MOBILE BASED REAL TIME PROPERTY/LAND FOR SALE VIEWING USING GOOGLE MAP AND COMMUNICATION TOOL FOR BUYER AND CLIENT/REAL ESTATE AGENT

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A project report submitted in partial fulfilment of the requirements for the award of Bachelor of Science (Hons.) Software Engineering

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September 2021

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project report entitled **"MOBILE BASED REAL TIME PROPERTY/LAND FOR SALE VIEWING USING GOOGLE MAP AND COMMUNICATION TOOL FOR BUYER AND CLIENT/REAL ESTATE AGENT"** was prepared by **BENJAMIN LEONG E-JENN** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Science (Honours) Software Engineering at Universiti Tunku Abdul Rahman.

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ABSTRACT

The global pandemic has taken a toll on businesses which caused them to transition from their traditional means of conducting business operations to a more digitalized manner through mobile applications, and the real estate industry is no exception. Real estate agents are gradually beginning to advertise their property listings on mobile applications more frequently, and property developers are releasing their own applications as well to provide an extension to their conventional booking systems. However, the property listing mobile applications that are currently available in today's market is only limited to information searching and registration. Thus, this project aims to develop and implement a mobile based property market application that is capable of providing an enhanced virtual home viewing experience, allow appointment bookings to be made, able to reach out to real estate agents more conveniently and integrate an improved chat feature. Evolutionary prototyping was adopted as the preferred software development methodology for this project as it enables its requirements to be flexible and iteratively refined throughout the project's implementation phase. In addition, a literature review was also conducted by analyzing existing applications that are currently available today to identify all the essential features that the developed application should contain, along with other areas which can be enhanced accordingly. Proper verification and validation of the implemented features and functionalities through unit, usability and user acceptance testing were also performed to ensure that all of them conform to the proposed requirements. All in all, it can be concluded that the project was a success as it managed to fulfil all of its objectives. Future enhancements can be made to implement more features and functionalities into the property listing application in order to be able to enhance its competitive advantage within the real estate industry.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Looking back at the start of the Digital Age, nobody would have predicted that the introduction of the World Wide Web would progress as swiftly as it did. It has successfully transitioned the daily lives of individuals from across the globe from businesses down to their daily activities.

And in the recent global outbreak of Covid-19, which has forced almost everyone to go into quarantine and isolation in order to control the widespread of the pandemic. This situation has affected the daily lives of all individuals as well as businesses in all economic sectors, forcing them to adapt to the changes in their daily lives. All forms of communication, celebratory events, work-related task and all other activities that were once considered a norm, were forced to be digitalized and be conducted in a different medium.

Economic sectors that have failed to transition their businesses online have suffered from major financial difficulties, which spans from a loss of company income down to relieving individuals from their job position. Conversely, for those who did manage to adapt and change their business models to be integrated into online platforms have managed to save themselves from this global pandemic and at the same time, certain business organization have also profited greatly from it. For one, it can be observed that online shopping platforms, logistic centres and delivery services are among the businesses that have increased in popularity because of this incident.

Moving back to the industry that the application to be developed is targeted on, which is the property market industry. As one would expect, the property prices in the market have indeed plummeted slightly, which causes a worry for tenants and landlords on whether to sell their current property on hand. Having a low market price is one thing, but the number of active clients who are in search of a property to buy or rent is also another factor.

Furthermore, since majority of the construction works also had to be delayed, property developers would also have to revise their schedule and budget, which would delay the launch of their respective projects. Although

online marketing during this period can be more effective than it was before, but the aspect of clients not being able to view the properties also had to be considered by both the real estate agents and developers. This is due to the fact that clients would usually prefer to view their preferred property in person before attempting to make a purchase, which is restricted due to the pandemic.

There are currently many property listing applications available in the market that could offer a platform for agents and developer to list their properties for sale, as well as for client to browse through the list of properties. However, majority of the applications only offers general features, which could be improved by implementing some of the newer technologies in the market, which will be explained in detailed in the following sections of the report.

1.2 Problem Statement

According to the answers provided by a former property development manager in a recent interview session, several problems were highlighted regarding the current state of the property market, which is beneficial in providing insights in this research. The problems were analysed and listed as shown below.

1.2.1 Lack Of Virtual Visualization Features For Home Viewing

As society progresses further into the digital age, property technology is becoming increasingly popular in the real estate industry. Two visualization techniques that are driving property technology include Virtual and Augmented Reality (VR and AR) respectively, which has already disrupted the traditional processes of purchasing and selling properties (Banoo, 2020).

Traditionally, clients would use the photos uploaded to the respective property's listing as a first impression when considering to rent or purchase a particular property. These would act as a baseline before scheduling for a site visit to the actual property itself. However, due to the circumstances of clients not being able to view the properties in person, a more convincing and realistic experience has to be provided in order to attract the interest of the potential homebuyers.

Several real estate applications have already provided additional visualization features through Augmented Reality, AR to enhance the user's experience (Lang and Sittler, 2012). In addition, PropertyGuru, which is one of the powerhouses of property-listing platforms in Malaysia since the early 2000s, have also offered VR features in both its web-based and mobile applications (PropertyGuru, 2020). While both AR and VR are in the spotlight of most property developers and property-listing platforms, but that does not mean that other technological prospects can not be integrated into the real estate industry as well. Panoramic views and 360-degree videos are also amongst the options that could be integrated into the real estate industry due to its past success in the construction industry (Felli, Liu, Ullah and Sepasgozar, 2018) as well as the education industry (Reyna, 2018).

However, the concern is not focused on the technology itself, but rather on the availability for real estate agents and developers to utilize it according to their needs. The major influencing factor is the cost, which includes the hardware, software and the servicing fees. Banoo (2020) provided an example of the cost of setting up VR functionalities, which costs around RM 8,000 for a VR headset and a computer. Property developers without a large financial backing might hesitate to invest in these newer technologies, especially those with multiple outlets and sales galleries across the country. Even more so for real estate agents, in which they might not have the budget allocated to include additional visualization functionalities into their listings as these services incur additional overhead costs.

1.2.2 Ineffective Booking Features When Purchasing Properties

The property market applications that are currently available in the market does not have a proper tracking system to monitor each stage of communication between the customers. In general, these applications were only used as a platform for agents and property developers to market their projects and currently available properties to be advertised to the public. According to a recent study conducted by Yap and Chua (2018), it was highlighted that e-booking systems in real estate applications were still incompetent and this feature was rarely discovered in the market today despite having positive feedbacks from respondents in their research. Although the

process of making e-bookings is no stranger to society today as many applications across different field have already adopted this approach, which includes the booking of movie tickets through a cinema's websites and purchasing a product through ecommerce platforms. The real estate industry is still yet to take a step further by incorporating these ideas to suit their business needs.

Information technology is the key driving factor in improving business procedures. Although the idea of allowing booking processes to be digitalized is categorized as a blue ocean strategy, which is difficult to adopt due to the lack of market research and information available. However, it could be a game changer in the real estate industry when it is applied correctly as the effect of the Covid-19 pandemic has accelerated the digitalization of real estate's sales and the procedures that follow immediately after (Banoo, 2020). This problem statement can also be associated to applications from other domains, such as e-commerce platforms in which a proper tracking status was associated to each transaction made and provides clear logistic updates. Initially, consumers were reluctant to make purchases online when compared to purchasing from physical retail stores. However, online shopping through ecommerce platforms have begun to grow in popularity and eventually disrupted traditional shopping processes. This is known as the "Amazon Effect", an idea which was initially less sought out by people across the globe (Mitchell, 2021). The feature implemented in this application for this research may play a role in transforming the way booking processes are taken place in the real estate industry.

1.2.3 Difficulties In Reaching Out To Reach Estate Agents

The National Association of REALTORS is a leading force in organized real estate, and America's largest trade association which handles all aspects of the residential and commercial real estate industry. In their recent "Real Estate in a Digital Age" report in 2019, it has been stated that 87% of homebuyers worked closely with a real estate agent to find their ideal property (National Association of REALTORS, 2019).

Baryla and Ztanpano (2020) highlighted that homebuyers spend a longer time searching for a property on their own compared to those that hired

a real estate agent to assist them in doing so. The above statistics is true for all types of homebuyers, regardless on whether they are new, experienced or an out-of-town buyer.

Figure 1.1: Most Common Features On Firms' Websites (National Association of REALTORS, 2019)

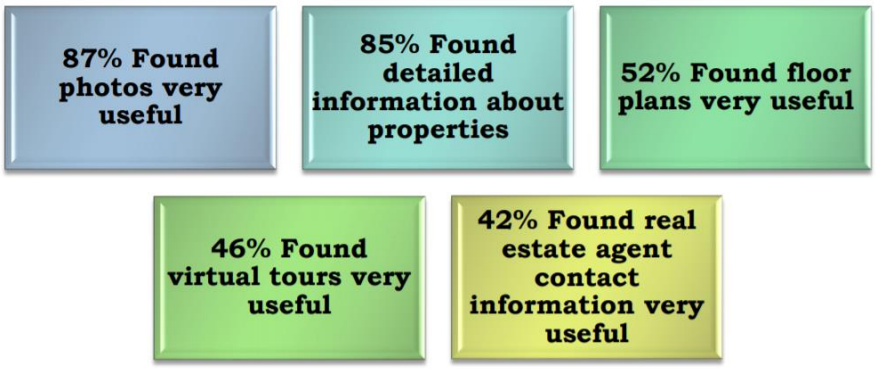

Figure 1.2: Value Of Website Features (National Association of REALTORS, 2019)

Referring to Figure 1.1 above, it was found that 76% of real estate firms have indeed included their agent's and staff's profiles on their respective websites, however only 42% of buyers who used the Internet found that the information provided was helpful as shown in Figure 1.2, which is considerably low compared to the other values states. (National Association of REALTORS, 2019). Therefore, instead of just focusing all the effort and attention on an application's property listings, it is also important to pay

attention on features that could improve the agent's connections with users of the application.

1.2.4 Lacks Features To Submit Important Documents Virtually

Throughout the entire process of purchasing a particular property, there are a variety of legal and important documents that have to be submitted and obtain approval from. Individuals such as the clients, tenants, homeowners, real estate agents, property developers and banks have their respective sets of documents that they would have to handle across different stages before a particular property can be successfully handed over to the clients. Instead of having to prefer these documents physically and having them being transferred from one party to another, wouldn't it be better if an application could help centralize the entire documentation handling process ? This problem can be clearly seen in recent times when real estate transactions are quickly shifting to go digital as movements are restricted due to the Covid-19 pandemic.

While the process to achieve a paperless business environment is not something new, many have lacked the motivation to adopt it appropriately. With the invasion of the coronavirus, hard copy documents, faxing and messenger services are beginning to become obsolete in the contract signing process. Furthermore, a real estate agent on The New York Times' website, which is an American daily newspaper company mentioned that his clients have to print out the physical copies of the legal documents, wet sign them, scanning them before e-mailing and sending the physical copy back to his clients, which took a tremendous amount of time and effort to complete (Franklin, 2020). Therefore, an alternative solution has to be implemented to ease the entire process of handling physical documents and manage them.

However, if you are thinking that all mortgage documents can be signed electronically and virtually, you might be a little disappointed as certain documents are still required to be finalized in face-to-face meetings or in the presence of a lawyer (notarization) as most countries have not updated their laws to allow it. Even so, the process of integrated e-signatures into legal documents might not be so farfetched as the restrictions on movements have accelerated the process of realizing a paperless and virtual society (Lewis, 2020).

1.3 Project Objectives

The main objective that this project aims to achieve is “To develop and implement a mobile based property market application within 30 weeks”. However, the main objective can be broken down further into sub-objectives which could be considered as the milestones for this project. The sub-objectives are as listed below.

a) Perform research and analysis on the currently available property market applications and other applications which are beneficial to the project within 12 weeks.
b) Design a system prototype which reflects the overall application within 12 weeks.
c) Implementing the proposed features and functionalities into the property market application within Project 2’s duration.
d) Perform functional and user acceptance testing to ensure that the features included in the system is working as expected.

1.4 Project Solution

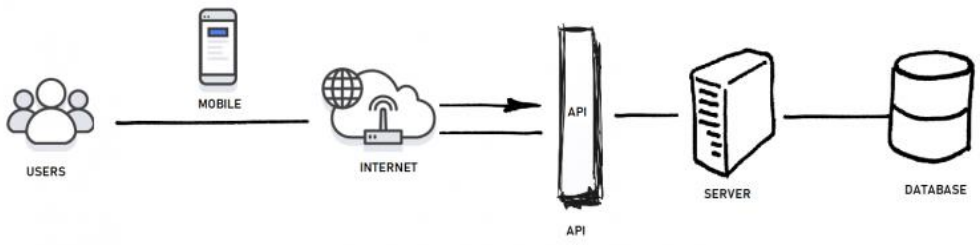

Figure 1.3: General Architecture Of The System

Figure 1.3 above shows the overall architecture of the application to be developed. The application will be developed using React Native which focuses on mobile platforms only. React Native was selected as it is a cross platform open-source codebase framework that allows native applications to be developed over JavaScript. In order to resolve all the issues mentioned in the problem statement above without neglecting the necessity features that all real estate mobile applications have, the following features and functionalities were included into the property market application solution.

1.4.1 Provide Additional Features That Enhances Virtual Home Viewing Experience

When you cannot bring the clients to view the property, bring the property to the clients. Although photos are a good way to provide clients using the application to be able to visualize the overall design and layout of the selected property, it is usually only effective for a first impression. Customers usually prefer to view their preferred property in a more detailed manner, which improves their confidence in purchasing a particular property.

Since customers are unable to personally view the property on site, techniques such as videos and interactive panoramas are great alternatives to provide a virtual tour experience that clients can utilize at their convenience.

Due to the current state of the world where society is still recovering from the Covid-19 pandemic, customers might still be hesitant to conduct site visits physically. Therefore, a suitable approach must be adopted to allow both real estate agents to include additional visualization features aside from the traditional static photographs. One feature that enables an enhanced virtualization feature to be achieved it through panoramic images as they are able to provide an improved visual enhancement to users without requiring any additional hardware.

1.4.2 Allow Appointment Bookings To Be Made On Property Listings

Whenever customers are interested in a particular property listing and wish to personally visit the location on site, they could schedule an appointment with the real-estate agent through the application itself. Each appointment will be recorded with the details of both parties along with the date and time of the scheduled visitation. This feature benefits the homeowner's side as they would be able to view and manage their scheduled appointments accordingly. However, this feature might not be applicable physically currently due to the pandemic, but even so, it will be a great feature to have once everything is reverted to normal.

Just like how online shopping platforms have a feature to enable customers to make offers for a particular product that they are interested in, the property listing application to be developed should also enable a booking feature which allows users of the application to schedule an appointment with

the real estate agent in charge of the property that the users are interested in. This way, real estate agents are able to keep track of all their potential tenants in a more centralized manner through the application.

1.4.3 Enhance General Features To Reach Out To Real Estate Agents

As mentioned earlier in sub-chapter 1.2, the entire process of searching and purchasing a particular real estate is not that simple. The entire process may take a long time to complete, homebuyers might be intimidated with the volume of legal documents to handle and the sheer complexity throughout the process of purchasing a particular property or unit. Therefore, this application plans to mitigate that by providing a feature that enables clients to find a real estate agent to assist them in specific services throughout the process of obtaining their ideal homes.

Amidst the pandemic, with society being confined within their own homes, potential homebuyers are having difficulties in reaching out to real estate agents to help facilitate them in accomplishing tasks related to owning a real estate property. Furthermore, they could no longer enter a real estate agency in person to negotiate for a particular service that they are interested in. In order to reduce the time and confusion required for potential homebuyers to search for a real estate agent, the property listing application that is part of this project plans to resolve this by including a feature within the application.

1.4.4 Allow Photos Of Documents To Be Uploaded In Chats

The process of purchasing a real estate property is a complex and lengthy one as there are many procedures and documentations involved. The number of important legal documents that has to be signed and be submitted throughout the entire process of purchasing a property is plenty. Instead of having to print and mail each document to the respective authorities, the application could allow the submission of these documents virtually through the application. Therefore, this project aims to develop a property listing application that comes with an integrated chat feature that enables users to not only send text messages to one another, but also enable them to send images as well.

1.5 Project Approach

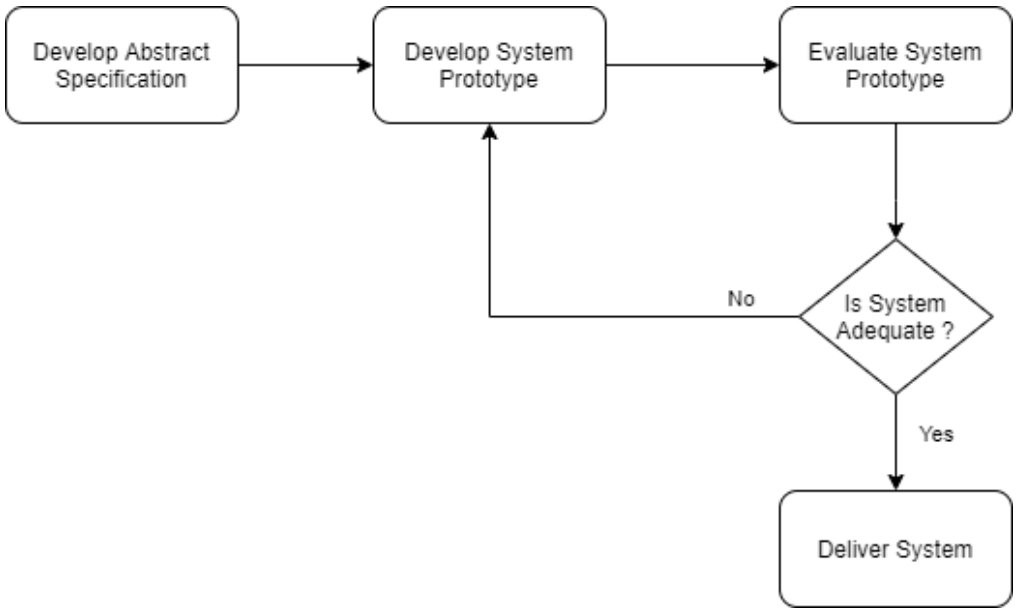

Figure 1.4: Workflow Of Evolutionary Prototyping (Shao, P. and Dida, M., 2020)

The software development methodology that was selected to be used throughout the project is evolutionary prototyping. This approach was selected because the general functionalities of a real estate application is clear from the start of the project as there are currently a large number of them available in the market, making the evolutionary prototype approach be best suited for this project (Asri, et al., 2020). As certain features identified to resolve the problem statements are relatively new, prototyping also enables requirements to be exploratory and iteratively refined. This significantly reduces the risk of project failures as users will be able to evaluate the prototypes developed in early stages of the software development life cycle by pointing out areas which does not meet the requirements as planned, potential areas which can be improved and aspects that could be removed to reduce the complexity of the system.

As users become more dependent on mobile application services to help facilitate in completing their daily tasks, so will their standards be when selecting a particular mobile application. User experience in mobile applications is essential to the business's success in today's day and age, therefore applications have to be designed in such a way that it can maintain

user's retention towards the application. Moreover, real estate applications contain various key functionalities that have to be integrated into one application, which might overcomplicate the user interface when developers are not cautious enough. As a prototype is considered to be the initial version of a complete application, this approach allows developers to try out different design options, such as the user interface design. Gathering requirements for the user interface design is not easy as even the clients have a hard time in explaining how they prefer the design to be (Adarsh, et al., 2017). This is where prototyping comes in handy as it allows designers to experiment with the user interface design by delivering a prototype of the application to be evaluated by the clients. If the clients are not satisfied with the overall design of the application, this process can be repeated until a satisfactory design is accepted by the clients. By doing so, this reduces the risk of spending too much time and cost working on a project only to be rejected by the clients during the evaluation phase.

Adarsh, et al. (2017) also mentioned that evolutionary prototyping helps in refining the requirements according to the client's feedbacks in which the requirements are not well defined at the start of the project with a high tendency to change over the software development lifecycle. And because of that, this methodology helps in minimizing the risks associated to the changing requirements as each iteration leads to a better and more refined prototype. Potential bugs and errors can also be discovered and rectified in the early stages of development, leading to an end product with minimal quality problems and smoother maintenance process.

1.6 Scope of the Project

Within this section, the project scope was categorized into targeted users in which the property listing application aims to serve, along with both the covered and uncovered modules that was integrated as part of this project.

1.6.1 Targeted Users

a. Tenants who are looking to purchase or rent a real estate property.

c. Real estate agents.

d. Administrators.

1.6.2 Modules Covered

1. Registration and login

a. First time users should be able to register a new account in order to utilize the full features of the application.

b. Existing users shall be able to login into their previously created account.

2. Searching for properties and units

a. Users shall be able to search for a property or unit by typing in the location through text within the search bar provided.

b. Users shall be able to search for a property or unit by specifying the location in the GoogleMaps provided, which would then display the search results within the radius of the coordinates specified.

3. Display search results

a. Users shall be able to view their search results in a traditional structured list format.

b. Users shall be able to view their search results on the GoogleMaps itself by pop-ups on the same screen after specifying the coordinates of their desired property or unit.

4. Integrated chat feature

a. Tenants shall be able to utilize the integrated chat feature to contact real estate agents to enquire about the listings that they are interested in.

b. Real estate agents shall be able to utilize the integrated chat feature to respond to their client's enquiries.

5. List properties for sale or rent

a. Real estate agents shall be able to list their available properties and units up for sale or rent on the application.

6. Favourite selected properties

a. Tenants shall be able to favourite their selected properties which allows them to revisit those listings easier in the future.

7. Schedule and manage viewing appointments

a. Tenants shall be able to schedule appointments with real estate agents in charge of the preferred listing in order to view that particular property or unit.

b. Real estate agents shall be allowed to view the list of appointments scheduled with their respective clients through the application.

8. Display details of a selected listing

a. Details regarding each listing includes static photos, panoramic photos, location, price, size per square feet, number of bedrooms and bathrooms, property type, listing type, furnishing condition, unit features, description and nearby amenities.

i. Real estate agents shall be able to provide detailed description regarding their respective listings and projects on the application.

ii. Tenants shall be able to view the detailed description provided by the handlers of the respective listing that they are interested in.

9. Search for real estate agent services

a. Tenants shall be allowed to search for real estate agents on the application to help facilitate them in accomplishing their process of purchasing or renting a property.

10. Upload and access important documents

    a. Users shall be allowed to upload documents through the application within the application itself.

11. Add new real estate agents

    a. Administrators are allowed to register new real estate agents which enables them to publish new property listings on the application.

1.6.3 Modules Not Covered

Due to the limitations set by time constraints, certain modules will not be covered and implemented into application in order to be able to deliver the system on time. The modules that would not be covered are listed below.

1. Integrated payment features

Although there is potential for payment services to be implemented into real estate applications to facilitate the initial procedures of purchasing a property, such as booking fees and down payments. There is a significant risk that is associated with it in which clients might be hesitant to make payments of large sums through the application. However, the overall features of the application would not be affected even though any form of payment shall be done in external platforms.

2. Chatbot assistance

It is understood that many platforms and applications have their own integrated chatbot assistance that could provide immediate responses to clients regarding their enquiries, such as frequently asked questions (FAQs). However, due to time constraints, an effective and accurate artificial intelligence may not be able to be programmed on time to meet the submission deadline. Thus, this feature was omitted from the development process.

3. Virtual and augmented reality visualization features

Technological advancements have allowed applications to be equipped with virtual and augmented reality features to improve their user’s experience. However, there are still areas in these newer technologies that have yet to be explored and solidified through research. Additional time and effort is

required to study on how these features can be implemented into the real estate application and thus, these visualization features will be excluded from this project.

4. Rating and feedback for real estate agents

Due to the large scope that has been set in this project, including more features to be implemented might risk them not being able to meet the scheduled deadline. Therefore, features that allow clients and tenants to leave reviews and feedbacks to the real estate agents that has assisted them in the past have been excluded from this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

As mentioned in the earlier parts of this report, there are currently several similar applications that are currently available in the market today. In this chapter, five applications with similar features and functionalities in the property domain is selected and analysed in detailed.

For each application, the key features will be highlighted along with a detailed evaluation of the overall application, in which a breakdown between the pros and cons of each application will be emphasized. This includes the application's design, features and the overall user experience that it offers. At the end of this section, the essential features of the application to be developed will be highlighted along with some additional features in which the application can be improved to offer a wider and more complete application its targeted users.

2.2 Analyse Similar Mobile Applications

5 applications with similar features and functionalities within the property domain was selected to be analysed in detail within this section of the report. This process was done in order to facilitate the requirements definition process, whereby essential features that the project should contain was extracted. Furthermore, loopholes and potential enhancements that could be made to improve the existing property listing applications was also analysed in order to implement the enhancements within this project.

2.2.1 EdgeProp

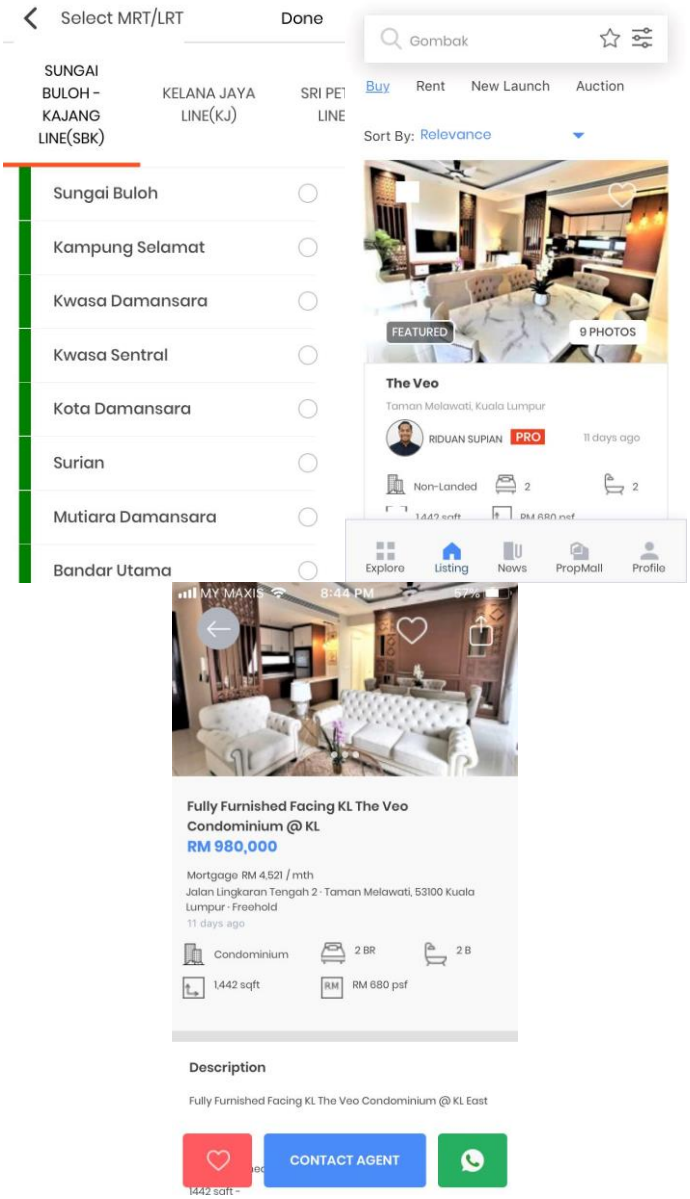

Figure 2.1: Screens Of EdgeProp's Mobile Application

Main Features of EdgeProp

- Search By MRT

  Instead of having a just general search by text feature to allow users to search for a particular location, EdgeProp's application provides a selection list that contains the names of MRT stations. Users could select the MRT station of their choice and the application would display the search results of the properties which are close the selected station. This

feature eliminates the need for users to enter the names of the MRT stations manually in order to search.

- Search By Area

  Similar to the selection list feature for searching by MRT, EdgeProp's application also provides a similar feature which allows users to search for properties by area. For example, should users wish to view all the available properties to buy and rent in Balakong, they could utilize this feature by first selecting the state of the district followed by the district itself. In this case, users would have to click on Selangor from the selection list, followed by Balakong immediately after that.

- Provide Updates To Latest Property News

  EdgeProp also provides a feature that integrates the latest property news into the application to allow users to read through and stay up to date with the latest occurrences in the property industry.

- Features Latest Property Developer's Projects

  Instead of focusing on the attributes of real estate agents, EdgeProp's application also provides a feature that allows property developers who are interested to advertise their latest projects in the application. In each detailed project listing, information such as the description of the project, company background, project location, features of each unit, floorplans and key amenities situated close to the project location will be provided. In addition, should users be interested to know more about a particular project, they could fill in an enquiry form so that the company involved could reach out to them in return.

2.2.2 PropertyGuru

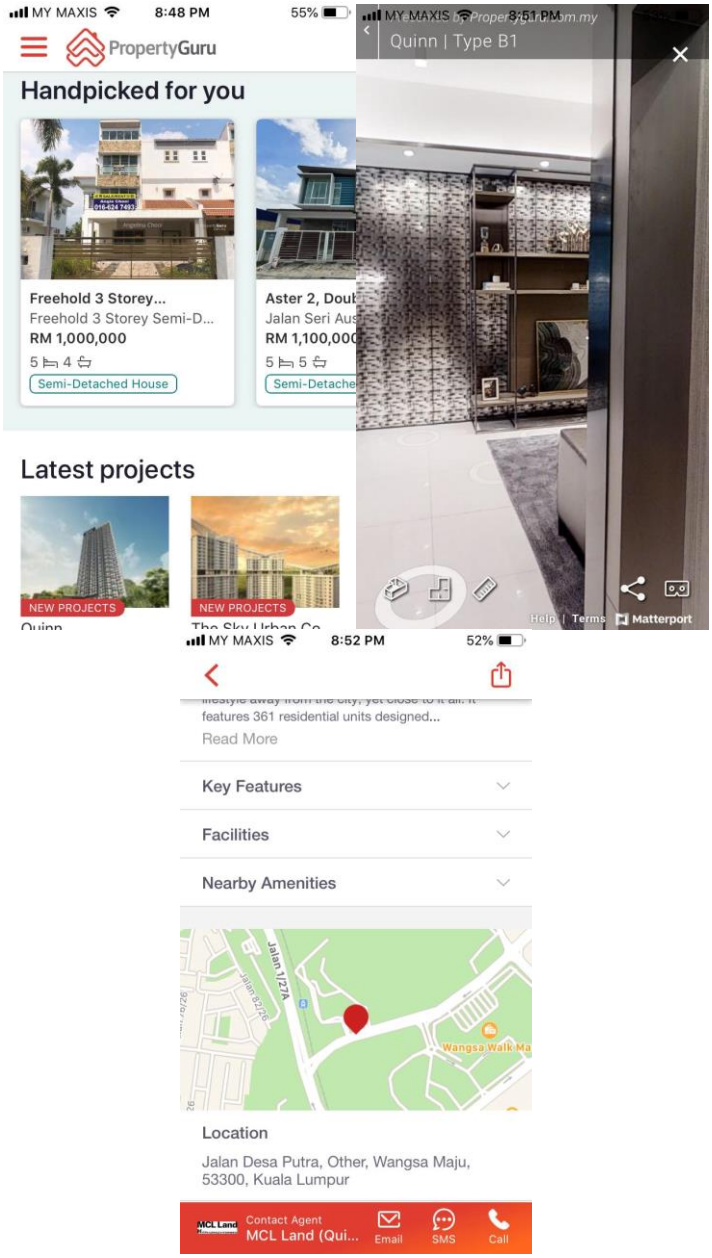

Figure 2.2: Screens Of PropertyGuru's Mobile Application

Main Features of PropertyGuru

- Select By Location On GoogleMap

  PropertyGuru's application provides an additional search feature in addition to the general searching through text. Users are able to utilize the integrated GoogleMap provided within the application and pinpoint a particular coordinate in which they would like to search properties at. The property listings relative to the location of the search result will be displayed shortly after.

- Display Search Results On GoogleMap

  Instead of displaying the search results in a list format similar to what most application have done. PropertyGuru's application also provides a different style of presenting the location of each property, which is through coordinates on the integrated GoogleMap. Upon clicking on one of the pop up locations on the map, more detailed information can be viewed regarding the selected property.

- Provide Suggestions For "Similar Properties"

  Property Guru's application considers the past search results that users have made and provides suggestions on properties with features similar to it. This feature reduces the need for users to search for properties that contains features similar to the ones that they are currently looking for. Users are able to browse through the featured listings handpicked by the application itself.

- Features Latest Property Developer's Projects

  Similar to what has been mentioned in EdgeProp's application in the previous section of this report, this application also provides a platform for developers to advertise and market their projects.

- Find Agents For Specialized Services

  PropertyGuru's application also provides a feature that allows users to search for qualified real estate agents to assist them in their required services. Users will be able to select the agent of their choice, view the background information provided by them and contact them if the users are interested. Agents are categorized and grouped into several categories, which includes the monthly featured agents, landed property specialized agents, commercial featured agents and many more categories that are offered.

- Offers Virtual Tour For Specific Property Listings

  PropertyGuru's mobile application offers virtual tour features for selected properties. Instead of using the traditional approach of only providing static photos of the property to the potential homebuyers, property developers or homeowners that are interested can contact PropertyGuru's team to request for a virtual tour functionality to be integrated. By doing so, potential homebuyers will be able to tour the selected property listing from the edge of their fingertips. This is done by tapping on an area within the interior of the unit and the application will navigate to that point of contact to enable users to have the full experience of a site visit.

2.2.3 trovit

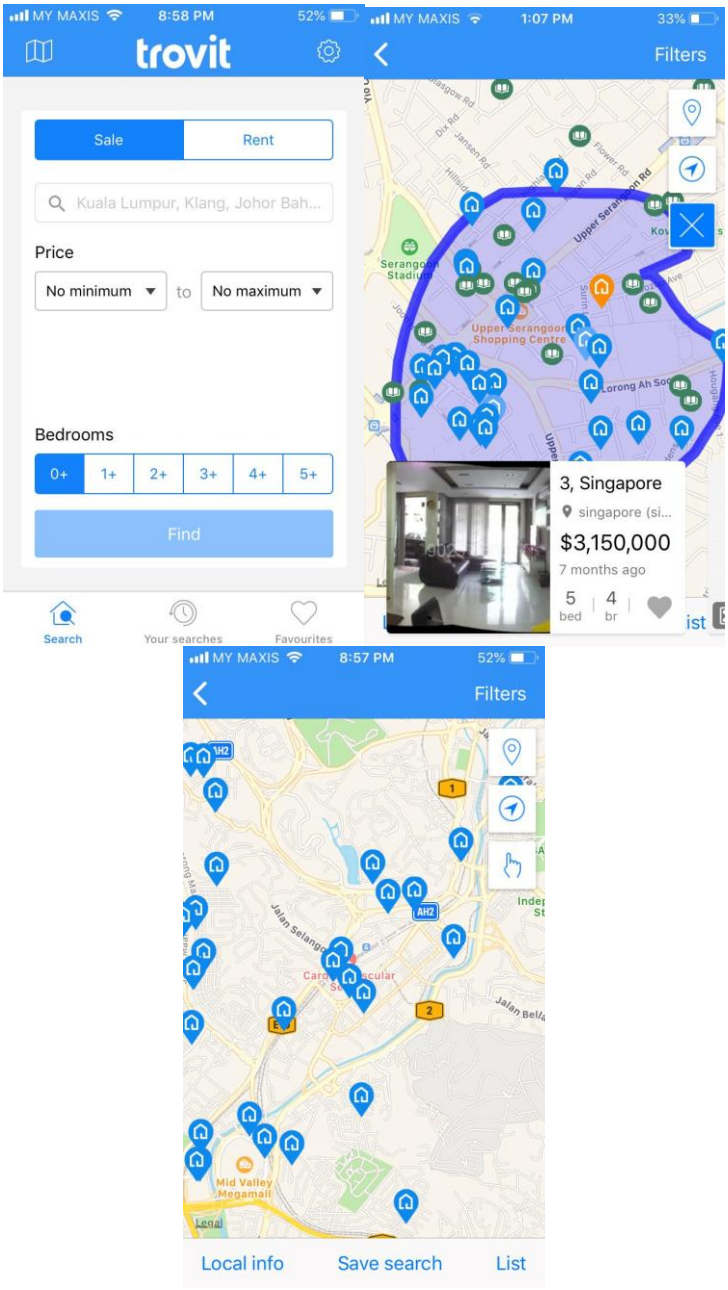

Figure 2.3: Screens Of trovit's Mobile Application

Main Features of trovit

- **Display Search Results On GoogleMap**

  Trovit's application also offers an alternative way of searching for a particular property location and displaying the search results. Users could either display their search results in a classic list format or display them as coordinates on the integrated GoogleMap itself.

- **Select A Specific Area On GoogleMap To Narrow Down Searches Results**

  In addition to displaying the search results on the integrated GoogleMap, trovit's mobile application also allows users to narrow down and filter their search result's location by "circling" the area in the map. This feature enables the mobile application to only display the search results in areas of the map of the user's preferred property location.

- **Include Points Of Interest On GoogleMap (Schools, Supermarkets, Hospitals)**

  In contrast with the feature of displaying the user's search results on the integrated GoogleMap, the application also allows user to include points of interests to be displayed along with the property's location. Key landmarks, which includes schools, supermarkets and hospitals can also be displayed as icons on the GoogleMap to allow users to consider the location and distance between each amenity from their preferred property.

2.2.4 Ohmyhome

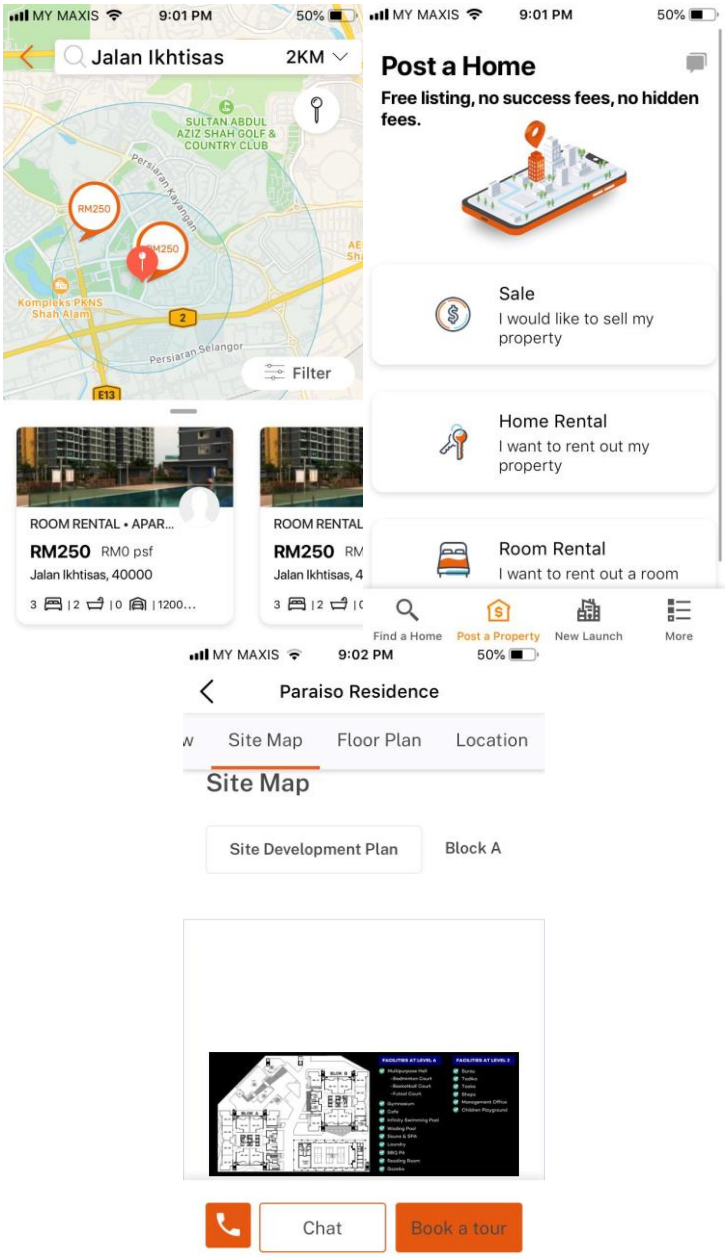

Figure 2.4: Screens Of Ohmyhome's Mobile Application

- Search By Location On GoogleMap

  Similar to what other property market mobile applications have thus far, Ohmyhome's mobile application also contains a feature that enables user to search by location on its integrated GoogleMap. Users will be able to pinpoint the exact coordinate in which they would like to search for a particular property. Furthermore, users are able to specify the radius in

which properties within that range will be displayed on the map as its search results.

- Search By City In Kuala Lumpur

  In addition to searching by text and location, Ohmyhome's application also provides an option to allow users to search through a selection list for a particular property within Kuala Lumpur, which is a hotspot for home searchers.

- Find Agents For Specialized Services

  Specialized agent services are also available in this application itself, whereby users will be able to easily obtain assistance from agents which could help them in selling and buying a particular property. Moreover, specialized agents could also offer their services to clients regarding landlord and tenant scenarios.

- Able To See What Other Users Are Looking For

  Ohmyhome's mobile application also provides a feature whereby users could specify the aspects and criteria of a particular property that they are currently searching for. Not only that, but users could also view what other users are searching for within the application. This feature enables a two-way communication in which real estate agents, tenants and landlords could reach out to their potential clients instead of the traditional way having clients to make the first move.

- Integrated Chat Feature

  Instead of providing external contact information such as phone numbers and email address that requires users to reach out to the respective real estate agents and tenants to enquire more information about a property that they are interested in through a third-party application, Ohmyhome has provided an integrated chat feature to counter this factor. Users could now communicate with one another within the application itself, just like how applications in other domains have done.

- Features Latest Property Developer's Projects

  Similar to what has been highlighted in other applications prior to this one, Ohmyhome's application also provides a platform for developers to advertise and market their projects. Detailed information and features such as the price range, location overview, site map, floor plan, available infrastructures and the distance between amenities are provided in each of the project's listing.

- Able To List Own Property

  Ohmyhome's mobile application also provides a feature that allows homeowners to list their property on the application itself for free, with no success fees and additional hidden charges. This feature extends up to selling a property, renting a home and renting a room. However, regular homeowners would not be able to handle the selling and renting of their properties by themselves and instead require the assistance of a real estate agent.

2.2.5 StarProperty

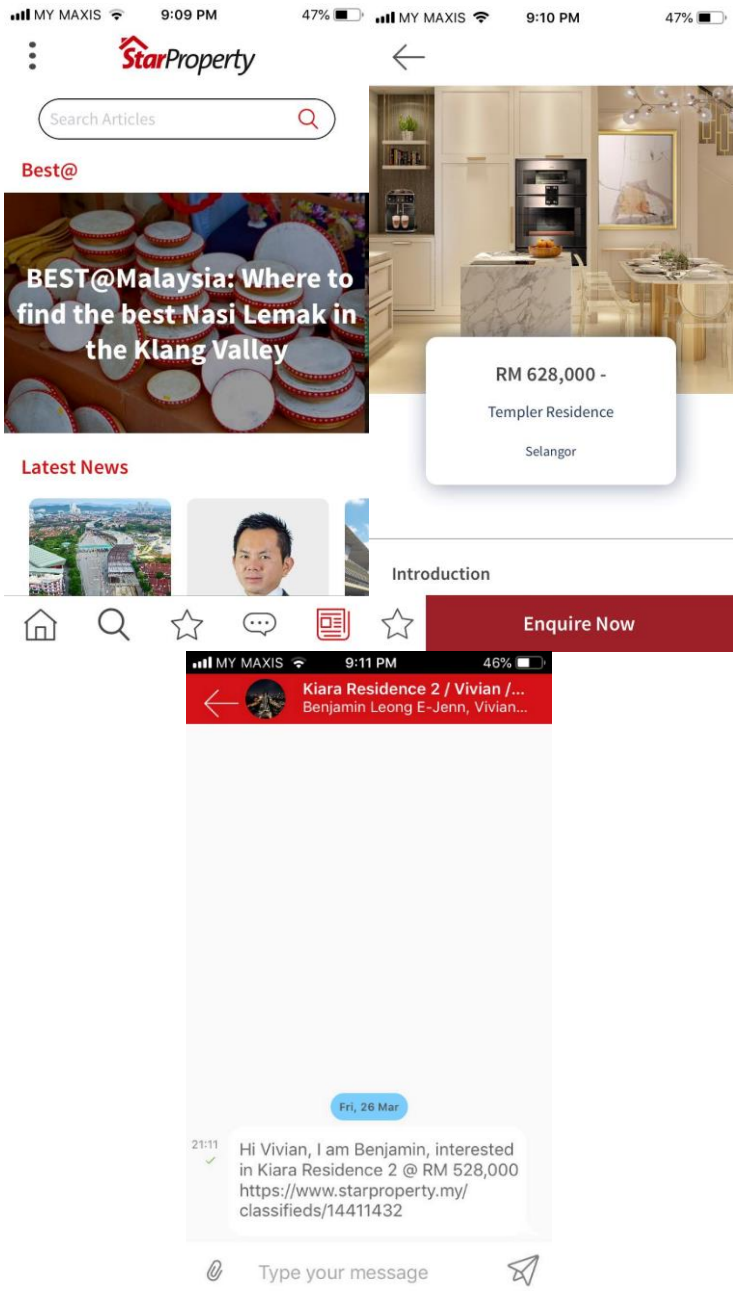

Figure 2.5: Screens Of StarProperty's Mobile Application

- Search By Location On GoogleMap

  Similar to what other applications that have been described thus far, StarProperty's application also provides an alternative to searching by text. In this application, users will be able to pinpoint the exact location of their preferred property and the application will perform the searches accordingly.

- Features Latest Property Developer's Projects

  Instead of focusing solely on listings made by real estate agents, property developers could also utilize this extensive feature to publish their projects to be featured on the application. Details such as company background, project information, an overview of the units, project location, floor plans and the available facilities are provided along with each project. Clients who are interested can enquire about it further from the project's respective developers.

- Integrated Chat Feature

  To ease the process of StarProperty's mobile application users to not have to switch to a third-party application for the sole purpose of communication, an integrated chat feature has been implemented to allow all forms of communication to take place within the application.

- Schedule Viewing Appointments

  In order for real-estate agents and property developers to keep track of their potential clients that have enquired about their listings, a feature that allows viewing appointments to be scheduled is implemented. Through this functionality, clients are able to schedule an appointment to view the property that they are interested in, as well as easing the process of the agents and developers to keep track of their potential clients.

- Provide Updates To Latest Property News

  StarProperty also provides a sub-section within their mobile application to publish the latest news in the property market. This helps its users to stay up to date with the latest occurrences in the industry.

2.2.6 Mobile Applications Comparison Matrix

Table 2.1: Mobile Applications Comparison Matrix

Features	EdgeProp	Property Guru	trovit	Ohmyhome	StarProperty
Search by Text					
Search by MRT (Not through text, but a selection list)					
Search by Area (State -> District) (Not through text, but a selection list)					
Select a Category Before Searching (Condo Directory -> Search Preferred Location -> Display GoogleMap)					
Select by Location					
Search by selecting a coordinate location on GoogleMap					
Group by Buy, Rent and Projects					
Sort (By Relevance, Latest First, Price Low to High, Price High to Low)					

Filter by Buy, Rent, New Launch and Auction					
Can "Create New Account" and "Login"					
Contains Tabs of News / Projects / Guide / Tips					
"Favourite" Properties					
Contact Agents Through Form Submission					
Contact through Call, SMS or WhatsApp					
Integrated Chat Function					
List Own Property					
Available listed properties will all be displayed on GoogleMap (can be clicked)					
Provide suggestions for "Similar Properties"					
Tags for easier searching					
Mortgage Calculator					

Find Agents (For Seller, Buyer, Landlord & Tenant Service)					
Display Listing Description In App					
Able to see what other users are looking for (owners can contact tenants instead)					
Show distance between amenities					
Virtual Tours					
Schedule Viewing Appointments					

Upon completing the analysis between the 5 real estate applications that are currently available in the market today, the structure of the overall application to be developed can be understood even more clearly. From the comparison matrix in Table 2.1 above, certain features are common in all the applications, while there are some of them which are relatively unique. In general, Ohmyhome is the best application among the rest as it has the complete set of features that is required for a real estate application as well as it provides good user experience through its design layout and responsiveness.

For the analysis, features or functionality that have been adopted by at least 4 applications are to be considered as a general, or a “must-have” feature for a property listing application. In contrast, those with less than 4 will be considered as a unique, or an “optional” feature. Take the “Search by Text” feature as example, a property application without a feature that allows users to search for a particular property’s location through text is an incomplete

application as it restricts users from performing even the simplest of actions required. Whereas the less important features, such as the “Mortgage Calculator” is optional as the presence of this functionality would not affect the purpose of the overall application.

From the comparison above, it can be concluded that the property listing application that is to be developed as part of this project should contain the following features and functionalities:

1. Search by Text
2. Search by selecting a coordinate location on GoogleMap
3. Offers effective sorting features of the search result
4. Enables property listings to be group according to Buy, Rent and Projects
5. Provides filters to narrow down the search results according to the user’s preference
6. Enable users to "Create New Account" and "Login"
7. Allow user to favourite their preferred property listings
8. Display search result’s property listing within the application
9. Integrated chat feature
10. Provides an option that allows virtual tours to be performed
11. Allows documents to be submitted through the application
12. Displays a list of available property agent services
13. Enable appointments to be scheduled between the potential homebuyers and the real estate agent / property developers

2.3 Comparison of System Development Methodologies

In this section, four system development methodologies were selected and compared in order to determine the best approach to be adopted for this project.

2.3.1 Waterfall Development Methodology

Despite many organizations having attempted to transition their developmental approaches from the traditional waterfall approaches to an agile development methodology, interestingly enough, the waterfall development methodology continues to maintain its status as the most widely used approaches in practice

(Shaydulin and Sybrandt, 2017). One of the main reasons that waterfall technology is preferred is that it offers stability throughout the entire development lifecycle as it is highly process centric, enabling even the more complex modules to be maintained (Javanmard and Alian, 2015).

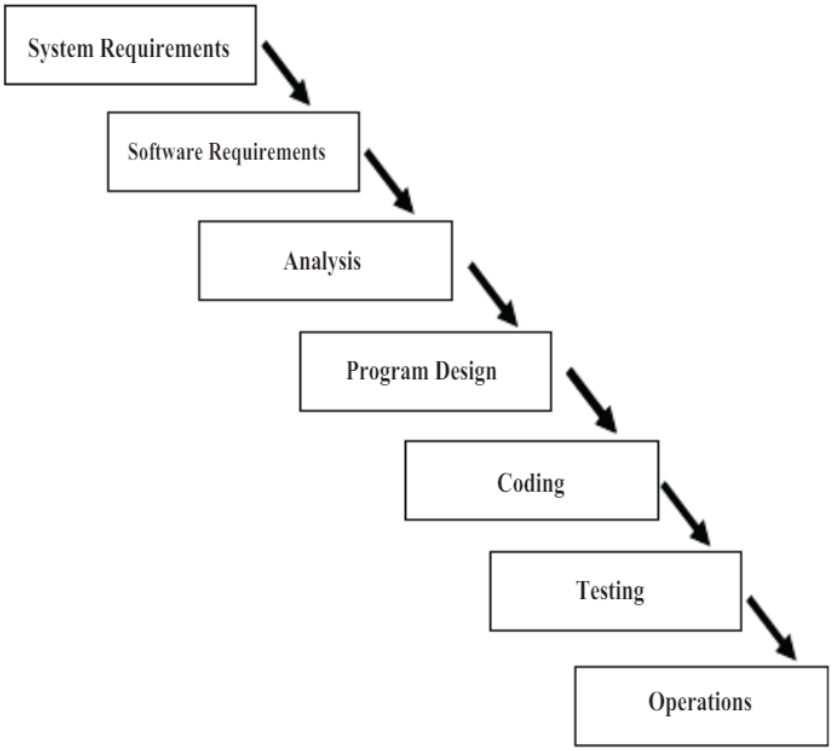

Figure 2.6: Waterfall Development Methodology (Casteren, 2017)

Just like the meaning behind its original term, the waterfall development methodology associated with it consists of phases that follows a sequential approach, in which one phase has to be concluded before the next one can begin (Kisling, 2019; Casteren, 2017). Figure 2.6 above indicates the 7 different phases within the waterfall development methodology, Unhelkar (2016) mentioned that each phase within the software development lifecycle is dependent on the phases that comes before it. One example that could be seen is that the development team is unable to begin designing the system to be developed as the analysis phases is still yet to be completed.

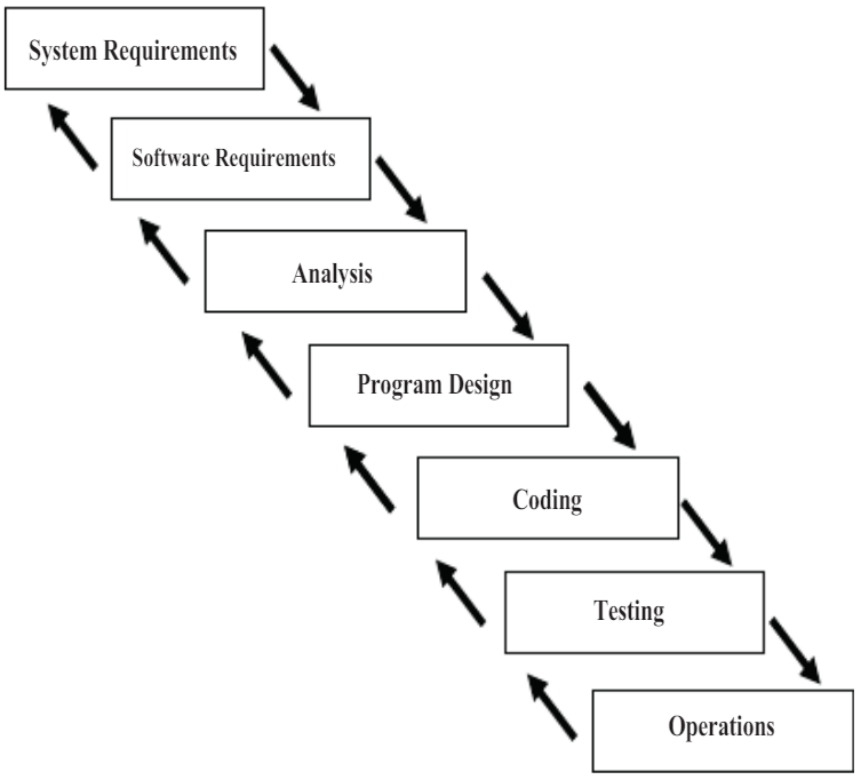

Figure 2.7: Incremental Waterfall Development Methodology (Casteren, 2017)

Figure 2.7 above shows the "improved" version of the waterfall development methodology. Chari and Agrawal (2017) mentioned that the main concern for projects to adopt a waterfall developmental approach is the impact of change requests due to defects for its requirements, which are mainly incorrect, incomplete and new requirements respectively. Similarly, Casteren (2017) also found that the number of documents to be approved during the end of every phase, iteration difficulties and high costs were among the issues of adopting the waterfall development methodology. The implications should these issues not be addressed would cause the specified requirements to not be met and an inefficient development process. While it can be said that the addition of an incremental approach as opposed to its traditional form is able to mitigate the impact of changes being made by allowing a particular phase to return to its previous phases (Shaydulin and Sybrandt, 2017), the extent to which the methodology is susceptible to changes is unable to outweigh that of Agile approaches.

Although many organizations and even industrial practitioners have claimed that waterfall development methodology have fallen out of favour due

to its inability to adapt to the ever-changing requirements within the software development industry. It still remains as one of the most popular methodologies to be used in practice as there is not a single methodology out there that could replace it (Shaydulin and Sybrandt, 2017). And because of that, it still does have its own set of benefits as opposed to its limitations. Table 2.2 below attempts to summarize the advantages and disadvantages of the waterfall development methodology.

Table 2.2: Advantages and Disadvantages of Waterfall Development Methodology

Advantages	**Disadvantages**
Accurate estimation of time-box.	Requires a longer time to gather requirements and plan before any code can be developed.
Projects can be documented well.	Small changes or errors may cause a lot of problems to the overall project.
Has a clear structure which properly determine its end goals early.	Testing is only performed during the later stages of the life cycle.
Offers stability throughout the entire software development life cycle.	Not flexible for requirements to change
Suitable for smaller projects where all the requirements are well defined.	End users only get involved during the implementation phase of the software development life cycle.

2.3.2 Agile Development Methodology

Despite both Waterfall and Agile development methodologies having the same goal of producing a high-quality product, the process and principles that they both are completely different from one another. However, for projects that do not have a clear set of requirements during its initial stages, the Agile development methodologies are more preferred as it allows for continuous delivery in which regular feedbacks can be provided to the developers (Andrei et al., 2019) and embraces iterations rather than individual phases (Casteren, 2017). Through its iterative approach, this allows the requirements to be

gradually improved and added as the project progress over time which enables frequent changes, fast delivery and reduced risks (Hayat et al., 2019).

In Agile methodologies, the development team does not halt its work temporarily whenever a major change is required, but rather it identifies the necessary procedures on how to better handle the changes that is being introduced throughout the entire project lifecycle through an empirical process control model mentioned by Javanmard and Alian (2015). The empirical process control model emphasizes control through constant inspection and adaptation for processes throughout the entire software life cycle that are not well defined. Since processes throughout the software development lifecycle are relatively complex and variable in nature, this model poses to be a proper solution to produce a proper high-quality software.

Several methodologies that revolve around the principle of the agile manifesto have been widely adopted across many development teams since its introduction, these includes Scrum, Extreme Programming (XP), Kanban and many other variations (Javanmard and Alian, 2015; Shaydulin and Sybrandt, 2017). However, all of the methodologies that adopts the Agile framework share similarities between them, there are just different agile approaches to manage a particular project (Andrei et al., 2019).

Figure 2.8: Agile Development Methodology (Tartila, n.d.)

Figure 2.8 above shows the overall flow of the agile development methodology. In general, projects that adopts the above approach performs the development work in short iterations, and at the end of each cycle, the product is presented to the end users in order to obtain their feedback. Each of these cycles are known as a Sprint, which usually only takes between 1 to 4 weeks long to complete before a new Sprint will be carried out. Adaptive requirements can be obtained from the feedback provided by the end users, in

which developers could implement and present it to them once more at the end of each sprint (Casteren, 2017).

Although agile development methodology offers numerous benefits to projects that adopt this approach due to its flexibility and adaptability, it still has its own fair share of drawbacks. Table 2.3 below attempts to summarize the advantages and disadvantages of the said approach.

Table 2.3: Advantages and Disadvantages of Agile Development Methodology

Advantages	Disadvantages
Flexible and able to adapt to change in requirements.	Requires more skilled and experienced developers.
End users can be actively involved throughout the software development life cycle.	Unable to cope with the realities of technical debt and large scaled systems.
Defects and bugs can be fixed more quickly.	More difficult to track the work in progress.
Waster less resources as the development teams always focus on up-to-date tasks.	High possibility for scope creep to occur.

2.3.3 Prototyping Methodology

A prototype can be defined as a first or preliminary model of a particular software that is built to test a concept or process. In order to obtain a prototype, prototyping has to be performed. According to Guru99 (n.d.), there are currently 4 different prototyping approaches, which are throwaway prototyping, evolutionary prototyping, incremental prototyping and extreme prototyping. However, the one that will be focused on is the Evolutionary Prototyping methodology.

In general, prototyping is performed by iteratively building, testing and enhancing a particular prototype until an acceptable final version of the prototype is obtained (Nyandowe, 2014). However, the 4 different type of prototyping mentioned above does have some variations between them. In the

following parts of this sub-chapter, evolutionary prototyping will be used as a base to compare its differences between the other 3 approaches.

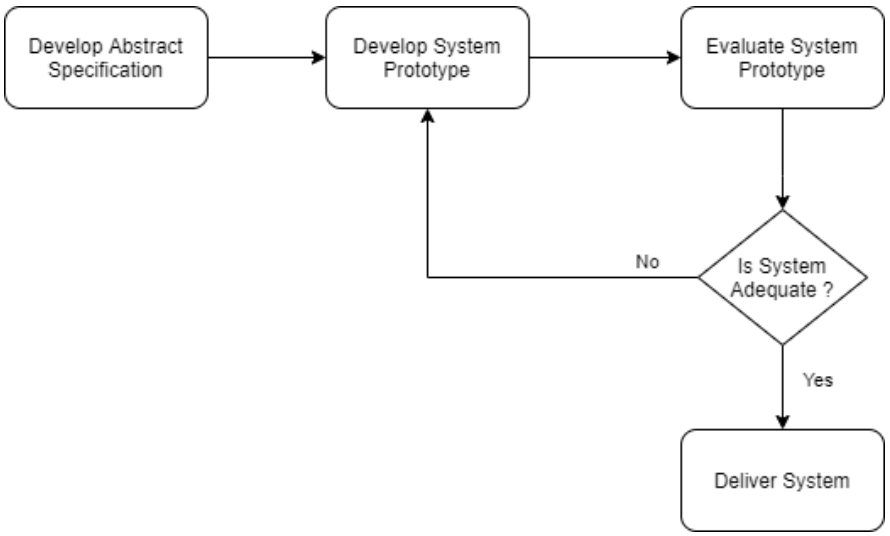

Figure 2.9: Evolutionary Prototyping Methodology (Shao, P. and Dida, M., 2020)

Sherrell (2013) and Agustiono (2018) defines evolutionary prototyping as an approach that requires a developer or a development team to build a prototype. After deploying the prototype to the end users to obtain their feedback, subsequent prototypes are developed incrementally with enhanced and additional features before it eventually evolves until it is agreed for release. Furthermore, evolutionary prototyping is more suitable to be adopted for projects with ambiguous requirements which constantly face changes. This methodology is also beneficial in a sense that it is able to reduce defects and encourages end user involvement. However, by providing the ability to offer constant changes in the project's requirements, this introduces its own set of drawbacks as well which would be covered in Table 2.4.

Evolutionary prototyping differs from throwaway prototyping as the former begins with the best understood requirements first, whereas the latter begins with the least understood requirements. In addition, evolutionary prototyping incrementally improves a prototype with additional requirements until it is finally accepted by the end users. However, throwaway prototyping discards each developed prototype as it would not be part of the final product (Khalid, 2018; Sherrell, 2013; Guru99, n.d.).

Incremental prototyping approach is similar to evolutionary prototyping in a way that the prototype is gradually refined until a final end product is produced (Sherrell, 2013). However, the difference between them is that evolutionary prototyping uses the same prototype to perform improvements and add functionalities after receiving feedback from the end users. However, instead of having just a single prototype being worked on, incremental prototyping conducts development on individual different small prototypes before eventually being combined into a single end product (Guru99 n.d.).

Lastly, extreme prototyping is an approach that is mainly used for developing web applications. The 3 sequential phases of extreme prototyping, namely Build, Transform and Code enables the user interface to be designed and developed even before any underlying technology is implemented. In contrast, evolutionary prototyping is a methodology that can be used for most projects rather than being specifically limited to developing web applications.

Table 2.4 below indicates the advantages and disadvantages of prototyping methodology.

Table 2.4: Advantages and Disadvantages of Prototyping Methodology

Advantages	**Disadvantages**
Allows products to be delivered more quickly.	May encourage excessive change requests.
Encourages user involvement throughout the software development life cycle.	Poor documentation as the requirements are constantly changing.
Flexible and adaptive to change in requirements.	Requires skilled and experienced developers to accommodate all the changes made by the clients.
Enables implementation phase to begin despite not understanding all the requirements provided.	End users may lose interest in the final product if the initial prototype is delivered poorly.

2.3.4 Rapid Application Development (RAD) Methodology

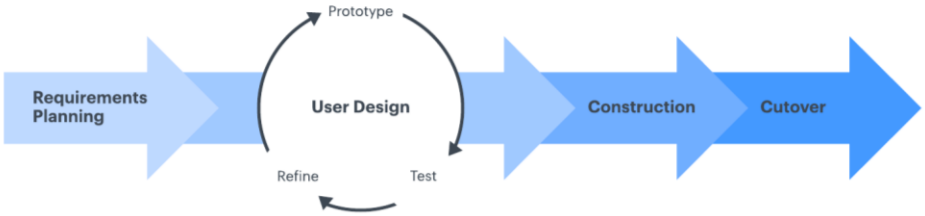

Figure 2.10: Rapid Application Development (Lucidchart, n.d.)

Rapid application development (RAD) is an approach that emphasizes on user involvement throughout the design phase to solidify techniques and requirements of the project. In this particular approach, the design phase is broken down into 4 separate phases, which are the requirements planning phase, user design phase, construction phase and the cutover phase (Shaydulin and Sybrandt, 2017). When implemented correctly, RAD enables projects to have a shorter planning phase in order to expend more effort in developing the prototype, which results in greater efficiency faster development and more effective communication (Lucidchart, n.d.).

The difference between RAD as compared to the other traditional approaches is that user interactions does not end at the requirements gathering phase, but instead continues into the design phase. In addition, prototypes will be able to be deployed much quicker as RAD prioritizes prototyping rather than partially functional deliverables (Javanmard and Alian, 2015; Shaydulin and Sybrandt, 2017). While it can be said that having a high user involvement throughout the design phase can reduce the risk for changes to occur during the later stages of the software development life cycle, the reality is that the above statement is only half true. By presenting users with excessive control over the requirements gathering process, it can become ambiguous as to how to continue when those involved begin to disagree with one another. Failure to property categorize the users that are involved during the design phase reveals a weakness of the RAD approach (Shaydulin and Sybrandt, 2017).

Similar to all other the software development methodologies, there is no one methodology that is capable to be fit into all projects, and RAD is no exception. Table 2.5 below summarizes the advantages and disadvantages of RAD.

Table 2.5: Advantages and Disadvantages of Rapid Application Development

Advantages	Disadvantages
Prototypes can be deployed to end users within a shorter time frame.	Less effective for larger teams.
Increase the efficiency of the design process due to high involvement from end users.	Requires more skilled and experience developers to handle the frequent change in requirements from end users.
Flexible towards change in requirements.	Only suitable for projects with a shorter development time
Increases reusability of components.	End user involvement is crucial especially during the design phase.

2.3.5 System Development Methodologies Comparison Matrix

Table 2.6: System Development Methodologies Comparison Matrix

Features / Methodology	Waterfall	Agile	Rapid Application Development	Prototyping
Requirement's flexibility	Low	High	High	High
Clear requirements specification level	High	Low (Increments as project progresses)	Moderate (Changes as project progresses)	Moderate (Changes as project progresses)
Focused on end users	Low (Only in the beginning)	High	High	High
Susceptible to unforeseen circumstances and risks	Low	Moderate	Moderate (When given end users too much power)	Low

Dependency on end user feedback	Low	High	High	High
Development team's skillset level	Moderate	High	High	High
Applicability for smaller teams	No	Yes	Yes	Yes

After reviewing 4 different type of software development methodologies, it is clear to see that there is practically not one methodology that can act as a silver bullet to address all types of projects within the software development industry. Each one of them has their own unique characteristics that led to their respective advantages and disadvantages, therefore developers have to understand the aspects of each software development approaches clearly and consider the scale of their projects before attempting to decide on a software development methodology. Choosing the right methodology can be the key deciding factor to determine a project's success and failure.

For this project, the prototyping methodology will be chosen, specifically evolutionary prototyping. The main reason that this approach was selected is because it offers flexibility and adaptability to handle the change in requirements throughout the entire software development lifecycle. As certain features of the property listing application involve the integration of newer technologies, such as the interior navigation feature, that is not common among the currently available applications in the market, evolutionary prototyping is able to allow me, as a developer to experiment with the functionalities rather than planning the design from the start.

In addition, as weekly discussions are being conducted frequently among myself and my supervisors, evolutionary prototyping enables our progresses to be properly tracked to ensure that the necessary requirements are always up to date. Moreover, at the end of each weekly discussion, supervisors are able to provide quality feedbacks on areas where the system can be potentially improved. Evolutionary prototyping allows the additional feedback to be integrated incrementally through a repetitive evaluation process until it is finally accepted by the supervisors of this project. This reduces the risk in

which requirements are not satisfied by the developers due to poorly understood features.

2.4 Native and Cross-Platform Application Review

Looking back a couple years when mobile applications was just an emerging industry, native mobile applications were the go-to approaches in development (Xanthopoulos and Xinogalos, 2013). However, developers were already well-aware of the constraints surrounding native development methodologies back then and have thus beginning to slowly shift to cross-platform development approaches. With the market for mobile applications becoming increasingly active, which was said to have generated nearly $190 billion by 2020 (Huber and Demetz, 2019), it is interesting to see what the current trend is within the mobile development industry. Several academic literatures and conference papers were analyzed in hopes of being able to determine the perception of developers regarding cross-platform approaches, popular development frameworks and the trade-offs that they had to make when adopting the said approach in their projects.

According to Xanthopoulos and Xinogalos (2013), native applications were found to be much more difficult to be developed and maintained as it requires developers to be proficient in various programming languages and tools required in the platforms to be ported to. And because of that, it has failed to promote code reusability as source codes have to be maintained across several code bases. These findings also coincided with the research conducted by Biørn-Hansen et al. (2019), whereby it was said that code reusability has managed to capture the interest of both academia and industrial practitioners as the arduous effort required to develop and maintain source codes in traditional native development approaches can be mitigated by adopting cross-platform mobile development frameworks.

While it can be said that cross-platform development approaches has its own set of advantages, it also has its own fair share of drawbacks. Past research have managed to identify that native applications consumed significantly lower memory compared to cross-platform mobile applications. In addition, its CPU usage was also twice as low compared to applications that were developed using cross-platform frameworks (Huber and Demetz, 2019;

Willocx, Vossaert, and Naessens, 2016). Some may consider that performance issues are irrelevant to be taken into consideration, this is true if only high ended devices were taken into consideration. However, as interactions with the User Interface is an essential part of using mobile applications, performance metrics should not be ignored (Huber and Demetz, 2019). This isn't a new issue as performance loss was found to be one of the more frequently reported problems in cross-platform applications. While it is to be expected that a small amount of performance is required to be sacrificed when transitioning from native to cross-platform applications, it does not mean that it renders the application to be completely unacceptable performance wise (Biørn-Hansen et al., 2019). The fact is that developers and industry practitioners are well-aware of the trade-offs that has to be made in order to enjoy the benefits that cross-platform approaches provide.

As cross-platform application development does not specifically focus on a particular product, tool or approach, there are a multitude of technical frameworks, tools and overarching conceptual developmental methodologies to be selected from. Each of the cross-platform developmental framework can be grouped according to its own set of parameters (Biørn-Hansen et al., 2019). Recent studies have shown that there is not one best framework to be used from developing applications across multiple platforms through a single code base. As each framework follows its own set of paradigms, which framework to be used is ultimately dependent on the developer's preference as the developmental effort outweighs majority of the external factors (Majchrzak, Biørn-Hansen and Grønli, 2017). The developer's expertise and fluency in using the framework is essential in tackling key factors of a successful cross-platform application, which are user experience, technical implementation, performance and testability.

In conclusion, the software industry is constantly transitioning rapidly from one set of requirements to the other. With a multitude of smartphone operating system emerging from the society, cross-platform development approaches are becoming increasing popular in businesses to simplify the maintenance and distribution procedures, reduces development time and effort. While it is clear that cross-platform application incurs additional overhead compared to its native counterparts in terms of performances, its benefits still

outweigh its drawbacks, making the trade-off worthwhile to be taken. In addition, since most of the cross-platform technical frameworks are relatively open-sourced, it is important for both hobbyist and industrial practitioners to be aware of the changes being made towards it as an actively maintained framework by the community causes new features and bug fixes to be provided on a regular basis.

2.5 Summary

All in all, this chapter can be concluded after a literature review was carried out on 3 different areas which would benefit the development of the current project.

Firstly, 5 individual applications with similar features and functionalities within the property domain were analysed, which were EdgeProp, PropertyGuru, trovit, Ohmyhome and StarProperty respectively. This research and review process is important as it helps in defining the requirements of this project as the general and essential features that a property listing application should have was extracted. In addition, loopholes of the 5 existing applications can be identified as an opportunity for this project to implement features to improve them. Information regarding both the functional and non-functional requirements defined can be found in Chapter 4 below.

Next, a comparison of 4 different system development methodologies in order to determine the best approach to be adopted for this project was performed. In the end, the prototyping methodology was adopted, specifically the Evolutionary Prototyping. This is because the selected software development methodology is capable of allowing requirements to be flexibly changed, focuses on end users, has low susceptibility to unforeseen circumstances and risks as well as being applicable for smaller teams. Although Evolutionary Prototyping somewhat requires clear initial requirements at the specification level, this can be fulfilled during the process of analysing the similar features and functionalities of the 5 selected applications. The need for end user feedback to be constantly provided can also be satisfied as meetings were conducted regularly between me, as a developer and my supervisor. With the abovementioned characteristics,

Evolutionary Prototyping can be considered as the best and preferred software development methodology for this project.

Lastly, the pros and cons of both native and cross-platform applications were determined with the project being developed using React Native as the preferred cross-platform programming language for this project. Despite native applications having the upper hand in terms of lower CPU and memory consumption, its benefits still failed to outweigh the advantages of cross-platform applications. Modern devices have little to no problems in running applications with a slightly higher CPU and memory usage. In addition, cross-platform applications promote code reusability by only requiring developers to maintain a single code base across multiple platforms that the application plans to be ported to. The availability of a multitude of technical frameworks, tools and overarching conceptual developmental methodologies that are open-sourced and actively maintained by a community are also amongst the benefits of selecting a cross-platform application development framework.

CHAPTER 3

METHODOLOGY AND WORK PLAN

3.1 Introduction

This chapter focuses on discussing the chosen software development methodology, the research strategies used to obtain the user requirements necessary for the scope of this project along with the development tools which are used to develop the solution. Sub-chapter 3.2 emphasizes the details of each phase within the selected software development methodology, which is the evolutionary prototyping methodology. While sub-chapter 3.3 focuses on the discussion about the adopted research techniques used to obtain the user requirements for the property listing application. Continuing on with sub-chapter 3.4, which aims to highlight the tools used throughout the entire software development lifecycle. Lastly, this chapter is concluded with the Work Breakdown Structure (WBS) and the Gantt chart to illustrate the overall project plan.

3.2 Chosen Software Development Methodology

After reviewing 4 different types of software development methodologies in the previous chapter, namely sub-chapter 2.3, evolutionary prototyping methodology was selected as the preferred approach to be used in this project after considering its own set of pros and cons.

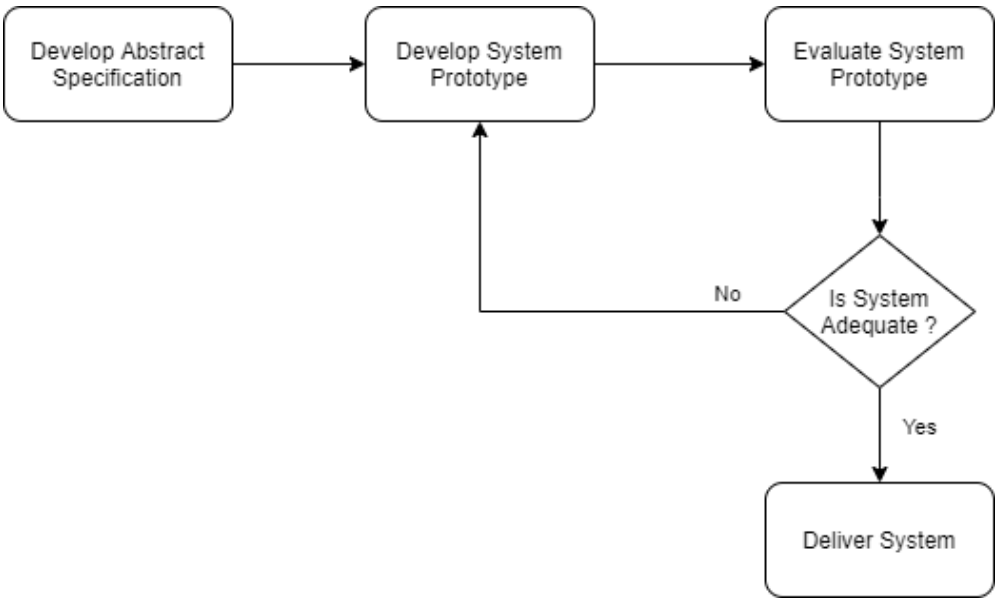

Figure 3.1: Phases of Evolutionary Prototyping (Shao, P. and Dida, M., 2020)

However, a quick search online reveals that the phases involved in the evolutionary prototyping approach differs from one researcher to another. More specifically, each researcher and website online tend to have a different diagram being used to describe the said approach. Upon closer analysis, it was found that although the diagrams differ from one another, the process involved throughout the entire methodology is still relatively similar to each other. Figure 3.1 above indicates the overall flow of the evolutionary prototyping, with the details of each phase to be defined in the following sections of the report.

3.2.1 Develop Abstract Specification

Developing the abstract specification can also be considered as the process of performing requirements elicitation and analysis, which attempts to define what a system should and should not do. During this phase, the requirements are gathered through a quantitative approach which focuses on accomplishing the project's objectives. In this project, literature review on the currently available applications that are related to the real estate industry will be analysed to extract the key and necessary features that will be integrated into the application. Aside from the general features, additional functionalities that could further improve the existing applications will be proposed.

Secondly, surveys will be conducted by distributing questionnaires virtually to obtain the perceptions of stakeholders in the real estate industry regarding the development of a property listing mobile application. The scope of the questions being asked and analysed will revolve the features and functionalities of the property listing application to-be-developed. Past academic research will also be analysed to determine how their questionnaires are structured to avoid missing out on questions that are vital to the requirements elicitation of the project. Surveys might be able to provide additional insight from the respondents that are useful to revise the initial requirements. The detailed information on how each requirement gathering techniques is performed will be highlighted in sub-chapter 3.2 below.

By doing so, the functional and non-functional requirements of the project can be identified and will be documented as system specifications and use cases in Chapter 4.

3.2.2 Develop System Prototype

This phase mainly focuses software building activities that develops the system's prototype through iterative designing, building, testing and refining after obtaining feedbacks from end users upon evaluation. Generally, this entire phase is feature-driven in a sense that changes will be made continuously and revisited until a final prototype is approved by the end users, which in this case is the project's supervisor. The developing of the system prototype can be further broken down into 2 distinct phases, one of which requires codes to be written while the other does not.

The design of the system should reflect the requirements that were collected during the previous phases, which in this case is the development of the abstract specification. The initial prototype will be designed using Axure RP. This is because Axure RP offers a set of drag and drop placement tools, resizing and a variety of widgets that allow both low-fidelity and high-fidelity prototype to be designed rapidly without requiring any code to be written. Furthermore, the user interface can also be redesigned and restructured easily to enable developers to experiment more on which layout offers a better user experience. A storyboard is then drawn to illustrate the links and flows between each screen in order to provide a clear overview on the overall system.

Once the low-fidelity prototype is approved by the supervisor of this project, the second and subsequent iterations can be conducted, which is developing the application using React Native.

During the second and subsequent development iterations, the prototype design from the previous iteration will be transformed into programming codes and logics. Similar process and workflow will also take place during this stage in which the emulated application will be presented to the supervisor of this project to allow them to evaluate the prototype. Upon the completion of each evaluation process, feedbacks can be provided which is then transformed into additional project's requirements. The process of making enhancements and adding new features will be performed iteratively until a satisfactory end product is accepted by the supervisor.

3.2.3 Evaluate System Prototype

As mentioned briefly in the previous section, the evaluation of the system prototype is done by the supervisor of this project. This process can be performed as many times as necessary until a satisfactory end product is produced and approved by the supervisor. Throughout the entire iteration, question can be asked regarding how easy the prototype was to use, ways to improve the current prototype, areas where the end user likes and dislikes as well as the suitability to be applied within the targeted domain.

After each round of evaluation has been completed, the current prototype would not be discarded as evolutionary prototyping emphasizes that the prototype is to be developed incrementally by adding new features on top of the existing ones in which will be carried over until the deployed step of the project.

3.2.4 Deliver System

Evolutionary prototyping concludes when the end user accepts a prototype and the final end product will be delivered. Generally, this final product will be an enhanced version that consists of previously integrated features and functionalities that meets the end user's expectations. Before deploying the system, a user acceptance testing will be performed to ensure that all the

existing test case passes without any issues and provides the developers with confidence in the developed system.

Once that has been performed, the project will be properly documented to allow future maintenance and enhancement work to be accomplished with minimal effort. This form of documentation will be presented together with the final report of this project, which aims to highlight all the important and necessary details of the newly developed system.

3.3 Research Methods

Two research methods were adopted in order to gather the necessary requirements to proceed with the development of this project, which are questionnaires and analysing similar applications within the property domain respectively.

Distribution of questionnaires through online surveys was conducted to obtain informative statistical knowledge, feedback and potential solutions from the respondents. This quantitative approach is widely adopted across multiple types of research as it is not only effective and efficient, but cheap as well. An in-depth step by step process of determining the sample size and the tasks performed throughout the entire process of gathering requirements through this approach will be elaborated within this section.

As Evolutionary Prototyping was selected as the preferred software development methodology for this project, requirements gathering is essential as it is important to have an initial general knowledge regarding the system to be developed prior to the start of the project, despite offering the flexibility to enable requirements to be iteratively refined. Thus, a literature review was performed involving five applications from a similar domain as the system to be developed.

3.3.1 Questionnaires

Surveys through online questionnaires were used to gather user requirements for this project. Due to the restriction of the pandemic enforcing strict protocols, distributing physical copies of questionnaires face to face is not an ideal approach. Therefore, respondents were obtained by distributing questionnaires through Google Forms.

Recent studies have proven that internet-based survey methods offer numerous benefits to the researchers who are hosting it. Some of the key advantages that it provides is that it allows researcher to reach out to a wider and more diverse set of respondents (Dewaele, 2018), cheap and efficient (McLeod, 2018) as well as enabling more timely and reliable data to be collected (Rice, 2017).

Now the next question is, how large should the sample size of respondents be ? One of the focal aspects in planning a survey is the calculation of its sample size as it is not feasible for one to study the entire population as a whole. Selecting a sample size that is too small may cause the findings obtained to contain a certain level of biasness, causing the results to be unable to be generalized to the entire target population. However, selecting one that is too large is also unethical as it tends to waste a lot of precious resources and puts them at risk of intervention (Kadam and Bhalerao, 2010). To mitigate these risks, a sampling methodology has to be adopted as it enables an adequate sample size to be calculated at an optimum level to deliver results that are ethical and valid.

The sample size calculation was done by applying Yamane sampling methodology on an 85% confidence level, which was calculated using the following formula:

$$n = \frac{N}{1 + N(e)^2}$$

where

n = sample size

N = total population

e = confidence level

The current population in Malaysia as of 2021 is estimated at 32.7 million (Department of Statistics Malaysia, 2021), which will be used to substitute the value of *N*. For this project, a confidence level of 85% was selected which means that 85 out of 100 samples will have true population value which fall within the confidence interval. Due to time constraints and

the large amount of time required for implementing the said features and functionalities, a lower confidence level was selected to ease the data analysis process. Therefore, by doing so the data will be representative at the same time. The result of the calculation for the sample size is as follows:

$$n = \frac{N}{1 + N(e)^2}$$

$$n = \frac{32700000}{1 + 32700000(1 - 0.85)^2}$$

$$n = 44.44438404$$

However, the sample size of respondents selected to answer the questionnaires prepared is limited to 40 respondents as compared to the 44.44438404 obtained as a result of the calculation above. The structure of the questions within the questionnaires comprises of closed ended questions that adopts a combination of both single choice questions and multiple-choice questions. In order to ease the process of data analysis once all the respondents have provided their feedback, a Likert scale approach is also incorporated into some of the questions to facilitate it.

3.3.2 Literature Review

Essential and generic features of an application can be obtained by analysing the currently available applications within the market today. By doing so, it enables developers to have an initial understanding on what the overall project is like. Furthermore, features that are present in majority of the applications out there today means that the particular feature is essential to that application and the chance of it being left out during the development process can be mitigated by performing proper literature review.

Often times when conducting literature reviews, developers are able to pinpoint certain loopholes within the currently available applications that could be improved by incorporating additional features. These enhancements can then be proposed and experimented before incorporating them into their respective projects.

Moreover, by understanding each feature and functionalities that is contained within the applications similar to the one being developed, developers are able to stay up to date with the latest aspects of the industry so that they application to be developed would not falter behind in terms of features and functionalities.

As discussed in Chapter 2 above, 5 similar applications within the real estate industry were selected to perform literature review on. These applications include EdgeProp, PropertyGuru, trovit, Ohmyhome and StarProperty. The features of each of these applications are analysed and extracted into a matrix which aims to compare various features within the chosen mobile applications. The outcome of the literature review process will be converted into functional and non-functional requirements, which will be further discussed in Chapter 4.

3.4 Development Tools

Throughout the entire software development process, various tools are required to be used to facilitate the entire workflow. Thus, this sub-chapter provides a brief explanation for each of the tools used.

3.4.1 Git, GitHub and Git Bash

Git is a free and open-sourced distributed version control system that is used to facilitate the tracking of changes throughout the entire project folder. As the evolutionary prototyping methodology that has been adopted for this project is susceptible to constant changes, a proper version control handling must be carried out to mitigate the risk of breaking the entire application due to a faulty change. Should a defect were to occur, developers could roll back the changes to a previous commit that is working in a previous version.

Source codes can be committed to GitHub through the Git Bash command window. By committing changes to GitHub’s repositories, developers will be able to retrieve their updated project files in case of a hard drive failure were to occur without any issue.

3.4.2 Visual Studio Code

Microsoft's Visual Studio Code, or VS Code for short is the preferred integrated development environment (IDE) throughout the development life cycle of this project. The main reason that this IDE was selected is because it offers an integrated source code management (SCM) that supports Git, which enables code changes to be tracked as compared to its previous commit almost immediately as shown in Figure 3.2 below.

Moreover, Visual Studio Code also offers a wide variety of extensions that can be installed according to the developer's preferences. One example that can be seen is by installing the Prettier code formatter, this allows indentation and formatting of the source codes to be done automatically by the IDE itself without needing the developers to do it manually. This enforces a consistent styling that enables the project to be properly documented in a more readable format.

In addition, other features that enables developers to benefit from choosing Visual Studio Code as the IDE is its IntelliSense code completion, rich semantic code understanding and navigation as well as code refactoring (Visual Studio Code, n.d.).

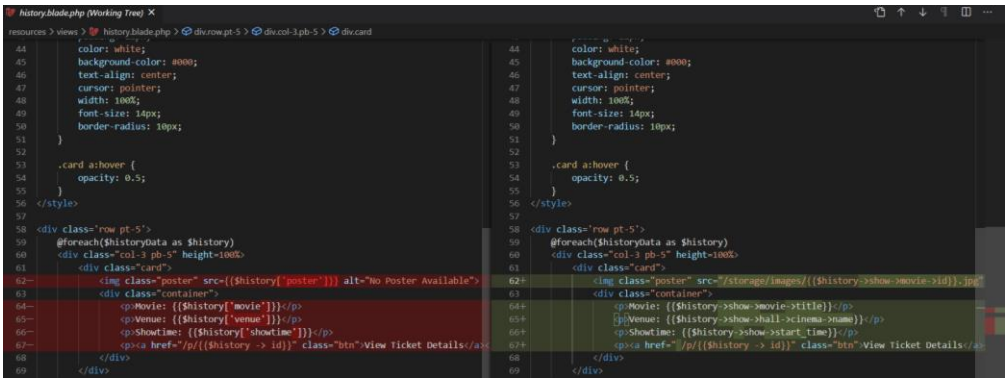

Figure 3.2: Visual Studio Code Source Control

3.4.3 Axure RP

As mentioned briefly in the previous section, Axure RP is a simple yet powerful prototyping tool that offers a set of drag and drop placement tools, resizing and a variety of widgets that allow both low-fidelity and high-fidelity prototype to be designed rapidly without requiring any code to be written. Axure RP also offers a temporary license for university students to utilize the

software, which is perfect in minimizing the costs required to design and develop the application as part of this project.

Furthermore, the user interface can also be redesigned and restructured easily to enable developers to experiment more on which layout offers a better user experience. Once the individual screens of the prototype is crafted, a storyboard will then be drawn to illustrate the links and flows between each screen in order to provide a clear overview on the overall system. Once the low-fidelity prototype is approved by the supervisor of this project, the second iteration can be conducted, which is developing the application using React Native.

3.4.4 Android Studio

Despite already having selected VS Code as the preferred IDE to be used throughout the implementation phase of this project, Android Studio, which is also an IDE will be used alongside VS Code. However, the main purpose of selecting Android Studio as part of the development tools is because it offers an Android Virtual Device to emulate the environment of a real mobile device within the computer.

By using the emulator to simulate Android devices on a local computer, the applications under development can be tested without requiring the need to own a physical device. This will speed up the development process as developers will be able to detect any potential issues while the application is actively running in the emulator and implement the fixes accordingly.

3.4.5 React Native Framework

As mentioned in Chapter 2.4, which discussed the comparison between native and cross-platform applications, React Native framework was selected to be the main approach for developing the property listing application.

React Native is an open-sourced framework that offers a swift and smooth way of developing mobile applications with responsive user interfaces along with a decrease in the time taken to boot the application. Not only that, but it also offers various components, dependencies and application programming interfaces (API) that is developed and actively maintained by its community. In addition, React Native also enables the incorporation of third-

party plug-ins and APIs that could be integrated easily and enable developers to utilize them. Since the property listing application emphasizes the need to display available properties on a Google Map interface instead of the traditional list view, an API associated with maps can be installed and imported with ease.

While it can be said that the React Native framework has its drawbacks and other options such as the Ionic framework or Flutter might be a better option, the main deciding factor is that it all comes down to the developer's preference, as each framework has their own set of advantages and disadvantages. Due to the past experience and expertise in the developers involved in this project has with React Native, this framework is selected as it does not require the learning of another language for the purpose of developing this property listing application.

3.4.6 Google's Firebase

Google's Firebase was selected to be the back-end database for this project, specifically Firebase Cloud Firestore and Firebase Storage. The main reason that Firebase was chosen is because it contains its own set of APIs that functions well with React Native. In addition, the communication channels between the front-end and the back-end of the application can be made just with a simple line of code to utilize the APIs.

As the property listing application contains an integrated chat feature, developers that chose Firebase would benefit their development process as it contains an API that enables the integration of online chat functionality with minimal complexity.

With just a little bit of configuration, which was also properly documented with clear feedback and next steps, developers are able to handle all of the application's backend requirements. This includes user authentication, storing data, real-time event listeners and configuring access rules.

3.5 Project Plan

To prevent developers from missing the deadlines of the key deliverables for this project, a Work Breakdown Structure (WBS) and a Gantt chart was constructed to keep track and monitor the progress of the project to ensure that it is well within its schedule.

3.5.1 Work Breakdown Structure (WBS)

The WBS for this project is attached as part of Appendix A.

3.5.2 Gantt Chart

The Gantt chart for this project is attached as part of Appendix B.

CHAPTER 4

PROJECT INITIAL SPECIFICATION

4.1 Introduction

Throughout this entire chapter, the approaches carried out to obtain the requirements for the property listing application will be discussed. Upon analysing the results obtained from the requirements discovery process, both the functional and non-functional requirements of the project will be documented.

Appropriate Unified Modelling Language (UML) techniques will also be performed to enable the requirements as well as the flow of the entire application to be visualized better. This includes the Use Case Diagram, Use Case Descriptions and the User Interface Design of the proposed prototype.

4.2 Requirements Discovery

This sub-chapter focuses on describing the techniques used to gather requirements throughout the project.

4.2.1 Questionnaires

For this project, surveys conducted through online questionnaires was the approach taken to obtain requirements from the application's potential users. Google Forms was the platform selected to prepare the set of questionnaires before distributing it to the targeted respondents, with a sample size of 40.

The main goal of this survey is to identify the targeted respondent's perspectives regarding the implementation of a mobile application within the real estate industry. Generally, questions regarding features that they like or dislike, potential improvements that they would like to see as well as the limitations of the existing applications that are currently available in the market were asked.

The survey questionnaires and the results obtained are attached as part of Appendix C and D respectively. Using the information obtained from the survey results, a relative importance index can be adopted to determine the overall ranking for the benefits and features of the property listing application. The formula of the Relative Important Index is as follows:

$$RII = \frac{\Sigma W}{(A * N)}$$

where

W = weight given to each factor by the respondents from 1, 2, 3, 4 and 5 for very low, low, moderate, high and very high respectively

A = highest weight (i.e., which is 5 in this case)

N = total number of respondents

The results for each question were computed using Microsoft Excel and tabulated as follows:

Table 4.1: Key Functionalities Of The Property Listing Application Ranking

Functionality	**No. Of Respondents**	**W**	**RII**	**Rank**
Display information about the listed properties	37	0.137037	0.025	1
Allows reservation of property listings	25	0.092593	0.016892	9
Enables transactions to be made within the application (eg: make down payments through the application)	30	0.111111	0.02027	5
Allows appointments to be set between tenants and real estate agents/property developers	32	0.118519	0.021622	3
Find real estate agents within the application to help facilitate the property's buying/selling process	33	0.122222	0.022297	2
Virtual tours for property listings	31	0.114815	0.020946	4

Able to provide real-time notification updates	26	0.096296	0.017568	7
In-app communication between tenants and real estate agents/property developers	29	0.107407	0.019595	6
Mortgage Calculator	26	0.096296	0.017568	7
Feedback on property defect and services	1	0.003704	0.000676	10

Table 4.2: Reasons Respondents Enjoy Using Mobile Applications Ranking

Functionality	**No. Of Respondents**	**W**	**RII**	**Rank**
Design of the application's interface looks nice.	32	0.14953271	0.022222222	4
Able to accomplish certain tasks that you require efficiently.	33	0.154205607	0.022916667	3
Provides sufficient level of security / data protection.	34	0.158878505	0.023611111	2
Easy to use and navigate through the application.	36	0.168224299	0.025	1
Constantly offers fresh and new updates to its users.	26	0.121495327	0.018055556	6
Receiving good discounts and offers.	28	0.130841121	0.019444444	5
Has a large variety of features to explore.	25	0.11682243	0.017361111	7

Table 4.3: Reasons Respondents Dislike Using Mobile Applications Ranking

Functionality	No. Of Respondents	W	RII	Rank
Overly complicated user interface designs.	34	0.162679426	0.025	1
Learning process is tedious and time consuming.	31	0.148325359	0.022794118	4
Time taken to accomplish the desired task is too long.	32	0.153110048	0.023529412	2
Features of the application are too complicated to understand.	32	0.153110048	0.023529412	2
Limited amount of functionalities provided.	24	0.114832536	0.017647059	7
Boring / dull user interface designs.	27	0.129186603	0.019852941	6
Requires large memory space in mobile devices.	29	0.138755981	0.021323529	5

4.2.2 Comparison With Existing Applications

In addition to obtaining requirements through surveys, existing applications within the market that are related to the real estate industry are studied. Essential features that a property listing application should have been identified along with potential enhancements to the system is proposed.

Detailed information regarding the analysis can be retrieved in sub-chapter 2.2, which provides detailed features of each of the selected applications.

4.3 Requirements Specification

This sub-chapter focuses on discussing both the functional and non-functional requirements of the property listing application.

4.3.1 Functional Requirements

Tenants:

1. The system shall allow tenants to register for a new account.
2. The system shall allow tenants to login to their existing accounts.
3. The system shall allow tenants to view all the listed properties.
4. The system shall allow tenants to view the detailed description of a selected property.
5. The system shall allow tenants to search for a specific property.

a. The system shall allow tenants to search through text.

b. The system shall allow tenants to search using the integrated Google Map.

6. The system shall allow tenants to favourite a property listing.
7. The system shall allow tenants to communicate with real estate agents and property developers using an integrated chat feature.
8. The system shall allow tenants to schedule an appointment with real estate agent and property developers.
9. The system shall allow tenants to search for a real estate agent to help facilitate with their respective tasks.
10. The system shall allow tenants to upload and submit documents virtually through the application.

Real Estate Agents:

1. The system shall allow real estate agents to login using their authorized account.
2. The system shall allow real estate agents to list a property up for sale or rent respectively.
3. The system shall allow real estate agents to review the documents uploaded by their respective tenants.
4. The system shall allow real estate agents to communicate with tenants using an integrated chat feature.

5. The system shall allow real estate agents to manage the scheduling of their respective appointments.

Administrators:

1. The system shall allow administrators to login using their authorized account.
2. The system shall allow administrators to view a list of all the available real estate agents.
3. The system shall allow administrators to add new real estate agents.

4.3.2 Non-Functional Requirements

1. Availability
    a. The system shall be available for 97% of the time per day with only a minimal downtime of 5 minutes.
2. Adaptability
    a. The system shall be designed in such a way that it is easily modifiable should enhancements be required in the future.
3. Performance
    a. The system shall be able to display all the necessary information required on a screen within 15 seconds.
    b. The system shall be able to notify users through their preferred communication method within 15 seconds of the occurrence of a particular event.
4. Reliability
    a. The system shall be able to reconnect to the server within 15 seconds should the internet connection be dropped during the time of browsing through the application.
5. Security
    a. The system shall not display sensitive login credentials at any point of time throughout the usage of the application.
    b. The system shall log each unsuccessful login attempt to prevent any attempts of a malicious event from occurring.

6. Usability
    a. The system shall be designed with a consistent and user-friendly interface to enhance the user's experience of utilizing the application.
    b. The system shall be able to display useful and relevant error messages.
    c. The system shall be designed with a high navigability to allow tasks to be accomplished with minimal effort.

4.4 Modelling

In order to allow the functional requirements in sub-chapter 4.2.1 to be able to be visualized and understood more clearly, proper Unified Modelling Language (UML) techniques will be documented within this sub-chapter.

4.4.1 Use Case Diagram

The Use Case Diagram for this project is attached as shown below.

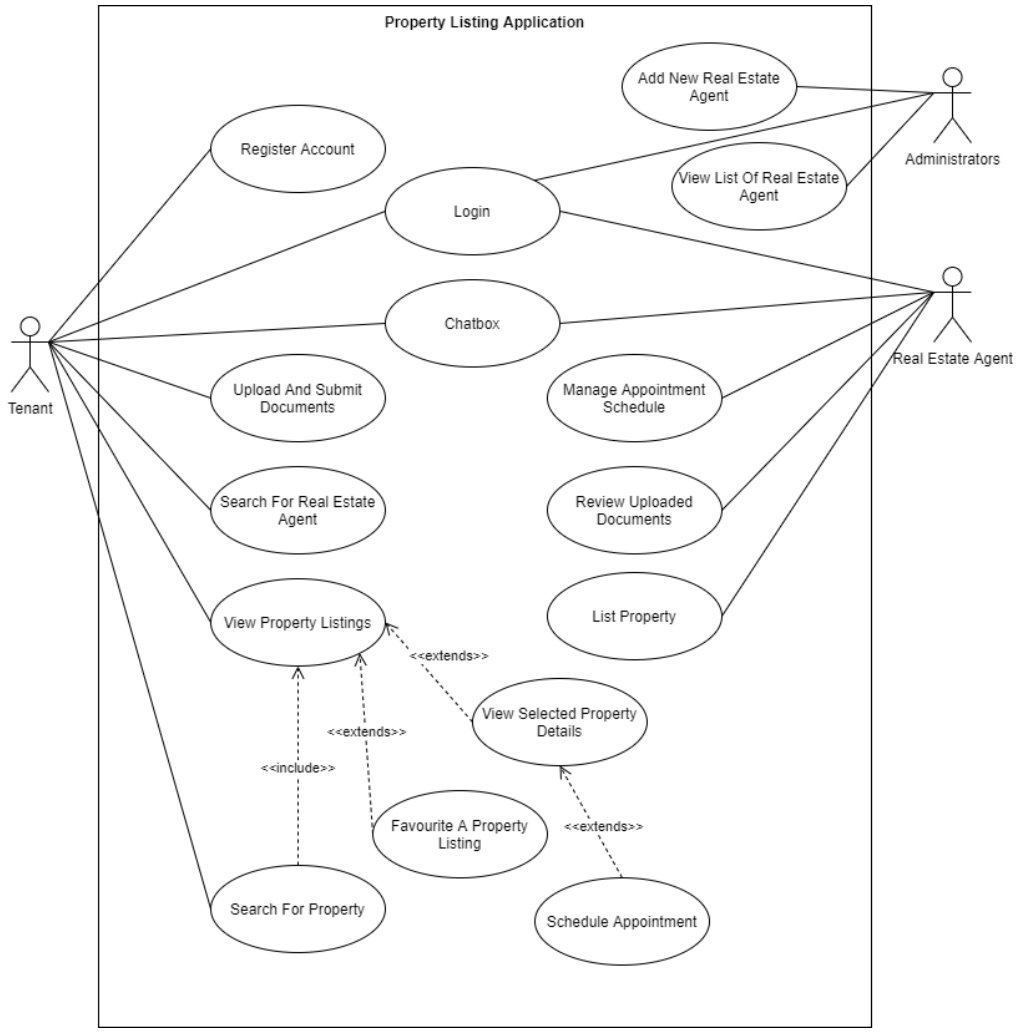

Figure 4.1: Use Case Diagram

4.4.2 Use Case Description

This section of the report focuses on emphasizing a detailed description regarding each use case that was highlighted in the Use Case Diagram under Figure 4.1.

4.4.2.1 Login

<table>
<tr><td>Use Case Name: Login</td><td>ID:1</td><td>Importance Level: High</td></tr>
<tr><td>Primary Actor: Tenants</td><td colspan="2">Use Case Type: Detail, Essential</td></tr>
<tr><td colspan="3">Stakeholders and Interests:
Tenants and Real Estate Agents – Login into the system to use the full features of the application.
Administrators – Login into the system to add new real estate agents into the application.</td></tr>
<tr><td colspan="3">Brief Description:
This use case allows users with an existing account to login using their own credentials into the application.</td></tr>
<tr><td colspan="3">Trigger:
Tenants, real estate agents or administrator wish to login into the application.</td></tr>
<tr><td colspan="3">Relationships:
Association: Tenants, Real Estate Agents and Administrators
Include: -
Extend: -
Generalization: -</td></tr>
<tr><td colspan="3">Normal Flow of Events:
1. The application will display an interface to the user and requests them to fill in their login credentials.
2. User clicks on the “Login” button.
3. System will validate the user’s inputs and redirect them to the application’s home screen.</td></tr>
<tr><td colspan="3">SubFlows:</td></tr>
</table>

Alternate/Exceptional Flows: 3.1.1 Invalid E-Mail Address 3.1.1.1 User inputs an invalid e-mail address and clicks on the “Login” button. 3.1.1.2 System displays the appropriate error messages. 3.1.2 Empty Username And/Or Password Field 3.1.2.1 User clicks on the “Login” button with either one or both of the fields being left empty. 3.1.2.2 System displays the appropriate error messages. 3.1.3 Invalid Password 3.1.3.1 User inputs a password with less than 6 characters and clicks on the “Login” button. 3.1.3.2 System displays the appropriate error messages.

4.4.2.2 Register Account

Use Case Name: Register Account	ID: 2	Importance Level: High
Primary Actor: Tenants	Use Case Type: Detail, Essential	
Stakeholders and Interests: Tenants – Registers a new account on the application.		
Brief Description: This use case allows users to create a new account to gain access to the full features of the application.		
Trigger: User clicks on the “Sign Up” button within the application.		
Relationships: Association: Tenants Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. User clicks on the “Sign Up” button within the application.		

2. System prompts the user to enter the required information needed to register. 3. User fills in the required information within the input fields provided accordingly. 4. User clicks on the “Register” button. 5. System will validate the user’s inputs and redirect them to the application’s home screen upon successful registration.
SubFlows: -
Alternate/Exceptional Flows: 4.1.1 Invalid E-Mail Address 4.1.1.1 User inputs an invalid e-mail address and clicks on the “Login” button. 4.1.1.2 System displays the appropriate error message. 4.1.2 Empty Required Input Fields 4.1.2.1 User clicks on the “Register” button with at least one of the required input fields left empty. 4.1.2.2 System displays the appropriate error message. 4.1.3 Violation Of Unique Information 4.1.3.1 User clicks on the “Sign Up” button with an existing e-mail address. 4.1.3.2 System displays the appropriate error messages. 4.1.4 Invalid Password 4.1.4.1 User inputs a password with less than 6 characters and clicks on the “Login” button. 4.1.4.2 System displays the appropriate error messages.

4.4.2.3 Chatbox

Use Case Name: Chatbox	ID: 3	Importance Level: High
Primary Actor: Tenants	Use Case Type: Detail, Essential	
Stakeholders and Interests: Tenants – Wants to communicate with the real estate agents to enquire about a particular listing. Real Estate Agents – Wants to communicate with tenants about a particular listing.		
Brief Description: This use case describes how tenants and real estate agents communicate within the application.		
Trigger: Tenants click on the "Contact Now" button featured on a particular property listing.		
Relationships: Association: Tenants and Real Estate Agents Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. Tenants click on the "Contact Now" button featured on a particular property listing. 2. Tenants type in the information that they would like to enquire to the real estate agents. 3. Tenants click on the "Send" button to forward the message. 4. Real estate agents would receive the message on their end and responds to the tenants following the same series of steps.		
SubFlows: -		
Alternate/Exceptional Flows:		

4.4.2.4 Upload And Submit Documents

<table>
<tr><td>Use Case Name: Upload And Submit Documents</td><td>ID: 4</td><td>Importance Level: Moderate</td></tr>
<tr><td>Primary Actor: Tenants</td><td colspan="2">Use Case Type: Detail, Essential</td></tr>
<tr><td colspan="3">Stakeholders and Interests:
Tenants – Wants to upload or submit a particular document to their respective real estate agents.</td></tr>
<tr><td colspan="3">Brief Description:
This use case describes how tenants are able to upload and submit a particular document through the application.</td></tr>
<tr><td colspan="3">Trigger:
Tenants click on the “Document” icon featured in a chat.</td></tr>
<tr><td colspan="3">Relationships:
Association: Tenants
Include: -
Extend: -
Generalization: -</td></tr>
<tr><td colspan="3">Normal Flow of Events:
1. Tenants navigate to the chatroom of the real estate agent in which they would like to submit the documents to.
2. Tenants click on the “Document” icon.
3. System offers tenants a choice of uploading a document through their mobile phone’s photo gallery.
4. System displays all the photos stored within the user’s image gallery.
5. Tenants select the images of the documents that they would like to upload.
6. Tenants click on the “Confirm” button.</td></tr>
<tr><td colspan="3">SubFlows:</td></tr>
<tr><td colspan="3">Alternate/Exceptional Flows:</td></tr>
</table>

4.4.2.5 Schedule Appointment

Use Case Name: Schedule Appointment	ID: 5	Importance Level: Moderate
Primary Actor: Tenants	Use Case Type: Detail, Essential	
Stakeholders and Interests: Tenants – Wants to schedule an appointment with the real estate agent of the selected property listing.		
Brief Description: This use case describes how tenants can schedule an appointment for their selected property listing.		
Trigger: Tenants click on a "Schedule Appointment" button after selecting a particular property listing that they are interested in and initiating a chat.		
Relationships: Association: - Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. Tenants will first navigate to the property listing that they are interested in. 2. Tenants click on the "Contact Now" button to initiate a chat with the real estate agent in charge. 3. Tenants click on a "Schedule Appointment" button within the property listing page. 4. System displays a form containing a date and time in which the tenants are required to specify the details of the appointment. 5. Tenants click on the "Submit" button to forward the appointment information to the real estate agents of that listing to review.		
SubFlows: -		
Alternate/Exceptional Flows:		

4.4.2.6 Search For Real Estate Agent

Use Case Name: Search For Real Estate Agent	ID: 6	Importance Level: Moderate
Primary Actor: Tenants	Use Case Type: Detail, Essential	
Stakeholders and Interests: Tenants – Wants to search for a real estate agent to obtain help from their areas of expertise.		
Brief Description: This use case describes how tenants search for real estate agents within the application.		
Trigger: Tenants click on the "Agent" button on the bottom navigation tab.		
Relationships: Association: Tenants Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. Tenants click on the "Agent" button on the bottom navigation tab. 2. System displays a list of real estate agents grouped according to their respective categories. 3. Tenants click on either one of the categories. 4. System displays a list of real estate agents that are available within the selected category. 5. Tenants click on the real estate agent which they prefer. 6. System provides the selected real estate agent's contact information to the tenants.		
SubFlows: -		
Alternate/Exceptional Flows:		

4.4.2.7 View Property Listings

Use Case Name: View Property Listings	ID: 7	Importance Level: High
Primary Actor: Tenants	Use Case Type: Detail, Essential	
Stakeholders and Interests: Tenants – Wants to view the property listing that are currently available on the application.		
Brief Description: This use case describes how tenants can view the property listings that are currently available on the application.		
Trigger: Tenants browse through the application or search for a particular location through the search bar.		
Relationships: Association: Tenants Include: - Extend: View Selected Property Details, Favourite A Property Listing and Filter Search Results Generalization: -		
Normal Flow of Events: 1. Tenants can view the property listings that are currently available 1.1 By browsing through the application by default 1.2 After searching for a location through the search bar 2. System displays the listings of all the available properties accordingly.		
SubFlows: 1.1 By browsing through the application by default 1.1.1 By default, the system will display a list of all the available property listing that were publish on the application. 1.2 After searching for a location address through the search bar 1.2.1 The system will display the search results in a format that follows the search options chosen.		
Alternate/Exceptional Flows:		

1.2(a) No Search Results Found 1. System displays a message indicating that the search result is not found.

4.4.2.8 Search For Property

Use Case Name: Search For Property	ID: 8	Importance Level: High
Primary Actor: Tenants	Use Case Type: Detail, Essential	
Stakeholders and Interests: Tenants – Wants to search for a property to buy or rent.		
Brief Description: This use case describes how tenants could search for a property to buy or rent through the application.		
Trigger: Tenants click on the search bar.		
Relationships: Association: Tenants Include: - Extend: View Selected Property Details, Favourite A Property Listing and Filter Search Results Generalization: -		
Normal Flow of Events: 1. Tenants click on the search bar located on the top of the application. 2. System offers the tenants two options to search, which is either through 2.1 Text 2.2 Google Maps 3. Tenants proceed to search for property following the procedures of their chosen search option.		
SubFlows: 2.1 Text 2.1.1 Tenants enter the location of the property listing that they wish to search within the search bar provided.		

2.1.2 Tenants click on the “Search” button. 2.1.3 System displays the search results in a list format accordingly. 2.2 Google Map 2.2.1 Tenants enter the location of the property listing that they wish to search within the search bar provided. 2.2.2 Tenants click on the “Search” button. 2.2.3 System displays the search results by mapping the property listing’s coordinates on a Google Map interface.
Alternate/Exceptional Flows: 2.1(a) No Search Results Found 1. System displays a message indicating that the search result is not found. 2.2(a) No Search Results Found 1. System displays no property listing markers in the Google Maps.

4.4.2.9 View Selected Property Details

Use Case Name: View Selected Property Details	ID: 9	Importance Level: High
Primary Actor: Tenants	Use Case Type: Detail, Essential	
Stakeholders and Interests: Tenants – Wants to view the detailed description of the property that they are interested in.		
Brief Description: This use case describes how tenants can view the detailed description of the property that they are interested in.		
Trigger: Tenants click on a particular property listing.		
Relationships: Association: - Include: - Extend: Schedule Appointments		

Generalization: -
Normal Flow of Events: 1. Tenants click on a particular property listing that they would like to view more information on. 2. System displays the details of the property listing that was selected.
SubFlows: -
Alternate/Exceptional Flows:

4.4.2.10 Favourite A Property Listing

Use Case Name: Favourite A Property Listing	ID: 10	Importance Level: Moderate
Primary Actor: Tenants	Use Case Type: Detail, Essential	
Stakeholders and Interests: Tenants – Wants to favourite a particular property listing.		
Brief Description: This use case describes how tenants can favourite a property listing that they are interested in.		
Trigger: Tenants click on the “Favourite” button of a particular property listing.		
Relationships: Association: - Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. Tenants navigate to the property listing in which they would like to favourite. 2. Tenants clicks on the “Favourite” button located on the top of the screen of the selected property listing. 3. System stores the property that was favourited into a list on the tenant’s profile.		

SubFlows: -
Alternate/Exceptional Flows:

4.4.2.11 List Property

Use Case Name: List Property	ID: 11	Importance Level: High
Primary Actor: Real Estate Agent	Use Case Type: Detail, Essential	
Stakeholders and Interests: Real Estate Agent – Wants to list their properties up for sale or rent.		
Brief Description: This use case describes how real estate agents can list their properties up for sale or rent in the application.		
Trigger: Real estate agents click on the "+" button within the application on their respective profiles.		
Relationships: Association: Real Estate Agent Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. Real estate agent clicks on the "+" button within the application on their respective profiles. 2. System displays a form with input fields that are required to be filled in by the real estate agents. 3. Real estate agent was asked to 3.1 Add Images 3.2 Fill In Required Input Fields 4. Real estate agent clicks on the "Confirm" button after filling in the necessary details. 5. System checks and validates all the input data. 6. System redirects the real estate agent back to the home page after successfully listing the new property.		

SubFlows: 3.1 Add Images 3.1.1 Real estate agent clicks on the “Upload” button. 3.1.2 System displays all the photos stored within the real estate agent phone’s image gallery. 3.1.3 Real estate agent selects the images that they would like to upload. 3.1.4 Real estate agent clicks on the “Confirm” button. 3.1.5 System uploads the selected images onto the application to be ready for it to be listed. 3.2 Fill In Required Input Fields 3.2.1 Real estate agent fills in all the required information within the respective input fields accordingly. 3.2.2 Real estate agent clicks on the “Confirm” button.
Alternate/Exceptional Flows: 5.1.1 Invalid Information 5.1.1.1 Real estate agent inputs an invalid information that is different from what is required. 5.1.1.2 System displays the appropriate error messages. 5.1.2 Empty Required Input Fields 5.1.2.1 Real estate agent clicks on the “Confirm” button with at least one of the required input fields left empty. 5.1.2.2 System displays the appropriate error messages.

4.4.2.12 Manage Appointment Schedule

Use Case Name: Manage Appointment Schedule	ID: 12	Importance Level: High
Primary Actor: Real Estate Agent	Use Case Type: Detail, Essential	
Stakeholders and Interests: Real Estate Agent – Wants to manage their appointment schedules.		
Brief Description: This use case describes how real estate agents can manage their appointment		

schedules according to their preference.
Trigger: Real estate agents click on the “View Appointments” button within their respective profiles.
Relationships: Association: Real Estate Agent Include: - Extend: - Generalization: -
Normal Flow of Events: 1. Real estate agents navigate to their respective profiles and clicks on the “View Appointments” button. 2. System prompts a set of actions in which the real estate agents can perform, which is either accepting or declining an appointment. 3. System updates the appointment’s status according to the real estate agent’s actions.
SubFlows:
Alternate/Exceptional Flows:

4.4.2.13 Review Uploaded Documents

Use Case Name: Review Uploaded Documents	ID: 13	Importance Level: High
Primary Actor: Real Estate Agent	Use Case Type: Detail, Essential	
Stakeholders and Interests: Real Estate Agent – Wants to review the documents submitted by their respective tenants.		
Brief Description: This use case describes how real estate agents are able to review the documents submitted by their respective tenants.		
Trigger: Real estate agents click on the “Chat List” button within their respective		

profiles.
Relationships: Association: Real Estate Agent Include: - Extend: - Generalization: -
Normal Flow of Events: 1. Real estate agent clicks on the “Chat List” button within their respective profiles. 2. System displays a list of chats from their respective tenants. 3. Real estate agent clicks on the chat room with the tenants of a specific property that they wish to review the documents of. 4. System displays the contents of the messages sent by the tenants within the chat interface. 5. Real estate agent clicks on the image of the document that they wish to review. 6. System displays the documents in a more clear and detailed manner.
SubFlows:
Alternate/Exceptional Flows:

4.4.2.14 View List Of Real Estate Agent

Use Case Name: View List Of Real Estate Agent	ID: 14	Importance Level: High
Primary Actor: Administrator	Use Case Type: Detail, Essential	
Stakeholders and Interests: Administrator – Wants to view the list of all the real estate agents that are currently registered within the application.		
Brief Description: This use case describes how administrators are able to view the list of all the real estate agents that are currently registered within the application.		

Trigger: Administrators login into the application by inputting the correct authentication credentials.
Relationships: Association: Administrators Include: - Extend: - Generalization: -
Normal Flow of Events: 1. Administrators fill in their login credentials on the login page of the application. 2. Administrators click on the “Login” button. 3. System verifies the e-mail and password that was inputted. 4. System redirects the administrators to the home page of the administrators.
SubFlows:
Alternate/Exceptional Flows: 3.1.1 Invalid E-Mail Address 3.1.1.1 User inputs an invalid e-mail address and clicks on the “Login” button. 3.1.1.2 System displays the appropriate error messages. 3.1.2 Empty Username And/Or Password Field 3.1.2.1 User clicks on the “Login” button with either one or both of the fields being left empty. 3.1.2.2 System displays the appropriate error messages. 3.1.3 Invalid Password 3.1.3.1 User inputs a password with less than 6 characters and clicks on the “Login” button. 3.1.3.2 System displays the appropriate error messages.

4.4.2.15 Add New Real Estate Agent

Use Case Name: Add New Real Estate Agent	ID: 15	Importance Level: High
Primary Actor: Administrators	Use Case Type: Detail, Essential	
Stakeholders and Interests: Administrators – Wants to add a new real estate agents to the application.		
Brief Description: This use case describes how administrators are able to add new real estate agents to the application.		
Trigger: Administrators click on the "Add Agent" button situated on the admin home page of the application.		
Relationships: Association: Administrators Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. Administrators click on the "Add Agent" button situated on the admin home page of the application. 2. System displays a form containing input fields in which the administrators are required to fill in. 3. Administrators fill in the form with all the required information. 4. Administrators click on the "Add Agent" button. 5. System verifies all the input fields that were inputted. 6. System redirects the administrators back to the admin home page whereby they are able to verify that the new real estate agent was indeed added.		
SubFlows:		
Alternate/Exceptional Flows: 5.1.1 Invalid E-Mail Address 5.1.1.1 Administrators input an invalid e-mail address and clicks on the		

"Add Agent" button.

5.1.1.2 System displays the appropriate error messages.

5.1.2 At Least One Input Field Left Empty

5.1.2.1 Administrators click on the "Add Agent" button with at least one of the input fields being left empty.

5.1.2.2 System displays the appropriate error messages.

5.1.3 Invalid Password

5.1.3.1 Administrators input a password with less than 6 characters and clicks on the "Add Agent" button.

5.1.3.2 System displays the appropriate error messages.

4.4.3 User Interface Design

This sub-chapter focuses on providing an overview of the overall flow that the property listing application adopts. In addition, detailed screen designs of the initial prototype are briefly highlighted along with its respective screenshots.

4.4.3.1 Overall Storyboard

The Overall Storyboard of the user interface design is attached as part of Appendix E.

4.4.3.2 Detailed Screen Design

An initial prototype interface design was completed for the first iteration of this project using Axure RP. In this section of the report, the respective screen designs will be highlighted along with their associated descriptions indicating the proposed features of the application.

4.4.3.2.1 Login

Figure 4.2: Login

Figure 4.2 above shows the proposed login page of the property listing application. Every user is required to be logged in before they are capable of proceeding to utilize the full features of the application. During the initial stages of designing the low fidelity prototype, users will be able to log in into the application by entering their username and password as their credentials.

4.4.3.2.2 Search Property Listing By Text

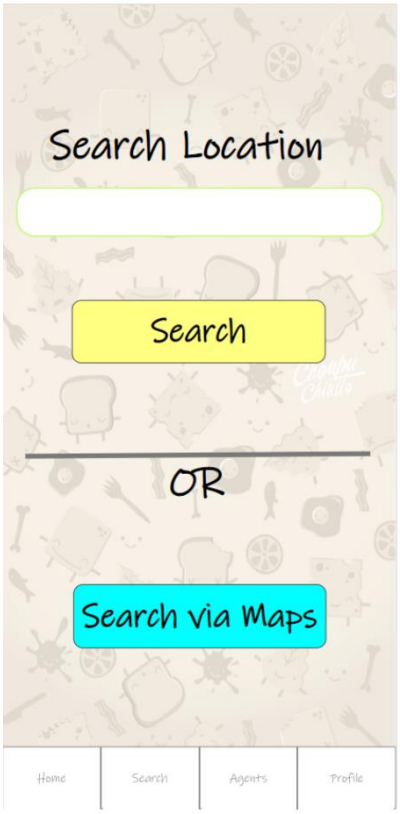

Figure 4.3: Search Property Listing By Text

Figure 4.3 shows how users are capable of searching for their preferred property listing within the application through text. This is one of the two ways that users are able to search for listings, which is by typing in details of a partial or complete address within the search bar provided.

4.4.3.2.3 Search Property Listing Through GoogleMaps

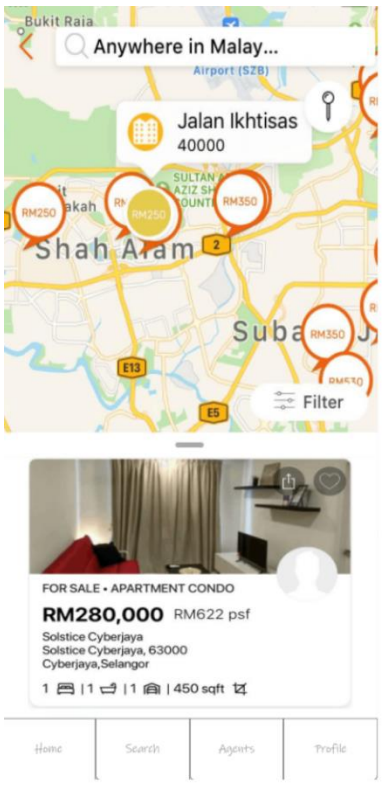

Figure 4.4: Search Property Listing Through GoogleMaps

Figure 4.4 shows the alternative method of searching for property listings, which is through a GoogleMaps interface through a search bar provided on the top of the screen. Upon keying in the necessary details of the desired location, markers and icons of property listings situated within a search radius will be displayed on screen.

Apart from that, a slider was also provided on the bottom of the screen to enable users to have a clearer visualization of the selected property listing. Clicking on the any one of the card views within the slider will redirect the users to a screen, whereby detailed descriptions of the selected property can be shown.

4.4.3.2.4 Display Property

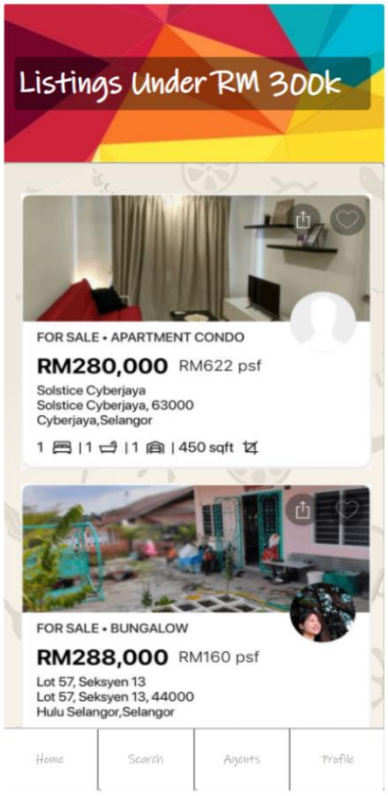

Figure 4.5: Display Property Listings As Search Result

Figure 4.5 above displays all the property listings that are available in accordance with the search address entered by the user. Within this page, users can freely navigate through the search results by scrolling vertically before clicking on their targeted listings.

4.4.3.2.5 Display Property Listing Details

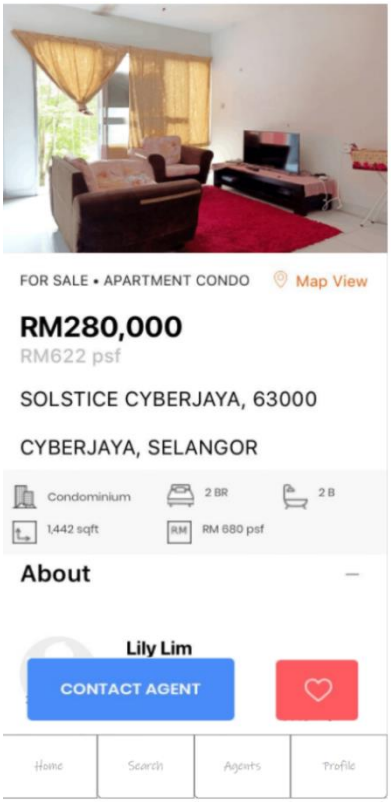

Figure 4.6: Display Property Listing Details

Figure 4.6 above shows an example of the detailed description of a selected property listing. Within this page, users will be able to discover details such as the property type, price, square feet, price per square feet, number of bedrooms and bathroom, the real estate agent in charge, its nearby amenities as well as a brief description regarding the selected property listing.

Moreover, other various features are also presented within this screen. This includes being able to favourite a property listing, contacting the real estate agent in charge and conducting a virtual tour of the selected listing. Each of these features will be elaborated in their own respective sections in the following sections of this report.

4.4.3.2.6 Virtual Tour

Figure 4.7: Virtual Tour

Figure 4.7 above shows a sample screenshot of how users are capable of conducting a virtual tour for their selected property listing. For this feature, users are capable of navigating through panoramic images by swiping either left or right and toggle between different locations within the unit.

Panoramic images are capable of providing an enhanced virtual visualization feature compared to static images as it promotes user interaction with the application. Instead of only being capable of zooming in and out of static images, this feature aims to enable users to navigate around it by swiping horizontally as if they are within the actual physical unit on site.

4.4.3.2.7 Chatbox

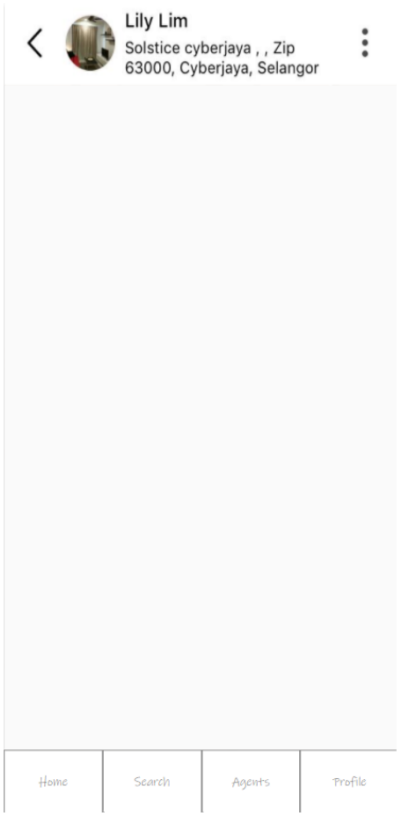

Figure 4.8: Chatbox

Figure 4.8 above shows a chatbox between a user and a real estate agent. Within this page, users are capable of sending text messages, images and schedule appointments with the real estate agent in charge of the property listing that they are interested in.

4.4.3.2.8 Upload / Submit Documents

Figure 4.9: Upload / Submit Documents

Figure 4.9 above shows that users are capable of uploading and submitting documents virtually within the chatbox of the application. Upon initializing this feature, the application will display the user's phone gallery to prompt them to select an image from it. Once the user clicks on the image of the document that they intend to send, the application will then proceed to upload the image to the database and display it within chat.

Without getting into too much technical detail of how it is actually implemented, just note that despite the term "document", it will be sent as an image attachment instead of a .pdf format. Further implementation details regarding this feature will be elaborated in Section 5 and 6 of the report accordingly.

4.4.3.2.9 Find An Agent

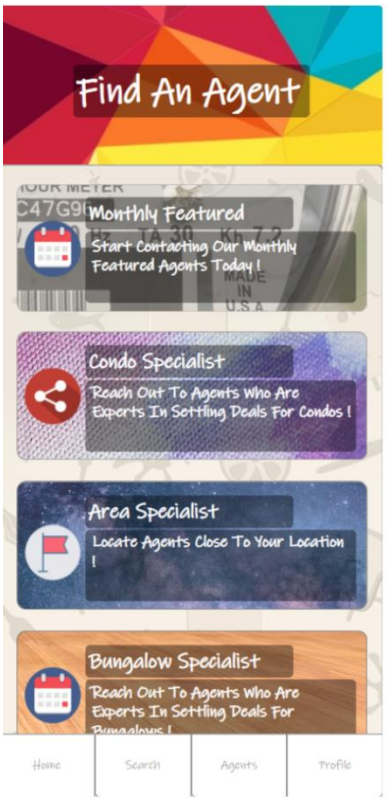

Figure 4.10: Find An Agent

Figure 4.10 above shows a list of real estate agents grouped together according to different sets of categories. Clicking on either one of them will display a list of all the real estate agents under that particular category.

4.4.3.2.10 Select Agent Category

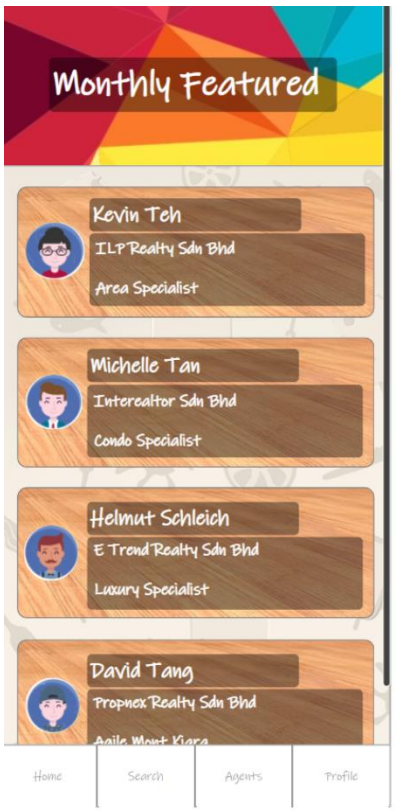

Figure 4.11: Select Agent Category

Figure 4.11 shows a list of all the available real estate agents under a particular category. In this case, all the Monthly Featured real estate agents are listed as shown above to enable users to conveniently locate the agents that is capable of providing the services that they are currently looking for.

4.4.3.2.11 Display Agent's Details

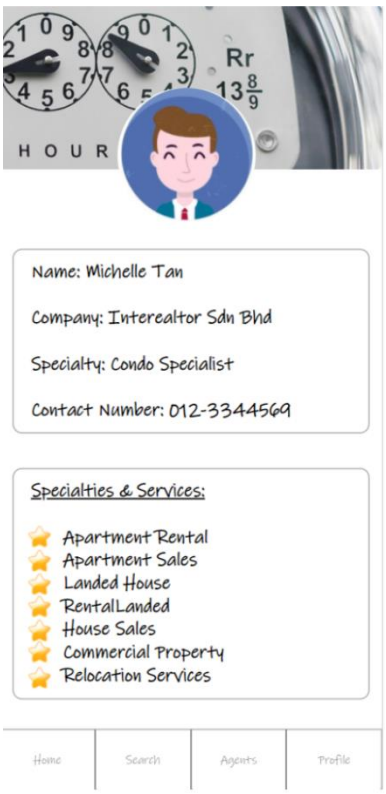

Figure 4.12: Display Agent's Details

Figure 4.12 shows the details of a selected real estate agent. This includes his/her name, company, area of specialty, contact number along with the specialties and services being offered.

4.4.3.2.12 Profile Page

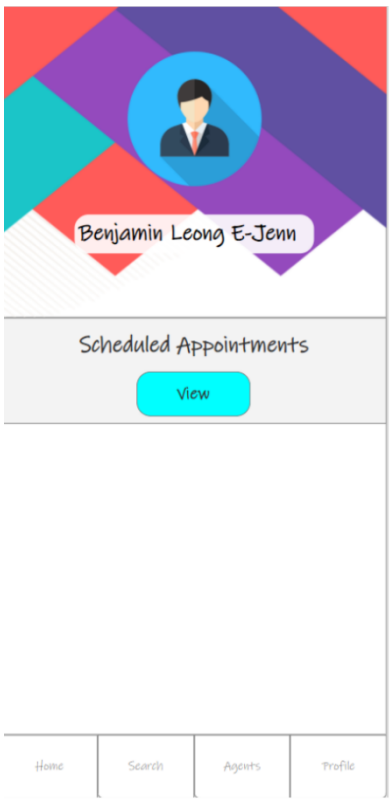

Figure 4.13: Profile Page

Figure 4.13 shows the user's profile page. Within this page, users are able to view a list of all their scheduled appointments as well as their entire chat room histories.

4.4.3.2.13 Real Estate Agent's Appointment

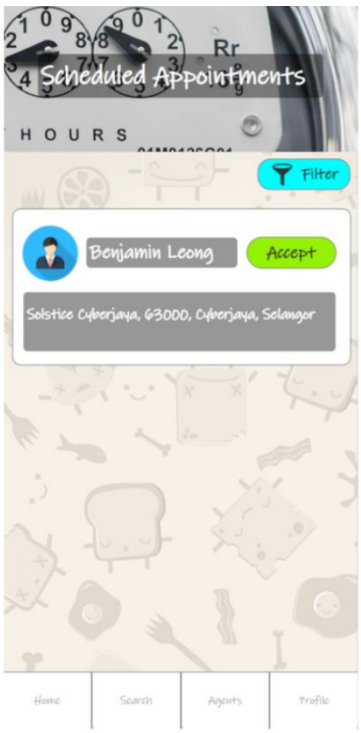

Figure 4.14: Real Estate Agent 's Appointments

Figure 4.14 shows a list of all the scheduled appointments from the real estate agent's perspective. As this was a low fidelity prototype, and the first version one at that, it only contains the function to accept an appointment. However, in subsequent iterations, proper status tracking and an additional feature to decline an appointment will be implemented. The details of this feature will be further elaborated in Section 5 and 6 of this report.

4.4.3.2.14 Tenant's Appointments

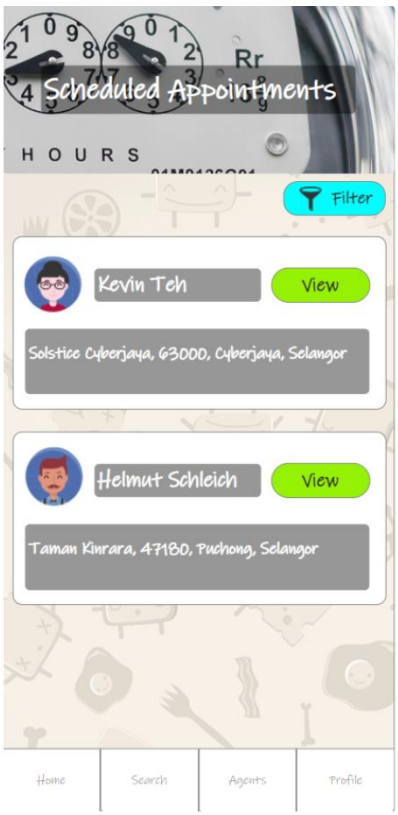

Figure 4.15: Tenant's Appointments

Figure 4.15 shows a list of all the scheduled appointments from the tenant's perspective. Users that are logged in as tenants are able to view the details of their previously scheduled appointments by clicking on the "View" button under a targeted appointment. This allows them to view the date and time of the selected appointment accordingly.

CHAPTER 5

DESIGN

5.1 Introduction

In this chapter, the design of the entire system was highlighted through a System Architecture Diagram and Entity Relationship Diagram. In addition, screenshots of the User Interface Design were also used to illustrate the design that provides the user's experience (UX), along with a screen navigation flow diagram to provide insights of the application's logic flow.

5.2 System Architecture Design

In this section, a System Architecture Diagram was used to provide a more detailed explanation regarding the overall architecture of the developed system as well as the tools and frameworks used throughout the entire development process. The Property Listing Application adopts a three-tier architectural system, which consists of a front-end layer, business logic layer and data storage layer. Superseding the traditional client-server architecture, the vast popularity of cloud computing services and technologies has made it possible for applications to be hosted on a cloud or a dedicated workstation depending on the computing power required by the application. In general, each tier within the architecture can be summarized as follows:

Table 5.1: Description Of Each Layer Within A Three-Tier Architecture

Layer	Description
Front-End	Encompasses the user interface components in which the end user interacts with the application. Furthermore, this layer is also where information is displayed and obtained from the end users.
Business Logic	Contains the core business logic which drives the application's core capabilities, which is essentially the heart of the application. Information obtained from the front-end layer is processed against a set of business

	rules and API calls can be made to manage data located within the Data Storage level.
Data Storage	Layer where the information obtained and/or processed by the application is stored. However, the front-end layer is not capable of interacting directly with the data storage layer as it has to first bypass the application's core logic as a channel of communication.

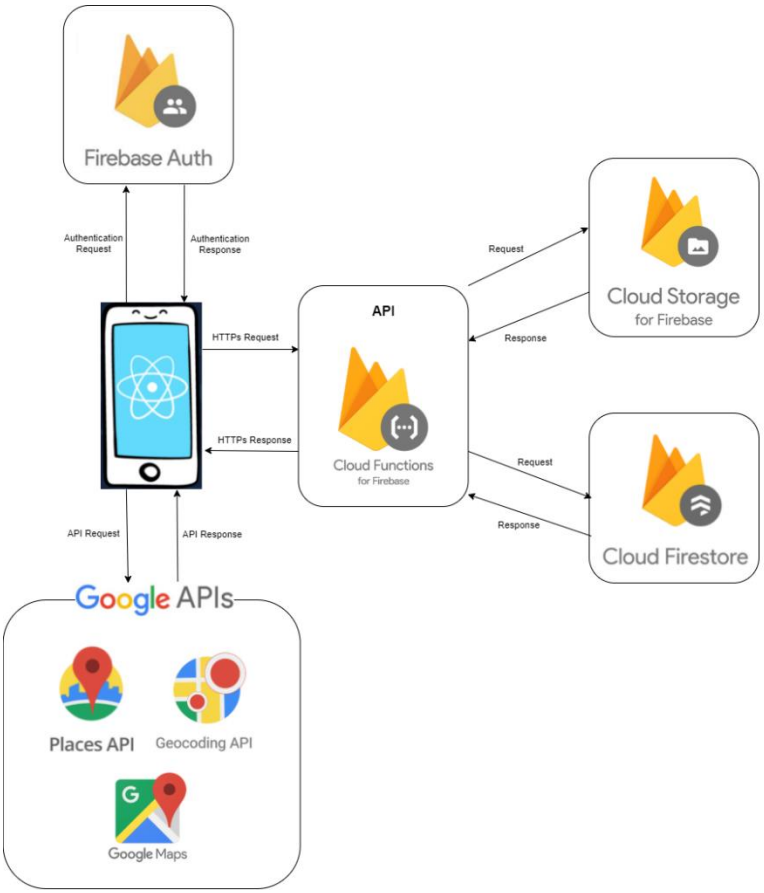

Figure 5.1: System Architecture Diagram

React Native is the framework that was selected to develop the front-end components of the Property Listing Application. As mentioned previously in Chapter 2, the type of framework used for mobile application development is dependent on the developer's preference. Since React Native offers a large variety of built-in core components and APIs bundled along, it was selected as the preferred choice over other frameworks that are currently available.

As for the back-end of the application, Google's Firebase was selected as the database that is used to store all the data pertaining towards the Property Listing Application. In addition, its non-relational database structure as well as the Chat API that it offers is capable in fulfilling the "Real Time" and "Communication" requirements of the application as proposed.

As mentioned briefly, the front-end layer of an application is unable to directly access the data storage layer, it has to bypass the application's core logic beforehand. React Native is able to achieve this without needing developers to manually construct their own REST APIs to access Firebase's back-end functionalities. With just a little bit of configuration, which was also properly documented with clear feedback and next steps, developers are able to handle all of the application's backend requirements. This includes user authentication, storing data, real-time event listeners and configuring access rules.

Firebase Authentication offers a set of back-end services, Software Development Kits (SDKs) and authentication services featuring traditional e-mail addresses or popular federated identity providers such as, Google, Facebook, Twitter and many other options according to the needs of the developers. By using its easy-to-use authentication features, less development time can be expended on building an authentication solution from scratch and utilize the Firebase Authentication SDK to integrate the preferred sign-in and registration methods instead.

Firebase's Cloud Firestore also offers a callback feature to listen on a specific document by comparing snapshots of the current document with the contents stored within the database. Should the information within the document change, the latest updated will be retrieved through the snapshot listeners almost instantly. Going back to a point that has been mentioned earlier regarding the abstraction between the front-end and the data storage layer, whenever the user performs a write request from the front-end, the event listeners will be notified with a metadata property to indicate that there is a change in contents from the previous snapshot even before the data is written to the Cloud Firestore database.

As Google's Maps feature will be one of the main features of the Property Listing Application, it is important for the application to be

implemented according to the said requirements. Instead of having to develop the layout of the map and its corresponding features from scratch, Google Cloud offers a Google Maps Platform that can be easily integrated into any application just by making calls through its APIs. Three APIs were used to facilitate the development of this project, which are the Geocoding API, Maps SDK for Android and Places API respectively. The features of each API can be summarized in Table 5.2 below.

Table 5.2: Description For Google API Used

API	Description
Geocoding API	Converts addresses (in text) into geographic coordinates, which can be used to be displayed on Google Maps through the Maps SDK.
Maps SDK for Android	Enables maps to be added to an Android application to handle Google Maps data, map displays and map gesture responses. In addition, markers, polygons and overlays can be added to the application for enhanced user experience (UX).
Places API	Returns information regarding real-world locations through HTTP requests through landmarks, geographical coordinates or points of interest. It also provides a search feature that returns detailed responses in either JSON or XML format, such as coordinates, user reviews, photos and many more properties.

5.3 Database Design

In this section, an Entity Relationship Diagram, or more commonly known as an ERD is used to illustrate the back-end database design of the Property Listing Application. Within the ERD, relationships between each entity as well as the attributes that each entity contains can be clearly visualized.

Furthermore, a data dictionary is also prepared to enable clear descriptions regarding the attributes within each entity to be provided.

5.3.1 Entity Relationship Diagram

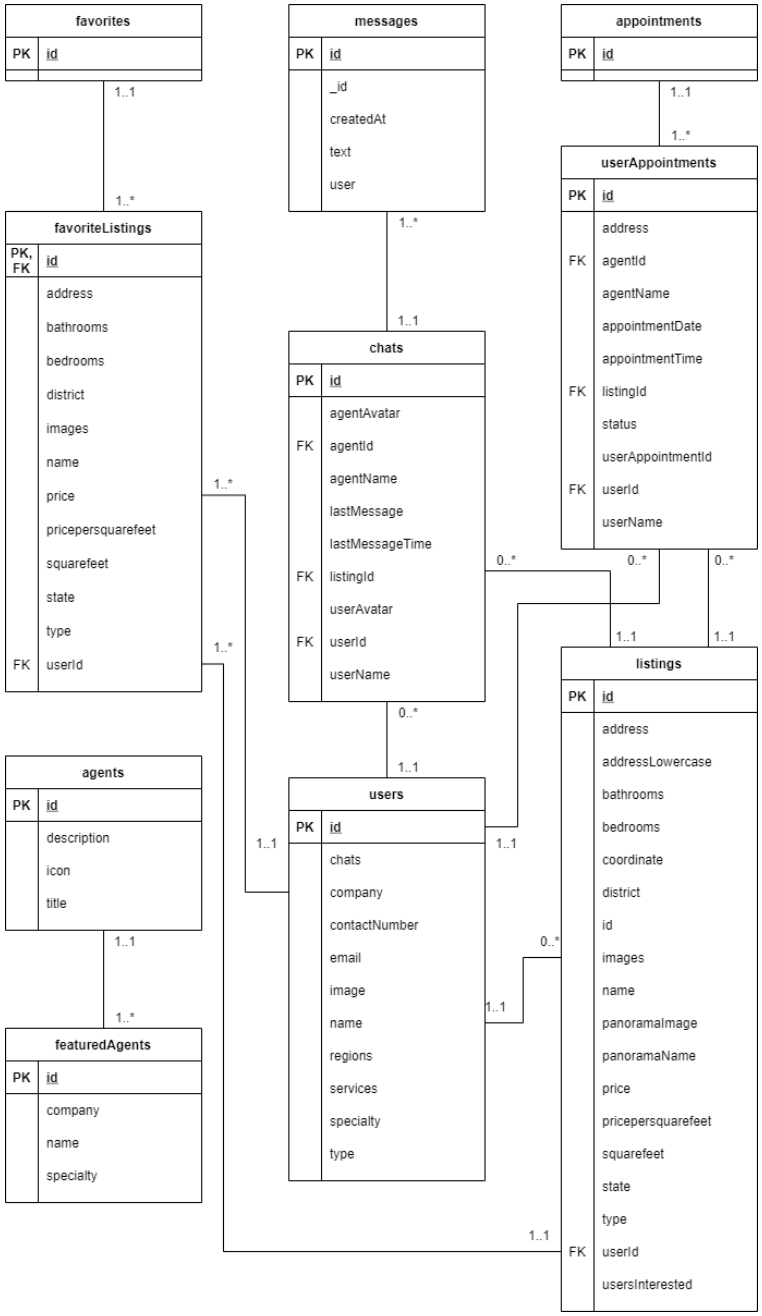

Figure 5.2: Entity Relationship Diagram

Figure 5.2 above shows the entity relationship diagram for the property listing application that was developed as part of this project. Although a non-relational database such as Firebase does not have a recommended database diagram design, entity relationship diagrams are still viable to be used for the sake of documentation.

5.3.2 Database Table Description

With regards to the Entity Relationship Diagram (ERD) that was constructed in Figure 5.2, Table 5.3 below will provide a brief description regarding each individual table entity.

Table 5.3: Description For Each Database Table

Table	Description
users	Contains information of all the users that registered for the application.
listings	Contains information of all the listings that were published by the real estate agents.
agents	Contains the information regarding the type of agent groups.
featuredAgents	Contains all the agent's information within each type of agent group.
chats	Contains information regarding each chat room between a user and a real estate agent.
messages	Contains messages that were sent in each "chats" document.
appointments	Acts as a container for each of the "userAppointments" collection to store all the appointments that they have scheduled.
userAppointments	Contains appointment information that users have scheduled with the respective real estate agents.
favorites	Acts as a container for each of the "favoriteListings" collection to store all the listings that users have favorited.
favoriteListings	Contains information regarding the property listings that users have favorited.

5.3.3 Data Dictionary

Table 5.4: users Table Data Dictionary

Attribute	Description	Data Type	PK / FK	FK Referenced Table
id	Unique ID for all users	string	PK	-
chats	User's chat rooms	array	-	-
company	Company real estate agents are working for	string	-	-
contactNumber	Real estate agent's contact number	string	-	-
email	User's email	string	-	-
image	User's profile image	string	-	-
name	User's name	string	-	-
regions	Regions that real estate agents cover	array	-	-
services	Services that real estate agents offer	array	-	-
specialty	Real estate agent's specialty	string	-	-
type	User's account type	string	-	-

Table 5.5: listings Table Data Dictionary

Attribute	Description	Data Type	PK / FK	FK Referenced Table
id	Unique ID for all property listings	string	PK	-
address	Listing's address	string	-	-
addressLowercase	Tokenized listing's address in lowercase	array	-	-
bathrooms	Number of bathrooms	string	-	-
bedrooms	Number of bedrooms	string	-	-
coordinate	Listing's geographic coordinates	map	-	-
district	Listing's district	string	-	-
id	ID of the current listing	string	-	-
images	Listing's published images	array	-	-
name	Listing's name	string	-	-
panoramaImage	Listing's published panorama images	array	-	-

panoramaName	Listing's panorama image names	array	-	-
price	Listing's price	string	-	-
pricepersquarefeet	Listing's price per square feet	string	-	-
squarefeet	Listing's size in square feet	string	-	-
state	Listing's state	string	-	-
type	Listing's type	string	-	-
userId	Real estate agent's ID in charge of the listing	string	FK	users
usersInterested	IDs of users who favorited the listing	array	-	-

Table 5.6: agents Table Data Dictionary

Attribute	**Description**	**Data Type**	**PK / FK**	**FK Referenced Table**
id	Unique ID for all real estate agent groups type	string	PK	-
description	Real estate agent group type's description	string	-	-
icon	Real estate agent group type's icon	string	-	-

title	Real estate agent group type's title	string	-	-

Table 5.7: featuredAgents Table Data Dictionary

Attribute	Description	Data Type	PK / FK	FK Referenced Table
id	Unique ID for all real estate agents	string	PK	-
company	Real estate agent's company	string	-	-
name	Real estate agent's name	string	-	-
specialty	Real estate agent's specialty	string	-	-

Table 5.8: chats Table Data Dictionary

Attribute	Description	Data Type	PK / FK	FK Referenced Table
id	Unique ID for all chat rooms	string	PK	-
agentAvatar	Real estate agent's avatar	string	-	-
agentId	Real estate agent's unique ID	string	FK	users
agentName	Real estate agent's name	string	-	-

lastMessage	Contents of last message sent	string	-	-
lastMessageTime	Time last message was sent	timestamp	-	-
listingId	Unique ID for selected property listing	string	FK	listings
userAvatar	User's avatar	string	-	-
userId	User's unique ID	string	FK	users
userName	User's name	string	-	-

Table 5.9: messages Table Data Dictionary

Attribute	**Description**	**Data Type**	**PK / FK**	**FK Referenced Table**
id	Unique ID for each message	string	PK	-
_id	ID to keep track of the messages sent	string	-	-
createdAt	Time message was sent	timestamp	-	-
text	Contents of the message	string	-	-
user	Information of user that sent the message	map	-	-

Table 5.10: appointments Table Data Dictionary

Attribute	Description	Data Type	PK / FK	FK Referenced Table
id	Unique ID for each userAppointments document	string	PK	-

Table 5.11: userAppointments Table Data Dictionary

Attribute	Description	Data Type	PK / FK	FK Referenced Table
id	Unique ID for each appointments a user made	string	PK	-
address	Address of appointed property listing	string	-	-
agentId	ID of real estate agent appointed	string	FK	users
agentName	Name of real estate agent appointed	string	-	-
appointmentDate	Appointment schedule date	string	-	-
appointmentTime	Appointment schedule time	string	-	-
listingId	ID of appointed property listing	string	FK	listings
status	Appointment's status	string	-	-

userAppointmentId	ID of the same appointment from the user's appointment collection	string	-	-
userId	ID of user appointed	string	FK	users
userName	Name of user appointed	string	-	-

Table 5.12: favorites Table Data Dictionary

Attribute	Description	Data Type	PK / FK	FK Referenced Table
id	Unique ID for each favoriteListings document	string	PK	-

Table 5.13: favoriteListings Table Data Dictionary

Attribute	Description	Data Type	PK / FK	FK Referenced Table
id	ID of property listing favorited	string	PK, FK	listings
address	Favorited listing's address	string	-	-
bathrooms	Favorited listing's number of bathrooms	string	-	-

bedrooms	Favorited listing's number of bedrooms	string	-	-
district	Favorited listing's district	string	-	-
images	Favorited listing's published images	array	-	-
name	Favorited listing's name	string	-	-
price	Favorited listing's price	string	-	-
pricepersquarefeet	Favorited listing's size in price per square feet	string	-	-
squarefeet	Favorited listing's size in square feet	string	-	-
state	Favorited listing's state	string	-	-
type	Favorited listing's property type	string	-	-
userId	Favorited listing's real estate agent	string	FK	users

5.4 User Interface Design

Since the Property Listing Application will be used by three different categories of users, which are the Tenants, Real Estate Agents and Administrators respectively, there will be a slight difference in terms of user interfaces from one category of users to another. However, there will also be certain areas in which the application's design is similar for different user roles and this will be highlighted in their respective sections of the report.

Therefore, each user category will be broken down into their respective sections to prevent confusions from one user role to another. To facilitate that, a Screen Navigation Flow will be provided in each user category's section.

5.4.1 Tenants Interface Design

The mobile application from the Tenant's perspective consists of 13 interfaces, all of which will be highlighted within Section 5.4.1 and its sub-sections.

5.4.1.1 Screen Navigation Flow

The Screen Navigation Flow Diagram in Figure 5.3 below illustrates the application's logic flow for the Property Listing Application from the Tenant's perspective.

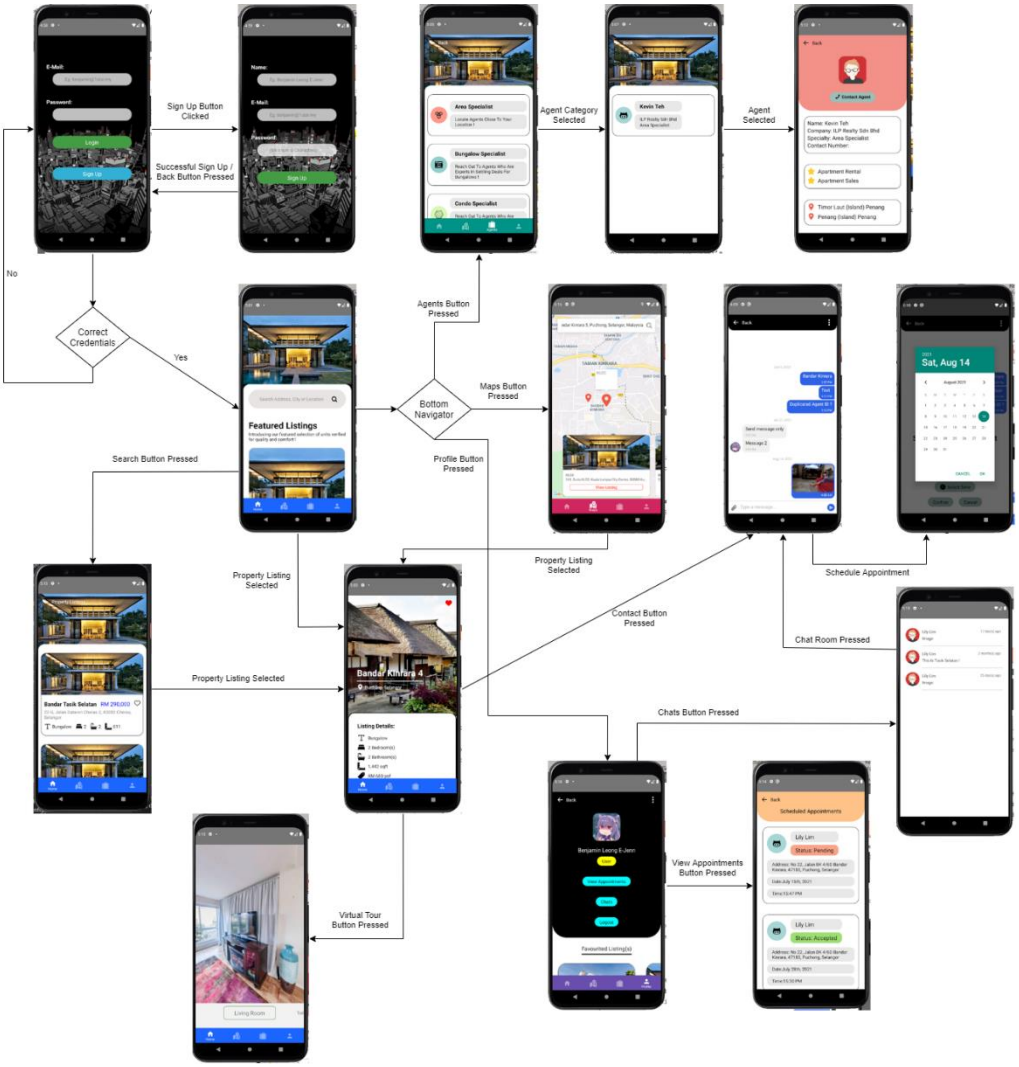

Figure 5.3: Screen Navigation Flow Diagram (Tenant)

5.4.1.2 Login Page

Upon initiating the start of the application, the user will be brought to the Login Page as shown in Figure 5.4 below in which they are required to input their e-mail and password as their authentication credentials.

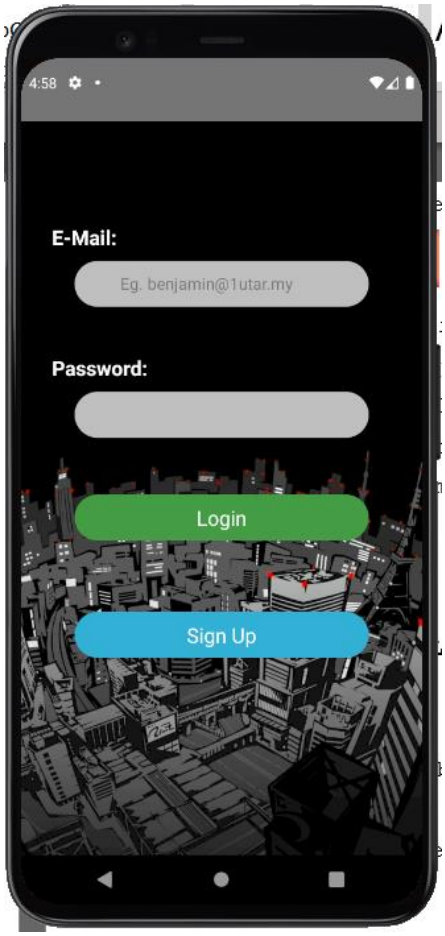

Figure 5.4: Login Page

5.4.1.3 Register Page

New users are able to register for a new account, which is mandatory to have before being able to access the full features provided by the application. The required information to be filled in is illustrated in Figure 5.5 as shown below.

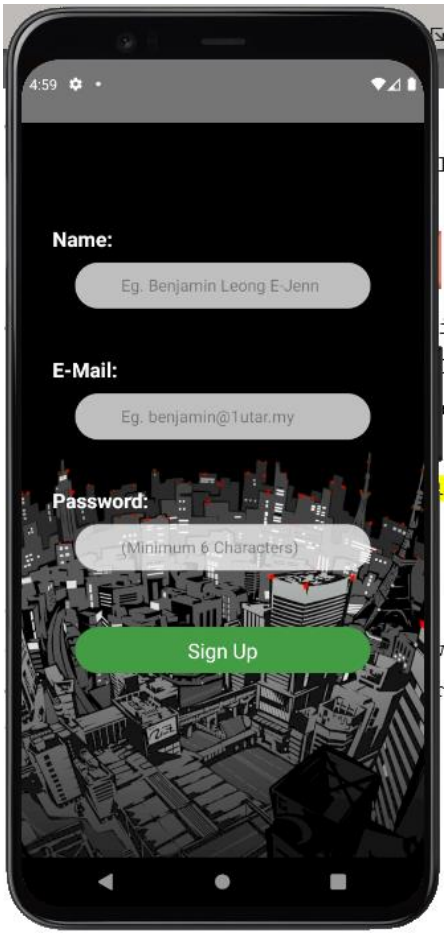

Figure 5.5: Register Page

5.4.1.4 Home Page

Upon successfully logging into the application, users will be redirected to the Home Page of the Property Listing Application as shown in Figure 5.6 below. Within this page itself, users are able to view the featured property listings provided by the application, along with other property listings grouped together in their respective categories.

Clicking on either one of the listings will redirect users to the respective Property Listings Page accordingly, which will be discussed in Section 5.4.1.5 in this report.

In addition, users are also provided with an option to search for a particular property listing using the search bar located on the top of the screen. Upon submitting the search request, users will be navigated to a Search Results Page whereby the property listings that they have searched for will be displayed.

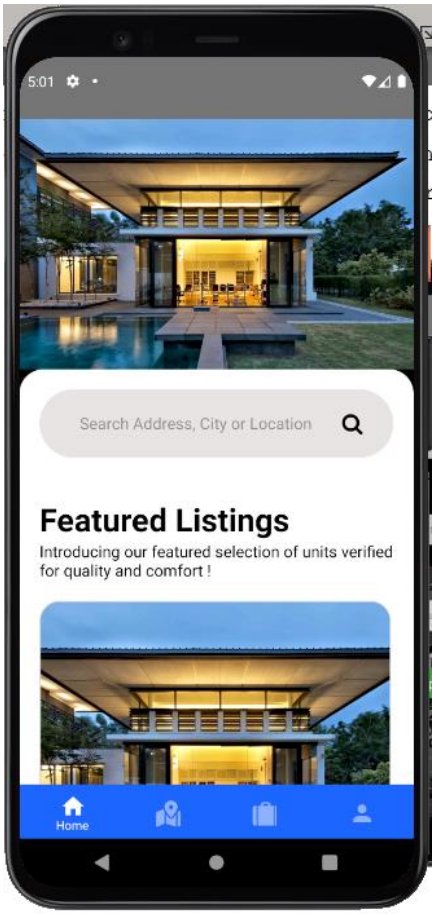

Figure 5.6: Home Page

5.4.1.5 Property Listings Page

Upon selecting a particular property listing either from the Home Page or from the search results that the users have made, users would then be redirected to a Property Listings Page as shown in Figure 5.7 below. Within this page, detailed information related to the selected listing can be viewed.

Bringing the focus to the top of the screen, users will be able to view the images provided by the real estate agent in charge of the selected property. The images will be displayed in an image carousel format in which users are able to click on it to display a particular image in a more detailed manner.

In addition, key information regarding the selected property can also be displayed on the interface, which includes the property type, price, square feet, number of bedrooms, number of bathrooms and many other characteristics that tenants may be interested to find out before purchasing or renting a particular property.

Clicking on the “Virtual Tour” button will enable users to take a tour around the selected property at the edge of their fingertips. This feature is one of the more noticeable features integrated within the application and will be explained further in its respective sub-section.

Tenants would also be able to contact the real estate agent in charge of the selected property listing by clicking on the “Contact” button located beside the agent’s details field. Upon doing so, the user will then be redirected to a Chat Page in which they would be able to communicate with the real estate agent to entertain any enquiries that they may have. This would be further elaborated in Section 5.4.1.12 of this report.

Furthermore, nearby amenities located within the range of 1KM from the geographic coordinates of the selected property listing’s location will also be displayed within this page. However, instead of having the application to fetch the list of amenities from the back-end database storage, it would be dynamically retrieved by making API calls through the Google Places API.

Figure 5.7: Property Listings Page

5.4.1.6 Search Results Page

Continuing on from Section 5.4.1.4, which provides a brief insight regarding the Home Page of the Property Listing Application. Users will be redirected to this Search Results Page whenever they submit a search request through the search bar and the search results will be displayed on the screen accordingly. A sample search result can be seen similar to the one in Figure 5.8 below.

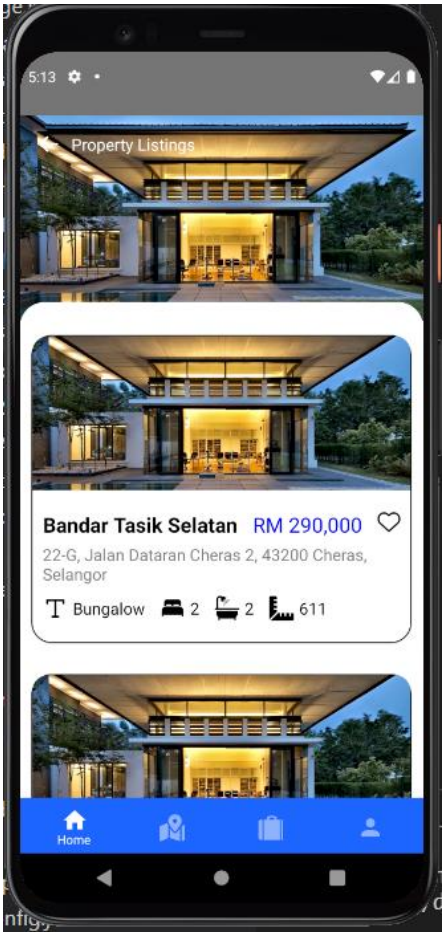

Figure 5.8: Search Results Page

5.4.1.7 Real Estate Agents List

From the screenshot shown in Figure 5.9 below, users are able to discover real estate agents that could fulfil their needs and requirements to help accomplish the assistance that users are currently looking for. Real estate agents are grouped according to their services and specialties that they are offering, and this eases the user's search process as they are not required to click on each individual real estate agent in order to find out more detailed about the real estate agents.

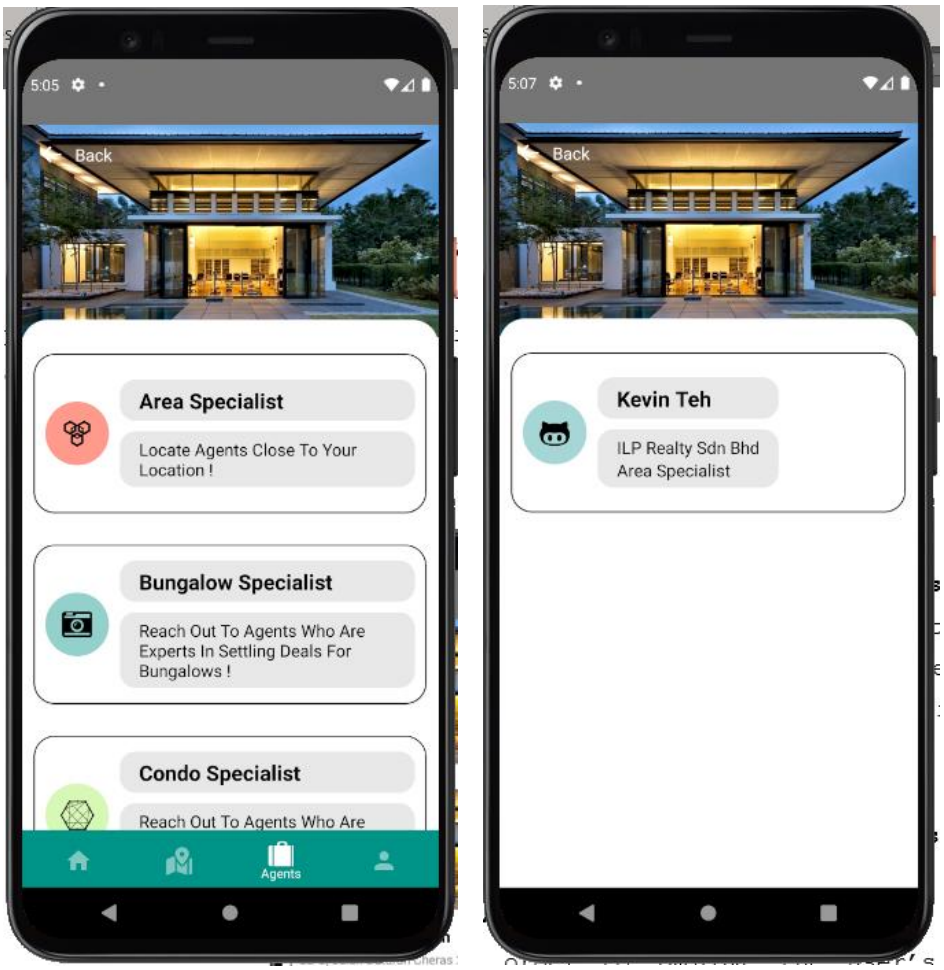

Figure 5.9: Real Estate Agents List

5.4.1.8 Real Estate Agent Details

Upon discovering the real estate agents that the users are interested in, they would be able to obtain more details about them as well as their contact information by accessing this page. A sample screen showing the details of a particular real estate agent can be seen on Figure 5.10 below.

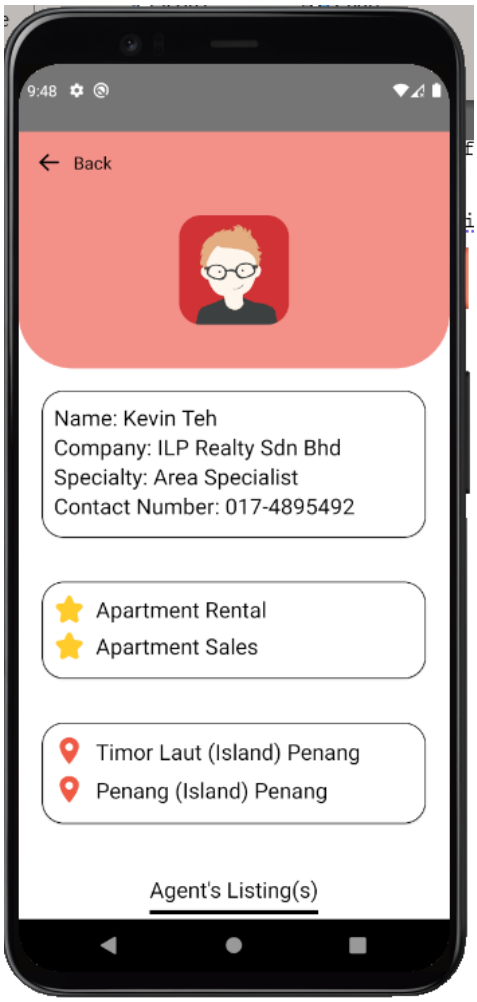

Figure 5.10: Real Estate Agents List

5.4.1.9 Virtual Tour

In order to enhance the user's virtual home viewing experience, this virtual tour feature was developed to enable users to view a particular property in a more detailed manner, which improves their confidence when purchasing a particular property. This feature is highly convenient as users are currently unable to make site visits in person, and panoramas are able to offer this extensive visualization experience.

The Property Listing Application will display each floor or room within a property unit one at a time, and users will be able to toggle and navigate between different areas by utilizing the horizontal scroll view as shown in Figure 5.11 below.

Figure 5.11: Virtual Tour

5.4.1.10 User Profile

Figure 5.12 below depicts the User Profile interface, which displays the user's details, that includes their name, their appointment's list and all the property listings that they have currently "Favorited" within the application.

Furthermore, users will also be able to access all of their chats that they have conducted previously with other real estate agents. Clicking on the "Chats" button will navigate the users to the Chat List page, which will be highlighted in Section 5.4.1.11 accordingly.

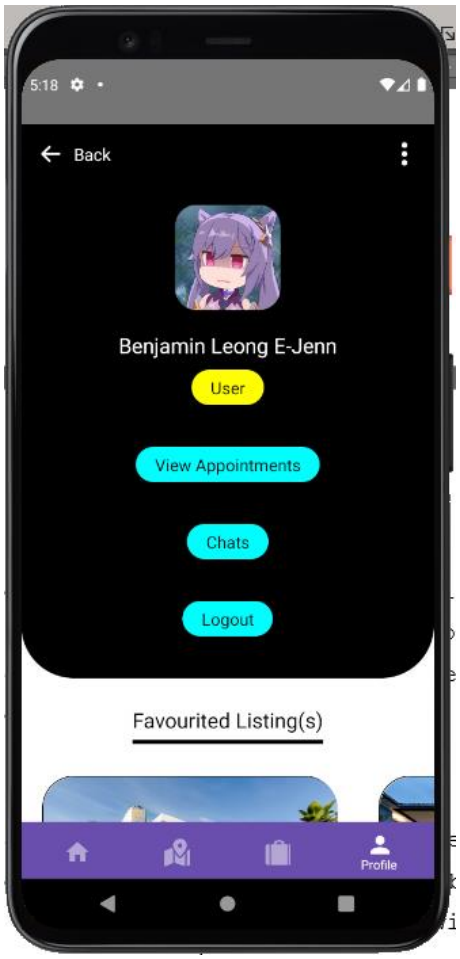

Figure 5.12: User Profile

5.4.1.11 Chat List

The list of chat histories displayed on this page can be accessed from the user's profile. Users are able to click on any one of the chats that are displayed on screen, and they would be redirected to the chat page respectively. Figure 5.13 below shows a screenshot of a user's chat history along with their own respective details.

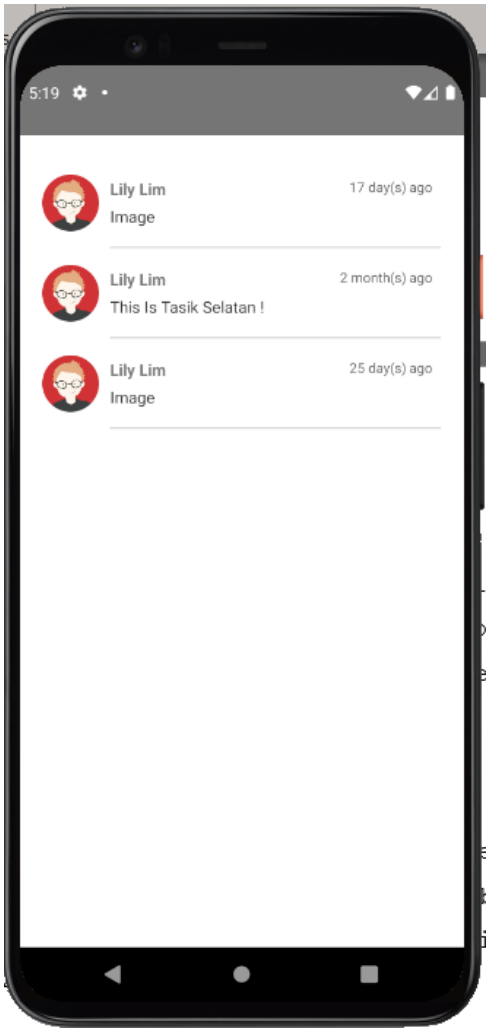

Figure 5.13: Chat List

5.4.1.12 Chat Page

Figure 5.14 below indicates the user interface design for the chat page. Within this page, users are able to send messages and images to the opposing party within the application itself by accessing the chat page with the real estate agent handling the selected property.

In addition, they are also able to schedule appointments with the real estate agents according to the date and time that they wish to conduct the site visit to the property unit.

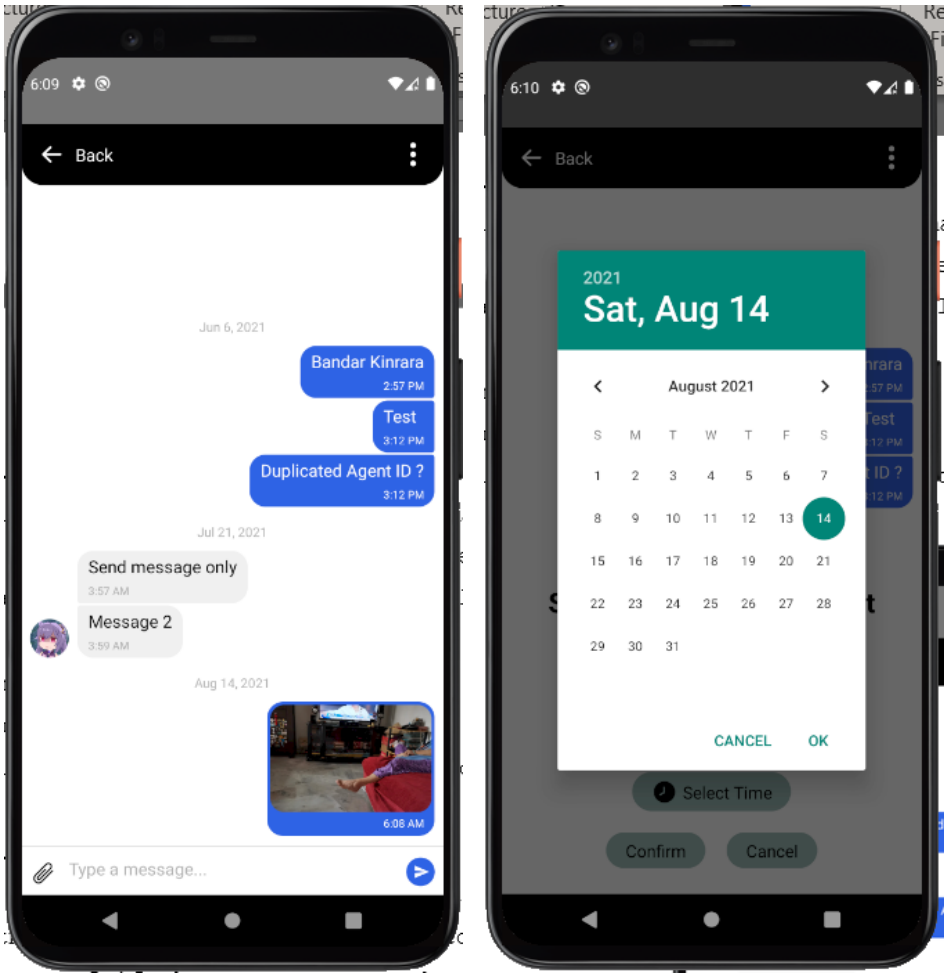

Figure 5.14: Chat Page

5.4.1.13 Appointments List

Figure 5.15 below shows the list of all the appointments that a user has scheduled previously in the past, regardless of if they were accepted or declined.

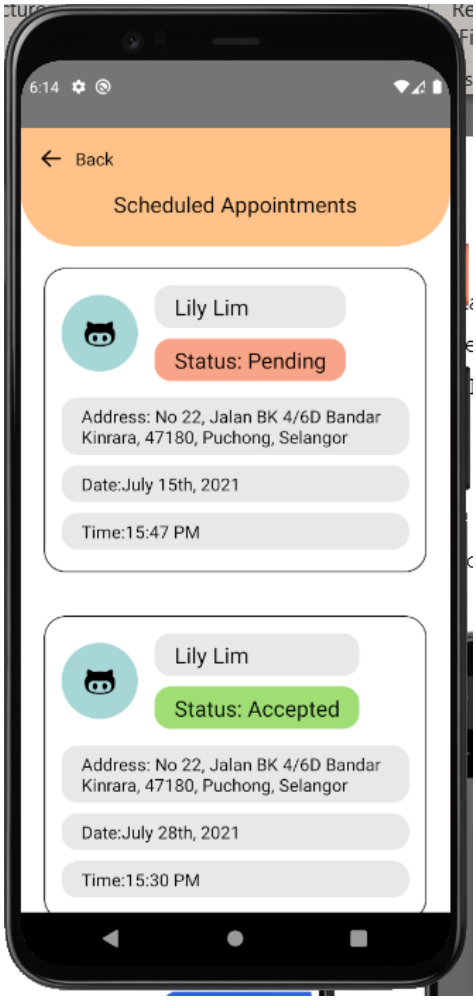

Figure 5.15: Appointments List

5.4.1.14 Search By Maps

The Maps SDK for Android is capable in providing a map interface similar to the ones usually seen on Google Maps just by making a simple API call. As mentioned previously, Maps SDK for Android is customizable and flexible enough to adjust to handle user's requirements. This includes features such as the map's interface display, map gesture responses, custom markers and overlays. In Figure 5.16 below, custom marker indicators and card overlaps are added to adjust accordingly to suit the needs of the Property Listing Application.

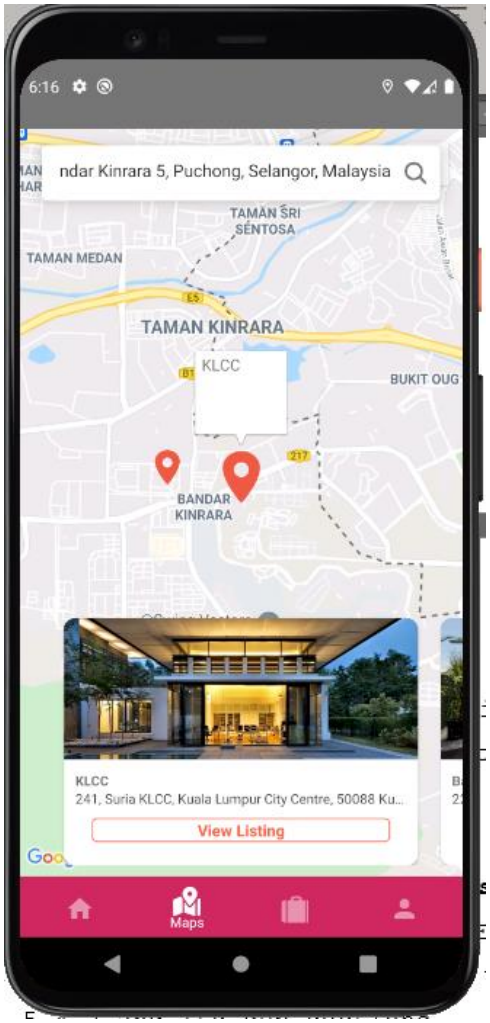

Figure 5.16: Search By Maps

5.4.2 Real Estate Agents Interface Design

The mobile application from the Real Estate Agent's perspective consists of 3 interfaces, all of which will be highlighted within Section 5.4.2 and its sub-sections.

However, there are certain features and functionalities that are shared between normal users and real estate agents. In order to avoid a duplicate explanation within the report, this section only focuses on explaining the features that are exclusive to users with a real estate agent type account. It is also important to keep in mind that real estate agents are able to utilize the main features of the application just like how a regular user does.

5.4.2.1 Screen Navigation Flow

The Screen Navigation Flow Diagram in Figure 5.17 below illustrates the application's logic flow for the Property Listing Application from the Real Estate Agent's perspective.

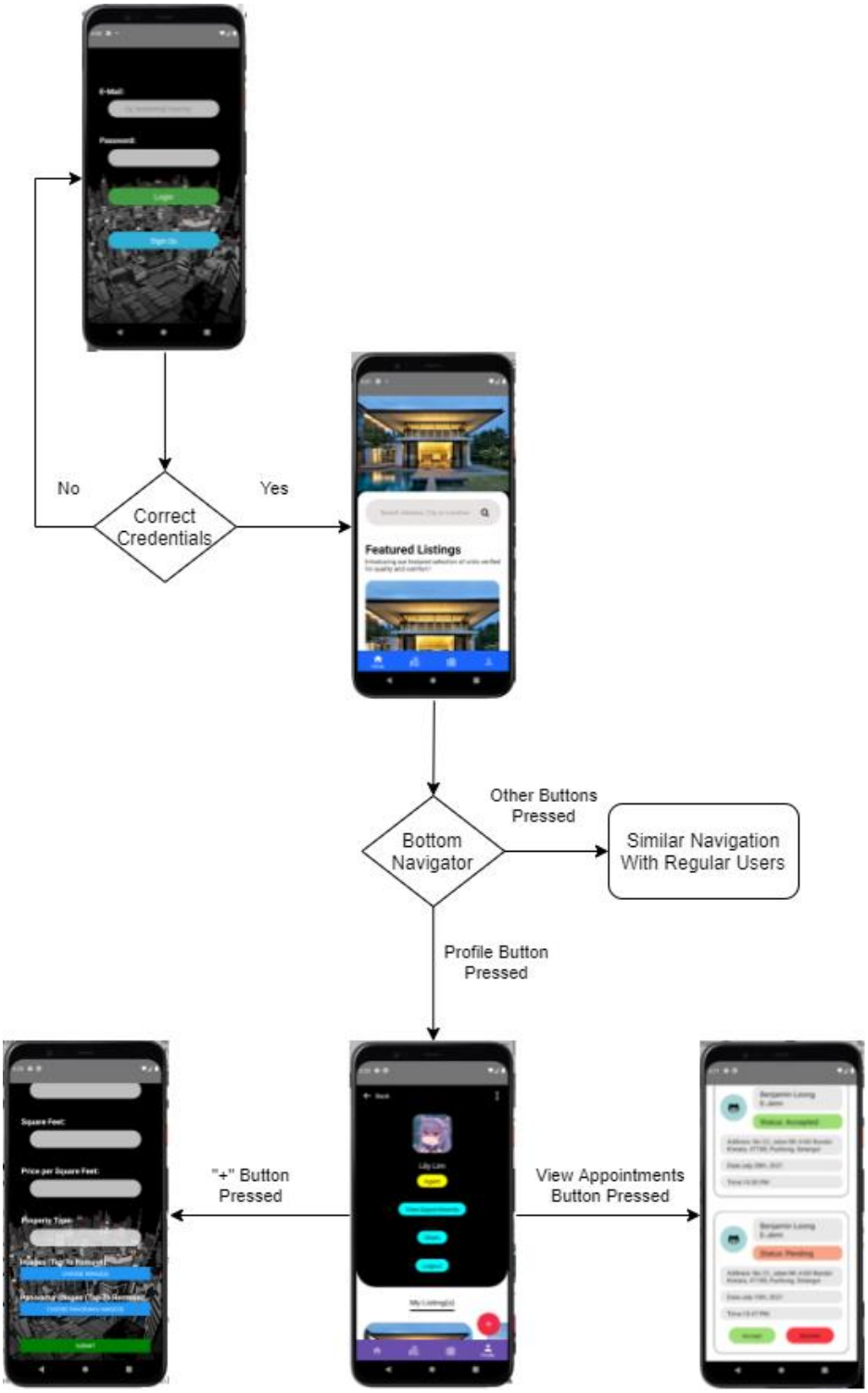

Figure 5.17: Screen Navigation Flow Diagram (Real Estate Agent)

5.4.2.2 Real Estate Agent Profile

Although the real estate agent's profile has a similar interface design with that of a regular user's account. A minor difference that this user type's account has is that instead of being able to view a list of the "Favorited" property listings, a real estate agent is able to view a list of all the property listings that they have published previously. This can be seen from the screenshot shown in Figure 5.18 below.

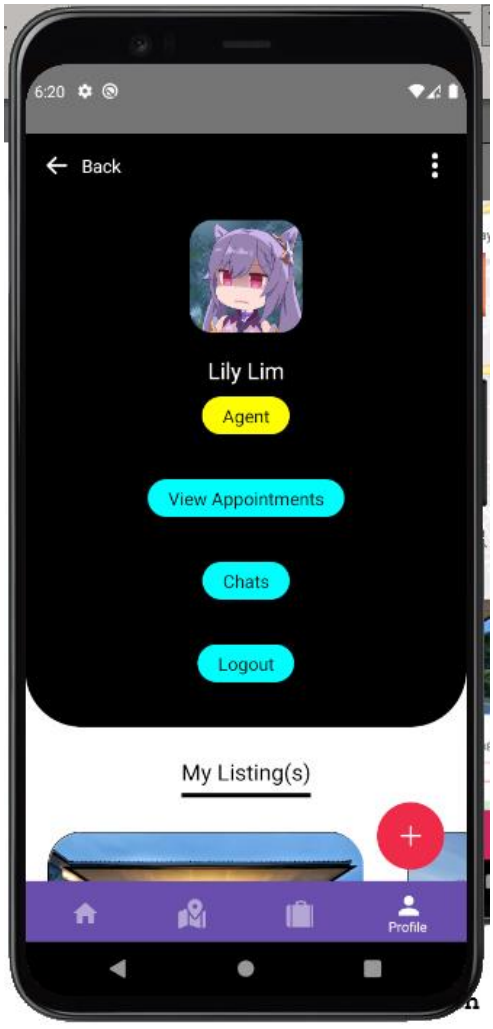

Figure 5.18: Real Estate Agent Profile

5.4.2.3 Appointments List

Real estate agents are allowed to view the list of appointments that their potential customers have scheduled with them within the interface similar to the one shown in Figure 5.19.

Appointments with actions that are yet to be taken against them will be labelled as “Pending”. When an appointment is set to this state, the real estate agents are allowed to either Accept or Decline the targeted appointment. Once the action is triggered by them, the appointment’s details will be updated to reflect the decision made by them, and the users involved will receive the same appointment details concurrently.

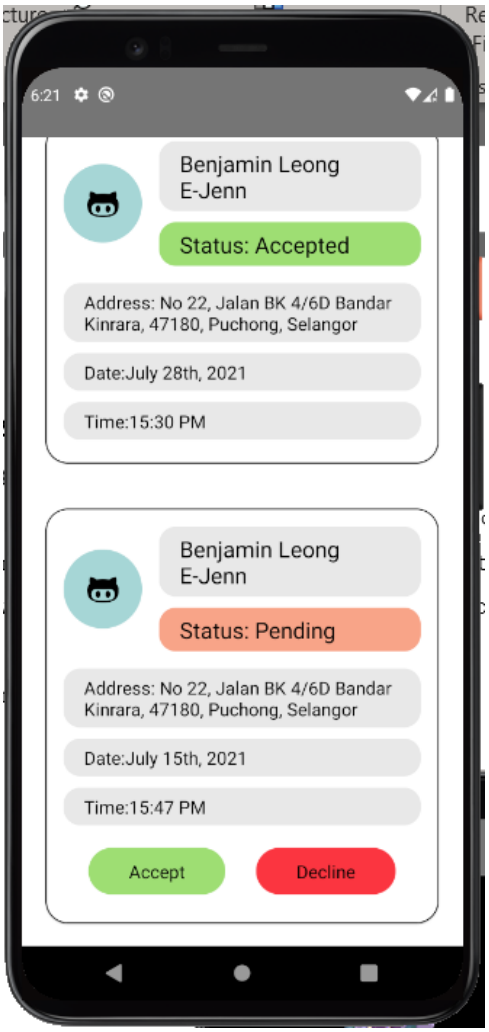

Figure 5.19: Appointments List

5.4.2.4 Add New Property Listing

Figure 5.20 displays a sample screenshot of how real estate agents are capable of adding new property listings within the application itself. This can be done by clicking on the "+" button located on the bottom right corner of their profile. Once that's done, the real estate agent will be redirected to a page whereby they can proceed to fill in all the necessary and required information that are requested by the Property Listing Application.

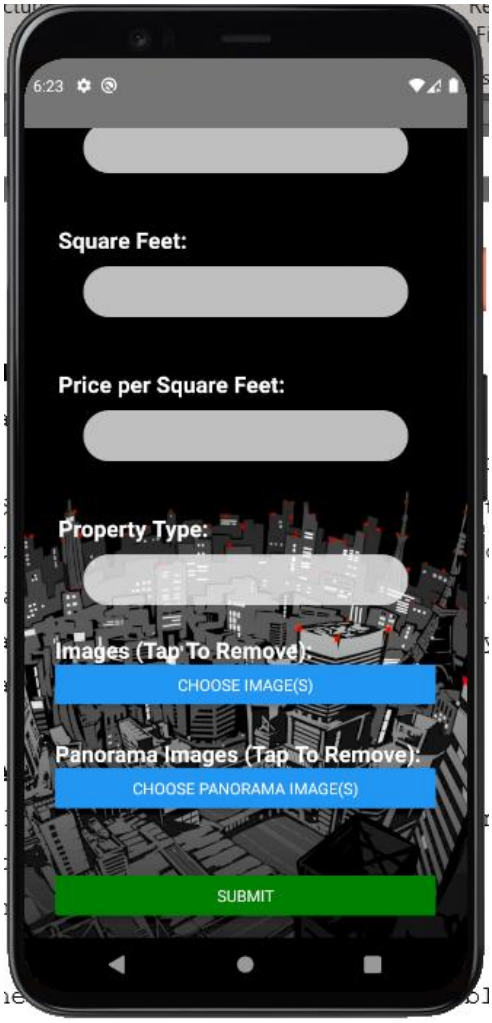

Figure 5.20: Add New Property Listing

5.4.3 Administrators Interface Design

The mobile application from the Administrator's perspective consists of 2 interfaces, all of which will be highlighted within Section 5.4.3 and its sub-sections.

The administrator is only capable of performing 2 tasks, that is to view a list of all the currently available real estate agents and register a new real estate agent to the application. This is the only way that real estate agents are able to obtain an account in order to publish their property listings through the Property Listing Application. This is done to prevent random users from misusing the application.

5.4.3.1 Screen Navigation Flow

The Screen Navigation Flow Diagram in Figure 5.21 below illustrates the application's logic flow for the Property Listing Application from the Administrator's perspective.

Figure 5.21: Screen Navigation Flow Diagram (Administrator)

5.4.3.2 List Of Real Estate Agents

Upon logging in as an Administrator of the Property Listing Application as shown in Figure 5.22 below, instead of being redirected to the Home Page as the previous two user roles did, the administrator would be navigated to a page consisting of a list of real estate agents. Clicking on the button located at the top of the screen would redirect the administrators to a page where new real estate agents can be added, which would be further elaborated in Section 5.4.3.3 below.

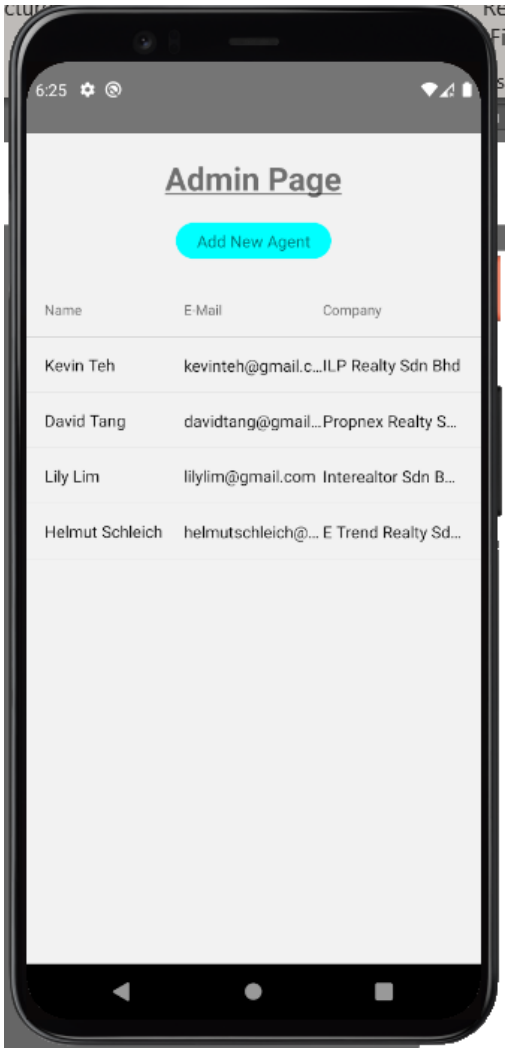

Figure 5.22: List Of Real Estate Agents

5.4.3.3 Add New Real Estate Agents

In order to register for a new real estate agent, the administrators are required to fill in all the necessary information as prompted by the application on a page similar to the one shown in Figure 5.23 below. Once all the input fields are filled in, they can proceed to click on the Submit button whereby a new real estate agent's account can be added successfully.

Figure 5.23: Add New Real Estate Agents

CHAPTER 6

IMPLEMENTATION

6.1 Introduction

This chapter aims to provide a more detailed description regarding the developed system according to its proposed design. Previous chapters have already provided a brief insight on how the application's design is like without getting into too much of the technical aspects of how it is actually being implemented, in which this chapter aims to do. The modules of the different user groups are broken down into tenants, real estate agents and administrators, whereby an in-depth analysis will be conducted in each one of them accordingly.

6.2 Modules For Tenants

This section aims to focus on elaborating the implementation details for all the tenant's modules that were implemented as part of this project.

6.2.1 Account Registration

Before being able to gain access to the full features of the property listing application, users are required to first register for an account by clicking on the "Sign Up" button on the Login Page of the application. Upon doing so, the users will be redirected to an interface which prompts them to enter in their name, e-mail address and a password. The following criteria has to be fulfilled before the account registration process can be successful, otherwise relevant error messages will be displayed to the users instead.

1. All input fields are required to be filled in.
2. E-mail must be of a proper formatting.
3. E-mail provided must not be registered previously and/or linked to an already registered account.
4. Password has to be a minimum of 6 characters long.

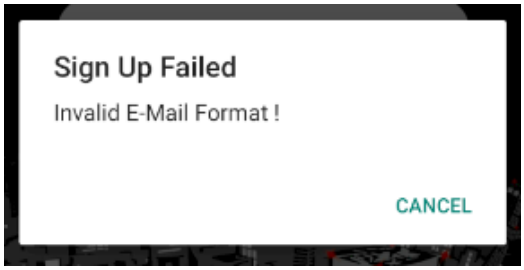

Figure 6.1: Invalid E-Mail Format Error Message

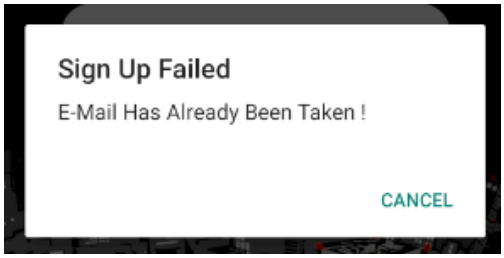

Figure 6.2: E-Mail Already Registered Previously Error Message

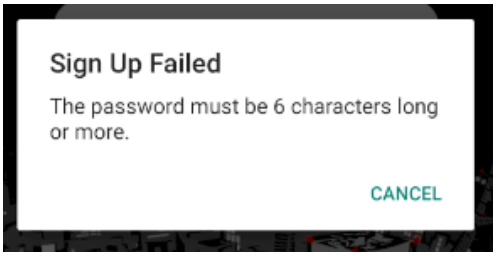

Figure 6.3: Password Length Error Message

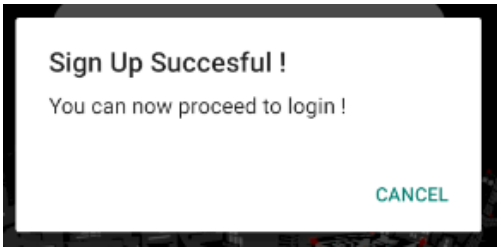

Figure 6.4: Account Created Successfully Message

Once all the required information is filled in correctly, users can then proceed to click on the “Sign Up” button whereby Firebase Authentication’s sign-up methods will be called to handle the account creation process. A message will be displayed to the users indicating that their account has been created successfully, whereby they can then proceed to log in using the authentication credentials in which they have provided accordingly. Should

the user submit the form with invalid input fields, the associated error messages will be prompted to provide feedbacks to them accordingly as shown in Figure 6.1 to 6.4 above.

6.2.2 Login

Within this page, users are able to log in using the authentication credentials that they have registered previously. Once again, Firebase Authentication's login methods will handle the authentication process automatically by verifying the user's inputs and display appropriate error messages when required as shown in Figure 6.5 and 6.6 below. Should the login process be successful, users will then be redirected to the Home Page of the property listing application and begin access the full features of the application.

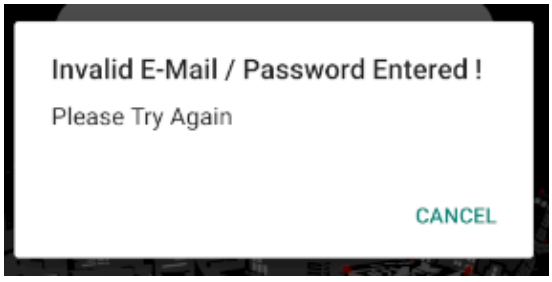

Figure 6.5: Invalid E-Mail Or Password Entered Error Message

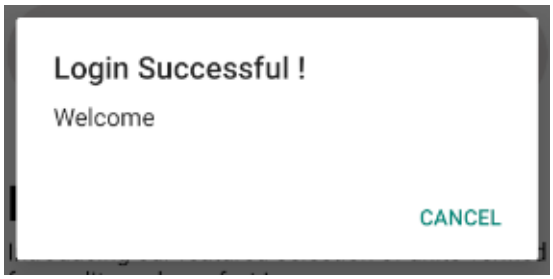

Figure 6.6: Login Successful Message

6.2.3 Home Page

The Home Page of the property listing application acts as a center point of the entire application, whereby users can navigate themselves to use the intended features of the application by clicking on the relevant tabs in the bottom navigation bar, which was developed using "@react-navigation/material-bottom-tabs" and looks similar to the one shown in Figure 6.7.

Figure 6.7: Bottom Navigation Tab

Within this page, users are provided with a brief overview with some of the property listing details that are currently available being displayed briefly. These listing details are all retrieved dynamically from Firebase's Cloud Firestore. In order to achieve a better user experience, an image carousel slider was implemented to enrich the user interface design with its animation features as shown in Figure 6.8 below.

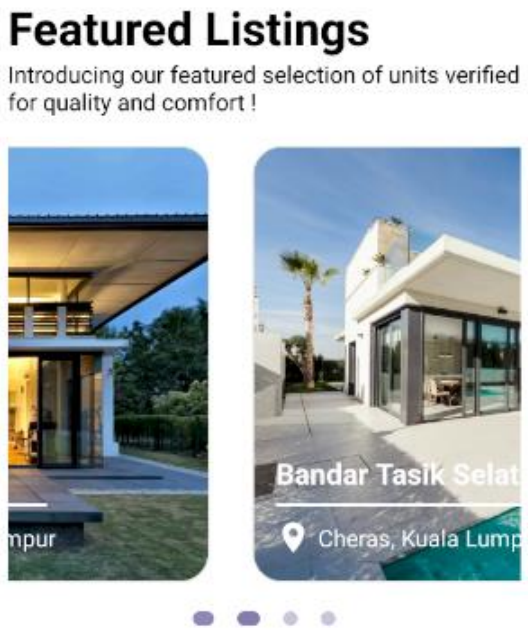

Figure 6.8: Animated Image Carousel Slider

6.2.4 Search Using Text

Still focusing our attention on the Home Page of the application, notice that there is a search bar provided on the top of the screen that enables users to input their desired search inputs when toggled, which a screenshot shown in Figure 6.9. Users are able to search for a particular property listing by either entering in its address, city or location. Once the users are satisfied with their search inputs, they can then proceed to click on the search icon located towards the right of the bar itself whereby they would then be redirected to a page in which their search results will be displayed.

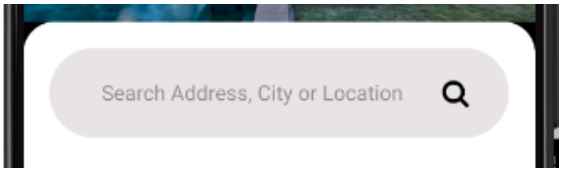

Figure 6.9: Search Bar

6.2.5 Display Search Results

One of the disadvantages of using Firebase as the back-end database storage is that Firebase does not have a built-in feature that enables a full-text search to be carried out. For example, users would like to search for a particular property listing by specifying a particular text, which could be a substring of the listing's address. However, as Firebase's Cloud Firestore does not support native indexing and searching for text fields in documents, the use of a dedicated third-party search provider such as Elastic, Algolia or Typesense. The downside is that all these public cloud managed services require a subscription fee before being able to access its functionalities.

Figure 6.10: Array Of Tokenized Addresses In Firebase Cloud Firestore

One workaround that has been adopted into this project that could still enable the search feature to be conducted is to tokenize the entire listing's address into an array of strings as shown in Figure 6.10 above and make use of

Firebase's query operators. The chosen compound query method is the "array-contains" operator, which enables strings to be filtered based on values within the specified array. As a result, the search feature is working as expected with the results being displayed in Figure 6.11 below.

```
useEffect(() => {
  const tempListings = [];

  firebase
    .firestore()
    .collection("listings")
    .where(
      "addressLowercase",
      "array-contains",
      searchText.toLowerCase().trim()
    )
    .get()
    .then((querySnapshot) => {
      querySnapshot.forEach((doc) => {
        tempListings.push(doc.data());
      });

      setListings(tempListings);
    });
}, []);
```

Figure 6.11: Firebase's "array-contains" Search Feature Workaround

6.2.6 Search By Maps

The feature that enables users to search for a specific property listing through a map view was implemented using a combination of react-native-maps, react-native-google-places-autocomplete, and geolib. Each of the components mentioned above play a vital role in bringing this feature to fruition, and each of their usage will be further elaborated below along with Figure 6.12 to provide a clearer visualization of the outcome of the implementation.

Figure 6.12: React Native Map View

Firstly, react-native-maps was selected to facilitate with the implementation of this feature because its MapView API component is constructed in such a way that their custom layouts can be added as a child component of the MapView itself. The map was first rendered with an initially specified region on load using the predefined geographic coordinates, which can be programmatically changed upon usage by using React Native's refs, component methods or states.

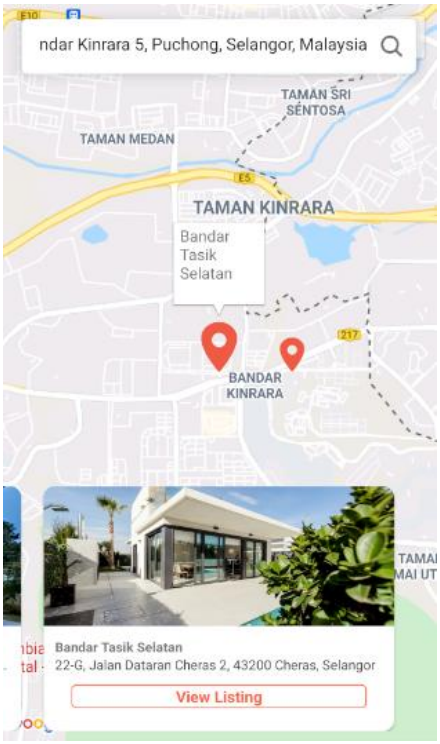

Figure 6.13: Animated Markers, Callouts And Horizontal Card View

Moreover, react-native-maps is also capable of handling animations by having the entire component being defined as an animated component. Thus, an animated marker was also used to implement this feature by increasing the custom marker's size based on the user's selection when scrolling through the horizontal card views located on the bottom of the screen. A sample screenshot of the outcome can be shown in Figure 6.13 above. This is done by modifying the region prop of the component to control the map marker's positioning. As you might have noticed when navigating through the horizontal card views, a custom callout is also interactive in a similar manner just like the red markers. These callouts react arbitrarily with the user's selection by displaying the names of the selected property listing to provide a much-enhanced user experience.

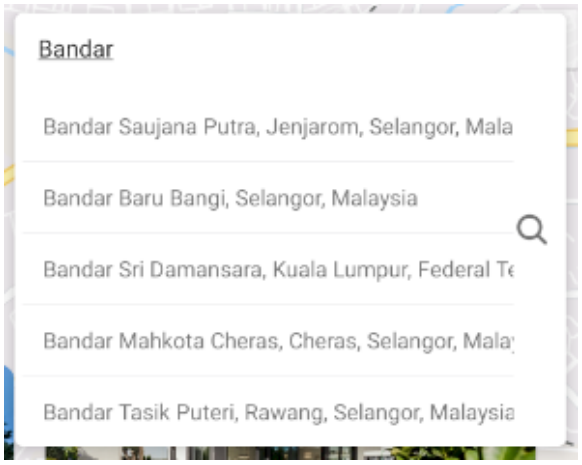

Figure 6.14: React Native Google Places Autocomplete

Moving on, we would proceed to explain how react-native-google-places-autocomplete helps in realizing this search feature. In certain applications, suggestions tend to be displayed below the search bar even before the entire search input is entered completely. This functionality can be accomplished with minimal effort without expending too much development time by just calling this API directly from the package. As this application only focuses on targeting real estate properties that are located in Malaysia, the search feature is capable to reflect this by limiting the search suggestions and results to just one country by specifying it on the components sub-prop within the query prop. As a result, the implementation was a success as Figure 6.14 shows that all the suggested locations are situated within Malaysia only.

```
const renderMarkers = () => {
  let markerToBeRendered = listings.filter((marker) => {
    let distance = geolib.getDistance(
      { latitude: region.latitude, longitude: region.longitude },
      {
        latitude: marker.coordinate.latitude,
        longitude: marker.coordinate.longitude,
      }
    );

    return distance <= 5000;
  });

  setMarkers(markerToBeRendered);
};
```

Figure 6.15: Function To Limit Listing Results Within 5 Kilometers

Thirdly, rendering all the available property listings at once within the application takes a long time and is expensive in terms of computing resources. Therefore, the search results being displayed should only be limited to a certain range that is specified by the user's search input, that it within a 5 kilometers radius only. Therefore, the geolib library is able to assist this developmental process by calculating the distance between two geographic coordinates and only returning the search results that fall within the specified range. A code snippet of the function used to achieve this was shown in Figure 6.15 above.

6.2.7 Selected Property Listings Page

Upon selecting a particular property listing either from the Home Page, maps view or search results, users would then be redirected to an interface whereby they are provided with a detailed description on the selected property. While some contents of the description can be directly retrieved from Firebase's Cloud Storage as it was store in that manner, certain information is retrieved and processed dynamically, which can be found in the amenities section of the interface as shown in Figure 6.16 below.

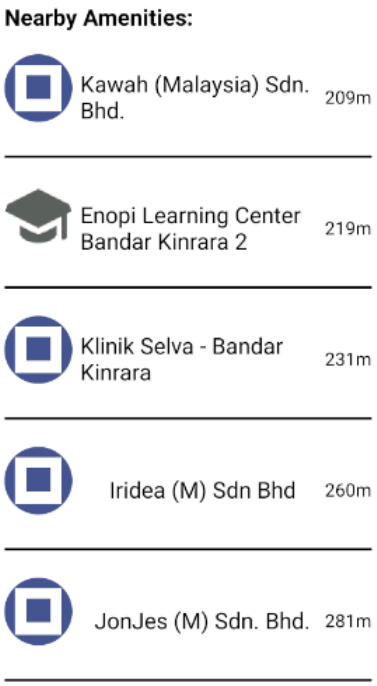

Figure 6.16: Nearby Amenities List

```
getAmenities = () => {
  const url = "https://maps.googleapis.com/maps/api/place/nearbysearch/json?";
  const location = `location=${this.state.listing.coordinate.latitude},${this.state.listing.coordinate.longitude}`;
  const radius = "&radius=1000";
  const key = "&key=AIzaSyBjpFW7RwycLmTUbAVtU4_swA4lJ3wf4TA";
  const amenitiesSearchUrl = url + location + radius + key;
```

Figure 6.17: Google Places API

Nearby amenities of a particular property listing can be retrieve dynamically using Google Places API along with the help of the geolib library. The main goal is to retrieve all popular landmarks that are within a 1 kilometer range from the property listing's geographical coordinates. The API request is called in a HTTP URL format with all the necessary parameters specified, geographic coordinates defined, and all the search results will be returned in JSON format automatically. A code snippet of the function used to achieve this was shown in Figure 6.17 above. The geolib library is responsible for calculating the distance between the landmarks and the listing's location in order to properly display the results in a more structured manner.

6.2.8 Real Estate Agents List & Details

In order to ease the process for users to search for a real estate agent that could assist and help in accomplishing their required tasks, the application will group the real estate agents according to their specialties. Although this feature might not have any form of external complexities as compared to the other sub-modules, but proper structuring of information on user interfaces is essential in enhancing the user's experience. Through this feature, users will be able to obtain the selected real estate agent's contact information along with their specialty and services offered.

6.2.9 Virtual Tour

The virtual tour feature offers an additional method to view a particular property listing instead of having just the traditional static images. This feature was implemented by using lightbase/react-native-panorama-view and react-native-smooth-picker, and the areas where each of these packages are implement will be further elaborated in more detailed.

Panoramic images can be embedded as part of the entire mobile phone screen with just a simple component's API call offered by lightbase/react-

native-panorama-view. Users are able to scroll through the panorama image by swiping the screen from any directions that they prefer. This feature offers an extension towards the traditional static images and a cheaper substitute as compared to VR hardware. The outcome is shown in Figure 6.18 below.

Figure 6.18: Virtual Tour Panoramic View And Smooth Picker

As a real estate property does not consist of only one single area within its parameters, there are multiple rooms to be explored through virtual tours instead of just a single panoramic view. In order to accomplish this, the application would first be required to preload all the panoramic image URIs from Firebase's Cloud Firestore and store it within an array. Once that process has been completed, the application would then proceed to map the index of the array to a picker, which is managed by a component from the react-native-smooth-picker package. Upon accomplishing this process, the panoramic image view can be rendered according to the image array's index toggled by the picker, enabling users to navigate between different premises of the selected property listing.

6.2.10 User Profile

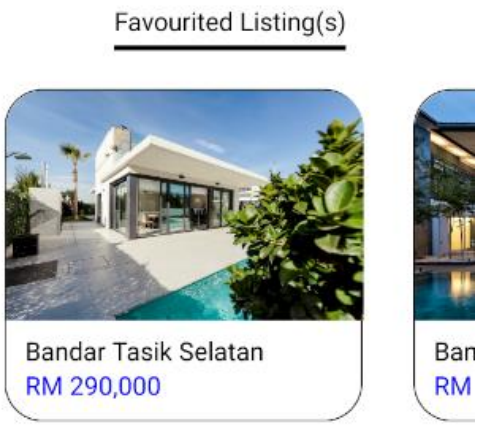

Figure 6.19: User's Favourited Listings List

Apart from the user's own personal information, the user's profile page also displays information regarding the property listings that they have previously favourited in the past as shown in Figure 6.19 above. This information is retrieved from Firebase's Cloud Firestore by calling Firebase Function's APIs. Moreover, users are also able to navigate to the chat list page and view all their scheduled appointments from their profile by clicking on their respective button.

6.2.11 Chat List

Figure 6.20: User's Chat List

Figure 6.20 shows the entire chat list of a particular user, accessed from their respective profile. Within this page, the list of all the available chats between a combination of different real estate agents and different property listings can be viewed. Other details include the time that the last message was sent to the

designated chat room and the last message that was sent. Clicking on either one of the chats will redirect users to the chat room, whereby the entire conversation can be viewed in a more detailed manner.

6.2.12 Chat Messaging Feature

One of the main reasons why Firebase was chosen as the project's back-end database storage is due to the fact that it works very well with react-native-gifted-chat. This package not only offers a simple approach in creating a complete chat UI for a React Native application, but it also provides various of other beneficial features such as having customizable components, composer actions to send images, multi-line text input and system messages. By making slight modifications to the GiftedChat component, a full-fledged chat feature can be deployed almost immediately by being able to send, store and fetch messages to and from Firebase's Cloud Firestore. However, sending images through react-native-gifted-chat has to be assisted with an image picker, which can be accomplished by using the react-native-image-picker package. As a result of the combination of the above-mentioned packages used, the chat messaging feature of the application was a success, and a sample chat between a tenant and a real estate agent is shown in Figure 6.21 and 6.22 below.

Figure 6.21: Sending Messages And Images Through Text

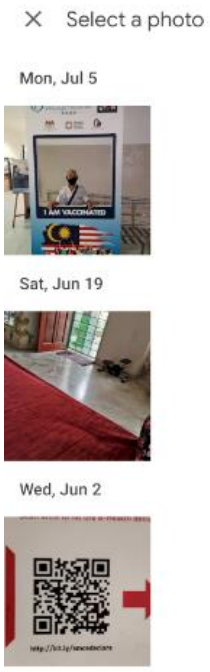

Figure 6.22: React Native Image Picker

6.2.13 Schedule Appointments

Users can also schedule appointments with the real estate agent in charge of the targeted property listing that they are interested in within the chat interface of the application. This can be accomplished by clicking on the “three dots” icon located on the top right corner of the screen, whereby an animated bottom sheet will then be displayed on the screen for the user to enter their appointment details as shown in Figure 6.23 below.

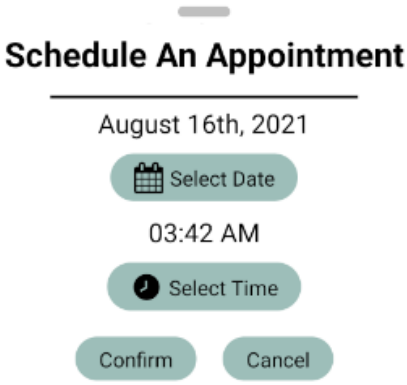

Figure 6.23: Appointments Scheduling Bottom Sheet

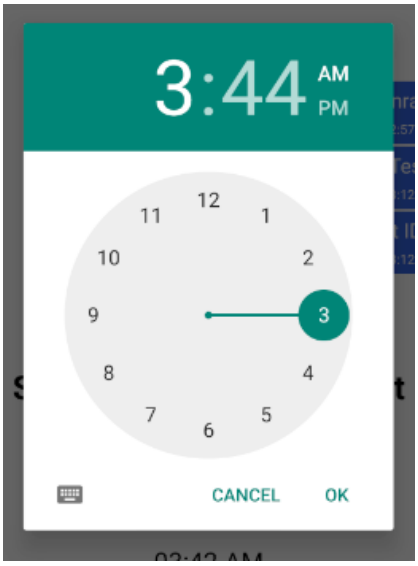

Figure 6.24: React Native Date Time Picker

The react-native-community/datetimepicker package is capable of fulfilling this requirement by having a built-in native date and time picker respectively to accommodate the selection of the appointment's date and time as shown in Figure 6.24 above. Once the date and time for the appointment to be scheduled is set, users can proceed to click on the "Confirm" button to submit their appointment schedule request, which will be stored in a proper format as assisted by JavaScript's moments.

6.2.14 View Appointments

Figure 6.25 below demonstrates the scheduled appointments list of a particular tenant. Users are able to verify the status of their appointment by accessing their appointments list from their respective profiles, which could be either "Pending", "Accepted" or "Declined" depending on the real estate agent's response.

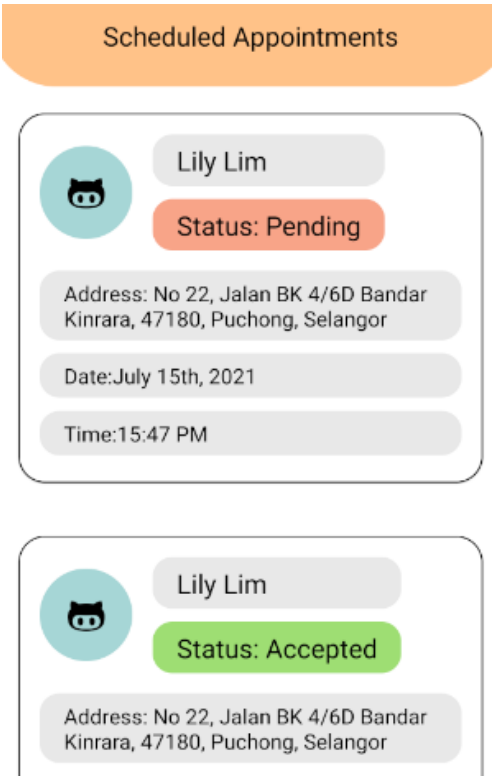

Figure 6.25: Scheduled Appointments List

6.3 Modules For Real Estate Agents

This section aims to focus on elaborating the implementation details for all the real estate agent's modules that were implemented as part of this project.

6.3.1 Real Estate Agent Profile

Similar to how the user profile's interface is like, the real estate agent's profile also contains their own personal information along with a horizontal scroll view containing a list of all their published property listings. This information is also retrieved from Firebase's Cloud Firestore by calling Firebase Function's APIs.

6.3.2 Appointments List

A real estate agent's appointment list differs slightly from the ones a regular user has and this can be seen from Figure 6.26 below. Not only does it allow them to view a list of all the appointments that their potential customers have scheduled with them previously, but they are also able to either "Accept" or "Decline" a particular appointment by clicking on their corresponding buttons.

Once the action is triggered by the real estate agents, the appointment's details will be updated in both them and their corresponding user's Firebase Cloud Firestore's document accordingly.

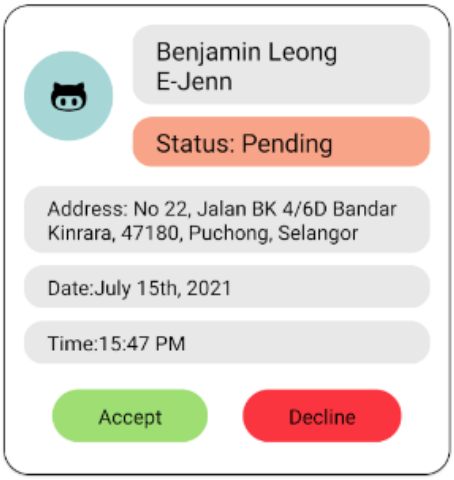

Figure 6.26: Scheduled Appointment With "Pending" Status

6.3.3 Add New Property Listing

Upon clicking on the "+" button located on the bottom right corner of the real estate agent's profile, they would be automatically navigated to a page which enables them to publish a new property listing to the application. While most of the input fields that are being prompted on the application can be filled in with minimal effort through a TextInput field, there are certain information that require a little computation before the data is able to be stored within Firebase's Cloud Firestore.

```
geocodeAddress = () => {
  // Search by address
  Geocoder.from(this.state.address).then((json) => {
    var location = json.results[0].geometry.location;
    console.log(location);

    this.setState(
      {
        coordinates: { latitude: location.lat, longitude: location.lng },
      },
      function () {
        this.submitButtonPressed();
      }
    );
  });
};
```

Figure 6.27: Function To Geocode Addresses Using React Native Geocoding

Firstly, a coordinate has to be assigned to the database based on the current property listing's address, which can be achieved by geocoding the address inputted using the react-native-geocoding package. This package contains a Geocoder component whereby physical address, such as a street address or town name can be transformed into a set of geographic coordinates as it utilizes Google Maps Geocoding API to accomplish it. In terms of the implementation within React Native, the code snippet in Figure 6.27 above is capable of achieving the intended feature.

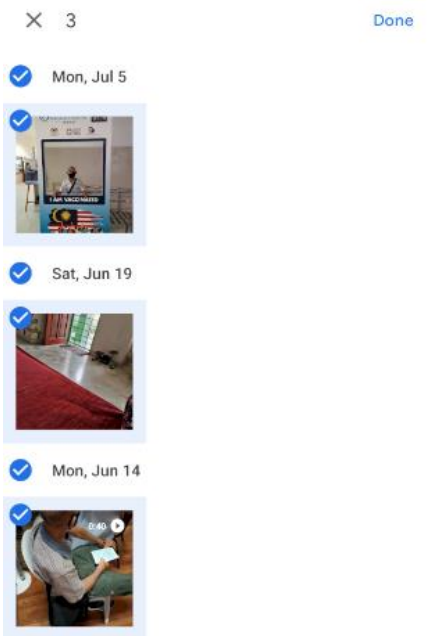

Figure 6.28: Select Multiple Images With React Native Image Crop Picker

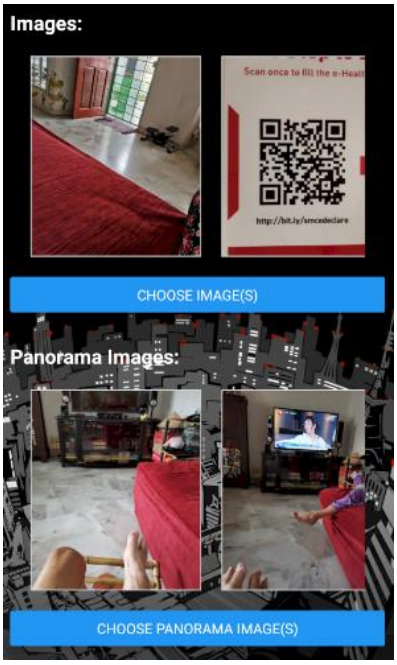

Figure 6.29: Multiple Images Uploaded After Confirmed Selection

On the other hand, as each property listing contains a lot of listing images and panoramic images, a React Native package such as the react-native-image-crop-picker is selected to handle the task of allowing real estate agents to submit multiple images to be stored into the Firebase Storage as shown in Figure 6.28 and 6.29 above. The react-native-image-crop-picker package is capable to enable its users to take photos from the camera as well as upload images and videos with multiple configurable compression qualities. As the application is only interested in enabling the real estate agents to upload multiple images and not videos, a prop can be set to implement the said feature. The application reuses the same image picker component to enable the uploads of both the static images and panoramic images, which component state to update is depending on the prop that is being passed into the function. In order to prevent the overwriting of the same image when it coincidentally has a same name, a timestamp is appended to the file name, which makes it unique within the database regardless.

```
splitAddress = () => {
  this.setState({
    addressLowercase: this.state.address.replace(/,/g, " ").trim().split(" "),
  });
};
```

Figure 6.30: Function To Tokenize Addresses

As mentioned in Section 6.2.5, the search feature of this application requires the address to be tokenized into an array of strings in order for this functionality to be working as expected. This is no exception to every new property listing that is being added into the application. Therefore, a function called splitAddress() will be defined to manage this process and update the state of the computed results as shown in Figure 6.30 above.

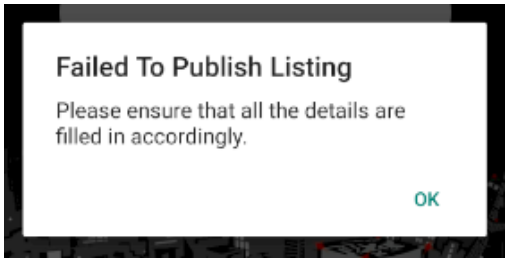

Figure 6.31: Failure To Publish New Listing Error Message

Should the real estate agent attempt to publish a new property listing with at least one of the input fields left empty, an error message similar to the one in Figure 6.31 above will be displayed, indicating that they are required to fill in all the necessary information accordingly.

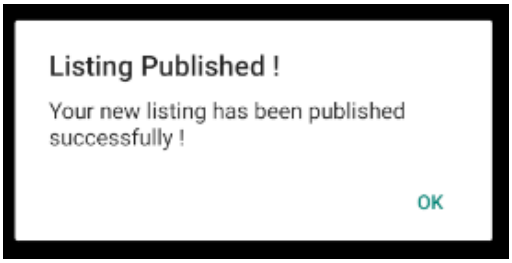

Figure 6.32: Listing Published Successfully Alert Message

However, once all the required information is filled in completely, the real estate agents can proceed to click on the “Submit” button in order to proceed and publish their new property listing on the application. This process

will be facilitated with an alert message as shown in Figure 6.32 above, to provide feedbacks to the end users regarding their progress.

6.4 Modules For Administrators

This section aims to focus on elaborating the implementation details for all the administrator's modules that were implemented as part of this project.

6.4.1 List Of Real Estate Agents

Only administrators of the application are capable of gaining access to this page as it displays all the real estate agents that are registered within the application. A well-structured DataTable from the react-native-paper package was used to display the said results.

6.4.2 Add New Real Estate Agents

Figure 6.33: Adding Multiple Regions And Services For Real Estate Agents

In order to register for a new real estate agent, the administrators are required to fill in all the necessary information as prompted by the application. Unlike how real estate agents add new property listings into their application which requires images, the administrators are only required to fill in input texts.

In addition, should the real estate agents that the administrators wish to add contains more than one region and/or service that they are planning to

offer, then could add an additional field by clicking on the “+” button accordingly as shown in Figure 6.33 above.

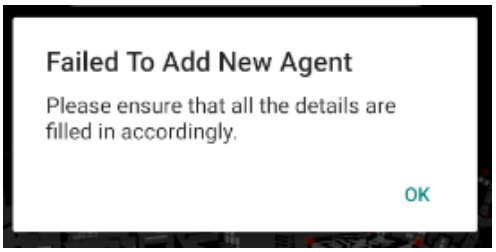

Figure 6.34: Error Message With At Least 1 Input Field Empty

Should the administrators attempt to submit the form with at least one of the input fields being left empty, an error message similar to the one in Figure 6.34 above will be prompted, indicating that they are required to fill in all the details accordingly as they are mandatory.

Figure 6.35: Error Message With An Invalid E-Mail Format

Similarly, an error message will be displayed to the administrators should they attempt to submit the form with an invalid e-mail format being entered as shown in Figure 6.35 above.

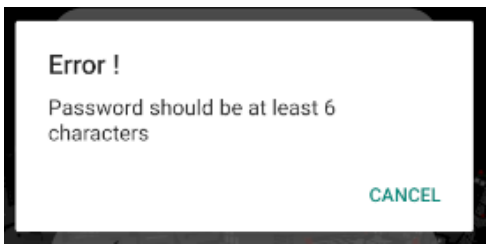

Figure 6.36: Error Message With A Password Of Less Than 6 Characters

An error message will be displayed to the administrators should they attempt to submit the real estate agent account creation form with a password of less than 6 characters as shown in Figure 6.36 above.

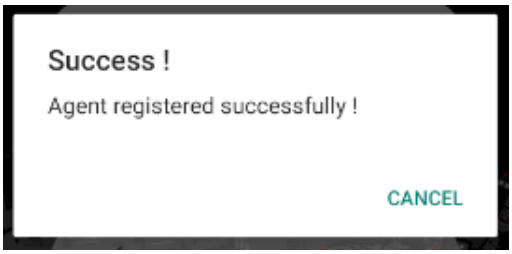

Figure 6.37: New Real Estate Agent Added Successfully

Once all the input fields satisfy the requirements of the application and the administrator clicks on the “Add Agent” button. An alert message will be prompted similar to the one in Figure 6.37 above, indicating that the real estate agent has been added successfully, and the administrator will be redirected back to the Admin Home Page thereafter.

CHAPTER 7

TESTING AND EVALUATION

7.1 Introduction

This chapter aims to discuss the testing activities that were executed after each evolutionary prototyping's implementation phase of the property listing application. Testing was conducted iteratively throughout the entire software development life cycle to ensure that all the features and functionalities of the application are working as expected. Furthermore, it was also performed to ensure that any issues and bugs that were introduced could be detected earlier to prevent any major impediments from occurring in the later stages of the software development lifecycle. Four types of testing methods were conducted, which includes unit testing, integration testing, usability testing as well as user acceptance testing respectively.

7.2 Unit Testing

Unit testing is an approach that is performed to verify that each individual component of the software manages to achieve the features and functionalities determined by its pre-defined set of requirements. The entire software system was broken down into their own individual units, whereby suitable test cases are associated to each of the respective units. By doing so, bugs and defects within a software system can be detected in a similar manner to a bottom-to-top approach. This manages to reduce the time required to troubleshoot issues within the code base, which also reduces development time as the code base is capable to be narrowed down to a specific unit's source code.

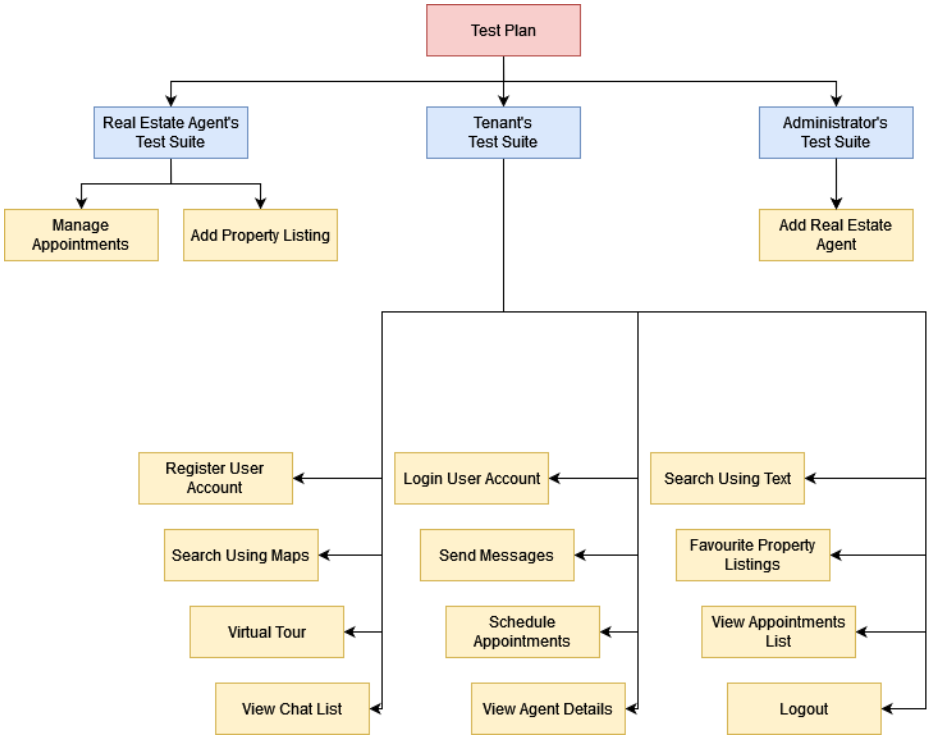

Figure 7.1: Test Plan

28 different unit test cases were executed in total across all modules defined within the project in which the test cases are grouped together based on their modules, these are also known as test suites. This can be seen from Figure 7.1 above whereby each module was grouped together according to their respective user type, which are tenants, real estate agents and administrators respectively. However as mentioned previously in Chapter 5 and 6, real estate agents are capable of performing the exact same features as tenants, with the addition of 2 unique features, which are manage appointments and add property listings respectively. Therefore, to reduce redundancy during the testing process, the test cases are designed in such a way that each similar feature is only tested once.

For each module, there are several details that are required to take note of, which will be summarized in Table 7.1 below.

Table 7.1: Unit Test Form Field Names And Descriptions

Field	Description
Pre-Condition	Condition(s) in which must be fulfilled before the start of a particular test suite.
Dependencies	Modules which the test suite covers.
Test Priority	Status used to associate the level of priority of each test suite.
Test Case ID	Unique ID that is used to associate each individual test case within the project.
Test Summary	Short description to provide a brief overview on what the entire test case focuses on.
Test Steps	Series of detailed steps to guide the testers on how to execute a particular test case step-by-step.
Test Data	Data required throughout the entire process of executing a particular test case.
Expected Results	Results / outputs that the test case is expected to achieve.
Actual Results	Results / outputs that the test case managed to achieve after its execution.
Post-Condition	Condition(s) that the testers will come across upon the completion of the execution of a particular test case.
Status	Status to indicate whether the actual results obtained matches the expected results, which is tagged using either Pass / Fail respectively.

7.2.1 Tenant Module Test Suites

Table 7.2: Unit Test Case For Register Tenant Account

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Register Tenant Account**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to have a valid e-mail address.
Dependencies:	Tenant module.
Test Priority:	High.

Test Case ID:	TCRTA-001	**Status (Pass/Fail):**	Pass
Test Summary:	Register a new account using a valid e-mail, name and password.		
Expected Result:	A "Sign Up Successful !" alert message, indicating that the account registration process was successful.		
Actual Result:	A "Sign Up Successful !" alert message, indicating that the account registration process was successful.		
Post-Condition:	Redirect tenants to the login page.		
Test Steps		**Test Data**	
1. Enter an e-mail.		E-mail with the correct formatting (includes "@" and ".com").	
2. Enter the tenant's name.		Any proper name.	
3. Enter a password.		Password with a minimum of 6 characters.	
4. Tap on the "Sign Up" button.		N/A.	

Test Case ID:	TCRTA-002	**Status (Pass/Fail):**	Pass

Test Summary:	Register a new account using an invalid e-mail address.
Expected Result:	A "Sign Up Failed" alert message, indicating that the account registration process was unsuccessful due to an invalid e-mail format.
Actual Result:	A "Sign Up Failed" alert message, indicating that the account registration process was unsuccessful due to an invalid e-mail format.
Post-Condition:	Redirect tenants to the login page.

Test Steps	**Test Data**
1. Enter an e-mail.	E-mail with incorrect formatting (without "@" and/or ".com").
2. Enter the tenant's name.	Any proper name.
3. Enter a password.	Password with a minimum of 6 characters.
4. Tap on the "Sign Up" button.	N/A.

Test Case ID:	TCRTA-003	**Status (Pass/Fail):**	Pass
Test Summary:	Register a new account using an invalid password.		
Expected Result:	A "Sign Up Failed" alert message, indicating that the account registration process was unsuccessful as the password must be 6 characters long or more.		
Actual Result:	A "Sign Up Failed" alert message, indicating that the account registration process was unsuccessful as the password must be 6 characters long or more.		
Post-Condition:	Redirect tenants to the login page.		

Test Steps	**Test Data**
1. Enter an e-mail.	E-mail with the correct formatting (includes "@" and ".com").

2. Enter the tenant's name.	Any proper name.
3. Enter a password.	Password with less than 6 characters.
4. Tap on the "Sign Up" button.	N/A.

Test Case ID:	TCRTA-004	**Status (Pass/Fail):**	Pass
Test Summary:	Register a new account with an already existing e-mail address.		
Expected Result:	A "Sign Up Failed" alert message, indicating that the account registration process was unsuccessful because the e-mail has already been taken.		
Actual Result:	A "Sign Up Failed" alert message, indicating that the account registration process was unsuccessful because the e-mail has already been taken.		
Post-Condition:	Redirect tenants to the login page.		

Test Steps	**Test Data**
1. Enter an e-mail.	E-mail that has been used to register an account on the application previously.
2. Enter the tenant's name.	Any proper name.
3. Enter a password.	Password with a minimum of 6 characters.
4. Tap on the "Sign Up" button.	N/A.

Table 7.3: Unit Test Case For Login Tenant Account

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Login Tenant Account**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to have an account created / registered.
Dependencies:	Tenant module.
Test Priority:	High.

Test Case ID:	TCLTA-001	**Status (Pass/Fail):**	Pass
Test Summary:	Login using a valid e-mail and password.		
Expected Result:	A "Login Successful !" alert message, indicating that the process was successful.		
Actual Result:	A "Login Successful !" alert message, indicating that the process was successful.		
Post-Condition:	Redirect tenants to the home page.		

Test Steps	**Test Data**
1. Enter an e-mail.	E-mail that was used to created / register an account previously.
2. Enter a password.	Password of the associated e-mail.
3. Tap on the "Login" button.	N/A.

Test Case ID:	TCLTA-002	**Status (Pass/Fail):**	Pass
Test Summary:	Login using an invalid e-mail and/or password.		
Expected Result:	An "Invalid E-Mail / Password Entered" alert message, indicating that the process was unsuccessful due to an invalid information being entered.		
Actual Result:	An "Invalid E-Mail / Password Entered" alert message, indicating that the process was unsuccessful due to an invalid information being entered.		
Post-Condition:	Redirect tenants to the home page.		

Test Steps	**Test Data**
1. Enter an e-mail.	E-mail with incorrect formatting (without "@" and/or ".com") and/or have not been used to register for an account previously.
2. Enter a password.	Password without a minimum of 6 characters and/or is not associated to the e-mail entered.
3. Tap on the "Login" button.	N/A.

Table 7.4: Unit Test Case For Search Using Text

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Search Using Text**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account.
Dependencies:	Tenant module.
Test Priority:	Moderate.

Test Case ID:	TCSUT-001	**Status (Pass/Fail):**	Pass
Test Summary:	Search for property listings with correct search results being displayed.		
Expected Result:	All property listings in Cheras will be displayed on the screen.		
Actual Result:	All property listings in Cheras were displayed on the screen.		
Post-Condition:	N/A.		
Test Steps		**Test Data**	
1. Click on the search bar		N/A.	
2. Enter a valid district, street address or other valid location addresses.		Type "cheras" into the search bar, which is a valid address location.	
3. Tap on the "Search" icon.		N/A.	
4. View the displayed search results.		N/A.	

Test Case ID:	TCSUT-002	**Status (Pass/Fail):**	Pass

Test Summary:	Search for property listings with no search results being displayed.
Expected Result:	No property listings will be displayed on the screen.
Actual Result:	No property listings were displayed on the screen.
Post-Condition:	N/A.

Test Steps	**Test Data**
1. Click on the search bar	N/A.
2. Enter a valid district, street address or other valid location addresses.	Type "abcd1234" into the search bar, which is an invalid address location.
3. Tap on the "Search" icon.	N/A.
4. View the displayed search results.	N/A.

Table 7.5: Unit Test Case For Search Using Maps

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Search Using Maps**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account.
Dependencies:	Tenant module.
Test Priority:	Moderate.

Test Case ID:	TCSUM-001	**Status (Pass/Fail):**	Pass
Test Summary:	Search for property listings with correct search results being displayed.		
Expected Result:	All available property listings within Bandar Kinrara 5 will be displayed on the screen.		
Actual Result:	All available property listings within Bandar Kinrara 5 are displayed on the screen.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Click on the Maps tab on the bottom navigation bar.	N/A.
2. Tap on the search bar.	N/A.
3. Enter a valid district, street address or other valid location addresses.	Type "Bandar Kinrara" into the search bar.
4. Tap on the intended search address.	Tap on "Bandar Kinrara 5…" from the suggested list.
5. View the displayed search results.	N/A.

Test Case ID:	TCSUM-002	**Status (Pass/Fail):**	Pass
Test Summary:	Search for property listings with no search results being displayed.		
Expected Result:	No property listings will be displayed on the screen.		
Actual Result:	No property listings were displayed on the screen.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Click on the Maps tab on the bottom navigation bar.	N/A.
2. Tap on the search bar.	N/A.
3. Enter a valid district, street address or other valid location addresses.	Type "Georgetown" into the search bar.
4. Tap on the intended search address.	Tap on "Georgetown…" from the suggested list.
5. View the displayed search results.	N/A.

Table 7.6: Unit Test Case For Send Messages

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Send Messages**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account.
Dependencies:	Tenant module.
Test Priority:	High.

Test Case ID:	TCSM-001	**Status (Pass/Fail):**	Pass
Test Summary:	Send text messages through the chat feature.		
Expected Result:	The sent message will be updated in the chat room.		
Actual Result:	The sent message was updated in the chat room.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Tap on a property listing either from the home page, search results or maps.	Any selected property listing.
2. Navigate to the "Agent Details" section.	N/A.
3. Tap on the "Contact Now" button.	N/A.
4. In the text input bar, type a message.	Any text input message (For example, "Hi There !")
5. Tap on the blue "Send" icon.	N/A.

Test Case ID:	TCSM-002	**Status (Pass/Fail):**	Pass
Test Summary:	Send images through the chat feature.		
Expected Result:	The sent image will be updated in the chat room.		
Actual Result:	The sent image was updated in the chat room.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Tap on a property listing either from the home page, search results or maps.	Any selected property listing.
2. Navigate to the "Agent Details" section.	N/A.
3. Tap on the "Contact Now" button.	N/A.
4. Towards the left of the text input bar, tap on the "Paperclip" icon.	N/A.
5. Select an image from the phone's gallery.	Any image from the phone's gallery.
6. Confirm the selection.	N/A.

Table 7.7: Unit Test Case For Favourite Property Listing

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Favourite Property Listings**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account.
Dependencies:	Tenant module.
Test Priority:	Moderate.

Test Case ID:	TCFPL-001	**Status (Pass/Fail):**	Pass
Test Summary:	Favourite and view a selected property listing.		
Expected Result:	The property listing that was favourited will be updated to the list.		
Actual Result:	The property listing that was favourited was updated to the list.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Tap on a property listing either from the home page, search results or maps.	Any selected property listing.
2. Tap on the "Heart" icon located on the top right corner of the interface.	N/A.
3. Click on the Profile tab on the bottom navigation bar.	N/A.
4. View the property listing being updated in the favourites list.	N/A.

Table 7.8: Unit Test Case For Virtual Tour

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Virtual Tour**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account.
Dependencies:	Tenant module.
Test Priority:	High.

Test Case ID:	TCVT-001	**Status (Pass/Fail):**	Pass
Test Summary:	Conduct a virtual tour of a selected property listing.		
Expected Result:	The virtual tour feature will display panoramic images that enables users to navigate between different areas using a slider.		
Actual Result:	The virtual tour feature displayed panoramic images that enables users to navigate between different areas using a slider.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Tap on a property listing either from the home page, search results or maps.	Any selected property listing. (Use "KLCC" for this Test Case)
2. Tap on the "Virtual Tour" button.	N/A.
3. A panoramic image and a slider will be displayed on the screen.	N/A.

4. Navigate around the selected area by swiping left and right.	N/A.
5. Use the slider to change to another area within the selected property.	N/A.
6. The panoramic image will change accordingly.	N/A.

Table 7.9: Unit Test Case For Schedule Appointments

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Schedule Appointments**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account.
Dependencies:	Tenant module.
Test Priority:	High.

Test Case ID:	TCSA-001	**Status (Pass/Fail):**	Pass
Test Summary:	Schedule an appointment with a real estate agent for a particular property.		
Expected Result:	The appointment will be scheduled successfully and the appointments list will be updated.		
Actual Result:	The appointment was scheduled successfully and the appointments list was updated.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Tap on a property listing either from the home page, search results or maps.	Any selected property listing.
2. Navigate to the "Agent Details" section.	N/A.
3. Tap on the "Contact Now" button.	N/A.
4. Tap on the "Three Dots" icon located on the top right corner of the screen.	N/A.
5. Tap on the "Select Date" button.	N/A.

6. Select the date of the desired appointment.	Any desired date. (For example, 15 September 2021)
7. Tap "OK" to confirm the date selection.	N/A.
8. Tap on the "Select Time" button.	N/A.
9. Select the time of the desired appointment.	Any desired time. (For example, 3:30 p.m.)
10. Tap "OK" to confirm the time selection.	N/A.
11. Tap on the "Confirm" button to schedule the appointment.	N/A.

Table 7.10: Unit Test Case For View Appointments List

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**View Appointments List**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account & have an appointment scheduled beforehand.
Dependencies:	Tenant module.
Test Priority:	High.

Test Case ID:	TCVAL-001	**Status (Pass/Fail):**	Pass
Test Summary:	View all of the scheduled appointments.		
Expected Result:	The scheduled appointment will be displayed on the list.		
Actual Result:	The scheduled appointment was displayed on the list.		
Post-Condition:	N/A.		
Test Steps		**Test Data**	
1. Click on the Profile tab on the bottom navigation bar.		N/A.	
2. Tap on the "View Appointments" button.		N/A.	
3. View the scheduled appointments in the list being displayed on screen.		N/A.	

Table 7.11: Unit Test Case For View Chat List

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**View Chat List**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account & have sent or received a message or image in a chat room beforehand.
Dependencies:	Tenant module.
Test Priority:	High.

Test Case ID:	TCVCL-001	**Status (Pass/Fail):**	Pass
Test Summary:	View all of the user's chat rooms.		
Expected Result:	All of the user's chats will be displayed on the list.		
Actual Result:	All of the user's chats was displayed on the list.		
Post-Condition:	N/A.		
Test Steps		**Test Data**	
1. Click on the Profile tab on the bottom navigation bar.		N/A.	
2. Tap on the "Chats" button.		N/A.	
3. View all chat rooms in the list being displayed on screen.		N/A.	

Table 7.12: Unit Test Case For View Agent Details

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**View Agent Details**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account.
Dependencies:	Tenant module.
Test Priority:	High.

Test Case ID:	TCVAD-001	**Status (Pass/Fail):**	Pass
Test Summary:	View details of a selected real estate agent.		
Expected Result:	Details of the selected real estate agent will be displayed on screen.		
Actual Result:	Details of the selected real estate agent was displayed on screen.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Click on the Agents tab on the bottom navigation bar.	N/A.
2. Select any real estate agent's category from the list.	Any real estate agent's category. (For example, Area Specialist)
3. Select any real estate agent that is displayed on screen.	Any real estate agent. (For example, Kevin Teh)
4. View all details of the selected real estate agent.	N/A.

Table 7.13: Unit Test Case For Logout

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Logout**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Tenants are required to log in to their account.
Dependencies:	Tenant module.
Test Priority:	High.

Test Case ID:	TCLout-001	**Status (Pass/Fail):**	Pass
Test Summary:	Logout from the current user's account.		
Expected Result:	The user will be logged out from the application.		
Actual Result:	The user was logged out from the application.		
Post-Condition:	Redirect tenants to the login page.		
Test Steps		**Test Data**	
1. Click on the Profile tab on the bottom navigation bar.		N/A.	
2. Tap on the "Logout" button.		N/A.	

7.2.2 Real Estate Agent Module Test Suites

Table 7.14: Unit Test Case For Manage Appointments

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Manage Appointments**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Real Estate Agents are required to log in to their account & have an appointment scheduled by a user beforehand.
Dependencies:	Real Estate Agent module.
Test Priority:	High.

Test Case ID:	TCMA-001	**Status (Pass/Fail):**	Pass
Test Summary:	Accept a scheduled appointment.		
Expected Result:	The scheduled appointment's status will be updated to "Accepted"		
Actual Result:	The scheduled appointment's status was updated to "Accepted"		
Post-Condition:	Both the "Accept" and "Decline" buttons will be hidden from the interface.		

Test Steps	**Test Data**
1. Click on the Profile tab on the bottom navigation bar.	N/A.
2. Tap on the "View Appointments" button.	N/A.
3. View the scheduled appointments in the list being displayed on screen.	N/A.

4. Tap on the "Accept" button for a selected property listing.	Any pending scheduled appointments.

Test Case ID:	TCMA-002	**Status (Pass/Fail):**	Pass
Test Summary:	Decline a scheduled appointment.		
Expected Result:	The scheduled appointment's status will be updated to "Declined"		
Actual Result:	The scheduled appointment's status was updated to "Declined"		
Post-Condition:	Both the "Accept" and "Decline" buttons will be hidden from the interface.		

Test Steps	**Test Data**
1. Click on the Profile tab on the bottom navigation bar.	N/A.
2. Tap on the "View Appointments" button.	N/A.
3. View the scheduled appointments in the list being displayed on screen.	N/A.
4. Tap on the "Decline" button for a selected property listing.	Any pending scheduled appointments.

Table 7.15: Unit Test Case For Add Property Listing

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Add Property Listing**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Real Estate Agents are required to log in to their account.
Dependencies:	Real Estate Agent module.
Test Priority:	High.

Test Case ID:	TCAPL-001	**Status (Pass/Fail):**	Pass
Test Summary:	Add a new property listing using valid information.		
Expected Result:	A "Listing Published !" alert message will be displayed indicating that the new listing was published successfully.		
Actual Result:	A "Listing Published !" alert message was displayed indicating that the new listing was published successfully.		
Post-Condition:	Redirect real estate agents to their respective profile page.		

Test Steps	**Test Data**
1. Click on the Profile tab on the bottom navigation bar.	N/A.
2. Tap on the "+" button.	N/A.
3. Tap on the "House" button.	N/A.
4. Fill in a valid name.	Fill in the name of the property listing, do not leave the input field blank.

5. Fill in a valid address.	Fill in the address of the property listing, do not leave the input field blank.
6. Fill in a valid number of bedrooms.	Fill in the number of bedrooms of the property listing, do not leave the input field blank.
7. Fill in a valid number of bathrooms.	Fill in the number of bathrooms of the property listing, do not leave the input field blank.
8. Fill in a valid district.	Fill in the district of the property listing, do not leave the input field blank.
9. Fill in a valid state.	Fill in the state of the property listing, do not leave the input field blank.
10. Fill in a valid price.	Fill in the price of the property listing, do not leave the input field blank.
11. Fill in a valid price per square feet.	Fill in the price per square feet of the property listing, do not leave the input field blank.
12. Fill in a valid square feet.	Fill in the square feet of the property listing, do not leave the input field blank.
13. Fill in a valid property type.	Fill in the property type of the property listing, do not leave the input field blank.
14. Tap on the "Choose Images" button.	N/A.
15. Select one or more images from the phone's gallery.	Any image from the phone's gallery
16. Confirm the selection.	N/A.

17. Tap on the "Choose Panorama Images" button.	N/A.
18. Select one or more panorama images from the phone's gallery.	Any image from the phone's gallery
19. Confirm the selection.	N/A.
20. Fill in valid panorama names in all of the input fields specified.	Fill in the panorama names for the selected panorama images, do not leave the input field blank.
21. Click on the "Submit" button.	N/A.

Test Case ID:	TCAPL-002	**Status (Pass/Fail):**	Pass
Test Summary:	Add a new property listing using invalid information by leaving at least one of the input fields blank.		
Expected Result:	A "Failed To Publish Listing" alert message will be prompted indicating that the listing was not added successfully because there are still empty input fields.		
Actual Result:	A "Failed To Publish Listing" alert message was prompted indicating that the listing was not added successfully because there are still empty input fields.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Click on the Profile tab on the bottom navigation bar.	N/A.
2. Tap on the "+" button.	N/A.
3. Tap on the "House" button.	N/A.
4. Fill in a valid name.	Fill in the name of the property listing or leave the input field blank.

5. Fill in a valid address.	Fill in the address of the property listing or leave the input field blank.
6. Fill in a valid number of bedrooms.	Fill in the number of bedrooms of the property listing or leave the input field blank.
7. Fill in a valid number of bathrooms.	Fill in the number of bathrooms of the property listing or leave the input field blank.
8. Fill in a valid district.	Fill in the district of the property listing or leave the input field blank.
9. Fill in a valid state.	Fill in the state of the property listing or leave the input field blank.
10. Fill in a valid price.	Fill in the price of the property listing or leave the input field blank.
11. Fill in a valid price per square feet.	Fill in the price per square feet of the property listing or leave the input field blank.
12. Fill in a valid square feet.	Fill in the square feet of the property listing or leave the input field blank.
13. Fill in a valid property type.	Fill in the property type of the property listing or leave the input field blank.
14. Tap on the "Choose Images" button.	N/A.
15. Select one or more images from the phone's gallery.	Any image from the phone's gallery
16. Confirm the selection.	N/A.

17. Tap on the "Choose Panorama Images" button.	N/A.
18. Select one or more panorama images from the phone's gallery.	Any image from the phone's gallery
19. Confirm the selection.	N/A.
20. Fill in valid panorama names in all of the input fields specified.	Fill in the panorama names for the selected panorama images or leave the input field blank.
21. Click on the "Submit" button.	N/A.

7.2.3 Administrator Module Test Suites

Table 7.16: Unit Test Case For Add Real Estate Agent

Project Name:	**Property Listing Application**	**Test Executed By:**	**Benjamin Leong E-Jenn**
Module Name:	**Add Real Estate Agent**	**Test Execution Date:**	**18-Aug-21**

Pre-Condition:	Administrators are required to log in to their account.
Dependencies:	Administrator module.
Test Priority:	High.

Test Case ID:	TCAREA-001	**Status (Pass/Fail):**	Pass
Test Summary:	Add a new real estate agent using valid information.		
Expected Result:	A "Success !" alert message, indicating that the new real estate agent was added successfully.		
Actual Result:	A "Success !" alert message, indicating that the new real estate agent was added successfully.		
Post-Condition:	Redirect administrators to the admin home page.		
Test Steps		**Test Data**	
1. Tap on the "Add New Agent" button.		N/A.	
2. Fill in a valid name.		Fill in the name of the real estate agent, do not leave the input field blank.	
3. Fill in a valid e-mail.		Fill in the e-mail of the real estate agent with the correct formatting (includes "@" and ".com").	
4. Fill in a valid password.		Fill in the password with a minimum of 6 characters.	

5. Fill in a valid company.	Fill in the company of the real estate agent, do not leave the input field blank.
6. Fill in a valid specialty.	Fill in the specialty of the real estate agent, do not leave the input field blank.
7. Fill in one or more valid regions.	Fill in at least one of the real estate agent's regions, do not leave the input field blank.
8. Fill in one or more valid services.	Fill in at least one of the real estate agent's services, do not leave the input field blank.
9. Tap on the "Add Agent" button.	N/A.

Test Case ID:	TCAREA-002	**Status (Pass/Fail):**	Pass
Test Summary:	Add a new real estate agent using an invalid e-mail address.		
Expected Result:	A "Error !" alert message, indicating that the new real estate agent was not added successfully due to an invalid e-mail format.		
Actual Result:	A "Error !" alert message, indicating that the new real estate agent was not added successfully due to an invalid e-mail format.		
Post-Condition:	N/A.		
Test Steps		**Test Data**	
1. Tap on the "Add New Agent" button.		N/A.	
2. Fill in a valid name.		Fill in the name of the real estate agent, do not leave the input field blank.	

3. Fill in a invalid e-mail.	Fill in the e-mail of the real estate agent with the incorrect formatting (without "@" and ".com").
4. Fill in a valid password.	Fill in the password with a minimum of 6 characters.
5. Fill in a valid company.	Fill in the company of the real estate agent, do not leave the input field blank.
6. Fill in a valid specialty.	Fill in the specialty of the real estate agent, do not leave the input field blank.
7. Fill in one or more valid regions.	Fill in at least one of the real estate agent's regions, do not leave the input field blank.
8. Fill in one or more valid services.	Fill in at least one of the real estate agent's services, do not leave the input field blank.
9. Tap on the "Add Agent" button.	N/A.

Test Case ID:	TCAREA-003	**Status (Pass/Fail):**	Pass
Test Summary:	Add a new real estate agent using an invalid password.		
Expected Result:	A "Error !" alert message, indicating that the new real estate agent was not added successfully as the password must be at least 6 characters long.		
Actual Result:	A "Error !" alert message, indicating that the new real estate agent was not added successfully as the password must be at least 6 characters long.		
Post-Condition:	N/A.		
Test Steps		**Test Data**	

1. Tap on the "Add New Agent" button.	N/A.
2. Fill in a valid name.	Fill in the name of the real estate agent, do not leave the input field blank.
3. Fill in a valid e-mail.	Fill in the e-mail of the real estate agent with the correct formatting (includes "@" and ".com").
4. Fill in an invalid password.	Fill in the password with less than 6 characters.
5. Fill in a valid company.	Fill in the company of the real estate agent, do not leave the input field blank.
6. Fill in a valid specialty.	Fill in the specialty of the real estate agent, do not leave the input field blank.
7. Fill in one or more valid regions.	Fill in at least one of the real estate agent's regions, do not leave the input field blank.
8. Fill in one or more valid services.	Fill in at least one of the real estate agent's services, do not leave the input field blank.
9. Tap on the "Add Agent" button.	N/A.

Test Case ID:	TCAREA-004	**Status (Pass/Fail):**	Pass
Test Summary:	Add a new real estate agent using an e-mail address that already exists.		
Expected Result:	A "Error !" alert message, indicating that the new real estate agent was not added successfully because the e-mail has already been taken.		
Actual Result:	A "Error !" alert message, indicating that the new real estate agent was not added successfully because the e-mail has already been taken.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Tap on the "Add New Agent" button.	N/A.
2. Fill in a valid name.	Fill in the name of the real estate agent, do not leave the input field blank.
3. Fill in a invalid e-mail.	Fill in the e-mail of the real estate agent that has been used to register an account on the application previously.
4. Fill in a valid password.	Fill in the password with a minimum of 6 characters.
5. Fill in a valid company.	Fill in the company of the real estate agent, do not leave the input field blank.
6. Fill in a valid specialty.	Fill in the specialty of the real estate agent, do not leave the input field blank.
7. Fill in one or more valid regions.	Fill in at least one of the real estate agent's regions, do not leave the input field blank.
8. Fill in one or more valid services.	Fill in at least one of the real estate agent's services, do not

	leave the input field blank.
9. Tap on the "Add Agent" button.	N/A.

Test Case ID:	TCAREA-005	**Status (Pass/Fail):**	Pass
Test Summary:	Add a new real estate agent with at least one of the input fields left empty.		
Expected Result:	A " Failed To Add New Agent" alert message, indicating that the new real estate agent was not added successfully because there are still empty input fields.		
Actual Result:	A " Failed To Add New Agent" alert message, indicating that the new real estate agent was not added successfully because there are still empty input fields.		
Post-Condition:	N/A.		

Test Steps	**Test Data**
1. Tap on the "Add New Agent" button.	N/A.
2. Fill in a valid name.	Leave at least one of the input fields blank.
3. Fill in a valid e-mail.	
4. Fill in a valid password.	
5. Fill in a valid company.	
6. Fill in a valid specialty.	
7. Fill in one or more valid regions.	
8. Fill in one or more valid services.	
9. Tap on the "Add Agent" button.	N/A.

7.3 Usability Testing

Usability testing is required to be conducted in order to be able to evaluate the designed system through the feedback provided by the testers after the testing session has been conducted. Furthermore, the perceptions and feedbacks that the testers provide throughout the entire testing process is valuable in hopes of improving the software system.

Although usability testing and user acceptance testing both share a similar purpose in terms of evaluating the quality of the software system, the difference between them is that usability testing aims to measure the ease for users to utilize the software, while user acceptance testing is done to evaluate the software in order to ensure that the developed software contains functionalities that matches with the requirements that were initially agreed upon.

As the property listing application will be catered towards real estate agents and their potential tenants, 5 real estate agents were selected to participate in the usability testing.

7.3.1 Usability Test Plan

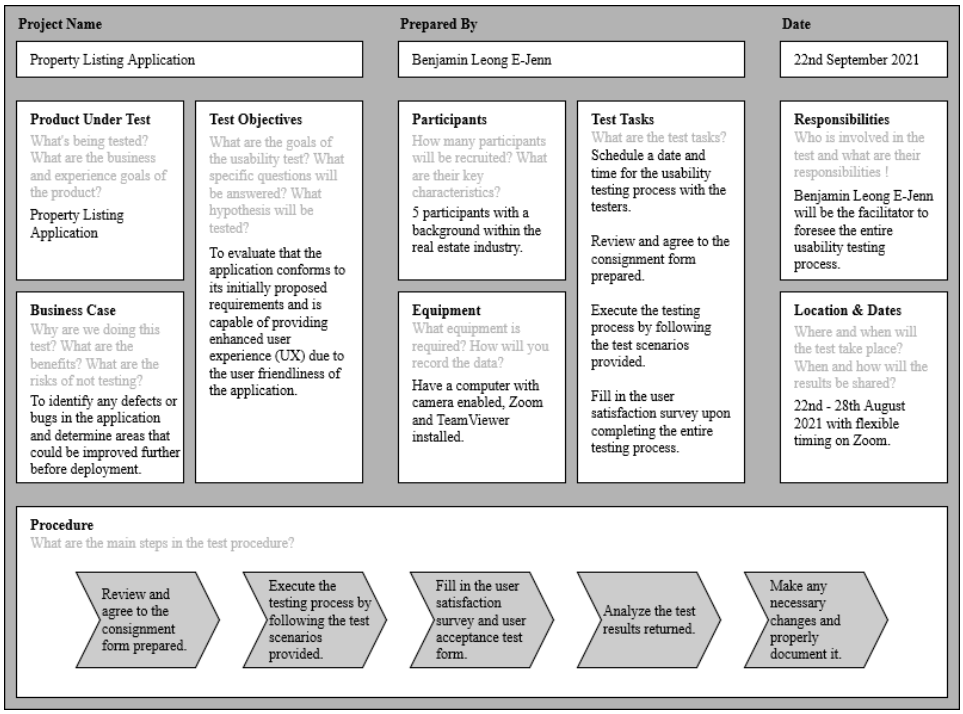

Figure 7.2: Usability Test Plan

A usability test plan is used to identify the product that is currently under test, the objectives of the entire usability testing process, the number of testers participating, the roles and responsibilities of the facilitator, the equipment and tools that are required to perform the test, where and when the test is scheduled to be conducted as well as all the necessary test procedures required to execute the usability testing process.

7.3.2 Usability Test Guidelines

Due to the Covid-19 pandemic restricting the movements of the people among the society, all usability testing procedures will be conducted virtually through a remote access and remote-control computer software, which in this case is TeamViewer.

TeamViewer enables users to gain full control over their partner's remote computer, enabling them to interact and perform the necessary actions in order to complete the test scenarios provided. Moreover, testers are also not required to go through the trouble of installing the application on their own personal devices as the entire testing process can be performed on the remote computer.

All 5 of the testers were provided with 15 test scenarios in which they would attempt to complete all of them on their own with guidance from the host being provided only should they come across any difficulties that may hinder the usability testing process. The details of the test scenarios will be elaborated in Section 7.3.2 of this report. The entire usability testing process will also be recorded with the participant's consent, which could help developers to analyze the issues and problems that they may face during the session.

At the end of each testing process, a user satisfaction survey will be distributed to the participants in which they are required to fill in their scores based on each of the criteria being assessed. The user satisfaction survey will then be retrieved back from the participants upon completion and the information obtained will be tabulated after the System Usability Scale (SUS) score is calculated.

7.3.3 Usability Test Scenarios And User Satisfaction Survey

The usability test scenarios and user satisfaction survey for this project are attached as part of Appendix F and Appendix G respectively.

7.3.4 Usability Test Results

Upon the completion of the usability testing process, the testers are required to fill in a User Satisfaction Survey to judge the usability of the system that has been evaluated. The results will be retrieved, converted into a System Usability Scale (SUS) and be tabulated in Table 7.17 below.

The User Satisfaction Survey consists of 10 statements which are scored from a range of 1 (strongly disagree) to 5 (strongly agree). The scoring system was retrieved from a journal (Brooke, 2020) before being converted into an excel spreadsheet template for a more convenient calculation process. The scoring system is as follows:

1. For odd items: subtract one from the user response.
2. For even-numbered items: subtract the user responses from 5.
3. This scales all values from 0 to 4 (with four being the most positive response).
4. Add up the converted responses for each user and multiply that total by 2.5. This converts the range of possible values from 0 to 100 instead of from 0 to 40.

Table 7.17: System Usability Scale (SUS) Score Results

Participant No.	**Scores Of Each Statement**										**Total**	**SUS Score**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		
1	3	2	3	0	4	2	4	4	3	1	26	65
2	4	4	4	0	4	4	4	4	4	4	36	90
3	3	3	4	4	4	4	4	4	4	4	38	95
4	4	4	4	4	4	4	4	4	4	4	40	100
5	4	3	4	3	4	3	3	4	3	0	31	77.5
Average	3.6	3.2	3.8	2.2	4	3.4	3.8	4	3.6	2.6	34.2	**85.5**

Overall, the property listing application has managed to achieve an average SUS Score of 85.5% as shown in Table 7.17 above.

Furthermore, four descriptive feedback questions were also provided to the users at the end of the User Satisfaction Survey, enabling them to provide short answers to feedback their likes, dislikes and potential improvements regarding the property listing application. In general, the overall responses obtained was positive despite receiving some comments in return on areas which the testers would like to see some enhancements on.

7.4 User Acceptance Testing

As mentioned briefly in the previous section of the report, user acceptance testing (UAT) is done to evaluate the software in order to ensure that the developed software contains functionalities that matches with the requirements that were initially agreed upon.

7.4.1 User Acceptance Testing Guidelines

The same 5 real estate agents that took part in the usability testing were selected to participate in the UAT process. However, since the usability testing's test scenarios covers the features and functionalities of the system apart from just the usability aspects, the testers are not required to re-do the entire testing process from scratch. But instead, the test scenarios will be adjusted slightly during the actual testing process to adhere for not only the usability testing process, but also the UAT process as well.

Aside from just performing the usability testing process according to the test scenarios, testers are also required to evaluate a UAT Test Form by associating either a "Pass" or "Fail" status depending on the respective test cases. However, the facilitator has to guide the testers on when to fill in the UAT Test Form throughout the entire phase as the form contains test steps which may disrupt the integrity of the usability testing process. This is because the usability testing's test scenarios require lesser guidelines to be provided to the participants as compared to the clear test steps provided in the UAT Test Form. Likewise, the facilitators will prevent from giving out any hints unless the testers come face to face with an obstruction during the testing process.

By ensuring that the testers fully understand the entire flow of the testing procedures along with the facilitators handling the testing process with vigilant and care, the integrity of the test results obtained can be maintained.

7.4.2 User Acceptance Testing Results

The user acceptance testing results for this project are attached as part of Appendix H. However, a summary of the overall results obtained was also tabulated in Table 7.18 below.

Table 7.18: Summary Of User Acceptance Testing Results

Test Case ID	Test Module	Number Of Times Performed	Number Of Times Passed
UAT-001	Account Registration	5	5
UAT-002	Login	5	5
UAT-003	Search Using Text	5	5
UAT-004	Search Using Maps	5	5
UAT-005	View Property Listing Details	5	5
UAT-006	Send Messages	5	5
UAT-007	Send Images	5	5
UAT-008	Schedule Appointments	5	5
UAT-009	Virtual Tour	5	5
UAT-010	Favourite A Property Listing	5	5
UAT-011	View Real Estate Agent Details	5	5
UAT-012	Logout	5	5
UAT-013	Manage Appointments	5	5
UAT-014	Publish New Property Listing	5	5

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

With the completion of this project, it can be concluded that the main objective, which was to develop and implement a mobile based property market application within 30 weeks, along with all the other sub-objectives that were defined and set as the milestones for this project has been achieved successfully. In addition, the property listing application that was developed as part of this project was able to conform to the requirements specification that were proposed initially.

As a result, the application is now capable to act as a one stop location to browse, view, organize and enquire about property listings virtually through the edge of the user's fingertips. In addition, a feature was also incorporated to provide an enhanced virtual home viewing experience through panoramic images aside from regular static images. Furthermore, users of the application are now able to schedule appointments with the real estate agents in charge should they encounter a property listing that they are interested in obtaining more information about. Not only that, the property listing application also provides a feature that enables users to find the contact information of real estate agents to assist them in specific areas throughout the process of obtaining their ideal homes. Lastly, users are now also able to upload images in chat aside from just regular text messages and this would benefit the entire homebuying process as it is capable of speeding it up by allowing important documents to be sent for review within the application itself just by uploading them to the opposing parties.

8.2 Limitations

While it can be said that the project has managed to achieve the target of its initial specification successfully. However, there are still certain limitations regarding the scope of the application that could not be implemented at the end of this project due to time constraints. These limitations were tabulated in Table 8.1 below.

Table 8.1: Limitations

Limitations	Description
Lack of proper status tracking feature	Without having a proper status to associate each step of the property purchasing process, it is possible for miscommunications to occur between the tenants and real estate agents. Real estate agents that manage multiple property listings at once may find it difficult to identify which property has been reserved or sold, and to whom they are dealing with. However, in the current state of the property listing application, this feature only covers up to the appointments scheduling process.
Limitations of chat feature	Currently, the chat feature is only capable of allowing users to send text messages and images. However, due to the large number of documents required throughout the entire process of purchasing a property, there would be certain occasions in which sending documents in a PDF format is more preferred compared to images. In addition, videos could also enhance the user's home viewing experience compared to static images when obtaining visuals around the property.
Absence of payment feature	The first step in reserving a property in Malaysia is to make a down payment with an amount totaling up to 5% - 10% of the actual price. In the modern world, digitalized transactions have become a norm

	among society whereby applications have enabled users to make payments in-app. However, this is a feature that has yet to be integrated into the application.

8.3 Recommendations For Future Work

Like most applications out there in today's market, there was never a perfect software as new features and updates are constantly being pushed out to its users. Thus, the same can be said about this property listing application in which the recommendations tabulated in Table 8.2, or any other potential enhancements could be implemented in the near future.

A good starting point would be resolving the limitations that were mentioned earlier in Table 8.1.

Table 8.2: Recommendations

Recommendation	Description
Implement a proper status tracking feature	By implementing a proper status tracking feature, it can ensure that both the tenants and real estate agents are in sync throughout each step of purchasing a property. Similar to how logistics work in courier services, tenants can stay up to date with the latest updates progress through by the real estate agent. For example, once a tenant makes the down payment for a property listing that he/she is interested in, the real estate agent can proceed to update the listing with a "Reserved" status, preventing any other users from enquiring further about the already reserved property.
Enable videos and documents to be sent within chat	By implementing a feature that enables users to send videos to each other, it can provide a wider range of options for real estate agents to advertise their property listings. This is because videos are able to provide a more realistic appearance when

	viewing a property. Furthermore, viewing documents in a PDF format is much clearer and more appropriate as compared to viewing them through an image. Therefore, this feature would greatly enhance the chat feature that is currently available in the application.
Allow tenants to make payments through the application	An in-app payment feature can greatly speed up the process of purchasing a property as real estate agents can be notified as soon as the tenants makes the required payment successfully. This can be accomplished by linking FPX transaction portals with the application, which would also provide different set of bank teller options in which the user is able to make their payment to.

8.4 Feature Benchmark Comparison

Now that the property listing application that was developed as part of this project has been finalized, a feature benchmark comparison matrix can be tabulated to evaluate the developed application against other similar applications that are already currently available.

Referring to Table 2.1, which provides a summarized mobile application comparison matrix after the literature review process has been performed a feature benchmark comparison can be computed. In addition, Georgiou (2019) also provided some insights regarding features that a real estate agent application should have, therefore the feature benchmark comparison matrix would take those in considerations as well.

Table 8.3: Feature Benchmark Comparison Matrix

Features	**EdgeProp**	**Property Guru**	**trovit**	**Ohmy home**	**StarProperty**	**FYP**
Search by Text	✓	✓	✓	✓	✓	✓
Search by selecting a		✓	✓	✓	✓	✓

coordinate location on GoogleMap						
Filter by Buy, Rent, New Launch and Auction	✓	✓	✓	✓	✓	
User Onboarding (Sign Up / Login)	✓	✓		✓	✓	✓
Contains Tabs of News / Projects / Guide / Tips	✓	✓		✓	✓	
"Favourite" Properties	✓	✓	✓	✓	✓	✓
Integrated Chat Function				✓	✓	✓
List Own Property	✓			✓		✓
Available listed properties will all be displayed on GoogleMap (can be clicked)		✓	✓	✓		✓
Find Agents (For Seller, Buyer, Landlord & Tenant Service)		✓		✓		✓
Display Listing Description In App	✓	✓		✓	✓	✓
Show distance between amenities				✓		✓

Virtual Tours		✓				✓
Schedule Viewing Appointments				✓	✓	✓

According to Table 8.3 above, it can be seen that the property listing application that was developed as part of this project (labelled as FYP) is capable of matching the standards of other real estate mobile applications that are widely available today. This is because the FYP mobile application contains all the features that a real estate application should have, plus some additional enhancements to improve the overall user experience and functionalities, with the most noticeable feature being the Virtual Tour feature. This is because as society is being confined within their own homes due to the pandemic, new means of viewing the listings are vital to the industry as 70% of first-time homebuyers have reported that a virtual tour to the for-sale homes is capable of providing them a real-time feel of the properties that they are interested in no matter how far apart they may be (Georgiou, 2019). Although the convenient methods of photos and videos are still a major component of a listing's details, but a panoramic image that offers human computer interactions will definitely improve the process.

Although it can be argued that other real estate applications do in fact offer features in which the FYP application currently does not provide, which includes a mortgage calculator, searching by MRT locations or grouping property listings according to tags. Those features are considered to be Quality of Life (QoL) features that would not impact the overall functionalities of a property listing application should they be left out at the current stage of development. However, the above-mentioned features, along with any other potential enhancements can be implemented into the application for future improvements according to the requirement and needs of its users.

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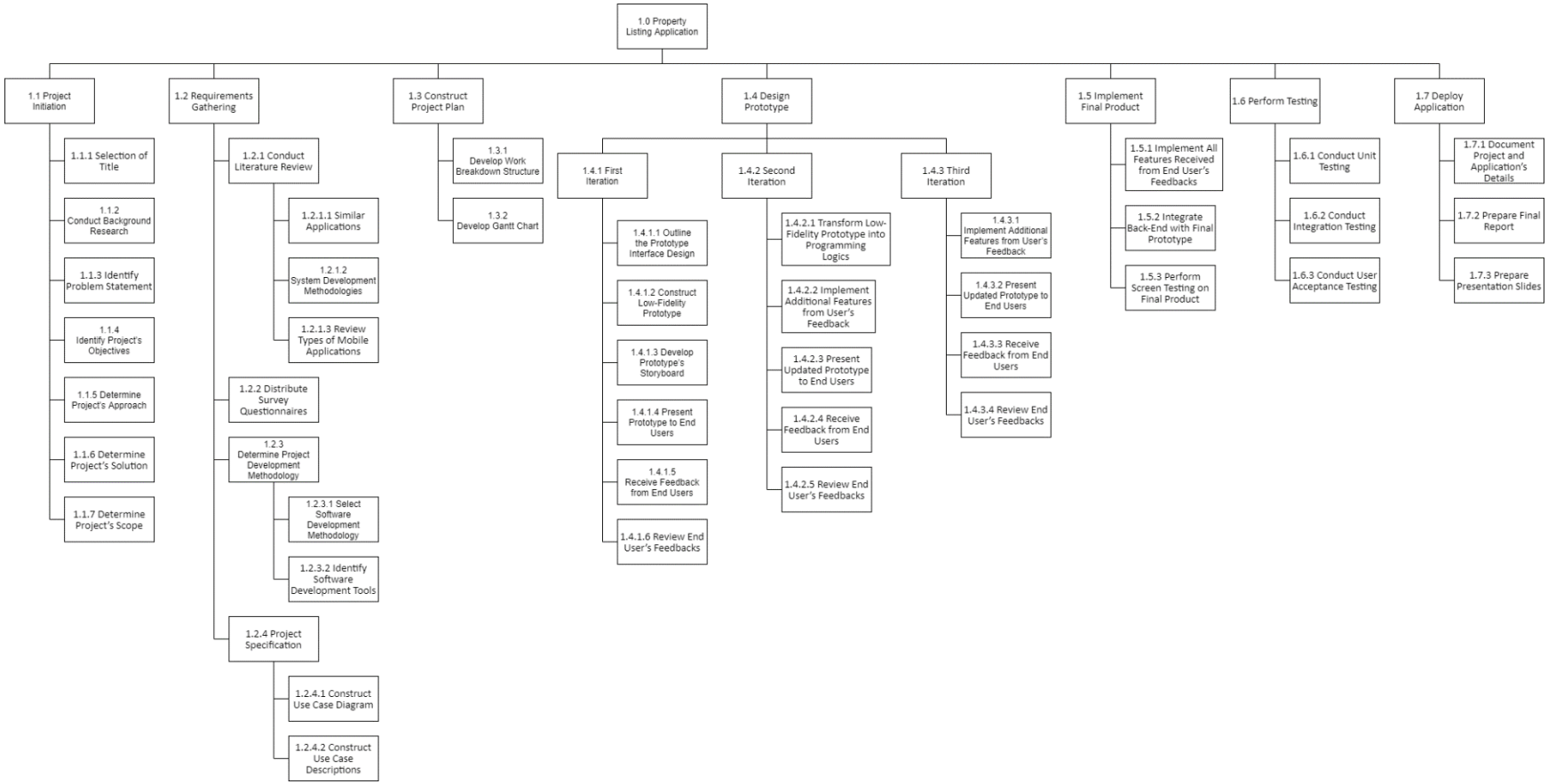
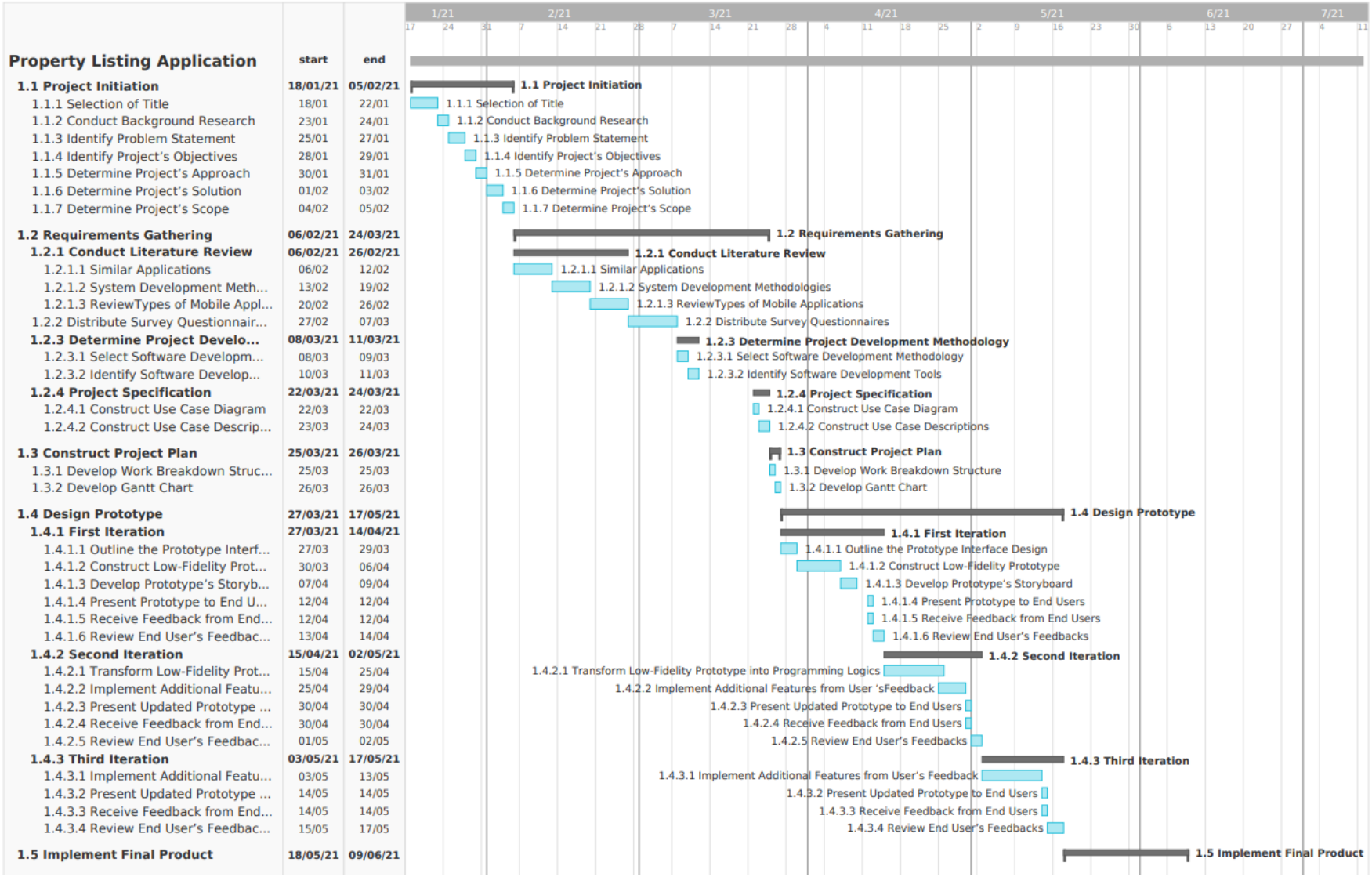
APPENDICES

Appendix A: Work Breakdown Structure



Appendix B: Gantt Chart

teamgantt
Created with Free Edition



teamgantt
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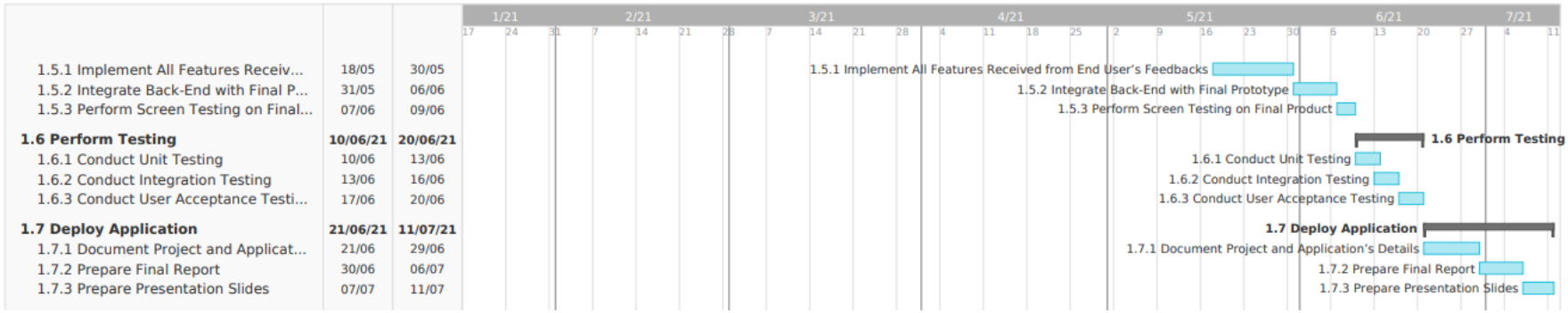


Appendix C: Survey Questions

Mobile-Based Property Listing Application

Greetings dear respondents !

I'm Benjamin Leong E-Jenn, a Final Year student from Universiti Tunku Abdul Rahman and currently pursuing a Bachelor of Science (Hons) Software Engineering. I'm currently conducting a survey to obtain data for my Final Year Project (FYP) with the course code UECS3583 - Project 1.

The main objective of this survey is to identify the fellow respondent's perception regarding the usage of mobile applications within the real estate industry.

Moreover, as this project aims to develop a mobile based real-time application that caters towards tenants, real estate agents and property developers, I really appreciate your feedback regarding your own preferred designs and potential features that you would personally like to see within the application.

This questionnaire consists of 3 parts.

Part A: Demographics (6 Question)
Part B: Perceptions Regarding The Real Estate Industry During MCO (4 Question)
Part C: Design Features Regarding Our Real Estate Mobile Application (5 Question)

In addition, I would also like to mention that your responses will be kept strictly confidential

Moreover, as this project aims to develop a mobile based real-time application that caters towards tenants, real estate agents and property developers, I really appreciate your feedback regarding your own preferred designs and potential features that you would personally like to see within the application.

This questionnaire consists of 3 parts.

Part A: Demographics (6 Question)
Part B: Perceptions Regarding The Real Estate Industry During MCO (4 Question)
Part C: Design Features Regarding Our Real Estate Mobile Application (5 Question)

In addition, I would also like to mention that your responses will be kept strictly confidential and that I would only utilize it for my own analysis purposes.

Should you have any doubt, feel free to contact the personnel below:

Name: Benjamin Leong E-Jenn
Role: Student
E-Mail: leongejenn@1utar.my

Name: Dr. Sugumaran a/l Nallusamy
Role: Lecturer / Immediate Supervisor
E-Mail: sugumaran@utar.edu.my

You can begin answering by clicking on the "Next" button below.
Thanks for taking up your time to fill in this questionnaire, I really appreciate the effort !

Part A - Demographics:

Name: *

Your answer

Gender *

- ◯ Male
- ◯ Female
- ◯ Prefer not to say

Age Group: *

- ◯ Between 18 – 25 Years Old
- ◯ Between 26 – 35 Years Old
- ◯ Between 36 – 45 Years Old
- ◯ Between 46 – 55 Years Old
- ◯ More than 55 Years Old

Occupation Status: *

- ◯ Employed within a company
- ◯ Freelancer
- ◯ Student
- ◯ Self employed
- ◯ Currently unemployed
- ◯ Retired

Frequency of internet usage per day *

- ◯ Never
- ◯ Less than 1 hour per day
- ◯ 1 to 4 hours per day
- ◯ 5 to 8 hours per day
- ◯ 9 to 12 hours per day
- ◯ More than 12 hours per day

Have you ever made any transactions through the internet previously ? *

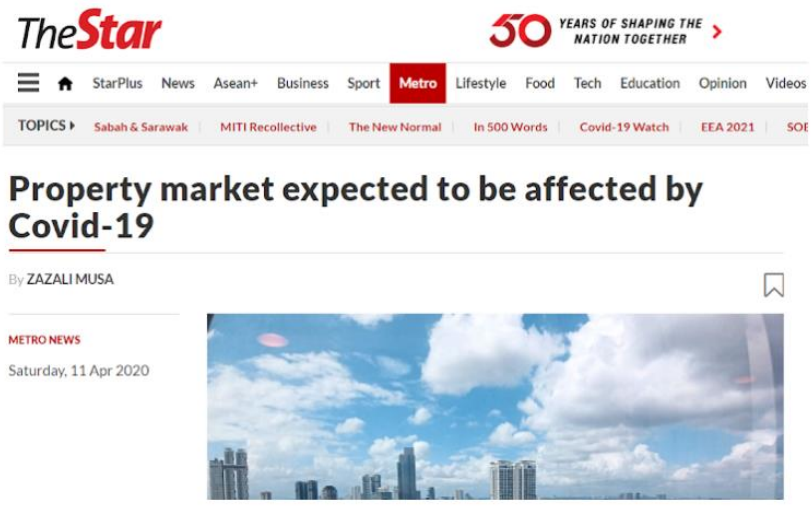
- ◯ Yes
- ◯ No

From the list below, what form of internet transactions have you performed ? (You may select more than one) *

- ☐ Online shopping (Shopee, Lazada, etc)
- ☐ Online booking of tickets (Cinema tickets, Concert tickets, etc)
- ☐ Online booking of vehicle rides (Taxi, Grab, UBER, etc)
- ☐ Online reservation of hotels / rooms
- ☐ Forex trading
- ☐ Online marketing
- ☐ Never made any internet transactions before

Part B - Perceptions Regarding The Real Estate Industry During MCO:

Source: https://www.thestar.com.my/metro/metro-news/2020/04/11/property-market-expected-to-be-affected-by-covid-19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Property market expected to be affected by Covid-19

By ZAZALI MUSA

METRO NEWS

Saturday, 11 Apr 2020

According to the news article reported by The Star above, it can be seen that the introduction of the Movement Control Order (MCO) imposed by the government due to the Covid-19 pandemic has impacted the economy of Malaysia drastically, and the property market is no exception.

With restrictions being imposed on travel distances, working policies and the halt of tourism sectors, society is forced to adapt to the new norm, which comes in the form of digitalization. Online shopping is becoming increasingly popular as an alternative to shopping malls, and food delivery services are also becoming seemingly common amongst society today.

Now the main question is, where does the real estate industry stand within the boundaries of the market today ? Should it continue to follow the traditional processes of approaching a sales gallery to enquire about the details of a property that one is interested in ? Or should it begin to slowly migrate into the digital market.

How do you normally acquire information about a property that you're interested in ? (You may select more than one) *

- [ ] Walk into a sales gallery
- [ ] Property websites (iProperty, EdgeProp, PropertyGuru, etc)
- [ ] Social networking platforms (Facebook, Twitter, Instagram, etc)
- [ ] Property publications (Property Insight, Business Today, Property Insight, etc)
- [ ] Signboards, buntings and other forms of street advertising
- [ ] Suggested by salespersons
- [ ] Through friends and family members
- [ ] Newspapers
- [ ] Other: _____

Have you ever used / considered using a real estate mobile application to obtain information about properties that you would like to buy, rent or sell ? *

- ◯ Yes
- ◯ No

According to the scale below, how likely would you begin / continue using a real estate mobile application ? (Tick only one) *

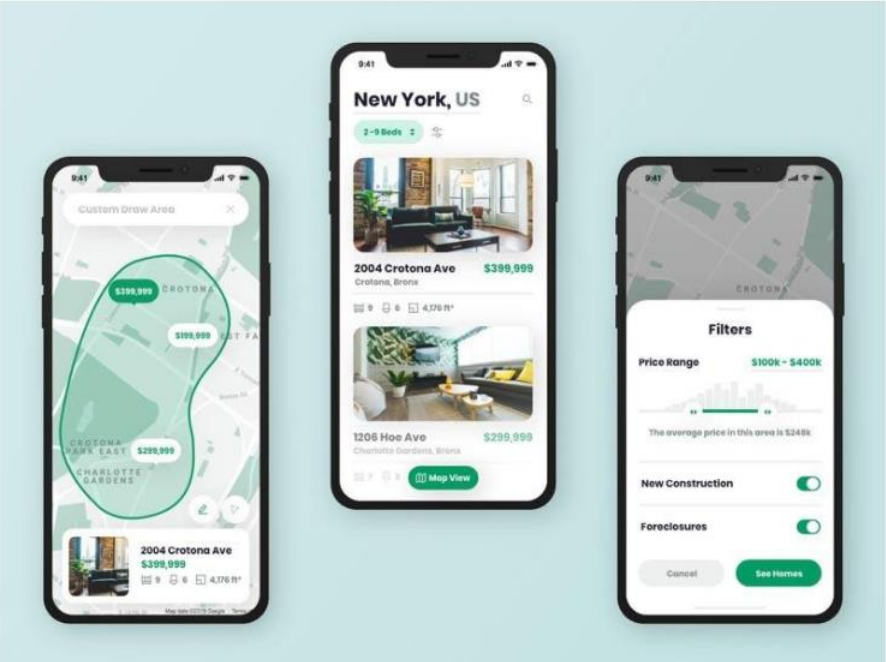
	1	2	3	4	5	
Very Unlikely	○	○	○	○	○	Very Likely

What are some of the benefits that you personally feel that a real estate mobile application provides to its users ? (You may select more than one) *

- [ ] Saves time
- [ ] Reduces costs
- [ ] Provides useful and informative information
- [ ] Easy to use
- [ ] Allows comparison between multiple properties to be done
- [ ] Able to be accessed anywhere, at anytime
- [ ] Offers various features to facilitate the process of buying/renting a property
- [ ] Easy to reach out to buyers/real estate agents/property developer representatives
- [ ] Other: _____

Part C – Design Features Regarding Our Real Estate Mobile Application:

Source: https://www.mobindustry.net/how-to-create-a-successful-real-estate-mobile-app-for-your-needs/



Main Goal Of The Project

This project aims to develop a mobile application that includes some of the following features:

1. Tenants to search and view property listings that are available on the application,
2. Real estate agents publish listing of their respective properties units.
3. Property developers to publish details of their current and upcoming projects.
4. Enables communication between tenants and real estate agents/property developers to be performed within the application.
5. Allows bookings to be scheduled for tours.

..... and many other features to be integrated within the application.

Should the application be completed, would you be interested in using it ? *

- ◯ Yes
- ◯ No
- ◯ Maybe

If your answer in the previous question is 'No', please provide an answer to explain your reasons.

Your answer

In your opinion, what are some of the key functionalities that a property listing application should have ? (You may select more than 1) *

- ☐ Display information about the listed properties
- ☐ Allows reservation of property listings
- ☐ Enables transactions to be made within the application (eg: make down payments through the application)
- ☐ Allows appointments to be set between tenants and real estate agents/property developers
- ☐ Find real estate agents within the application to help facilitate the property's buying/selling process
- ☐ Virtual tours for property listings
- ☐ Able to provide real-time notification updates
- ☐ In-app communication between tenants and real estate agents/property developers
- ☐ Mortgage Calculator
- ☐ Other:

Based on your own preferences, what are some of the reasons / features that you enjoy when using your applications. (You may select more than 1) *

- [ ] Design of the application's interface looks nice.
- [ ] Able to accomplish certain tasks that you require efficiently.
- [ ] Provides sufficient level of security / data protection.
- [ ] Easy to use and navigate through the application.
- [ ] Constantly offers fresh and new updates to its users.
- [ ] Receiving good discounts and offers.
- [ ] Has a large variety of features to explore.
- [ ] Other:

What are some of the reasons / features that you think an application should NOT have ? (You may select more than 1) *

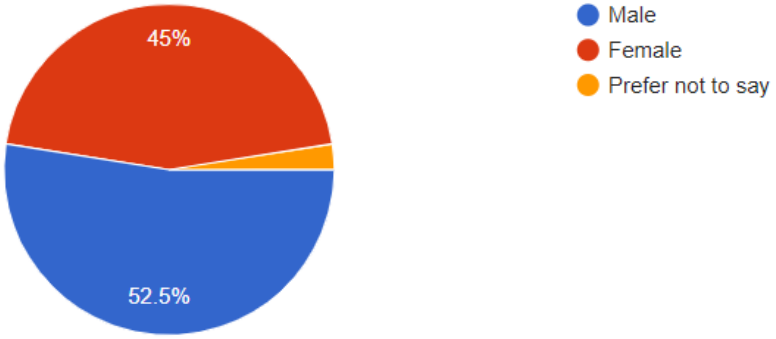
- [ ] Overly complicated user interface designs.
- [ ] Learning process is tedious and time consuming.
- [ ] Time taken to accomplish the desired task is too long.
- [ ] Features of the application are too complicated to understand.
- [ ] Limited amount of functionalities provided.
- [ ] Boring / dull user interface designs.
- [ ] Requires large memory space in mobile devices.
- [ ] Other:

Appendix D: Survey Results

Part A - Demographics:

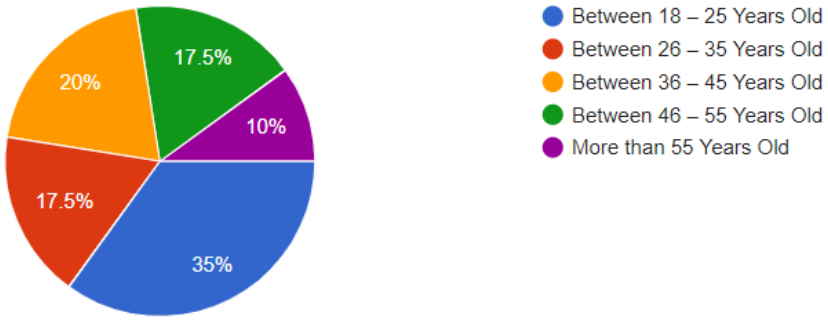
Gender

40 responses



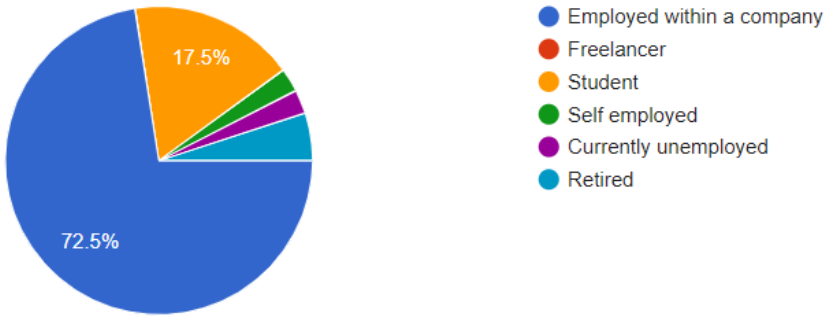
Age Group:

40 responses



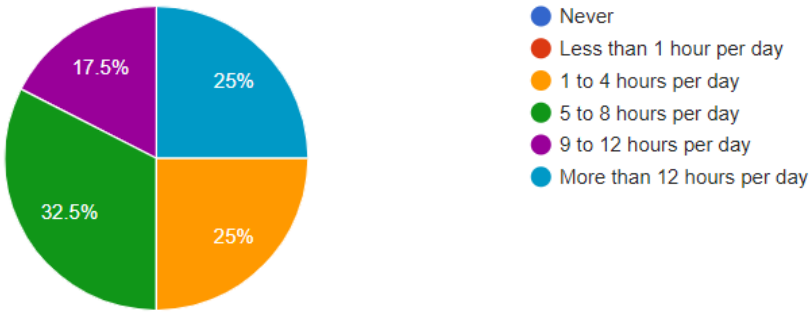
Occupation Status:

40 responses



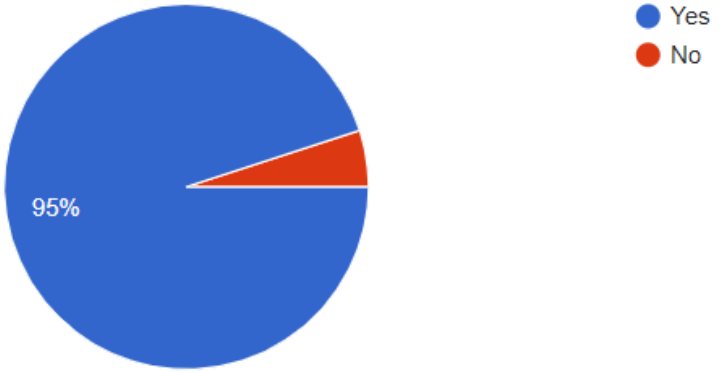
Frequency of internet usage per day

40 responses



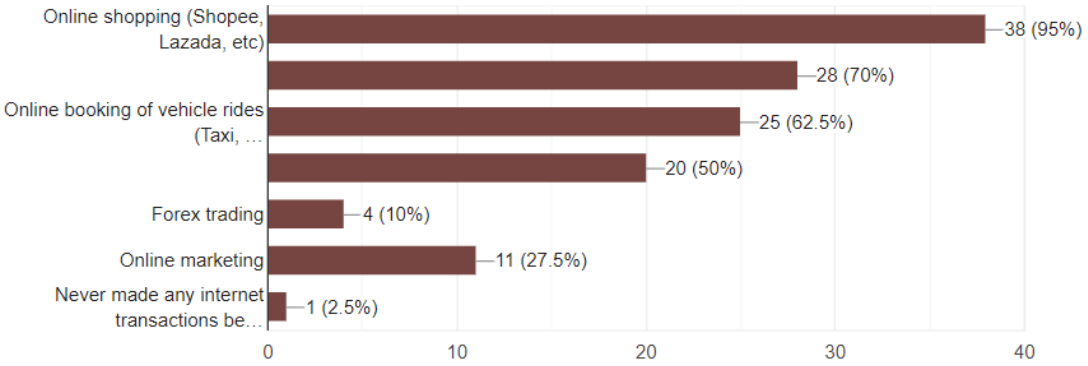
Have you ever made any transactions through the internet previously ?

40 responses



From the list below, what form of internet transactions have you performed ? (You may select more than one)

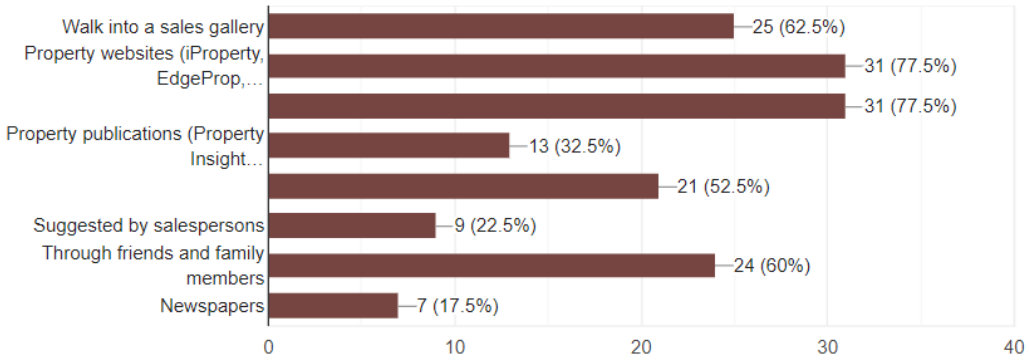
40 responses



Part B - Perceptions Regarding The Real Estate Industry During MCO:

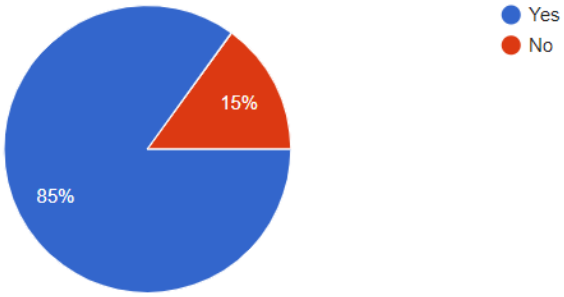
How do you normally acquire information about a property that you're interested in ? (You may select more than one)

40 responses



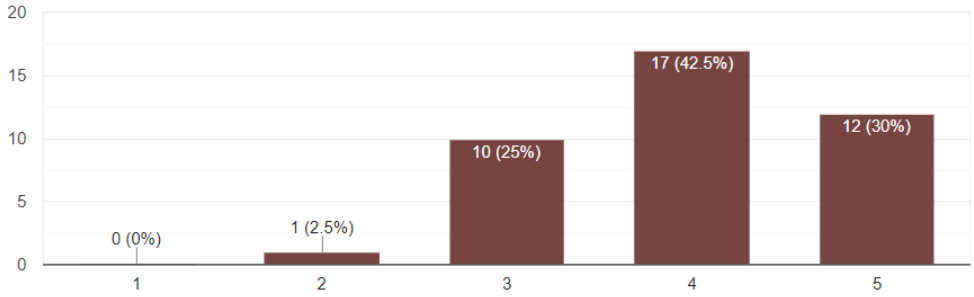
Have you ever used / considered using a real estate mobile application to obtain information about properties that you would like to buy, rent or sell ?

40 responses



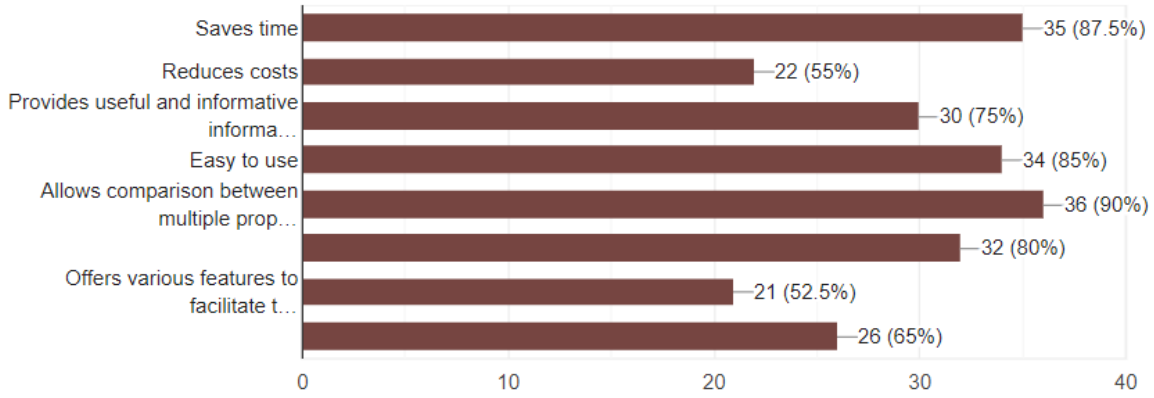
According to the scale below, how likely would you begin / continue using a real estate mobile application ? (Tick only one)

40 responses



What are some of the benefits that you personally feel that a real estate mobile application provides to its users ? (You may select more than one)

40 responses

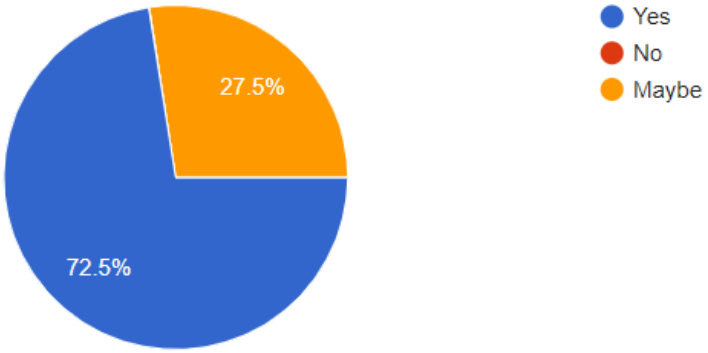


Part C – Design Features Regarding Our Real Estate Mobile Application:

Main Goal Of The Project

Should the application be completed, would you be interested in using it ?

40 responses



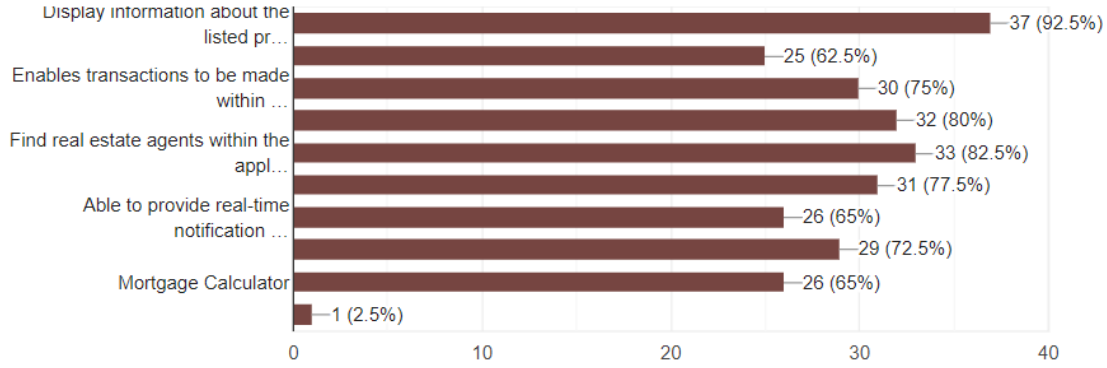
If your answer in the previous question is 'No', please provide an answer to explain your reasons.

1 response

-

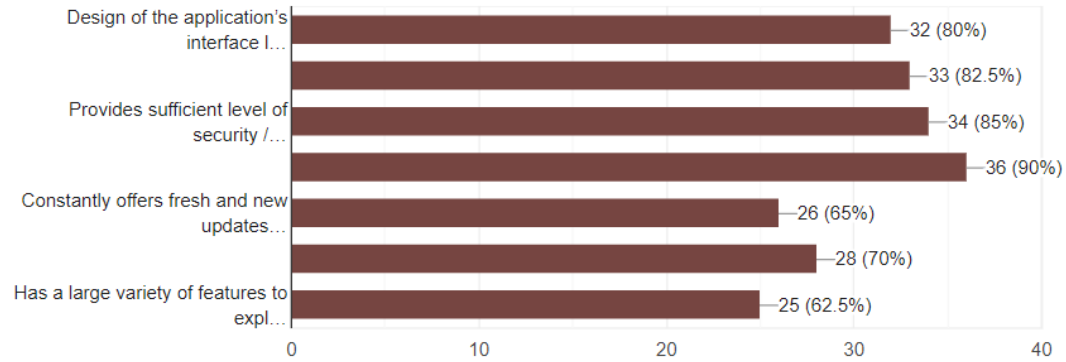
In your opinion, what are some of the key functionalities that a property listing application should have ? (You may select more than 1)

40 responses



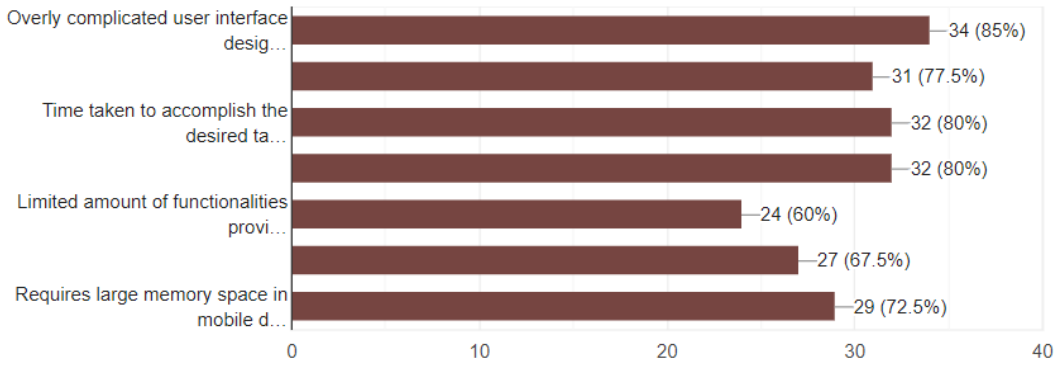
Based on your own preferences, what are some of the reasons / features that you enjoy when using your applications. (You may select more than 1)

40 responses

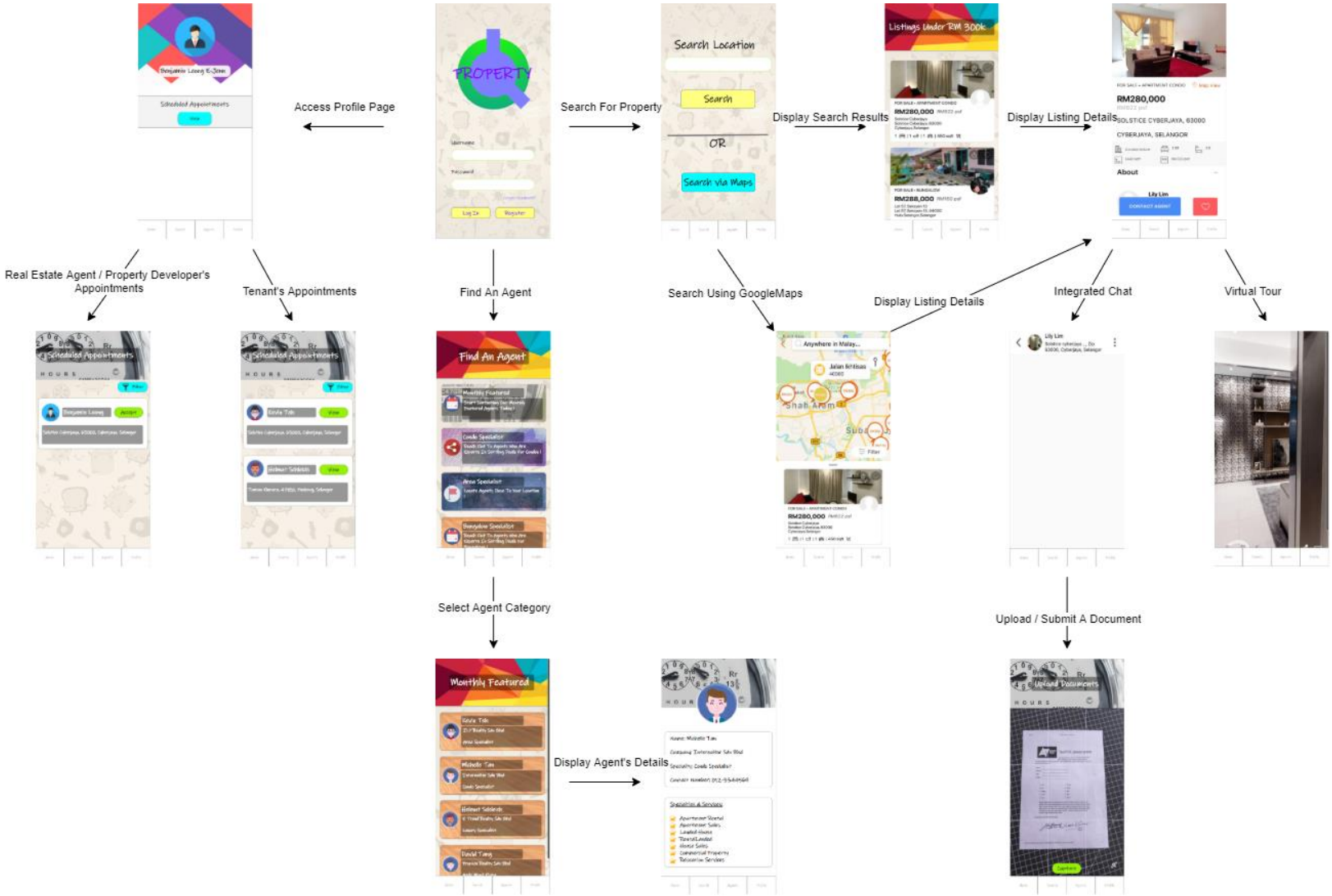


What are some of the reasons / features that you think an application should NOT have ? (You may select more than 1)

40 responses



Appendix E: Overall Storyboard


Access Profile Page
Search For Property
Display Search Results
Display Listing Details
Real Estate Agent / Property Developer's Appointments
Tenant's Appointments
Find An Agent
Search Using GoogleMaps
Display Listing Details
Integrated Chat
Virtual Tour
Select Agent Category
Display Agent's Details
Upload / Submit A Document
Search Location
Search
OR
Search via Maps
Listings Under RM 300k
RM280,000
RM288,000
Find An Agent
Monthly Featured

Appendix F: Usability Test Scenarios

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(Co. No. 578227-M)
DU012(A)

Greetings ! I'm Benjamin Leong E-Jenn, a final year student from Universiti Tunku Abdul Rahman and currently pursuing Bachelor of Science (Hons) Software Engineering. I am currently conducting a usability study for an application that I have developed, which is a property listing application.

In an effort to evaluate the system, I'm looking for people who may be interested in trying out the system and giving feedbacks after using it as it is an industrial standard for a software to undergo both a usability test and user acceptance test before releasing it to the public.

You will be asked to perform **15 Test Scenarios** with the software system. As you perform these test scenarios, you are required to **talk out loud as you work** so the facilitator can follow along. In the end, you will be asked to **fill in a survey form** to judge the usability of the system that you have evaluated.

The entire process would take **roughly 20 minutes** to complete.

With your permission, the session **will be recorded**. However, I would like to mention that the recording will be kept **strictly confidential** and that I would only utilize it to decide how to improve the underlying system. I, as a facilitator will **not** be evaluating you in any way. Your name will **not** be associated with any data that are collected during this session.

Thanks for taking up your time to help us conduct this usability study, I really appreciate the time and effort !

Section A: Test Scenarios

Scenario 1: Sign Up For A New Account

Imagine that you're currently looking to purchase or rent a particular property, therefore you've gone ahead and download this property listing application in hopes of being able to discover a property that matches your expectations. However, you're currently **new** to the application and **do not** have an account created yet.

What would you do to **sign up for a new account** in order to be able to log in to the application ?

Scenario 2: Login

Congratulations! You've successfully signed up for an account, now try **logging into** your account using the details that you've entered previously.

Scenario 3: View A Property Listing

Since you've managed to log in, you're now being brought to the home page of the application. Now, there are a variety of property listings being displayed on screen but only the name and a single image of the property listing is made available for you.

What would you do in order to be able to **view more details of a particular listing** ?

Scenario 4: Search For A Property Listing

You've noticed that the property listings on the **home page** contains properties from all across Malaysia instead of narrowing down to a specific location. However, you're currently only interested to view property listings from **Cheras**,

What would you do in order to be able to **search for property listings within Cheras only** ?

Scenario 5: Search Using Google Maps

You noticed that the search result being displayed only shows property listings in a list format. Moreover, you wish to **view** the exact location of the property listings in a **Google Maps format**.

What would you do in order to be able to accomplish this ?

Scenario 6: Favourite A Property Listing

Now imagine that you're browsing through the application and discovered a property listing that you like, and you wish to **favourite that property listing** so that you may revisit it later in the future much easier.

How are you able to **favorite a specific property listing** ?

Scenario 7: Virtual Tour

After clicking on a particular property listing, you noticed that the normal images are not sufficient enough to provide a clear overview on what the actual property is like. Furthermore, you noticed that the application offers a **"Virtual Tour" feature**, which provides an enhanced way to visualize the property listing.

What are the steps that you would take in order to be able **to access the virtual tour features** of the application ?

(Note: Use the "KLCC" property listing to perform this test scenario.)

Scenario 8: Send Messages

Now you've managed to come across a property listing that you like and wish to **contact the real estate agent in charge** in order to obtain more information about it.

What are the steps that are required to be taken in order for you to **contact the real estate agent** and **send him a message** ?

Scenario 9: Send Images

After sending a text message to the real estate agent in chat, you felt like you needed to **send an image** to the real estate agent as well to make the entire conversation clearer in terms of enquiring about the property.

How would you attempt to **send an image** to the real estate agent ?

Scenario 10: Schedule Appointment

After having a conversation with the real estate agent, he / she has provided you with sufficient information about the selected property and you're interested in making a site visit physically to view the unit. However, the real estate agent requires you to **schedule an appointment** with him through the application to allocate a particular time slot.

What are the steps that you would take in order to be able to **schedule an appointment** with the real estate agent through the application ?

Scenario 11: Find Real Estate Agent's Details

Imagine that you're planning on purchasing a particular property but have no idea on how or where to start. Therefore, you've decided to **obtain help from a real estate agent** to assist you throughout the entire process of purchasing a property. Fortunately, this property listing application offers a feature that enables users **to search for a real estate agent's contact number.**

If you were the user, how would you **obtain the contact number and other information of a real estate agent** ?

Scenario 12: View List Of Appointments

Remember that you've previously scheduled an appointment with a real estate agent to have a site visit to view the property unit in person ? Did you manage to remember the date and time of the appointment that you've scheduled previously ? Afraid not, because you can **view a list of all the appointments** that you have scheduled in the past so that you would not miss out on an important appointment.

Therefore, what are the steps that you would take in order for you to **view the appointment list** ?

Scenario 13: Log Out

Since you've managed accomplished all the tasks for today, it's time for you to log out of the application.

How would you attempt to log out from the application ?

Scenario 14: Publish New Property Listing

Congratulations ! You've successfully made it this far and completed all the features and functionalities that the application has to offer from the tenant's perspective ! However, there are still two features left that you as a participant is required to test. The first is to play the role of a real estate agent and **publish a particular property listing**.

In order to do so, you are required to be logged in as a real estate agent. However, you are not required to create a new account, but instead just log in using the credentials provided in the table below:

Field Name	Value
E-Mail Address	lilylim@gmail.com
Password	123456

Now that you've successfully logged in as a real estate agent, you can proceed to **publish a new property listing**.

(Hint: Go to your profile.)

Scenario 15: Management Appointments

Imagine that you're currently a real estate agent and you've just received an appointment that was scheduled by a potential client of yours. However, due to unforeseen circumstances you are unable to attend to the appointment at the

scheduled time. Therefore, you wish to **decline the tenant's appointment** to inform him that the appointment is called off.

What are the steps that are required for you to **decline an appointment** that was scheduled previously?

Appendix G: User Satisfaction Survey

Section B: User Satisfaction Survey *(adapted from System Usability Scale, Brooke, J. (1986))*

Participant # _1_

Statement	Strongly Disagree 1	2	3	4	Strongly Agree 5
1. I think that I would like to use this application to search for a property listing.				/	
2. I found the application unnecessarily complex.			/		
3. I thought the application was easy to use.				/	
4. I think that I would need the support of a technical person to be able to use this application.					/
5. I found this application was easily moved through without a lot of backtracking or data re-entry.					/
6. I thought there was too much inconsistency in this application.			/		
7. I would imagine that most people would learn to use this application very quickly.					/
8. I found the application very awkward to use.	/				
9. I felt very confident using the application.				/	
10. I needed to learn a lot of things before I could get going with this application.				/	

What did you like best about the application? easy to use

What did you like least about the application? need the icon to be more interactive

If you were to describe this application to a colleague in a sentence or two, what would you say? able to assist in marketing the property easily

Do you have any other final comments or questions? need additional features

Section B: User Satisfaction Survey *(adapted from System Usability Scale, Brooke, J. (1986))*

Participant # _2_

Statement	Strongly Disagree 1	2	3	4	Strongly Agree 5
1. I think that I would like to use this application to search for a property listing.					-
2. I found the application unnecessarily complex.	-				
3. I thought the application was easy to use.					-
4. I think that I would need the support of a technical person to be able to use this application.					-
5. I found this application was easily moved through without a lot of backtracking or data re-entry.					-
6. I thought there was too much inconsistency in this application.	-				
7. I would imagine that most people would learn to use this application very quickly.					-
8. I found the application very awkward to use.	-				
9. I felt very confident using the application.					-
10. I needed to learn a lot of things before I could get going with this application.	-				

What did you like best about the application? Virtual tour

What did you like least about the application? More listing option

If you were to describe this application to a colleague in a sentence or two, what would you say? this app is user friendly to both homebuyer and agent!

Do you have any other final comments or questions? Good job!

Section B: User Satisfaction Survey *(adapted from System Usability Scale, Brooke, J. (1986))*

Participant # _3_

Statement	Strongly Disagree 1	2	3	4	Strongly Agree 5
1. I think that I would like to use this application to search for a property listing.				/	
2. I found the application unnecessarily complex.		/			
3. I thought the application was easy to use.					/
4. I think that I would need the support of a technical person to be able to use this application.	/				
5. I found this application was easily moved through without a lot of backtracking or data re-entry.					/
6. I thought there was too much inconsistency in this application.	/				
7. I would imagine that most people would learn to use this application very quickly.					/
8. I found the application very awkward to use.	/				
9. I felt very confident using the application.					/
10. I needed to learn a lot of things before I could get going with this application.	/				

What did you like best about the application? It has VR facility that can improves user experiences & help agent to market their property better

What did you like least about the application? _____

If you were to describe this application to a colleague in a sentence or two, what would you say? i have found great apps that you can use to look for a property. You can look for a property using maps itself instead of going thru one/one listing or set a filter

Do you have any other final comments or questions? Nil

Section B: User Satisfaction Survey *(adapted from System Usability Scale, Brooke, J. (1986))*

Participant # _4_

Statement	Strongly Disagree 1	2	3	4	Strongly Agree 5
1. I think that I would like to use this application to search for a property listing.					/
2. I found the application unnecessarily complex.	/				
3. I thought the application was easy to use.					/
4. I think that I would need the support of a technical person to be able to use this application.	/				
5. I found this application was easily moved through without a lot of backtracking or data re-entry.					/
6. I thought there was too much inconsistency in this application.	/				
7. I would imagine that most people would learn to use this application very quickly.					/
8. I found the application very awkward to use.	/				
9. I felt very confident using the application.					/
10. I needed to learn a lot of things before I could get going with this application.	/				

What did you like best about the application? set appointment

What did you like least about the application? no

If you were to describe this application to a colleague in a sentence or two, what would you say? Easy to use

Do you have any other final comments or questions? if can add a surrounding price comparison feature then will be good

Section B: User Satisfaction Survey *(adapted from System Usability Scale, Brooke, J. (1986))*

Participant # _5_

Statement	Strongly Disagree 1	2	3	4	Strongly Agree 5
1. I think that I would like to use this application to search for a property listing.					/
2. I found the application unnecessarily complex.		/			
3. I thought the application was easy to use.					/
4. I think that I would need the support of a technical person to be able to use this application.		/			
5. I found this application was easily moved through without a lot of backtracking or data re-entry.					/
6. I thought there was too much inconsistency in this application.		/			
7. I would imagine that most people would learn to use this application very quickly.				/	
8. I found the application very awkward to use.	/				
9. I felt very confident using the application.				/	
10. I needed to learn a lot of things before I could get going with this application.					/

What did you like best about the application? Virtual tour

What did you like least about the application? -

If you were to describe this application to a colleague in a sentence or two, what would you say? A friendly user app and easy to manipulate it

Do you have any other final comments or questions? -

Appendix H: User Acceptance Testing Results

User Acceptance Testing (UAT) Test Form					
Participant No.: 1	**Date: 28th August 2021**		**Start Time: 7:30 PM**	**End Time: 8:10 PM**	
Test Case ID	**Test Module**	**Test Scenario**	**Test Data**	**Expected Results**	**Status (Pass/Fail)**
UAT-001	Account Registration	1. Tap on “Sign Up” button. 2. Fill in all the required information. 3. Tap on the “Sign Up” button.	1. Valid e-mail address. 2. Password with a minimum of 6 characters.	A “Sign Up Successful !” alert message indicating that the user has successfully created an account.	Pass
UAT-002	Login	1. Enter e-mail and password. 2. Tap on the “Login” button.	1. Existing account with valid e-mail and password.	A "Login Successful !" alert message, indicating that the process was successful.	Pass
UAT-003	Search Using Text	1. Tap on the Search Bar. 2. Type in a location to search for property listings. 3. Tap on the "Search" icon.	1. Any valid location, such as “Cheras”. Otherwise, no results will be displayed.	Results of the search was displayed accordingly.	Pass
UAT-004	Search Using Maps	1. Click on the Maps tab on the bottom navigation bar. 2. Tap on the search bar.	1. Any valid location, such as “Bandar Kinrara 5”. Otherwise, no results will	All available property listings within the specified area will be	Pass

		3. Enter a valid district, street address or other valid location addresses. 4. Tap on the intended search location.	be displayed.	displayed accordingly.	
UAT-005	View Property Listing Details	1. Tap on a particular property listing. 2. View the listing's details.	N/A.	Details of the selected listing will be displayed accordingly.	Pass
UAT-006	Send Messages	1. Start a chat with the real estate agent of a selected property listing. 2. Send him/her a message.	1. Any form of text message.	The message that was sent is updated within the chat room.	Pass
UAT-007	Send Images	1. Start a chat with the real estate agent of a selected property listing. 2. Send him/her an image through chat.	1. Any image from the phone gallery.	The image that was sent is updated within the chat room.	Pass
UAT-008	Schedule Appointments	1. Start a chat with the real estate agent of a selected property listing. 2. Tap on the "Three Dots" icon	1. Any desired date (For example, 15 September 2021). 2. Any desired time (For	The appointment will be scheduled successfully, and the appointments list on your profile will be	Pass

		located on the top right corner of the screen. 3. Specify a date and time of the desired appointment. 4. Tap on the "Confirm" button to schedule the appointment.	example, 3:30 p.m.).	updated.	
UAT-009	Virtual Tour	1. Tap on a particular property listing. 2. Tap on the "Virtual Tour" button.	N/A.	Navigate around the virtual tour to view the property. Also, try changing to a different room to view it as well.	Pass
UAT-010	Favourite A Property Listing	1. Tap on a particular property listing. 2. Tap on the "Heart" icon located on the top right corner of the interface.	N/A.	View the favourited property listing being updated in the favourites list on your profile.	Pass
UAT-011	View Real Estate Agent Details	1. Click on the Agents tab on the bottom navigation bar. 2. Select any real estate agent's category from the list. 3. Select any real estate agent	N/A.	All details of the real estate agent were displayed correctly.	Pass

		that is displayed on screen. 4. View all details of the selected real estate agent.			
UAT-012	Logout	1. Click on the Profile tab on the bottom navigation bar. 2. Tap on the "Logout" button.	N/A.	You'll be logged out from the application and be redirected to the login page.	Pass
UAT-013	Manage Appointments	1. Login to a Real Estate Agent's account. 2. Open the list of all the scheduled appointments. 3. Accept or Decline a particular appointment.	1. Use the following login credentials: • E-Mail: lilylim@gmail.com • Password: 123456	Verify that the appointment's status is updated correctly according to your actions.	Pass
UAT-014	Publish New Property Listing	1. Click on the Profile tab on the bottom navigation bar. 2. Tap on the "+" button. 3. Tap on the "House" button. 4. Fill in all of the required information. 5. Click on the "Submit" button.	1. For the input fields, fill in any information without leaving any one of them empty. 2. For the images, select any number of images from the photo gallery without leaving them empty.	A "Listing Published !" alert message will be displayed indicating that the new listing was published successfully.	Pass

User Acceptance Testing (UAT) Test Form					
Participant No.: 2	**Date: 29th August 2021**		**Start Time: 11:30 PM**	**End Time: 11:54 PM**	
Test Case ID	**Test Module**	**Test Scenario**	**Test Data**	**Expected Results**	**Status (Pass/Fail)**
UAT-001	Account Registration	4. Tap on “Sign Up” button. 5. Fill in all the required information. 6. Tap on the “Sign Up” button.	3. Valid e-mail address. 4. Password with a minimum of 6 characters.	A “Sign Up Successful !” alert message indicating that the user has successfully created an account.	Pass
UAT-002	Login	3. Enter e-mail and password. 4. Tap on the “Login” button.	2. Existing account with valid e-mail and password.	A "Login Successful !" alert message, indicating that the process was successful.	Pass
UAT-003	Search Using Text	4. Tap on the Search Bar. 5. Type in a location to search for property listings. 6. Tap on the "Search" icon.	2. Any valid location, such as “Cheras”. Otherwise, no results will be displayed.	Results of the search was displayed accordingly.	Pass
UAT-004	Search Using Maps	5. Click on the Maps tab on the bottom navigation bar. 6. Tap on the search bar.	2. Any valid location, such as “Bandar Kinrara 5”. Otherwise, no results will	All available property listings within the specified area will be	Pass

		7. Enter a valid district, street address or other valid location addresses. 8. Tap on the intended search location.	be displayed.	displayed accordingly.	
UAT-005	View Property Listing Details	3. Tap on a particular property listing. 4. View the listing's details.	N/A.	Details of the selected listing will be displayed accordingly.	Pass
UAT-006	Send Messages	3. Start a chat with the real estate agent of a selected property listing. 4. Send him/her a message.	2. Any form of text message.	The message that was sent is updated within the chat room.	Pass
UAT-007	Send Images	3. Start a chat with the real estate agent of a selected property listing. 4. Send him/her an image through chat.	2. Any image from the phone gallery.	The image that was sent is updated within the chat room.	Pass
UAT-008	Schedule Appointments	5. Start a chat with the real estate agent of a selected property listing. 6. Tap on the "Three Dots" icon	3. Any desired date (For example, 15 September 2021). 4. Any desired time (For	The appointment will be scheduled successfully, and the appointments list on your profile will be	Pass

		located on the top right corner of the screen. 7. Specify a date and time of the desired appointment. 8. Tap on the "Confirm" button to schedule the appointment.	example, 3:30 p.m.).	updated.	
UAT-009	Virtual Tour	3. Tap on a particular property listing. 4. Tap on the "Virtual Tour" button.	N/A.	Navigate around the virtual tour to view the property. Also, try changing to a different room to view it as well.	Pass
UAT-010	Favourite A Property Listing	3. Tap on a particular property listing. 4. Tap on the "Heart" icon located on the top right corner of the interface.	N/A.	View the favourited property listing being updated in the favourites list on your profile.	Pass
UAT-011	View Real Estate Agent Details	5. Click on the Agents tab on the bottom navigation bar. 6. Select any real estate agent's category from the list. 7. Select any real estate agent	N/A.	All details of the real estate agent were displayed correctly.	Pass

		that is displayed on screen. 8. View all details of the selected real estate agent.			
UAT-012	Logout	3. Click on the Profile tab on the bottom navigation bar. 4. Tap on the "Logout" button.	N/A.	You'll be logged out from the application and be redirected to the login page.	Pass
UAT-013	Manage Appointments	4. Login to a Real Estate Agent's account. 5. Open the list of all the scheduled appointments. 6. Accept or Decline a particular appointment.	2. Use the following login credentials: • E-Mail: lilylim@gmail.com • Password: 123456	Verify that the appointment's status is updated correctly according to your actions.	Pass
UAT-014	Publish New Property Listing	6. Click on the Profile tab on the bottom navigation bar. 7. Tap on the "+" button. 8. Tap on the "House" button. 9. Fill in all of the required information. 10. Click on the "Submit" button.	3. For the input fields, fill in any information without leaving any one of them empty. 4. For the images, select any number of images from the photo gallery without leaving them empty.	A "Listing Published !" alert message will be displayed indicating that the new listing was published successfully.	Pass

User Acceptance Testing (UAT) Test Form					
Participant No.: 3	**Date: 30th August 2021**		**Start Time: 10:15 AM**	**End Time: 10:35 AM**	
Test Case ID	**Test Module**	**Test Scenario**	**Test Data**	**Expected Results**	**Status (Pass/Fail)**
UAT-001	Account Registration	7. Tap on “Sign Up” button. 8. Fill in all the required information. 9. Tap on the “Sign Up” button.	5. Valid e-mail address. 6. Password with a minimum of 6 characters.	A “Sign Up Successful !” alert message indicating that the user has successfully created an account.	Pass
UAT-002	Login	5. Enter e-mail and password. 6. Tap on the “Login” button.	3. Existing account with valid e-mail and password.	A "Login Successful !" alert message, indicating that the process was successful.	Pass
UAT-003	Search Using Text	7. Tap on the Search Bar. 8. Type in a location to search for property listings. 9. Tap on the "Search" icon.	3. Any valid location, such as “Cheras”. Otherwise, no results will be displayed.	Results of the search was displayed accordingly.	Pass
UAT-004	Search Using Maps	9. Click on the Maps tab on the bottom navigation bar. 10. Tap on the search bar.	3. Any valid location, such as “Bandar Kinrara 5”. Otherwise, no results will	All available property listings within the specified area will be	Pass

		11. Enter a valid district, street address or other valid location addresses. 12. Tap on the intended search location.	be displayed.	displayed accordingly.	
UAT-005	View Property Listing Details	5. Tap on a particular property listing. 6. View the listing's details.	N/A.	Details of the selected listing will be displayed accordingly.	Pass
UAT-006	Send Messages	5. Start a chat with the real estate agent of a selected property listing. 6. Send him/her a message.	3. Any form of text message.	The message that was sent is updated within the chat room.	Pass
UAT-007	Send Images	5. Start a chat with the real estate agent of a selected property listing. 6. Send him/her an image through chat.	3. Any image from the phone gallery.	The image that was sent is updated within the chat room.	Pass
UAT-008	Schedule Appointments	9. Start a chat with the real estate agent of a selected property listing. 10. Tap on the "Three Dots" icon	5. Any desired date (For example, 15 September 2021). 6. Any desired time (For	The appointment will be scheduled successfully, and the appointments list on your profile will be	Pass

		located on the top right corner of the screen. 11. Specify a date and time of the desired appointment. 12. Tap on the "Confirm" button to schedule the appointment.	example, 3:30 p.m.).	updated.	
UAT-009	Virtual Tour	5. Tap on a particular property listing. 6. Tap on the "Virtual Tour" button.	N/A.	Navigate around the virtual tour to view the property. Also, try changing to a different room to view it as well.	Pass
UAT-010	Favourite A Property Listing	5. Tap on a particular property listing. 6. Tap on the "Heart" icon located on the top right corner of the interface.	N/A.	View the favourited property listing being updated in the favourites list on your profile.	Pass
UAT-011	View Real Estate Agent Details	9. Click on the Agents tab on the bottom navigation bar. 10. Select any real estate agent's category from the list. 11. Select any real estate agent	N/A.	All details of the real estate agent were displayed correctly.	Pass

		that is displayed on screen. 12. View all details of the selected real estate agent.			
UAT-012	Logout	5. Click on the Profile tab on the bottom navigation bar. 6. Tap on the "Logout" button.	N/A.	You'll be logged out from the application and be redirected to the login page.	Pass
UAT-013	Manage Appointments	7. Login to a Real Estate Agent's account. 8. Open the list of all the scheduled appointments. 9. Accept or Decline a particular appointment.	3. Use the following login credentials: • E-Mail: lilylim@gmail.com • Password: 123456	Verify that the appointment's status is updated correctly according to your actions.	Pass
UAT-014	Publish New Property Listing	11. Click on the Profile tab on the bottom navigation bar. 12. Tap on the "+" button. 13. Tap on the "House" button. 14. Fill in all of the required information. 15. Click on the "Submit" button.	5. For the input fields, fill in any information without leaving any one of them empty. 6. For the images, select any number of images from the photo gallery without leaving them empty.	A "Listing Published !" alert message will be displayed indicating that the new listing was published successfully.	Pass

User Acceptance Testing (UAT) Test Form					
Participant No.: 4	**Date: 30th August 2021**		**Start Time: 03:20 PM**	**End Time: 03:42 PM**	
Test Case ID	**Test Module**	**Test Scenario**	**Test Data**	**Expected Results**	**Status (Pass/Fail)**
UAT-001	Account Registration	10. Tap on “Sign Up” button. 11. Fill in all the required information. 12. Tap on the “Sign Up” button.	7. Valid e-mail address. 8. Password with a minimum of 6 characters.	A “Sign Up Successful !” alert message indicating that the user has successfully created an account.	Pass
UAT-002	Login	7. Enter e-mail and password. 8. Tap on the “Login” button.	4. Existing account with valid e-mail and password.	A "Login Successful !" alert message, indicating that the process was successful.	Pass
UAT-003	Search Using Text	10. Tap on the Search Bar. 11. Type in a location to search for property listings. 12. Tap on the "Search" icon.	4. Any valid location, such as “Cheras”. Otherwise, no results will be displayed.	Results of the search was displayed accordingly.	Pass
UAT-004	Search Using Maps	13. Click on the Maps tab on the bottom navigation bar. 14. Tap on the search bar.	4. Any valid location, such as “Bandar Kinrara 5”. Otherwise, no results will	All available property listings within the specified area will be	Pass

		15. Enter a valid district, street address or other valid location addresses. 16. Tap on the intended search location.	be displayed.	displayed accordingly.	
UAT-005	View Property Listing Details	7. Tap on a particular property listing. 8. View the listing's details.	N/A.	Details of the selected listing will be displayed accordingly.	Pass
UAT-006	Send Messages	7. Start a chat with the real estate agent of a selected property listing. 8. Send him/her a message.	4. Any form of text message.	The message that was sent is updated within the chat room.	Pass
UAT-007	Send Images	7. Start a chat with the real estate agent of a selected property listing. 8. Send him/her an image through chat.	4. Any image from the phone gallery.	The image that was sent is updated within the chat room.	Pass
UAT-008	Schedule Appointments	13. Start a chat with the real estate agent of a selected property listing. 14. Tap on the "Three Dots" icon	7. Any desired date (For example, 15 September 2021). 8. Any desired time (For	The appointment will be scheduled successfully, and the appointments list on your profile will be	Pass

		located on the top right corner of the screen. 15. Specify a date and time of the desired appointment. 16. Tap on the "Confirm" button to schedule the appointment.	example, 3:30 p.m.).	updated.	
UAT-009	Virtual Tour	7. Tap on a particular property listing. 8. Tap on the "Virtual Tour" button.	N/A.	Navigate around the virtual tour to view the property. Also, try changing to a different room to view it as well.	Pass
UAT-010	Favourite A Property Listing	7. Tap on a particular property listing. 8. Tap on the "Heart" icon located on the top right corner of the interface.	N/A.	View the favourited property listing being updated in the favourites list on your profile.	Pass
UAT-011	View Real Estate Agent Details	13. Click on the Agents tab on the bottom navigation bar. 14. Select any real estate agent's category from the list. 15. Select any real estate agent	N/A.	All details of the real estate agent were displayed correctly.	Pass

		that is displayed on screen. 16. View all details of the selected real estate agent.			
UAT-012	Logout	7. Click on the Profile tab on the bottom navigation bar. 8. Tap on the "Logout" button.	N/A.	You'll be logged out from the application and be redirected to the login page.	Pass
UAT-013	Manage Appointments	10. Login to a Real Estate Agent's account. 11. Open the list of all the scheduled appointments. 12. Accept or Decline a particular appointment.	4. Use the following login credentials: • E-Mail: lilylim@gmail.com • Password: 123456	Verify that the appointment's status is updated correctly according to your actions.	Pass
UAT-014	Publish New Property Listing	16. Click on the Profile tab on the bottom navigation bar. 17. Tap on the "+" button. 18. Tap on the "House" button. 19. Fill in all of the required information. 20. Click on the "Submit" button.	7. For the input fields, fill in any information without leaving any one of them empty. 8. For the images, select any number of images from the photo gallery without leaving them empty.	A "Listing Published !" alert message will be displayed indicating that the new listing was published successfully.	Pass

User Acceptance Testing (UAT) Test Form					
Participant No.: 5	**Date: 31st August 2021**		**Start Time: 12:55 PM**	**End Time: 01:25 PM**	
Test Case ID	**Test Module**	**Test Scenario**	**Test Data**	**Expected Results**	**Status (Pass/Fail)**
UAT-001	Account Registration	13. Tap on “Sign Up” button. 14. Fill in all the required information. 15. Tap on the “Sign Up” button.	9. Valid e-mail address. 10. Password with a minimum of 6 characters.	A “Sign Up Successful !” alert message indicating that the user has successfully created an account.	Pass
UAT-002	Login	9. Enter e-mail and password. 10. Tap on the “Login” button.	5. Existing account with valid e-mail and password.	A "Login Successful !" alert message, indicating that the process was successful.	Pass
UAT-003	Search Using Text	13. Tap on the Search Bar. 14. Type in a location to search for property listings. 15. Tap on the "Search" icon.	5. Any valid location, such as “Cheras”. Otherwise, no results will be displayed.	Results of the search was displayed accordingly.	Pass
UAT-004	Search Using Maps	17. Click on the Maps tab on the bottom navigation bar. 18. Tap on the search bar.	5. Any valid location, such as “Bandar Kinrara 5”. Otherwise, no results will	All available property listings within the specified area will be	Pass

		19. Enter a valid district, street address or other valid location addresses. 20. Tap on the intended search location.	be displayed.	displayed accordingly.	
UAT-005	View Property Listing Details	9. Tap on a particular property listing. 10. View the listing's details.	N/A.	Details of the selected listing will be displayed accordingly.	Pass
UAT-006	Send Messages	9. Start a chat with the real estate agent of a selected property listing. 10. Send him/her a message.	5. Any form of text message.	The message that was sent is updated within the chat room.	Pass
UAT-007	Send Images	9. Start a chat with the real estate agent of a selected property listing. 10. Send him/her an image through chat.	5. Any image from the phone gallery.	The image that was sent is updated within the chat room.	Pass
UAT-008	Schedule Appointments	17. Start a chat with the real estate agent of a selected property listing. 18. Tap on the "Three Dots" icon	9. Any desired date (For example, 15 September 2021). 10. Any desired time (For	The appointment will be scheduled successfully, and the appointments list on your profile will be	Pass

		located on the top right corner of the screen. 19. Specify a date and time of the desired appointment. 20. Tap on the "Confirm" button to schedule the appointment.	example, 3:30 p.m.).	updated.	
UAT-009	Virtual Tour	9. Tap on a particular property listing. 10. Tap on the "Virtual Tour" button.	N/A.	Navigate around the virtual tour to view the property. Also, try changing to a different room to view it as well.	Pass
UAT-010	Favourite A Property Listing	9. Tap on a particular property listing. 10. Tap on the "Heart" icon located on the top right corner of the interface.	N/A.	View the favourited property listing being updated in the favourites list on your profile.	Pass
UAT-011	View Real Estate Agent Details	17. Click on the Agents tab on the bottom navigation bar. 18. Select any real estate agent's category from the list. 19. Select any real estate agent	N/A.	All details of the real estate agent were displayed correctly.	Pass

		that is displayed on screen. 20. View all details of the selected real estate agent.			
UAT-012	Logout	9. Click on the Profile tab on the bottom navigation bar. 10. Tap on the "Logout" button.	N/A.	You'll be logged out from the application and be redirected to the login page.	Pass
UAT-013	Manage Appointments	13. Login to a Real Estate Agent's account. 14. Open the list of all the scheduled appointments. 15. Accept or Decline a particular appointment.	5. Use the following login credentials: • E-Mail: lilylim@gmail.com • Password: 123456	Verify that the appointment's status is updated correctly according to your actions.	Pass
UAT-014	Publish New Property Listing	21. Click on the Profile tab on the bottom navigation bar. 22. Tap on the "+" button. 23. Tap on the "House" button. 24. Fill in all of the required information. 25. Click on the "Submit" button.	9. For the input fields, fill in any information without leaving any one of them empty. 10. For the images, select any number of images from the photo gallery without leaving them empty.	A "Listing Published !" alert message will be displayed indicating that the new listing was published successfully.	Pass

Appendix I: Feedback for Project I

Project title:	Mobile Based Real Time Property/Land For Sale viewing Using Google Map and Communication Tool For Buyer and Client/Real Estate Agent
Student Name	BENJAMIN LEONG E-JENN
Supervisor	Dr Sugumaran a/l Nallusamy
Moderator	Ts Dr Maythem Kamal Abbas Al-Adilee

Key Assessment for Project Proposal	Supervisor Comments/Remarks	Moderator Comments/Remarks
Project Description - Is the problem or need to be addressed clearly presented? - Is the proposed approach or solution clearly presented and justified?	**None**	**Please, be more specific in stating what problem you are trying to solve.**
Project Scope and Objectives - Is the scope of the project clearly defined? - Are the objectives of the project clearly specified? - Are the project scope and objectives appropriate for a final year project?	**None**	**None**
Literature Review / Fact Finding for Benchmarking / Verification of Project - Are sources for literature review / fact finding appropriate? - Is information from literature review / fact finding relevant and adequate? - Is information from literature review / fact finding clearly presented and discussed?	**None**	**Please, add some benchmark comparison between the existing related systems/applications that you can use at the end of your dissertation to evalutate your developed system/application's features against others.**
Research/Development Methodology and Development Tools - Is the methodology for the project clearly described and discussed? - Are the required development tools clearly described and discussed? - Are the stated methodology and development tools appropriate?	**None**	**None**
Project Plan - Are the phases and tasks of the project properly defined and planned? - Are the phases and tasks consistent with the methodology of the project?	**Suggest to plan the development accordingly as there are a quite number of requirements to be implement.**	**Please, include the sample size calculation and sampling criteria in your final dissertation.**
Initial Deliverables - Are deliverables (e.g. use case diagrams and descriptions) of initial phases of the project plan included in the report?	**None**	**None**
Report Structure and References - Is the report organised in a logical structure? - Are references listed in accordance to Harvard format?	**None**	[redacted]
Language and Clarity of Writing - Are the sentences concise and understandable? - Are there spelling and grammar issues?	**None**	