Route Planning Mobile Application in Transportation Management

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ABSTRACT

Finding the shortest yet most efficient route to travel through a given list of specific destinations is a well-known challenge known as Travelling Salesman Problem (TSP). E-hailing or ride-hailing services are services that enable users to gain short-term access to transportation modes on an as-needed basis through online-enabled platforms such as Grab, Uber, etc. This study aims at providing a route planning mobile application for drivers to determine an optimal means of traveling between two or more given locations. In "Share your Ride" mobile application, the route search is optimized based on the shortest distance traveled. Usability of the proposed route planner mobile application is presented to provide insights on the possibility of using it in daily routine. This will help in managing knowledge particularly in transportation and logistic management.

Keywords: route planner, e-hailing, transportation management, mobile application.

I INTRODUCTION

Ride-hailing services or e-hailing are services that connect passengers and local drivers through an online-enabled platform for transportation purposes. Ride-hailing services are a comfortable method for door-to-door transport recently as they are cheaper compared to licensed taxicabs. In some countries, ride-hailing services are regulated in the same way as regular taxicabs (*Ride Hailing Services*, n.d.). There are more than 23 e-hailing apps available in Malaysia nowadays and E-hailing is now a part of a wider development in the economy towards a so-called "sharing economy". "Sharing economy" is where private citizens are able to share their assets and services over a platform that efficiently connects users and providers (Tirachini, 2020; Todd et al., 2018).

An example of ride-hailing services will be Grab. Grab Holdings Inc. is a company formerly known as GrabTaxi and MyTeksi. Grab is a transportation network company based in Singapore which not only offers transportation but food delivery and digital payments as well through their mobile app. Grab was originally founded in Malaysia but moved to Singapore later as it's headquarter. Grab now operates in most of the Southeast Asian countries. Grab Holdings Inc. is the region's first company to be valued at over US$10 billion. In 2016, Grab opened a major development center and office in Seattle to serve as a tech hub to attract talent in the United States (*Grab (Company)*, n.d.).

Taxis and private hire cars are assigned by the Grab app to nearby commuters through a location-sharing system. Grab provides smartphones for their drivers each time they enter a new market. This allows every driver to have access to the platform and those drivers are allowed to pay daily installments for the phone. Grab earns its profit through part of the booking fees. Grab also teaches taxi drivers that work alongside them on using their smartphones as well as how to operate the Grab mobile app. Grab has also tried to reach out to as many markets as they could such as large cities and smaller cities (*Grab (Company)*, n.d.). To improve the services of e-hailing, various functions can be incorporated to add competitiveness, and this includes a route planner. A route planner is a specialized search engine used to find an optimal means of traveling between two or more given locations. In transportation management (Bast et al., 2016; Lovelace & Ellison, 2019), route search may be optimized on different criteria, such as shortest time taken, shortest distance traveled, etc. (*Journey_planner*, n.d.). With the implementation of the route planner into a ride-hailing application, drivers can know the best route for fetching their passengers. This will help drivers to save travel costs for fetching passengers as the shortest possible route can be determined.

The rest of this paper is organized as follows; related studies are presented in section II while the methodology of the study is as in section III. Section IV includes a discussion on evaluation of the developed "Share your Ride" mobile application, section V concludes the study with some insight for future work.

II RELATED STUDIES

Travelling Salesman Problem (TSP) is a well-known algorithmic problem in computer science and operations research. TSP revolves around finding the best possible route (shortest distance or lowest travel costs) to travel through a given list of specific destinations with each destination traveled at least once during the trip. This problem mimics the route planning issues that arise in the e-haling services. Various machine learning algorithms have been deployed in solving TSP. Among others is the Genetic Algorithm (Mirjalili, 2019; Okwu & Tartibu, 2021)

which is a metaheuristic that was inspired by Charles Darwin's theory of natural evolution (Ruse, 1975). GA is used to generate high quality solutions to problems such as TSP through operators such as Crossover, Mutation, and Selection.

Many related studies have used genetic algorithm (GA) based techniques for route planning problems (Ahn & Ramakrishna, 2002; Chakraborty, 2004; Inagaki et al., 1999; Kanoh & Nakamura, 2000; Nanayakkara et al., 2007). For example, a study in 2007 (Nanayakkara et al., 2007) proposed a hybrid GA algorithm for large urban street networks such as Singapore. Prior to that, Chang and Ramakrishna (2002) proposed an algorithm that utilizes genetic algorithm operators such as crossover and mutation to improve the quality of a solution. Chakraborty (2004) proposed a GA based algorithm in her paper that has a novel fitness function to avoid overlapping of multiple routes. Furthermore, Kanoh and Nakamura (2000) proposed a solution that uses crossover and viral infection to determine the optimal combination that will generate an alternative route in the shortest time when traffic congestion changes during driving. Lastly, Inagaki, Haseyama, and Kitajima (1999) discussed the genetic algorithm approach for the Vehicle Routing Problem (VRP) in their paper. All algorithms from these papers were on actual road maps and were proven effective.

Similar to the reported work, this study employs the shortest distance metric in determining a suitable route for e-hailing drivers. Route search is deployed to present the driver with the sequence of locations for him to pick-up/drop-off his passengers. Such an approach contributes a simple way to solve day-to-day problems and drive the quality of services in transportation management. Deploying knowledge management in public transportation has shown to be promising as it allows companies to reach a competitive advantage (Durst & Evangelista, 2018; Raymundo et al., 2014). In the current era, businesses are seeking new approaches for better leveraging the resources available to gain efficiencies and deliver value to the traveling public. Hence the use of knowledge management that many public and private sector organizations have applied to improve performance, create a culture that enables innovation, and reduce disruptions associated with workforce transitions. While there are many examples of successful KM programs, KM needs to be enriched.

III METHODOLOGY

The realization of the "Share your Ride" mobile application study is based on the Software Development Life Cycle (SDLC). The SDLC model that was deployed was the Iterative SDLC. There are four phases involved in the model: planning, analysis, design, and implementation.

In the planning phase, a problem was identified in the current ride-hailing services where drivers are having problems finding the best route to fetch their passengers. At this stage, a plan was proposed to develop a system that can help drivers to determine the best route to fetch their passengers. In the second phase (i.e analysis), user requirements were documented, focusing on the functional and non-functional requirements for the route planner. The requirements were gathered by analyzing several ride-hailing systems which include Uber, Grab, Mula, etc. A use case analysis, process modeling, and data modeling were then produced at this stage. In the design phase, sketches of the user interface are made available via the Android Studio Integrated Development Environment (IDE). This is followed by a low-fidelity prototype that was used to refine the functional and non-functional requirements. The prototype is then shown to selected users for suggestions of improvement. Upon completing the prototype, a user acceptance study was undertaken to evaluate the acceptance of the route planner application. A group of users that are of roles driver and passenger were recruited to evaluate the mobile application.

Table 1 shows the list of requirements and their respective priorities for the Share Your Ride application that was gathered from the requirements gathering process.

Table1. List Of Requirements For Share Your Ride application

ID	Requirement Description	Priority
SRP_01	**Make Ride Booking**	
SRP_01_01	Passengers can provide input and select their desired destination to complete the booking.	M
SRP_01_02	System will prompt error messages if the passenger's location is not found.	D
SRP_01_03	System will prompt error messages if the passenger did not fill in the destination field.	D
SRP_01_04	Passengers can cancel a booking at any time by clicking the 'Cancel' button.	O
SRP_02	**Generate List of Booking**	
SRP_02_01	System is able to generate a list of ride-booking from passengers that have confirmed booking every two minutes.	M
SRP_03	**Create subgroup from List of Booking**	
SRP_03_01	System will calculate the distance between each passenger.	M

SRP_03_02	System can create a subgroup of passengers from a list of bookings based on the destination that the passengers have booked.	M
SRP_04	**Plan Driver's Route**	
SRP_04_01	System can calculate the distance between the driver and each passenger from the subgroup.	M
SRP_04_02	System can calculate every possible route for the driver to fetch their passenger.	M
SRP_04_03	System can select the best route for the driver to fetch their passenger.	M
SRP_05	**Register Passenger**	
SRP_05_01	Passengers are needed to insert a username, password, e-mail, phone number, and security question to complete the registration.	M
SRP_05_02	System should have a check button to check the availability of the username.	O
SRP_05_03	System will send one verification mail to the passenger that just registered.	M
SRP_05_04	System will prompt error messages if the passenger did not fill in details on fields that are mandatory (marked with asterisks *).	D
SRP_05_05	System will prompt an error message if the username has already been taken by another passenger/driver.	D
SRP_05_06	Passengers can cancel the registration at any time by clicking the 'Cancel' button.	O
SRP_06	**Register Driver**	
SRP_06_01	Drivers are needed to insert username, password, e-mail, phone number, security question and provide information in regard to their vehicle to complete the registration.	M
SRP_06_02	System should have a check button to check the availability of the username.	M
SRP_06_03	System will send one verification mail to the driver that just registered.	M
SRP_06_04	System will prompt error messages if the driver did not fill in details on fields that are mandatory (marked with asterisks *).	D
SRP_06_05	System will prompt an error message if the username has already been taken by another passenger/driver.	D
SRP_06_06	Drivers can cancel the registration at any time by clicking the 'Cancel' button.	O
SRP_07	**Login Driver and Passenger**	
SRP_07_01	Drivers and passengers are required to fill in their username and password to log into the system.	M
SRP_07_02	Drivers and passengers can request a password reset if they forget their password. (Security question will be asked to confirm the identity of the user and verification code will be sent to user's email)	M
SRP_07_03	System will prompt error messages such as "Username/Password does not match" and "Username does not exist" if the user inputs a wrong username/password combination.	M
SRP_07_04	Drivers and passengers can cancel by logging into the system by clicking the 'Cancel' button.	O
SRP_08	**Manage Passenger's Information**	
SRP_08_01	Passengers can change their password, telephone number, security question upon using the system.	M
SRP_08_02	Passengers can delete their account if they wished to.	O
SRP_08_03	System will verify and prompt an error message if the passenger did not enter the correct existing password while changing their account password.	O
SRP_08_04	System will verify and prompt an error message if passengers entered a new password that is similar to the existing password while changing their account password.	O
SRP_08_05	System will verify and prompt an error message if passengers entered a new telephone number that is similar to the existing telephone number while changing their account password.	O
SRP_08_06	Passengers are able to cancel changing user information at any time by clicking the 'Cancel' button.	O
SRP_09	**Manage Driver's Information**	
SRP_09_01	Drivers are able to change their password, telephone number,	M

	security question upon using the system.	
SRP_09_02	Drivers are able to delete their account if they wished to.	O
SRP_09_03	Drivers are able to update the information about their vehicle in case there are changes.	O
SRP_09_04	System will verify and prompt an error message if the driver did not enter the correct existing password while changing their account password.	D
SRP_09_05	System will verify and prompt an error message if the driver entered a new password that is similar to the existing password while changing their account password.	D
SRP_09_06	System will verify and prompt an error message if the driver entered a new telephone number that is similar to the existing telephone number while changing their account password.	D

A prototype of the Share Your Ride mobile application was developed with the gathered requirements while using Firebase as the application database. Some snapshot of the Share Your Ride application is illustrated in Figure 1, 2, 3, and 4.

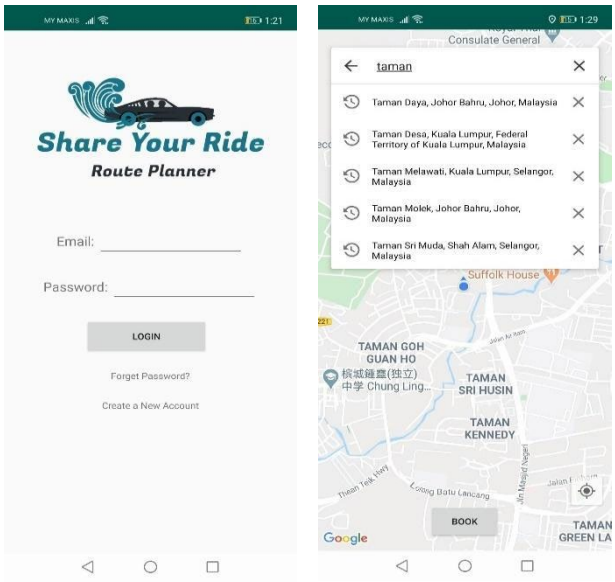

Figure 1. Login Interface (Left) And Ride Booking Interface (Right)

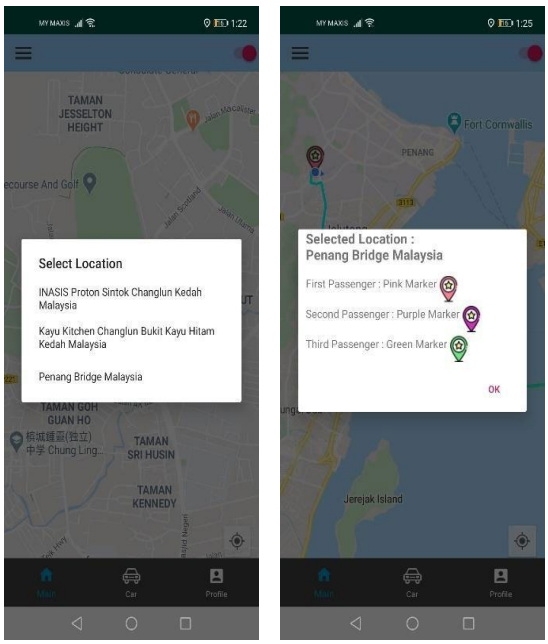

Figure 2. Driver Main Interface Before Selecting A Location (Left) And After Selecting A Location (Right)

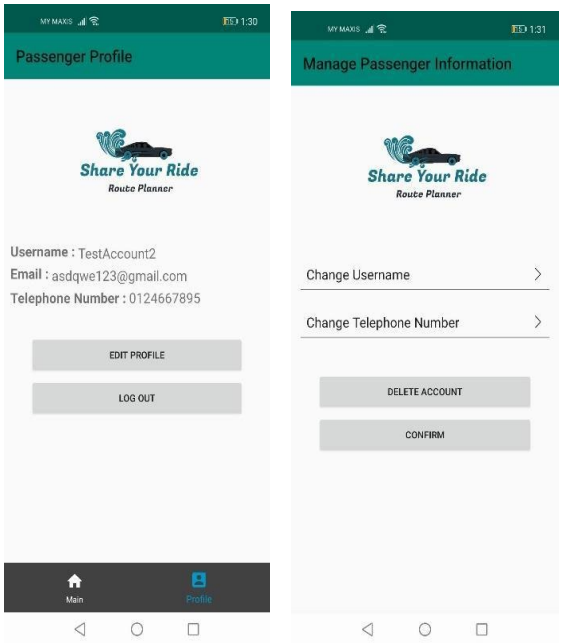

Figure 3. User Profile Interface (Left) And Manage User Information Interface (Right)

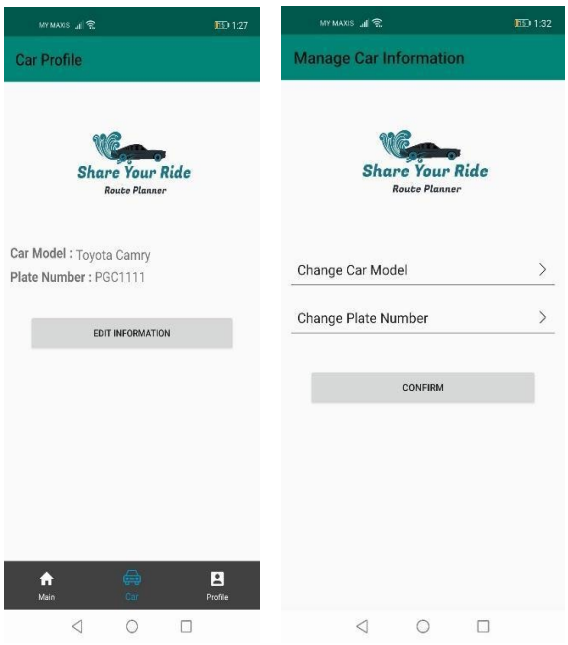

Figure 4. Car Profile Interface (Left) And Manage Car Information Interface (Right)

IV EVALUATION OF SHARE YOUR RIDE MOBILE APPLICATION

Evaluation Setting

A usability evaluation was conducted to test how well users can learn and use the system and also their satisfaction level while using the system. The purpose of the evaluation is also to gather respondents' feedback on the usefulness, ease-of-use, and also satisfaction of the system called "Share Your Ride" Route Planner (SRP). To perform the evaluation, the Share Your Ride application and a post-task questionnaire have been used. There are 30 respondents involved in this usability evaluation and all the respondents participated voluntarily. The respondents involved are users with or without experience in using a Route Planning System. The respondents participated in this evaluation through remote testing which was performed online. Respondents were given an invitation email along with Google Form URL to participate in the evaluation. The post-task questionnaire is the method used to conduct a usability evaluation of this system. The post-task questionnaire consists of two sections, sections A and B. The demography and background information of the respondents were included in section A while respondents' opinion on the usability of the mobile application is investigated through section B.

Respondents' Demographic Information

User acceptance of the application begins with Section A which reveals a user's demography profile. The majority of the respondents are drivers which scale up to 53% of the respondents. 47% of the respondents chose to evaluate the system as a passenger. Most of the respondents are Male which is 57% and this is expected as they are ones mostly involved as drivers in e-hailing services. The respondents of the evaluation consist of people ranging from age 16 to 46 and above. Most of the respondents are age 21-25 which is made up of 30% of the respondents. This is followed by a group age 46 and above (i.e 23% of the respondents). The age group 26-35 is ranked third while group 36-45 years as the fourth group. The age group 16-20 is the one of least number of respondents. Even though all the respondents use the Internet daily, not all have been using e-hailing services. A total of 33% of respondents use e-hailing every week followed by a monthly basis with 27% of the respondents. There are 23% of the respondents who use e-hailing occasionally. On the other hand, only 17% of respondents use e-hailing on daily basis.

In terms of the number of e-hailing systems that have been used by respondents, most of the respondents (73%) used 2 or fewer systems. The remaining respondents have used at least 3 e-hailing systems. Nearly half of the respondents (i.e 12/30) have heard about route planner while the remaining are either have not heard of it or unsure about it. Nevertheless, 16 out of 30 respondents agree that they think a route planning system is necessary for drivers nowadays. Besides, most of the respondents (i.e 26/30) wanted to have a system that plans the traveling route for them.

Usability of Share Your Ride Mobile Application

The respondents' responses in Section B of the post-task questionnaire were analyzed to evaluate the usability of the Share Your Ride application. This section measures respondents' thoughts on the usefulness, ease of use of Share Your Ride, and their satisfaction with the application. Tables 2, 3, and 4 show the responses of the respondents towards the usefulness, ease of use, and satisfaction of Share Your Ride, respectively. The ratings deployed in the tables are represented using abbreviations where "SD" represents Strongly Disagree, "D" for Disagree, "N" for Neutral, "A" for Agree, and "SA" for Strongly Agree.

Table 2. Respondents' Response On The Usefulness of SRP

Items	SD	D	N	A	SA
SRP enhances my effectiveness to complete all tasks	0	0	12	7	11
SRP gives me greater control over my work.	0	0	5	14	11

SRP enables me to accomplish tasks more quickly.	0	0	7	12	10
SRP saves my time when I use it.	0	0	5	13	12
SRP meets my needs.	0	0	10	9	10
SRP does everything I would expect it to do.	0	0	8	18	4
Overall, SRP is useful.	0	0	6	16	8

Table 3. Respondents' Response On The Ease of Use of SRP

Items	SD	D	N	A	SA
SRP is easy to use.	0	1	11	5	13
SRP is user friendly	0	0	9	14	7
SRP is flexible.	0	0	13	9	8
It is easy to learn how to use SRP.	0	0	6	16	8
I can use SRP without written instructions.	0	0	7	13	10
I can easily remember how to use SRP.	0	0	11	11	8
I have not noticed any inconsistencies as I use SRP.	0	0	5	17	8
I can recover from mistakes quickly and easily when using SRP.	0	0	7	12	11
I can use SRP successfully every time.	0	0	7	14	9

Table 4. Respondents' Response on The Satisfaction of SRP

Items	SD	D	N	A	SA
I am satisfied with SRP.	0	0	8	6	15
I would recommend SRP to my friend.	0	0	9	14	6
SRP works the way I want it to work.	0	0	6	17	6
I feel I need to have SRP.	0	0	4	16	9
SRP is wonderful and pleasant to use.	0	0	8	11	10
Overall, I am satisfied with the ease of completing the task using SRP.	0	0	5	15	9
Overall, I am satisfied with the amount of time it took to complete a task in SRP.	0	0	7	10	12

The outcome of the application evaluation suggested that the Share Your Ride mobile application is useful, easy to use and respondents are satisfied with the application. Most of the respondents agree that Share Your Ride is easy to use and flexible that it could help them to find the best route to fetch their passengers and meet their needs. In terms of ease of use, respondents responded that Share Your Ride is easy to learn without any written instructions and they can easily remember how to use the app. Lastly, respondents are satisfied with Share Your Ride and would recommend the application to others.

V CONCLUSION

With the advancement of technology nowadays, mobile application is preferred by most of the people as it is very convenient without needing to bring a laptop with them all the time to have access to the application. This paper described the design and development of the Share Your Ride application that helps drivers to plan the best route to fetch their passengers. Based on the results from the evaluation, it is learned that the application is well accepted by the users, particularly the drivers. Drivers thought that the application is useful in their e-hailing services. The application of shortest distance helps the e-hailing company to ease their drivers in managing passengers. Knowledge management generates some kind of benefit to business organizations, putting them in more favorable positions in terms of profitability and competitiveness.

Nevertheless, there is a need to improve on the ease of use of the Share Your Ride application in order to attract users of different age groups. A better user interface design is required to improve the user experience. In addition, to facilitate drivers during an emergency or unexpected scenario, there is a need to incorporate a re-routing function that provides alternatives routes to be taken by drivers. This would be much useful in the event of an accident or land collision.

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