Smart City Bus Application With QR Code : A Review

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Abstract—**Smart City Bus Application with QR Code is an Android application that provides bus information in real-time in Malaysia. It uses the commonly available function on any modern Android device such as the Global Positioning System (GPS). Other than that, Smart City Bus Application also provides many functions mainly QR code payment that might be useful for the public generally to make payment without using cash or card. This review paper brightens the idea of the application in a much simpler way.**

Keywords—*Android Application, Bus Application, Internet-of-Things (IoT), Smart City, Quick Response (QR) Code Payment, Global Positioning System (GPS), Real-time Positioning using GPS.*

I. INTRODUCTION

Smart mobile devices becoming common and some stated it as necessity. Brand like Samsung and Apple been pushing the smart mobile devices to becoming more powerful device and useful device in people everyday life. It is fun, magical, and some already replaces their laptop for a small compact phone. These smart mobile devices popular because many developers make interesting application for it. It manages to turns mobile devices into like a computer device that could do more functions [1].

Private and comfortable is what people looking for in their life. People prefer private vehicle instead of the other such as public transport, and this is because of how people perceive private vehicle as functional, psychological and cultural values. This resulting in tremendous increase in motorized vehicles from 75 million to 675 million between 1950 and 1990 [2]. With that said, it is important to reduce the usage of private transport by introducing a better systematic public transport in a country [3]. In this paper, we present the related literature where it discusses specific and general solutions of the project.

Smart City Bus Application exist in order to solves some lack of crucial features in existing Android bus application in Malaysia.

- The first features that Android bus application lack is that the bus route guide gave only name of places for every bus stop and this do not give the exact desired location.

- Next, passengers require information such as the exact location of bus since estimate time arrival can be inconsistent due to traffic jams or random stops at each bus stops.

- Other than that, passenger required to be on alert for incoming bus because bus can skip to the next bus stop without stopping.

- Sometimes, asking for fare can be an annoyance and inconvenient since it happens very frequently especially for those who move around to unfamiliar places.

- Lastly, the convenient method of payment using technologies that is available can be improved.

Entire mentioned problems can be solved by integrating features such as:

These problems can be solved by implementing these features in the application:

- Display bus routes using Google Maps API.

- Display buses live location on the Google Maps using Global Positioning System (GPS).

- Alarm passenger when bus is coming near by invoking notification such as vibration and sound.

- Display fare based on users' location and destination by calculating number of bus stops.

- Payment using QR code technology.

With the features of the application, passengers be able to plan ahead of their journey. The application also provides a detailed but simple bus route information resulting in passenger take less time to read and understand route comparing to traditional route guide. Other than that, the applications also provide real-time bus location, expected arrival time, and incoming bus notification for more peace of mind waiting at bus stop. With the commonly used smart mobile phone that everyone has, passenger can make payment without the use of cash. Overall, the application can solve the inconvenience of waiting buses, especially in Shah Alam, Selangor, Malaysia, and in the future more area of the bus will be covered.

Unfortunately, the application itself also have downside. For example, application currently only works and be installed on Android operating system version 4.4 and above. GPS accuracy also depends on the GPS hardware itself but in this paper, there are improvement can be made, for example the cell towers nearby can act as location prediction to increase the accuracy especially in city where tall buildings might affect the performance of GPS. To improve the application usability, the GPS updates have to be frequently updated location into the database. Therefore, the application might consume a lot of energy which might not ideal for mobile devices [4,5], however, the application only consume energy when users use it to monitor bus location. Lastly, the application only covers routes in Shah Alam, Selangor, Malaysia area.

II. REVIEW OF RELATED LITERATURE

A. Can public transport application gives impact on users?

Public transport vehicle has long been inevitable to those do not own private transport vehicle. The only solution for this group of people are either taxis, ride sharing, trains, or buses. Comparing the mentioned transits, buses have the cheapest fare but passengers are not having a good experience with it. So, to enhance the passengers' experience, mobile application that could give real time information is a positive move especially based on survey result in [6]. The system they have developed called "OneBusAway" aim to improve bus public transport by providing at least a good traveller information scheme. OneBusAway is a transit tool focused on real-time bus arrival information for bus passengers. The questionnaire where about issues of comfort, utility, waiting interval, travel regularity, safety, and other factors. A total of 488 respondents with more than 60% have been using bus daily gave result of overwhelmingly positive outcomes.

B. What are the technologies that can be used to build the overall application?

Smart devices such as devices that run Android operating system often have advanced hardware that could do almost anything that a computer can such as processing data, always connected internet, or locating the device. According to [7], the system focuses more on Short Message Service (SMS) for request-reply of expected arrival time from the bus's current location to passenger's current location. The concept of the system is that user has to send SMS containing current passenger's location and a specific bus to the central server. The central server then will interpret the SMS request then will be able to reply the expected arrival time from the input using Artificial Neural Network (ANN) compute. In coming advance era, article [8] stated that, which is about research and development on the technologies of locating the mobile (wireless) phone caller, talks about locating mobile phones becomes a hot topic among telecommunication giants and what technologies are standardised. Article mentioned that one of the ways to locate device accurately is using Global Positioning System (GPS) but article also mentioned that GPS might not be sufficient as it could not locate accurately under big and tall buildings such as in the city. Alternatively, author also discuss about automatic vehicle location (AVL) capability for gaining accurate location of public transport such as bus in the city. An AVL system tracks locations of the bus in a particular area and report to the centralised server via a communication network. Some related literature that uses GPS to get information are from the article [9], which the system that they developed was "A System for Notifying Passengers Waiting for Public Transit". Basically, the system can notify passengers if the public vehicles coming near to a stop. To make the system happen, most data is gathered from the central server also from possibly many vehicles. The data includes devices location or routes then this data is being processed at the central server resulting in giving passengers who is using the system the arrival time and notification to a selected stop. According to the article [10], the application able to give users location of the bus according to the source and destination for which the user will make a request to the made central server which using relational database containing records of the bus and their routes. Considering the bus passengers will get the exact location of the bus on the map, the author assume that passengers can arrive their stop just in time thus avoiding without or minimal waiting time to board the bus. Moving on to a much more different article where making payment using quick response (QR) code [11], implementation of quick response (QR) into payment system based can be secure. The mentioned application can execute payment between user and shop in offline mode. The payment can be made when the shop displays the QR-code window then user can shoot the QR-code by using their mobile phone camera. The user then can confirm the payment information then payment system basically can be settled by itself. In terms of application security, the application provides payment information confidentiality and authentication between user and shop.

C. What are the related products that are related to the project?

1) RapidKL Fare: RapidKL Fare is an Android application that shows trains' route and fare. It also provide route viewing on map. The route includes fare for RapidKL, KTM Commuter, MRT, and KLIA express in Malaysia. This application has the largest dataset of transits' route and fare but not for any bus transport. It is a good reference for the workflow or design.

2) Selangor Intelligent Transport System (SITS) [12]: This application is Selangor state's ambition under the Smart Selangor Delivery Unit (SSDU) to increase the service of Smart Selangor Bus for the benefit of bus passengers as it will enable them to plan their bus trip better. User of the application able to access and read bus information provided by the application for example estimated time of arrival is provided for each bus stop that is available within the application. This application able to show buses map routes for free buses only for free Selangor buses. It also provides real time tracking for buses so that users can detect locations of the buses.

3) PJ City Bus [13]: PJ City Bus is also a mobile application that could show map view of bus routes as shown above figure. It's an application for Petaling Jaya citizen to use and be ease on their daily travel planning. Reliable real-time information such as estimated time of arrival (ETA), service alerts, the position of each bus, schedule changes or transit delays is shown on this lightweight app to restore people's confidence in public transport.

4) Moovit [14]: Moovit is an application to provide travel guides to almost more than 100 million users throughout the globe. Commuters will find updated schedules and, where available, real-time line arrivals based on GPS devices on-board buses and trains. In some countries, the application also able to find nearby bus stops, provide live navigation, arriving destination alerts, and some crucial to ensure a smooth ride. Moovit do have a login page but doesn't require login to access the features offered. Moovit does view bus route on map but only when user enter destination where to go. It does not calculate fare for the destination but it could notify user when destination is coming near. This require constant GPS signal from user phone to make it works. It also gives sound and vibration for the notification.

5) myrapid (RapidKL) [15]: myrapid which is also a part of RapidKL, is a website that gives information about bus routes (as in the figure) and display fare information in a table form. It is run by RapidKL which also happen to run trains such as LRT and monorail lines. myrapid itself gives all the information for RapidKL buses but the information given were too little to help in more time mannered transport planner for passengers.

6) MyRapidGo [16]: Similarly to SITS, this mobile application focuses more on Klang Valley bus routes coverage area. MyRapidGo is a mobile application established by Prasarana Group to provide RapidKL bus services within Klang Valley. Other than that, ETA and Estimated Time Departure (ETD) is provided, enabling public to have the whereabout of the buses. Hence, waiting time at the relevant bus stops would be hugely reduced. This application launched on the 6th of August 2018, covered Klang Valley initially and may extend the coverage area in the future.

7) bus@sg for Android: bus@sg for Android is also a mobile application that provides buses' visibility to the public. Unlike SITS and MyRapidGo, this mobile application provided for only around Singapore. The application can provide features such as add bus stop favourite, shows list of nearby bus stops, map view, search function to find bus stops, bus routes, and schedules.

8) Boost App: Boost App is an e-wallet which can be used to pay without physical cash. The e-wallet term is and electronic wallet meaning the value of real cash store inside digital form. It provides the money exchange through the internet between merchant-customer or between individual but they all must have installed the same application. The process of money exchange is to provide application's generated QR code then the other party that intend to send money should scans the QR code using the same application. There are some highlighted features the application provides such as hassle-free payment, send and request money easily, and trustable security.

9) Touch 'n Go eWallet: Touch 'n Go eWallet also a mobile application that is similar to Boost App. It stores money value in form of digital which is highly secure from stealing. It is also associated with Touch 'n Go prepaid card so, users can view the card balance through the application. From paying various bills, movies, and flight, it could also make payment for limited number of transit stations. It uses QR code technology to make payment for the transits such as Light Rail Transit (LRT).

10) APP 1933 - KMB/LWB: KMB/LWB Smartphone App is a multi-functional application that provides public with the estimated time bus arriva, updates on bus services and the latest route information to assist with travel planning. The main features highlighted were bus estimated time of arrival and journey time, bookmark, instant traffic news, route sharing, landmark route search, bus stop navigation, and display bus fare.

III. PROJECT AND RESEARCH METHODOLOGY

Agile software development methodology is used in the project by using scrum model approach. Scrum model used for the project because it is compatible in the area where, is its iterative software development, easy manageable in a small team, changes are easier to cope with, frequently having meeting with reviewer to reduce mistakes in development, and able to produce quality product in scheduled time. The scrum model consists of four phases for every iteration:

1) Planing: Planning can be crucial phase because it defines the complete part of the iteration. Planning phase is a phase that specify which task should be develop first for an iteration. For planning phase is to split work into segmented pieces so that it can be finish in time. This planning phase will be done at the beginning of each iteration.

2) Building: Build phase is aim to complete a task after planning phase is complete. It can take a long time to complete this phase and mistake can be made during this phase. [17] The solution is to proceed to the next phase – test phase. For each iteration, this phase will complete at least a feature which mentioned in Objective. This will take place after the planning phase and before testing phase. The guide to build the application is by following the UML (Unified Modelling Language) diagrams later in this chapter. [18] This is to avoid any undesired or unplanned results.

3) Testing: Testing phase is a phase that focusing in quality control of the product. This phase debugs a part of the product to check for errors and results of the product. This can be done by thinking of possibility of testing that can be made. At the same time, testing phase will be evaluated by an organisation such as Rapid KL. Rapid KL can give feedback based on interface. Rapid KL was selected for the project testing because they had more experience and understand problems much more clearly. Rapid KL had more feedback from bus passengers from the whole Malaysia. With this in mind, bus passengers can also be part of this testing phase. Same as the organisation testing method, they could test the application by giving feedback based on interface. Passengers understand the problems since they face it since it is based on their experience. They had used such similar application such as SITS very often.

4) Reviewing: Review phase is an intensive testing of the application where details things is focused on. This phase is executed by experienced software testing that have the full understanding in related field. Without passing the review phase, the next iteration will not be proceeded. During the final iteration, this phase will combine all the required features then release an actual working application. The reviewer for the project will be the evaluators during the presentation.

Each iteration will take 1 to 3 weeks to complete a feature. Figure 1 shows the workflow of each iteration.
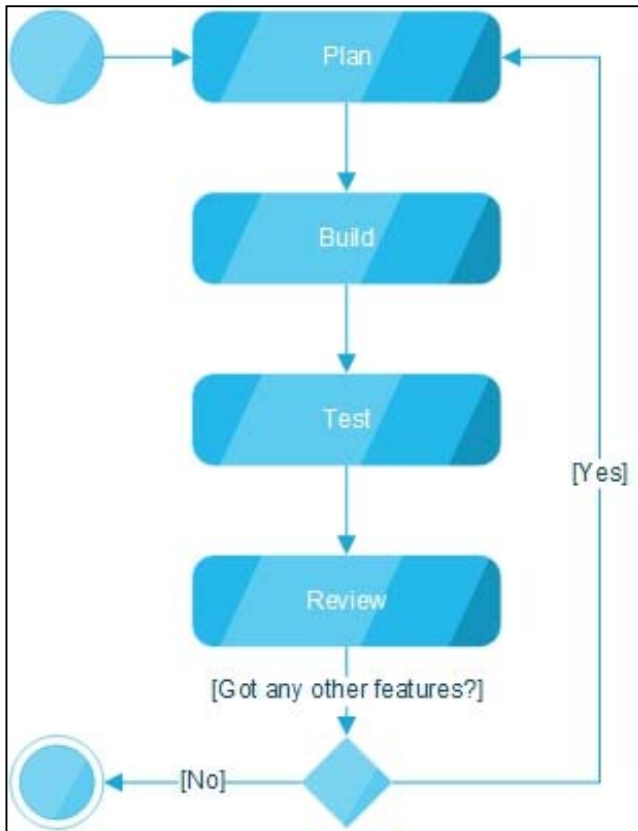
Fig. 1.   Scrum model workflow for each iteration.

To prove that the problem statement indeed exists in the area where the study is conducted, questionnaire were given out to users that ever used the public transport bus. Questionnaire where given out to users that ever used the public transport bus. These are the questions:

- What is your age group?

- What is your employment status?

- How comfortable are you with smartphones?

- How frequent do you use buses in Shah Alam area?

- How familiar are you with public transport smart application such as SITS (Selangor Intelligent Transport System)?

- Do you prefer bus routes to be displayed on the map?

- Do you need to know the current bus location while waiting for it?

- Do you need a notification when the selected bus is approaching near?

- It is necessary to display the bus fare according to the distance of destination?

- How convenient will it be to use QR technology for bus fare payment?

- What are the improvements can be made in smart bus application?

The results for the survey shows out of 45 responses, most respondents were 18 – 24 years old as shown in Figure 2 and response were mostly positive as shown in Figure 3 – 7.
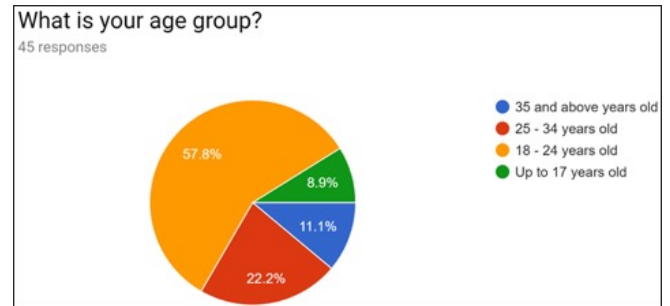

Fig. 2.   Result of "What is your age group?"

Figure 2 shows that the majority of the passengers is around 18 to 24 years old. While 22.2% of the passenger are around 25 to 34 years old. Around 11.1% of the passengers is 35 years old and above. Only 8.9% of the passengers are under 17 years old.
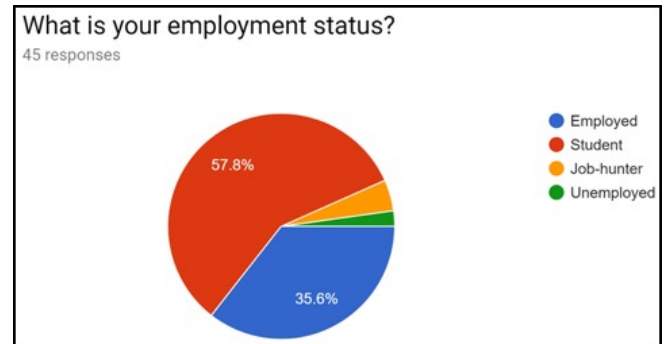

Fig. 3.   Result of "What is your employment status?"

Figure 3 stated that more than half of passengers are student with the percentage of 57.8% while 35.6% are employed and the leftover is unemployed. This indicate that student and employed uses bus public transport the most.
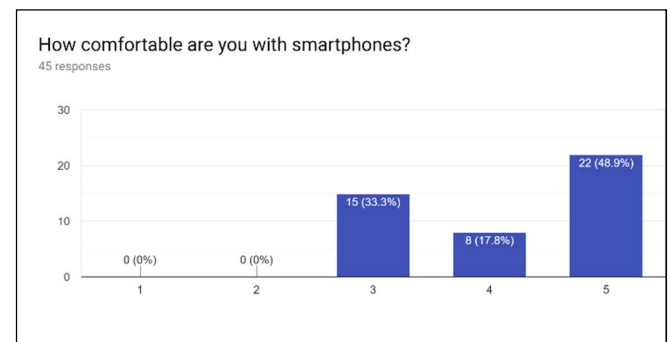

Fig. 4.   Result of "How comfortable are you with smartphones?"

The graph above illustrates the responses of 45 passengers based on the question of whether they are comfortable in using smartphones. According to the responses, most of the passengers selected agree with 48.9% which indicates that they are most comfortable with their smartphones. In addition

to the above figure, 17.8% also selected comfortable with their smartphones but 33.3% of the passengers selected somewhat comfortable.
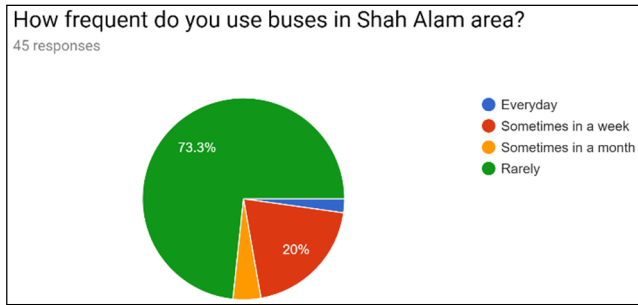

Fig. 5.   Result of "How frequent do you use buses in Shah Alam area?"

Figure 5 however is to show that most the passengers are from Shah Alam area where this application will gets tested.
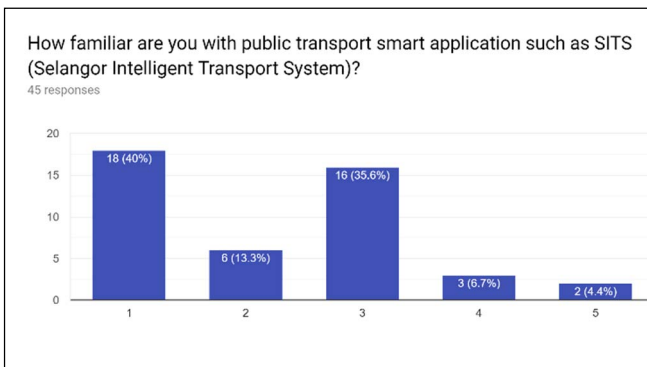

Fig. 6.   Result of "How familiar are you with public transport smart application such as SITS (Selangor Intelligent Transport System)?"

SITS is an available bus application service for Selangor area to use. Figure 6 shows that most of them rarely use the application.
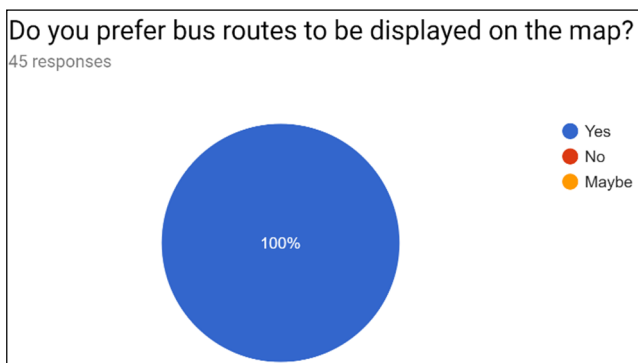

Fig. 7.   Result of "Do you prefer bus routes to be displayed on the map?"

Figure 7 shows that all the passengers strongly agree that they want the bus routes to be displayed on the map.
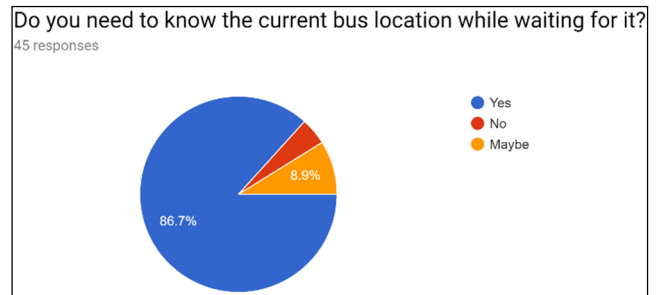

Fig. 8.   Result of "Do you need to know the current bus location while waiting for it?"

Based on the figure above, 86.7% of the passengers agreed that they need to know the current bus location while waiting for it. Only about 8.9% of the passenger are not sure whether they need to know the bus location while waiting of the bus to arrive.
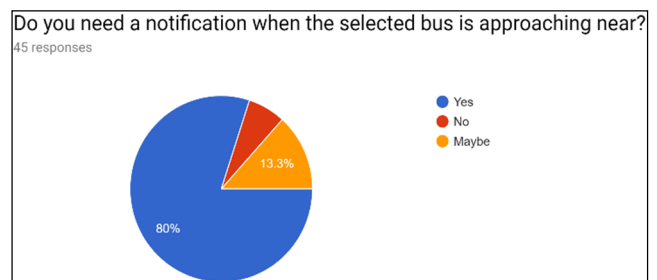

Fig. 9.   Result of "Do you need a notification when the selected bus is approaching near?"

Figure 9 tells us that passengers do really appreciate the notification on bus arrival on a bus station with the positive rate up to 80%.
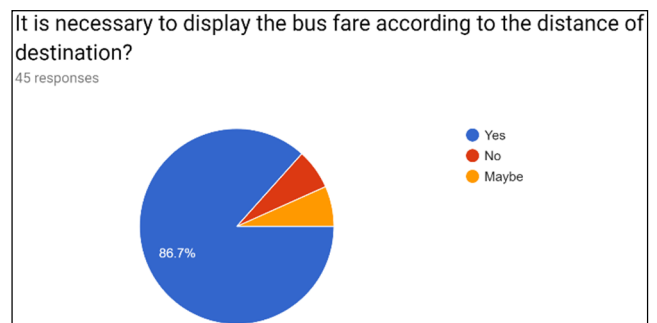

Fig. 10. Result of "It is necessary to display the bus fare according to the distance of destination?"

Figure 10 indicate that 86.7% passengers really positive and need for displaying bus fare from one selected destination to another. While the remaining either not sure or not necessary to get bus fare information.
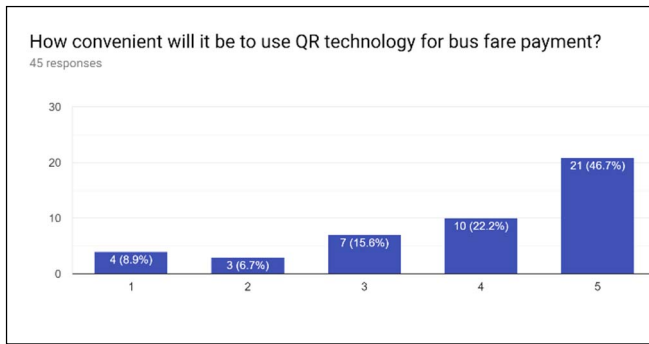
Fig. 11. Result of "How convenient will it be to use QR technology for bus fare payment?"

Figure 11 shows that the majority of passengers positive using QR code technology for more convenient fare payment that reaching 46.7%. Another 22.2% of the passengers still agree on the convenience of QR code technology payment system. Lastly, a total of 31.2% remaining left were less comfortable with the idea of using QR code payment system.

IV. CONCLUSION

In this paper, we have discussed the possible solutions that could enhancement existing related products. The benefits of having this mobile application is that, the passengers' experience is improved. Some other literatures that have been reviewed indicate that central server, GPS, notification, mobility, and secure QR payment is often important in public transport application. [19] Lastly, some other related products such as SITS, PJ City Bus, Moovit, MyRapidGo, and Boost App give solutions and ideas that could contribute to the applications' overall usability.

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