

E-Wallet System with Fingerprint Authentication (Evolet)

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Abstract—Evolet aims to improve convenience by replacing all physical cash into the virtual payment method which can be performed by our smartphone. In response to replacing cash with phone, payment can actually be done much safer in the sense that miscounted payment amount will be reduced. Since most of the people nowadays carry their own smartphone to different places, they can actually keep their wallet at home while still able to make transaction at stores and restaurant. Not forgetting the indirect benefits by minimizing losses from robbery due to the virtual money being brought along with them. In short, this virtual payment system improve convenience by letting users to make payments via smartphone.

Keywords—E-wallet, Fingerprint, smartphone, QR code, payment

I. INTRODUCTION

Evolet is an E-wallet payment system with Fingerprint Authentication which designed to be an application in a smartphone for payment purposes with extra security and convenience. Currently, most of the stores, restaurants, shopping centre are still using cash for many different types of transactions. However, traditional cash payment is far too less secured and inconvenient which can have many drawbacks. Moreover, people nowadays generally carry a smartphone with them pretty much everywhere they go. Therefore, cash payment can be such an inconvenient way of payment method for long term point of view.

Currently, E-Wallet payment system is a growing industry in Malaysia and will continue to grow with the coming years. However, most of the E-Wallet payment system does not come with full security feature. Before a payment is made, user will need to enter their 6-digit passcode on the screen in order to enter the QR code payment page. This can result in not able to remember the passcode for many consumers as especially for senior citizens. Most importantly, someone can sneak peek the person in front making payment to key in the 6-digit passcode easily. With Evolet, user can make their payment all within their smartphone to pay virtually with QR code and verified with fingerprint authentication method. Before user make a payment, user just need to enter the transaction amount after authenticated with a fingerprint authentication method. In short, this futuristic way of payment method is far more convenient and safer.

II. LITERATURE REVIEW

A. Domain Research

Recent years, many of the Mobile Application start to evolve themselves to apply the usage of QR code for payment

purposes. For some, the application even uses QR code for reason of interacting with other mobile devices such as QR code to add friends/ contacts on an application. Especially in China, the Chinese are using QR code so widely that they can forget their wallet and just pay everything with their mobile phone through QR code. Based on research shown, WeChat pay has brought in millions of users to the pie. It was later wisely used as part of Tencent's O2O strategies. In response to that, Tencent indeed came out with something from QR code. Not only using QR code for payment, Tencent has made QR code breaking the traditional way of adding WeChat contact by searching ID replaced by QR code scanning [1]. Later in the business, competitors trying to embed the functionality into their businesses as well. Today, many merchants are actually using the QR code scanning to perform transactions. It empowers merchants to promote in the offline world and enables customers to access all services that merchants developed on this platform. All sorts of businesses are embedding the functionalities into their business in the sense that it can be used in many domain areas. Merchants are using it for restaurant location direction, voucher purpose, hotel checking as well as food delivery order platform [1]. In the first place of passcode problems, it exists with reasons which then be compelling for biometric authentication exist in the market. Fingerprint authentication method offers several benefits such as it is usable without the need of remembering password or anything else. Users just has to lay their finger down on the scanner and authentication is successful after a blink of eye [2]. On top of that, one of the significant reason to use fingerprint authentication is that fingerprints are almost impossible to be shared [2].

However, there are drawbacks of a fingerprint sensor being authentication method as well. When an extremely strong password is compared with a fingerprint authentication, certainly fingerprint authentication will not be secured enough [3]. Eventually, it can be said that a fingerprint authentication can be handy if it is intended to replace passcode lower than 6 digits considering that the higher the security, the lower the usability and vice versa [4]. In the context of biometric authentication, facial recognition must be brought to the table too. Facial recognition has been released for around 3 years. At the moment, facial recognition is considered as another convenient method to authenticate. However, it comes with a cost of compromised security which does not solve password problems in the first place. According to popular tech reviewer, the Samsung S10 which released in Q1 2019, has serious security issue with its facial authentication itself. When using the facial recognition system, the same person

which appear in another device's image view can also be authenticated successfully and unlock the phone [5].

B. Similar Systems

One of the similar systems existing in the current market is Touch N' Go and GrabPay. Grab application was originally designed to be a taxi booking application where users book their taxi within mobile phone. Later in the development, it turns to be more comprehensive in terms of taxi booking as well as other areas such as becoming another E-Wallet. As of today, it is supporting for bill payment, food ordering, hotels as well as acting as an E-Wallet platform. User can top up their account with credits for payment such as food ordering and merchandise virtual payment. Similarly, GrabPay allows user to make payment with QR code. In addition to QR code payment, the system allows for scanning other account's QR code for fund transfer. Similarly, Touch N' Go was also a platform for road toll and evolve into a famous E-Wallet application. In comparison of GrabPay and Touch N' Go to Evolet project, these 2 platform uses the 6-digits passcode as authentication method before user can make a payment. In return, it brings some drawbacks to these 2 platform which is certain degree on inconvenience.

For many people, remembering passcode can be difficult especially the 6-digit passcode is not a typical login password people will use. Hence, it may be a different passcode for users to remember. Besides, someone from behind can watch the person entering the 6-digit passcode when payments are made. Thus, the suggested Evolet system removes the 6-digit passcode authentication and replace with the fingerprint authentication method before user perform transactions and other impactful actions in the app such as change password. With the user of fingerprint authentication method, remembering passcode is no longer needed as well as user need not to worry about someone from behind peeking at phone when entering the passcode.

III. PROPOSED METHOD

A. Justification of System selection proposed

In a nutshell, the programming language chosen is Java programming language due to its long history existence and easy to learn feature. Not only that, it is widely used in the University as part of the learning programming language. Hence, it is much easier to develop the system with Java programming language due to familiarity.

Moreover, the IDE chosen is Android studio due to its strong support from Google's team. On top of that, it has a frequent IDE update receiving almost one a fortnight to fix bug and continuous feature improvement. Next, the database management system chosen is the Firebase database due to its great integration with Android Studio in the IDE itself. Setting up a firebase database will never be difficult, and it is relatively easy to setup without requiring the download of external software or tools. In terms of libraries, the chosen library for the system development is Zxing library which offers the QR code generating feature as QR code scanning interface and content reading function. In response to that, the development of QR code function in both aspect will be quick and easy.

Ultimately, the targeted operating system will be Android Operating System with API 21 and above. Considering the fingerprint service requirement, API 21 and 22 are the last

batch of supported Android version and will soon be banned from using the fingerprint service. Thus, any version lower than API 21 is not supported.

B. Data Collection

Data collection methods will be used for this system is questionnaire. Interview is the most effective for quantitative research as it collects data from wide range of target audience for data collection. This technique allows researcher to collect opinions, ideas, experiences as well as knowledge effortlessly. Therefore, questionnaire is chosen as for data collection method and to be further analysed once the questionnaire sampling size has reached. Based on the results of the questionnaire results, researcher can analyse the data according to the questions asked along with the decisions and conclusions for the system development.

The method of data collection is through questionnaire targeting friends and peers in APU, other universities as well as outsiders who consumes and purchase goods and services. The platform chosen for questionnaire design is using Google Forms. For the sample size, the questionnaire is targeting for 50 responses. In this questionnaire, consumers will be asked for their knowledge with E-Wallet, consumers' behaviour as well as some system requirements. Based on the questionnaire results data collected, there are some decisions and requirements needed to be applied in the system. First of all, most of the users are using Android devices and so the platform should be focused on the platform primarily before moving to other platform development. Furthermore, it is crucial to have the funds balance shown on the relevant page of the application for the users to view their balance. In this case, they can avoid the scenario where they wish to pay without aware of the low balance in their E-Wallet. Most significantly, the payment should be authenticated with fingerprint scanning process. This is to allow users to make their payment in the quickest way possible yet most secured without having to remember passcodes. Moreover, using QR code to make payment itself can already be much secured than other payment methods [6].

C. System Architecture

System architecture is defined as the conceptual model which defines the structure, behaviour, and more perspective views of a system. Furthermore, it is also a formal description and representation of a system, organized in a way that supports reasoning about the structures and other behaviours of the system [7]. In this topic, various diagrams will be illustrated to demonstrate the system architecture including use-case diagram, sequence diagram, entity-relationship diagram and so on, as shown in Fig. 1 to 4. Each of the diagram helps to understand the design of the system in every aspect regardless of database structure or data attributes. In addition, a detailed storyboard system design of the proposed mobile application will be included as well.

D. Database Design

The Evolet mobile application uses the database offered by Google Firebase. Firebase consist of Real-time database and Firestore database. In the Evolet project, real-time database was used to implement the system. Regarding to the firebase database, it uses different type of data storing method than other database data storing method. In Firebase, JSON objects are used to store data. It is somehow different from the typical SQL database where most databases use. SQL

database store data in the form of table-like structure. Instead of storing data that way, Firebase uses nodes to store data inside JSON structure. The nodes are scalable to represent different attributes or intended class to store its attributes in it.

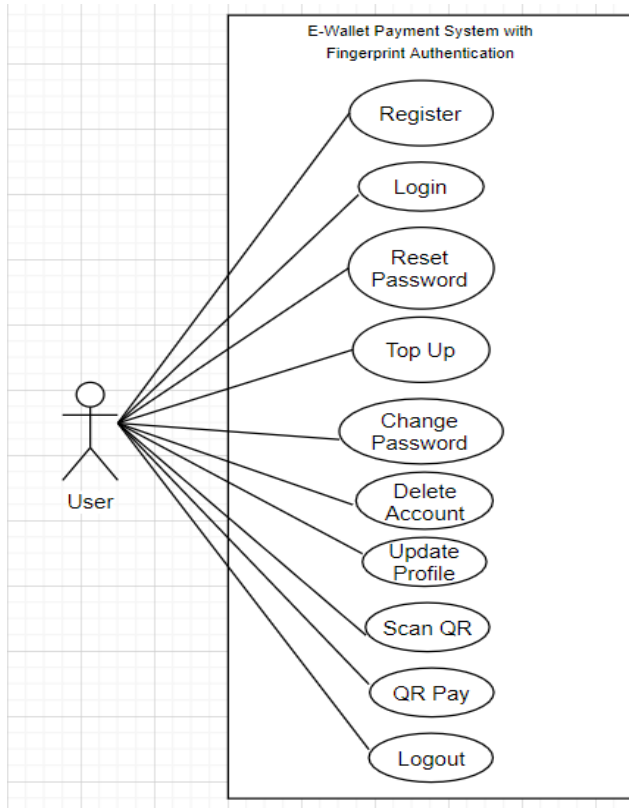


Fig. 1. Use-case diagram

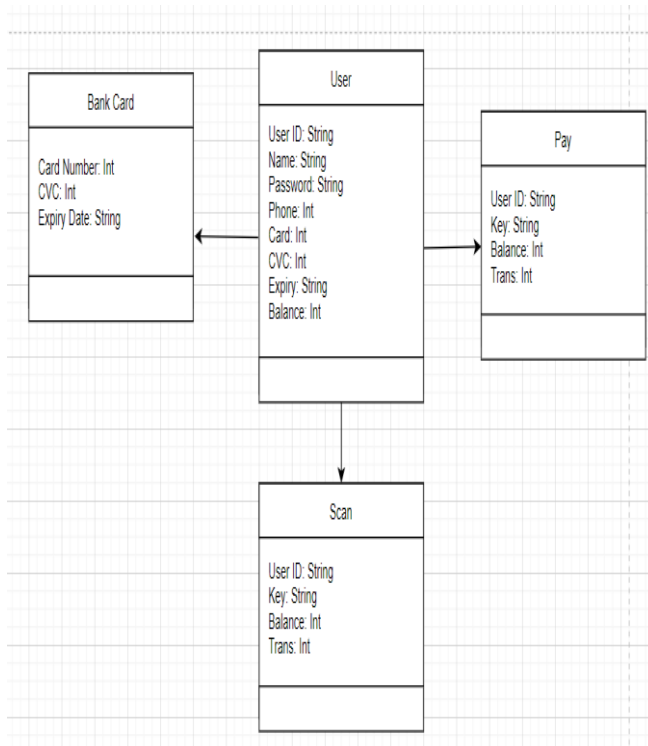


Fig. 2. Class diagram

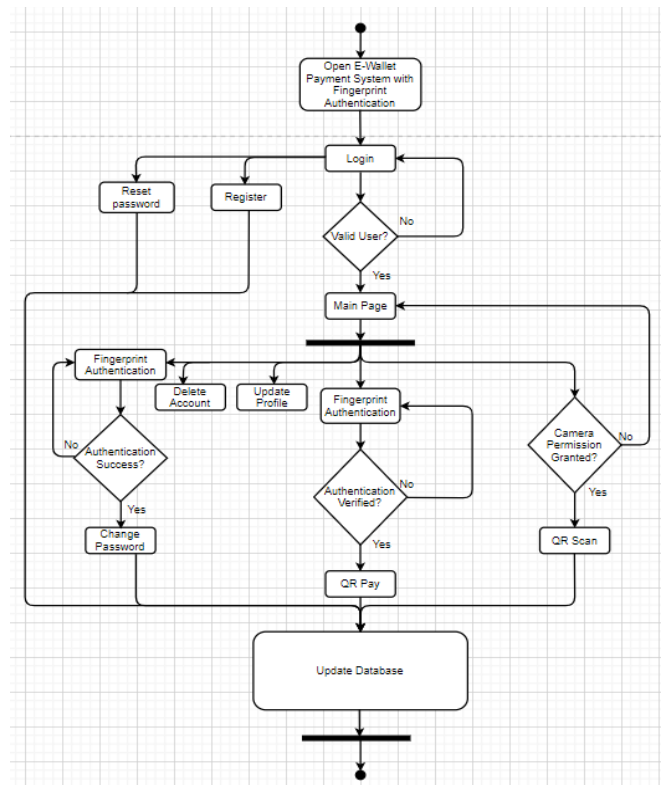


Fig. 3. Activity diagram

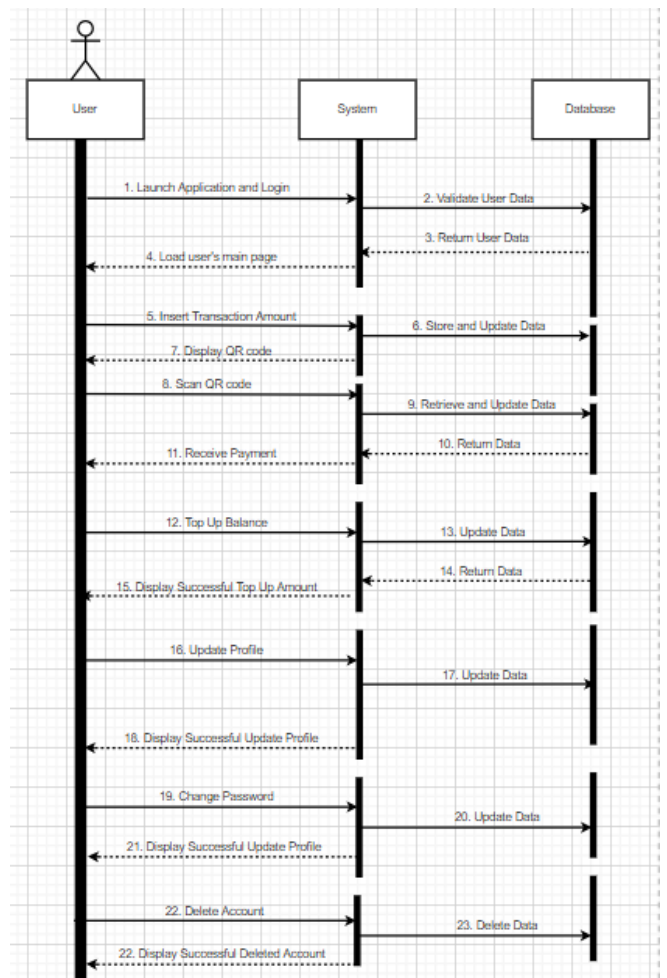


Fig. 4. Sequence diagram

IV. SYSTEM IMPLEMENTED

A. Splash Screen

Upon the launch of the Evolet application, the splash screen with the Evolet application name will be shown on screen as a step further to modern smartphone application design. This is considered as a compensation while the app is loading which takes time. Therefore, instead of letting user to see the blank screen, this will beautify the app to a further mile. After the splash screen waiting time of 2000ms (2 seconds) is gone, the first screen appear is the login screen for user to login to their own account. Throughout the entire application, empty filed validation and formatting validation is done to prevent errors and unwanted problems which is as illustrated as in the Fig 5. In this login page, user must login their account with both fields entered. If the user wants to register an account, just click on the blue text below to enter the registration page. Otherwise, the user can also proceed with the forgot password page if password is forgotten. If the credentials are entered correctly, user will then be brought to the Main page which is the home page for the Evolet application as shown in Fig. 5.

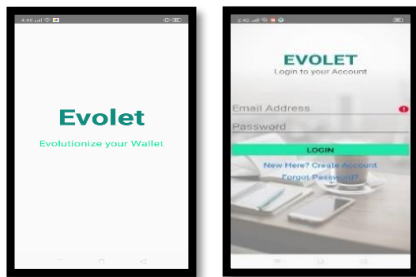


Fig. 5. Splash screen and login page

On the registration page, it is similar that validations such as empty field validation and at least 6 digits for password field are done to avoid errors. After all the fields are entered, user can create the account. If the user enters the registration page by mistake hitting the register link from login page, user can now return back to login page by hitting the “Already Registered? Login Here” link below the register button. Similarly, the register button will bring user to the main page upon successful registration of account. Otherwise, the red error icon will be displayed to the user if registration criteria is not met.

As mentioned in the login page, user can proceed with the forgot password feature if they do. That will bring the user to this reset password page where an email address field is displayed to the user to enter their email address. After pressing the reset password button, an email from Google Firebase will be sent to the user to reset their password as shown in Fig 6.

After clicking the reset password button, user will receive an email to redirect to the reset password webpage. After user click on the link from their email address, the Google firebase reset password page will be brought to the user to reset password. Apparently, user can reset their password effortlessly from this page and return to the mobile application with the immediate updated version of their password.

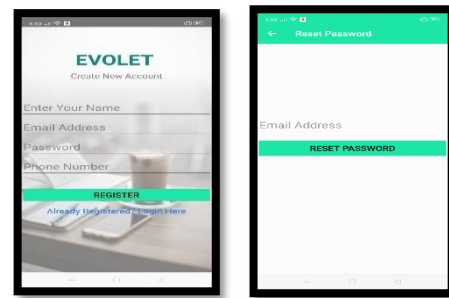


Fig. 6. Account Registration page and reset password

On the main page after user has successfully logged in, this main page will be displayed to the user with all the master control of the application features. Aside from that, user who have already logged in previously and currently not at the state of logged out, they will be automatically brought to this page without starting at the login page again. Hence, this feature can enhance user experience. On the home screen, the basic information of the user will be displayed such as the username and account balance. User can immediately aware of the basic information of their account by just having a quick glance. Other than that, there are also multiple buttons on the screen which represent different pages and application features. There are 4 buttons visually appeared to the user which includes the pay, scan, top up and action bar buttons. By cling on the pay button, pay and top up buttons, user will be brought to respective pages as self-explanatory the button names are. In addition, the action bar button will expand upon the click of it to reveal more additional buttons apart from the main features of the application as shown in Fig. 7.

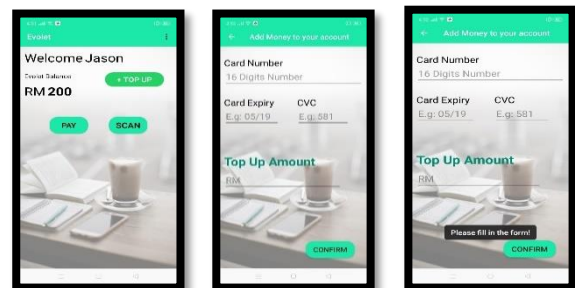


Fig. 7. Main page, Top-up page and Feedback

After clicking the top up button at the main page, the top up page will be brought up and user can enter their card information to reload their account balance. If the user enters the correct card credential corresponding to their Evolet account, reload balance is then occurred. User account balance will then be reloaded based on the entered amount.

Throughout the entire mobile application, error message and this feedback message will be given to alert the user for application state understanding purpose. This feature can improve the user experience.

Upon successful transactions including top up and payment feature, user will be shown with the Successful page along with the information criteria feedback to the user as shown in Fig.8.

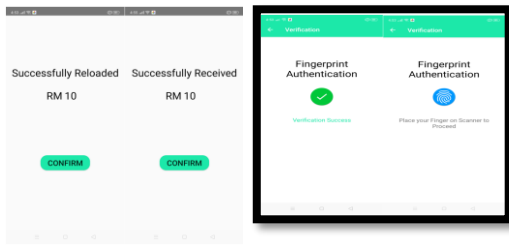


Fig. 8. Successful action performed and verification successful

Throughout the entire application, there are 2 features which involve this fingerprint authentication method prior to the usage. The 2 features including the change password and pay feature. This fingerprint feature can secure the transaction without issues. However, the statement “Place your finger on the scanner to proceed” will only show up if the device met the criteria such as device OS version > Marshmallow, the device has a fingerprint scanner, the device lock screen has secured with at least one type of lock, the device has at least saved one fingerprint in settings. Otherwise, error message will be displayed instead.

When the user scans their fingerprint with the fingerprint scanner, error statement will be displayed based on specified criteria. For instance, unmatched fingerprint with user’s device fingerprint image stored within their device will trigger the “Authentication Failed” error. Otherwise, scanning fail to capture user’s fingerprint will show the error message telling “Finger was moving too fast”.

When the user clicks on the Pay button on the Main page, the QR pay page will be brought up with the empty QR code matrix box. This is because the user has not entered the amount and the click of the pay button. After the user enter the amount and press pay button, the QR code will be generated and display on the white box area.

After the user enter the amount and press pay button, the QR code will be generated along with the feedback message to inform the user that the QR code is ready to be scanned as shown in Fig. 9.

Upon the first time that the user using the scan feature, the alert menu will be shown to the user to request for permission under the camera hardware access.

If the camera permission is granted by user, the QR code scanner interface will be appeared to the user for the QR code scanning operation. User just place the QR code images inside the rectangular frame and it will automatically show the result.

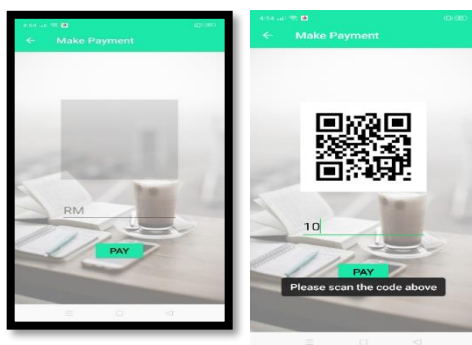


Fig. 9. QR page and code generated

Update profile page can be accessed by the user from the home page action bar menu button after expended. From update profile page, user can fill in the new name and phone number which needs to be updated as per wish. Besides, user also has the option to change their password by pressing the “Change Password” button as shown in Fig. 10.

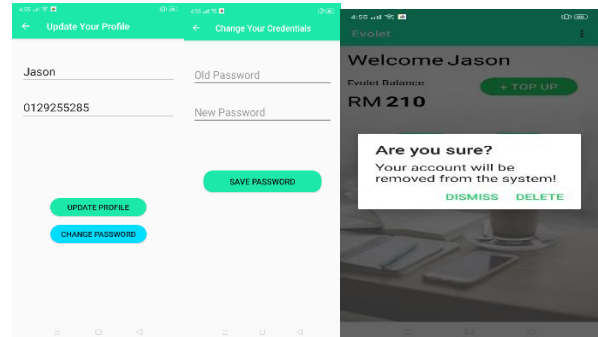


Fig. 10. Update profile page, change password and delete account

Change Password page can be accessed from the home page action bar menu or the update profile page. User will need to enter the current password and the old password for the update.

From the home page action bar menu, user can delete account with the confirmation alert dialog. After the user confirm the delete alert, the account along with the user’s data will be wipe out completely from the firebase database.

V. RESULTS

A. Interface Design (GUI)

Based on the result from the chart as shown in Fig. 11, 2 of the participant’s rate it at 4 and 1 of them rate it as 5. Hence, it is considered as satisfied for the Interface Design. 2 of the users who rated it at 4 are most likely because of the white background. In conclusion, it is just a minor issue where the interface design can be improved by changing some of the background from white plain background to some colourful one.

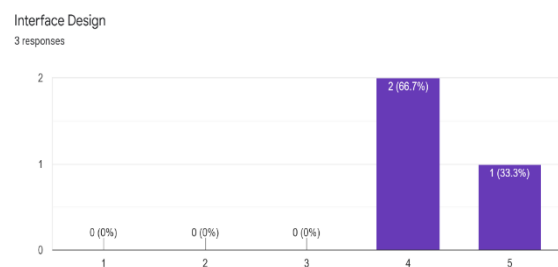


Fig. 11. Interface design result

B. System Validation

Based on the survey result as shown in Fig. 12, it can be seen that 2 of the participants rated the validation as 4 and 1 participant for 5. Hence, it can be seen that the participants are satisfied with the validation but still has a small room of improvement to perfect it. From the analysis, it can be

concluded that the validation can be further programmed to validate better every input from user.

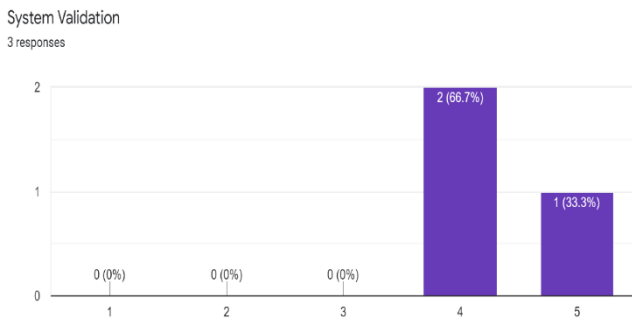


Fig. 12. System validation

C. System Maintainability

Based on the result chart as shown in Fig. 13, it can be seen that the system maintainability is considered very high due to the use of Android Studio IDE. Generally, it should not be hard to maintain. At any time, new features can be added or the app itself to evolve better.

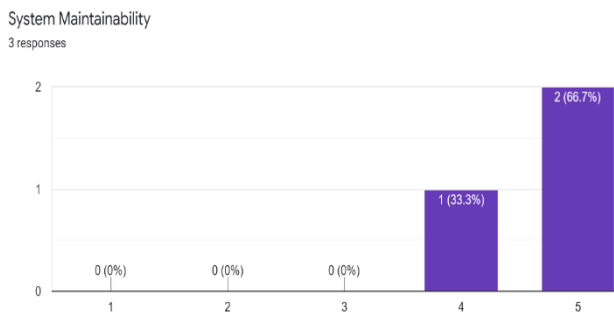


Fig. 13. System maintainability

D. Free From Bug

Based on the survey result as shown in Fig. 14, it is understandable that the participants are happy with the use of the mobile application. Generally, using the app does lead to any sudden shock of a bug that overwhelm the participants.

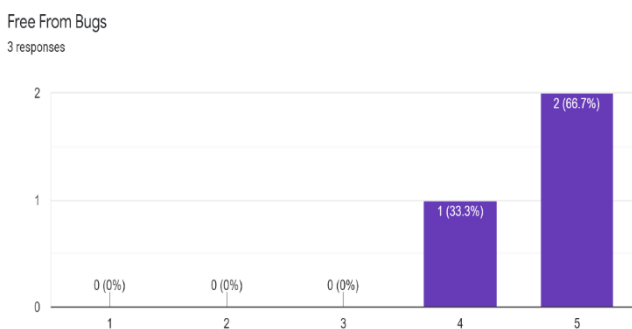


Fig. 14. Free from Bugs

Unit testing had been made to address the test plan defined earlier of the project. Generally, the test plan was develop based on the feature functionality, form submit validation, task operation error and so on. Some of the testing had fail to comply with the expectation at the beginning. However, those errors will all be solved by the end of the

project development and the fully functional. By addressing the feedbacks and comments, there are a few objectives to focus on upon the testing completion. First, the interface design must be addressed by adding some color or images to the background or the buttons. In terms of functionality, it can be further enhanced by adding the recommended features by the survey participants. By combining both of the feedbacks and recommendations, it can be said that the Evolet Android mobile application will be flawless and able to work properly without issues from emerging to users by the end of development.

VI. CONCLUSION

For traditional cash payment, it is beginning to be considered as old-fashion transaction method. In today's society, consumers always look for speed in everything. Naturally, transaction method will also change by generation. By implementing the Evolet mobile application, it will further speed up the transaction due to no passcode needed during the QR code payment. Unlike Evolet, other E-Wallet in the market uses the 6 digits passcode prior to the payment. In the security point of view, the 6 digits passcode can sometimes be extra or redundant to consumers on E-Wallet because someone behind waiting for the payment in a restaurant might be able to see the front consumers entering their 6 digits passcode. For the speed transaction perspective, it is also causing certain degree of inconvenience since not everybody can remember the 6-digit passcode and may lead to waste of time.

With the literature review of the Fingerprint authentication prior to the development stage of Evolet, it helps to understand how Fingerprint Authentication can replace the 6 digits passcode and make payment way faster without having to remember the passcode. Speaking of the convenience of Fingerprint Authentication, it gives consumer the speed for transactions with any extra steps to perform. Most importantly, it simply aligns with the purpose of QR code payment method which is Easy to use.

In order to make sure that Evolet is working as intended and fully functional, diverse types of testing are needed to be accomplished. Fortunately, the testing of the application also leads to some adaptable features and bug fixes. For instance, the interface design (graphic user interface) was not done properly which leads to boring interface. In addition, the features were recommended to be added on as well. Those features include reset password, update profile and delete account. After the analysis, adjustments were made to further enhance the system to be more usable and viable upon the deployment of the project final product.

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