Design and Development of Bus Tracker: A Mobile App for Tracking Buses in Real Time

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Abstract— **This paper presents the development of an android mobile app, bus tracker application, to enhance the bus management system for students in Universiti Utara Malaysia (UUM). This is to reduce the students' waiting time, thereby to inspire for sharing updated information between the bus drivers and students. It would inform the students about the estimated arrival time and the coordinate of buses. It will reduce the traffic, especially during peak time by estimating the arrival time. With the most accurate coordinate of buses, it will reduce the anxious and impatient of students. This application would let the bus driver know the number of students that waiting for a bus at each bus stop. This proposed bus tracker application would specifically be used by students and bus drivers of Universiti Utara Malaysia (UUM). The objective is to identify the requirements of bus tracker application and to develop a bus tracker application prototype. The main users of this bus tracker application are administrator, bus driver and students. The administrator has the most privilege to add, update, delete or view data, the bus driver can view the number of students waiting for a bus at each bus stop and students can track the estimated arrival time and coordinate of the bus. GPS is implemented in the system in the form of a GPS receiver which is used to track bus location in real-time by latest Latitude and Longitude position. This project uses the prototype development to complete all the system and was developed using Android Studio IDE and Java programming language. The design and development of the app followed the Software Development Life Cycle (SDLC) methodology. The prototype of Bus Tracker Application was developed based on the requirements and later a field study was done to evaluate the usability of the prototype. The outcome of the evaluation demonstrated that the Bus Tracker Application is functional and user-friendly. Further, the respondents outlined they were satisfied with the features of the app that helps them to track buses easily. The study contributes towards an understanding the system requirements and user interface of a mobile app for tracking buses. It can be a reference model for developers and researchers in the area to develop similar apps or enhancing the capabilities in tracking buses.**

Keywords—*Bus Tracker Application, arrival time, number of students, GPS, Android*

I. INTRODUCTION

Public transportation in Malaysia is broadening and expanding [1] to satisfy the demand of people to travel. Public transportation assumes a major part of the transportation industry. The public transportation provides transport services to Institute of Higher Learning (IHL) students. Public transport mainly buses have been used all over the world.

Technology is expanding at a fast pace; bus tracker application can be used to track, show estimated arrival time and number of students that waiting at the bus stop.

Bus arrival time and prediction are very vital to students. The problem derives if the arrival times or departures time of the buses at the bus stop cannot be predicted by students. This interconnection leads to the bus arrival time at a different stop on a route. Inaccurate arrival time will affect the schedule outlined by the bus management. This paper focuses on the primary development of optimum arrival time by tracking and estimate the arrival time based on the number of students waiting at the bus stop.

Public transportation (such as university shuttle bus service) [2] that satisfied the demand of people (students) to travel from one place to another. A university shuttle bus can normally fit up to 80 students which makes it one of the most preferred vehicles for university students go to class. By taking the university shuttle bus can reduce the traffic jams that happened on the road.

In Malaysia, there are many universities already have implemented similar bus tracker application [3]. University students used the application to track bus scheduled and this makes students do not have to worry about late to class [4]. To further understand the bus tracker application, observation has been done on bus service at Universiti Utara Malaysia (UUM).

With this Bus Tracker Application, outstanding bus services provide to the users; students and bus drivers in UUM. This paper well defined on basic development of most accurate arrival time that predicted based on user current position. The arrival time also takes into consideration other unpredictable factors such as the number of students at the bus stop, traffic jam, and harsh weather condition.

II. BACKGROUND AND RELATED STUDIES

This section describes the background of bus transportation services and related studies of other public transportation application from the perspective of users and researchers. A good bus management system plays a key role nowadays [5]. Bus transportation services are highly demanded, and with less flexible services, it may lead to partially utilize.

A. Analysis On Existing System

1) Universiti Malaya (UM)

A bus tracking app shown is currently being implemented by Universiti Malaya (UM). This system was developed to provide logistic assistance to their students while reducing traffic problem within the UM campus. The app allows students to browse by route, browse by start/destination stops, and check the route and stops information. This system enables the student to know the bus current location and the start point with the next destination of the bus.

2)   Singapore Bus (Singabus) − Bus Timing + MRT

This bus-tracking app called Singabus is currently implemented in Singapore that uses data directly from the Land Transport Authority of Singapore (LTA).

This app is suitable and convenient for the fast-paced Singaporeans. It also supports all public transport operators in Singapore like Tower Transit, Go-Ahead, SBS and SMRT. This app tracks the bus in real-time including type of bus (Single deck, double deck, blendy, etc). It displays the bus route, view nearest stops, search for bus stops using by bus stop number or bus name, set a reminder when reaching your destination and so on.

3)   Universiti Teknologi Malaysia

The bus tracking app shown in Fig. 3 is implemented by Universiti Teknologi Malaysia (UTM). Information technology (IT) is growing rapidly and can be seen everywhere now especially tracking app. It is a combination of automatic vehicle location and software for data collection of the current location. Further, GPS can help to locate the vehicle in the tracking system [7].

UTM has been designed and developed a tracking app which the main aim to enable student gets to know estimated bus arrival time within the campus. In this app, student able to choose a bus, share to social media and show the details of the distance and estimated arrival time between the user and bus coordinate [8].

B. Studies On Technology Involved
1) GPS

Global Positioning System (GPS) and an Android mobile app platform are needed to build a tracking system. GPS is a satellite-based radio navigation system which is operated by the United States Space Force. It was used for navigation to receive data from satellite and needed GPS receiver and every smartphone owned with GPS receiver [4].

2) Android Platform

Android is a mobile operating based on a modified version of the Linux and other open-source software. It was initially developed for mobile devices that uses touchscreen. With the upgrading technology revolution of smartphone and AI-based Android, development cut the limits of smartness to make the best of the utility for the user. Well talking about the full form of Android there was nothing mentioned about it. Android was the company started in 2003 by Palo Alto and his team.

It also applicable for multiple devices [5] and GPS features can undeniably design by the developer due to the useful tools contributed by Google. Google has contributed a convenient tool for developers to implement an application with GPS feature.

III. METHODOLOGY

The study was done using the Software Development Life Cycle (SDLC) to obtain more user responses and able to produce a successful system based on user assumption. The accuracy of estimated arrival time determines how effective is the system. Hence, this methodology will be suitable for testing the satisfaction of final system from users. It consists of five main phases namely planning, analysis, design, the implementation for prototype and implementation for the final system. The flow of the phases is demonstrated in Fig. 1.
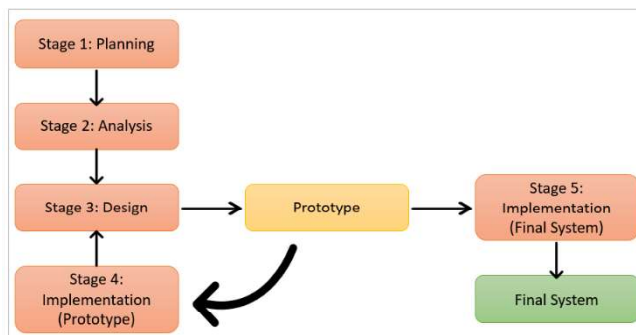

Fig. 1. Software Development Life Cycle.

The planning phase is to determine and reach a decision of the system with the supervisor. This system will implement for bus drivers and students to track the bus stop or bus driver location, estimated distance and duration, arrival time and the number of students waiting at the bus stop. In the analysis phase, the requirements of a mobile app are obtained for tracking buses and analyze the existing system. A reflection of the real system is done to further understanding about the existing bus tracking app. UML diagrams is used to present the requirements of a system in this design phase and this phase considered a looping stage due to the prototype that evaluated by users; students and bus drivers in UUM came out with new requirements. The implementation phase is to transmute the design into a real system by applying the coding. GPS is implemented to get the coordinate of the bus to get the estimated arrival time. Android Studio is used to design the mobile platform used by bus drivers and students to track buses location and number of students at the bus stop.

IV. DESIGN AND DEVELOPMENT OF BUS TRACKER

This section illustrated the design and development of a mobile app for tracking buses following the first three phases of SDLC. The section is then split up into two sub-sections. The first sub-sessions are the functional requirements and non-functional requirements of Bus Tracker Application and the second is the prototype development of Bus Tracker Mobile Application used to validate the requirements.

The requirements gathering process was done by referring from experts and reviewing articles about similar apps. The results of the discussion came out by the real-life experience in UUM and the harassment of lecturer. In secondary requirements, articles were searched using Google searching engine by entering keywords "bus tracking", "real-time tracking system", "bus management services", and "transportation app". The articles were studied to extract the requirements for a mobile app that can track bus and driver and check the number of students. There are seven significant

functional requirements and three non-functional requirements generated from the process. The functional requirements include login to the app, show bus driver and bus stop location, forgot password, track bus and bus stop location, check the number of students, logout from the app, get distance and duration between two points, and manage bus stop and bus driver details. The non-functional requirements are security, usability, and reliability.

V. THE BUS TRACKER PROTOTYPE DEVELOPMENT

In this phase, the prototype of the mobile app for tracking buses was developed as mentioned under sub-section 2. Software prototyping was used to demonstrate the software requirements. The users can suggest improvements based on their experience in interacting with the prototype. The main Integrated Development Environment (IDE) tool used was Android Studio and the JOMHosting platform. They were used to enable vital functions like for example user authentication and database. Fig. 2 and Fig. 3 show the selected interface of Bus Tracker Application for driver and student user while Fig. 4 - 7 are the selected webpage for admin.
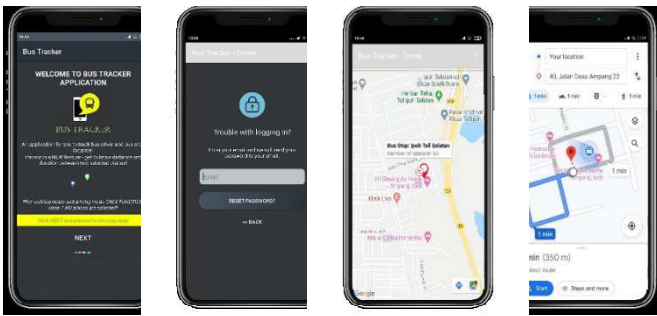

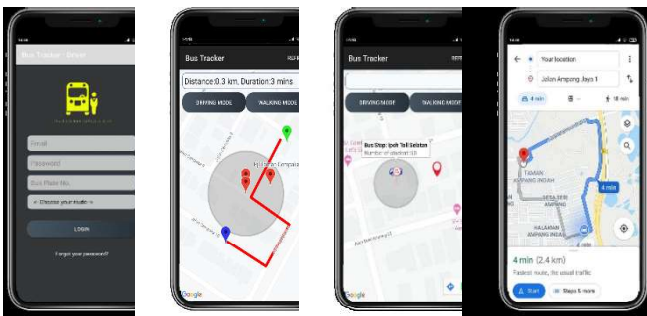Fig. 2. Interface of Bus Tracker Application for driver app.

Fig. 3. Interface of Bus Tracker Application for student app.

Fig. 4. Webpage of Driver Details for admin.

Fig. 5. Webpage of Add Driver Details for admin.

Fig. 6. Webpage of View Driver Details for admin.

Fig. 7. Webpage for Edit Driver Details for admin.

VI. EVALUATION OF BUS TRACKER

A. The Evaluation Setting

A usability evaluation was conducted on 34 participants, consist of students and person who drive a car. The respondents were picked among student who studies in university. The instruments used for the evaluation were the Bus Tracker Application and a questionnaire. This post-task questionnaire consists of 24 items in five sections. Section A focusses on the respondents' demographic and background information. Section B, C, D and E asked the respondents opinion about Bus Tracker Application using a five-point Likert scale answers. The respondents carried out the following systematic procedure for evaluation: (1) read the instruction listed in google form, (2) interacted with Tracker Application and (3) answered the post-task questionnaire.

B. Demographic and Background Information

Analysis of the demographic and background information revealed that 75% of the respondents are female and 29% is male. 76% of them aged between 21 and 25. A total of 9% was aged over 46, 6% was between 26 and 35, and between 16 and 20. 3% of them aged between 36 and 45. Regarding how frequent to take a bus, 53% of them occasionally which is 18 out of 34 respondents and 32% take daily. 3% of them never

take for a bus, 3% take a bus monthly and 9% of them take a bus weekly. The respondents also reported that 50% of the track bus online (Bus Official Page), 38% using bus information board to track a bus and 12% using the application. Regarding the condition prompt them to take a bus, most of the respondents (i.e., 82%) track a bus every single time, 12% track the bus only when emergency and 6% of them never track the bus. All the respondents have heard about Uber, Waze, Google Maps and Grab, and 6% of them did not use these apps before.

C. The Usability of Bus Tracker Application

A respondent's feedback analysis was conducted in Section B, C, D and E of the post-task questionnaire. These sections measure the perception towards Bus Tracker Application usefulness, ease of use and functionality. It also measured the respondents' satisfaction towards Bus Tracker Application. Tables 1 - 4 demonstrated the frequency of the feedback. The respondents rated 3, 4 or 5 of the post-task scales for the four aspects of the usability. Only three respondents rated two and none of the respondents rated one.

Table 1. The responses for the usefulness of Bus Tracker App.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Bus Tracker Application make my transportation easier.	0	0	7	22	5	34
Bus Tracker Application bring convenience and control with technology.	0	0	1	25	8	34
Bus Tracker Application meets my needs.	0	0	13	15	6	34
Bus Tracker Application does everything I would expect it to do.	0	0	17	11	6	34
Bus Tracker Application is useful in overall.	0	0	2	28	4	34

Table 2. The responses for Ease of Use of Bus Tracker App.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Bus Tracker Application is easy to use.	0	0	7	21	6	34
Bus Tracker Application is user friendly	0	1	3	25	5	34
Bus Tracker Application is easy to learn how to use it.	0	0	5	23	6	34
I don't notice any inconsistency as I use Bus Tracker Application	0	1	12	15	6	34
Bus Tracker Application can track bus successfully every time	0	0	8	23	3	34

Table 3. The responses for Satisfaction of Bus Tracker App.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
I am satisfied with Bus Tracker Application.	0	0	3	26	5	34
I would recommend Bus Tracker Application to my friend.	0	0	15	15	4	34
I feel I need to have Bus Tracker Application.	0	0	16	11	7	34

Table 4. The responses for Functionality of Bus Tracker App.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Bus Tracker Application get the distance and duration correctly.	0	0	6	16	12	34
Bus Tracker Application get the current location correctly.	0	0	4	15	15	34
Bus Tracker Application get the number of students correctly	0	1	19	10	4	34

The outcome of the evaluation demonstrated that the Bus Tracker Application is functional and user-friendly. Further, the respondents outlined they were satisfied with the features of the app that helps them to track buses easily.

VII. CONCLUSION AND FUTURE WORKS

This paper described the design and development of a mobile app for tracking buses. There are still many aspects that can be studied. In the future work, the developer plan to expand the bus tracking system and some of the function can be improved to be better than what had been done. The limitation of this application is that the user needs to have internet access to this application. Besides that, multiple to multiple connections is recommended to be developed in this application. Even then, the one to one connection does not affect its own function.

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