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COVID-19 ALERT APPLICATION USING GLOBAL POSITIONING SYSTEM (GPS)

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BACHELOR OF COMPUTER SCIENCE (HONS.)

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Thesis submitted in fulfilment of the requirements for
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SUPERVISOR APPROVAL

COVID-19 ALERT APPLICATION USING GLOBAL POSITIONING SYSTEM (GPS)

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This thesis was prepared under the supervision of the project supervisor, Muhammad Izzad Mohd Ramli. It was submitted to the Faculty of Computer and Mathematical Sciences and was accepted in partial fulfilment of the requirements for the degree of Bachelor of Computer Science.

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JULY 19, 2021

STUDENT DECLARATION

I certify that this thesis and the project to which it refers is the product of my own work and that any idea or quotation from the work of other people, published or otherwise are fully acknowledged in accordance with the standard referring practices of the discipline.

……..

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ABSTRACT

The purposes of these research are to implement reliable alert application to the COVID-19 disease using Global Positioning System (GPS) and to test the correctness and effectiveness of the app. The application will be used Mobile Application Development Life Cycle (MADLC) which consists of seven (7) phases, Identification, Design, Development, Prototyping, Testing and Maintenance. The application uses Global Positioning System (GPS) to spot places around the users with unknown status either there are hotspot areas or not which it shows on the Google Map. The hotspot areas' information will be fetched from the database which will be uploaded by the administration. However, users need to turn on their GPS on their mobile devices as the system needs access to the user's current location. Next, the system will pop up the alert dialog when the user's current location is nearby the hotspot areas and notify the user through the notification bar. Besides, the secondary data collection is conducted related to high-risk areas in Malaysia. This application will help to decrease risks of COVID-19 transmission by providing information about the places which happen to have high-risk people. By implementing this application, the patient will be more aware of their health status and have the consciousness to keep distancing and isolate themselves from others.

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List of Abbreviations

API	Application Programming Interface
CDC	U.S Centers for Disease Control and Prevention
COVID-19	Corona Virus Disease 2019
COVID-19 RT-PCR	COVID-19 Real-Time reverse Transcription Polymerase Chain Reaction
CQAS	COVID-19 Quarantine Alert System
CSS	Cascading Style Sheet
GPS	Global Positioning System
HTML	Hyper Text Markup Language
IDE	Integrated Development Environment
MADA	Mobile Application Development Approach
MADLC	Mobile Application Development Life Cycle
MCO	Movement Control Order
MERS	Middle East Respiratory Syndrome
MHCD	Mobile Healthcare Computing Devices
MOH	Ministry of Health
OTP	One Time Password
PDA	Personal Digital Assistants
PUI	Person Under Investigation
PUS	Person Under Surveillance
SARS	Severe Acute Respiratory Syndrome
SDK	Software Development Kit
UI	User Interface
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

This chapter describes the project background that consists of the problem statement, project aim and objectives, project scope, and significance. Section 1.1 describes the background of the project, the current COVID-19 system, how the system works, and the terms used in the system. Section 1.2 explains the difficulty of the existing research. Section 1.3 focuses on the objectives of the project. The project scopes are in Section 1.4 that stated the limitation of the project. Lastly, it highlights the significance of this project to the community.

1.1 Project Background

According to U.S Centers for Disease Control and Prevention (CDC), Chinese health authorities discovered an outbreak caused by a new coronavirus, SARS-CoV-2. It is different from others such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS). Therefore, SARS-CoV-2 was termed for COVID-19. The acronym is derived from coronavirus disease 2019. COVID-19 was reported to the World Health Organization (WHO) at the end of 2019. On March 11, 2020, the WHO declared COVID-19 a global pandemic which is worse than H1N1 influenza in 2009 (Jaakkimainen, Bondy, Parkovnick, & Barnsley, 2014). The virus had spread all over the world and infecting susceptible people (Novel, 2020).

This project is carried out around Selangor, Malaysia and it focuses on the high-risk COVID-19 area which there happened to have the high-risk person that classified as Person under Investigation (PUI) or Person under Surveillance (PUS) who are suffered from the disease. According to the Ministry of Health, Sep 17, 2020, PUI are people that experienced COVID-19 symptoms and attended events with known COVID-19 cluster or close contact to a confirmed case of COVID-19. PUS is the asymptomatic person however they are in close contact with confirmed cases.

Both categories need to undergo quarantine for 14 days until the COVID-19 RT-PCR or COVID-19 test comes out. The current health monitoring that Malaysian authorities created is using quarantine bracelets. This system as a symbol that are worn on the wrist by PUS and PUI that consists of several colors such as pink, white, blue, red, or yellow. The place and time of the screening or COVID-19 test will be written on the bracelets. Individuals who have this bracelet will be put under quarantine and cannot leave the house until the 14 days quarantine expires (Ministry of Health, 18 September 2020).

The application uses Global Positioning System (GPS) to spot places around the users with unknown status either there are hotspot areas or not which it shows on the Google Map. The hotspot areas' information will be fetched from the database which will be uploaded by the administration. However, users need to turn on their GPS on their mobile devices as the system needs access to the user's current location. Next, the system will pop up the alert dialog when the user's current location is nearby the hotspot areas and notify the user through the notification bar.

1.2 Problem Statement

In this pandemic of COVID-19, Malaysian have been ordered to restrict their movement by the authorities with a series of control strategies known as the Movement Control Order (MCO) to prevent the transmission of the viruses (Khor et al, 2020). Hence, going out to public places caused many people to gather at one place which can increase the risks of COVID-19 transmission especially a crowded place, confined and enclosed spaces (WHO, 2020). For instance, when a person goes out to do their chores such as buying groceries, there are many people at the supermarket. As they did not know, around them may have someone with the viruses. By introducing the alert application, the people with the apps will know the places where there have high-risk people who are suspected people. Hence, they will avoid going to a certain supermarket.

1.3 Aim and Project Objectives

The aim of the study is to implement a reliable alert application to the COVID-19 disease. The objectives for the study are:

a. To identify high-risk areas with location-based tracking of COVID-19.
b. To develop an alert application using GPS.
c. To test the correctness and effectiveness of the app.

1.4 Project Scope

The scope of this project is to develop an application that able to alert the user for COVID-19 disease only. So, to achieve the function above, the alert app is specifically designed out as this disease has spread continuously across the world. Besides, this application only detects the certain location in which the place has public places such as restaurants.

1.5 Significance

The significance of the project is this app will decrease the risks of COVID-19 transmission by providing information about the places which happen to have high-risk people. By implementing this application, the people will be more aware of their health status and have the consciousness to keep distancing and isolate themselves from others. Moreover, the alert application is crucial to help the Ministry of Health (MOH) for adequate information in surveillance of the COVID-19 as the Unit of Surveillance is systematically monitors trends in COVID-19 disease. In addition, this is also important to educate the people to stay at home if they are suspected person and identify the exact location of red zone places.

1.6 Outline of Thesis

This thesis consists of five chapters. Chapter 1 describes previous work related to the project's title and gives idea for the work performed in this thesis. Next, Chapter 2 presents the study of the Mobile Application Development Life Cycle (MADLC) on technologies. The domain of the project is also explained in this chapter, which is Coronavirus 2019 (COVID-19). Chapter 3 describes the methodology used in the development of the project. Chapter 4 presents the results and findings from the method used. Finally, Chapter 5 discusses the conclusions of the project.

1.7 Summary

This project is known as the alert application for COVID-19. This specifically for Malaysians with unknown status that helps them to observe their places through the map. This project idea appeared because many problems need to avoid during the outbreak such as people tend to go out during the pandemic. Furthermore, this project aims are to implement a reliable alert application to the COVID-19 suspected person and specifically to enable the patient to give emergency alerts to people with unknown status. In advance, this application is significant to decrease the risks of COVID-19 transmission by providing information about the places that have high-risk people which are marked as the red zone. This is also crucial to help the Ministry of Health (MOH) with adequate information in surveillance of the COVID-19. This is also important to educate the people to stay at home if they are suspected person and identify the exact location of red zone places.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The study of alert applications that have already been developed and created which is used in the medical industry either in Malaysia or overseas countries. Section **2.2** stated the study of MADLC on technologies for developing mobile applications. This is also divided into MADA that has 3 different approaches which is the first step for developers to choose one of them for their application. Section 2.4 consists of the study of the domain; Coronavirus Disease 2019 that has been a critical pandemic in 2020 for the whole world. There also different types of applications that have been developed for this disease to help to stop the spread of COVID-19. Lastly, Section 2.5 compares the different types of similar apps that already on the market.

2.2 Alert System

Alert system has been developed widely in healthcare, which it is used for various types of conditions. For example, medication monitoring, laboratory examination results, and patient information are categorized as urgent which refer to as alerts. These tasks or condition tends to use the smartphone for communication. With the recent growth of mobile phone technologies, the use of personal digital assistants (PDAs) with its features has been used for internet accessibility in healthcare environments which is called Mobile Healthcare Computing Devices (MHCD) (Kafeza et al, 2004).

Kafeza et al. (2004) stated that the alert conceptual model consists of two parts, process, and alerts model. The process model is a healthcare process that describes the procedures of a hospital. While the alert model is devices used to notify the medical staff member who is available (Kafeza et al, 2004). Lastly, there are also

wireless applications such as TraceTogether for COVID-19 diseases which apps use Bluetooth to notify users if they have been exposed to the virus through close contact with other TraceTogether users (tracetogether, 2020).

2.3 Mobile Application Development Life Cycle

There are a lot of current and different life cycles models such as waterfall model, spiral model, agile model, and prototyping model even though those are not much difference in developing applications for desktops such as Windows or MacOS, webs, or for mobile devices such as Android or IOS (Md. Raus et al, 2016). Mobile Application Development Life Cycle (MADLC) has been proposed by Tejas Vithani and Anand Kumar (2014) that includes seven (7) phases; Identification, Design, Development, Prototyping, Testing, and Maintenance. The main reason for this MADLC is on separating functional requirements into various modules that will be presented as the prototype.

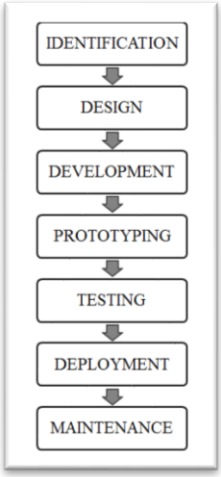

Figure 2.1 MADLC
(*Source*: Vithani & Kumar, 2014)

2.3.1 Identification Phase

The first phase in the mobile application development life cycle deals with the functional and non-functional of the application (Kendall & Kendall, 2014). The purpose of this phase is to generate new ideas or improvements to the existing application which be collected and categorized. Customers, clients, or even developers can come out with any ideas (Kaur & Kaur, 2015). The ideas brought out by customers will be further detailed and analyzed. That also will be brainstormed by developers to generate ideas for the new application which will be developed. Besides, the ideas will be filtered by the mobile application idea team and compromised of the business and information technology representatives to launch a project in terms of feasibility (Vithani & Kumar, 2014).

2.3.2 Design Phase

In this phase, the mobile application team will develop the ideas into an initial design of the application. The important thing of the design phase is to create the storyboard of the user interface which describes the step by step of the application.

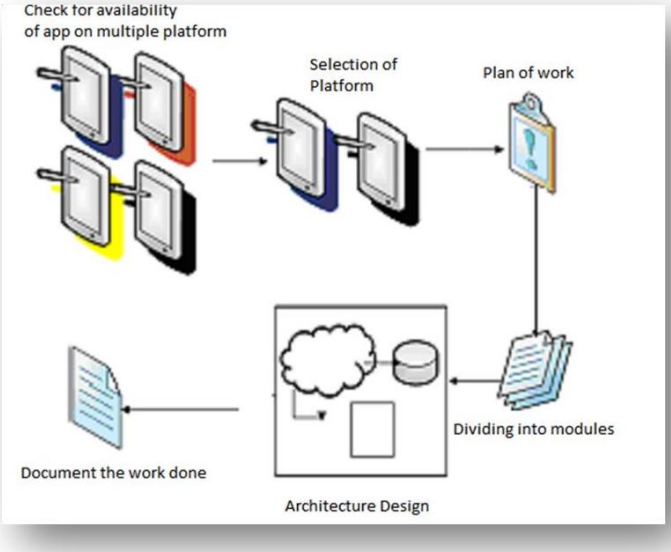

Figure 2.2 Design Phase

(Source: Vithani & Kumar, 2014)

As shown in figure 2.2, the mobile application team will check the availability of applications on multiple platforms either in Android or iOS. They also need to decide whether the application will be developed is to be released in a free version or trial version. After they had selected the suitable platform, designing the work will begin and all the functionality of the application will be divided into modules as a prototype. The architecture design as the functional requirement and software architecture of the application is defined and created (Vithani & Kumar, 2014). The design team then will be documented the works to the development team for further actions.

2.3.3 Development Phase

In this phase, the application will be coded into two stages: Coding for Functional Requirement and Coding for User Interface. Coding for Functional Requirements means the objective of the application and the Coding for User Interface is the multimedia process of the application such as images and links (Letchumanan, 2019). In the first stage, the modules from the same prototype that are independent of each other will be integrated through parallel development. Furthermore, in the second stage, the user interface (UI) will be designed to be able to support many mobile operating system platforms (Vithani & Kumar, 2014).

2.3.4 Prototyping Phase

In this phase, for each prototype, the functional requirements need to analyze (Fenty et al, 2014; Vithani & Kumar,2014). Besides, the prototypes will be tested and forward to clients for any feedbacks (Md. Raus et al,2016). Letchumanan (2019) and Md. Raus (2016) also stated after clients have given the feedbacks and required changes to the prototype will be implemented back in the development phase until the requirement are met and the final prototype is ready.

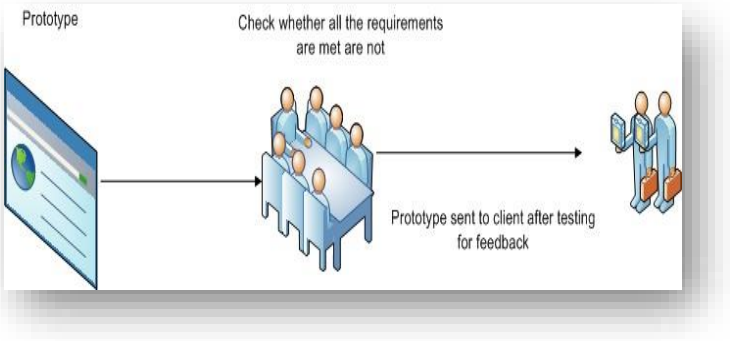

Figure 2.3 Prototyping Phase

(Source: Vithani & Kumar, 2014)

2.3.5 Testing Phase

This phase is the most important in any development life cycle. The final prototype will be tested on an emulator either Android or iOS. Then, it will be tested on a real device with multiple operating system versions. For the Android operation system, it will be better if it is tested in the latest Android versions such as Android 10 and Android 11.

2.3.6 Deployment Phase

Letchumanan stated that the deployment phase is the final phase in the development process as the application will be uploaded to the application store such as Play Store in Android and App Store in iOS for user implementation. Nevertheless, before the deployment, some steps need to be checked such as

- Developers need to register on the application developer's website by paying their fee (Vithani & Kumar,2014).
- Developers need to know the rule and regulations of the application store (Vithani & Kumar, 2014).
- Developers need to follow the right guidelines by Google and any service provider (Md. Raus et al, 2016).

2.3.7 Maintenance Phase

Raus et al (2014) indicated that the maintenance phase is the final phase in the mobile application development life cycle and this phase is a continuous process in which improvement will be incremental. In this phase, the feedback from users for the developed application which had been uploaded in the application store will be collected and the developers will improvise it based on the feedback. Moreover, the marketing of the application such as advertising included in maintenance (Vithani & Kumar, 2014).

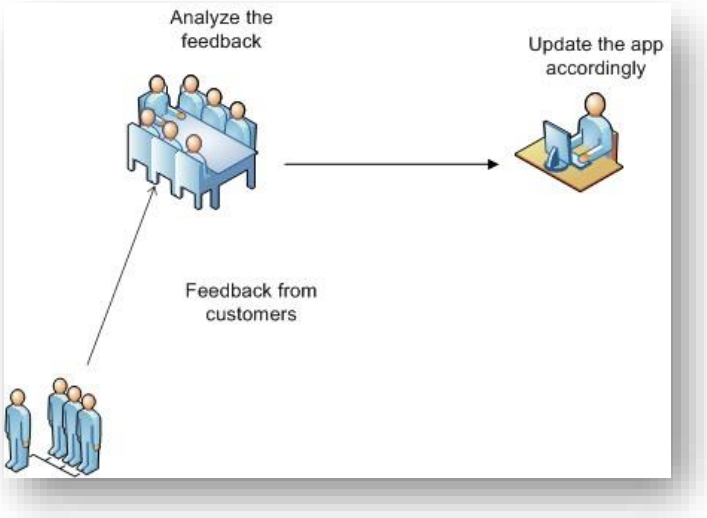

Figure 2.4 Maintenance Phase

(Source: Vithani & Kumar, 2014)

2.4 Types of Mobile Application Development

The growth of mobile devices is spreading worldwide that almost any technology developed for desktop computers to mobile devices. Smartphones are developed with an operating system that has the capabilities to implement various features including common mobile phone capabilities (Min Tun, 2014). According to mobile operating system market share worldwide by statcounter, 2020, Android recorded the highest with 71.18% of the market and followed by iOS with 28.19% market share from November 2019 until November 2020. Mobile app developers that want to target many users must develop apps that able to use by any platform (Min Tun, 2014).

Furthermore, many applications such as Facebook and Instagram are available to be downloaded into the users' smartphones through the application store (Mahmoud & Popowicz, 2010). However, mobile applications have developed with a series of specific features which are implemented by many programming languages, development tools, standards, protocols and network technologies, types of devices, and their capacity (Delia et al, 2019). There are three categories of mobile apps development approaches: web, native, and hybrid mobile applications.

2.4.1 Web App

Mobile web applications usually will be run from a browser that is already installed in mobile devices such as Google Chrome and Safari (Min Tun, 2014). The development process is in the form of a web page that exists on a server or a set of HTML, CSS, or JavaScript-based technologies (Delia et al, 2019). Min Tun also stated in his article that to enable users to access through the mobile devices' web browser, the web pages are formatted specifically for the smartphone.

The advantages of using the web application development approach will make the developer's works easier which are less complex, low in development cost, fast to build, and easier to maintain (Min Tun, 2014). Moreover, because this approach

uses HTML, CSS, and JavaScript as its source code, the process of development will be faster as the programming language is very easy to learn (Geoff, 2020).

The disadvantages are the users cannot access the content of the web application when the devices disconnect the internet connection, it is because it depends only on online functionalities.

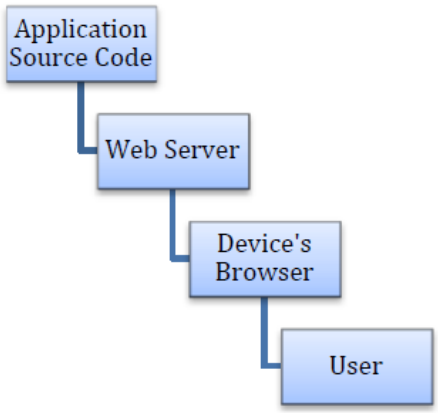

Figure 2.5 Web App

(Source: Min Tun, 2014)

2.4.2 Native App

Native mobile applications are developed for a specific mobile operating system, platform, type of devices, and the version of the operating systems (Delia et al, 2019). Moreover, platform-specific SDKs and developments tools are used in developing the native apps. For iOS, the programming language; Objective C and Swift are used for Apple's XCode. Meanwhile, for Android, Java and Google's Android SDKs are used for the development process (Anglin, 2014).

The advantages of using the native application development approach are it can be accessed to the features and APIs available on any platform. Moreover, it has maximum control over the software and hardware. Min Tun stated that they can take over the latest technology available on the users' mobile devices and can take part with built-in apps such as a camera, media player, and photo gallery. In the end, native

apps have a better performance than other mobile apps development approaches (Delia et al, 2019).

Disadvantages: There are many multiple implementations and multiple programming languages are needed as they can be accessed by many platforms. Moreover, native apps undergo highly in cost development and maintenance for each mobile platform (Min Tun, 2014).

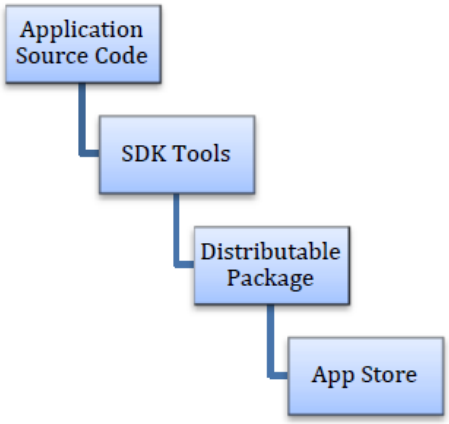

Figure 2.6 Native App

(Source: Min Tun, 2014)

2.4.3 Hybrid App

The last of mobile apps development approaches are hybrid apps that combine both native and web apps, however, it shows more like web apps than mobile apps. Even though, this app used web developments tools; HTML, CSS, and JavaScript, but it executed on mobile devices and has access to the features through an API (Delia et al, 2014).

Advantages: Hybrid apps used the same codes for all platforms. Hence, the developers can save from the development and maintenance costs (Min Tun, 2014). Anglin stated in its article that these native apps are easy to transform from web to hybrid as its coding can be reused.

Disadvantages: The hybrid apps need software or known as the native container that operates the native features, which gives better performance because hybrid apps are developed independently on the operating system.

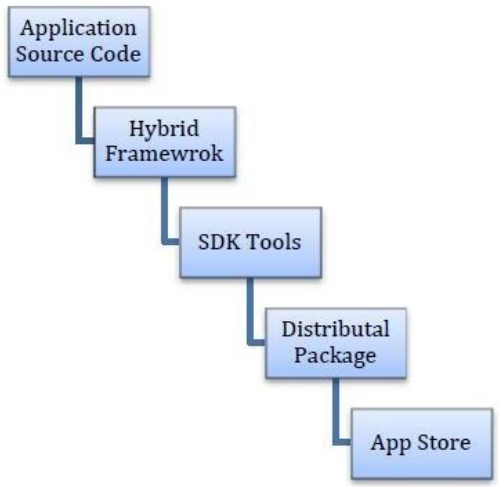

Figure 2.7 Hybrid App

(Source: Min Tun, 2014)

2.4.4 Comparison of Mobile Application Development

Table 2.1 shows the comparison of three types of Mobile Application Development which are Native, Hybrid, and Web. It will compare in the term of development cost, the programming language used, the performance, distribution channel, device access, and the code reusability or portability. Hence, for this project, Native will be chosen as Mobile App Development.

Characteristics	Native	Hybrid	Web
Development Cost	Expensive	Less expensive than Native app	The cheapest
Programming Language	Objective-C, Swift or Java	HTML, CSS, and JavaScript	HTML, CSS, and JavaScript
Performance	The fastest	Slower than Native	Based on internet connectivity
Distribution Channel	Yes	Yes	No
Device Access	Full	Full	Partial
Code reusability/ portability	Cannot be reuse for another platform	Enable portability of a single codebase	Performance are the only concerns

Table 2.1 Comparison of Mobile Application Development

2.5 Coronavirus Disease 2019 (COVID-19)

Coronavirus Disease 2019 (COVID-19) is a term from SARS-CoV-2 which is a short form for Severe Acute Respiratory Syndrome. Since World Health Organization had declared worldwide as a pandemic on March 11, 2020 (WHO,2020), the worldometer has recorded on their website that there were over 64 million cases recorded all over the world with a total of 1.48 million deaths cases as of December 2, 2020. To control the spread, many countries have established several prevention strategies including developing various mobile health applications specifically for this disease. Those application that has been developed are objectively for contact tracing, quarantine application, system monitoring and providing information (Singh et al, 2020).

2.5.1 Contact Tracing Application

The first-ever application for COVID-19 disease with the scope of contact tracing is TraceTogether that had been developed by Government Technology Agency Singapore (GovTech) which this application is freely available to developers around the world (Hariz Baharudin, 2020). Singh stated in his article that TraceTogether will push alert notifications to let people know when someone in their close proximity had infected to the virus by connected through Bluetooth. If the authorities detected the infected users, they would immediately find out their close contact with the user. Since then, the various application developed by many countries. Furthermore,40% of 15 contact tracing applications had used GPS technology as a signal to trace the infected users such as South Korea's Corona 100m (Singh, 2020; Watson & Jeong, 2020 Feb 28).

2.5.2 Quarantine Application

Moreover, many countries also came up with a quarantine application with a geofencing feature that applies the quarantine by using GPS to track the movements of the person under quarantine. This application ensures the users stay confined to the designated place (Sukumar R, 2020 March 28). The authorities will be notified when the users violate the rules and regulations of quarantine in those countries such as go outside when still in isolation period (Dalal M, 2020; Singh et al,2020). Singh also stated that the concept of this geofencing feature is to create a virtual fence around the users' houses. One of the applications that use the geofencing feature is the COVID-19 Quarantine Alert System (CQAS) which was developed by the India Department of Telecommunications (DoT) (Singh V, 2020 April 3). In Hong Kong, a quarantine strategy for people who arrive from other countries by using a wristband as a wearable device which will be scanned to sign it into the application upon installation and it works with Bluetooth, Wi-Fi, and geospatial signals in the neighborhood (Government of Hong Kong, 2020).

2.5.3 Symptoms Monitoring Application

Besides quarantine applications, various countries and companies also developed a special application to monitor their users' symptoms. These applications will ask various questions related to COVID-19 symptoms such as fever, coughing, contact with infected persons, and recent travel to identify via an algorithm whether the user is highly risked to the viruses, thus if the result shows that the users are suspected to the viruses, the application will provide recommendations on what to do such as wearing the face mask and provide information about the nearby hospitals (Government of Singapore,2020). Likewise, Corona-Datenspende application, a smartwatch app that had been launched by Germany's public health authority on March 7. This smartwatch can monitor vitals sign including pulse, temperature, and sleep to detect any symptoms that more related to the virus and the result of it will be

represented in online map with other information which it can be assessed by the health authorities (Busvine D., 2020 Apr 07).

2.5.4 Information Providing Application

Since the coronavirus outbreak, countless information has been spread using any platform by the government organizations and health agencies through social media such as Facebook, Instagram, and Twitter. However, WhatsApp has been created an initiative to collaborate with WHO to develop an information-providing tool, which works when users request information about the COVID-19 from a Chatbot in WhatsApp. The bot will respond to user's chats with various series of prompts, covering key queries and also recovering any misinformation around the outbreak (Hutchinson A.,2020 March 21; Newman L., 2020 March 20). Moreover, Malaysia developed the MySejahtera application which the application provides useful information such as hotline numbers (Sagar M., 2020 April 7). This application can be downloaded in any application such as GooglePlay, AppStore, Apps Gallery, and Gamma (MySejahtera, 2020).

2.6 Comparison of Alert Application

2.6.1 AlertMe – Regroup

AlertMe app developed by Regroup Mass Notification enables users to push their notification settings and communicate better with others. The benefits of using this app are it can increase deliverability and reliability which it sends mobile push notifications directly to the recipients faster than traditional SMS messages. Furthermore, this app also can notify the user in specific areas. For example, it notified users from entering a danger zone using the GeoFence message (Regroup M, 2018).

2.6.2 COVID Alert - Let's protect each other

COVID-19 Alert developed by Health Canada that notifies users if someone near them is tested positive in the past 14 days using Bluetooth. This works when it exchanges random codes with other users and the app will check a list of codes from users who recorded to the app if they are tested positive. Hence, the users that tested positive will receive a one-time-key with a diagnosis to sign in to the app (Sante C, 2020).

2.6.3 Emergency SOS Safety Alert – Personal Alarm App

The Emergency SOS Safety Alert was developed by appCDM which this app notifies users' contact list that users need urgent help including family members, friends, or even medical staff. This only will be working when the user adds their contact list to the alert system. Hence, the contacts can directly help the user depending on the situation or they can help the user contact emergency services such as police and ambulance. By installed this app, users need to connect to GPS and update their location on the map (appCDM, 2019).

2.6.4 Earthquake Tracker - Latest quakes, Alerts & Map

Earthquake Tracker developed by trinitytech which this app shows users all the earthquakes cases from around the world and will notify users. Furthermore, the user can observe the location where the earthquake on the map, and the user can decide which earthquakes to receive a notification. For example, when users want to receive a notification for their area, they can set up them first (trinitytech, 2020).

Characteristics	AlertMe – Regroup	COVID Alert - Let's protect each other	Emergency SOS Safety Alert – Personal Alarm App	Earthquake Tracker - Latest quakes, Alerts & Map
Connection	GPS	Bluetooth	GPS	GPS
Push Notification	Yes	Yes	Yes	Yes
Observe on Map	Yes	Yes	Yes	Yes
Add Contact List	No	No	Yes	No
Connect to another user's mobile phone	No	Yes	Yes	No

Table 2.2 Comparison of Similar Work

2.7 Global Positioning System (GPS)

Based on Ahmed El-Rabbany in his book entitled Introduction to GPS: The Global Positioning System, GPS is a satellite-based navigation system that provides constant positioning and timing information around the world under any weather conditions. This is because it has an unlimited number of users. El-Rabbany also stated that GPS consists of three segments which are a space segment, a control segment, and a user segment. The space segment is composed of 24-satellite or Space Vehicles (SV) which each of them transmits signal; two sinewaves, two digital codes, and a navigation message (El-Rabbany, 2002). The codes and the message then will be added to carriers which are used to determine the distance from the user's receiver to the GPS satellite. Next is the control segment, which consists of a worldwide network of tracking stations, with a master control station (MVC) that functioned to track the GPS satellite including the behavior of the satellite, and then it will be packed and uploaded into GPS satellite through the S-band link (El-Rabbany, 2002). The user segment consists of users who can receive the signals that determined his or her position anywhere in the world.

GPS has made many changes to the navigation field since its early stages of development. GPS is a cost-effective process which El-Rabbany stated that the cost will be achieved at least 50% reduction whenever it is possible. GPS also could achieve more than 75% in terms of productivity and timesaving. Moreover, GPS has many applications in land, marine, and air navigation. For example, vehicle tracking, and navigation are rapidly growing applications.

2.8 Summary

The literature review is simplified as the study of the technology of alert systems in the medical field that consists of structural, wireless, and apps. The study of the MADLC is the step by step for developed a project. Furthermore, the approach that has been used is MADA that consists of web, hybrid, and native apps. The comparison between those approaches has been described as my project will be the native apps. The discussion on the domain; COVID-19 and the different types of applications have been developed in the market specifically for these diseases. In section 2.6 will compare the different types of similar apps that already on the market. Finally, the explanation about the Global Positioning System in section 2.7

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, stated the method in developing the project by phases. Firstly, Identification phase detailing the data collection method which are secondary collection method, reading journal and study the similar application. These methods are to retrieve the problem statement, objectives, scopes, and significance. Next, Design and Development Phase are about the explanation about the chosen approach which are Native approach, the programming language which are Dart, the software used are Visual Studio Code (VSCode) and the platform for development are iOS and Android. Besides, the design such as Use Case Diagram, User Interface and Software Architecture will shows how the application works more details. Third phase is Prototyping and Testing which the prototype will be tested on emulator to test its correctness and effectiveness with the given specifications. Lastly, Deployment and Maintenance will deploy the prototype on FireBase.

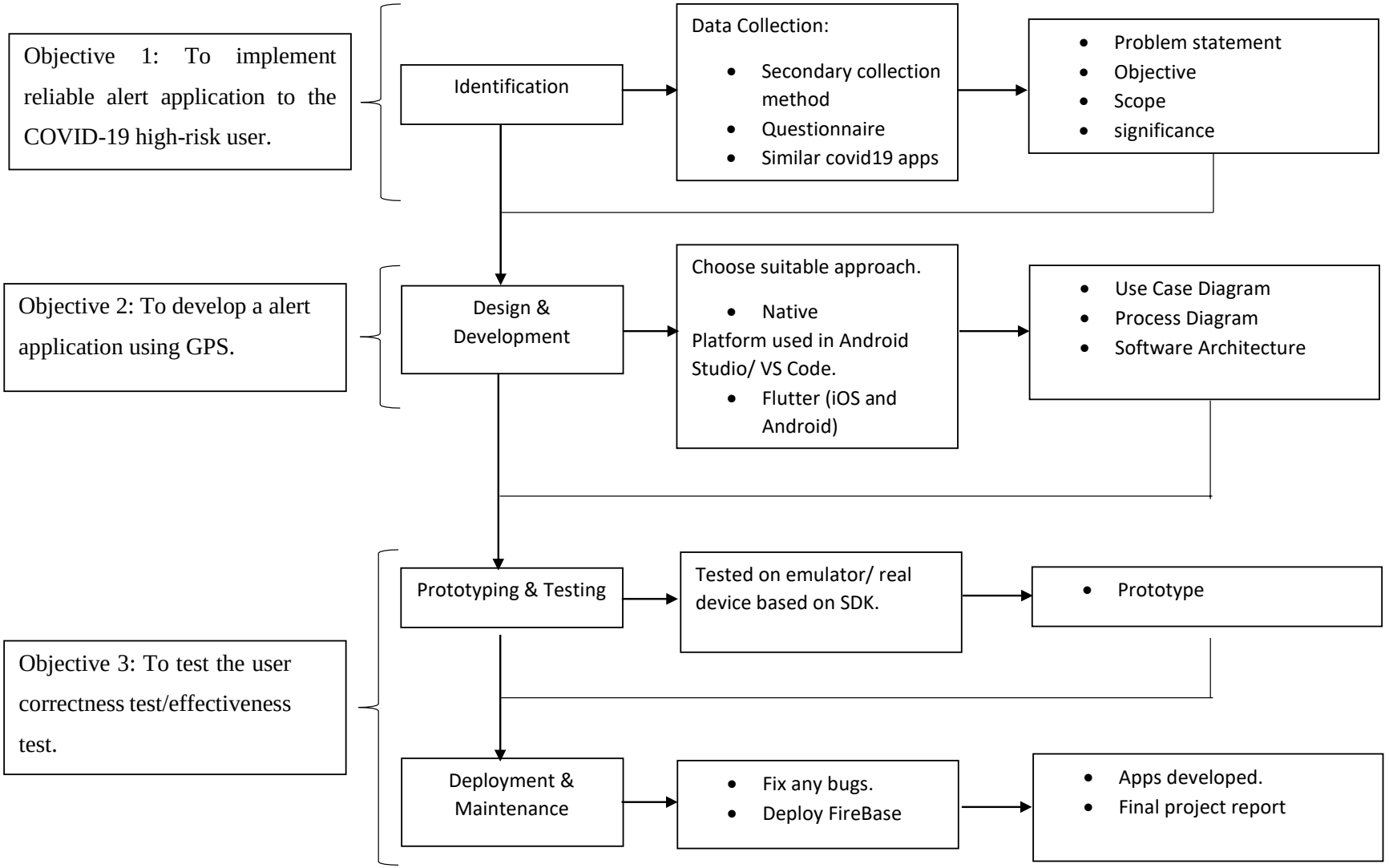

Figure 3.1 Project Framework

3.2 Phase 1: Identification

For this project, by performing the secondary data collection method with conducting research related to high-risk area in Malaysia based on government official posts such as Portal Rasmi Kementerian Kesihatan Malaysia. Furthermore, official statement from the official government's social medias such as the Facebook can be useful to the project collection data.

Furthermore, studies the similar work of COVID-19 applications are chosen in order to collect data. For example, MyTrace and TraceTogether. This is because when we downloaded the applications, we will know the feature provided by the applications such as symptom monitoring and contact tracing. Hence, we will get the ideas in developing our own applications.

Lastly, by reading article or journal about mobile application development and current COVID-19 news will be a method to collect data. We can know about the problem related to the diseases, the objectives that we need to achieve for the application development, the scope, and the significance of the apps.

3.3 Phase 2: Design & Development

3.3.1 Use Case Diagram

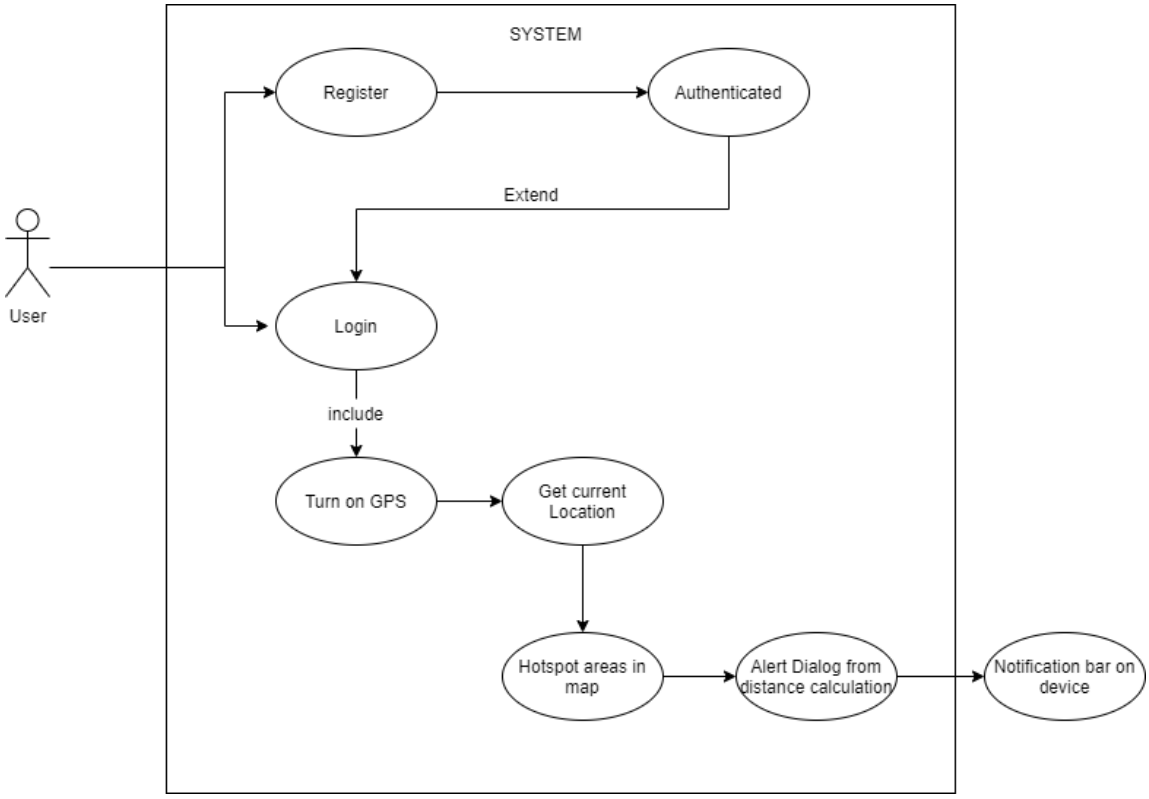

Figure 3.2 Use Case Diagram

Based on Figure 3.2, user needs to register into the mobile app system using email and password and it will be able to continue the authentication. As user successfully registered, it will proceed to login page. Throughout the process, user need to turn on their GPS on their mobile phone. System will get the user current location on map. At the same time, the hotspot areas will be shows on the map as it uploaded by the administration. If there are any nearby hotspot areas around the user current location, it will pop-up the alert dialog. At the same time, it will notify the user on notification bar with the same function as the alert dialog.

3.3.2 User Interface Design (UI)

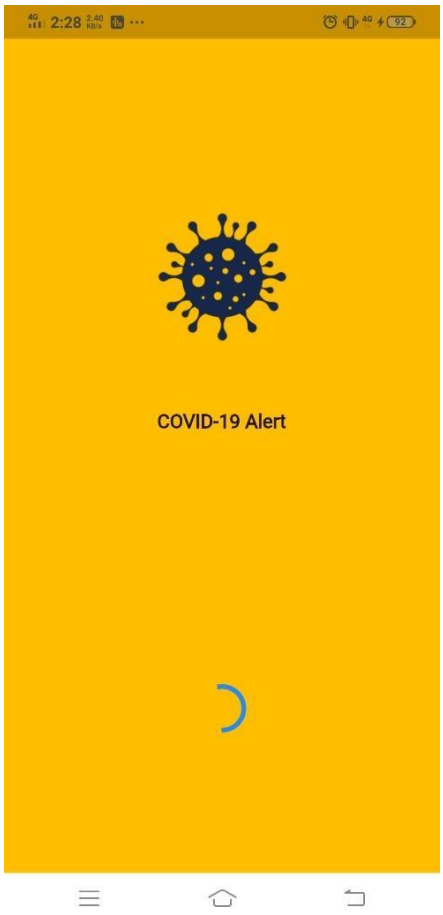

Figure 3.3 Splash Screen

Figure 3.3 shows the splash screen of the application. Splash screen is the first screen to pop-up when user click the icon app.

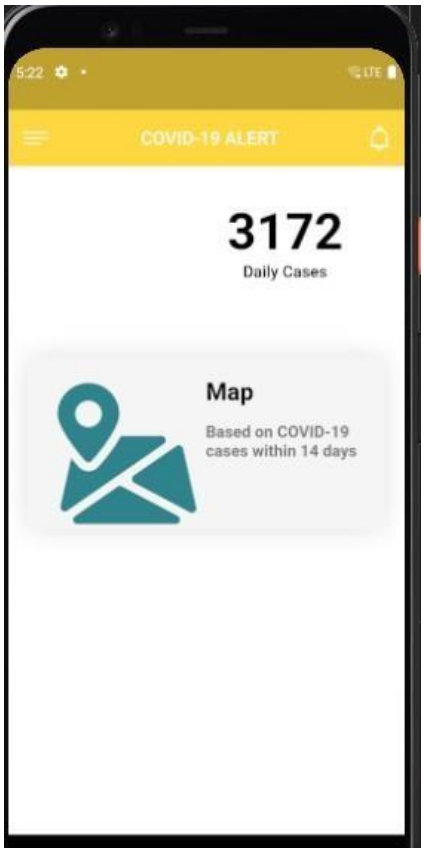

Figure 3.4 Main Screen

Figure 34. shows the main screen of the application. User need to click the ‘Map’ word to get to the Google Map page.

3.3.3 System Architecture

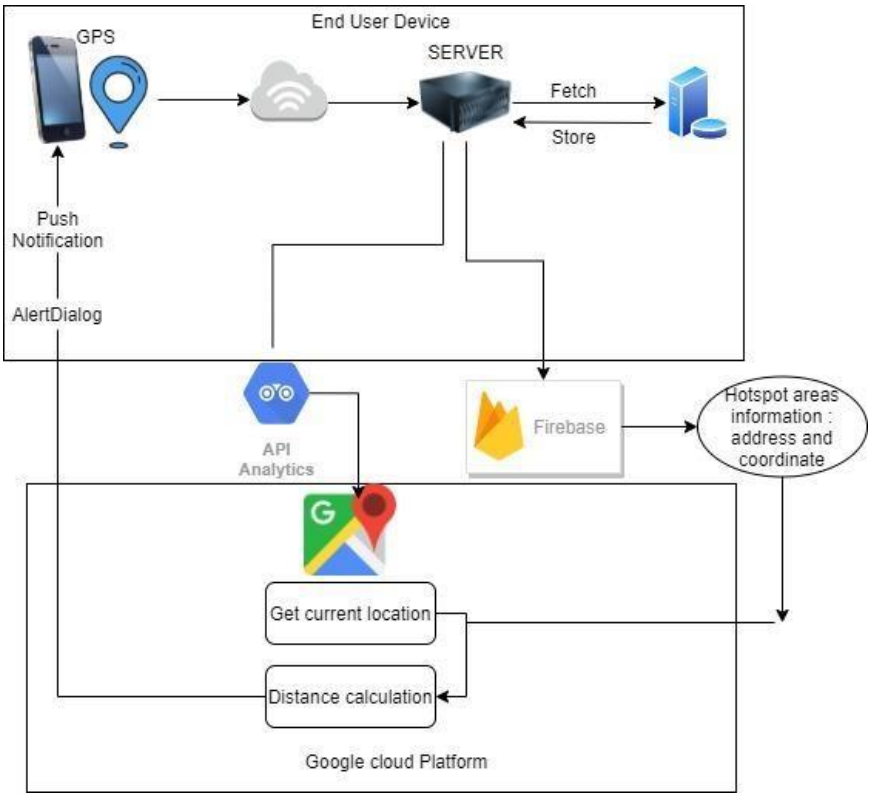

Figure 3.5 System Architecture

Figure 3.3 shows system architecture which user need to use GPS on their mobile devices and connect through an internet to get accessed to the server. Then, server connect to the Firebase where the administration already uploaded the information of hotspot areas such as the address and the coordinates. Before user can get to use the Google Map, system need an API to use the features of the Google Map. Next, system will get the user's current location and verify if there are any nearby hotspot areas around them. Then system will calculate the distance between the current location and the hotspot area's markers and pop-up the alert dialog on devices' screen. At the same time, system will notify user through mobile device's notification bar.

3.4 Tools Used for Development

3.4.1 Platform

Android

The proposed application is mobile application. Hence, Android platform will be one of the platforms that had been chosen to develop the application. Android is famous platform that developed by Google. The reason developers need to choose Android is because it is open source and application will be easier to install as user can download Android app from any website, not just Google Play Store (Spencer).

iPhone OS (iOS)

iOS is famous platform developed by Apple which will be used in development. iOS platform helps developers to develop a smooth and consistent user experience. It is because iOS environment provides natural feel and good application speed. Furthermore, iOS devices are always in sync with each other, and it leads to faster and easier development (Octal, 2017).

3.4.2 Software

Visual Studio Code (VS Code)

VS Code had been so popular among developers especially because it is open source. Hence, there is no need to spend money on the software. Moreover, its simplicity and intuitive attracts developers to use it. Furthermore, VS Code provide thousands of extensions in its marketplace (Cangemi, 2020).

3.4.3 Programming Language

Dart

Dart is a programming language launched by Google to help developers build applications. The reason Dart is used in development is because it is flexible which developers can write the code and then run it without any limitations. In example, app written in Dart with Flutter can be run on both Android and iOS. Besides, Dart has great tooling support which it can be use in almost every major text editor and IDE such as IntelliJ IDEA, Android Studio and VS Code (Fuad, 2019).

3.5 Phase 3: Prototyping & Testing

The mobile application prototype will be tested in emulator or real device to test its correctness and the effectiveness. As shown as Table 3.1, the specification of Android and iOS version that need to be used in the development.

Operating System	Android 10.0 and above	iOS 13 and above
API Level/ Latest Release	29 and above	13.7 and above

Table 3.1 Specification for Android and iOS

3.6 Phase 4: Deployment & Maintenance

The successful application that has been tested will be deployed in FireBase. FireBase is developed by Google with complete package of products that allows developers to build web and mobile apps (Patel, 2016). Furthermore, FireBase came with a lot of built-in features which is being able to grow and engage with users over the course of time such as Crash Reporting which it keeps developers' apps stable (Aicardi, 2016).

3.7 Summary

In this chapter, there are project framework that shows the flow of the project development which consists of phases. In Phase 1, shows, the method of data collection which is questionnaire, articles, and journal analysis, and study the similar application. In Phase 2, shows the design of application development such as Use Case Diagram, UI Design and System Architecture. Furthermore, in 3.4 section is the details of tools used for development which explained the platform, software, and programming language. In Phase 3, explains the requirement of Android and iOS to test the prototype on emulator. Lastly, the deployment phase that use FireBase platform to deploy the successful application.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter explains how the result of this project was achieved, going into detail on the coding of the system, and how the user interface works. It also covers the evaluation and testing of the system as well as the additional discussions.

4.1 Data Preparation

The data used in this project are collected from Ministry of Science, Technology, and Innovation official website. Data extracted are in text and table format in PDF files. Figure 4.1 shows a sample of data extracted from the PDF files.

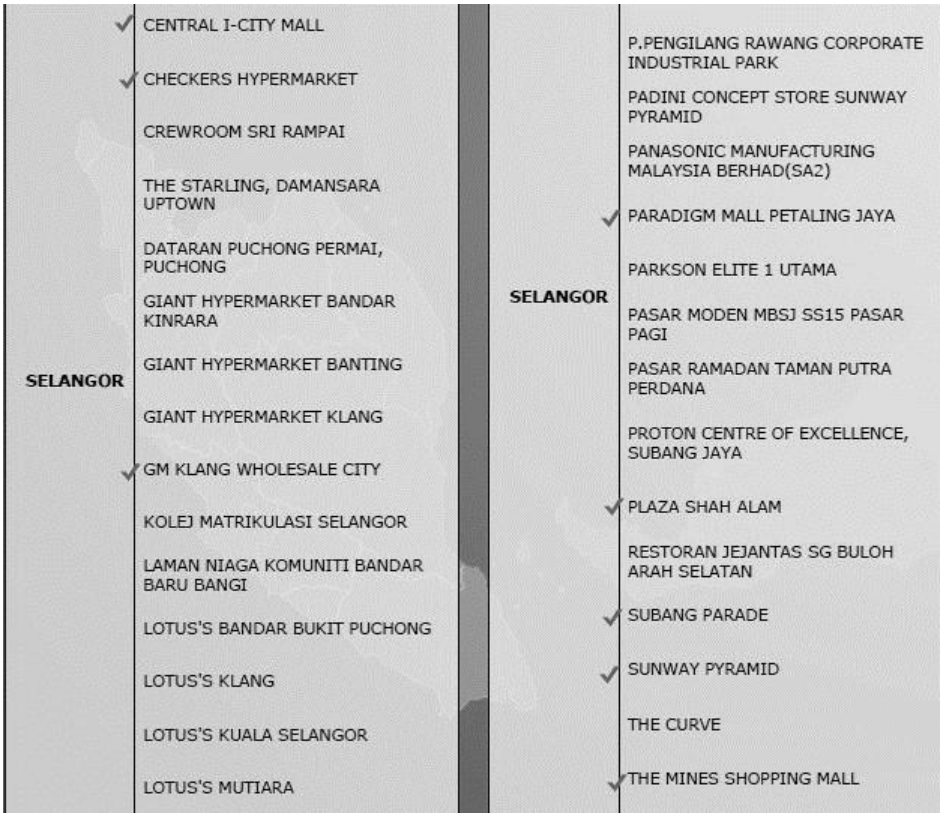

Figure 4.1 Sample of Raw Data

The data extracted from geocode process into excel as shown in Figure 4.2, as it allows an easier conversion to a jpg file. It shows the address, latitude, longitude, and the coordinates of the hotspot area.

Address	Latitude	Longitude	Coordinates
Central I-City, I-City, Shah Alam, Selangor, Malaysia	3.0624082	101.4817408	3.0624082,101.4817408
Checkers Hypermarket Sdn Bhd (Headquarters), Persiaran Selangor, Seksyen 15, Shah Alam, Selangor	3.0623837	101.5264415	3.0623837,101.5264415
GM Klang Wholesale City, Jalan Kasuarina 1, Bandar Botanik, Klang, Selangor	2.9907943	101.449589	2.9907943,101.449589
Mydin Mart Shah Alam, Jalan Pinang G 18/G, Seksyen 18, Shah Alam, Selangor	3.0450766	101.5157242	3.0450766,101.5157242
Plaza Shah Alam, Section 9, Shah Alam, Selangor	3.0846946	101.5233751	3.0846946,101.5233751
Paradigm Mall, Jalan SS 7/26a, SS7, Petaling Jaya, Selangor	3.1051171	101.5959701	3.1051171,101.5959701
Subang Parade, Jalan Kemajuan Subang, Ss 16, Subang Jaya, Selangor	3.0817432	101.5852077	3.0817432,101.5852077
Sunway Pyramid, Jalan PJS 11/15, Bandar Sunway, Petaling Jaya, Selangor	3.0727824	101.6075529	3.0727824,101.6075529
Jaya Grocer, Plaza Jelutong, Bukit Jelutong, Shah Alam, Selangor	3.1153569	101.5288772	3.1153569,101.5288772
The Mines Shopping Mall, Jalan Dulang, Mines Wellness City, Seri Kembangan, Selangor	3.028268	101.7186151	3.028268,101.7186151

Figure 4.2 Converted Data

4.2 Google Map

The implementation of Google map in this project required a key called API key to be able to use the Google Map features such as Geocoding and Geolocation. Hence, developers need to register into the Google Maps Platform to get the API key. Figure 4.3 shows the example of API key for the Android and Browser.

Figure 4.3 API keys

4.2.1 Setup

First step is to setup the Google Maps Flutter plugin as dependencies in the pubspec.yaml as in Figure 4.4.

```
dependencies:
  flutter:
    sdk: flutter
  splashscreen: ^1.3.5
  cupertino_icons: ^1.0.2

  http: ^0.13.3
  fluttertoast: ^8.0.7

  google_maps_flutter: ^2.0.6
  location: ^4.1.1
  geolocator: ^7.2.0+1
  geocoding: ^2.0.0
  geoflutterfire: ^2.0.2
```

Figure 4.4 Google Map Flutter plugin

Next, the permission of using Google Map in the project and the given API key copied into the project file android/app/src/main/AndroidManifest.xml as shown in Figure 4.5.

```
android > app > src > main > AndroidManifest.xml
1   <manifest xmlns:android="http://schemas.android.com/apk/res/android"
2       package="com.example.alert_covid19_app">
3       <uses-permission android:name="android.permission.INTERNET" />
4       <uses-permission android:name="android.permission.ACCESS_FINE_LOCATION" />
5       <uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION" />
6       <application
7           android:usesCleartextTraffic="true"
8           android:label="alert_covid19_app"
9           android:icon="@mipmap/ic_launcher">
10          <meta-data android:name="com.google.android.geo.API_KEY"
11            android:value="AIzaSyAvijmYEaQbhz8oAYW_K1wN6qSqV70OAZw"/>
```

Figure 4.5 API key in project file

4.2.2 Adding Google Map Widget

Adding the Google Map widget consists of three important methods as shown in Figure 4.6. Firstly, onMapCreated which this method will be called on map creation and takes GoogleMapController as a parameter. Next, initialCameraPosition which this required a parameter that set the initial camera position when users open the Google Map's page. Lastly, mapController which this method manages the camera function such as zoom and position.

```
body: GoogleMap(
    mapType: MapType.hybrid,
    markers: Set<Marker>.of(markerFire.values),
    initialCameraPosition: initialLocation,
    onMapCreated: (GoogleMapController controller) {
      _controller = controller;
    },
    myLocationButtonEnabled: true), // GoogleMap
floatingActionButton: FloatingActionButton(
    child: Icon(Icons.location_searching),
    onPressed: () {
      getCurrentLocation();
    }), // FloatingActionButton
```

Figure 4.6 Google Map Widget

4.2.3 Get User's Current Location

System needs to get access to user's current location through Global Positioning System (GPS). Hence, l.latitude, l.longitude is used as coordinate of the current location.

```
//Current Location
void getCurrentLocation() async {
  _location.onLocationChanged.listen((l) {
    _controller.animateCamera(
      CameraUpdate.newCameraPosition(
        CameraPosition(target: LatLng(l.latitude, l.longitude), zoom: 15),
      ),
    );
  });
}
```

Figure 4.7 Current Location

4.2.4 Fetch Hotspot Area Information from Firebase

System needs to fetch hotspot areas' information that has been added manually into the Firebase shown as in Figure 4.8. The information consists of address and the geoFire point of the address. Next, system will generate the coordinate into markers on the Google Map.

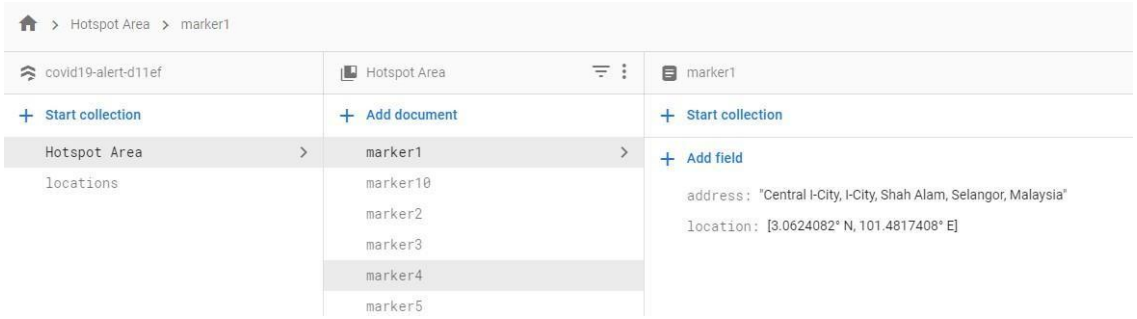

Figure 4.8 Coordinate Data in Firebase

Figure 4.9 shows the method populateClients to fetch the markers from the firestore and calling initMarker().

```
// Setup Hotspot area
populateClients() {
  Firestore.instance.collection('Hotspot Area').getDocuments().then((docs) {
    if (docs.documents.isNotEmpty) {
      for (int i = 0; i < docs.documents.length; i++) {
        initMarker(docs.documents[i].data, docs.documents[i].documentID);
      }
    }
  });
}
```

Figure 4.9 Fetch Coordinate from Firebase

initMarker() creates a markers from the fetched data and adds it to the map as in Figure 4.10.

```
//marker for hotspot area
void initMarker(request, requestId) {
  var markerIdVal = requestId;
  final MarkerId markerId = MarkerId(markerIdVal);
  //create a new marker
  final Marker marker = Marker(
    markerId: markerId,
    position:
        LatLng(request['location'].latitude, request['location'].longitude),
    infoWindow:
        InfoWindow(title: "Hotspot Area", snippet: request['address']),
  ); // Marker
  setState(() {
    //add marker to map
    markerFire[markerId] = marker;
    print(markerId);
  });
}

@override
void initState() {
  populateClients();
  super.initState();
}
```

Figure 4.10 Fetch Data and Add Markers

4.2.5 Calculate Distance

The formula used for calculating the distance between two geographic coordinates is as shown in Figure 4.11.

```
import 'dart:math' show cos, sqrt, asin;

double _coordinateDistance(lat1, lon1, lat2, lon2) {
  var p = 0.017453292519943295;
  var c = cos;
  var a = 0.5 -
      c((lat2 - lat1) * p) / 2 +
        c(lat1 * p) * c(lat2 * p) * (1 - c((lon2 - lon1) * p)) / 2;
  return 12742 * asin(sqrt(a));
}
```

Figure 4.11 Distance Calculation Formula

4.3 Alert Dialog

The total of the calculation for the two geographic coordinates then will push the AlertDialog to show the user's current location either there are nearby hotspot areas or not.

4.4 Push Notification

Next, the total of the calculation also will push the notification to notify the user with the same function as the AlertDialog.

4.5 Evaluation Result

The evaluation and testing process done in this project is by validating the correctness as well as ensuring the effectiveness of the application to people

4.5.1 Correctness Testing

First validation done is to ensure the correctness of the application. A testing was conducted to make sure the project, or the application are free from error and the algorithm used is correct with the specification.

4.5.2 Effectiveness Testing

Second validation was conducted to confirm the effectiveness of the application to the related user either the application is successful and effective to the current situation or not.

4.6 Discussion

The challenges from the beginning of the project until the end is mostly on implementation of Google Map. The fetching data of hotpot area was a difficult process during the development of this project. The options were to either to use geocoding package or storing GeoFire point such as coordinate in Firebase Finally, the decision was to use the Firebase to display the markers of hotspot areas. This is because the ideas of redundancy data can be avoided when using the Firebase feature compared to geocoding.

Another difficulty faced during the development of the webpage is the process of making sure the calculation of distance from user's current location to the hotspot area.

4.7 Summary

To sum up, this chapter covers the result of the project, validation processes done as well as the additional discussions on this project. The result of this project was shown in this chapter from the process of preparing the data, the implementation of Google Map widget to the interface of the webpage. The data preparation process includes coding snippets explaining how the data was converted from pdf file to jpg file, explanation of the formula used to calculate the distance of current location to the hotspot areas as well as the placing the hotspot's markers on the map. The user interface is shown in different conditions including the main user interface, and other interfaces. The evaluation of this project was implemented to ensure the objectives of the project have been successfully fulfilled to counter the problem statement mentioned earlier in this project. A process of validating the correctness and effectiveness of the application to the related people. Lastly, this chapter discussed the difficulty in selecting a variety of ways to calculate the distance and pop-up the alert dialog was also carried out.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

This chapter provides the conclusion of this project. Hence, each of the objectives will be discussed regarding its accomplishment. Correlatively, based on the issues and limitations observed throughout this project, the recommendation for future enhancement will be laid out as well.

5.1 Objectives Recap

This section explains the accomplishment of each objective throughout this project. There are three objectives set up during the initial study. Hence, revisiting each objective, the recap is provided to state the activities in attaining the objective.

5.1.1 Identification the high-risk areas with location-based tracking

The first objective is to identify the high-risk areas with location-based tracking application for COVID-19. Hence, the literature review is done to obtain a thorough understanding of the applications related to COVID-19 disease. Correlatively, a comparative analysis is done between the COVID-19 applications implemented in the previous study. There is multiple application with different features such as quarantine application and health monitoring application.

Throughout the study, the tracking applications by using high-risk areas information is found to be popularly mentioned among past researchers. Next, the

method that was mentioned is location-based tracking. Correlatively, by referring through the comparative analysis done by previous studies on several techniques, location-based tracking gained the highest popularity through the best performance produced compared to the others.

Hence, the first objective is achieved by the identification of the high-risk areas with location-based tracking.

5.1.2 Development an alert application using Global Positioning System

Next, an alert application is developed through a series of planning and development processes. The methodology employed in the accomplishment of the second objective is through the preliminary study including data collection, and further, the algorithm design, system design including architecture design, user interface design, and use case diagram are constructed. Correlatively, the hardware and software requirements are fulfilled to enable the development process.

The system is developed using Flutter with Dart programming language to produce an alert application. Besides, the external resources are also employed which are Udemy.my. The combination of the Udemy and own algorithms consequence to successfully developed an alert application.

The second objective is achieved by accomplishing the development of an alert application for COVID-19 using Global Positioning System (GPS).

5.1.3 Evaluation of the correctness and effectiveness of application

Then, the system is further evaluated for its correctness and the effectiveness of the application is validated. There are two types of testing implemented, which are correctness and effectiveness testing. The correctness testing includes the process of executing the application by the related people. This is to ensure a smooth functioning system that readies for the implementation to the end-users. On the other hand, the effectiveness of the results produced is validated through an execution to find how the application can helps people. This is done by conducting a survey to get the feedback by the user.

Hence, the third objective is achieved by passing all test cases constructed to check the correctness of the whole system and validate the effectiveness of the alert application by conducting a survey.

5.2 Limitations

The limitations of the project include the application can be use for COVID-19 disease only. Besides, this application only detects the certain location in which the place has public places such as restaurants.

5.3 Recommendations

Recommendation section is providing the suggestion for the improvement of the current system. From the discussion provided in the previous chapter, there are several issues addressed that contributed to the inefficiency of the system.

Regarding the first issue, Thus, future system improvement is encouraged to development of the application into Android and iOS. However, during the development, the system just developed for Android user.

Next, as part of the activity in validating the effectiveness of the system, the concern has been addressed from the user in their feedbacks. Thus, it is recommended that the system should be improved by uploading more hotspot areas as the current situation are worse than the first phase of COVID-19.

Conclusively, the system can be enhanced in several ways as suggested. Thus, further, improvement is anticipated to increase the effectiveness of the alert application and raising its efficiency.

5.4 Summary

In conclusion, the initial objectives of this project have been accomplished. First, the identification of the high-risk areas using location-based tracking was achieved from a thorough study on multiple application in the literature review. Second, the development of alert application using Global Positioning System (GPS) was attained. Third, the evaluation of the correctness and effectiveness was observed through the system testing process implemented. Then, several recommendations were addressed to encourage further study in this area, hence provide an enhancement to the current system. Nonetheless, the system developed has contributed to the significance of this study. Mainly, this project has increased the exploration in the computer science area to demonstrate one of the techniques that can be applied. Next, the system benefits the user to make a future decision to visit places with unknown status.

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