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Locating Real-time Location of Perak Transit Buses and Determining its Estimation of Time of Arrival (ETA) at a Particular Bus Stop through the Development of Mobile Application on Android Platform

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Abstract – **Creating an added value service to the current passengers and eventual users of public transports requires service providers to deal with and engage in the issues related to mobility, productivity, efficiency as well as security to vitally enhance the user's travelling experience and improve the current public transportation scenario in Malaysia. Although with existing products and application, certain mentioned issues are not being satisfied by the developers. The project is centred on designing and developing a mobile application to track the real-time location of Perak Transit buses and determine the ETA of the bus at a specific bus stop. Through the use of technology and mobile application, the project and the development of the mobile application support the realization of 'Perak Maju 2015' by increasing the value of the public transportation sector in Perak, which should be considered a part of the development strategy. The application is built on Android platform using Rapid Application Development (RAD) method through the use of prototyping and utilizes the Global Positioning System (GPS) for the tracking purpose. The development of the project is focused on empowering the existing and prospective users of Perak Transit buses to obtain comprehensive set of information in making informed travelling decisions**

Keywords – mobile application; technology; development; public transportation

I. INTRODUCTION

Public transportation serves three (3) different key areas which are economy, environment and social equity [1]. Public transportation service in each nation differs from one another as it depends on the state of the country's development. Public transportation is deemed as a critical component especially in provincial ranges as it has exhibited in the changes of welfare in a community in the recent years [2].

Past researches regarding the Malaysian public transportation sector suggest that Malaysian citizens are not satisfied with the current service provided by the public transportation service providers. It is reported that the level of satisfaction does not meet the expected level of user's preference on the service [3].

Information is deemed important for the users of public transportations in Malaysia in which decisions can be made properly and in an informed manner. The lack of information regarding Perak Transit bus services on their website (www.peraktransit.com.my) becomes the main driver of the project and the development of the mobile application.

The problems are further explored and segmented into several smaller problems, thus proving the actual need for the project. The segmentations include: (1) need for ample information, (2) need for productivity and (3) need for security.

The development of this project centres on the two types of public transportation users which are (1) commuters and (2) journeyers to which both users rely heavily on information pertaining to the a specific public transportation they use [4]. The project focuses on designing and developing a mobile application that provides comprehensive information about Perak Transit bus services which include its current location, estimation of time of arrival to a particular bus stop, bus routes and fares.

The benefits of using the mobile application are by allowing the users to track the real-time location and estimation of arrival of Perak Transit buses at a particular bus stop, reducing the idle waiting time at a bus stop and enabling the Perak Transit users to plan their journey efficiently.

Upon the highlights of the problems to be solved, it is significant to develop a mobile application to enable users to obtain complete information regarding the bus services for them to properly plan their journey. Hence, the objectives of developing the mobile application are:

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☐ To design and develop a tracking system algorithm using GPS to track the real-time location of the buses

☐ To design a mobile application to track the real-time location of the buses and provide estimation of time of arrival

☐ To develop a mobile application to track the real-time location of the buses and provide estimation of time of arrival

☐ To evaluate the effectiveness of the mobile application developed based on the outcomes from the user testing

The scopes covered for the project and mobile application development are categorized into: (1) mode of transportation of the project, (2) targeted users of the mobile application and (3) development platform to create and build the mobile application.

☐ Mode of transportation selected – The mobile operates throughout Perak

☐ Target users – The mobile application is designed and developed for the use of the current passengers as well as the prospective users of Perak Transit buses regardless local people or visitors (both international and local)

☐ Development platform – The mobile application is designed and developed using Phonegap which is a mobile development framework. The mobile application is built using web application development languages such as HTML5, Cascading Stylesheet (CSS), Javascript, jQuery mobile and a cloud service provider, *Firebase* as database.

☐ Operating system (OS) – The mobile application is developed for Android platform as a recent study shows that 65 per cent of the mobile phones used in Malaysia are Android-based [5]. It can help the developed mobile application to cater to a wider market segment as compared to iOS (Apple Inc.) or Research in Motion (Blackberry).

In explaining about the development of bus tracker mobile application, this paper is structured as follows. First, comparative studies on the existing applications available in both local and international markets as well as the technology used for the tracking purpose are introduced in Section II. Following this, the methodology that is used to develop the mobile application to locate the real-time location is explained in Section III. In Section IV, the results and findings of this research is presented. Finally, this paper ends with a conclusion.

II. LITERATURE REVIEW

The two main effects of rapid increase in the number of privately-owned vehicles are: (1) worsening traffic congestion and (2) increase in the rate of pollution [3]. Hence, the Malaysian government has induced a policy to encourage the citizens to use public transportation as a part of their travelling solutions to reduce the current situation [6].
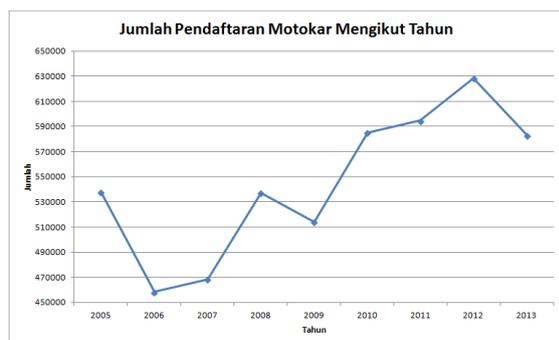
CHART 1: The increasing number of privately-owned vehicles in Malaysia from 2005 until 2013. Source: Jabatan Pengangkutan Jalan (JPJ), Malaysia

However, it is understood that the government effort has failed as people are relying more on their own vehicles to commute due to the poor standard of services received from the public transportation providers. Younger generations in Klang Valley have been identified as having the highest level of prejudice towards local public transportations [7]. Therefore, this situation justifies that the level of satisfaction on using public transports in Malaysia is surprisingly lower than the level of expectation of the users.

The use of public transportation is often associated with being unsafe, longer travelling time, and uncomfortable as well as low self-image [8]. Thus, the public transports are not a premier option for travelling. Using public transportation also commonly linked to higher dissatisfaction due to delays, unpredictability and longer time to travel [9].

Consequently, public transport service providers need to increase their quality of service in order to become parts of the sustainable solutions to the current quandary which will satisfy the needs of the current users as well as future passengers that will ensure the success of their services and businesses. The solution of this problem needs to include the factors of frequency, travel experience, security and travel time in order to guarantee a desirable consequence [3].

Learning from past exploration and previous researches demonstrate that public transportation in Malaysia is still an option as a travel mode of choice for some individuals. To pull in prospect travellers, public transport service providers must enhance their administrations to suit and satisfy extensive variety of clients need and desire on the services received.
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Therefore, as part of the requirement of this project to satisfy the stakeholders which include Perak Transit operators and its passengers – the focus will be based on delivering an end-product that caters the issues of safety, comprehensive information of the journey, in hassle-free environment when using Perak Transit buses and delivering added-value service to increase one's sense of self.

The mobile application will be built on Android platform as 65 per cent of smart phone OS (*refer to Figure 1*) used by people in Malaysia is Android [5].
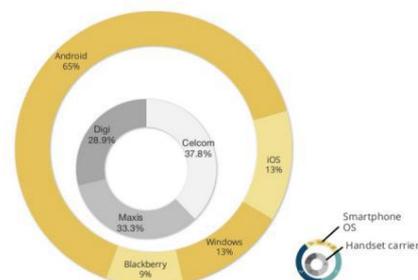
FIGURE 1: Breakdown of smart phone OS in Malaysia as in 2014

The initial stage of the project implementation refers to decision-making process of selecting technology (hardware) to be used to the buses. The selected technology to be implemented is Global Positioning System (GPS) that seems most suitable for the project when compared with other technologies such as Real-time Locator System (RTLS) and Radio Frequency Identification (RFID).

GPS is most suitable for the use in the outdoor and global tracking as it is useful in spacious area [10]. Due to its efficiency and usage policy, GPS is used in smart phones for its consumer applications and car navigation system. The cost however, differs and has a wide range (*refer to Table 1*).

Comparative Study - Hardware/ Technology

Technology / Characteristics	Radio-frequency Identification (RFID)	Global Positioning System (GPS)	Real-time Location System (RTLS)
Suitability of implementation	For smaller spaces	For outdoor, global tracking	For assets and people tracking over Wi-fi
Tracking accuracy	Only locatable next to RFID reader gates	10+ meter	Typically ranges from 1 to 3 meter
Cost	Ranges from low-cost to high-cost	Ranges from low-cost to high-cost	Fairly expensive
Usage	Warehousing, logistics	Smartphone consumer apps, car navigator	Assets management, healthcare

Reference: http://integratedwireless.blogspot.com/2013/04/the-difference-between-gps-rfid-and-rtls.html

There are few similar product offerings from different parties both in local and international scenes. Three (3) existing commercial products have been chosen in which two (2) are Malaysian products and one (1) is from United States of American (USA).

The chosen applications and systems are Asian Pacific University ("APU") Bus Tracking and Timetable, Chicago Transit Authority ("CTA") Tracker and myUniBus (*refer to Table 2*). All applications serve the same objective with the same target which is public buses only to differ from one another in certain criteria.

APU bus tracking and timetable is a web-based service that informs users the time of departure of a bus and the current fleet locations on a Map. myUnibus however, only shows the current location of buses based on its routes. CTA Tracker on the other hand, offers both web service and text messages (SMS) utilizing push-notification technique by providing the estimation time of arrival (ETA) of a bus and the current location of the buses.

Hence, myPerakTransit mobile application aims to close the gaps of the existing applications by providing more comprehensive information to the users so that they can make informed decision by focusing on mobility, productivity, efficiency and safety. The information that is made available to the users includes ETA, distance from the bus stop, bus routes, bus locations and bus fares.

Mobile apps / Characteristics/Features	Asian Pacific University (APU) Bus Tracking & Timetable	myUnibus	Chicago Transit Authority Bus (CTA) Tracker	myPerakTransit
Platform	Web application	Web application	Web application, text messages (SMS)	Smartphones (Android devices)
Scheduled time of departure	✓			
Estimation of time of arrival (ETA)		✓	✓	✓
Fleet routes		✓		✓
Fleet locations	✓	✓	✓	✓
Fares	N/A	N/A		✓

TABLE 2: Comparison between existing applications (APU, myUnibus and CTA) with myPerakTransit mobile application.

Thus, the myPerakTransit mobile application has those features that could help to encounter those weaknesses revealed from other technologies. First, it provides accessibility from anywhere and at any time. Second, it includes all set of information deemed necessary by the users and passengers of Perak Transit buses to make their travelling journey smooth and efficient.

III. RESEARCH METHODOLOGY

This study has followed the rapid prototyping development (RAD) methodology (*refer to Figure 2*) in developing the mobile application. A prototype has been developed as a tool to solicit and understand user's requirements. The prototype was then being refined incrementally until end-users are satisfied. Although it took a longer time that estimated to develop the mobile application, rapid prototyping allowed developer and stakeholders to reach mutually agreed to the features, designs and accessories of the application. This has prevented the developer from building a product that fails to meet stakeholders' expectations.
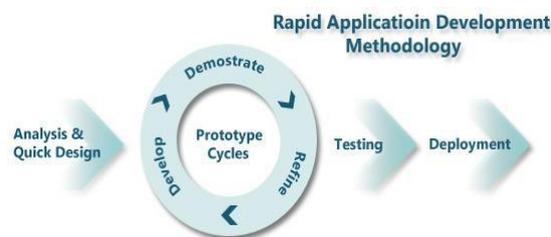

FIGURE 2: Rapid application development (RAD)

In the effort of developing the mobile application, this project has followed the archetypal flows used in conventional system development lifecycle (SDLC) methodology which begins with project planning, requirement elicitation and gathering, design analysis stage, prototype development, validation and verification (V&V) and maintenance as well as change management.

The mobile application is developed using web development languages which include *Hypertext Markup Language* (HTML), *Cascading Stylesheet* (CSS), *Javascript*, *jQuery mobile* and *Firebase* for the database to store the positions (longitude and latitude) of the tracked bus. The project is then compiled and transformed into a mobile application using *PhoneGap*.

In order to sustain the project quality management aspect of this project and the end-product, two forms of test are performed which graphical user interface (GUI) testing and system (functionality) testing. Both testing are performed with the users

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of Perak Transit buses. It is important that the development process is kept incremental to keep up with the requirements and feedback obtained from the users to ensure its usability at the end of the project, upon project pull-off. Continuous refinement is made until the end-product is deemed appropriate by the users prior to the commercialization stage.

The testing is performed to compensate the risk factor associated with the RAD model which concerns with the appropriateness of the testing performed due to the nature of the method.

The use case diagram below (*refer to Figure 3*) explains the functionalities of the mobile application which include track location of bus, obtain ETA and check bus fare.
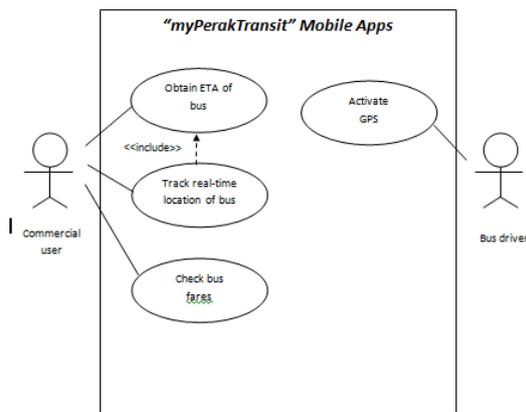

FIGURE 3: *Use case diagram of myPerakTransit mobile application*

The data flow diagram (*refer to Figure 4*) however, explains the relationship between each functionality by exemplifying the flow of data (input and output) from one functionality to another. Among the information necessary for the mobile application to operate and display to the users are bus details (bus routes and fares), ETA to a bus stop, distance of the bus from the stop and current location of the bus.
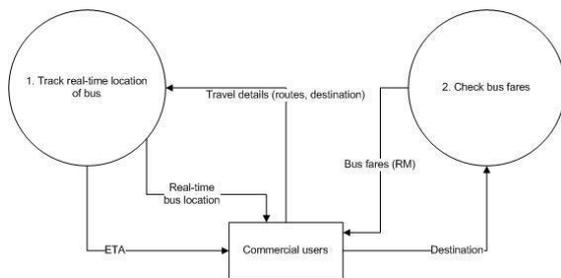

FIGURE 4: *Data flow diagram of myPerakTransit mobile application*

IV. MOBILE APPLICATION TO TRACK THE REAL-TIME LOCATION OF THE BUS AND PROVIDING ETA TO THE USERS

A. GRAPHICAL USER INTERFACE

The mobile application is developed for the use of current passengers and prospective users of Perak Transit bus services. The mobile application receives input from the users (the user's current bus stop and desired destination) and translates the input into the output which will display: ETA of the bus at the user's current location, distance of the bus from the bus stop and bus fare that the user needs to pay for the journey.
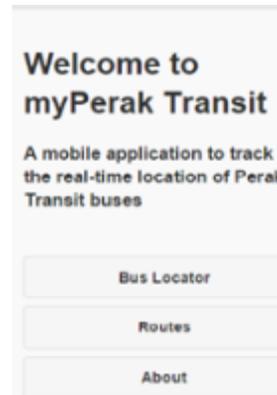

FIGURE 5: *Home page of the developed mobile application. Users will obtain the bus ETA, distance and bus fare from the 'Bus Locator' function. 'Routes' will show the routes and the bus stops that the bus will go to.*
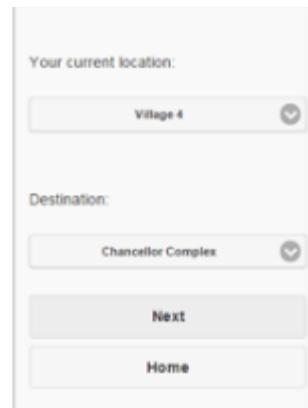

FIGURE 6: *Bus Locator – User will select their current bus stop of where they are at and preferred destination*
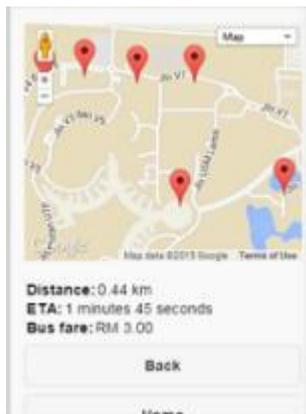
FIGURE 7: The information (distance of the bus from the stop, ETA and bus fare) will be displayed on the next screen.

Using the information, users are empowered to make decision regarding their travelling journey.

B. REAL-TIME LOCATOR USING MOBILE PHONE GPS

The current position of the tracked bus (latitude and longitude) is obtained using the mobile phone GPS (*refer to Figure 8*). The position is continually updated in *Firebase* (online database) and the position is extracted by the user's application side to be translated into distance and ETA.

FIGURE 8: The application to track the real-time location of the bus, installed on the driver's phone

C. SYSTEM AND FUNCTIONALITY TESTING OF THE MOBILE APPLICATION

During the testing period, five selected participants are chosen to test the developed mobile application to understand its usability, user-friendliness and accuracy in providing the said information for them to make decisions. The samples are given scenario cards which enlist several questions regarding the three mentioned aspects for the evaluation of the mobile application. The results of the scenario cards are collected and analyzed (*refer to the Chart 2*).

CHART 2: Results from the testing performed with five selected samples

CONCLUSION

The unique objectives of this project have been met in order to help alleviate the current problem faced by the passengers of Perak Transit buses.

Objective 1: To design, develop and implement a tracking system algorithm to track the real-time location of the Perak Transit buses.

Objective 2: To design and develop a mobile application that enables the users to track the real-time location of Perak Transit buses and its ETA at a particular bus stop

Objective 3: To evaluate the effectiveness of the mobile application developed based on the outcomes from the users of Perak Transit buses

The mobile application enables user empowerment of passengers of Perak Transit buses by providing comprehensive set of information (bus route, fare, ETA and distance of the bus from a bus stop) in catering to the issues of security, efficiency and productivity. The development of the mobile application provides additional value to the users as well as the operator and management of Perak Transit bus service.

Nevertheless, future enhancement can be done onto the new version of the mobile application by utilizing Google Maps API to provide more accurate ETA. The accurate result is more reliable for the commercialization phase, which can be extended to the other routes that the Perak Transit buses operate at in Perak region.

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