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Real-Time Campus University Bus Tracking Mobile Application

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Real-Time Campus University Bus Tracking Mobile Application is a mobile application to help campus members detect the current location of the bus in real-time. Real-Time Campus University Bus Tracking Mobile Application is a hybrid mobile application. However, for this development, it is developed for Android user only. It can show updated estimation time arrival and the number of persons inside the bus. This project using two devices embedded inside the bus, which are GPS Tracker device and IoT people counter device. All devices will transmit the data into cloud database which is Firebase. Real-Time Campus University Bus Tracking Mobile Application is developed as a platform for user to receive the data transmitted from database. Other than that, Student will know the time arrival of the bus and the current quantity of people inside the bus to lead them avoid wasted time knowing that they wait for the bus that pack of passenger. The student also able to make complaint and feedback via the platform. Furthermore, this project using PhoneGap as a tool platform to develop the application. The GPS Tracker device using Arduino and IoT people counter using Raspberry PI to transmit data. Overall this project using the reusability techniques and Agile method to complete all the system which it is involved four interactions to make it full system work as expected.

Keywords—Hybrid, GPS, PhoneGap, Raspberry PI, Agile, Reusability

I. INTRODUCTION

Bus Transportation already began on August 10, 1826, in Nantes called Omnibus [1]. Omnibus consist of 2 horses and can hold into 16 passengers at one time. The word bus is derived from Latin word which is Omnibus that carry the meaning of carriage for all. After the development of Omnibus, people keep invented by reuse the similar architecture of the system such as horsecar, cable car streetcar and modern bus. Public transportation in Malaysia starts developed during the British era. Since then, public transportation in Malaysia is getting better over the time.

However, over the years, many issues occurred such as the time management of the bus transportation is decrease due to the environment factors [2]. For example, in University, the main passengers are students and staff members. Currently, they are often late to class and faculty because they decide to wait for the bus without knowing the exact location of the bus. Most of them feel unsure where the location of the bus. They do not know the current location of the bus and they could not estimate the time arrival and time for them to get prepared. Other than that, not knowing the unique identification for a bus will also complicate them on which bus they should take.

To reduce this inconvenience, Real-Time Bus Tracking System is developed. The system ease people in managing their journey plan. The main function of the system is to track the exact location of a bus. Other than that, the main objective of developers developed Real-Time Bus Tracking System is to motivate more people to ride public transportation and increase their satisfaction. This system is can help reduce traffic congestion as well as environmental impact.

II. RELATED WORK

A. Similar Existing System

Around the world, there are many vehicles tracking system have been developed. These systems have their own uniqueness. An example of EVO GPS Tracker is developed to provide vehicle security and GPS location for personal and fleet vehicle owners. This device combines with advanced technology and safely features to keep the vehicles secured whenever they go. Controlling and Monitoring the vehicles can be done in an easy and convenient way [3]. LiveViewGPS designed to provide vehicle security and GPS location for fleet vehicle owners. Now they have variety of option to choose either personal, bus, professional vehicle, and all sorts of vehicle tracking system. They have a device that combines with advanced technology that keep the vehicle secured whenever they are [4]. XSSecure XTS Tracking System is GPS navigation engineered for use in vehicles. This device is manufactured in Conjoinix which is a multinational company and a producer of security equipment. It provides huge list of features like, stolen vehicle recovery, asset tracking, video & audio surveillance, transit tracking, fuel monitoring, distance calculation, historic tracking data auditing and etc [5].

B. Techniques Used

Nowadays, people used many kinds of different operating system in their smartphone such as iOS, Android and many others. Thus, developers need to develop many kinds of platforms using different frameworks, architectures and contents to build an equal application for all. The cost of

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implementation for the multiple platforms are high. Developers also need to have the expertise on the various platforms. Developers are introduced to use the alternative way or approach for the multiple implementation such as a cross-platform development approach. There is also an alternative way for developers to less the workload which they can implement and applying reusability techniques in developing equal applications. Thus, by using the two mentioned techniques, they could choose any suitable approaches along with the reusability techniques in using the existing components of existing systems into a new platform that they want to develop.

a) Cross-platform development

Cross-platform development approach can be classified into few approaches such as web approach, hybrid approach, Interpreted approach and cross-compiled approach. These approaches have their own advantages and challenges in developing a multiple platform system.

b) Reusability Techniques

The idea of reusability has been proposed for a long time. Instead of developing an invention of solutions, Ecole et al on 2014 has claimed that it is easier if developers innovate a new product or system by using the applicable information that can be extracted from the previous developed solutions [6]. There are various reusable approaches that can be applied such as software product line approach (SPL) in extracting components from existing system and component-based approach (CB) in implementing extracted components into new development. The selection of suitable approaches typically not defined in a proper way. Each project finds its own approach based own the time management and budget pressure. The selection of the right approach requires careful consideration of multiple criteria and careful balancing among application requirements, technical characteristics and financial issues.

III. METHODOLOGY

Agile method is used in developing this Real-Time Bus Tracking Mobile Application. This method is used as it has simple phase flow that allows any changes in requirement made by the client [7]. This proof that this method makes the development process more flexible in term trends and technologies [8]. Minimize the overall risk of the project is one of the advantages of the agile method. This method follows every interaction, as the interaction ends, the development is considered finish and moved into the next interaction. The Figure 1 shown the phase that needs to be taken by each interaction. Agile method lightens the work that needs to be done by the development team. Therefore, the team can focus on rapid development and delivery of the system. The development process is ensured to be optimized by this method.

Besides that, reusability techniques also been used in this development. Software product line approach and component-based development approach are chosen for implementing reusability technique in this project. Both approaches are suitable as the authors apply vertical reuse type as same domain is used for the implementation which is real-time bus tracking system.

Fig. 1. Agile Method for Real-Time Bus Tracking Mobile Application

IV. ANALYSIS AND DESIGN

As software product line approach (SPL) is chose as the reusability technique approach, the components can be extracted by analyzing few similar systems. SPL is one of an effective approach which allows systematic reuse of development artifacts through efficient identification and management of commonality and variability of a product [9]. SPL is developed from a common set of core assets and variable features. SPL identifies and manages the commonalities across a set of system artifacts such as requirements, architectures, code components and test cases [10]. Thus, few similar system as existing system need to be compared to identify the components that can be reused.

After the components were identified, they were used in developing the new system by using component-based development approach. Component-based development approach is a branch of application engineering. It is also a reuse-based approach in implementing independent components into systems. Table I shows the analysis of few selected similar system.

Next, Table II shows the requirement model based on the similar existing systems. This requirement model is analysed by comparing and featuring the three similar system with the use case specification of Real-Time Bus Tracking Mobile Application. This analysis is based on the model invented by Halim on 2016 named CVAnalysis [14]. Thus, the developers reused the software architecture which are Three-Tier Layer and few components that stated.

The symbol ‘x’ that tabulated in Table II means the specified system have corresponds the functional requirements. ‘P’ means the feature is optional while ‘c’ means the feature is common. In order to determine whether the requirement is common or variable, the total occurrences of each feature among all the system is calculated. The author set if the occurrences value is equal or more than half of 100%, it be considered as C while below the percentage it will be denoted by P. In scoping the requirements by identifying the features property and calculate predictive of core assets is using the CVAnalysis [15].

TABLE I: ANALYSIS ON THE COMPARISON ON SIMILAR EXISTING SYSTEM

Description \ Author(s) and System Name		Real-Time College Bus Tracking application for Android smartphone [11]	Real-Time Bus Tracking System [12]	Real time Web Based Bus Tracking System [13]
Environment	System Platform	Android	Hybrid	Web system
	System Task (Functionality)	-Able to track the location of vehicle. -Able to estimate the estimation time arrival of a vehicle	-Able to track the location of vehicle. -Able to estimate the estimation time arrival of a vehicle. -Feedback session	-Able to track the location of vehicle. -Able display an updated static bus schedule
Hardware features (Tracker Device)		GPS Tracker (GPS tracking device)	Android Application installed in any portable device (Mobile phone-based tracking)	GPS Tracker (GPS tracking device)
Software Architecture Used		Three Tier Layer	Client Server	Three Tier Layer
Software used for implementation	Software Tools	Android Studio	-Sublime -phoneGap	-Sublime
	Languages	C#	HTML, PHP and CSS	HTML and CSS
	Database	Localhost (for testing) *for real implementation (not mention)	Firebase	Localhost (for testing) *for real implementation (not mention)

TABLE II: THE REQUIREMENT MODEL

Requirements Model:	Vehicle Tracking System Name and Author(s)			Total of occurrences per row(A).	Value (%)(A/3) *100)	CV Property
	Real-Time College Bus Tracking application for Android smartphone	Real-Time Bus Tracking System	Real-Time Web Based Bus Tracking System			
Requirement Model: Select Destination	x	x	x	3	100	C
Requirement Model: Scan location by using QR Code		x		1	33.3	P
Requirement Model: Detect User Current Location	x	x		2	66.7	C
Requirement Model: Detect Vehicle Location	x	x	x	3	100	C
Requirement Model: Display vehicle Details	x	x	x	3	100	C
Requirement Model: Update Location	x	x	x	3	100	C
Requirement Model: Display schedule of bus		x	x	2	66.7	C

V. ARCHITECTURE USED

The architectural style of this system is a Three tier layer. The system is designed to be used on a mobile device application with the connection to a server using the Internet. Mobile application's core operation is to update the user interface with the newly requested information based on the user's input and retrieve data from a data store. This system has few modules which can be break into three partitions; (i) Transportation module, (ii) Admin module and (iii) User module. Those modules have their own characteristics.

Transportation module describe how the bus is tracked by installing the GPS Tracker. The GPS satellite transmits microwave signal to GPS bus tracker device that allows the device to give related information such as location, bus speed, estimation time arrival, and direction. This allows GPS tracker device to update the historic navigation data in real time. The data received by GPS satellite is then transferred into GSM or Cellular Network for the location of the bus map in the mapping system. The recorded navigation data is stored in an internet server. The client will receive this historic navigation data in Real-Time Campus University Bus Tracking Mobile Application when they make a request to check where the current bus is. For IoT people counter, its calculate how many people in the current bus. Once it did calculate the total of people inside the bus, it will transmit the data into internet server and store the data there. The total number of people inside the current bus

will transmit into the client when client choose their destination in real-time campus university bus tracking mobile application.

Next, admin module describes how the bus driver and management team to manage the location and information. Admin module is responsible to manage and update all static information about bus such as new buses, routes into database. Besides that, admin also keep in touch with end user through feedback session to maintain the reliability and the performance of the system. In addition, admin module contains a web interface for administrators that shows the summary of the bus being tracked. It will display a map using the Google Static Maps API, with vehicle and location data from database. Furthermore, admin also can monitor bus stop frequently used by user for further bus route improvement. Figure 2 shows the architecture of system.

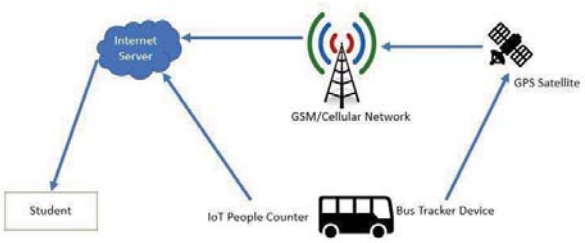

Fig. 2. System Architecture for Real-Time Bus Tracking Mobile Application

Finally, user module describes how the user interact with the functionality to use the Real-Time Campus University Bus Tracking Mobile Application. User module describe interfaces of all the functions provided with user interface to remote the end users. There are 6 main function in the main interface which is Where's My Bus, Bus Schedule, Feedback, Gallery, Contact, and Call Us. Where's My Bus interface required user to set starting and destination point. The starting point can be set using user's current location via GPS or scan QR code at the bus stop. In Bus Schedule, user send request of queries to the server for accessing the information stored in a server database to retrieve information on bus arriving time.

V. IMPLEMENTATION AND EVALUATION

A. Apparatus & Experimental Setup

To fulfil requirements needed in developing proposed application system, development team used some apparatus to reach the target.

1) Apparatus 1: System Interfaces

a) Google Map API

Our proposed system will be interfaced with Google Maps API. Google Maps API provides our application with full access to Google's worldwide database of over 100 million business. By using this APIs, we can show our users a filtered list of places that are most relevant to them [16].

2) Apparatus 2: Software Interfaces

a) PhoneGap Tools

Every user in university may use different type of mobile operating system. Every mobile operating system provides their own set of tools and environments to develop apps that will run on them. Our development team needs to understand and cover all major development tools for different operating systems. This will increase the time taken in implementation phase. Thus, we decide to use PhoneGap tools as it is a solution to all problems mentioned above. PhoneGap allows its users to upload the data contents on website and it automatically converts it to various App files [17]. Besides PhoneGap is an open-source and free, development team does not require to have an expertise over any mobile operating system. Developers only need to know web development using HTML, CSS and JavaScript.

b) Firebase Realtime Database

The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and synchronized in real-time to every connected client. Drivers will send the data of location bus to the database by using the android application platform. Then, Firebase Realtime Database will automatically receive the updates with the newest data. Our system will then fetch the update data of a bus from the same database. The data in Firebase Realtime Database is synced across all clients in real-time and remains available although our application goes offline [18], as shown in Figure 3.

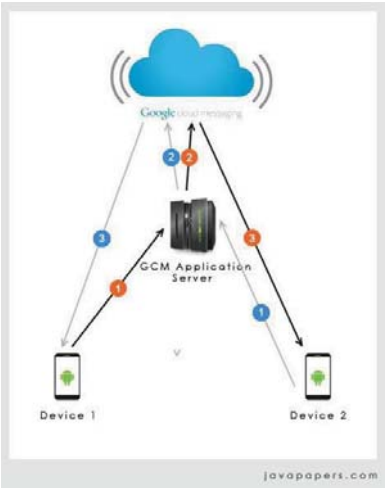

Fig. 3. Architecture of Firebase

3) Apparatus 3: Hardware Interfaces

Our proposed system needs external device to display all the information. Besides that, a tracker device is used to track the location of vehicle. We used a GPS Module that

attached with Arduino kit and IoT counter to count people in bus.

a) GPS Module

The extension module that we used are Neo-6m which is a GPS module. The module works perfectly with Arduino. It enables the Arduino to track the movement or location of the device in real time. However, to enable that functionality, the connection between the module and the Arduino must be established first. Then, create an application via visual studio which we can locate the current GPS location.

b) IoT Module

Raspberry Pi and webcam are selected to be used in developing an IoT device for counting the people in bus. Raspberry Pi is a microcomputer that suitable to develop IoT device with the help of a webcam. The author used image processing in the process of detecting the quantity of people in bus.

4) Apparatus 4: User Interfaces

The menu page for a mobile application that contains six main icons. All icon has it is own function. However, menu page for real-time campus University bus tracking mobile application also will act as the home page for the apps. Figure 4 shows the main page of Real-Time Campus University Bus Tracking Mobile Application.

Fig. 4. Menu Page of Real-Time Bus Tracking Mobile Application

Content design is shown in Figure 5. Figure 5 is the page for user to select the destination that they wanted to go. Whenever the user is ready it can get the route simply touch the get route button. The user has two options to detect user current location either using QR Code or turning on the GPS to allow the current location on their smartphone.

B. Testing Evaluation

Real-time bus tracking system is evaluated by using simple test cases that focus on the main functions of the system which are locating the location of bus and counting the people in the bus. The result shows this system is more effective compare to the existing system. A small group of respondents from university members agreed that this system can help them in managing the time and problem faced regarding the bus transportation managements system. The comparison of the performance on the functionality is tabulated in Table III.

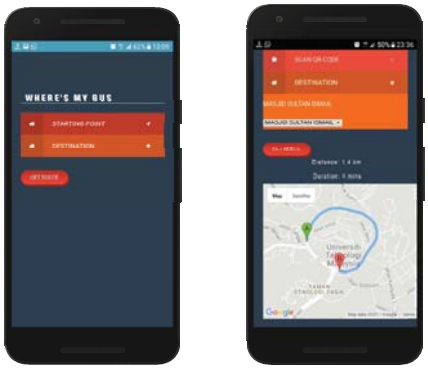

Fig. 5. 'Where my Bus" of Real-Time Bus Tracking Mobile Application

TABLE III: THE COMPARISON ON THE PERFORMANCE FUNCTIONALITY

Functionality	Existing System 1[11]	Existing System 1[12]	Existing System 1[13]	Proposed System
Locating Bus	Yes	Yes	Yes	Yes
Updating Location	Yes	Yes	Yes	Yes
Display Timeline Schedule	Not Applicable	Yes, in dynamic schedule	Yes, in dynamic schedule	Yes, in static schedule
Counting People in Bus	No	No	No	Yes, using the image processing

Example of test case used to evaluate the system is shown in Table IV.

TABLE IV: EXAMPLE OF TEST CASE

Test Case ID	Use Case	Data		Status	Expected Result	Actual Result
T012	Give Feedback	1	Email	Valid	Successful feedback > redirect to main page	Pass
		2	Name	Valid		
		3	Comment	Valid		
		4	Stars	Valid		

VI. CONCLUSION AND FUTURE WORK

A lot of mobile applications installed in user's smartphone, especially student who download some mobile application for education purpose and manage their task using the mobile application. Nowadays, Internet connection in student smartphone is necessary since they need full internet access to know the current issue and use the facility for discussion through the mobile application. Real-Time Campus University Bus Tracking Mobile Application's

project is believed to help student in managing their trip to class. Besides, students are able to use the Real-Time Campus University Bus Tracking Mobile Application as an opportunity to make a complaint to be heard by management. The main objective of this project is to help in solving the problem faced by students regarding bus transportation on campus is achieved.

For future works, the existing application will be tested further for functional and non-functional performance evaluation.

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REFERENCES

[1] Premiers omnibus à Nantes - Herodote.net. (2017, January 03). Retrieved from https://www.herodote.net/10aou1826-evenement18 26 08 10. php [Accessed April 04, 2018]

[2] Sejarah Bas Mini. (2013, September 20). Retrieved from https://bm.ca ri.com.my/portal.php? mod=view&aid=4528 [Accessed April 04, 2018]

[3] Product Overview. Retrieved from http://www.Evogpstracker.com/pro duct-overview/

[4] Feet Management. Retrieved from https://www.liveviewgps.Com/flee t+management.html, [Accessed April 04, 2018]

[5] *XSSecure XTS Tracking System.* Retrieved from http://www.xssecure.com/product.html/ [Accessed March 28, 2018

[6] Mohamed-V Agdal Univ, Ecole Mohammadia, 2014. All about software reusability: a systematic literature review. *Journal of Theoretical and Applied Information Technology,* pp. 1992-8645

[7] L. Gherardi,, D. Hunziker, and G. Mohanarajah, , 2014. A Software Product Line Approach for Configuring Cloud Robotics Applications. In *Cloud Computing (CLOUD), 2014 IEEE 7th International Conference on,* IEEE, (June), pp. 745-752.

[8] M.A. Babar, L. Chen and F. Shull, 2010. Managing variability in software product lines. *Software, IEEE*, *27*(3), pp.89-91.

[9] S. Halim, 2016. Core Asset Variability Modeling Approach for Software Product Line Development (Doctoral dissertation).

[10] M.A. Babar, L. Chen, and F. Shull, 2010. Managing variability in software product lines. *Software, IEEE*, *27*(3), pp.89-91.

[11] Supriya Sinha, Pooja Sahu, Monika Zade et al., 2017. Real Time College Bus Tracking Application for Android Smartphone. *Vol. 6, Issue 2,* pp. 20281-20284.

[12] Muhammad Irsyad Kamil Riadz, Nurul Nazihah Jamal, Mohammad Shafri Amir Mohd Sharif, Mohd Sufi Mohd Suhaimi, 2017. *A real-time bus tracking System,* Undergraduate Project Report*,* Universiti Teknologi Malaysia: Faculty of Computing.

[13] Manini Kumbhar, Meghana Survase, Pratibha Mastud, Avdhut Salunke, 2016. *Real-Time Web Based Bus Tracking System,* International Research Journal of Engineering and Technology.

[14] S. Halim, 2016. Core Asset Variability Modeling Approach for Software Product Line Development (Doctoral dissertation).

[15] S. N. M. Ekssan, 2017. *Enhanced Educational Robotics Feature Model With Pedagogical Elements In Software Product Line,* Universiti Teknologi Malaysia: Faculty of Computing.

[16] Google Developers. (2017, August 16). Google Maps for every platform. Retrieved from https://developers.google.com/maps/

[17] Adobe Systems Inc. (2015). Adobe Phonegap Documentation. Retrieved from https://phonegap.com/Google Developers (2017). Firebase. Retrieved from https://firebase.google.com/