Efficient Campus Shuttle Tracking and Management Mobile Application for College Campus

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Abstract

The purpose of this study is to address the current paper-based shuttle booking and tracking system at INTI International College, Penang. Shuttle Stalk, a Real-Time Campus Shuttle Booking and Tracking System was a proposed solution that enables the students to register for the shuttle service through the mobile application, reducing the administrative burden and tracking its current location in real-time, allowing them to plan their journeys more effectively. The application developed serves as a comprehensive solution for both students and administrators, providing real-time shuttle tracking and streamlined management capabilities. The development of this application is informed by extensive data collected through pre- and post-acceptance surveys, to ensure its effectiveness and alignment with user needs. The mobile application not only enhances the efficiency of shuttle services but also contributes to higher user satisfaction, improving the overall campus experience.

Keywords: Campus shuttle-tracking application, real-time shuttle location, Global Positioning System (GPS), Google Maps, Firebase, Mobile Application

1. Introduction

Shuttle services are a form of public transportation that respective schools and universities often provide to enable their students to travel from the pick-up point to the institution's location. However, there is no way to track and see the shuttle's arrival and departure time. According to a study [3], the drawback of public transportation (such as buses and shuttles) is that the commuter has an unknown amount of time to wait for their transport's arrival. This results in commuters opting for private vehicles, which adds consequences in environmental, social, and economic terms [7].

A study [7] shows that (from a survey sent to 3378 correspondence), 59% of the students opt for public transportation such as buses and shuttles. Distance, time, and economic capabilities are the most important factors when choosing a mode of transportation. With that in mind, the free transportation offered by some schools and universities (e.g., INTI International College and Universities) appeals mostly to students, as it meets the criteria of choosing a transportation mode. However, the lack of information regarding the transportation's arrival time, current location, and seat availability makes commuters or students reluctant to use public transportation [8].

Therefore, a shuttle booking and tracking system was proposed as a solution for the current paper-based shuttle management at INTI International College, Penang. It enables the students to book the shuttle service through the mobile application, where they can decide whether the registration may proceed or not depending on the seating availability in the shuttle. Moreover, the students will be able to track the shuttle's real-time location as well as efficiently mark their attendance when the shuttle is nearby. Lastly, the students will be able to receive notifications from both admins and drivers if the shuttle is unavailable.

2. Literature Review

The current shuttle management system in INTI International College, Penang enables the students to use the shuttle through Google Form registration every new semester. Attendance marking and tracking were paper-based; the student's name and matriculation number must be written manually by the student after riding the shuttle. There was also no administrator dashboard for the overall management of the shuttle service on campus.

Fig. 1 shows the pre-acceptance survey which was sent out to 100 students with 63 respondents. Most of the students voted on having a real-time shuttle tracking application to help plan transportation ahead of time.

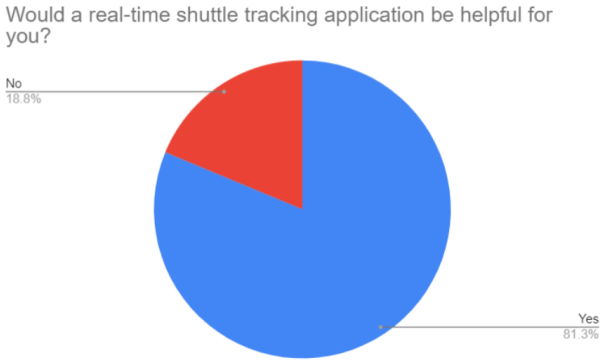

Fig. 1. Pre-acceptance survey result

A real-time location tracking application is a type of software application where the location data of any two or more devices are updated in each period to the database so that both devices' location data information synchronizes with each other. There has been much research about the implementation of real-time location tracking applications in a school and campus' public transportation system, each with different implementation methods and techniques.

Saad et al. [8] conducted research on a real-time on-campus public transportation monitoring system for Universiti Teknologi Malaysia. The researchers implemented a GPS receiver hardware and attached it to the campus bus, where it retrieves the latitude, longitude, and speed of the bus. The data is then synchronized to the student web application. This system is not as portable and accessible, however, since students mostly use mobile applications nowadays. The system must also adapt to the current design and UI trends. Lastly, each of the campus transportation vehicles must have GPS receiver hardware, which may add to the cost.

Hoque, et al. [1] developed a bus tracking system for the International Islamic University Chittagong in Bangladesh. Instead of using a physical GPS receiver, the researchers made use of an Android smartphone's embedded location-aware hardware, making the system cost and configuration time lesser. The system is mobile-based, therefore, improving student accessibility and access. There were also two added features in the system, namely the driver accident reporting and seat availability checking. These features are beneficial to students, however, the way that the seat availability checking was implemented may be hazardous (as the driver has to continuously accept/deny students' requests, even while driving). The UI for the application may also need a lot of time getting used to.

Shibghatullah, et al. [11] implemented Tracker, a real-time location tracking system that makes use of GPS-aware devices to track the current location of public transportation. It caters to a wider audience and is mobile-based. It has a much-improved UI with detailed information (e.g., real-time traffic conditions, error messages) which makes it easier for users to navigate through the application, as well as a notification feature, allowing the users to receive updates from the administrators. In terms of improvement, the application does not have a way to check seat availability, and the notification feature can be further improved by adding a push notification alert.

3. Methodology

The research methodology used for this study was the Waterfall Methodology (as shown in Fig. 2). During requirements gathering, feedback regarding the current shuttle service on the campus was compiled from administrators and students alike. The design phase implements a non-working prototype of the application with the main features. Once the idea was confirmed, the working prototype was implemented based on the pre-acceptance survey result and the initial design of the application. Testing was done afterward, where the working application was sent to the end users for the purpose of gathering UI and feature-related issues and feedback. Lastly, the application was updated based on the result of the usability testing.

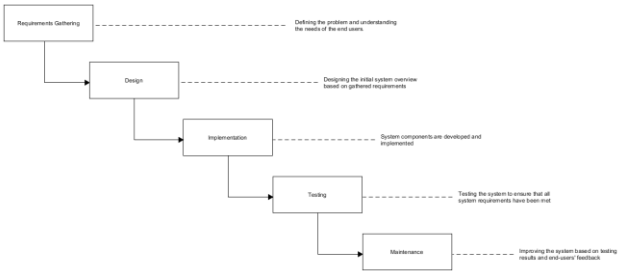

Fig. 2. Research Methodology

Fig. 3 shows the administrator website, where the admins can manage the campus' shuttle services. It contains various managerial features like shuttle and driver registration, where the admin can input the shuttle details (e.g., plate number, seating capacity) as well as create an account for the driver (to be used on the driver's side of the application). Route management is also included on the website, where the admin can assign a registered shuttle and driver to the route and enter its pickup/dropoff schedule and location. The admins can also view the number of bookings made by students, as well as the registered students.

Fig. 3. Administrator Website

A student application was also implemented as shown in Fig. 4. It allows the students to book a shuttle based on the pickup/dropoff location, as well as view the shuttle's current real-time location. The application has a built-in attendance feature where the student can mark their own attendance if the shuttle is nearby. Unmarked attendance may result in the "no show" penalty embedded in the application that denies the student from booking the shuttle. Moreover, the student may book the shuttle as long as there is available seating in the vehicle. The student can also receive push notifications from administrators and drivers alike whenever there are updates regarding the shuttle service on the campus (e.g., shuttle maintenance). Lastly, an option to cancel the shuttle booking was also in place if the journey time was not within 2 hours.

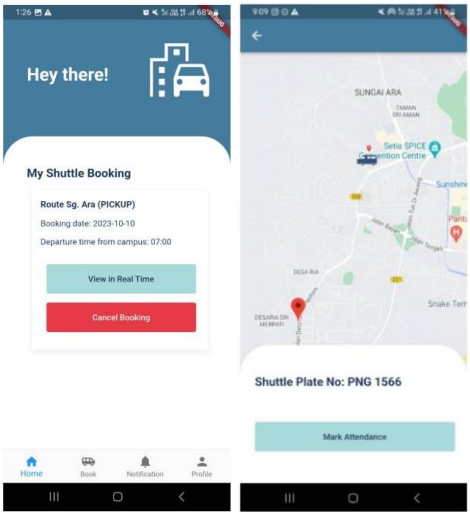

Fig. 4. Student Application

Lastly, a driver application was implemented to foster communication between the student and the driver's location (refer to Fig. 5). A listing of all available and assigned journeys to the driver can be seen on the home page. When the driver starts a journey, the application saves the device's current location and updates the database with it whenever the shuttle or driver moves 100 meters from the last location. The driver application also has an emergency reporting feature that triggers whenever the driver cancels a journey or ends a journey early. The submitted report sends a push notification to the student's application side and cancels the journey without penalizing the student.

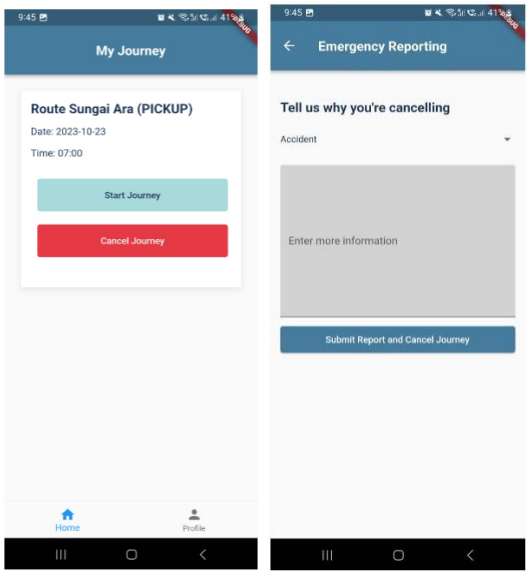

Fig. 5. Driver Application

4. Results and Discussion

For this study, the application underwent usability testing. Existing research [4], [5] shows that the amount of usability testers should be 5 testers (given that the study does not focus on quantitative results, in which case, 20 testers are required). A total of 8 participants, however, were compiled for this study as it ensures that almost all usability problems were covered as much as possible.

Table 1 below shows the result and overall feedback of the participants from the usability testing.

Table 1. Usability testing results

Participant no.	Feedback
1	- Some parts of the text instructions when logging in and registering are obstructed. - Overall, the application has nice features and is smooth and fast.
2	- Application is easy to use and straightforward with minimalistic design. - There should be an option for weekly booking of the shuttle.
3	- There should be a polyline location to track the shuttle route. - Improve the arrangement of the input boxes on the booking page.
4	- The application is easy to use as the layout is pretty similar to other applications. - There was a missing toast message for cancellation of shuttle booking.
5	- The application is easy to navigate around - More optimization in the future updates
6	- Overall application experience is smooth, and the interface is nice. - There should be more customization options for personalized application experience.
7	- There should be a password confirmation during registration. - Overall, the application is straightforward and easy to use.
8	- The application is not overwhelming to use. - It takes some time to load (optimization).

It can be seen from the table that the overall impression of the system was smooth, easy to navigate, and straightforward, with most of the participants liking its minimalistic design and similarity in layout with other applications (thus contributing to its ease of use). Further improvements of the system focused more on optimization, minor element obstruction, and other requested features by the users (e.g., personalization, polyline for Google Maps).

5. Conclusion

In this paper, an efficient shuttle tracking and management application has been developed for INTI International College, Penang campus. The proposed system proved beneficial to both the campus administrators and students, especially when it comes to managing shuttle bookings and tracking the shuttle location, compared to its initial paper-based and manual shuttle management system. Furthermore, the application was a success in terms of user acceptance as proven by the result of the usability testing.

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Authors Introduction

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