Free Feeder/Bus Ticketing Systems Modelling for Students in Surakarta City Based on Android Platform

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Abstract. High population growth causes an increase in community mobility to meet their travel needs. This has an impact on the use of private vehicles that are not controlled, which is causing transportation problems. The solution to the transportation problem is to use public transportation as a mode of travel. The government is obliged to provide adequate public transportation so that people switch from using private vehicles to using public transport vehicles. In order to meet the needs of public transportation, therefore, the Surakarta City Government provides a free BST bus/feeder fleet specifically for student. In connection with this, a ticketing BST bus/feeder system is needed to monitor and supervise public transportation users. The aim of study is to develop a free ticket system for student to use public transportation in the form of BST bus/feeder using Android smartphone technology. By using this system, students are expected to depart and return from school using public transportation provided by the city government for free without the need to be escorted and picked up by parents or guardians. Study results is an android application called Ride for Free, which is user friendly and helps students to their daily riding activities to school.

Keyword : transportation, vehicles, public transportation, government

1. Introduction
Transportation is a form of human needs that allow the movement of people and goods from one place to another. Many Indonesian populations lead to increase transportation needs. Increased transportation requirements resulted in increased expenditure emissions [1]. The congestion is also a cause of the expensive an uneconomic transportation cost. Public Transportation is a real solution in reducing the gas emissions of transportation activities [2]. Its big capacity makes the smaller number of vehicles operate to serve people in moving in cities. The use of private cars and motorcycles will significantly decrease. The transportation cost will be more economic with the use of public transportation. The current condition of public transportation is poor. The number of inadequate fleets and unsatisfactory services causes the lack of users of this mode, which impact on the use of massive private vehicles in the form of cars or motorcycles. An effort is needed to change the situation, so that public transportation becomes more attractive to public. Businesses that can be done include adding facilities on buses [3], or public subsidies [4]. The Surakarta city is currently revitalizing urban public transportation by providing free Batik Solo Trans (BST) bus/feeder public transportation facilities for students as part of the government subsidy program. This aims to reduce transportation problems in the form of traffic accidents, traffic congestion and air pollution in the Surakarta city.

The use of massive smartphones today is very beneficial for the development of systems based on this technology. At this time, the smartphone has been equipped with various hardware for connectivity with various systems such as camera, Global Positioning Systems (GPS), Bluetooth,
Wireless Fidelity (WiFi), touchscreen and others. Android Operating System (OS) is the most popular OS used for smartphones today. It occupies more than 70% of smartphone market share in recent years [5].

Quick Response Code (QR Code) is form of 2-dimensional barcode, where a barcode is readable optical label which contains certain information of things such as item identification, time tracking, document management [6]. It can be utilized with optical tool within smartphone using related library to build application based on this technology. In addition, currently almost all smartphones are equipped with GPS technology. For the android operating system, the map library is provided by Google Maps so that it can be used to determine the position or route of a vehicle trip, as well as the estimated travel time based on the current traffic situation.

This research is designated to develop a free bus/feeder ticketing application system in android systems platform. The application simulates that students to register and use the application to ride a bus/feeder to get to the schools. This main goal of the systems is to attract students to use public transport in their daily activities based on subsidiary system. In long term, it is hoped to reduce traffic congestion and air pollution so that quality of cities increases significantly.

2. Literature Review

2.1. Public Transport
Public transport (also known as public transportation, public transit, or mass transit) is a system of transport for passengers by group travel systems available for use by the general public, typically managed on a schedule, operated on established routes, and that charge a posted fee for each trip [7]. In Indonesia cities, public transportation that has certain routes and schedules can be city buses/feeders. For ideal conditions, a passenger can estimate when to take public transportation and what time he will arrive at the destination. Besides the cheap and affordable travel costs will be a special attraction for a prospective passenger.

2.2. Geographic Information Systems and Google Maps API
Geographic Information Systems (GIS) is defined a computer system used to process data, store in a database and display them in map. Benefits of GIS in general, it provides information approaching real-world conditions and predicts an outcome and strategic planning [8]. Within today, the widespread use of internet become a point of interest among researchers to develop cross platform applications which can be accessed by any tools connected to internet, for example by web browsers. Google as a giant internet industry has been trying to provide application of GIS accessed via web browser and providing a tool for developers to enrich their spatial web application with its API (Application Program Interface) [1]. Google Maps API has started its service since 2005 until today provided by Google [9]. This API library can be accessed by a developer after he registered and get an API key so that he can put Google Maps on his websites and to utilize the Google Map in developing their applications. Unfortunately, today the Google Map API is not free of charge anymore.

2.3. QR Code and Android Platform
Barcode is an optical readable label. It can be a collection of numbers/characters encoded into a combination of thick/thin lines and spaces among them. There are two major symbology of barcode i.e. Linear (1D) and 2-dimensional (2D) barcode [6], see Figure 1. The QR Code is a form of 2-dimensional barcode widely used at today application.

![Figure 1. Shape form of linear and 2-dimensional barcode.](image-url)
The QR Code has several advantages such as it can store much larger amount of data ranging up to thousands of alphanumeric characters; Error correction formula can be embedded into barcode, which helps in the retrieval of data. In case barcode is damaged up to 15 to 20% and Variety of data can be embedded into these barcodes such as numeric, binary, text and Unicode data [10]. The Android Platform Developer [11] (Android Studio Inc) has provided library to read a barcode data and decode it into alphanumeric character data i.e. ZXing library that must be added in the AndroidManifest.xml file. It can deal with both linear and two-dimensional barcode types.

2.4. Relational Database Management Systems

Storage system using a database (Database management system-DBMS) is a data storage system that is widely used when. This system allows us to process data well compared to the file system because the process of manipulating data becomes easier. Relational DBMS (RDBMS) is a database system that uses keys (primary and foreign) to maintain its tables consistency. A key plays important role in inserting, updating, deleting and retrieving data in RDBMS system. MARIADB [12] is a kind of free RDBMS developed based on MYSQL [13] database systems. MARIADB is compatible with most operating systems (OS) such as Windows and Linux based OS (FreeBSD server, Ubuntu server). To work with this RDBMS, several script such as PHP (Hypertext Pre-processor), ASP (Active Server Pages) or JSP (Java Server Pages) as middle ware and Webserver such as Apache or IIS (Internet Information Services) are required. Figure 2 shows the architecture of web based and android application accessing MariaDB RDBMS.

![Figure 2. Architecture of web/android applications.](image)

3. Research Method

3.1. Location

This research is conducted at computing laboratory of Department of Civil Engineering University of Sebelas Maret Surakarta. The database model and application developed uses Surakarta City as a case study. The Surakarta City map is shown in Figure 3.
3.2. **Tools**

The development process of the application requires online web and database servers, Google Maps API key. The address of the servers is https://sipil.ft.uns.ac.id with support PHP54 engine as main web language programming. The tools for editing remote files at server are Win FTP client and Putty telnet client, where Android Studio is used to develop android application with an attached smartphone to laptop for application emulation.

3.3. **Research Stages**

This research focuses on developing database model public transportation (bus/feeder) ticketing systems and android application for public transportation users. The data flow diagram is built to identify all the process required by the systems. All information obtained from data flow diagram such as all entities and result of the processes is stored in the database systems developed. The next step is to developed interface between server and android application using PHP54 scripts. The last step is to build android application supported with Map API library and barcode reader functionality.

4. **Result and Discussion**

4.1. **Data Flow Diagram (DFD)**

A Data Flow Diagram (DFD) is a traditional way to visualize the information flows within a system. It shows how information enters and leaves the system, what changes the information and where information is stored. The purpose of a DFD is to show the scope and boundaries of a system [14]. The Figure 4 shows the context DFD of Free Bus Ticketing Systems. It contains 3 entities i.e. students, buses/feeder and service admin and one process namely trip to school. This system facilitates the public transportation service for students free of charge to travel from home to school and back home after school. Students as customers must register prior to using the facility, buses/feeder are public transport vehicles that provide the service where service admin is a staff who manage the administration of the system.

![Figure 4. Context DFD of Free Bus Ticketing Systems.](image-url)
The level 1 DFD of Free Bus Ticketing Systems is presented at the Figure 5. The DFD contains two external entities, 3 data stores and 3 processes. At the 1st process (registration), a student must register to the systems using his/her own smartphone after downloading and installing the installer (apk file) on it. The registration data submitted by student are verified by service admin to check the validity of data entered and activate the account. The account is bound to the International Mobile Equipment Identity (IMEI) and phone serial number (SN) of the gadget used so that a student is only able to use her/his account with the same gadget in which he/she has registered with.

![Level 1 DFD of Free Bus Ticketing Systems](image)

**Figure 5.** Level 1 DFD of Free Bus Ticketing Systems.

The 2nd process (trip), a student starts taking a trip to travel to the school at near bus/feeder stop and get on the bus/feeder by scanning QR code provided at bus/feeder with his/her gadget (online) and the data will be sent to the database server. After arriving at destination, the student updates his complete trip status. The 3rd Process contains activity of service admin to generate reports and send them to city government for administrative purpose.

### 4.2. Data Flow Diagram (DFD)

The database model is designed in MariaDB as shown in Figure 6. There are four tables namely `tblstudents`, `tblvehicles`, `tbltrip` and `tbladmin`. The relationships of tables (primary and foreign keys relationship) are `tblstudents` and `tbltrip` (one to many), `tblvehicles` and `tbltrip` (one to many). The `tbladmin` table is used to store user information who has administration access. The `tblstudents` table records students registered to the systems, the `tblvehicles` stores vehicle data owned by public transportation provider and the `tbltrip` records activity of students use public transportation to/from schools.

![Relationship model of the database](image)

**Figure 6.** Relationship model of the database.

### 4.3. Application User Interface

Figures below describe the application user interface at android platform. Figure 7(a) shows the icon of the Ride for Free App. The front menu contains three buttons namely Log in, Register and Exit buttons, see Figure 7(b). Log in button is used to trigger login dialog to appears as shown on Figure
A student (user) may register to the system using Register button so that registration form will appear. To leave the application, user press on exit button.

![Figure 7](image_url)  
**Figure 7.** Icon, Front Menu and Login Dialog of the Ride for Free App.

After press on Register button on Figure 7(b), the Registration form will appear where a student must fill out all fields completely. At this stage, the application will access IMEI and SN data of the phone. The data will be stored in the database along with all entered data once the student press on save button. At different level and platform, an admin service will validate the data with result the activation of the account if entered data are valid. The students can view and edit his/her profile information on Profile form.

![Figure 8](image_url)  
**Figure 8.** Registration and profile forms of the Ride for Free App.

The data will be stored in the database along with all entered data once the student press on save button. At different level and platform, an admin service will validate the data with result the activation of the account if entered data are valid. The students can view and edit his/her profile information on Profile form.
At main menu form, a user can start to use the application to take a trip (Figure 9(b)), view/edit his/her profile (Figure 8(b)), view historical data of his/her trips (Figure 10(a)) and check user’s current location (Figure 10(b)).

User may take a trip by using main menu (Figure 9(a)) and press on take a trip button. Soon, the take a trip form will appear (Figure 9(b)) and triggers camera activity in the smartphone. The camera must be focused on a 2-dimensional barcode sticker placed on the vehicle. After reading the sticker, the application decode the content of it and request data to server related to the data obtained. At succesful request, trip status form will appear, and informs the user about his/her trip status. After arriving at destination, the user must press on end my trip button to complete his/her trip.

Figure 9. Main menu, Take a Trip and Status forms of the Ride for Free App.

Figure 10. Registration and profile forms of the Ride for Free App.
5. Conclusion
Reducing gas emissions from transportation activities is very important to create a sustainable city of Surakarta. One effort that can be done is through subsidies on the use of public transportation. Potential target to this policy is students who take trips to their school at schooldays by private vehicles as most students are familiar with android gadget usage. This research has developed an application named Ride for Free along with its database model. The application is useful for government in order to encourage citizens especially students in using public transportation. The application required internet access and built-in GPS on its operation. It is user friendly to use because its simplicity at user interface and only uses several forms and buttons.

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