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An Authentication of Carpooling Apps Using OTP and Fingerprint

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Abstract: Many user passwords being leaked through security breaches of user account nowadays. Two-factor authentication (2FA) method of authenticating using a One-Time Password (OTP) and fingerprint was proposed for a carpooling application (app) to enhance the security of the password authentication in such circumstances. 2FA implementation aims at strengthening security by deploying secondary authentication tokens while the OTP was developed by utilizing the SMS system by sending users a message containing a string of code. Implementing OTP and fingerprint authentication to the Book a Seat Carpool application is a method of mitigating the security loopholes of having a password-only authentication method. Agile Model is used as the methodology for flexibility to the developer in order to complete the Android Studio with Java programming language, and Firebase Database is chosen as the development tool. With this application, user can register their account and verified using phone number, authenticate with fingerprint to log in, add ride details, update details, and logout from the application. This application is expected to reduce the risks of attacks on the breach of user account details.

Keywords: Authentication, Biometric, Fingerprint, One Time Password

1. Introduction

With the increasing concern on information security threats, many laws and standards on security issues have been developed to address the safety of information on the Internet [1]. As an example, authentication plays a big role to control access to users' data. Authentication is a mechanism by which the registered or already recognized user is confirmed to provide certain services and protect users information from an intruder [2]. Most information systems nowadays rely on static passwords to ascertain the identity of the user. Subsequently, hackers have the option to use other techniques to steal passwords such as surfing the arm, snooping, sniffing, guessing, and others [3].

Among the most popular strategies used to increase authentication security is the use of two factors, rather than just one-factor authentication. Two-factor Authentication (2FA) systems are implemented to address the vulnerability of a single password authentication scheme and improve the security aspect by introducing a second factor for authentication [4]. The second-factor authentication being proposed

in this study are: (1) OTP using the Short Messaging System (SMS) based and (2) fingerprint biometrics authentication method.

The first factor, One Time Password (OTP) is a password that valid for only one login session or transaction. The advantage of the OTP is it could facilitate the password breach scenario in which an OTP is still needed as a token to gain access [5]. The second factor, fingerprint is noted as the fastest and best biometric authentication method. Furthermore, they are safe to use and unique for each person because no two people have been found to have the same fingerprints, and its pattern will never change in one's lifetime [6].

According to Luè & Colorni [7], carpooling is the agreement of two or more individuals who often drive along the same route at mutually agreeable times to share the use of a private car. The existing system of carpooling apps comprise authentication loopholes since many applications are still implementing one-way authentication [8]. For instance, email and passwords login can be easily accessed by hackers who can illegally gain the passwords of users. Another example that can posed to a password breach is the negligence of users who store their passwords in unsafe places like on a notebook or notes application in mobile phones [9].

Attackers that can gain access to a user account will cause many information security-related issues. One of them is the attacker can act as an imposter and be someone else on the platform [10]. They can post fake rides and book a fake slot for passengers in the app. This will lead to many other issues regarding the user's safety.

In addition to the information security mechanisms, this application could save a lot of users' time waiting for a public transport. Instead, users could book a ride with other people who are going to the same destination [11]. The increasing amount of cars on the roads will lead to traffic congestion and also not environmentally friendly [12].

The remaining of this paper is organized as follows. Section 2 reviews all works related two-factor authentication method. Section 3 presents the Agile Model methodology used to perform application development tasks. Section 4 presents the results and discussion, Section 5 presents the results, and finally, Section 6 concludes with some direction for future work.

2. Background of Study

This section presents relevant study background about related terms of the proposed system, such as two factors authentication, biometric authentication, One Time Password (OTP), carpooling, information security issues on carpooling, and comparative study of the existing applications with the proposed method.

2.1 Two-Factor Authentication (2FA)

Two-factor authentication uses any combination of an authentication method or a combination of multiple composition of various authentication methods, and has been acknowledged for many years that it can protect authentication system against the pitfalls of the password and PIN [13]. Many organizations are adopting to the 2FA as a way to maintain user integrity within their networks while decreasing the possibility of any malicious users infiltrating their networks [14]. 2FA can be categorized into three categories as pointed out by Brainard et al., [15] :

- Knowledge Factors or Something we know which the common kind of authentication such as passwords, pin or secret questions.
- Possessive Factors or something that we have such as USB tokens, in this case, OTP SMS is also included in this category.
- Inherence Factors that is the users' characteristics such as fingerprints. This is the hardest to poof as it is unique to every individual.

A One Time Password (OTP) is a single string of password that is valid only once and instantly void after verified [2]. There are multiple ways of getting an OTP such as an external application which contains a single use token for OTP and SMS based OTP [3]. The SMS Based OTP is used by a system to verify an access request. For example, a mobile phone requests an OTP from a provider, then the SMS containing OTP sent to the user's phone [16].

The fingerprint authentication system is a popular biometric system and received significant attention of research in biometric technologies area. The traditional fingerprint systems discovered in the late 19th century stored criminals' fingerprints in the form of card filing in a database. To determine the identity of criminals, the fingerprints from the crime scene are taken and matched with this database [17]. Fingerprint has evolved to an automated biometric system through intelligence system domain [6]. An intelligent system captures fingerprint scan and extract the features from the fingerprint and conduct pattern matching afterword. Compared with other biometric features (e.g. face, iris, and voice), fingerprint-based recognition systems are the most thoroughly researched and widely deployed. This is due to the pattern of valleys and ridges is determined for a fingerprint after birth, and even identical twins possess different fingerprint patterns [18].

2.2 Carpooling

Carpooling enables travelers to share a journey to a common destination by sharing the same car and spreading the cost. Since carpooling reduces the number of cars travelers need, it is often associated with numerous societal benefit [11]. Carpooling applies only to the activities carried out by private motor car owners and drivers [12]. The carpool driver may pick up passengers from their home, or the passenger may find a way to get to the driver's home at a specified time, or they may meet at a given place. The benefits of carpooling includes reductions in energy consumption and emissions, congestion mitigation, and reduced parking infrastructure demand [11].

Apart from the various benefits of carpooling, there are information security issues that comes with the apps. For example, there are issues on fraudulent information provided by fake users. There are no regulations and checks for safety assurance of the carpooling apps customer [19]. User data privacy issues also being a concern concerning carpooling in which some users worried about their personal information accessed by other unauthorized persons [20]. Another issue is identity theft as the risk for a carpooling apps with a weak authentication method will pose a risk to hackers stealing user's credentials. Attackers acquired users identity through various methods such as computer hacking, fraud or tricking user with social engineering [21].

Implementing OTP and fingerprint as the two-factor authentication to the system will influence significance impact on the security aspects of the apps. The authentication of the users using a one-time code ensures that an extra layer of protection towards identity theft [10]. Fraud cases involving carpooling application can be reduced with a Two Factor Authentication method ensures there are no malicious users trying to gain access to the system illegally [22].

2.3 Study of Existing Systems

Carpooling application has been widely developed by many companies as they see the potential of carpooling to reduce many issues such as environmental related issues and also congestions [23]. Carpoolworld.com and RideSharing.com are the two examples of the existing carpooling apps.

Carpoolworld.com was developed in the year 2000 by Max Fox and Isabelle Boulard. Datasphere Corp. is the parent company of the website. Carpoolworld.com is a free to use website where it offers individuals public to use the system. It is also a website that matches other travelers to commute based on their transportation needs. To find a ride, users need to enter origin and their destination to search similar trips. The users will then contact each other by phone witch each other to make the ridesharing agreement. The cost for a trip is calculated using Carpoolworld estimation of fuel costs based on the

distance. However, the final cost and payment is all on users agreement between the passengers and drivers. Carpoolworld users registration is a straight up process. User enter details and click sign up. After that, a verification email will be sent to users and they need to verify the email first. Users also can choose the option to sign in using their Facebook account. After account is verifies, user can instantly post a carpool trip.

Ridesharing.com is a carpooling website founded in Montreal Canada in 2005. It targets the users of Canada and the USA to commutes daily such as university students and workers. The website claims to have a community of 179000 of members registered to the service in Canada and USA. Drivers and passenger can use the platform to find daily commute as well as a long-distance travel. The website specifically for Canada and USA and for noncommercial ridesharing only. The user registration process is straightforward with user needs to input credentials such as matching gender, put name and email address to the system. An email verification will be sent to user for verification purpose.

Table 1: Comparison of Existing System

Attributes	CarpoolWorld	Ridesharing	Book A Seat Carpool
Platform	Web	Web	Android
Authentication Methods	Email, Pass word	Email, Pass word	2 Factor (Email, Password, OTP, Fingerprint)
Cost Estimation	Yes	Yes	No
Technology Used	PHP and MySQL	PHP and MySQL	Java, XML and Firebase
Email Verification	Yes (Email verification link)	Yes (Email verification link)	No
Social Media Link	Yes (Face book)	Yes (Face book)	No
Phone No. Verification	No	No	Yes

Based on the observation of the comparative study in Table 1 with the features that each application offers, the Book a Seat Carpool application able to provide most of the basics functions comparing to other systems.

Furthermore, Book A Seat Carpool implements a Two Factor Authentication method and phone number verification. Other platforms only use traditional email and password sign in method. But Book A Seat Carpool did not have email verification upon signing up while the other two systems have the verification email send to user for verification purpose. Both Carpoolworld and Ridesharing integrate social network token which is Facebook account to sign into the application while Book a Seat did not apply the third-party apps token authentication.

3. System Development: Methodology and System Analysis

The model that is applied in the app development is Agile model. Agile model provides convenient in as it flexible to fixing or changing project requirements [24]. Furthermore, this model gives the developer flexible timing which will avoid any unneeded stress on pushing to the limit to complete the task for the specific parts. Figure 1 shows the Agile model which have number of iterations and phases of the model.
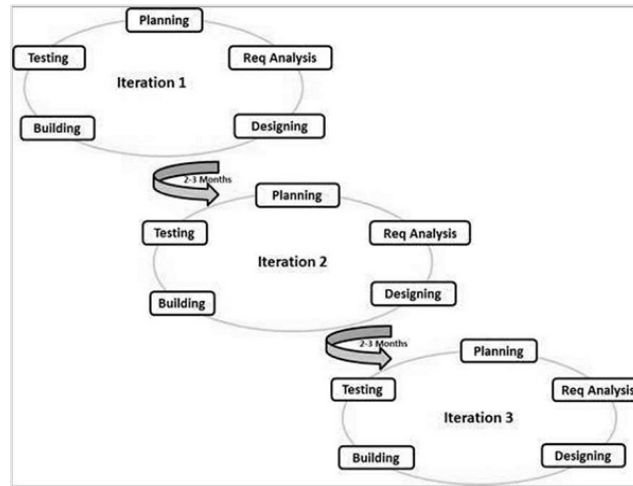
Figure 1: Agile Model [24]

The activities and outcome of each phases from the methodology are outlined in Table 2.

Table 2: System Development Activity and Outcome

Phase	Activity	Outcome
Planning	1. Proposed project objectives, problem statement and expected result. 2. Determine project schedule. 3. Study existing application. 4. Browse through journals and online resources.	1. Proposal. • Scope • Objectives • Problem statement • Project milestone 2. Literature review.
Analysis	1. Determine and analyse features according to comparison of existing application. 2. Identify software and hardware for development.	1. User requirements. 2. Functional and non-functional requirement.
Design	1. Design user interface and database.	1. Interface design. 2. Database design.
Implementation	1. Writes programming code. 2. Installing software application.	1. Android application.
Testing	1. Functional testing.	1. Test application.

Figure 2 presents the interaction between the user and the application while Figure 3 shows the activity diagram. There are an actor and six use cases to show the requirements of the application. The user will be able to perform the tasks as register and login, verify phone number, add trip post, view trip post, update data and logout.
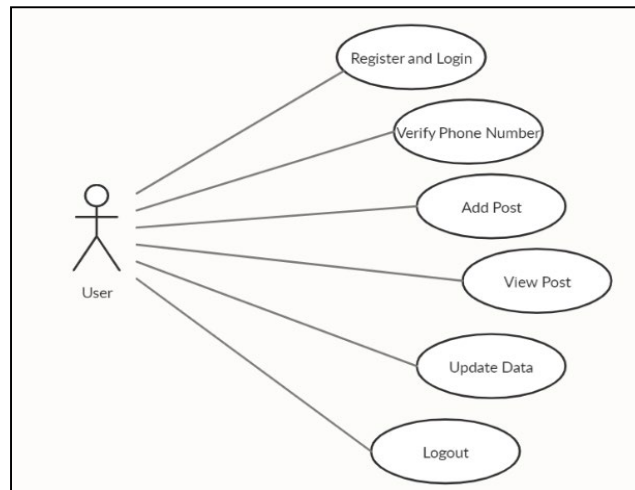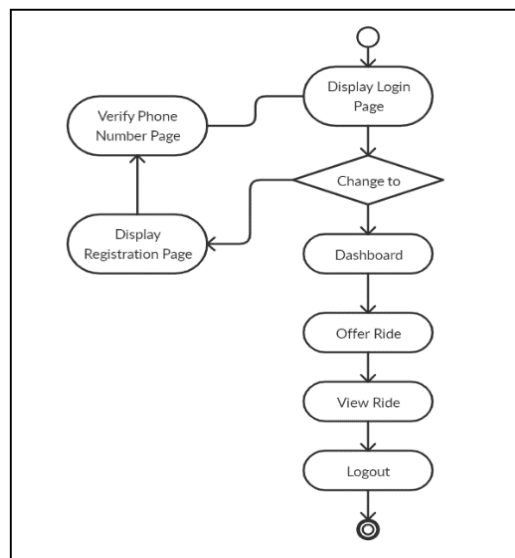
Figure 2: Use Case Diagram

Figure 3: Activity Diagram

4.   Result and Discussion

This section presents the implementation and testing that was conducted for Book a Seat Carpool application.

4.1 Implementation

Implementation process starts from the interface design and database. The two aspects of the application are very important in ensuring the apps runs smoothly. The coding for the application was done using Java programming language and the IDE is Android Studio. On the other hand, Firebase was used as the database for the application. The app is connected to Firebase Database with adding dependencies and implementation to Android Studio. To start using the application, a user need to create an account by registering to login to the application.

After entering registration details, the user is directed to a next page to verify the OTP pin sent to their phone. After a successful verification, the user can enter the app. Username, password and phone number must be provided to login the app. A message will be displayed if the username or password is invalid, the field is empty, or the phone number is wrong. The user then can proceed to add ride or view ride. Figure 4 shows the successful implementation of OTP and fingerprint authentication into the app.
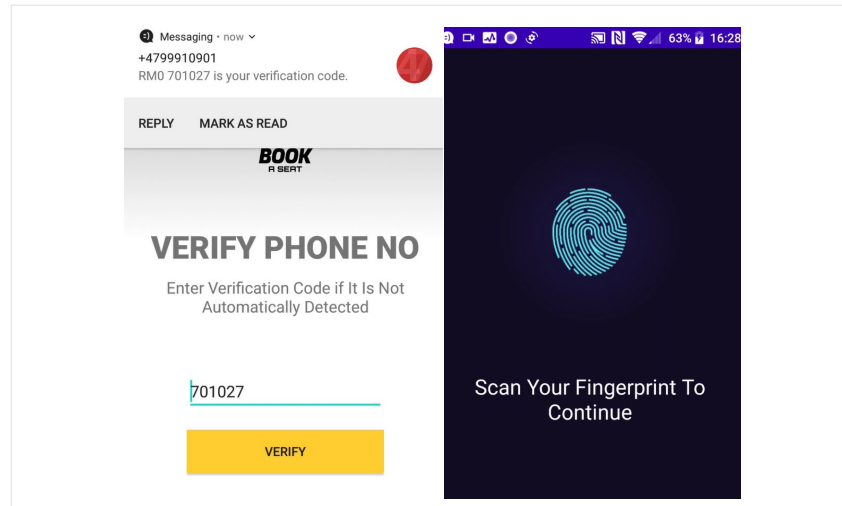
Figure 4: OTP and Fingerprint Authentication

4.2 Testing

Once the application has been developed, a testing phase is commenced to examine the functionality of the application. Testing was conducted to identify any sorts of error that comes arise when using the Book a Seat Carpool application. Another purpose of testing is to find out whether the application able to achieve their objective and scope specified. Table 3 shows the summary of the functional testing results.

Table 3: Functional Test

No.	Function Testing	Expected result	Result
1. Register Function			
i.	Users leave fields empty.	Error message shown	Success
ii.	Users enter wrong email format.	Shows error message.	Success
iii.	Users register with weak password which does not meet the strong password criteria.	Shows error invalid password.	Success
iv.	Users fill all the fields correctly and click sign up button.	Users can proceed creating account.	Success
v.	OTP sent through SMS to users' phone number.	User can verify OTP.	Success
2. Login Function			
i.	Application display login page.	Displays username, password and phone number textbox.	Success
ii.	Users leave the fields empty.	Shows invalid username or password error.	Success
iii.	Blank phone number.	Shows invalid phone number error message.	Success
iv.	Enter correct phone number, username and password correctly.	Login success.	Success
v.	Users' fingerprint authentication.	Users' fingerprint can be authenticated.	Success

Table 3: (cont.)

No.	Function Testing	Expected result	Result
3. Add Ride			
i.	Allow user to add ride details.	Users can add details to the form.	Success
ii.	Post button.	Users can click "Post" button after complete details to post ride.	Success
4. View Ride			
i.	View ride details.	Application allow user to view ride details.	Success
ii.	Add data.	User can add passenger's name into form.	Success
5. Logout			
i.	Logout	User able to logout from their account by clicking "Logout" button.	Success

5. Conclusion

Three objectives of this Book a Seat Carpool application have been set as the indicators of the application development as follows:

i) To design a carpooling application with OTP and fingerprint authentication added in the system as a two-way authentication method.

ii) To develop a carpooling apps with OTP and fingerprint authentication using Android Studio and Java programming language.

iii) To test the functionality of the developed carpooling apps.

All the three objectives of Book a Seat Carpool application are achieved. The developed application consists an authentication method of OTP and fingerprint. OTP was used as a verification method for user registration while fingerprint on the other hand gives an extra layer of security for user login. User able to receive an SMS from the server containing a verification code to create an account. The authentication method can mitigate potential authentication security risks such as identity theft and phishing.

There are several limitations that can be found on the application. Firstly, this application can only support Android platform. The fingerprint authentication method can only be supported on a device with a built-in fingerprint sensor. The application is not able to send notifications to users. Lastly, users are not able o filter and search post.

There are some improvements that can be implemented to enhance the limitation stated. This application is suggested to be able to support other operating systems such as iOS and Windows platform. Besides that, a notification feature should be for user. Other than that, a search and sort feature to look through various rides should also be considered.

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