AUTOPIA: Automotive Care System

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***Abstract*— Currently in Malaysia, the public awareness of vehicle care remained low; besides, there exists difficulties for vehicle owners to contact and place appointments with workshops for routine vehicle servicing. The software development method selected is Rapid Application Development (RAD), considering there is only a sole developer to this project and the given development time is limited. Then, to ensure the title proposed has demands, the developer conducted two requirements gathering activities with workshops and the public to dive deeper into this topic. It was found that this application is deemed useful by most of the respondents while they had provided valuable opinions to the developer to enhance the project too. After evaluating the responses, the developer had finally fixated the project scope and its features.**

Keywords—Automotive, Care System, management system, queuing system, Appointment management system

I. INTRODUCTION

Automotive industries are becoming a well-established industry as the usage of automotive vehicles in Malaysia is increasing drastically. Malaysian are purchasing brand new and used Automotive vehicles for personal use. Purchasing a brand-new vehicle would effortless the job of sending the vehicle for service. Servicing a used vehicle would require a lot more effort compared to a brand-new vehicle. With this proposed solution, Malaysian who purchased used vehicle would no longer need to spend time on picking their workshop or making appointment.

A. Background Study

The automotive industry is a broad sector that includes various complicated processes such as manufacturing, trading, and servicing of motor vehicles – the transportation tools to assist users travelling from one place to another easier and faster (Predictive Analytics Today, 2021). As time goes by, the industry received intense attention and grew tremendously globally due to it revolutionizing the traditional travelling method which was once energy and time-consuming.

Based on Müller's (2021) statements, Malaysia's automotive industry has always been thriving because it holds the third ranking among all ASEAN countries for a few years. For the past two years, although the negative impact of Covid-19 on automotive sales for the past two years is unarguably huge, the industry has slowly resumed to normal since the ease of MCO in August 2021. Automotive-related business activities such as car manufacturing, washing, and trading are allowed (Tan, 2021). Following the government's vital announcement, automakers pace up the vehicle manufacturing process to serve the expected spiking market demand. It is predicted that the demand for automobiles will increase rapidly due to the restriction being lifted. Additionally, Datuk Aishah Ahmad, the chairman of the Malaysian Automotive Association (MAA) mentioned that the authority promotes incentive plans consistently to encourage the national automotive market's growth (The Malaysian Reserve, 2021).

Currently, the main communication methods are via phone calling or text messaging (Mohd Sam & Farhana Baharin, 2018). The manual communication methods may cause many issues including inconvenience, time wastage, inefficiency issues and more.

Besides, the customer does not have an appropriate way to keep track of the service histories. It could be a problem when he or she wishes to trace back the services that had been completed in the past. Therefore, the proposed solution – Autopia: Automotive Care System is aimed to provide helpful functionalities to the targeted users – automotive mechanic workshops and automobile owners to overcome the gap identified. It is expected to allow the automobile owners to book appointments, view vehicle service histories, communicate with mechanic workshops and more. Therefore, the system platform will be deployed on Android as a mobile application for both user groups mentioned.

B. Problem Statement

Majority of the automotive mechanic workshops in Malaysia are still practicing manual appointments booking systems such as via phone calls, messages, or walk-ins (Mohd Sam & Farhana Baharin, 2018). Some problems posed by manual booking systems are unpredictability, a time constraint for appointment placement, long waiting time and queue, and lack of service history records. A car workshop owner had reflected the situation of being unable to predict the number of customers visiting daily (Selan, 2019). There are times when the shop is full of customers, yet it might be empty during other days. This may result in losses when there is sudden traffic of customers as the mechanics might not be able to cater for the spiking demand, forcing them to turn the customers away (Qtrac, n.d.). Turning customers away not only causes an impact on the business' sales and revenues, yet it might increase the perceived waiting time of the respective mechanic workshop among its customers (Worlitz et al., 2020). The manual booking systems are unable to assist unpredictability issue. Furthermore, a manual booking system via telephone calls also creates a barrier for the consumers to place appointments due to time constraints.

The consequence of long queues is the reduction of customer satisfaction as much as 50% (Tšernov, n.d.). Besides, considering the current situation of the Covid-19 pandemic, queueing is one of the "taboos" as it raises the risk of cross-contagion and difficulty to retain physical distancing (Perlman & Yechiali, 2020). Additionally, the manual booking system is also unhelpful in keeping track of service history records. Over 77% of respondents in research stated that service records are usually not well-retained when they visited automotive workshops (Abdul Wahab et al., 2017).

Neither of the manual booking methods could store the information about appointment or services' details properly into a database, which creates difficulties for the vehicle owners to trace the records in the future.

C. Rationale

The result of this project is an automotive care system that assists vehicle owners to manage their vehicle maintenance tasks with automotive mechanic workshops. It is mainly built to improve the problems of low awareness and willingness among Malaysians to perform regular vehicle maintenance and the downsides of using the manual appointment booking system. With the reminder and notification function provided by the proposed system to inform the users about the upcoming maintenance dates, it could be helpful to increase the awareness and willingness of vehicle owners to perform regular vehicle maintenance.

It reduces the hassle where vehicle owners no longer need to place appointments using manual methods such as phone calling and messaging. The users can browse through all the mechanic workshops available on the system then decide on which workshop that they would prefer to place appointments. Digitalizing appointment booking prevents users from issues including frustrative long queues, lack of service records, and time constraints to place appointments as mentioned in Problem Context. Besides, the system will be providing a rating and review system for users with experience to provide comments about the automotive mechanic workshops.

D. Potential Benefits

Through the preparation of the proposed system, two types of potential benefits are obtained, which are tangible benefits and intangible benefits. Below are the lists of tangible benefits and intangible benefits.

1) Tangible Benefits

The tangible benefits that are obtained throughout the preparation of the proposed system are as follows:

- Helps vehicle owners to reduce high repair costs in the event of vehicle breakdown due to long term poor vehicle care.
- Reduces the costs of paper works for automotive service history records purposes.
- Helps vehicle owners to estimate the expenditures by receiving quotations from the automotive mechanic workshops before proceeding to perform the actual services.
- Allows automobile owners to keep track of their vehicle service expenses to avoid unnecessary overspending.
- Increases revenue for the local mechanic workshops by attracting more customers through the system's ability to provide more exposure and visibility.
- Retains a vehicle's value for future reselling purposes as Richardson (2009) mentioned vehicles with complete service history are usually sold second handed at a higher price.Intangible Benefits

2) Intangible Benefits

- Increases the automotive mechanic workshops' productivity in managing customers' appointment requests.
- Raises awareness and willingness among Malaysian automobile owners regarding the importance of regular vehicle maintenance.
- Enhances the customer experience in terms of the reduced queue waiting time and more flexibility in appointment placement time selection.
- Allows users to review past vehicle service history records as an insight.
- Enhances user experience and satisfaction about the appointment booking procedure with the automotive mechanic workshops.

E. Aim

To build a system that includes automotive mechanic workshops and vehicle owners in facilitating automotive care services via a digital appointment booking system.

F. Objectives

i. To investigate the current issues of the automotive industry in Malaysia, especially regarding the manual appointment booking system that is widely adopted by the automotive mechanic workshops.

ii. To raise the awareness and willingness among Malaysian vehicle owners to perform regular vehicle maintenance through the adoption of service reminder notifications in the system proposed.

iii. To develop a system that facilitates digitalized service appointment booking between the vehicle owners and automotive mechanic workshops.

iv. To build a system that lets users to record automobile service history details to keep track of their vehicles' information.

v. To develop a system that assists the local automotive mechanic workshops in gaining more exposure

vi. To evaluate different scenarios in registering medical appointments of the system.

G. Deliverables

This project is expected to produce an automotive care system that intends to facilitate the appointment booking processes for vehicle servicing between vehicle owners and automotive mechanic workshops. The system may be focusing on functions such as service appointment booking, service reminder notifications, service history tracker and more. It is mainly to bridge the gap that currently, the local automotive workshops are still utilizing manual booking ways such as phone calling or text messaging to place appointments with the workshops.

H. Nature of Challenges

First and foremost, developing the system is one of the toughest challenges the developer will face. Throughout the process of development, the developer must conduct careful programming and debugging tasks to ensure that the system is functioning with minimal to zero issues. An underdeveloped system tends to have uncountable logical issues; thus, it impacts the user experience negatively.

Besides that, the anticipated challenge is the possible difficulty to obtain positive user involvement and engagement during the data-gathering phase. Based on the title proposed,

this project requires user participation from target groups such as automobile owners and automotive mechanic workshops' representatives. The main reason collecting user input for the investigation is considered challenging is because the participation is fully voluntary based

Moreover, selection of system development environment, programming languages, frameworks, application programming interfaces (APIs), and databases is challenging as they directly impact the system quality.

Finally, the time constraint imposed for this project's development phase is relatively limited and rigid. Four months period is allocated for the project's system development. Based on Moazed's (n.d.) arguments, this time frame is considered sufficient to develop a minimal viable product (MVP) under the assumption that there are a few developers assigned into both front-end and back-end teams.

II. System Architecture

A. System Design

1) System Architectural Diagram

The backend system architecture is designed to utilize a mixed approach including REST API built using AWS API Gateway, Lambda, S3, RDS, with ASP .Net Core (C# and Entity Framework Core) stack, and Firebase services from Google Cloud. The reason to mix such use cases was due to REST API had been proven to be poor at real time use cases like chat, which is needed for the project.

Based on the diagram in Fig 1., once users initiate any data fetching requests from the client-side mobile application, the request will pass through OkHttp and Retrofit libraries which are responsible to process the API interactions into simpler form – Plain Old Java Objects (POJOs) to prevent the developers from writing complicated low-level codes. The processes utilized the HTTPS REST architecture.

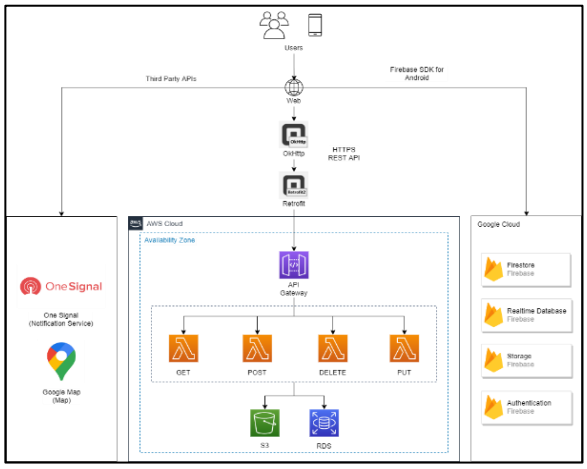

Fig. 1. System architectural diagram

Besides, a few third-party APIs had also been integrated to the project's structure. The first API is OneSignal, which is used heavily in this project to support notification services. It plays an important role due to Autopia's nature for being a CRM tool to remind customers about the maintenance schedules, as well as other activities like an appointment request's status updates, new messages from other users and more. The main reason to select OneSignal is due to it is free, which contributes favourableness to the project's budgets management. Besides, OneSignal is a professional notification services API; therefore, the integration with Android mobile application is smooth and requires lesser codes.

2) Client Mobile Application Architectural Design

The client mobile application is built using Android Studio in Kotlin language. Instead of employing Activity-Based architecture where majority of the screens are using Activity from Android, this project is adopting Single-Activity Architecture with Fragments. Activity-based architecture is an approach that tend to be practiced by Android developers earlier; however, it suffered from navigational issues. For example, users will witness total screen swapping every time they press to navigate to a new screen, which does not present a smooth navigational flow.

Worse, it tends to suffer from transition animation issues such as unusual blinking will be seen on the action bar upon navigation (Ghosh, n.d.). Another major constraint in Activity-Based Architecture is data retention and passing problems, as switching to a new activity depicts that the data is not retained within a similar scope anymore. Sabag (2018) said that the data passing between activities might require data object types to be Parcelable, a more error-prone method, and the assistance from Services and Content Providers classes. Therefore, it increased the risk and level of inconvenience.

3) User Case Diagram

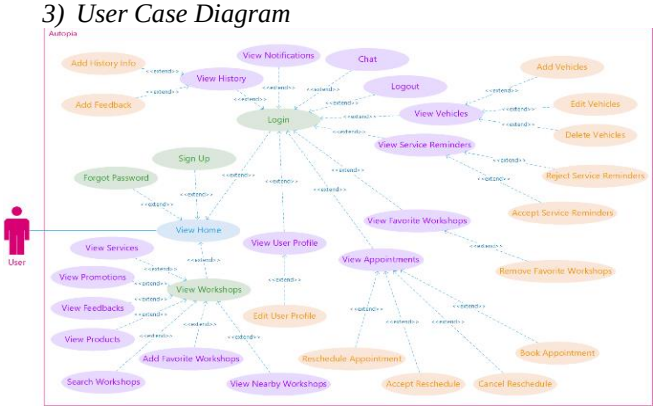

Fig. 2. Use case Diagram (User/Vehicle Owner)

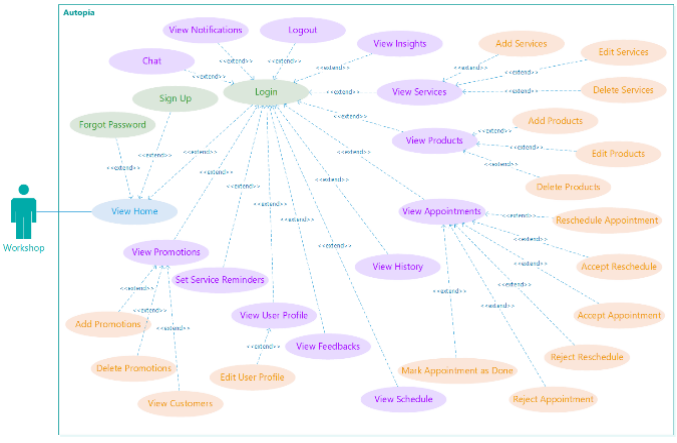

Fig. 3. Use Case Diagram (Worksop)

III. Interface Design

Interface design is a crucial chapter where an application's appearance is sketched with all the important components and features considered. To adhere to the design principles and guidelines, the developer had considered the six design principles from Donald Norman's book – The Design of

Everyday Things (1998). The six principles proposed by Norman included visibility, feedback, mapping, affordance, constraints, and consistency. All principles could be witnessed in each of the screen designed. Before implementation the it is important for the software to be tested. The main ideology to test the software before being implemented is to test its reliability and quality. Discovering a lack in either one comportment would result on improvement.

A. Interface Login Screen

Login Screen is common for users and workshops to instruct the system in initiating a user account's session. The screen is designed to contain of email and password input fields for the users to enter valid credentials. A login button is provided for users to press after filling in the email and password fields to start the processes. Besides, a forgot password button is also designed to assist the users who forgot the original password and wish to retrieve the user account by resetting it. As for the users who have yet to register a user account on Autopia, the sign-up button is designed to navigate the user to the Sign-Up Screen. The interface is designed to be minimal with necessary elements only to prevent cognitive overload and confusion. Fig 4. shows the Interface login screen.

Fig. 4. Interface login screen

B. Interface for Home Screen

Home Screen is designed to show the most important information of Autopia such as the workshops available on the platform. This is to display the most important information at the most prominent space so that the users can view them easily. The screen is also designed to be equipped with top and bottom navigation bars On the top navigation bar, a hamburger menu icon is showed which will trigger the opening of a navigation drawer. Besides, the screen name will also be displayed. On the bottom navigation bar, the design contains of important items for navigation such as "Home", "Appointment", "History", "Chat", and "Profile", where "Home" is the default selection. Upon clicking on each bottom navigation item, the system will navigate the users to the corresponding screen. Fig 5. shows the Interface for homescreen.

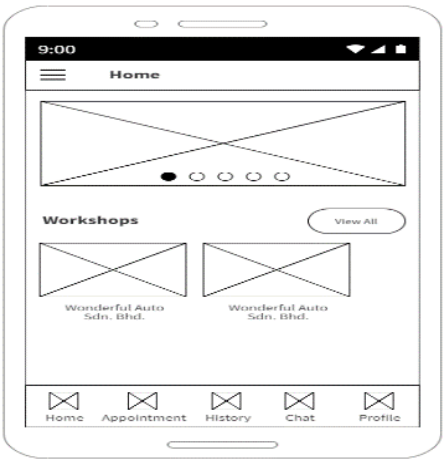

Fig. 5. Interface for homescreen

C. Interface for Workshop Screen

Workshop Screen shows the details of a workshop upon users clicking on the workshop card from Home Screen or Workshops Screen. The basic information of the selected workshop such as the profile image, information, services offered and more will be showed to the users clearly. A tab navigation bar is included in this screen to allow the users to swap between screens according to the information that they wish to browse. Essentially, there are three icons located above the name of the workshop. The icons represent Chat, Heart, and Appointment functions respectively. Upon clicking on these icons, the system performs certain functions or navigates users to the corresponding screens. Fig 6. shows the Interface for workshop screen implementation.

Fig. 6. Interface for Workshop Screen Implementation

IV. IMPLEMENTATION

A. Screenshot of Homepage

In this screen, there is a carousel showing all the latest events in images. Users can swipe or press on the indicator dots to navigate between the images. When user is logged in, the system will greet the user based on username. Following greetings, the Workshops section displays all the workshops registered on Autopia. Clicking the images of each workshop will lead user to each workshop's info screen. Fig 7. shows the screenshot of homepage.

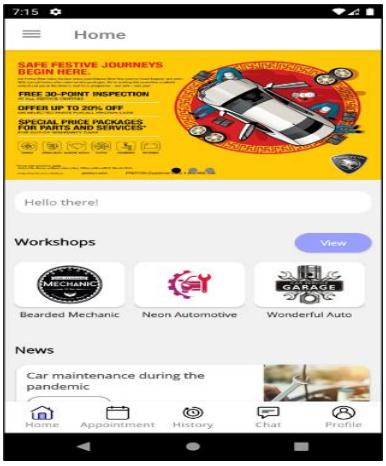

Fig. 7. Screenshot of homepage

B. *Screenshot for Login*

The users are required to fill in email and password with accurate credentials for the system to generate user session. If the inputs are invalid, a toast message will be displayed to notify the users that the login process had failed. Fig 8. shows the screenshot of login.

Fig. 8. Screenshot for login

C. *Screenshot for Search Workshop*

Workshops screen shows all the available workshops registered on Autopia with their name, description, address, and logo shown. Fig 9. shows the screenshot of search workshop.

Fig. 9. Screenshot for search workshop

Upon clicking on each of these workshop cards, the users will be navigated to the specific workshop's details screen. Apart from the main content, the screen also facilitates search by keyword and search by location.

D. *Screenshot for Workshop information*

Workshop Info screen is the detail screen when user selects a workshop. It shows all the information regarding the workshop, including its general information, services, products, and promotions offered, and feedbacks that had been submitted by other clients. In this screen, signed in users may also proceed to request for an appointment, chat, or add the workshop to their favourite list. Fig 10. shows the screenshot of for workshop information.

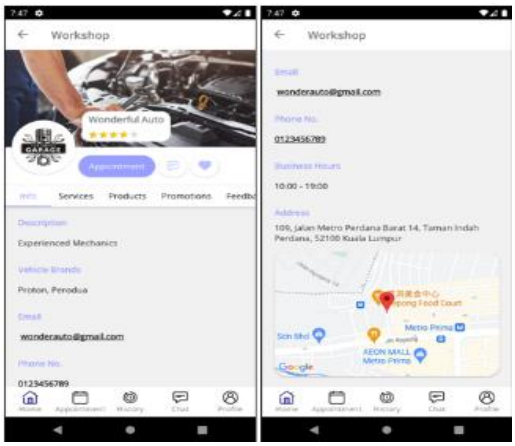

Fig. 10. Screenshot for workshop information

E. *Screenshot for Appoinment Booking*

This screen shows all the information, including workshop's basic information, service requested, vehicle selected, client's name, contact number, quotation, description, appointment date and time. It is to allow users to make confirmation before they officially request for an appointment. Once all the information had been confirmed, the user may proceed to press the "Request Appointment" button. Fig 11. shows the screenshot for appointment booking.

Fig. 11. Screenshot for appointment booking

F. Screenshot for Hospital Staff Dashboard Page

All the appointment-related screens from the workshop's point of view. However, since the functionalities are similar to the clients' features and they had been explained before, this section will only show the screenshots to prevent duplication. Fig 12. shows the screenshot for hospital staff dashboard page.

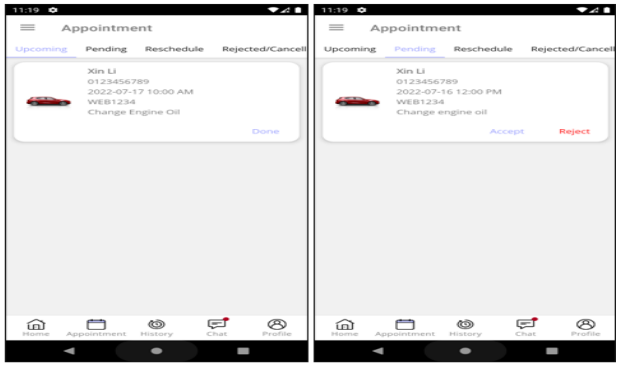

Fig. 12. Screenshot for hospital staff dashboard page

G. Screenshot of Feedback (Workshop)

Feedbacks screen displays all the previous feedbacks that had been given by the clients to the workshops. It shows the client's profile image, name, ratings, and comments. Upon clicking on the feedback card, workshops will be navigated to the Feedback Details Screen with all the client inputs filled for the workshops to view clearly. Fig 13. shows the screenshot of feedback (workshop).

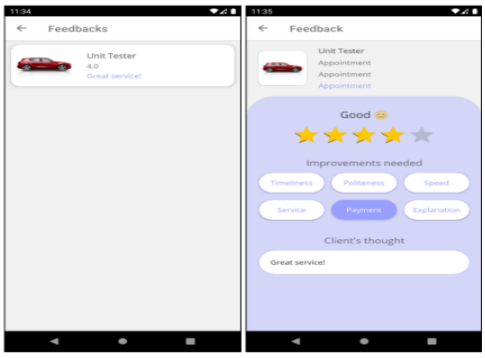

Fig. 13. Screenshot of feedback (workshop)

H. Screenshot of Notification

Autopia is also equipped with the ability of sending and receiving notifications upon activities like chatting, appointment requesting or status changing, new promotion events and more. Fig 14. shows the screenshot of notification.

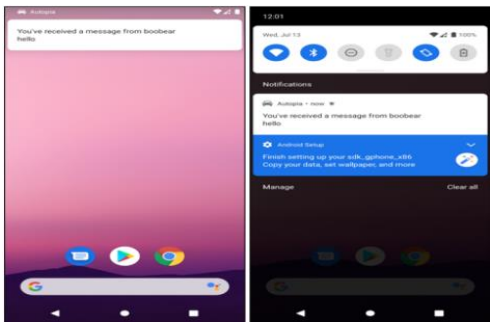

Fig. 14. Screenshot of notification

V. SAMPLE CODE

A. Smaple Code written for Login

The login function utilizes the Firebase Authentication sign-in method which takes in the user's email and password. This function will be launched when users press the login button on Login Screen, and it will only be accessible when both email and password input fields had been filled. Line 68 creates the instance of Firebase Authentication and then calls the pre-made sign-in method by Firebase which takes in email and password. Firebase will then use the email and password for validation purposes and return a task result upon completion. The developer then used the returned task to check if it is successful. If the task is successful, the system should show a toast message to inform the user that he or she had been signed in successfully. Then, the following codes are to check whether the user is a client or workshop based on the data returned by Firebase Firestore using the user's ID. Firebase Firestore is the database used to store user-related information. This checking is to ensure the system navigates the user to the correct home screen. Besides, line 89 registers the user with One Signal, the third-party API used in this project to support the notification feature. Upon user sign-in, it is crucial to update the user-ID with the API to notify it that the user session is active and should be receiving any notifications if applicable. Fig 15. shows sample code written for login.

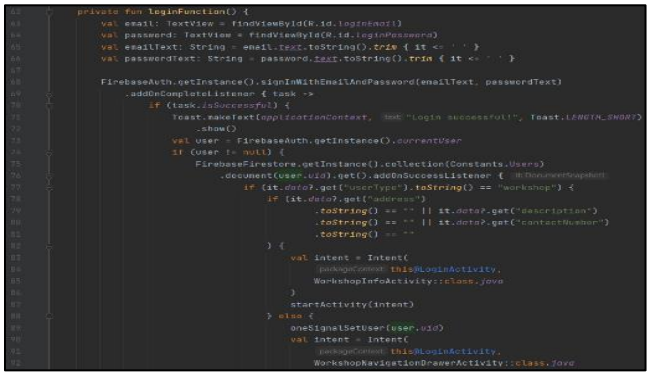

Fig. 15. Sample code written for login

B. Sample Codes Written for Sign Up

Sign Up function for clients is launched when a user presses the sign-up button on Sign-Up Screen. This function can only be launched when the user has entered all required inputs. Importantly, it first retrieves the inputs entered by user on the user interface and then send them to the Firebase Authentication's create user method. The method takes in email and password to create a new user account. Upon task completion, the developer will check on its status. If it is successful, an object with the type of User will be created using the user ID of the newly created account, email address, username, user type, and promotion status. This object will then be sent to the Firebase Firestore's Users collection to generate a new user record. Fig 16. shows sample code written for Sign Up.

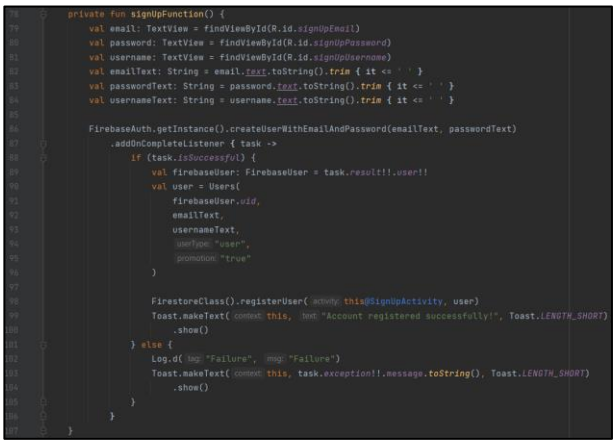

Fig. 16. Sample code written for Sign Up

C. *Sample Codes Written for Notification*

Notification is one of the essential components for appointment scheduling applications. This function will be called when any updates related to appointment matters happen. It takes in parameters like external user ID (the receiver's user ID), headings, and message of the notification. For safe coding, the developer wrapped the following codes in try and catch code block. Firstly, the system creates a string object which contains the URL link to One Signal's API. It then creates connection to the API with properties like headers, API credentials, request method, and its body. The body is appended as string with important information like the One Signal application ID, notification receiver IDs, contents, headings and more. Then, using the threading technique, the system executes the processes to send the POST HTTP request to the One Signal API without blocking the main UI thread. Afterwards, to facilitate the activity feed feature, the system is instructed to post the related notification information to the REST API hosted by the developer for display usages. Fig 17. shows sample codes written for notification.

Fig. 17. Sample codes written for notification

VI. CONCLUSION

A. *Critical Evaluation*

Autopia could bring benefits to both workshops and vehicle owners. For workshops, this application mainly assists in helping the local automotive workshop owners to build and maintain stronger customer relationships as it has features like chat, appointment management, and promotions. As mentioned in the Domain Research, in Malaysia, lack of proper platforms for workshops to communicate with customers is one of the major gaps this project is focusing on. Besides, the chat feature helps workshops to build stronger relationships with their clients as unique and personalized one-to-one experience could be gained by each client. The system is capable of broadcasting new promotion events uploaded by workshops to the clients who had turned on the receiving notification status.

B. *Conclusion & Reflection*

The developer would conclude the system developed had met the intention of solving lack of communication and appointment booking platform between automotive workshops and vehicle owners. The core of Autopia at the end of development is the appointment module with functions like request, accept, reject, cancel, reschedule appointments, auto-detect no shows, and mark appointments as "done". These are basic functionalities required for an appointment booking application, which would make the digitalized processes more convenient for both sides. Besides, another objective – to build a platform which could store service histories had also been met as Autopia can track past or completed appointments. It helps users to track their histories easier than the most popular approach selected based on the questionnaire's responses – stickers on vehicles' windshields given by workshops. This is because storing the histories in database would eliminate risks of fading words on stickers or falling stickers.

Therefore, this is the most time-consuming part for both development and debugging processes. Other coding tasks like setting device's alarm, sending and receiving notifications for users with certain IDs specifically, restraining date and time picker, auto no-show detection, auto appointment time clashing detection and more are also some of the difficult parts of this project.

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