can provide positioning information and time with very high accuracy [7].

The first GPS satellite was launched in 1978 and a constellation of 24 satellites successfully fitted in 1994. After the new routine satellites launched to upgrade or replace old satellites satellites are broken / not working anymore. Each satellite transmits navigation data in the signal of CDMA (Code Division Multiple Access) - Same as the type of signal for CDMA mobile phones. CDMA signal transmission using the code so that the GPS receiver can still recognize the GPS navigation signals even if there is interference on the same frequency. Frequency used is L1 (1575.42 MHz) and L2 (1227.6 MHz) [7].

2.5 Android

Android is a Linux-based operating system for mobile phones such as smart phones and tablet computers. Android provides an open platform for developers to create their own applications for use by a variety of mobile devices. Initially, Google Inc. bought Android Inc., newcomers who make software for mobile phones. Then to develop Android, formed the Open Handset Alliance, a consortium of 34 companies for hardware, software, and telecommunications [8].

At the inaugural release of Android, 5 November 2007, along with the Open Handset Alliance Android states support the development of open standards on mobile devices. On the other hand, Google released the Android code under the Apache license, a license software and open standard mobile devices. In this world

there are two types of distributor operating system Android. The first fully supported by Google or Google Mail Services (GMS) and the second is completely free distribution without direct support Google otherwise known as the Open Handset Distribution (OHD).

Android allows users to install third-party applications, whether derived from app stores or to download and install APK files from third party sites. Because Android devices are generally battery-powered, Android is designed to manage memory (RAM) in order to keep the power consumption minimal, unlike the desktop operating system that can be connected to an infinite power source. When an Android application is no longer used, the system will automatically suspend it (suspend) in memory - technically the application is still "open", but with suspended, the application will not consume resources (battery or processing power), and will be " silent "in the background until the application is re-used. This method has a double benefit, not only improves the response of Android devices because the application does not need to be closed and opened again from scratch every time, but also ensures that applications running in the background does not consume any power in vain [8].

Android manage applications that are stored in memory automatically: when a weak memory, the system will disable the applications and processes that are inactive for a while, the application will be turned off in reverse order, starting from the last use. This process is invisible to the user, so users do not need to manage memory manually or disable applications.

2.6 Web Services

Web service is the application of a set of data (databases), software (software) or a piece of software that can be accessed remotely by various devices with a particular intermediary. In general, the web service can be identified by using a URL such as web only in general. But what distinguishes web service to the web in general is the interaction provided by the web service. In contrast to the URL of the web in general, the URL of the web service contains only a collection of information, commands, configuration or useful syntax construct a certain functions of the application [9].

Web services can be interpreted also a method to exchange data, regardless of where an embedded database, created in what language an application that consume the data, and on a platform of what the data is consumed. Web service capable of supporting interoperability. So that the web service is able to be a bridge between the various existing systems.

Web service itself was formed from [9] :

a. Service provider, is the owner of Web Service which serves to provide a collection of Web Service operations.
b. Service requestor, an application that acts as a client of a Web Service that seek and initiate interaction with the services provided.
c. Service registry, the place where service providers publish their services. In the architecture of Web Services, Service registry is optional. Web service technology allows us to connect different types of software platforms and different operating systems.

   Web service technology is one way every business function to communicate. Not like a client / server model of traditional, such as a web server or a web

page system, the Web service does not provide a GUI for the user. Web service only provides business logic, processes, and data across the network programming interface. Web services do not require a browser or HTML. The next so that Web service can be added to a GUI (such as a web page or desktop application).

Web service built on several web technologies such as XML, SOAP, WSDL, and UDDI.

a. XML (Ekstensible Markup Language) is used for data resources that have a high interoperability (accessible and supported by a wide range of applications and technologies).
b. SOAP (Simple Object Access Protocol), lightweight protocol for XML so that it can be used to analyze the request and response information from the Web service before it is sent over the network.
c. WSDL (Web Services Description Language), an XML form language used to describe the ability of a Web service as a collection of interconnected communications transact messages.
d. UDDI (Universal Description, Discovery, and Integration), a directory which is distributed web-based so that it can register themselves to the Internet so it can be explored.

Web services technology enables an application to be very small in size, because most of the data stored on the web service so it does not need to be stored locally. Web service also makes it easy to update the data in the application because of the changes made in only a web service and all the applications installed locally and access this web service will automatically follow these changes. Web services technology is very suitable for application in mobile applications where the devices

are almost always connected to the Internet and applications that require light in the local installation.

2.7 XAMPP

XAMPP is one installation package of Apache, PHP and MySQL instant that we can use to assist in the installation of three products. XAMPP is a free software, which supports many operating systems, is a compilation of some programs [10]. Its function is as a stand-alone server, which consists of a program the Apache HTTP Server, MySQL database, and translator written in the programming language PHP and Perl. XAMPP name is an abbreviation of X (four operating system), Apache, MySQL, PHP and Perl. The program is available under the GNU General Public License and free, is a web server that can serve display is easy to use dynamic web pages. To get can download directly from its official website.

XAMPP is a development of the LAMP (Linux Apache, MySQL, PHP and PERL), XAMPP is a non-profit project developed by the Apache Friends established Kai 'Oswalad' Seidler and Kay Vogelgesang in 2002, their project aims to promote the use of Apache web server [10].

2.8 PHP

PHP was originally used as a programming language for server-side HTML-embedded with the name Personal Home Page Tools [10]. The first one was created by Rasmus Lerdorf in 1994. Subsequently renamed FI ("Form Interpreter"), his form a set of scripts that are used to process the form data from the web. Furthermore, Rasmus released the source code to the public in 1995 and named PHP / FI, short for

Hypertext Preprocessing / Form Interpreter. With the release of this source code into open source, so many programmers who are interested in developing PHP.

In June 1996, released PHP / FI 2.0. In this release the PHP interpreter program has been implemented in C. In this release also included extension modules that enhance the ability of PHP / FI significantly. In 1997, a company called Zend rewrite the PHP interpreter to be cleaner, better, and faster. Then in June 1998, the company released a new interpreter for PHP and formalize such as PHP 3.0 release.

In mid-1999, Zend released a new PHP interpreter and release is known as the PHP 4.0. PHP 4.0 is a PHP version of the most widely used at the beginning of the 21st century. This version is widely used due to its ability to build complex web applications but still has the speed and stability. In June 2004, Zend released PHP 5.0. In this version, the core of the PHP interpreter underwent major changes. This version also includes a model object-oriented programming in PHP programming language to address developments in the direction of the object-oriented paradigm [10].

Chapter 3. System Requirement

3.1 System Architecture

In order to accomplish the objectives of the thesis which relies on using Web services to integrate multiple datasets, there are several special requirements that need to be fulfilled such as accessibility for offering access the system using web service enable device and up to date which means data displayed in the application must be the latest data produced [11].

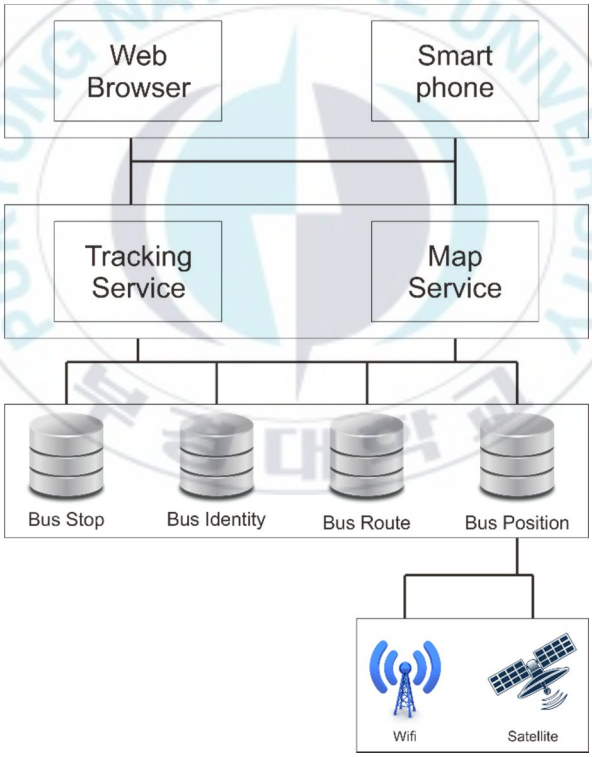

Figure 3.1 Logical Architecture

According to these requirements, the logical architecture of the proposed system are defined in figure 3.1 which includes the interaction among three layers:

a. Data Layer

This layer consist of datasets used by system:

- Bus position: It contains a real time position from bus that passenger want to take. The real time position provide from GPS that installed in a bus and information that get from connection between Wi-Fi device in a bus and in a bus stop.
- Bus route: This dataset contains information on the routes to be passed by each bus.
- Bus identity: The information contained in this dataset is information regarding the identity of each bus, as the bus number, bus drivers, and bus numbers.
- Bus stop: At this dataset contained information regarding the position of the bus stop.

b. Service Layer

This layer consists of service published by the system

- Map Service

  Map service host a position of every bus and bus stop. It will show in a map in the smartphone application or web service.

- Tracking Service

  Tracking service enable people to track a bus that they want to take. It provide a real time position of each bus.

c. Application Layer

Application layer deals with the user interface, user interaction, and data visualization. It consist of two different GUI for each web browser and

smartphone application. It has direct connection with user management database.

3.2 Functional Requirements

Functional requirements describe the possible effect of the system or what the system must accomplish. Based on the studies in the literature review, we determine the functionalities that are needed for the application are as follows [1] [12]:

a. Able to make a communication between Wi-Fi device on a bus and bus stop, and send a data to server.
b. Able to represent an information from data sources using layer and integrate them in one map that can show in a web browser or smartphone application.
c. Able to provide an information about bus stop, route, and bus position in a web browser or smartphone application.

These capabilities should be presented to three types of user involved within the system, which are depicted as actors in figure 3.2.

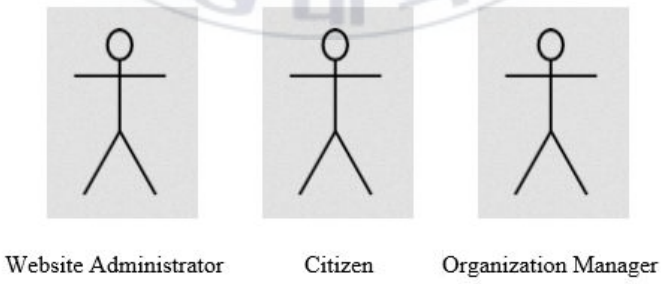

Figure 3.2 Use Case Diagram Actors

Website administrator is a super user in a system. This user responsible in managing the server, user, and database. Therefore, this user can perform all tasks

defined in the system. Organization manager is the person who posts their own data source to use by the system like bus stop and bus route information. Citizen is general public who uses the system to view the bus stop or bus location.

The actors are capable of performing these following tasks using the proposed system:

a. Layer management

   Add, edit or remove data sources and information to the database for both website administrator and organization manager. Website administrator is responsible for screening all the data sources posted in the system.

b. Bus Stop, Bus route, and Bus real time location

   User can view a bus stop and bus route and a real time position of bus that they want to take

c. User Management

   Website administrator can add manage users or organizational managers.

Table 3.1 List of use cases

Features	User	Use Case
Layer Management	Website Administrator	Manage published datasets
	Organization Manager	Manage layers on map
	Organization Manager	Publish datasets
Bus stop, route, and location	Citizen	View an information about bus from web browser or smartphone application
User management	Website Administrator	Manage users
	Organization Manager	Register user

Table 3.1 is a list summary of relationship between features, users, and use case which are depicted in figure 3.2.

Chapter 4. System Design

4.1 Overall System

In this system, user will be able to track the real time position of bus that they want to take. Information of real time bus position get from GPS on a bus and communication between Wi-Fi. All of the information will send to server and provide to user through smartphone application and web browser [13].

4.1.1 Tracking System

For track the bus position, GPS in a bus will send a bus position to the computer database periodically. Once the server receive the bus position, the database will update with the latest of bus information that server receive [14].

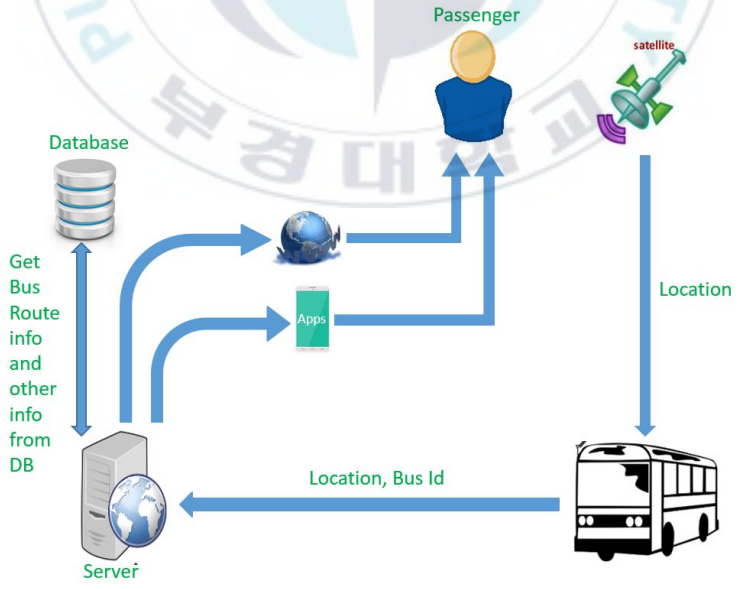

Figure 4.1 Process of sending bus position to computer database

4.1.2 Communication between bus and bus stop

Wi-Fi is use for make a communication between bus and bus stop. A Wi-Fi device will be assembled in each bus and bus stop [15]. The communication will make when a Wi-Fi in a bus stop recognize a Wi-Fi signal in a bus [16]. After the device in bus stop identify the signal, they will pairing. Communication will occur when the bus is within a distance 10 meters or less from the bus stop [1].

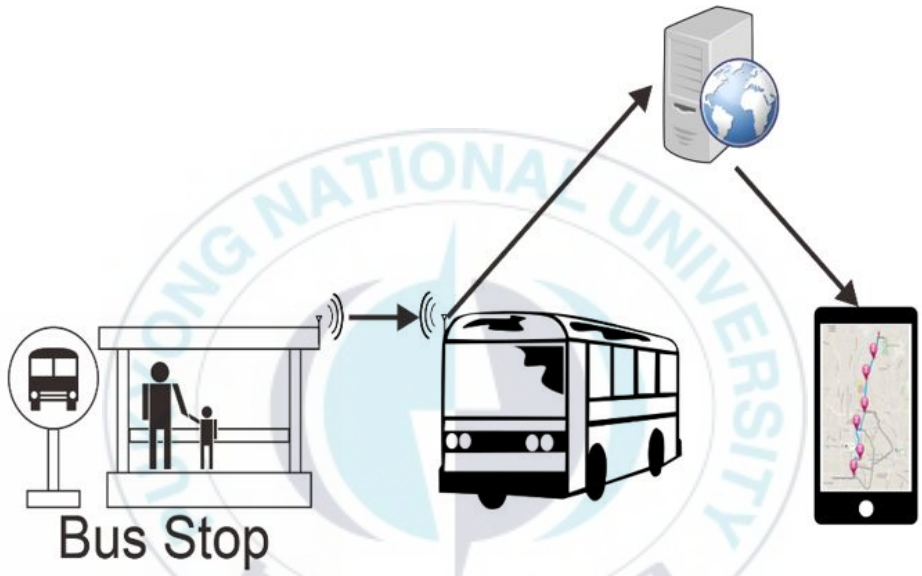

Figure 4.2 Smart Bus System Management

In figure 4.2 show how smart bus system management work. By the time the bus position is 10 meters or less from bus stop. There will be communication between the bus stop and bus. This communication generates data packets to be sent to a computer database. Data packets sent containing the bus number, driver's name, stop being visited, and the time of arrival of the bus at the bus stop.

4.2 Features

4.2.1 Tracking bus position

This feature allows users to track the bus position that passenger waiting for. The position of the bus that will be shown is a real time position, because the position will update automatically every time a device on bus send location to computer database.

4.2.2 Routes

This feature allows passengers to see the route of each bus. This feature can help passengers when passengers do not know which one bus that they should take to get to their destination

4.2.3 Near Bus Stop

In this feature the passenger can see the near bus stop. When passenger dont know well about their location, this feature will help passenger to find near bus stop around them.

4.3 Database Design

4.3.1 Bus Stop

#	Name	Type	Collation	Attributes	Null	Default	Extra	Action
1	ID	int(11)			No	None	AUTO_INCREMENT	Change Drop Primary Unique Index Spatial Fulltext More
2	Name	varchar(20)	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
3	Latitude	double			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
4	Longitude	double			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More

Figure 4.3 Design Table of Bus Stop

Figure 4.3 show a design for database table of bus stop. It contains bus identity number, driver name, position of a bus such as latitude and longitude. Identity number define as integer, name define as varchar, and position define as double.

4.3.2 Bus

#	Name	Type	Collation	Attributes	Null	Default	Extra	Action
1	ID	int(11)			No	None	AUTO_INCREMENT	Change Drop Primary Unique Index Spatial More
2	RouteID	int(11)			Yes	NULL		Change Drop Primary Unique Index Spatial More
3	PolicyNumber	varchar(15)	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial More
4	DriverName	varchar(100)	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial More
5	Status	int(11)			Yes	NULL		Change Drop Primary Unique Index Spatial More
6	Latitude	double			Yes	NULL		Change Drop Primary Unique Index Spatial More
7	Longitude	double			Yes	NULL		Change Drop Primary Unique Index Spatial More
8	Speed	double			Yes	NULL		Change Drop Primary Unique Index Spatial More
9	Timestamp	datetime			Yes	NULL		Change Drop Primary Unique Index Spatial More

Figure 4.4 Design Table of Bus

Database table design for Bus is illustrate in figure 4.4. This table consist of bus identity that define as a integer, route id define as integer, bus policy number define as varchar, driver name define as varchar, status of driver define as integer, bus position (latitude and longitude) define as double, bus speed define as double, and timestamp define as date time.

4.3.3 Route

#	Name	Type	Collation	Attributes	Null	Default	Extra	Action
1	ID	int(11)			No	None	AUTO_INCREMENT	Change Drop Primary Unique Index Spatial More
2	Name	varchar(20)	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial More
3	Icon	text	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial More
4	Path	text	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial More
5	PathReserve	text	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial More

Figure 4.5 Design Table of Route

Design of database table for route composed of bus identity that define as a integer, driver name define as varchar, icon define as text, path define as text, and las path reverse define as text.

4.3.4 Bus Stop Transaction

#	Name	Type	Collation	Attributes	Null	Default	Extra	Action
1	ID	int(11)			No	None	AUTO_INCREMENT	Change Drop Primary Unique Index Spatial Fulltext More
2	BusStopID	int(11)			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
3	BusID	int(11)			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
4	Status	int(11)			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
5	Timestamp	datetime			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More

Figure 4.6 Design Table of Bus Stop Transaction

In figure 4.6 show a database table design for bus stop transaction that consist of bus identity define as integer, bus stop identity define as integer, status define integer, and timestamp define as date time.

4.3.5 Location

#	Name	Type	Collation	Attributes	Null	Default	Extra	Action
1	BusID	int(11)			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext Distinct values
2	Latitude	double			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext Distinct values
3	Longitude	double			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext Distinct values
4	Speed	double			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext Distinct values
5	Timestamp	datetime			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext Distinct values

Figure 4.7 Design Table of Location

In figure 4.7 above show a design table of location for database smart bus management system that consist of bus ID, bus position (latitude, longitude), speed, and the last is timestamp.

4.4 Application Design

4.4.1 User Application

The first look of smart bus management system application is illustrated in figure 4.8. When user open the application, the first thing to be displayed is map like show in figure 4.8. To see the position of bus, user must click a button of start service first.

Figure 4.8 Design of user application

Figure 4.9 Design of track bus display

Figure 4.9 show a design for features track bus display. The position of each bus will be seen on the map in this application. To see a detail of bus, user need to click on a bus sign first then click a button of select bus. After that user can see a detail information of the bus.

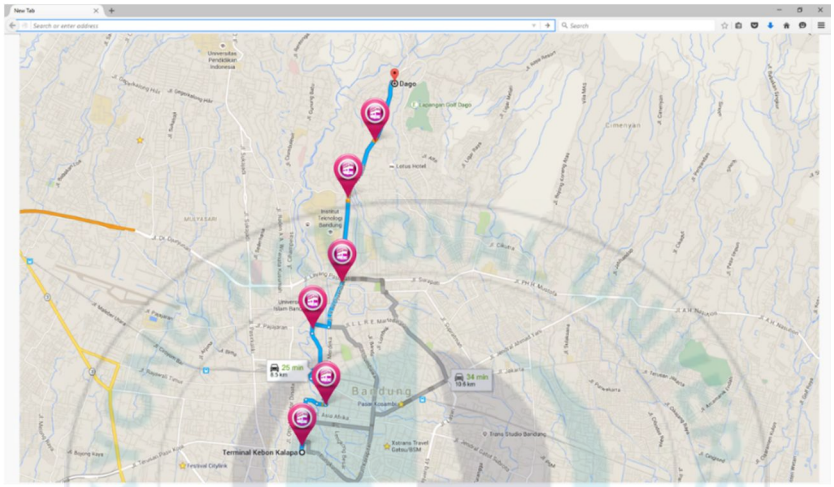

Figure 4.10 Bus Tracking in Web Browser

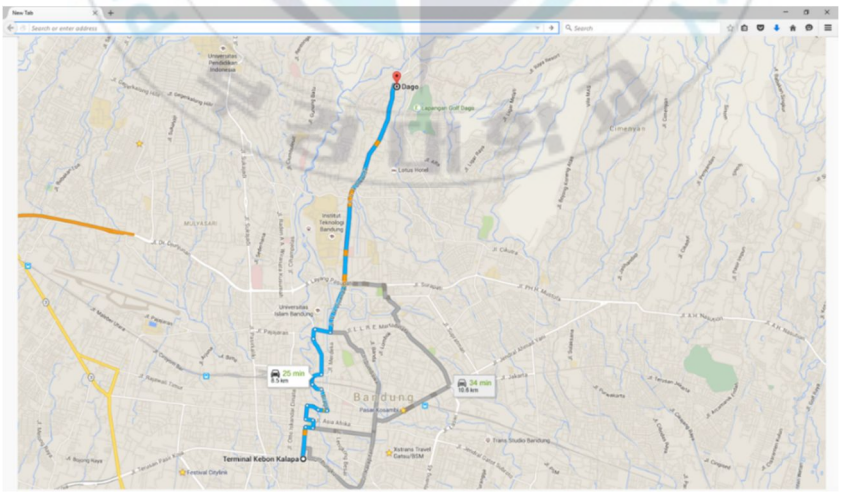

Figure 4.11 Bus Route

Design for web browser can show in a figure 4.10 and 4.11. This figure describe how the tracking bus menu and bus route menu looks like in a web browser.

Chapter 5. Implementation and System Analysis

5.1 Physical Architecture

This section describes smart bus management system architecture. The system consist of software which software which deployed in several machines including client and bus management server. The following are software needed to develop system:

a. Database management system

   A system consisting of base-data and Software (Software / program) which aims for effectiveness and efficiency in the management of the database. Database management system (DBMS) consists of software that can manage data storage. Making it easier for organizations to centralize the data, manage the data efficiently and provide access to data to the application program.

b. Smartphone application

   This application is used for driver and passenger. Driver use this for send location to server and passenger use this application for see bus schedule, bus stop, track bus, and bus route. In this thesis application is developed using Android.

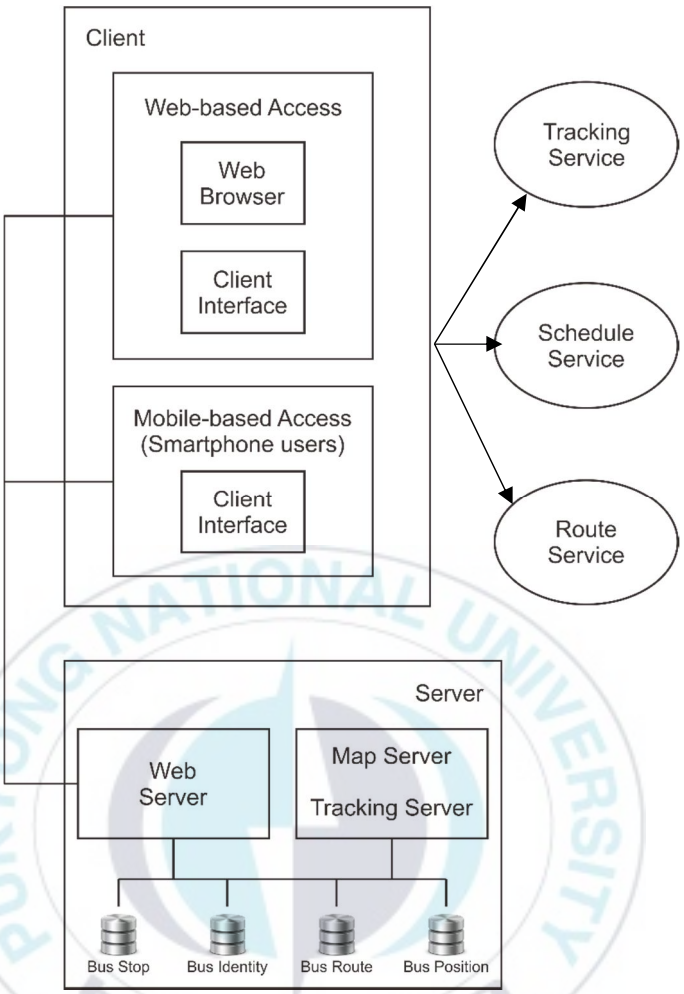

Figure 5.1 Physical Architecture

5.2 Flowchart

The system featured are divided into three categories for each actors involved which are administrator, manager, and user. User divided into driver and passenger. Administrator is the super user which can access every menu in the system. Manager acts as a supervisor who checks the data entered by the admin and check the bus management system work. The administrator will enter data bus stop, every bus route, which passed through each route stop, the bus numbers for each route

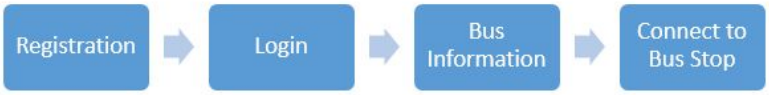

Figure 5.2 Bus Management System

Figure 5.3 show how management bus system work. It divided into 3 part. First part is register user, second is login application, and last is scanning Wi-Fi.

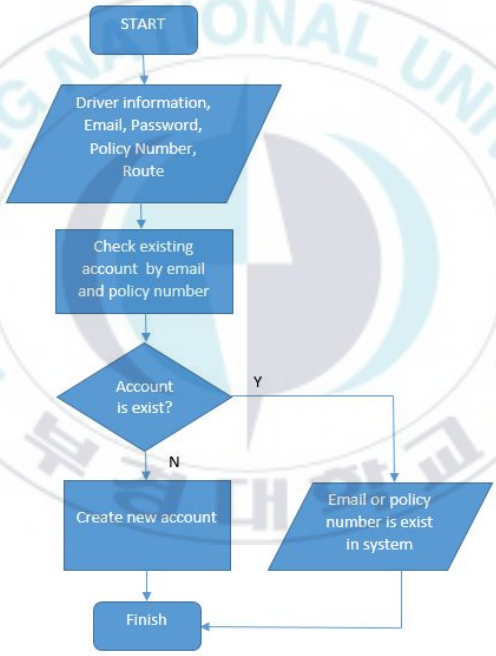

Figure 5.3 Register flowchart

In registration part, administrator actors will register a user as a driver. In this part administrator will enter a data about a driver and bus that he drive. Data to be entered are driver name, gender, email, password, bus number, and bus license plate. The system will check entered email and license plate. If the email or license plate

already exist, user can not register. If the license plate and email not yet register, there will be no problem to register the user. After register, driver can use the application as a driver user.

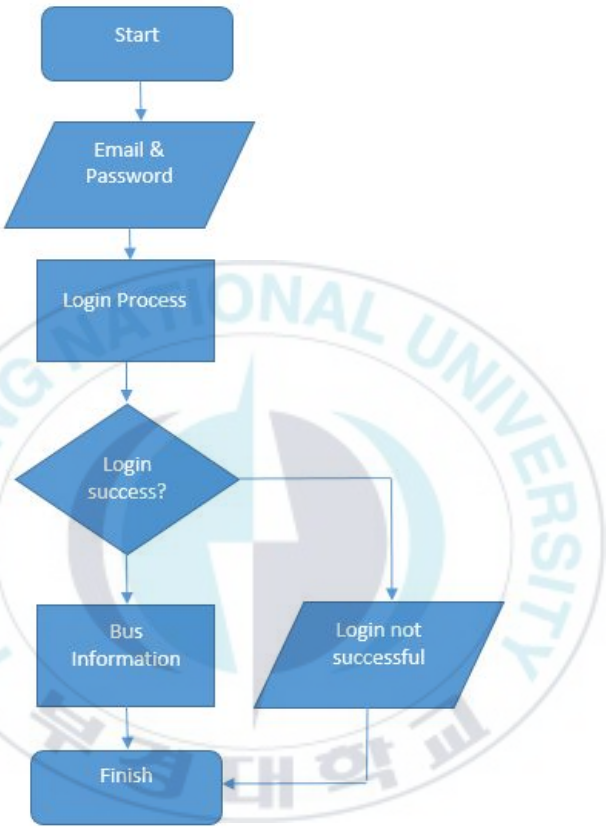

Figure 5.4 Login Application Flowchart

In this part, user is prompted to enter an email address and password. First system will check whether the entered email is correct. If not correct application will give pop up message tell that user not registered. Reverse if email match with registered user, system will check whether the entered password match. When the password incorrect application will show pop up to say that password incorrect. If the password correct, system will enter to map. The application is ready to use by driver.

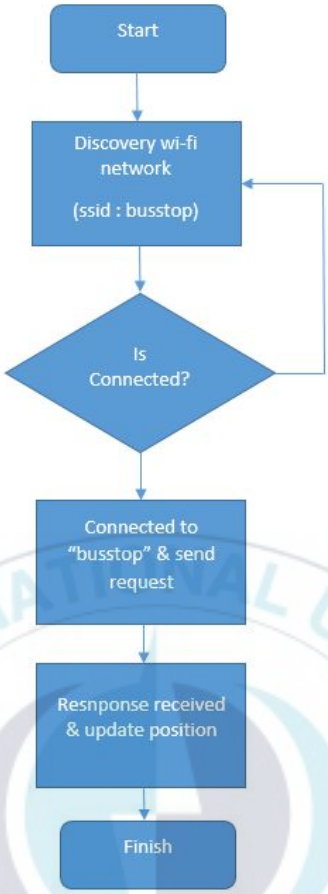

Figure 5.5 Scanning Wi-Fi Flowchart

As described in the previous chapter, at every bus stop will be installed Wi-Fi are named specifically. Phone inside a bus that has installed smart bus management application will detect the Wi-Fi signal from the bus stop. Wi-Fi is the name given in each stop the same, if the application detects the Wi-Fi name, then the application will send a request to the Wi-Fi. Applications will wait for a reply from the Wi-Fi destination. Replies will be received in the form of the name stops being visited. After getting the name of the stop, then the application will process the data to be sent to the server. The server will update the data on the last stop which is visited by the bus.

5.3 Simulation Result

The simulation consists of two entities, namely: buses and server. To perform the simulation, created 500 buses as the dummy data to send a bus position to server.

5.3.1 Analysis Server

Results of the simulation use to analyse the speed of the server to receive a data that sent by buses.

Table 5.1 Execution Time Server Needed for Receive a Data

Amount	Longest (ms)	Fastest (ms)	Average (ms)
1	12,008	12,008	12,008
10	31,248	12,162	17,186
100	59,539	12,508	17,871
200	69,015	12,007	20,886
300	198,131	12,008	38,645
400	231,153	12,007	40,361
500	243,661	12,433	47,573

Table 5.1 shows the time it takes by server to received data sent simultaneously by buses. The resulting is the longest time, average time, and the fastest time that server needed in receive data.

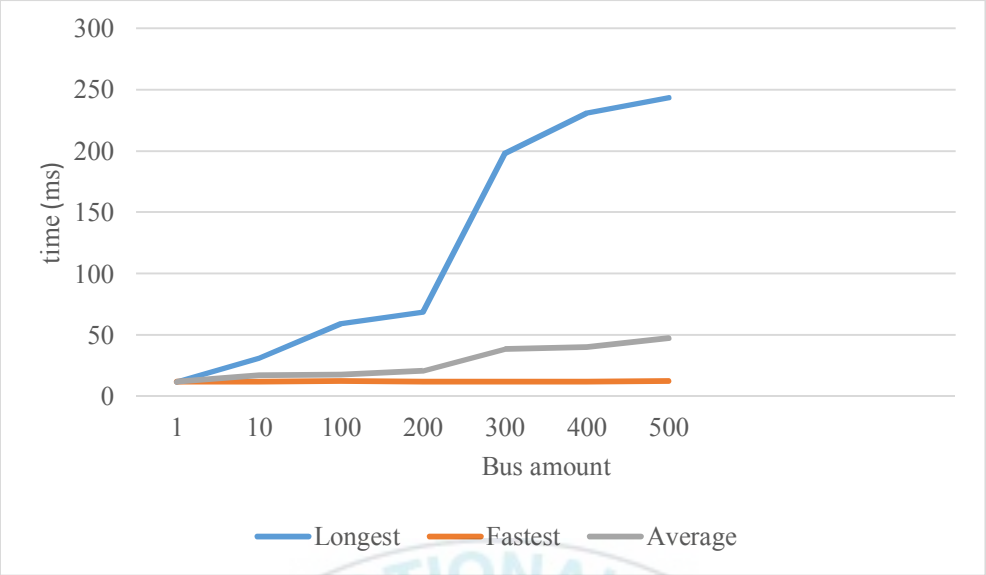

Figure 5.6 Graphic of time server take to receive a data

Figure 5.7 shows the graphic of the time it takes by server to received data sent simultaneously by buses. The resulting is the longest time, average time, and the fastest time that server needed in receive data. As we can see in the chart, the more requests received by the server then the longer time server takes to receive the data.

In the graph above shows a significant change in the longest time required by the bus, when the number of buses that transmit data simultaneously to 300 buses. The longest time it takes into 198.131 compared to the current number of buses that transmit data up to 200 buses. The longest time it takes up almost three-fold.

It may happen because of several factors, one of which is the number of users. A large number of users or the network at the same time can slow down the response time on the network, especially those networks are made without regard to any traffic or traffic data. The design of the network can be based on the details of the average number of network users who may simultaneously communicate at the same time.

However, in times of peak number of users to exceed the average of the estimated results that can degrade performance.

A server can only handle so many users at once. If hundreds, thousands, or millions of people are trying to reach a server at the same time, the data processing will be much slower and, in some cases, server may not even respond or load.

The second factor is the internet connection. The internet connection is greatly affect the process of sending and receiving data. Unstable Internet connection can result in sending data from the client side to the server be longer or even fail.

Another factor that affects and is related to the internet is a backbone. Backbone is a connection between computers that spans the globe who provide full service for internet service providers (ISP). Backbone has approached 45 MBps connection associated with a specific interconnection points called national access point. Local ISPs usually connect to this backbone through a router so that data is brought to its final destination through this backbone. Manufacture of a Backbone is a very high technology and funds. Most ISPs Backbone hired from another company or use together with other ISPs. Use of Backbone together can save costs, but can reduce the speed of access to each ISP [17].

The next factor is the bandwidth. Bandwidth will be allocated to the computers in the network and will affect the speed of data transfer on the computer networks. So the greater the bandwidth on the network computer the faster data transfer speeds that can be done by the client or server [17].

The location of server can also be one of the factors that affect the timing of data transmission. If the bus trying to transmit data from a considerable distance from the server, it will be much slower than a server that is hosted closer to its location [17].

Although not a common situation, a slow data transfer connection can also be caused when ISP is being attacked, e.g. a DoS attack. With a DoS attack, computers and routers become so overwhelmed with requests that it causes the data transfer to be slow. In addition other things such as the specification used on the server computer or operating system used can also influence the process of data transmission.

5.4 Data Collection

There are 4 data used by the system as described in data layer in Figure 3.

a. Bus position

   This data records position for each bus such as latitude, longitude, and latest bus stop visited.

b. Bus route

   Contains track route for public transport or the transportation service with a bus that has its origin and destination

c. Bus identity

   This datasets collected identity of bus such as number of bus, license plate, driver name, bus position, and route.

d. Bus stop

   This datasets contains complete information on bus stops located on each route.

Figure 5.1 shows a schema of smart bus management system database. It consist of bus table location, table bus stop, table bus stop log, table route, and table bus.

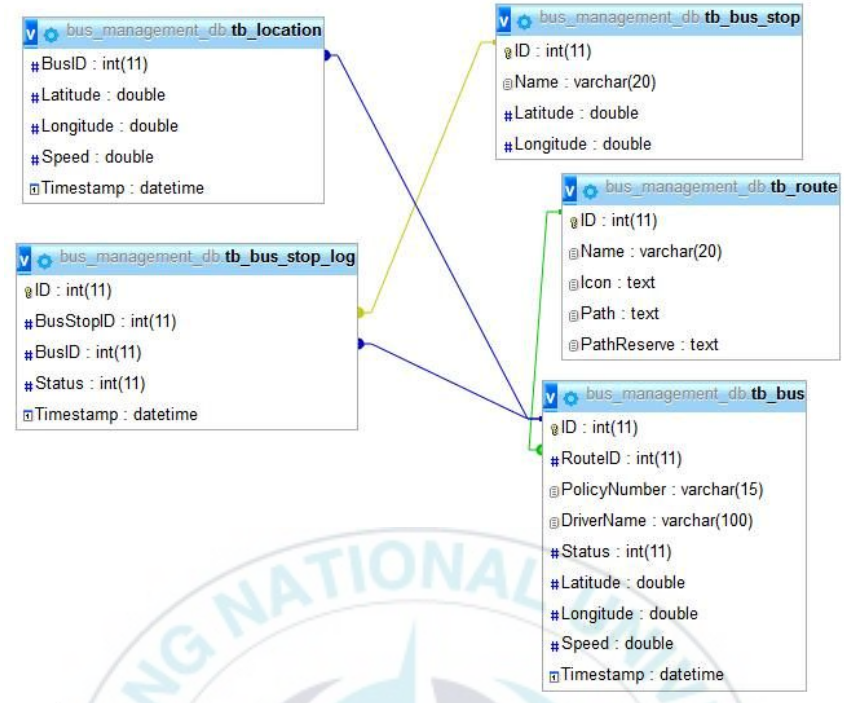

Figure 5.7 Database Schema for the system

5.4.1 System Analysis

On this system use a GPS to get the latest position of the bus. In addition, to ensure the bus latest position, this system also use wi-fi mounted on every bus stops. Communication that occur between buses and bus stops through Wi-Fi, helps to give information about bus stop that is being passed through by bus. So bus companies can do inspection about which bus stop already passed by the bus and travel time required by bus from one bus top to the other bus stop. This data can be used by bus companies to analyse the performance of the bus and conduct an evaluation. Therefore Bus Company can improve its performance services to be better than before.

For passenger side, this system will be really useful. Because before passengers heading to the bus stop, passengers can track the bus position they want to take. So passengers can do an estimation of their time of departure to take a bus. By doing this estimation, will helps passengers to be more efficient in the management of their time. Therefore, passenger will not waste their time just to wait a bus for a long time because they have no idea how much longer time will take for the bus that they waiting for come. And this system also helps passengers decide to keep using the bus or choose another alternative. Because through this system passenger can estimate the arrival time of buses awaited and when they will arrive at the destination. So if the passengers already knew that they did not have enough time to wait for the bus, passengers can look for another alternative to go to their destinations.

Chapter 6. Conclusion and Future Work

In order to attract people to prefer to use public transport compared to private vehicles, significant researches have been carried out on the design and implementation of smart bus management system.

The use of Wi-Fi and GPS on the smart bus management system is expected to help the process of monitoring to get a more accurate status of the position of the bus and the data can be sent in real time to a monitoring center to be forwarded to the passengers. An update bus position also helps the passengers to estimate the time that will take to their destination. This smart bus management system should be able to enhance the efficiency of the bus monitoring system.

In this thesis we develop database management system to collect all the data regarding management bus. The data collected is the data of all bus stops, bus schedules, bus number, route followed, the data driver, and the position of the bus. These data are needed to provide the required passenger information.

Also we design an application for passenger and driver. Utilizing the use of smartphones that are currently being rapidly adopted and with all the limitations encountered in developing countries such as Indonesia. Provides information on bus schedules and other things needed by the user can be one of the solutions for a better transport management.

For future work, in this system we can develop a notification for next stop of the bus that user take in user application and it also can use in driver application. In drivers application can be connected to the speaker, therefore when the application

connected to Wi-Fi in the bus stop, the application will issue a notification of the name of the bus stop next to be visited through loudspeakers mounted on bus.

Moreover, the features for accident management such as damage vehicle damage or accident will be added as a future work. And we will focus on optimizing computational overhead during data transmission.

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