UiTM Share Ride: Requirements Validation, Design and Development of a Campus Ride-Sharing Mobile Application

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***Abstract*—The excessive number of cars entering university campus and limitation of parking areas have resulted in difficulty of finding parking spaces for many university staff and students. It is a typical issue occurring in most of university campuses all around the world. Carpooling or ride-sharing is viewed as the practical approach to solve this problem. The suggestion to share rides will lessen the amount of vehicles entering university campuses thus reducing parking space problem and decrease fuel emission for a cleaner and healthier environment. Thus, development of a campus ride-sharing mobile application will be a good medium for university staff and students to share their rides and solve this pressing issue in many campuses. This research has attempted to validate the system requirements for UiTM Share Ride mobile application, followed by designing and developing the mobile application using Android platform for UiTM's staff and students. Four phases have been undertaken in order to complete the research, which are preliminary study, requirements validation, user design, and followed by application construction. The outcome is a UiTM Share Ride mobile application, which can manage ride sharing requests among passengers and drivers in UiTM communities that will eventually solve the issue of congestion in the university campus.**

Keywords—ride-sharing, mobile application, requirements validation, system design, system development

I. INTRODUCTION

The high number of cars entering university campus and limitation of parking areas has caused difficulty in finding parking space in most of university campuses all around the world [1]. It is a typical issue happening not only in universities, but also in many urban places [2]. Apart from that, the high number of cars entering university will emit excessive carbon into the air. Emissions from cars increase the levels of carbon dioxide and other greenhouse gases in the atmosphere.

Ride-sharing or carpooling is a term generally used when people are sharing a vehicle together to go to a common destination. Reference [3] said that carpooling is a system that two or more individuals share their ride in a private or public vehicle. They also stated that carpooling is fundamental to decrease the use of fuel, diminish road turned parking lot amid crest hours and upgrade the parking facilities [3]. Meanwhile, [4] stated that universities are the perfect spots for bicycle sharing frameworks because of three key issues, which are money related restrictions, air quality issues, and contracting land accessibility. Ride-sharing is viewed as an all the more environmentally friendly and practical approach to go as sharing adventures diminishes the requirement for parking spots, carbon emanations, and traffic jam on the streets [5].

Universiti Teknologi MARA (UiTM) being the largest higher learning institution in Malaysia in terms of size and population, has campuses in all 13 states of Malaysia with around 170,000 students on its enrolment with 25 faculties offering more than 300 courses [6]. In UiTM, where the parking spots are very limited for staff, students and visitors, discovering vehicle parking spaces is one of the most highlighted issues [7]. This situation becomes worst especially during holiday seasons, peak hours, sales carnival or any other festivals [2].

A study that has been done by [8] showed that staff and students in UiTM have voted that 'saving fuel cost' was the primary reason why they would opt for a ride sharing agreement. Majority of them were also interested in a formal car sharing arrangement if it was shared with someone they know. Thus, implementing the ride-sharing system in a university will be a good idea since most people know and trust each other better in the same campus. At the same time, cost of the journey could also be shared when people are carpooling. Ride sharing is henceforth beneficial for riders, drivers and society. While the idea has existed for a considerable length of time, pervasiveness of computerized and portable innovation and user habituation to shared services and electronic markets have brought about specific development as of late [9].

Reference [8] has produced a Software Requirements Specifications (SRS) for the UiTM Share Ride mobile application, however the SRS has not been validated yet. This study continued the work of [8] by validating the requirements of UiTM Share Ride mobile application, designing the apps and developing it so that it could be tested and implemented in the next phases.

II. LITERATURE REVIEW

A. Mobile Applications

A mobile application, most commonly referred to as an app, is a type of application software designed to run on a mobile device, such as a smartphone or tablet computer [10, 11]. Mobile applications frequently serve to provide users with similar services to those accessed on PCs. Apps are generally small, individual software units with limited function. This use of app software was originally popularized by Apple Inc. and its App Store, which offers thousands of applications for the iPhone, iPad and iPod Touch. A mobile application also may be known as an app, web app, online app, iPhone app or smartphone app.

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According to [10], mobile applications can be divided into three groups which are native applications, web-based applications and hybrid applications. Native applications use particular of programming language and IDEs (integrated development environment) for particular operating system. Web-based mobile applications are essentially an online page, or a series of sites, that are created to figure on small screen. It can be opened with any trendy mobile browser and developed using many internet technologies and programming languages. A hybrid application (hybrid app) is the one that combines elements of both native and web applications.

B. Ride-Sharing vs Ride-Hailing

Reference [12] stated that, ride-sharing is a method of transportation in which people proportion a vehicle for a trip and divide travel fees. It combines the flexibility and speed of private vehicles with the decreased expenditure of shared public transportation. Ride-sharing passengers share their vehicles to reduce vehicle costs, traffic congestion and automobile emissions [12]. On the other hand, ride-sharing mobile application is created to permit users to provide and request ride sharing trips using their mobile phones [13].

While some of the functions of ride-sharing and ride-hailing are similar, there are differences between the two services. Ride-hailing is when riders "hail" or hire a personal driver to take them where they need to go and the vehicle is not shared with other riders. E-hailing refers to the use of mobile application to source for a taxi or other forms of vehicle in conducting ride-hailing [14]. Ride-hailing is a profit-based service, while ride-sharing, although there may be money-exchange involved, is mainly conducted based on good will and societal reasons such as increased mobility, environmental friendliness, and cost-saving.

Nevertheless, ride-hailing and ride-sharing platforms have lowered the cost of riding [15]. With its low rates, ride-hailing has become popular especially with the Millennials generation [16]. Uber is a well-known e-hailing application that matches individuals who require a ride with drivers who will provide the ride by utilizing their own vehicles [17]. However, according to [18], Uber charges its customers depending on time and distance of travel. Nonetheless, amid times of high demand, Uber utilizes a "surge multiplier" to increase the price. Since the entry of Uber, various competitors have emerged, such as Lyft in the United States, Didi in China, and Grab in Southeast Asia [19].

C. Requirements Validation

Based on [20], the target of requirements validation is to confirm that the requirements of SRS comply with the description of the system to be implemented. It is also meant to verify that the SRS is basically complete, consistent with standards and the requirements have no dispute, do not consist of technical errors and unambiguous. One of the many types of requirement validation techniques is review technique, which is also known as manual validation. There are three major types of review which are commenting or audit, inspection and walk-throughs. The main goal of commenting or audit is to get review from an expert opinion related to the quality of a requirements. The reviewer reviews the requirement with a goal to identify issues that can damage the quality of the requirements such as ambiguity or errors with respect to predetermined quality criteria [20].

III. Methodology

The research was divided into four phases which are preliminary study, requirements validation, design and construction. The preliminary study is the phase for acquiring knowledge where the researchers gathered and reviewed previous SRS produced by [8]. Then, requirements stated in the SRS was validated using the review technique. Two categories of stakeholders that has involved in the review process were the expert and users. The expert used commenting or auditing technique on the activity diagram, use case diagram and use case description. Walk-through sessions with the users were done to get their review based on user interfaces that has been created to show the flow of the application. The result of the requirements validation phase were an updated activity diagram, a use case diagram and use case descriptions.

In the design phase, the application was designed to satisfy the requirements identified in the previous phase. Among the activities done were identifying the deployment environment, designing the application architecture, system controls and security, database and user interface. Lastly in the construction phase, application functions were coded and integrated based on design specified earlier, using Java programming language. Then, the function modules were integrated to make a full working application. In this phase the deliverables were code of functions modules and full version of UiTM Share Ride Mobile Application.

IV. Analysis and Findings

A. Requirements Validation

In software developments cycle, requirements validation process are important to prevent incompleteness. For this project, the researchers used review technique to validate the existing requirement. Review technique can identify issues that can damage the quality of the requirement such as ambiguity or errors with respect to predetermined quality criteria. To get expert opinion, researchers used audit review technique by getting review based on the activity diagram, use case diagram and use case description. Walkthrough session were done using prototype to get feedbacks of the users.

1) Review Technique: Audit Review

Audit review technique was used to validate the existing requirements of UiTM Share Ride. The audit was done by getting comments about the existing activity diagram, use case diagram and use case description from an expert opinion. The reviewing was done by a senior lecturer from Department of Information System, Faculty of Computer and Mathematical Sciences, UiTM Shah Alam. She is an expert in requirement engineering field having been acknowledged as Certified Professional for Requirements Engineering (CPRE), a personal certificate for people who work in the domain of Requirements Engineering, Business Analysis and Testing. Based on the review result, there were some use cases and use case description that were not well defined, wrongly named, ambiguous and irrelevant of activities. Table 1 below showed the result after the audit review session.

TABLE I. USE CASES REVIEW RESULT

Use Case Name	*Comments*	*Action*	*Updated Use Case Name*
		New use case created since no use case for confirming user details	Create Account
Login	Use Case description: What happens if ID and/or password are invalid?	Use Case description: Display invalid message	
Pick type of vehicle	Use Case description: • No pre-condition • Related use case – is this not related to UC1003 'Enter basic information'?	Use Case description: • Precondition: User choose type of vehicle • Related use case: Enter Vehicle information	
Enter Basic information	Use Case description: • Unrelated flow of events. • UC1003 is meant for Offer Rider to enter the basic information, not to Find Riders	Use Case description: • Change flow of activities	Enter vehicle information
Enter destination	Use Case description: Are you sure there is no Business Rules applicable?	Use Case description: Use case: combine use case Enter destination and Enter pick up location to Enter trip details	Enter trip details
Request for ride	-		
		New use case created since this function are located inside other use case which is Enter vehicle information	Find Rider
View basic information about the driver	-		
		New use case created since there are no function for driver to view information about rider	View basic information about rider
Approve or reject the ride	-		
Contact person needed	Use Case wrongly named. Use Case description: • Not Understandable	Change use case name to Communicate with user because use case must start with verb	Communicate with user
Enter pick up location	-	Use case: combine use case Enter destination and Enter pick up location to Enter trip details	Enter trip details
View cost of journey	Use Case description: • Irrelevant of activities	Use case description updated	
Rate the person	-		
Redeem point	-	Delete Use case because there is no function of redeem for this application	

Table Legend

	No change
	Change in use case description only
	Combine use case
	Delete use case
	Change use case name
	New use case

2) *Review Technique: Walkthrough*

Walkthrough technique were done by getting review from users about the flow and functions of the application. The users gave their review based on dummy prototype that was built and presented to them using marvelapp.com design tool. Four users have reviewed the flows and functions of the application based on the existing requirements. Most of the comments were about the interfaces and flow of the application, where some interfaces were not understandable to them.

B. *Findings*

Based on the two studies, the findings were formulated in an updated activity diagram, use case diagram and domain class diagram. As shown in Fig. 1, the flow of activity diagram starts when user choose to request a ride, then application will redirect it to the main page for the request rider. At the page, it will display request ride form where request rider can enter the details for the ride and request rider click the cost of journey button. Then the application will calculate and display the cost. Next, request rider will click the button to make a request. The application will find the nearby driver, and after the driver accept the request, application will display the driver information at the request rider site. Finally, the request rider can accept or reject the ride.

For the driver, first time users need to enter their vehicle information by clicking in the setting menu and the application will save the information. Next the driver can click find rider button to find the nearby request rider. After the application find the request riders, it will display the request rider information. The driver can choose to accept or reject the request and after that, the application will directly display the driver information at the request rider site. When request rider accept the ride, the application will also show the pickup button. After the journey ends, both users need to click the arrive button, then the application will display rating bar for them to rate each other.

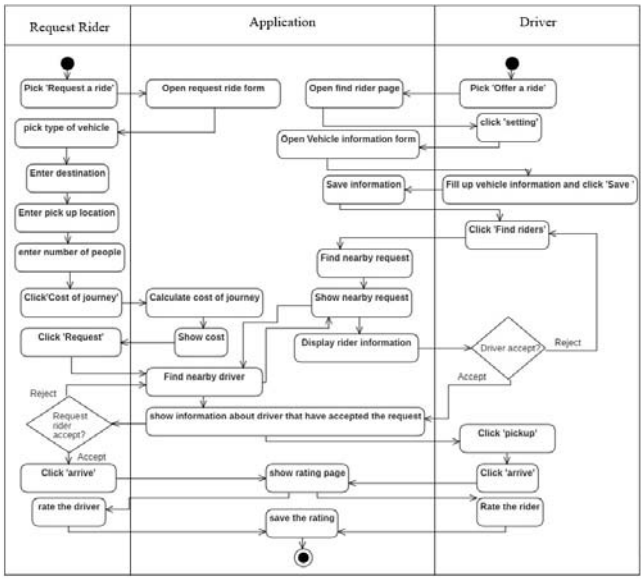

Fig. 1. Updated activity diagram

An updated use case was also constructed to show functionalities of the system. There were two actors interacting with this application which were the request rider and driver as shown in Fig. 2. There were changes in the use cases, where some of the use cases name were changed. For example, Enter Vehicle Information in the existing use case were named as Enter Basic Information and use case Contact Person Needed was rename as Communicate With

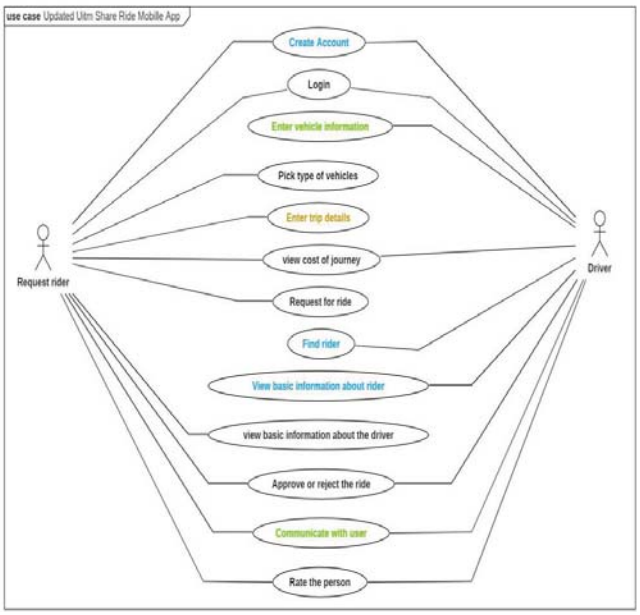

Fig. 2. Updated use case diagram

User. On the other hand, the use case Enter Destination and Enter Pick Up Location were combined into Enter Trip Details. There were three new use cases created after the validation process which were Create Account, Find Rider and View Basic Information about driver. Based on the updated use case and activity diagram, a domain class diagram was constructed as shown in Fig. 3, to show the classes and relationship between the classes of the UiTM Share Ride mobile application.

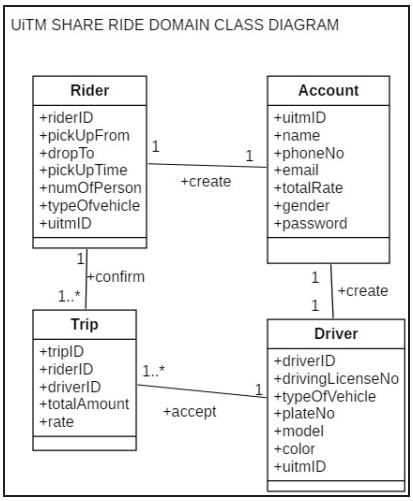

Fig. 3. Domain class diagram

V. Design and Development

The researchers used the requirements that have been validated to design the system architecture, system controls and security, database, user interface and perform the development.

The architecture of this application is a three-tier architecture as shown in Fig. 4. The system architecture contains three components which are presentation layer, application layer and data layer. The presentation layer display information and send result to other layers using Extensible Markup Language (XML). Application logic layer or middle tier contains the functional business logic where its processes managed the business logic of the application, and are allowed access to the third layer services using Java programming language. Data layer comprises database server where information is stored and retrieved. This application is using Firebase real-time database in its data layer.

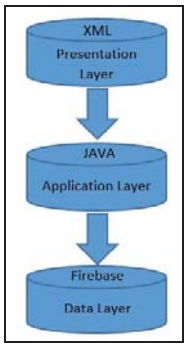

Fig. 4. Three-tier architecture UiTM Share Ride mobile application

The first iteration of the detail class diagram was created according to domain class diagram. Then, the first iteration of detail class diagram was used to design sequence diagram. After the sequence diagram has been confirmed, the result was used to refine the detail class diagram, the updated detail class diagram is depicted in Fig. 5.

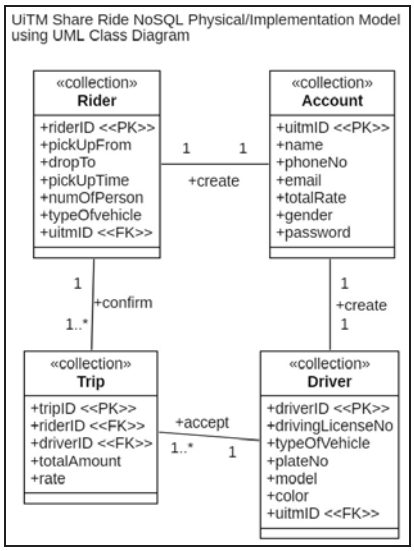

Fig. 5. Data model for UiTM Share Ride mobile application

The Firebase realtime database used in the development for UiTM Share Ride mobile application is a type of NoSQL database. Firebase is a document-oriented database which is designed to store semistructure data as document. According to [21], NoSQL database model do not has a conceptual design as it only has logical and physical designs. Therefore, documenting data model for UiTM Share Ride mobile application was a transformation from conceptual data model as shown in Fig. 6.

Fig. 7 shows the screenshots of the UiTM Share Ride mobile application in Android platform. As shown in the diagram, this application has a screen for main page, login and register for account. After a user has login into the application, he or she can choose whether to make a request for a ride or find riders, if he or she is a driver. If the user choose to offer a ride, he or she will be redirected to the Find Rider page. On the other hand, if the user choose to request a ride, he or she will be redirected to the Request Ride page.

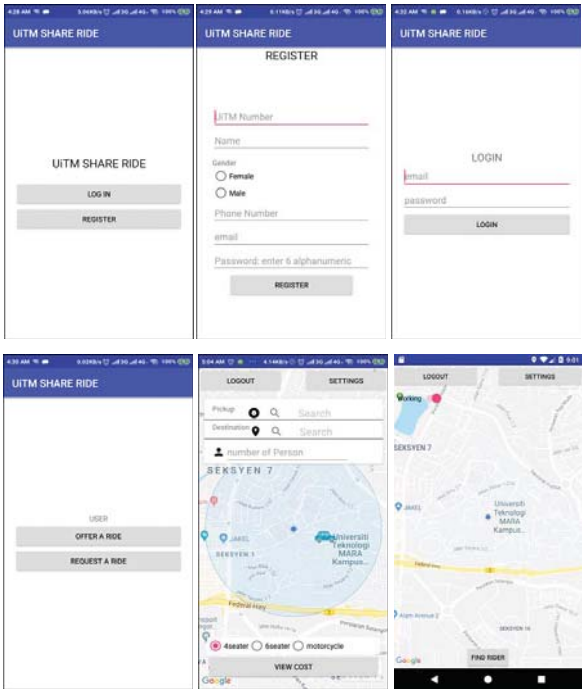

Fig. 7. UiTM Share Ride mobile application screenshots

All these functions were coded by using Java programming language, Android Studio as Software Development Kit (SDK), Firebase database for storing and retrieving data and Google Map API, to get location of the pickup location and destination from the request ride. The construction were based on the codes that was taken from open source codes, however not all functions were available in the codes and needed to be coded manually. Android Studio has Gradle build system where it has to include external binaries or other library modules to application build as dependencies. In this application, all the library for Firebase and Google Map API were embedded as shown in Fig. 8.

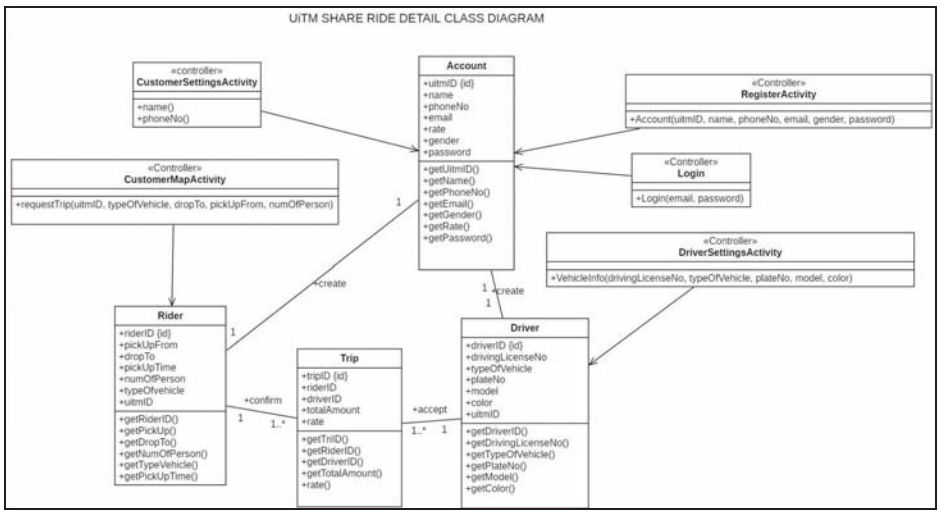

Fig. 6. Detail class diagram for UiTM Share Ride mobile application

Fig. 8. Importing the related package for Firebase and Google Map API

VI. Conclusions

This research was conducted as part of a larger project to gather requirements [22] and develop a campus ride-sharing mobile application. It was focused on validating requirements, designing system artifacts and developing a mobile application that was aimed to satisfy the users' needs for an environmentally friendly and practical vehicles ride sharing. The ride sharing application is supposed to make people journeying became an inexpensive fare [23] while managing ride sharing requests among passengers and drivers in UiTM communities that will eventually solve the issue of congestion in the university campus.

Future work will be done to test the application by using crowdsourcing method [24, 25] in order to validate the requirements gathered in this research. Apart from that, new enhancement will also be incorporated into the project after getting feedback from the users.

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References

[1] A. Kurkovsky, "Sustainability of a growing higher education institution: a simulation approach to analyze the dynamics of campus parking lots," in Proceedings of the 2014 Annual Simulation Symposium (p. 13). Society for Computer Simulation International, 2014.

[2] K. Abdullah, N. H. Kamis, N. F. N. Azahar, S. F. Shariff, and Z. C. Musa, "Optimization of the parking spaces: A case study of Dataran Mawar, UiTM Shah Alam," in 2012 IEEE Colloquium on Humanities, Science and Engineering, 684-687, IEEE, 2012.

[3] R. B. Jadhao, and J. M. Patil, "Recommendation system for carpooling and regular taxicab services," in 2017 International Conference on Inventive Systems and Control, 1-8, IEEE, 2017.

[4] N. B. Zainuddin, L. H. Min, C. S. Twng, and S. P. Khe, "Sustainable transportation scheme in university: Students' intention on bike sharing system: An empirical approach," Journal of Global Business and Social Entrepreneurship, 2(4), 144-163, 2016.

[5] U. Singh, D. Shinde, T. Sanap, N. Patil, and R. Jadhav, "Mobile application for carpool system," International Journal of Research and Scientific Innovation-IJRSI, vol.3, issue 4, pp.98-102, 2016.

[6] N. K. Sen, H. B. Chin, and T. H. Siok, "Needs analysis of Malay students studying Chinese at UiTM," in 2011 International Symposium on Humanities, Science and Engineering Research, 24-29, IEEE, 2011.

[7] UK. Essays, "Zonal parking studies in UiTM campus tourism essay," Retrieved [18/5/2018] from https://www.ukessays.com/essays/tourism/zonal-parking-studies-in-uitm-campus-tourism-essay.php?vref=1

[8] N. A, Roslan, "Requirements engineering of UiTM share ride mobile application using Kano Model prioritization," Universiti Teknologi MARA, 2018.

[9] T. Teubner, and C. M. Flath, "The economics of multi-hop ride sharing," Business & Information Systems Engineering, 57(5), 311-324, 2015.

[10] Z. Čović, and D. Babić, "Development and implementation of location based native mobile application," International Journal of Electrical and Computer Engineering Systems, 5(1), 2014.

[11] S. Siuhi, and J. Mwakalonge, "Opportunities and challenges of smart mobile applications in transportation," Journal of Traffic and Transportation Engineering (English Edition), 3(6), 582–592, 2016. https://doi.org/10.1016/j.jtte.2016.11.001

[12] B. Cici, A. Markopoulou, and N. Laoutaris, "Designing an on-line ride-sharing system," in Proceedings of the 23rd SIGSPATIAL International Conference on Advances in Geographic Information Systems - GIS '15 (pp. 1–4), 2015. https://doi.org/10.1145/2820783.2820850

[13] Y. Nalawade, V, Waghmare, and P. Waghmare, "Implementation of dynamic carpooling system on Android platform," International Journal of Innovative Research in Advanced Engineering, 2(2), 2014–2016, 2015.

[14] D. N. Anderson, "Not just a taxi? For-profit ridesharing, driver strategies, and VMT," Transportation, 41(5), 1099–1117, 2014. https://doi.org/10.1007/s11116-014-9531-8

[15] K. Niu, C. Wang, X. Zhou, and T. Zhou, "Predicting ride-hailing service demand via RPA-LSTM,". IEEE Transactions on Vehicular Technology, 68(5), 4213-4222, 2019.

[16] M. Young, and S. Farber, "The who, why, and when of Uber and other ride-hailing trips: An examination of a large sample household travel survey," Transportation Research Part A: Policy and Practice, 119, 383-392, 2019.

[17] F. Kooti, M. Grbovic, L. M. Aiello, N. Djuric, V. Radosavljevic, and K. Lerman, "Analyzing Uber's ride-sharing economy," in Proceedings of the 26th International Conference on World Wide Web Companion (pp. 574-582), 2017.

[18] L. Chen, A. Mislove, and C. Wilson, "Peeking beneath the hood of uber," in Proceedings of the 2015 Internet Measurement Conference (pp. 495-508). ACM, 2015.

[19] S. Agarwal, B. Charoenwong, S. F. Cheng, and J. Keppo, "Fickle fingers: Ride-hail surge factors and taxi bookings," available at SSRN 3157378, 2019.

[20] P. Klaus, "Requirements engineering: Fundamentals, principles, and technique," Heidelberg: Springer, 2010. https://doi.org/10.1017/CBO9781107415324.004

[21] K. Shin, C. Hwang, and H. Jung, "NoSQL database design using UML conceptual data model based on Peter Chen's framework," International Journal of Applied Engineering Research, 12(5), 632–636, 2017.

[22] K. A. Kamaruddin, and N. A. Roslan, "Using Kano model to prioritize requirements for UiTM Share Ride mobile application development," in press.

[23] A. Antao, V. Correia, and S. Gonsalves, "Carpooling application in Android," International Journal of Current Engineering and Technology, 5(2), 955–958. 2015. Retrieved from http://inpressco.com/category/ijcet

[24] Z. Zakariah, N. Janom, and N. H. Arshad, "Crowdsourcing business model for low income community: Conceptual model," in 2016 SAI Computing Conference (SAI), pp. 1173-1177. IEEE, 2016.

[25] M. Yusoff, M.N.S.B.M. Ikram, and N. Janom, "Task assignment optimization for crowdsourcing using genetic algorithm. Advanced Science Letters, 24(11), pp.8205-8208, 2018.